Geotechnical Investigation

Proposed Institutional Building

6600 Carrière Street
Ottawa, Ontario

Prepared for Mouvement d'Implication Francophone d'Orléans

Report PG3694-1 Revision 2 dated April 29, 2025

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Résumé Analytique

Il est de notre compréhension que le Mouvement d'Implication Francophone d'Orléans (MIFO) convoite de la démolition de l'édifice et la construction d'un nouveau bâtiment de deux (2) étages sur l'est du site.

Une étude géotechnique a été réalisé dans le but de déterminer la nature et les propriétés géotechniques en vue de la construction des bâtiments proposés. Les travaux sur le terrain se sont déroulés le 3 décembre 2018 et ont consisté de trois (3) forages d'une profondeur de maximal 6 m.

La stratigraphie rencontrée au site sont décrites dans le paragraphe suivant. Un sol organique, d'une épaisseur de 0.15 m, a été rencontré dans tous les forages. Un dépôt de sable silteux a été rencontrée sous le couvert organique ou le remblai. Sous le sable silteux, un dépôt d'argile silteuse a été rencontrée. Généralement, la portion supérieure consiste d'une croûte brune avec une consistance raide et une épaisseur variante de 3 à 3.5 m. Une argile grise a été retrouvée sous la croûte argileuse brune de consistance molle à ferme. L'épaisseur du dépôt argileux à l'emplacement du forage BH 2-16 est plus de 30.5 m. Selon une carte géologique de la région, le socle rocheux se retrouve à une profondeur variante entre 25 et 50 m. Le niveau de l'eau souterraine a été mesuré à une profondeur approximative de 2.9 m à 5.2 m.

Compte tenu des résultats des forages, le sol peut supporter les charges transmises par des semelles conventionelles. La capacité portante pour les fondations conventionnelles prenant appui dans le dépôt naturel d'argile silteuse sont 150 kPa a l'état limite en service (ELS) et 225 kPa a l'état limite ultime (ELU). Les capacités donnés s'applique à des semelles d'une largeur maximale de 4 m et à des semelles filantes de largeur maximal de 2 m.

La catégorie d'emplacement sismique du site est de "Classe X_{227}". Les sols du site ne sont pas liquéfiables sous une forte décharge sismique.

Ce rapport présente des recommandations additionnelles pertinentes à la conception des fondations du bâtiment.

Ce rapport a été préparé spécifiquement et seulement pour le Mouvement d'Implication Francophone d'Orléans (MIFO). Toute modification au projet doit être signalée à Paterson Group, afin que la portée et la pertinence de la reconnaissance géotechnique et des recommandations contenues dans ce rapport puissent être réexaminées et modifiées, le cas échéant.

1.0 Introduction

Paterson Group (Paterson) was commissioned by Mouvement d'Implication Francophone d'Orléans (MIFO) to conduct a geotechnical investigation for the propossed development to be located at 6600 Carrière Street in the City of Ottawa, Ontario (refer to Figure 1 - Key Plan in Appendix 2 of this report).

The objective of the geotechnical investigation was to:

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

- ❑ Provide geotechnical recommendations pertaining to the 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.

2.0 Proposed Development

Based on the available drawings, proposed development consists of an institutional building with a slab-on-grade. Associated asphalt-paved access lanes and parking areas with landscaped margins will immediately surround the proposed building. It is further understood that the existing building will be demolished prior to the new construction.

Additionally, it is also anticipated that proposed development will be municipally serviced.

3.0 Method of Investigation

3.1 Field Investigation

Field Program

The field program for the current geotechnical investigation consisted of 3 boreholes drilled to a maximum depth of 6 m on December 3, 2018. The borehole locations were determined in the field by Paterson personnel and distributed in a manner to provide general coverage of the proposed building location taking into consideration site features and underground utilities.

A previous geotechnical investigation consisted of 3 boreholes (BH1-16 through BH3-16) completed at the subject site on June 3, 2016, which were advanced to a depth of 6.7 m. The approximate locations of the test pits are shown in Drawing PG3694-1- Test Hole Location Plan, included in Appendix 2.

The boreholes were advanced using a truck-mounted auger drill rig operated by a two-person crew. All fieldwork was conducted under the full-time supervision of our personnel under the direction of a senior engineer. The drilling procedure consisted of augering to the required depths at the selected locations, and sampling and testing the overburden.

Sampling and In Situ Testing

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

The 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

Undrained shear strength testing was conducted at regular intervals in cohesive soils and completed using an MTO field vane apparatus.

The overburden thickness was evaluated by a dynamic cone penetration test (DCPT) at borehole BH 2-16. The DCPT consists of driving a steel drill rod, equipped with a 50 mm diameter cone at the 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

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

Groundwater

Flexible standpipes were installed in the boreholes during the field investigation to permit monitoring of the groundwater levels subsequent to the completion of the sampling program.

3.2 Field Survey

The test holes completed during the current field investigation were selected in the field and surveyed by Paterson. The ground surface elevations at the test hole locations were referenced to a temporary benchmark (TBM), consisting of the rim of a manhole located on Carrière Street with an elevation of 86.30 m, which is understood to be referenced to a geodetic datum.

The location of the TBM, test hole locations and ground surface elevation at each test hole location are presented on Drawing PG3694-2 - Test Hole Location Plan in Appendix 2.

3.3 Laboratory Review

Soil and samples were recovered from the subject site and visually examined in our laboratory to review the results of the field logging. All samples will be stored in the laboratory for one month after this report is completed. They will then be discarded unless otherwise directed.

3.4 Analytical Testing

1 soil sample was submitted by others 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 samples. The results are presented in Appendix 1 and are discussed further in Section 6.7

4.0 Observations

4.1 Surface Conditions

Currently, the subject site is occupied by a 1½ storey, slab-on-grade building with associated landscaped areas and asphalt-paved car parking and access lanes. An existing cellular tower and maintenance shed are located at the southwest and west portion of the site, respectively.

The site is bordered by Carrière Street to the north and school properties to the east, south, and west. The site is relatively level at geodetic elevation 86 to 87m, and is approximately at grade with neighbouring properties and adjacent roadways.

4.2 Subsurface Profile

Overburden

Generally, the subsoil conditions encountered at the borehole locations consist of a topsoil or pavement structure overlying a thin layer of silty sand extending to approximate depths of 0.5 to 0.6 m.

A silty clay deposit was encountered underlying the silty clay. The upper portion consists of a stiff, brown silty clay crust, which becomes a firm, grey silty clay at approximate depths of 2.9 to 3.7 m below the existing ground surface.

The overburden thickness was evaluated during the course of the investigation by completing a DCPT at borehole BH 2-16. The DCPT was terminated in the silty clay at an approximate depth of 30.5 m below the existing ground surface.

Reference should be made to the Soil Profile and Test Data sheets attached to the present report for specific details of the soil profile encountered at the borehole locations.

Bedrock

Based on available geological mapping, the bedrock in the area of the subject site consists of interbedded quartz sandstone, shaly limestone and shale with drift thicknesses expected to range between 25 and 50 m depth.

4.3 Groundwater

Based on our field observations and recovered soil samples' moisture levels, consistency and colouring, the long-term groundwater is expected to be between 3 to 4 m depth below existing ground surface. Groundwater levels are subject to seasonal fluctuations and therefore, the groundwater levels could vary at the time of construction.

Table 1 - Summary of Groundwater Levels

Test Hole Number	Ground Surface Elevation (m)	Measured Groundwater Levels		Dated Recorded
		Depth (m)	Elevation (m)	
BH 1-18	86.86	3.7	83.16	December 7, 2018
BH 2-18	86.80	2.9	83.90	December 7, 2018
BH 3-18	86.84	5.8	81.04	December 7, 2018
BH 1-16	87.27	4.61	82.66	June 14, 2016
BH 2-16	87.20	5.15	82.05	June 14, 2016
BH 3-16	86.84	4.65	82.19	June 14, 2016

Notes: The ground surface at the test hole locations was referenced to a (TBM) consisting of a storm manhole located on Carrière Street with an elevation of 86.30 m ,which is understood to be referenced to a geodetic datum.

5.0 Discussion

5.1 Geotechnical Assessment

From a geotechnical perspective, the subject site is considered adequate for the proposed building. The proposed building is recommended to be founded on conventional spread footings placed on an undisturbed, stiff brown silty clay bearing surface.

Due to the presence of a silty clay layer, the proposed development will be subjected to grade raise restrictions. Our permissible grade raise recommendations are discussed in Section 5.3.

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

5.2 Site Grading and Preparation

Stripping Depth

Topsoil, asphalt and deleterious fill, such as those containing organic materials, should be stripped from under the proposed building sand settlement sensitive structures.

Existing foundation walls and other construction debris should be entirely removed from within the footprints of the proposed buildings and paved areas.

Fill Placement

Fill used for grading beneath the proposed building footprint, unless otherwise specified, should consist of clean imported granular fill, such as Ontario Provincial Standard Specifications (OPSS) Granular A or Granular B Type II.

The fill should be tested and approved prior to delivery to the site. The fill should be placed in lifts no greater than 300 mm in thickness and compacted using suitable compaction equipment for the lift thickness. Fill placed beneath the building should be compacted to at least 98% of the standard Proctor maximum dry density (SPMDD).

Non-specified existing fill along with site excavated soil can be used as general landscaping fill where settlement of the ground surface is of minor concern. 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 used to build up the subgrade level for areas to be paved, the non-specified existing fill should be compacted in thin lifts to a minimum density of 95% of the respective SPMDD. Non-specified existing fill and site-excavated soils are not suitable for use as backfill against foundation walls, unless used in conjunction with a composite drainage system.

5.3 Foundation Design

Bearing Resistance Values

Strip footings, up to 2 m wide, and pad footings, up to 4 m wide, placed on an undisturbed, stiff silty clay bearing surface can be designed using a bearing resistance value at serviceability limit states (SLS) of **150 kPa** and a factored bearing resistance value at ultimate limit states (ULS) of **225 kPa**.

A geotechnical resistance factor of 0.5 was applied to the above noted bearing resistance value at ULS.

Footings designed using the above-noted bearing resistance value at SLS provided will be subjected to potential post construction total and differential settlements of 25 and 20 mm, respectively.

An undisturbed soil bearing surface consists of a surface 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.

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. Adequate lateral support is provided to a soil bearing medium when a plane extending down and out from the bottom edge of the footing at a minimum of 1.5H:1V, passes only through in situ soil or engineered fill of the same or higher capacity as the soil.

Permissible Grade Raise Restrictions

It is expected that a permissible grade raise of **0.5 m** will be sufficient for the proposed building. This is considered acceptable, from a geotechnical perspective.

5.4 Design for Earthquakes

Shear wave velocity testing was completed for the subject site to determine the applicable seismic site designation for the proposed buildings in accordance with Table 4.1.8.4 of the Ontario Building Code 2024. The shear wave velocity testing was completed by Paterson personnel. The results of the shear wave velocity test are provided in Figures 2 and 3 in Appendix 2 of the present report.

Field Program

The seismic array testing location was placed at the southern end of the site in an approximate east-west direction as presented on Drawing PG3694-1 - Test Hole Location Plan in Appendix 2. Paterson field personnel placed 18 horizontal 2.4 Hz. geophones mounted to the surface by means of two 75 mm ground spikes attached to the geophone land case. The geophones were spaced at 2 m intervals and connected by a geophone spread cable to a Geode 24 Channel seismograph. The seismograph was also connected to a computer laptop and a hammer trigger switch attached to a 12-pound dead blow hammer. The hammer trigger switch sends a start signal to the seismograph.

The hammer is used to strike an I-Beam seated into the ground surface, which creates a polarized shear wave. The hammer shots are repeated between 4 and 8 times at each shot location to improve signal to noise ratio.

The shot locations are also completed in forward and reverse direction (i.e.- striking both sides of the I-Beam seated parallel to the geophone array). The shot locations were 3 and 2 m away from the first geophone, 2, 3, and 14 m away from the last geophone, and at the centre of the seismic array.

Data Processing and Interpretation

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

The interpretation is repeated at each shot location to provide an average shear wave velocity, Vs30, of the upper 30 m profile, immediately below the building's foundation. The layer intercept times, velocities from different layers, and critical distances are interpreted from the shear wave records to compute the bedrock depth at each location.

It should be noted that due to the bedrock depth, the seismic survey testing results did not trace a refraction from the underlying rock. For the purpose of defining the appropriate seismic site classification according to OBC 2024, the subsurface profile was conservatively taken as consisting of a 30 m deep deposit of overburden.

Based on our testing results, the average overburden shear wave velocity is **227 m/s**. Accordingly, the VS30 was calculated using the standard equation for average shear wave velocity provided in the OBC 2012, and as presented below:

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

$$V_{s30} = \frac{30m}{\left(\frac{30m}{227\,m/s}\right)}$$

$$V_{s30} = 227\,m/s$$

Based on the results of the shear wave velocity testing, the average shear wave velocity, V_{s30}, for the proposed building is **227 m/s**. Therefore, as per OBC 2024 a **Site Designation X_{227}** is applicable for the design of the proposed structure within the subject site.

Soils underlying the subject site are not susceptible to liquefaction. Reference should be made to the latest version of the OBC 2024 for a full discussion of the earthquake design requirements.

5.5 Slab-on-Grade Construction

With the removal of the topsoil and deleterious fill, containing organic material, within the footprint of the proposed building, the native soil surface will be considered to be an acceptable subgrade on which to commence backfilling for floor slab construction.

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 should be placed in maximum 300 mm thick loose layers and compacted to at least 98% of its SPMDD.

It is recommended that the upper 200 mm of sub-slab fill consist of an OPSS Granular A crushed stone for slab-on-grade construction.

5.6 Pavement Design

The pavement structures for car only parking areas, heavy truck parking areas and access lanes are presented in Tables 2 and 3 on the following page, should they be required at the subject site.

Table 2 - Recommended Pavement Structure - Car Only Parking Areas	
Thickness (mm)	**Material Description**
50	**Wear Course** - HL 3 or Superpave 12.5 Asphaltic Concrete
150	**BASE** - OPSS Granular A Crushed Stone
300	**SUBBASE** - OPSS Granular B Type II
SUBGRADE - Either fill, in situ soil or OPSS Granular B Type I or II material placed over in situ fill, soil or bedrock.	

Table 3 - Recommended Pavement Structure - Access Lanes and Heavy Truck Parking Areas	
Thickness (mm)	**Material Description**
40	**Wear Course** - HL-3 or Superpave 12.5 Asphaltic Concrete
50	**Binder Course** - HL-8 or Superpave 19.0 Asphaltic Concrete
150	**BASE** - OPSS Granular A Crushed Stone
450	**SUBBASE** - OPSS Granular B Type II
SUBGRADE - Either fill, in situ soil or OPSS Granular B Type I or II material placed over in situ fill, soil or bedrock.	

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

If soft spots develop in the subgrade during compaction or due to construction traffic, the affected areas should be sub-excavated and replaced with OPSS Granular B 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 SPMDD with suitable vibratory equipment.

The pavement structure, where it abuts the existing pavement, should match the existing pavement layers. It is recommended that a 300 mm wide and 50 mm deep stepped joint be provided where the new asphaltic layer joins with the existing asphaltic layer to provide more resistance to reflective cracking at the joint.

Clean existing granular road subbase materials can be reused upon assessment by the geotechnical consultant at the time of excavation (construction) as to its suitability under the current specifications.

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.

Due to the impervious nature of the subgrade materials consideration should be given to installing subdrains during the pavement construction. These drains should extend in four orthogonal directions or longitudinally when placed along a curb. The clear crushed stone surrounding the drainage lines or the pipe, should be wrapped with suitable filter cloth. The subdrain inverts should be approximately 300 mm below subgrade level. The subgrade surface should be shaped to promote water flow to the drainage lines.

6.0 Design and Construction Precautions

6.1 Foundation Drainage and Backfill

Since the building will consist of slab-on-grade construction, a perimeter foundation drainage system is considered optional throughout the portions of the proposed building footprint where the exterior finished surface will consist of landscaping. In areas where hard-scaping or pavement structures will abut the building footprint, it is recommended to implement a foundation drainage system. The system should consist of a 150 mm diameter perforated corrugated plastic pipe wrapped in a geosock and surrounded on all sides by 150 mm of 19 mm clear crushed stone. The clear stone should be wrapped in a non-woven geotextile. The pipe should have a positive outlet, such as a gravity connection to the storm sewer.

The pipe should be placed at the footing level around the exterior perimeter of the structure if the backfill between the founding depth and finished grade will consist of crushed stone fill or site-generated soil backfill placed in conjunction with a composite foundation drainage board.

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 composite drainage system, such as Miradrain 6000 or Delta Drain 6000. Imported granular materials, such as clean sand or OPSS Granular B Type I granular material, should be used for backfill material.

6.2 Protection of Footings Against Frost Action

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

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

6.3 Excavation Side Slopes

The side slopes of excavations in the soil and fill overburden materials should either be cut back at acceptable slopes or should be retained by shoring systems from the start of the excavation until the structure is backfilled. It is assumed that sufficient room will be available for the excavation to be undertaken by open-cut methods (i.e., unsupported excavations).

The excavation side slopes above the groundwater level extending to a maximum depth of 3 m should be cut back at 1.5H:1V or flatter. The flatter slope is required for excavation below groundwater level. The subsoil at this site is considered to be mainly a Type 3 and 4 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 be kept away from the excavation sides.

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

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

6.4 Pipe Bedding and Backfill

Bedding and backfill materials should be in accordance with the most recent Material Specifications and 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 a soil subgrade. If the bedding is placed on stiff to firm silty clay, the thickness of the bedding should be increased to 300 mm for sewer pipes. The bedding should extend to the spring line of the pipe.

It should generally be possible to re-use the site materials above the cover material if the operations are carried out in dry weather conditions.

Where hard surface areas are considered above the trench backfill, the backfill material within the frost zone (about 1.8 m below finished grade) and above the cover material should match the soils exposed at the trench walls to minimize differential frost heaving. The trench backfill should be placed in maximum 225 mm thick loose lifts and compacted to a minimum of 98% of the material's standard Proctor maximum dry density.

6.5 Groundwater Control

Groundwater Control for Building Construction

Based on the anticipated foundation elevation and our observations, it is anticipated that groundwater infiltration into the excavations should be low to moderate and controllable using open sumps. The contractor should be prepared to direct water away from all bearing surfaces and subgrades, regardless of the source, to prevent disturbance to the founding medium.

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

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.

6.6 Winter Construction

Precautions must be taken if winter construction is considered for this project. The subsoil conditions at this site consist of frost susceptible materials. In the 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 use of straw, propane heaters and tarpaulins or other suitable means. In this regard, the base of the excavations should be insulated from sub-zero temperatures immediately upon exposure and until such time as heat is adequately supplied to the building and the footings are protected with sufficient soil cover to prevent freezing at founding level.

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

6.7 Corrosion Potential and Sulphate

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

6.8 Landscaping Considerations

Tree Planting Restrictions

Based on the stiffness of the clay encountered at the borehole locations, high sensitivity clay soil is present throughout the subject site. Large trees (mature height over 14 m) can be planted within these areas provided a tree to foundation setback equal to the full mature height of the tree can be provided (e.g. in park or other green space). Tree planting setback limits are **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 that the following conditions are met:

- ❑ The underside of footing (USF) is 2.1 m or greater below the lowest finished grade must be satisfied for footings within 10 m from the tree, as measured from the center of the tree trunk and verified by means of the Grading Plan.

- ❑ A small tree must be provided with a minimum of 25 m^3 of available soil 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.

- The foundation walls are to be reinforced at least nominally (minimum of two upper and two lower 15M bars in the foundation wall).

- 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.

7.0 Recommendations

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

- ❑ Review detailed grading plan(s) from a geotechnical perspective.
- ❑ Observation of all bearing surfaces prior to the placement of concrete.
- ❑ 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.
- ❑ Field density tests to determine the level of compaction achieved.
- ❑ Sampling and testing of the bituminous concrete including mix design reviews.

A report confirming that these works have been conducted in general accordance with our recommendations could be issued upon the completion of a satisfactory inspection program by the geotechnical consultant.

All excess soils should be handled as per ***Ontario Regulation 406/19: On-Site and Excess Soil Management.***

8.0 Statement of Limitations

The recommendations provided are in accordance with the present understanding of the project. Paterson requests permission to review the recommendations when the drawings and specifications are completed.

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

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

The present report applies only to the project described in this document. Use of this report for purposes other than those described herein or by person(s) other than Mouvement d'Implication Francophone d'Orléans, or their agents, is not authorized without review by Paterson for the applicability of our recommendations to the alternative use of the report.

Paterson Group Inc.

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Report Distribution:

- ❑ Mouvement d'Implication Francophone d'Orléans (MIFO) (1 email copy)
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APPENDIX 1

SOIL PROFILE AND TEST DATA SHEETS

SYMBOLS AND TERMS

ANALYTICAL TESTING RESULTS

patersongroup Consulting Engineers

154 Colonnade Road South, Ottawa, Ontario K2E 7J5

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Proposed Building Expansion - 6600 Carriere Street
Ottawa, Ontario

DATUM TBM - Top of storm manhole. Geodetic elevation = 86.30m.

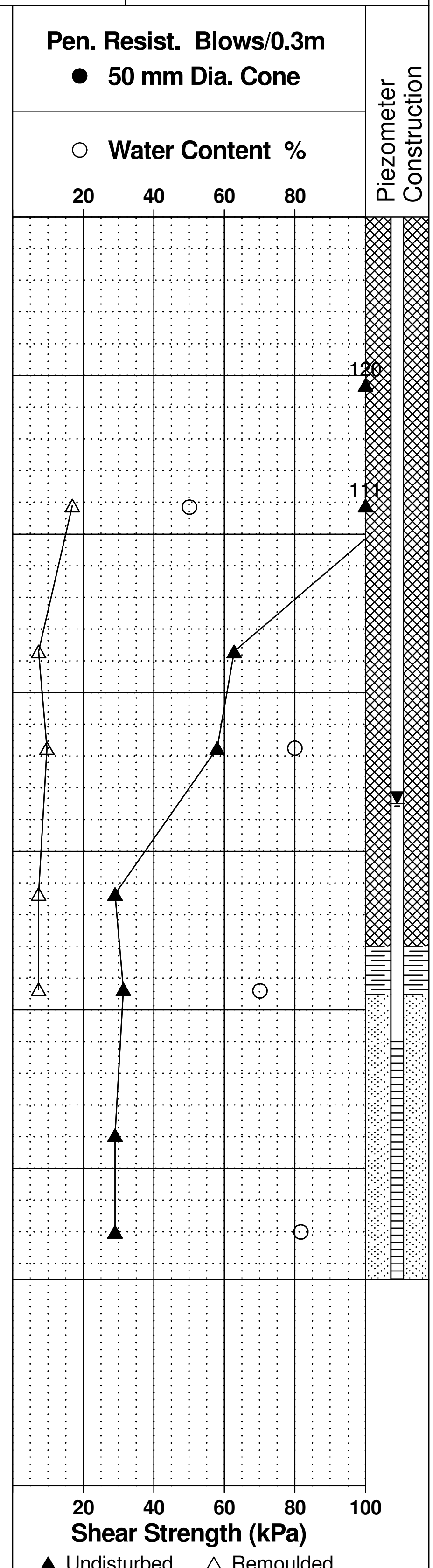
FILE NO. **PG3694**

REMARKS

HOLE NO. **BH 1-18**

BORINGS BY CME 55 Power Auger **DATE** December 3, 2018

SOIL DESCRIPTION	SAMPLE TYPE	NUMBER	% RECOVERY	N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE					0	86.86
Asphaltic concrete 0.05						
FILL: Crushed stone 0.46						
LOAM 0.76						
Very stiff to stiff, brown **SILTY CLAY**	AU	1			1	85.86
	SS	2	100	P	2	84.86
	SS	3	100	P	3	83.86
- firm and grey by 3.7m depth					4	82.86
	SS	4	100	P	5	81.86
	SS	5	100	P	6	80.86
6.70						
End of Borehole						
(GWL @ 3.70m - Dec. 7, 2018)						



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154 Colonnade Road South, Ottawa, Ontario K2E 7J5

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Proposed Building Expansion - 6600 Carriere Street
Ottawa, Ontario

DATUM TBM - Top of storm manhole. Geodetic elevation = 86.30m.

FILE NO. PG3694

REMARKS

HOLE NO. BH 2-18

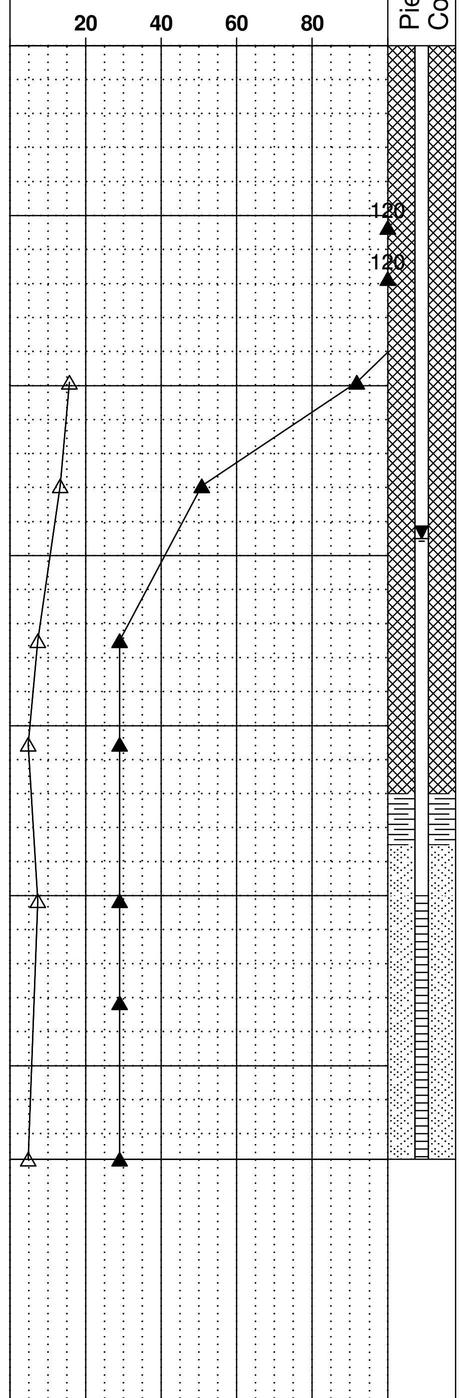
BORINGS BY CME 55 Power Auger

DATE December 3, 2018

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	NUMBER	% RECOVERY	N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	86.80
Asphaltic concrete — 0.05							
FILL: Crushed stone — 0.30							
Brown **SILTY SAND,** some clay — 0.60							
						1	85.80
Very stiff to stiff, brown **SILTY CLAY**						2	84.80
		SS	1	100	P		
- firm and grey by 3.0m depth						3	83.80
		SS	2	100	P	4	82.80
						5	81.80
		SS	3	100	P		
— 6.55						6	80.80
End of Borehole							
(GWL @ 2.90m - Dec. 7, 2018)							

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

○ Water Content %



Shear Strength (kPa)
▲ Undisturbed △ Remoulded

Piezometer Construction

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154 Colonnade Road South, Ottawa, Ontario K2E 7J5

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Proposed Building Expansion - 6600 Carriere Street
Ottawa, Ontario

DATUM TBM - Top of storm manhole. Geodetic elevation = 86.30m.

REMARKS

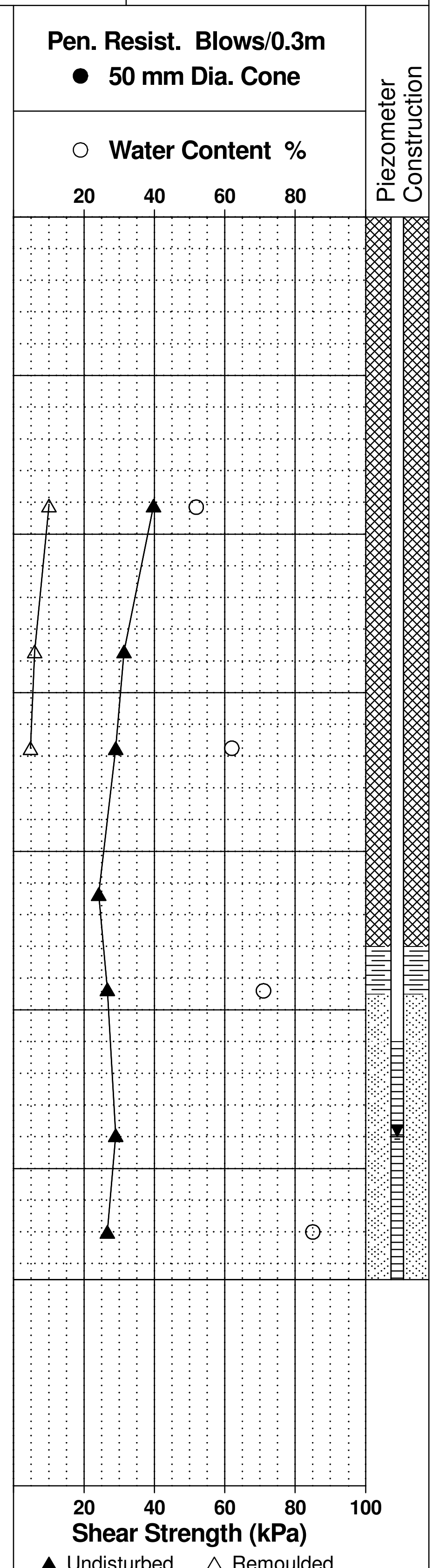
BORINGS BY CME 55 Power Auger

DATE December 3, 2018

FILE NO. PG3694

HOLE NO. BH 3-18

SOIL DESCRIPTION	Depth of stratum base (m)	SAMPLE TYPE	NUMBER	% RECOVERY	N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	86.84
Asphaltic concrete	0.05						
FILL: Crushed stone	0.30						
Brown **SILTY SAND** with clay	0.46	AU	1				
		SS	2	83	6	1	85.84
		SS	3	100	P	2	84.84
Firm, brown **SILTY CLAY**						3	83.84
		SS	4	100	P		
- grey by 3.7m depth						4	82.84
		SS	5	100	P	5	81.84
						6	80.84
	6.70	SS	6	100	P		
End of Borehole							
(GWL @ 5.80m - Dec. 7, 2018)							



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SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Proposed Building Expansion - 6600 Carriere Street
Ottawa, Ontario

DATUM TBM - Top of storm manhole. Geodetic elevation = 86.30m.

FILE NO. PG3694

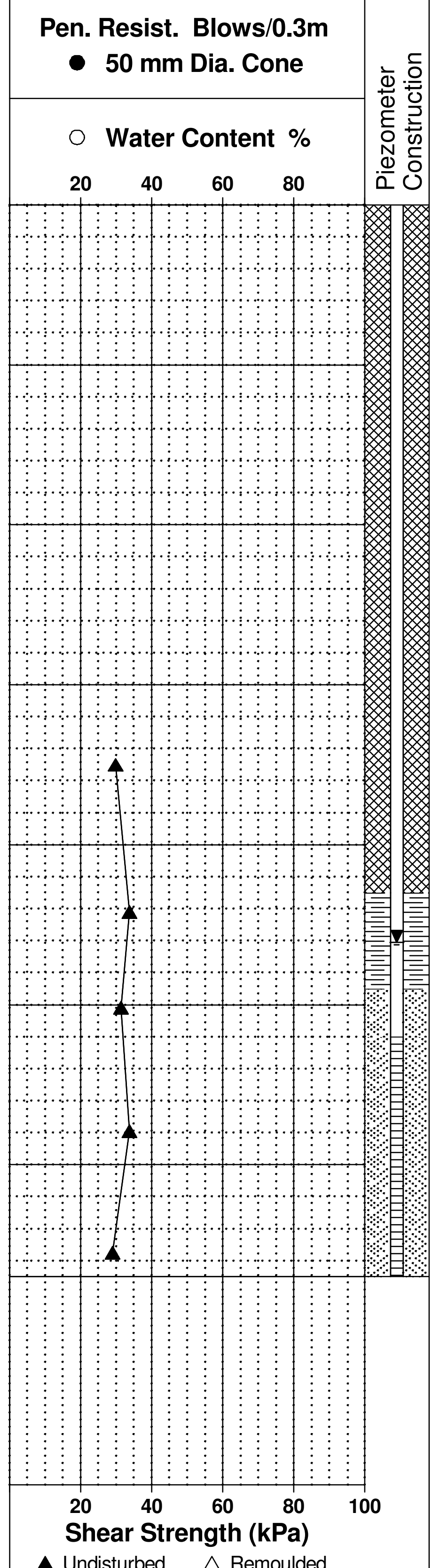
REMARKS

HOLE NO. BH 1-16

BORINGS BY CME-55 Low Clearance Drill

DATE June 3, 2016

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	NUMBER	% RECOVERY	N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	87.27
TOPSOIL 0.15							
Loose, brown **SILTY SAND,** some crushed stone, trace clay		AU	1				
0.91							
Stiff to firm, brown **SILTY CLAY**		SS	2	67	8	1	86.27
		SS	3	100	6	2	85.27
- grey by 2.9m depth		SS	4	0	4		
						3	84.27
						4	83.27
						5	82.27
						6	81.27
6.70 End of Borehole							
(GWL @ 4.61m-June 14, 2016)							



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154 Colonnade Road South, Ottawa, Ontario K2E 7J5

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Proposed Building Expansion - 6600 Carriere Street
Ottawa, Ontario

DATUM TBM - Top of storm manhole. Geodetic elevation = 86.30m.

REMARKS

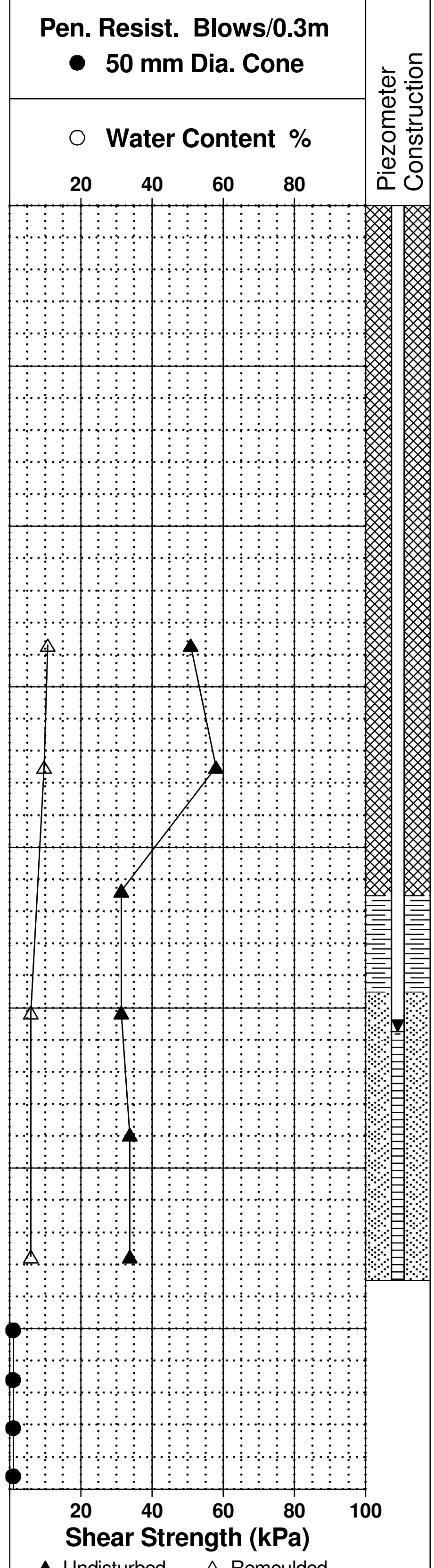
BORINGS BY CME-55 Low Clearance Drill

DATE June 3, 2016

FILE NO. PG3694

HOLE NO. BH 2-16

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	% RECOVERY	N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	87.20
TOPSOIL — 0.15							
Loose, brown **SILTY SAND,** some crushed stone, trace clay — 0.91							
		SS	1		8	1	86.20
		SS	2		8	2	85.20
Stiff to firm, brown **SILTY CLAY**						3	84.20
- grey by 3m depth						4	83.20
						5	82.20
						6	81.20
6.70							
Dynamic Cone Penetration Test commenced at 6.7m depth						7	80.20
						8	79.20



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SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Proposed Building Expansion - 6600 Carriere Street
Ottawa, Ontario

DATUM TBM - Top of storm manhole. Geodetic elevation = 86.30m.

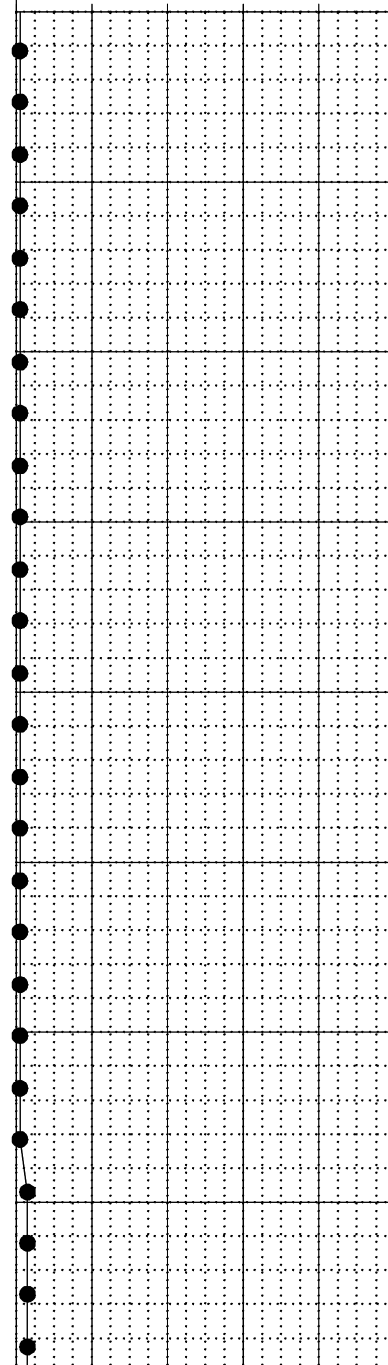
FILE NO. PG3694

REMARKS

HOLE NO. BH 2-16

BORINGS BY CME-55 Low Clearance Drill **DATE** June 3, 2016

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								20 40 60 80	
						8	79.20		
						9	78.20		
						10	77.20		
						11	76.20		
						12	75.20		
						13	74.20		
						14	73.20		
						15	72.20		
						16	71.20		



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SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Proposed Building Expansion - 6600 Carriere Street
Ottawa, Ontario

DATUM TBM - Top of storm manhole. Geodetic elevation = 86.30m.

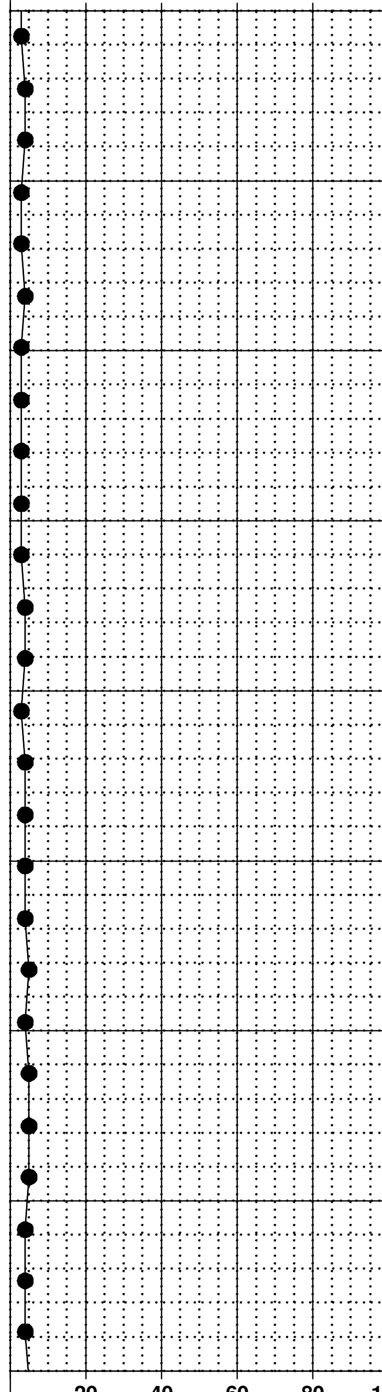
FILE NO. PG3694

REMARKS

HOLE NO. BH 2-16

BORINGS BY CME-55 Low Clearance Drill **DATE** June 3, 2016

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								20 40 60 80	
						16	71.20		
						17	70.20		
						18	69.20		
						19	68.20		
						20	67.20		
						21	66.20		
						22	65.20		
						23	64.20		
						24	63.20		



Shear Strength (kPa)

▲ Undisturbed △ Remoulded

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154 Colonnade Road South, Ottawa, Ontario K2E 7J5

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Proposed Building Expansion - 6600 Carriere Street
Ottawa, Ontario

DATUM TBM - Top of storm manhole. Geodetic elevation = 86.30m.

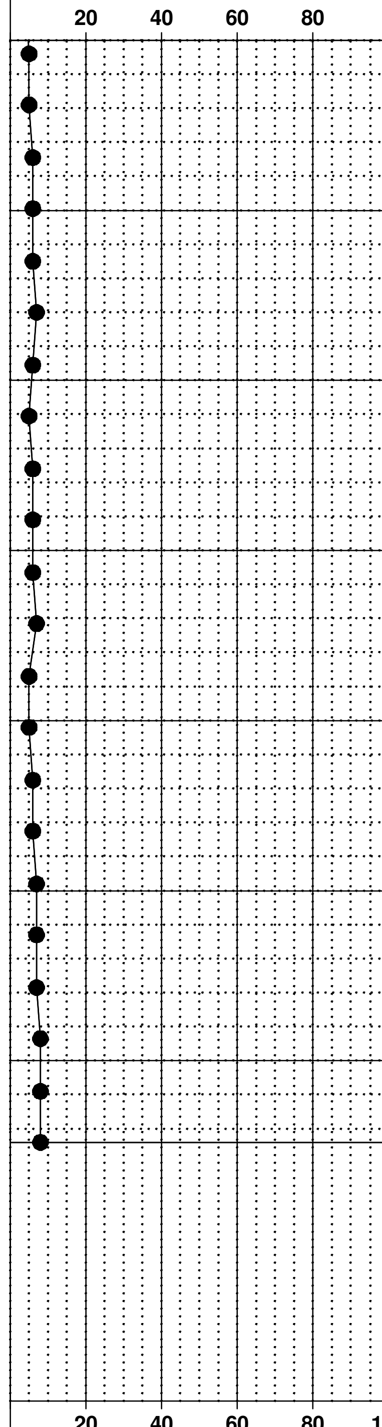
FILE NO. PG3694

REMARKS

HOLE NO. BH 2-16

BORINGS BY CME-55 Low Clearance Drill **DATE** June 3, 2016

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									
						24	63.20		
						25	62.20		
						26	61.20		
						27	60.20		
						28	59.20		
						29	58.20		
						30	57.20		
30.48									
End of Borehole Dynamic Cone Penetration Test terminated in inferred stiff grey silty clay at 30.48m depth (GWL @ 5.15m-June 14, 2016)									



Shear Strength (kPa)

▲ Undisturbed △ Remoulded

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154 Colonnade Road South, Ottawa, Ontario K2E 7J5

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Proposed Building Expansion - 6600 Carriere Street
Ottawa, Ontario

DATUM TBM - Top of storm manhole. Geodetic elevation = 86.30m.

REMARKS

BORINGS BY CME-55 Low Clearance Drill

DATE June 3, 2016

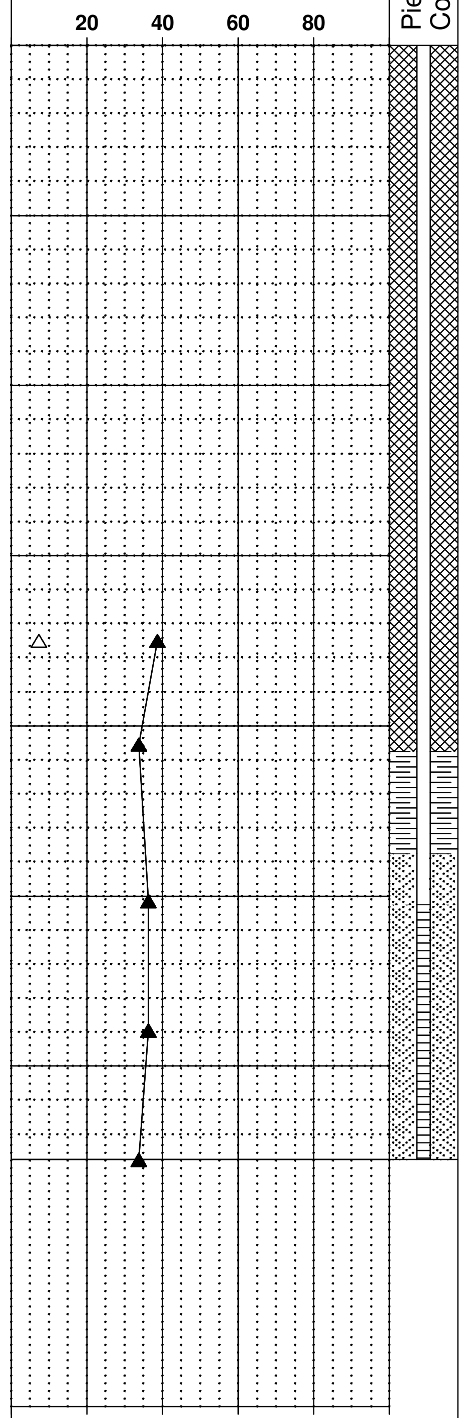
FILE NO. PG3694

HOLE NO. BH 3-16

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	% RECOVERY	N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	86.84
Asphaltic concrete 0.08							
FILL: Crushed stone 0.60							
Stiff, brown **SILTY CLAY,** some sand 1.45		AU	1		7	1	85.84
		SS	2		5	2	84.84
		SS	3		4		
Stiff to firm, brown **SILTY CLAY**						3	83.84
						4	82.84
- grey by 2.9m depth						5	81.84
6.55						6	80.84
End of Borehole							
(GWL @ 4.65m - June 14, 2016)							

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

○ Water Content %



Shear Strength (kPa)
▲ Undisturbed △ Remoulded

Piezometer Construction

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

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

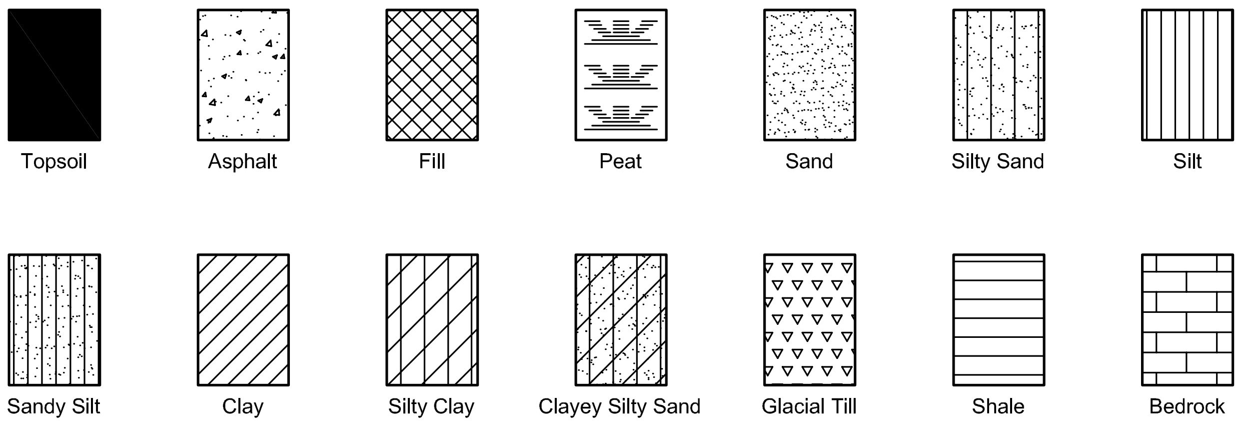
p'_o	-	Present effective overburden pressure at sample depth
p'_c	-	Preconsolidation pressure of (maximum past pressure on) sample
Ccr	-	Recompression index (in effect at pressures below p'_c)
Cc	-	Compression index (in effect at pressures above p'_c)
OC Ratio		Overconsolidaton ratio = p'_c / p'_o
Void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

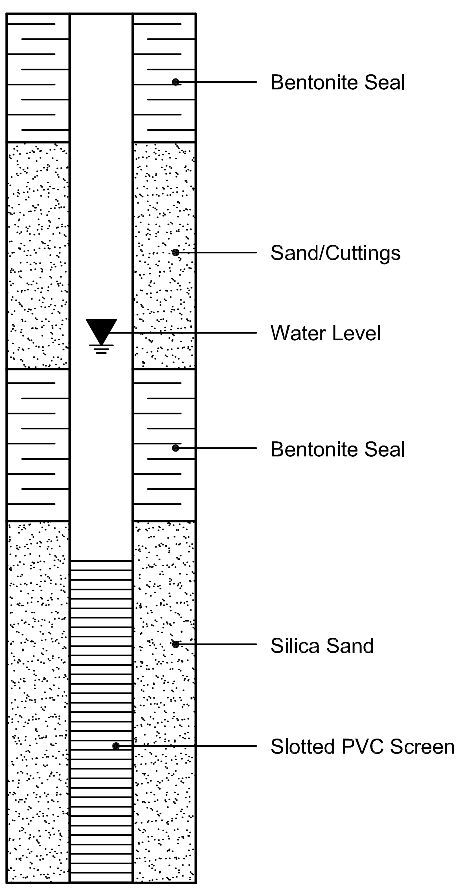
SYMBOLS AND TERMS (continued)

STRATA PLOT

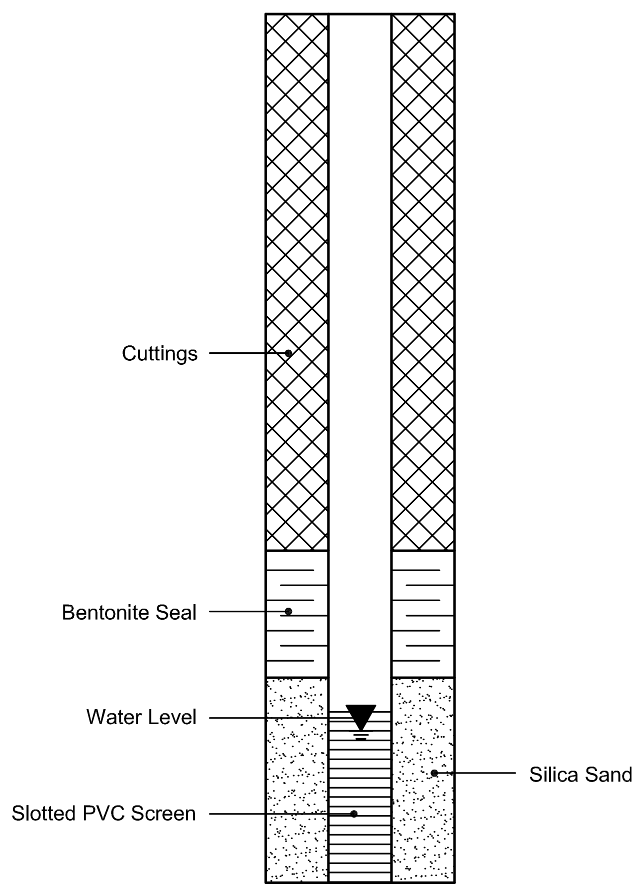


MONITORING WELL AND PIEZOMETER CONSTRUCTION

MONITORING WELL CONSTRUCTION



PIEZOMETER CONSTRUCTION



PARACEL LABORATORIES LTD.

Order #: 1623534

Certificate of Analysis

Client: Paterson Group Consulting Engineers

Client PO: 19878

Report Date: 09-Jun-2016

Order Date: 3-Jun-2016

Project Description: PG3694

	Client ID:	BH2 SS2	-	-	-
	Sample Date:	03-Jun-16	-	-	-
	Sample ID:	1623534-01	-	-	-
	MDL/Units	Soil	-	-	-
Physical Characteristics					
% Solids	0.1 % by Wt.	76.7	-	-	-
General Inorganics					
pH	0.05 pH Units	7.56	-	-	-
Resistivity	0.10 Ohm.m	57.5	-	-	-
Anions					
Chloride	5 ug/g dry	35	-	-	-
Sulphate	5 ug/g dry	54	-	-	-

APPENDIX 2

FIGURE 1 - KEY PLAN

FIGURE 2 & 3 - SEISMIC SHEAR WAVE VELOCITY PROFILES

DRAWING PG3694-1 – TEST HOLE LOCATION PLAN

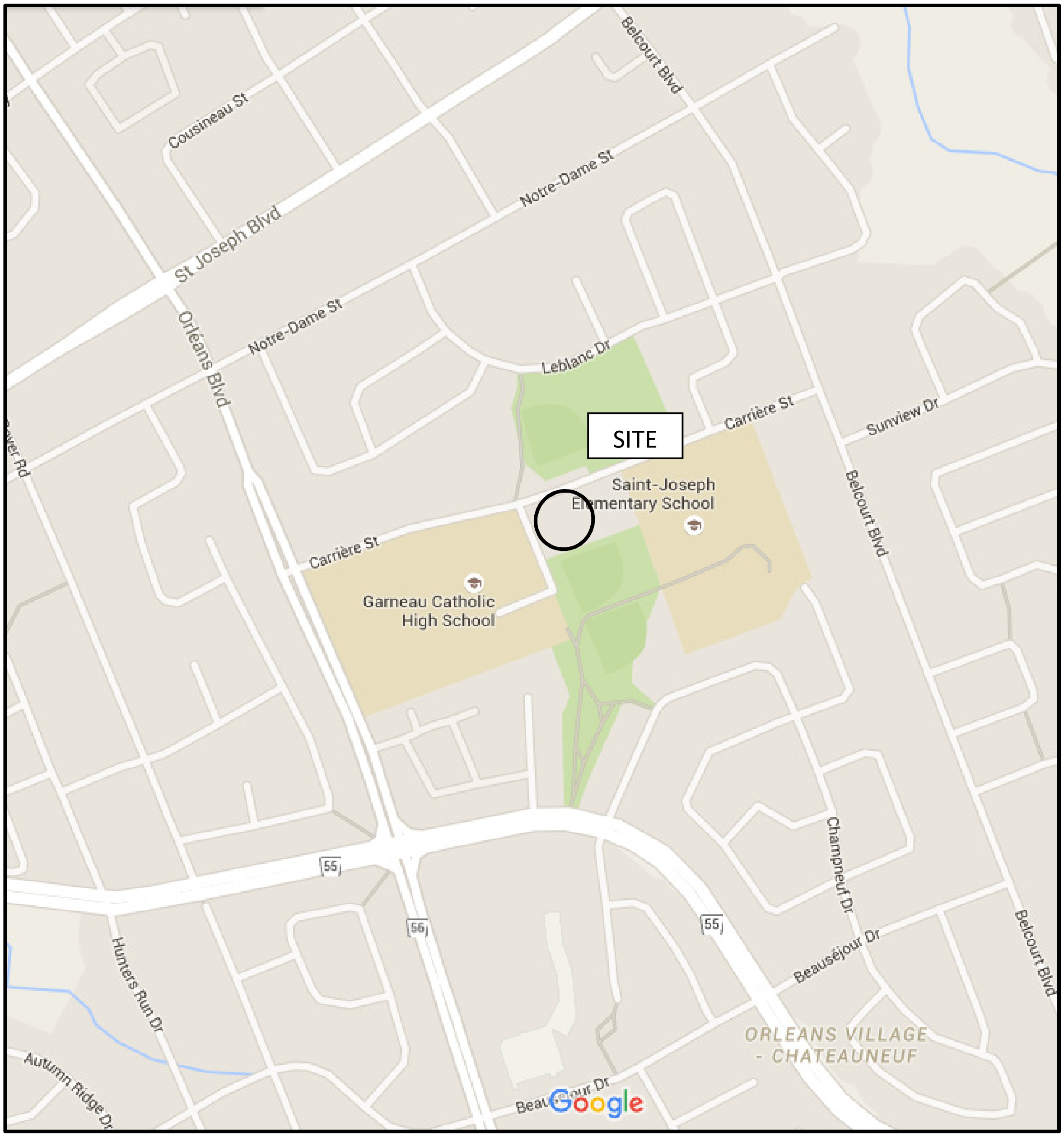


FIGURE 1

KEY PLAN

patersongroup

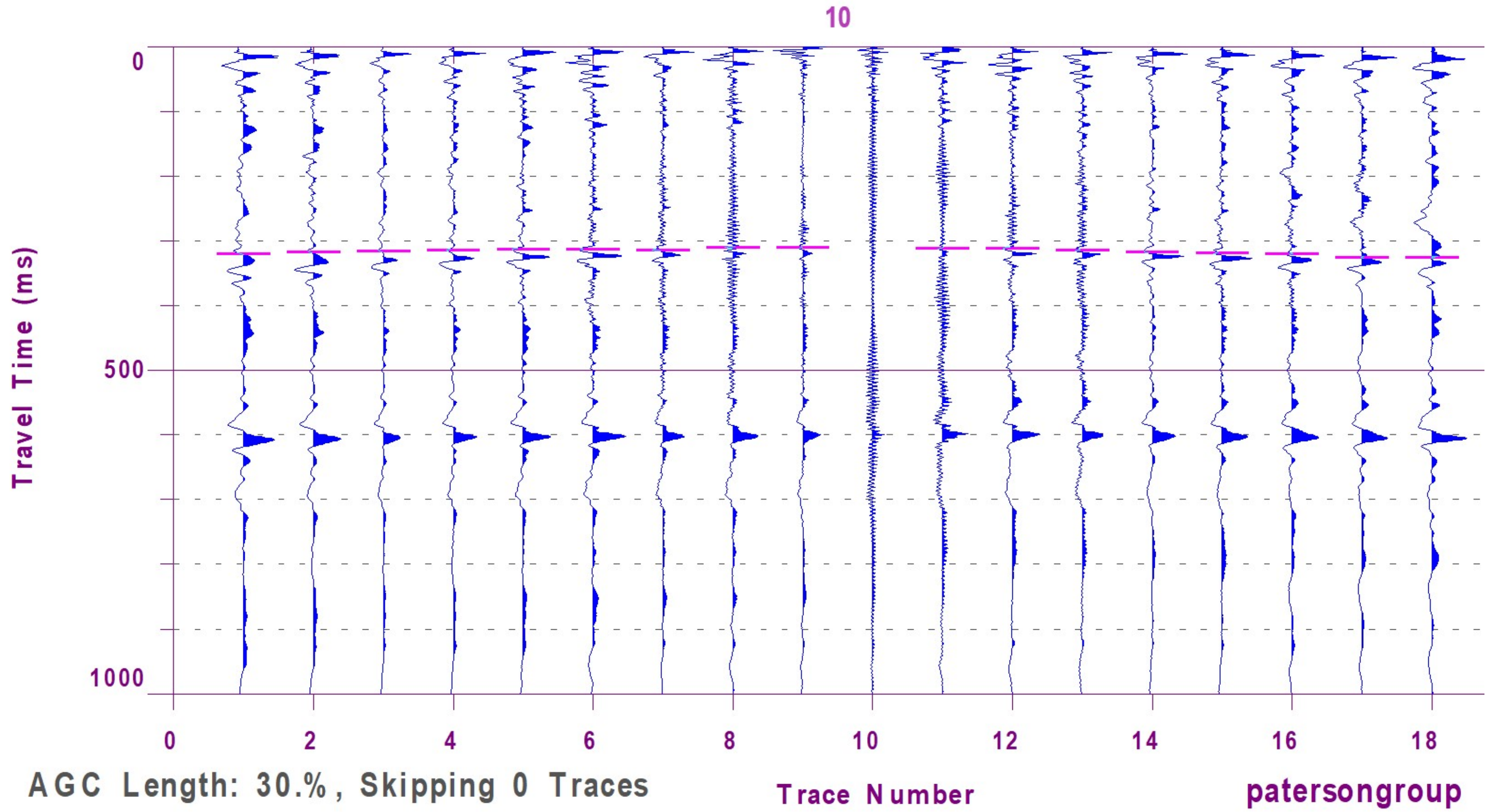
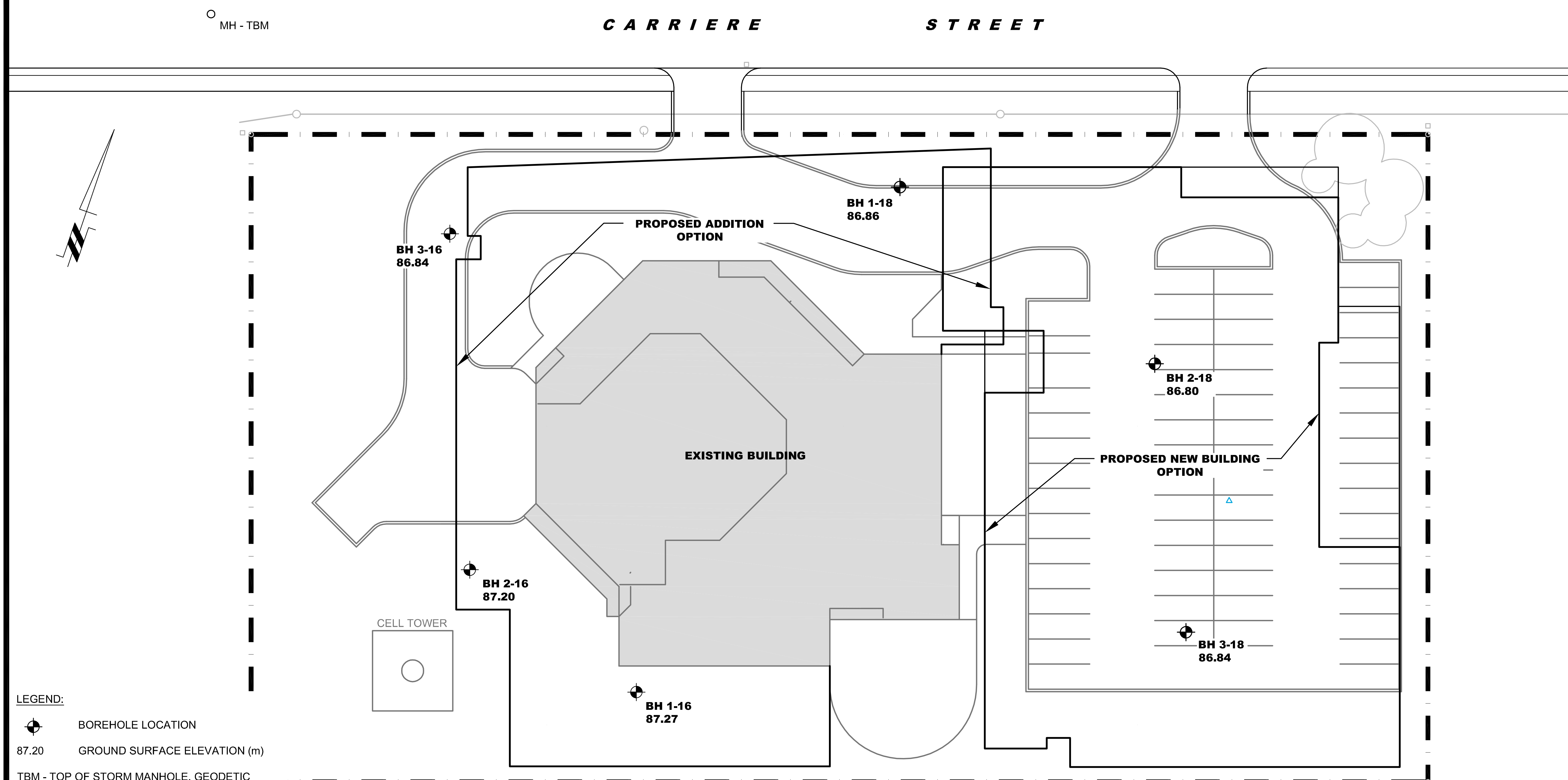


Figure 2 – Shear Wave Velocity Profile at Shot Location 17 m

Figure 3 – Shear Wave Velocity Profile at Shot Location 48 m



LEGEND:

⊕ BOREHOLE LOCATION

87.20 GROUND SURFACE ELEVATION (m)

TBM - TOP OF STORM MANHOLE. GEODETIC ELEVATION = 86.30m.

BASEPLAN DATA PROVIDED BY MORIYAMA & TESHIMA ARCHITECTS

SCALE: 1:400

0 5 10 15 20 25m

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consulting engineers

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

NO.	REVISIONS	DATE	INITIAL
0			

MIFO - MOUVEMENT D'IMPLICATION FRANCOPHONE D'ORLEANS

GEOTECHNICAL INVESTIGATION
PROPOSED BUILDING EXPANSION - 6600 CARRIÈRE STREET

OTTAWA, ONTARIO

Title:

TEST HOLE LOCATION PLAN

Scale: 1:400	Date: 12/2018
Drawn by: RG	Report No.: PG3694-2
Checked by: SD	Dwg. No.: PG3694-2
Approved by: SD	Revision No.: 0

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