Geotechnical Engineering

Environmental Engineering

Hydrogeology

Geological Engineering

**Materials Testing** 

**Building Science** 

**Archaeological Services** 

## **Geotechnical Investigation**

Proposed Warehouse Complex Boundary Road Ottawa, Ontario

### **Prepared For**

Broccolini

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Report PG4366-1



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## 1.0 Introduction

Paterson Group (Paterson) was commissioned by Broccolini to conduct a geotechnical investigation for the proposed warehouse complex to be located at Boundary Road in the City of Ottawa, Ontario (refer to Figure 1 - Key Plan in Appendix 2 of this report).

The objectives of the investigation were to:

- Determine the subsoil and groundwater conditions at this site by means of boreholes.
- □ Provide geotechnical recommendations for the design of the proposed development including construction considerations which may affect 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, it is understood that the proposed development will consist of a single-storey warehouse building with a footprint of approximately 93,000 m<sup>2</sup>. The building will have a slab-on-grade design capable of supporting 12.5 kPa loading associated with racking structures and interior vehicles.

The proposed building will have a height of approximately 12 m and will potentially have loading docks on both longitudinal sides. The warehouse will be surrounded by associated access lanes, loading areas, and parking areas. Truck traffic will be a large component of the vehicle loading on the pavement structure.



## 3.0 Method of Investigation

## 3.1 Field Investigation

### **Field Program**

The field program for the geotechnical investigation was carried out during the period of December 27, 2017 through January 5, 2018. A total of 9 boreholes were drilled and sampled to a maximum depth of 10.2 m below existing ground surface. Previous geotechnical investigations, which included a total of 15 test pits advanced to a maximum depth of 5.2 m at the subject site, were conducted at the site on July 15, 2014 and June 26, 2012. The test hole locations were distributed in a manner to provide general coverage of the subject site taking into consideration site features. The locations of the test holes are shown on Drawing PG4366-1 - Test Hole Location Plan included in Appendix 2.

The boreholes were completed with a track-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 test hole procedure consisted of augering to the required depths at the selected locations, and sampling and testing the overburden. Sampling and testing the overburden was completed in general accordance with ASTM D5434-12 - Guide for Field Logging of Subsurface Explorations of Soil and Rock.

### Sampling and In Situ Testing

Soil samples were recovered using a 50 mm diameter split-spoon sampler, a Shelby tube, or from the auger flights. The split-spoon and auger samples were classified on site and placed in sealed plastic bags. All samples were transported to our laboratory. The depths at which the split-spoon, Shelby tubes and auger samples were recovered from the boreholes are shown as SS, TW and AU, respectively, on the Soil Profile and Test Data sheets 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. This testing was done in general accordance with ASTM D1586-11 - Standard Test Method for Penetration Test and Split-Barrel Sampling of Soils.

Undrained shear strength testing, using a vane apparatus, was carried out at regular intervals of depth in cohesive soils.

The overburden thickness was evaluated by a dynamic cone penetration test (DCPT) at 5 borehole locations. 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 presented on the Soil Profile and Test Data sheets in Appendix 1 of this report.

### Groundwater

Flexible standpipe piezometers were installed in all boreholes and the test pits conducted in July 2014 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.

### **Sample Storage**

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

### 3.2 Field Survey

The test hole locations were selected by Paterson personnel in a manner to provide general coverage of the proposed development, taking into consideration site features.

The borehole locations and ground surface elevations were surveyed by Annis, O'Sullivan, Vollebekk Ltd. and are presented on Drawing PG4366-1 - Test Hole Location Plan in Appendix 2. The ground surface elevations of the test pits completed in July 2014 were interpolated from topographic information prepared by Annis, O'Sullivan, Vollebekk Ltd.

The test pits completed during our previous geotechnical field investigation in June 2012 were located and surveyed in the field by Paterson personnel. Ground surface elevations at these test pit locations were referenced to a temporary benchmark (TBM), consisting of the invert of an existing culvert with a geodetic elevation of 76.49 m provided by Annis, O'Sullivan, Vollebekk Ltd.

## 3.3 Laboratory Testing

Soil samples were recovered from the subject site and visually examined in our laboratory to review the results of the field logging.

A total of 6 Shelby tube samples were submitted for unidimensional consolidation testing from the boreholes completed for our investigation. In addition, Atterberg limit testing was performed on 2 samples obtained from the boreholes. The results of the consolidation testing are presented on the Unidimensional Consolidation Test Results sheets presented in Appendix 1 and are further discussed in Sections 4 and 5.

## 3.4 Analytical Testing

Two soil samples were submitted for analytical testing to assess the potential for exposed ferrous metals and the potential of sulphate attacks against subsurface concrete structures. The samples were analyzed to determine their concentrations of sulphate and chloride along with their resistivity and pH. The laboratory test results are shown in Appendix 1 and the results are discussed in Subsection 6.7.



## 4.0 Observations

## 4.1 Surface Conditions

The subject site is currently undeveloped and generally covered with grass, small brush, and forested areas. The approximately triangular-shaped site is bordered by Highway 417 to the north, Boundary Road to the west, and an industrial property to the south. The existing ground surface is relatively level across the site at elevations of approximately 76 to 78 m, as referenced to a Geodetic datum. Excavated drainage ditches were also encountered at the subject site.

### 4.2 Subsurface Profile

### Overburden

The subsurface profile encountered at the test hole locations consists of topsoil and/or fill material extending to approximate depths of 0.3 to 2 m below the existing ground surface. The fill material was generally observed to consist of a brown silty clay to silty sand with occasional gravel, cobbles, and boulders. A loose to compact, brown silty sand to sand layer was generally encountered underlying the fill, extending to depths of 0.9 to 4.5 m below ground surface. A stiff to soft, brown to grey silty clay deposit was observed underlying the silty sand to sand layer. Practical refusal to the DCPTs were encountered at depths ranging from 21.2 to 26.8 m. Reference should be made to the Soil Profile and Test Data sheets in Appendix 1 for specific details of the soil profiles encountered at each test hole location.

As noted above, 6 silty clay samples collected at this site were subjected to unidimensional consolidation testing. The results of the testing are presented in Appendix 1 and are discussed in Subsection 5.4.

The results of Atterberg Limits tests conducted on 2 samples of the silty clay are presented on the Atterberg Limits Results sheets in Appendix 1. The tested silty clay sample classify as an inorganic clay of low plasticity (CL) in accordance with the Unified Soil Classification System.

### Bedrock

Based on available geological mapping, the bedrock in this area consists of shale of the Carlsbad formation with an overburden drift thickness of 25 to 35 m.

### 4.3 Groundwater

Groundwater levels were measured in the piezometers at the borehole locations on January 23, 2018, and in the piezometers at the test pit locations on August 13, 2014. The measured groundwater level (GWL) readings are presented in Table 1 below. Based on our field observations, experience with the local area, moisture levels and the colouring of the recovered samples, it is expected that the groundwater level is between 0.5 to 2 m below the existing grade. It should be noted that groundwater levels are subject to seasonal fluctuations and therefore groundwater levels could differ at the time of construction.

| Table 1 - Summary of Groundwater Levels |  |                          |  |                             |  |  |  |  |  |  |
|---|--|--------------------------|--|-----------------------------|--|--|--|--|--|--|
| Borehole                                | Ground                                     | Measured Grou            |  |                             |  |  |  |  |  |  |
| Number                                  | Surface Elev.<br>(m)                       | Depth (m)                | Elevation (m)                                | Recording Date              |  |  |  |  |  |  |
| BH 1                                    | 77.30                                      | 1.23                     | 76.07  | January 23, 2018            |  |  |  |  |  |  |
| BH 2                                    | 77.92                                      | Dry                      | n/a  | January 23, 2018            |  |  |  |  |  |  |
| BH 3                                    | 76.42                                      | Not Accessible           | n/a  | January 23, 2018            |  |  |  |  |  |  |
| BH 4                                    | 77.02                                      | Not Accessible           | n/a  | January 23, 2018            |  |  |  |  |  |  |
| BH 5                                    | 76.15                                      | 0.71                     | 75.44  | January 23, 2018            |  |  |  |  |  |  |
| BH 6                                    | 76.67                                      | Frozen                   | n/a  | January 23, 2018            |  |  |  |  |  |  |
| BH 7                                    | 76.83                                      | Frozen                   | n/a  | January 23, 2018            |  |  |  |  |  |  |
| BH 8                                    | 76.11                                      | 0.61                     | 75.50  | January 23, 2018            |  |  |  |  |  |  |
| BH 9                                    | 76.77                                      | Not Accessible           | n/a  | January 23, 2018            |  |  |  |  |  |  |
| TP 1-14                                 | 77.30                                      | 1.45                     | 75.85  | August 13, 2014             |  |  |  |  |  |  |
| TP 2-14                                 | 77.50                                      | 1.47                     | 76.03  | August 13, 2014             |  |  |  |  |  |  |
| TP 3-14                                 | 76.20                                      | 0.92                     | 75.28  | August 13, 2014             |  |  |  |  |  |  |
| TP 4-14                                 | 76.50                                      | 1.17                     | 75.33  | August 13, 2014             |  |  |  |  |  |  |
| TP 5-14                                 | 76.50                                      | -                        | -  | August 13, 2014             |  |  |  |  |  |  |
| TP 6-14                                 | 76.00                                      | 0.53                     | 75.47  | August 13, 2014             |  |  |  |  |  |  |
| Note: Ground<br>Vollebel                | surface elevations a kk, Ltd. and are assu | t the test hole location | ons were provided b<br>ed to a geodetic datu | y Annis, O'Sullivan,<br>ım. |  |  |  |  |  |  |

## 5.0 Discussion

## 5.1 Geotechnical Assessment

From a geotechnical perspective, the subject site is considered satisfactory for the proposed warehouse. It is expected that the proposed building can be founded on conventional spread footings bearing on the undisturbed silty sand or stiff silty clay deposits. However, due to the presence of the deep silty clay deposit, a permissible grade raise restriction will be applied for the subject site.

Due to hydraulic gradients for site servicing, it is expected that the building finish floor elevation (FFE) will be at approximately 77.45 m. To accommodate this elevation, lightweight fill (LWF) will be required.

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

## 5.2 Site Grading and Preparation

### **Stripping Depth**

Topsoil and fill, containing deleterious or organic materials, should be stripped from under any building, paved areas, pipe bedding and other settlement sensitive structures.

### **Fill Placement**

Fill used for grading beneath the proposed building should consist of clean imported granular fill, such as Ontario Provincial Standard Specifications (OPSS) Granular A or Granular B Type II. 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 building and paved areas should be compacted to at least 98% of the material's 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. This material should be spread in thin lifts and at least compacted by the tracks of the spreading equipment to minimize voids. If this material is to be used to build up the subgrade level for areas to be paved, it should be compacted in thin lifts to at least 95% of the material's 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 membrane.

## 5.3 Foundation Design

As noted above, it is expected that foundation support for the proposed building will consist of conventional spread footings supported on an undisturbed, stiff silty clay and or compact silty sand bearing surface.

### **Conventional Spread Footings**

Strip footings, up to 3 m wide, and pad footings, up to 5 m wide, placed over an undisturbed, stiff silty clay and/or compact silty sand bearing surface can be designed using a bearing resistance value at Serviceability Limit States (SLS) of **100 kPa** and a factored bearing resistance value at Ultimate Limit States (ULS) of **180 kPa**, incorporating a geotechnical resistance factor of 0.5.

For larger pad footings designed for uplift resistance, up to 7 m wide, and other footing placed at a lower elevation on the undisturbed firm silty clay deposit bearing surface, these footings can be designed using a bearing resistance value at Serviceability Limit States (SLS) of **80 kPa** and a factored bearing resistance value at Ultimate Limit States (ULS) of **140 kPa**, incorporating a geotechnical resistance factor of 0.5.

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.

The total and differential settlements associated with the footing loading conditions using the bearing resistance value at SLS provided are estimated to be 25 and 20 mm, respectively.

## 5.4 Permissible Grade Raise Recommendations

Consideration must be given to potential settlements which could occur due to the presence of the silty clay deposit and the combined loads from the proposed footings, any groundwater lowering effects, and grade raise fill. The foundation loads to be considered for the settlement case are the continuously applied loads which consist of the unfactored dead loads and the portion of the unfactored live load that is considered to be continuously applied.



### **Consolidation Testing**

Generally, the potential long term settlement is evaluated based on the compressibility characteristics of the silty clay. These characteristics are estimated in the laboratory by conducting unidimensional consolidation tests on undisturbed soil samples collected using Shelby tubes in conjunction with a piston sampler. A total of 6 site specific consolidation tests are being carried out for this project. The results of the consolidation tests are included in Appendix 1.

Value  $p'_{\circ}$  is the preconsolidation pressure of the sample and  $p'_{\circ}$  is the effective overburden pressure. The difference between these values is the available preconsolidation. The increase in stress on the soil due to the cumulative effects of the fill surcharge, the footing pressures, the slab loadings and the lowering of the groundwater should not exceed the available preconsolidation if unacceptable settlements are to be avoided.

The values  $C_{cr}$  and  $C_{c}$  are the recompression and compression indices, respectively, and are a measure of the compressibility of the soil due to stress increases below and above the preconsolidation pressures. The higher values for the  $C_{c}$ , as compared to the  $C_{cr}$ , illustrate the increased settlement potential above, as compared to below, the preconsolidation pressure.

It should be noted that the values of  $p'_{c}$ ,  $p'_{o}$ ,  $C_{cr}$  and  $C_{c}$  are determined using standard engineering practices and are estimates only. In addition, natural variations within the soil deposit would also affect the results. Furthermore, the  $p'_{o}$  parameter is directly influenced by the groundwater level. While the groundwater levels were measured at the time of the fieldwork, the levels vary with time and this has an impact on the available preconsolidation. Lowering the groundwater level increases the  $p'_{o}$  and therefore reduces the available preconsolidation. Unacceptable settlements could be induced by a significant lowering of the groundwater level. The  $p'_{o}$  values for the consolidation tests carried out for the present investigation are based on the long term groundwater level being 0.5 m above the bottom of the silty clay crust. The level of the silty clay.

| Table 2 - Sur   | Table 2 - Summary of Consolidation Test Results |                        |                          |              |                 |                |  |  |  |  |  |  |
|-----------------|---|------------------------|--------------------------|--------------|-----------------|----------------|--|--|--|--|--|--|
| Borehole<br>No. | Sample  | Sample<br>Depth<br>(m) | p' <sub>c</sub><br>(kPa) | p'。<br>(kPa) | C <sub>cr</sub> | C <sub>c</sub> |  |  |  |  |  |  |
| BH 1            | TW 4  | 3.2                    | 72.9                     | 37.4         | 0.034           | 1.223          |  |  |  |  |  |  |
| BH 2            | TW 5  | 4.0                    | 72.7                     | 42.6         | 0.044           | 3.017          |  |  |  |  |  |  |
| BH 4            | TW 8  | 8.1                    | 88.3                     | 69.3         | 0.040           | 2.488          |  |  |  |  |  |  |
| BH 5            | TW 7  | 8.7                    | 88.4                     | 71.6         | 0.049           | 2.070          |  |  |  |  |  |  |
| BH 6            | TW 6  | 4.8                    | 73.8                     | 49.8         | 0.059           | 3.729          |  |  |  |  |  |  |
| BH 8A           | TW 2  | 3.4                    | 65.5                     | 40.7         | 0.049           | 5.921          |  |  |  |  |  |  |

### Settlement

For design purposes, the total and differential settlements associated with the combination of grade raises and footing loading conditions using the bearing resistance values are estimated to be 25 and 20 mm, respectively. A post-development groundwater lowering of 0.5 m was assumed.

### Permissible Grade Raise

Permissible grade raise recommendations have been determined for the proposed development based on the consolidation testing results of samples of the silty clay obtained during the geotechnical investigation. Based on our findings, a permissible grade raise of **0.5 m** is recommended for grading within 6 m of the proposed building. A permissible grade restriction of **0.8 m** is recommended for access roadways and parking areas.

It is expected that where proposed grades at the building exceed our permissible grade raise restrictions, consideration could be given to placing lightweight fill, consisting of EPS geofoam blocks (Type 22 or higher), to compensate for the permissible grade raise exceedance.

To reduce potential long term liabilities, consideration should be given to provide means to reduce long term groundwater lowering (e.g. clay dykes, restriction on planting around the structures, etc). It should be noted that building on silty clay deposits increases the likelihood of building movements and, therefore, of cracking. The use of steel reinforcement in foundations placed at key structural locations will tend to reduce foundation cracking as compared to unreinforced foundations.

## 5.5 Design for Earthquakes

A seismic shear wave velocity test was completed for the subject site to accurately determine the applicable seismic site classification for the proposed building based on Table 4.1.8.4.A of the Ontario Building Code (OBC) 2012. The shear wave velocity test was completed by Paterson personnel. A seismic shear wave velocity profile from the on site testing is presented in Appendix 2.

### Field Program

The seismic array testing location was placed directly to the east of the site in a northsouth direction as presented on Drawing PG4366-1 - Test Hole Location Plan in Appendix 2. Paterson field personnel placed 24 horizontal 4.5 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 3 m intervals and connected by a geophone spread cable to a Geode 24 Channel seismograph.

The seismograph was also connected to a computer laptop and a hammer trigger switch attached to a 12 pound dead blow hammer. The hammer trigger switch sends a start signal to the seismograph. The hammer is used to strike an I-Beam seated into the ground surface, which creates a polarized shear wave. The hammer shots are repeated between four (4) to eight (8) times at each shot location to improve signal to noise ratio. The shot locations are also completed in forward and reverse directions (i.e.- striking both sides of the I-Beam seated parallel to the geophone array). The shot location was located at the centre of the seismic array.

The methods of testing completed by Paterson are guided by the standard testing procedures used by the expert seismologists at Carleton University and the Geological Survey of Canada (GSC).

### Data Processing and Interpretation

Interpretation for the shear wave velocity results were completed by Paterson personnel. Shear wave velocity measurement was made using reflection/refraction methods. The interpretation is performed by recovering arrival times from direct and refracted waves. The interpretation is repeated at each shot location to provide an average shear wave velocity,  $Vs_{30}$ , of the upper 30 m profile, immediately below the building's foundation.

Based on the test results, the average overburden seismic shear wave velocity is 161 m/s. Through interpretation, the bedrock has a shear wave velocity of 1,500 m/s. The  $Vs_{30}$  was calculated using the standard equation for average shear wave velocity from the Ontario Building Code (OBC) 2012. The overburden thickness below underside of footing is assumed to be 22.4 m, based on an underside of footing at 1.5 m below ground surface.

The  $Vs_{30}$  was calculated using the standard equation for average shear wave velocity calculation from the OBC 2012, as presented below.

$$V_{s30} = \frac{Depth_{OfInterest}(m)}{\left(\frac{(Depth_{Layer1}(m)}{Vs_{Layer1}(m/s)} + \frac{Depth_{Layer2}(m)}{Vs_{Layer2}(m/s)}\right)}$$
$$V_{s30} = \frac{30m}{\left(\frac{22.4m}{161.4m/s} + \frac{7.6m}{1,500m/s}\right)}$$
$$V_{s30} = 208m/s$$

Based on the results of the seismic testing, the average shear wave velocity,  $Vs_{30}$ , for foundations placed on the overburden materials is 208 m/s. Therefore, a **Site Class D** is applicable for design of the proposed building, as per Table 4.1.8.4.A of the OBC 2012. The soils underlying the subject site are not susceptible to liquefaction.

## 5.6 Slab-on-Grade

### **Under Slab Materials**

With the removal of all topsoil and fill, containing deleterious or organic materials, the native soil will be considered an acceptable subgrade surface on which to prepare the profile, provided below, for slab-on-grade construction. Any soft areas should be removed and backfilled with appropriate backfill material.

It is recommended that the sub-slab profile consist of the following:

- A thickness yet to be determined of EPS Blocks Type 22 (LWF) overlying the native soil subgrade.
- Geotextile or poly separation layer overlying the EPS Blocks.
- 400 to 450 mm of OPSS Granular A directly underlying the slab-on-grade.

### Modulus of Subgrade Reaction

Typical values of subgrade modulus for the OPSS Granular A and native silty clay surfaces are provided in Table 3.

| Table 3 - Modulus of Subgrade Reaction |                                  |  |  |  |  |  |  |  |  |
|--|----------------------------------|--|--|--|--|--|--|--|--|
| Soil Type                              | Modulus of Soil Reaction (MPa/m) |  |  |  |  |  |  |  |  |
| OPSS Granular A Subgrade               | 20                               |  |  |  |  |  |  |  |  |
| Silty Clay Deposit                     | 5                                |  |  |  |  |  |  |  |  |

### 5.7 Pavement Structure

### **Minimum Pavement Structure Recommendations**

Car only parking areas, heavy truck parking areas and access lanes are anticipated at this site. The proposed pavement structures are presented in Tables 4 and 5.

| Table 4 - 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 |   |  |  |  |  |  |  |  |  |

SUBGRADE - Either fill, in situ soil, or OPSS Granular B Type I or II material placed over in situ soil or fill

| Table 5 - 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 soil or fill |   |  |  |  |  |  |  |  |

Minimum Performance Graded (PG) 58-34 asphalt cement should be used for this project. If soft spots develop in the subgrade during compaction or due to construction traffic, the affected areas should be excavated and replaced with OPSS Granular B Type 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 vibratory equipment.

### Pavement Structure Drainage

The pavement structure performance is dependent on the moisture condition at the contact zone between the subgrade material and granular base. Failure to provide adequate drainage under conditions of heavy wheel loading could result in the subgrade fines pumped into the stone subbase voids, thereby reducing the load bearing capacity.

Due to the impervious nature of the subgrade materials consideration should be provided to installing subdrains during the pavement construction. The subdrains should extend in four orthogonal directions and 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

### Foundation Drainage

It is recommended that a perimeter foundation drainage system be provided for the proposed building. The system should consist of a 150 mm diameter perforated corrugated plastic pipe, surrounded on all sides by 150 mm of 10 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.

### Foundation Backfill

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 layer 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.

## 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 should be provided for adequate frost protection for heated structures.

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 heated structure and require additional protection, such as soil cover of 2.1 m or an equivalent combination of soil cover and foundation insulation.

## 6.3 Excavation Side Slopes

The side slopes of excavations at the site should be either 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 expected that sufficient room will be available for the excavation to be undertaken by open-cut methods.

The excavation side slopes above the groundwater level extending to a maximum depth of 3 m should be excavated at 1H:1V or shallower. The shallower slope is required for excavation below groundwater level.

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

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

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.

## 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.

At least 150 mm of OPSS Granular A should be used for pipe bedding for sewer and water pipes. The bedding should extend to the spring line of the pipe. Cover material, from the spring line to at least 300 mm above the obvert of the pipe, should consist of OPSS Granular A or Granular B Type II with a maximum size of 25 mm. The bedding and cover materials should be placed in maximum 225 mm thick lifts compacted to 95% of the material's standard Proctor maximum dry density.

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 trench 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 95% of the material standard Proctor maximum dry density.

## 6.5 Groundwater Control

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

A temporary Ministry of the Environment and Climate Change (MOECC) 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 MOECC.

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 MOECC review of the PTTW application.

### 6.6 Winter Construction

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

The subsoil conditions at this site mostly 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, 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.

The trench excavations should be carried out in a manner to avoid the introduction of frozen materials, snow or ice into the trenches.

## 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 moderate to very aggressive corrosive environment.

## 7.0 Recommendations

A materials testing and observation services program is a requirement for the provided foundation design data to be applicable. The following aspects of the program should be performed by the geotechnical consultant:

- **Q** Review of the grading plan from a geotechnical perspective.
- **Q** Review of LWF recommendations and design.
- Observation of all bearing surfaces prior to the placement of concrete.
- Sampling and testing of the concrete and fill materials used.
- Periodic observation of the condition of unsupported excavation side slopes in excess of 3 m in height, if applicable.
- Observation of all subgrades prior to backfilling.
- **G** Field density tests to determine the level of compaction achieved.
- Sampling and testing of the bituminous concrete including mix design reviews.

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

## 8.0 Statement of Limitations

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

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

The recommendations provided herein should only be used by the design professionals associated with this project. They are not intended for contractors bidding on or undertaking the work. The latter should evaluate the factual information provided in this report and determine 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 Broccolini or their agents is not authorized without review by Paterson for the applicability of our recommendations to the altered use of the report.

### Paterson Group Inc.

Scott S. Dennis, P.E.

### **Report Distribution**

- Broccolini (3 copies)
- Paterson Group (1 copy)



Carlos P. Da Silva, P.Eng., ing., QP<sub>ESA</sub>

## **APPENDIX 1**

SOIL PROFILE AND TEST DATA SHEETS

SYMBOLS AND TERMS

**CONSOLIDATION TEST RESULTS** 

ATTERBERG LIMITS RESULTS

ANALYTICAL TESTING RESULTS

## SOIL PROFILE AND TEST DATA

FILE NO.

**PG4366** 

154 Colonnade Road South, Ottawa, Ontario K2E 7J5

**Geotechnical Investigation** Boundary Road at Highway 417 Ottawa, Ontario

### DATUM

| BORINGS BY CME 55 Power Auger                                   |         |              |        | C            | DATE           | Decembe | r 27, 201 | 17                     | HOLE N                      | <sup>o.</sup> BH 1                    |            |
|---|---------|--------------|--------|--------------|----------------|---------|-----------|------------------------|-----------------------------|---------------------------------------|------------|
| SOIL DESCRIPTION  | PLOT    | SAMPLE       |        |              |                | DEPTH   | ELEV.     | Pen. R<br>• 5          | esist. B<br>0 mm Di         | lows/0.3m<br>a. Cone                  | - <u>-</u> |
|   | TRATA 1 | TYPE         | UMBER  | °°<br>COVERY | VALUE<br>r RQD | (m)     | (m)       | • V                    | Vater Co                    | ntent %                               | zomete     |
| GROUND SURFACE  | Ñ       | •            | Ĩ      | REC          | zö             | 0       |           | 20                     | 40                          | 60 80                                 | S Pie      |
| FILL: Brown silty clay with sand, some gravel                   |         | ss           | 1      | 50           | 6              | 1-      | -         |                        |                             |                                       |            |
| Loose, brown <b>SILTY SAND</b>                                  | 1       | ∦ ss<br>∦ ss | 2<br>3 | 67<br>58     | 7              | 2-      | -         |                        |                             |                                       |            |
|   |         | тw           | 4      |              |                | 3-      | -         |                        |                             |                                       |            |
|   |         | ss           | 5<br>6 | 83<br>25     | 3              | 4-      | -         |                        |                             |                                       |            |
|   |         |              |        | 0            |                | 5-      | -         |                        |                             |                                       |            |
| Firm, grey SILTY CLAY   |         | ∦ SS<br>∎ TW | 8      | 100          | 0              | 6-      | -         |                        |                             |                                       |            |
|   |         |              | 9      | 33           |                | 7-      | -         |                        |                             |                                       |            |
|   |         |              |        |              |                |         |           |                        |                             |                                       |            |
|   |         |              |        |              |                | 8-      | -         |                        |                             |                                       |            |
|   |         |              |        |              |                | 9-      | -         |                        |                             | · · · · · · · · · · · · · · · · · · · |            |
| Dynamic Cone Penetration Test<br>commenced at 9.75m depth. Cone |         | -            |        |              |                | 10-     | -         |                        | <b>.</b>                    |                                       |            |
|   |         |              |        |              |                | 11-     | -         |                        |                             |                                       |            |
|   |         |              |        |              |                | 12-     | _         |                        |                             |                                       |            |
|   |         |              |        |              |                |         |           |                        |                             |                                       |            |
|   |         |              |        |              |                | 13-     | -         |                        |                             |                                       |            |
|   |         |              |        |              |                | 14-     | -         |                        |                             |                                       |            |
|   |         |              |        |              |                | 15-     | -         | 20<br>Shea<br>▲ Undist | 40<br>ar Streng<br>turbed 2 | 60 80<br>jth (kPa)<br>∆ Remoulded     | 100        |

## SOIL PROFILE AND TEST DATA

FILE NO.

40

Shear Strength (kPa)

20

▲ Undisturbed

60

80

△ Remoulded

100

**PG4366** 

154 Colonnade Road South, Ottawa, Ontario K2E 7J5

## **Geotechnical Investigation** Boundary Road at Highway 417 Ottawa, Ontario

| DA <sup>.</sup> | τU | М |
|-----------------|----|---|
|                 |    |   |

RE

| BORINGS BY | CME | 55 | Power | Auge |
|------------|-----|----|-------|------|
|            |     |    |       |      |

| REMARKS<br>BORINGS BY CME 55 Power Auger |          |      |       | D           | ATE I          | Decembe | er 27, 201 | 17     | HOLEN              | <sup>•0.</sup> BH 1   |                      |
|--|----------|------|-------|-------------|----------------|---------|------------|--------|--------------------|-----------------------|----------------------|
| SOIL DESCRIPTION                         | LOT      |      | SAN   | IPLE        |                | DEPTH   | ELEV.      | Pen. R | esist. E<br>0 mm D | lows/0.3m<br>ia. Cone | <u> </u>             |
|  | FRATA F  | LYPE | JMBER | %<br>COVERY | VALUE<br>r RQD | (m)     | (m)        | 0      | Vater Co           | ontent %              | zometei<br>1structic |
| GROUND SURFACE                           | <u>ي</u> |      | Ŋ     | REC         | z Ö            | 15      |            | 20     | 40                 | 60 80                 | C Ei                 |
|  |          |      |       |             |                | 15-     | -          |        |                    |                       | -                    |
|  |          |      |       |             |                | 16-     | -          |        |                    |                       |                      |
|  |          |      |       |             |                | 17-     | _          |        |                    |                       | -                    |
|  |          |      |       |             |                | 18-     | -          |        |                    |                       |                      |
|  |          |      |       |             |                | 19-     | _          | •      |                    |                       |                      |
|  |          |      |       |             |                | 20-     | -          |        |                    |                       |                      |
| 21.23                                    |          |      |       |             |                | 21-     | -          |        | •                  |                       |                      |
| End of Borehole                          |          |      |       |             |                |         |            |        |                    |                       |                      |
| Practical DCPT refusal at 21.23m depth   |          |      |       |             |                |         |            |        |                    |                       |                      |
|  |          |      |       |             |                |         |            |        |                    |                       |                      |
|  |          |      |       |             |                |         |            |        |                    |                       |                      |
|  |          |      |       |             |                |         |            |        |                    |                       |                      |
|  |          |      |       |             |                |         |            |        |                    |                       |                      |
|  |          |      |       |             |                |         |            |        |                    |                       |                      |
|  |          |      |       |             |                |         |            |        |                    |                       |                      |
|  |          |      |       |             |                |         |            |        |                    |                       |                      |

## SOIL PROFILE AND TEST DATA

FILE NO.

**PG4366** 

154 Colonnade Road South, Ottawa, Ontario K2E 7J5

**Geotechnical Investigation** Boundary Road at Highway 417 Ottawa, Ontario

### DATUM

|  |         |     |      | -           |             | December | × 07 001 | 7               | HOLE NO                        | BH 2                        |                     |
|--|---------|-----|------|-------------|-------------|----------|----------|-----------------|--------------------------------|-----------------------------|---------------------|
|  | LOT     |     | SAN  | IPLE        |             | DEPTH    | ELEV.    | Pen. R          | esist. Blo                     | ows/0.3m                    |                     |
| SOIL DESCRIPTION   | RATA PI | КРЕ | MBER | °°<br>SVERY | ALUE<br>RQD | (m)      | (m)      | • 5<br>0 V      | 0 mm Dia                       | tent %                      | ometer<br>structior |
| GROUND SURFACE   | ST      | Ĥ   | IUN  | REC         | N<br>OF C   |          |          | 20              | 40 6                           | 0 80                        | Piez                |
| TOPSOIL0.15  |         |     |      |             |             | 0+       | -        |                 |                                |                             |                     |
| Very loose, brown SILTY SAND                                     |         | ss  | 1    | 0           | 3           | 1-       | -        |                 |                                |                             |                     |
| Firm, grey-brown <b>SILTY CLAY</b> with sand seams 2.10          |         | ss  | 2    | 58          | 3           | 2-       | -        |                 |                                |                             |                     |
| Loose, grey SILTY SAND2.64                                       |         | ss  | 3    | 21          | 7           |          |          |                 |                                |                             |                     |
|  |         | тw  | 4    | 21          |             | 3-       | -        |                 |                                |                             |                     |
|  |         | тw  | 5    |             |             | 4-       | -        |                 |                                |                             |                     |
|  |         |     |      |             |             | 5-       | -        |                 |                                |                             |                     |
|  |         |     |      |             |             | 6-       | -        |                 |                                |                             |                     |
| Firm, grey SILTY CLAY  |         | TW  | 6    | 42          |             | 7-       | -        |                 |                                |                             |                     |
|  |         |     |      |             |             | 8+       | -        |                 |                                |                             |                     |
|  |         | ss  | 7    | 58          | Р           |          |          |                 |                                |                             |                     |
|  |         |     |      |             |             | 9        | -        |                 |                                |                             |                     |
| Dynamic Cone Penetration Test<br>commenced at 10.21m depth. Cone |         | 1   |      |             |             | 10-      | -        |                 |                                |                             |                     |
| pushed to 12.2m depth.   |         |     |      |             |             | 11-      | -        |                 |                                |                             |                     |
|  |         |     |      |             |             | 12-      | -        |                 |                                |                             |                     |
|  |         |     |      |             |             | 13-      | -        |                 |                                |                             | ••                  |
|  |         |     |      |             |             | 14-      | -        |                 |                                |                             |                     |
|  |         |     |      |             |             | 15-      | -        |                 | 40 2                           | 0 00 4                      |                     |
|  |         |     |      |             |             |          |          | Shea<br>Lindist | 40 6<br>ar Strengt<br>turbed △ | <b>h (kPa)</b><br>Remoulded | IUU                 |

## SOIL PROFILE AND TEST DATA

FILE NO.

**PG4366** 

154 Colonnade Road South, Ottawa, Ontario K2E 7J5

**Geotechnical Investigation** Boundary Road at Highway 417 Ottawa, Ontario

### DATUM

|                                  |      |       |      | -    |             |              |                  | 17         | HOLE NO                               | <sup>D.</sup> BH 2                    |           |
|----------------------------------|------|-------|------|------|-------------|--------------|------------------|------------|---------------------------------------|---------------------------------------|-----------|
| BORINGS BY CIVIE 55 POwer Auger  |      |       | SAN  |      |             | Jecembe      | r <i>21</i> , 20 | Pen B      | osist RI                              | ows/0.3m                              |           |
| SOIL DESCRIPTION                 |      |       |      |      |             | DEPTH<br>(m) | ELEV.<br>(m)     | • 5        | 0 mm Dia                              | a. Cone                               | er<br>ion |
|                                  | LATA | L D E | IBER | %    | ALUE<br>RQD | (,           | (,               |            | Vator Co                              | atont %                               | omet      |
| GROUND SURFACE                   | STF  | 7.L   | NUN  | RECO | N<br>OF     |              |                  | 20         | 40 (                                  | 60 80                                 | Piezo     |
|                                  |      |       |      |      |             | 15-          | -                |            |                                       |                                       |           |
|                                  |      |       |      |      |             | 16-          | _                |            |                                       |                                       |           |
|                                  |      |       |      |      |             |              |                  |            |                                       |                                       |           |
|                                  |      |       |      |      |             | 17-          | -                |            |                                       |                                       |           |
|                                  |      |       |      |      |             | 10           |                  |            |                                       |                                       |           |
|                                  |      |       |      |      |             | 10-          |                  |            |                                       |                                       |           |
|                                  |      |       |      |      |             | 19-          | _                |            |                                       |                                       |           |
|                                  |      |       |      |      |             |              |                  |            |                                       |                                       |           |
|                                  |      |       |      |      |             | 20-          | -                |            |                                       |                                       | -         |
|                                  |      |       |      |      |             | 21-          | -                | •          | · · · · · · · · · · · · · · · · · · · |                                       | -         |
|                                  |      |       |      |      |             |              |                  |            |                                       | · · · · · · · · · · · · · · · · · · · |           |
|                                  |      |       |      |      |             | 22-          |                  |            | •                                     |                                       | -         |
|                                  |      |       |      |      |             | 23-          | _                |            |                                       |                                       |           |
| 23.39                            |      | _     |      |      |             | 20           |                  |            |                                       |                                       | •         |
| Practical DCPT refusal at 23.39m |      |       |      |      |             |              |                  |            |                                       |                                       |           |
| depth                            |      |       |      |      |             |              |                  |            |                                       |                                       |           |
|                                  |      |       |      |      |             |              |                  |            |                                       |                                       |           |
|                                  |      |       |      |      |             |              |                  |            |                                       |                                       |           |
|                                  |      |       |      |      |             |              |                  |            |                                       |                                       |           |
|                                  |      |       |      |      |             |              |                  |            |                                       |                                       |           |
|                                  |      |       |      |      |             |              |                  |            |                                       |                                       |           |
|                                  |      |       |      |      |             |              |                  |            |                                       |                                       |           |
|                                  |      |       |      |      |             |              |                  |            |                                       |                                       |           |
|                                  |      |       |      |      |             |              |                  |            |                                       |                                       |           |
|                                  |      |       |      |      |             |              |                  | 20<br>Shea | 40 e<br>ar Strend                     | 50 80 1<br>th (kPa)                   | òo        |
|                                  |      |       |      |      |             |              |                  | ▲ Undist   | urbed $\triangle$                     | Remoulded                             |           |

## SOIL PROFILE AND TEST DATA

FILE NO.

HOLE NO.

**PG4366** 

154 Colonnade Road South, Ottawa, Ontario K2E 7J5

Geotechnical Investigation Boundary Road at Highway 417 Ottawa, Ontario

### DATUM

| BORINGS BY | CME 55 Power Auger |
|------------|--------------------|
|            |                    |

| BORINGS BY CME 55 Power Auger                        |       | DATE December 27, 2017 BH 3 |        |             |                |       |       |                         | SH 3                                  |                                  |                      |
|--|-------|-----------------------------|--------|-------------|----------------|-------|-------|-------------------------|---------------------------------------|----------------------------------|----------------------|
| SOIL DESCRIPTION                                     | РГОТ  |                             | SAN    | IPLE        | 1              | DEPTH | ELEV. | Pen. Re<br>● 50         | esist. Blows<br>) mm Dia. Co          | one                              | ar<br>on             |
|  | TRATA | ТҮРЕ                        | IUMBER | %<br>COVERY | VALUE<br>r RQD | (11)  | (11)  | • W                     | ater Conten                           | t %                              | ezomete<br>onstructi |
| GROUND SURFACE                                       | 0     |                             | Z      | RE          | z o            | 0     |       | 20                      | 40 60                                 | 80                               | ĕĞ                   |
| 150mm Topsoil over brown silty 0.30 sand <b>FILL</b> |       | -                           |        |             |                | 0-    | -     |                         |                                       |                                  |                      |
| Loose, brown <b>SAND,</b> some silt                  |       | ss                          | 1      | 58          | 10             | 1-    | _     |                         |                                       |                                  |                      |
|  |       | ∦ss                         | 2      | 100         | 4              | 2-    | -     |                         |                                       |                                  |                      |
| Firm, brown to grey SILTY CLAY                       |       | TW                          | 3      | 50          |                | 3-    | -     |                         |                                       |                                  |                      |
| - grey sandy silt seam from 4.0 to 4.7m depth        |       | ss                          | 4      | 50          | w              | 4-    | -     |                         |                                       |                                  |                      |
|  |       | ss                          | 5      |             |                | 5-    | _     |                         |                                       |                                  |                      |
|  |       | тw                          | 6      | 25          |                | 6-    | -     |                         |                                       |                                  |                      |
|  |       |                             |        |             |                | 7-    | _     |                         |                                       |                                  |                      |
|  |       |                             |        |             |                | 8-    | -     |                         |                                       |                                  |                      |
|  |       |                             |        |             |                | 9-    | -     |                         |                                       |                                  |                      |
| 10.21  |       |                             |        |             |                | 10-   | -     |                         |                                       |                                  |                      |
| End of Borenole                                      |       |                             |        |             |                |       |       | 20<br>Shea<br>▲ Undistu | 40 60<br>r Strength (I<br>urbed △ Reu | 80 100<br><b>kPa)</b><br>noulded | D                    |

## SOIL PROFILE AND TEST DATA

FILE NO.

**PG4366** 

154 Colonnade Road South, Ottawa, Ontario K2E 7J5

Geotechnical Investigation Boundary Road at Highway 417 Ottawa, Ontario

### DATUM

| BINGS BY CME 55 Power Auger   |        |                                  |                                      | Г                                | ATE .                 | lanuary 2   | 2018  |                        |                                       | <sup>0.</sup> BH 4                     |                     |
|---|--------|----------------------------------|--------------------------------------|----------------------------------|-----------------------|---|-------|------------------------|---------------------------------------|--|---------------------|
|   | TOT    |                                  | SAN                                  | /IPLE                            |                       | DEPTH   | ELEV. | Pen. R                 | esist. B<br>0 mm Di                   | lows/0.3m                              |                     |
|   | RATA P | ХРЕ                              | MBER                                 | °°<br>OVERY                      | /ALUE<br>RQD          | (m)   | (m)   | • •                    | Vater Co                              | ontent %                               | cometer<br>structio |
| ROUND SURFACE   | ST     | H                                | ŊŊ                                   | REC                              | N N N                 |   |       | 20                     | 40                                    | 60 80                                  | Piez                |
| L: Brown silty clay to sandy silt   |        |                                  |                                      |                                  |                       | 0-  | -     |                        |                                       |  |                     |
| 15  |        | ss                               | 1                                    | 58                               | 6                     | 1-  | -     |                        |                                       |  |                     |
| 1.5   |        | ss                               | 2                                    | 83                               | 8                     | 2-  | _     |                        |                                       |  |                     |
| ose to very loose, brown SILTY  |        | ss                               | 3                                    | 83                               | 2                     |   |       |                        |                                       |  |                     |
| NE SAND, trace clay   |        | ss                               | 4                                    | 33                               | 2                     | 3-  | _     |                        | · · · · · · · · · · · · · · · · · · · |  |                     |
| 4.5   | 7      | ss                               | 5                                    | 0                                | 3                     | 4-  | -     |                        |                                       |  |                     |
|   |        | ss                               | 6                                    | 100                              | 1                     | 5-  | -     |                        |                                       | ······································ | -                   |
|   |        | тw                               | 7                                    | 25                               |                       |   |       |                        |                                       |  |                     |
|   |        |                                  |                                      |                                  |                       | 6-  | _     |                        |                                       |  |                     |
|   |        |                                  |                                      |                                  |                       | 7-  | _     |                        |                                       |  |                     |
| m, grey SILTY CLAY  |        |                                  | 8                                    |                                  |                       |   |       |                        |                                       |  |                     |
|   |        |                                  |                                      |                                  |                       | 8-  | -     |                        |                                       |  |                     |
|   |        |                                  |                                      |                                  |                       | 9-  | _     |                        |                                       |  |                     |
| 10.2  |        |                                  |                                      |                                  |                       | 10-   | _     |                        |                                       |  |                     |
| 10.2<br>d of Borehole   |        | -                                |                                      |                                  |                       | 10  |       |                        |                                       |  | -                   |
|   |        |                                  |                                      |                                  |                       |   |       |                        |                                       |  |                     |
|   |        |                                  |                                      |                                  |                       |   |       |                        |                                       |  |                     |
|   |        |                                  |                                      |                                  |                       |   |       |                        |                                       |  |                     |
|   |        |                                  |                                      |                                  |                       |   |       |                        |                                       |  |                     |
|   |        |                                  |                                      |                                  |                       |   |       |                        |                                       |  |                     |
|   |        |                                  |                                      |                                  |                       |   |       |                        |                                       |  |                     |
|   |        |                                  |                                      |                                  |                       |   |       |                        |                                       |  |                     |
|   |        |                                  |                                      |                                  |                       |   |       | 20<br>Shor             | 40<br>sr Strong                       | 60 80 1                                | <b>00</b>           |
|   |        |                                  |                                      |                                  |                       |   |       | Undist                 | urbed                                 | ∆ Remoulded                            |                     |
| L: Brown silty clay to sandy silt1.5 ose to very loose, brown SILTY KE SAND, trace clay4.5 m, grey SILTY CLAY10.2 d of Borehole |        | SS<br>SS<br>SS<br>SS<br>SS<br>TW | 1<br>2<br>3<br>4<br>5<br>6<br>7<br>8 | 58<br>83<br>33<br>0<br>100<br>25 | 6<br>8<br>2<br>3<br>1 | 1-<br>2-<br>3-<br>4-<br>5-<br>6-<br>7-<br>8-<br>9-<br>10- |       | 20<br>Shea<br>▲ Undist | 40<br>ar Streng<br>urbed              | 60 80 1<br>gth (kPa)<br>△ Remoulded    | 00                  |

## SOIL PROFILE AND TEST DATA

 $\blacktriangle$  Undisturbed  $\triangle$  Remoulded

154 Colonnade Road South, Ottawa, Ontario K2E 7J5

**Geotechnical Investigation** Boundary Road at Highway 417 Ottawa, Ontario

### 

| DATUM  |        |      |        |             |                 |              |              |                | FILE NO.              | PG4366              | 5                 |
|--|--------|------|--------|-------------|-----------------|--------------|--------------|----------------|-----------------------|---------------------|-------------------|
| REMARKS  |        |      |        |             |                 |              |              |                | HOLE NO               |                     | -                 |
| BORINGS BY CME 55 Power Auger                  |        |      |        | D           | ATE             | January 3    | , 2018       |                |                       | впр                 |                   |
| SOIL DESCRIPTION                               | PLOT   |      | SAN    | IPLE<br>거   | M .             | DEPTH<br>(m) | ELEV.<br>(m) | Pen. Re<br>• 5 | esist. Bl<br>0 mm Dia | ows/0.3m<br>a. Cone | ter<br>tion       |
|  | STRATA | ТҮРЕ | NUMBER | *<br>SCOVER | VALUI<br>Dr RQD |              |              | • <b>v</b>     | /ater Cor             | ntent %             | ezome:<br>onstruc |
| GROUND SURFACE                                 | 07     |      | ų      | RE          | z               | 0-           | _            | 20             | 40 6                  | 50     80<br>+      | БŎ                |
| 1 <b>TOPSOIL</b> 0.15                          |        | -    |        |             |                 |              |              |                |                       |                     |                   |
| Loose, brown SAND to SILTY<br>SAND, trace clay |        | 7 99 | 1      | 12          | 6               | 1-           | _            |                |                       |                     | _                 |
| 1.68   |        |      |        | 72          |                 |              |              |                |                       |                     |                   |
|  |        | ≬ ss | 2      | 50          | 2               | 2-           | -            |                |                       |                     | - 🎇 👹             |
|  |        | 855  | 3      | 92          | 1               |              |              |                |                       |                     |                   |
|  | X      | N OO | 0      | 02          | '               | 3-           | -            |                |                       |                     | - 🗱 👹             |
|  |        |      |        |             |                 |              |              |                |                       |                     |                   |
|  |        | V ss | 4      | 92          | w               | 4-           | -            |                |                       |                     | - 🎇 👹             |
|  |        | ΔΟΟ  | •      | 02          |                 |              |              |                |                       |                     |                   |
| Stiff to firm, grey SILTY CLAY                 | X      | тw   | 5      | 33          |                 | 5-           | -            |                |                       |                     |                   |
|  | X      |      |        |             |                 |              |              |                |                       |                     |                   |
| - sandy silt seams from 3.8 to 5.2m            | X      |      |        |             |                 | 6-           | -            |                |                       |                     |                   |
| dopti  | X      | тw   | 6      | 33          |                 |              |              |                |                       |                     |                   |
|  | X      |      |        |             |                 | 7-           | -            | +              |                       |                     |                   |
|  | X      |      |        |             |                 |              |              |                |                       |                     |                   |
|  |        |      |        |             |                 | 8-           | -            |                |                       |                     |                   |
|  |        | тw   | 7      |             |                 |              |              | <b>-</b>       |                       |                     |                   |
|  |        |      | -      |             |                 | 9-           | -            |                |                       |                     |                   |
|  |        |      |        |             |                 |              |              |                |                       |                     |                   |
| 10.21  | XX     | -    |        |             |                 | 10-          | -            |                |                       |                     |                   |
| End of Borehole                                |        |      |        |             |                 |              |              |                |                       |                     |                   |
|  |        |      |        |             |                 |              |              |                |                       |                     |                   |
|  |        |      |        |             |                 |              |              |                |                       |                     |                   |
|  |        |      |        |             |                 |              |              |                |                       |                     |                   |
|  |        |      |        |             |                 |              |              |                |                       |                     |                   |
|  |        |      |        |             |                 |              |              |                |                       |                     |                   |
|  |        |      |        |             |                 |              |              |                |                       |                     |                   |
|  |        |      |        |             |                 |              |              |                |                       |                     |                   |
|  |        |      |        |             |                 |              |              |                |                       |                     |                   |
|  |        |      |        |             |                 |              |              | 20             | 40 (                  | 50 80               | ⊣<br>100          |
|  |        |      |        |             |                 |              |              | Shea           | r Streng              | th (kPa)            |                   |

## SOIL PROFILE AND TEST DATA

FILE NO.

**PG4366** 

154 Colonnade Road South, Ottawa, Ontario K2E 7J5

**Geotechnical Investigation** Boundary Road at Highway 417 Ottawa, Ontario

### DATUM



## SOIL PROFILE AND TEST DATA

▲ Undisturbed △ Remoulded

154 Colonnade Road South, Ottawa, Ontario K2E 7J5

Geotechnical Investigation Boundary Road at Highway 417 Ottawa, Ontario

### DATUM

| DATUM                                  |      |     |      |             |              |              |              |                | FILE                    | NO.<br>PC           | 34366              |                  |
|--|------|-----|------|-------------|--------------|--------------|--------------|----------------|-------------------------|---------------------|--------------------|------------------|
| REMARKS                                |      |     |      |             |              |              |              |                | HOLE                    | NO. DU              |                    |                  |
| BORINGS BY CME 55 Power Auger          |      |     |      | D           | ATE 、        | January 3    | , 2018       |                |                         | ВН                  | 6                  |                  |
| SOIL DESCRIPTION                       | PLOT |     | SAN  | MPLE        |              | DEPTH<br>(m) | ELEV.<br>(m) | Pen. Re<br>• 5 | esist.<br>0 mm          | Blows/0<br>Dia. Con | .3m<br>e           | er<br>tion       |
|  | RATA | ЗdХ | MBER | °°<br>OVER! | VALUE<br>ROD |              | ( )          | • <b>v</b>     | /ater C                 | Content             | %                  | zomet<br>istruct |
| GROUND SURFACE                         | SI   | н   | NN   | REC         | NO           |              |              | 20             | 40                      | 60                  | 80                 | Pie:<br>Cor      |
|  |      |     |      |             |              | 15-          | -            |                |                         |                     |                    |                  |
|  |      |     |      |             |              | 10-          | -            | •              |                         |                     |                    |                  |
|  |      |     |      |             |              | 1/-          | -            |                |                         |                     |                    |                  |
|  |      |     |      |             |              | 18-          | -            |                |                         |                     |                    |                  |
|  |      |     |      |             |              | 19-          | -            |                | · · · · · · · · · · · · |                     |                    |                  |
|  |      |     |      |             |              | 20-          | -            |                |                         |                     |                    |                  |
|  |      |     |      |             |              | 21-          | -            |                |                         |                     |                    |                  |
|  |      |     |      |             |              | 22-          | -            |                |                         |                     |                    |                  |
|  |      |     |      |             |              | 23-          | -            |                |                         |                     |                    |                  |
|  |      |     |      |             |              | 24-          | -            |                |                         |                     |                    |                  |
|  |      |     |      |             |              | 25-          | -            |                |                         |                     | •                  |                  |
| 00.77                                  |      |     |      |             |              | 26-          | -            |                | •                       |                     | •                  |                  |
| 26.77_<br>End of Borehole              |      | _   |      |             |              |              |              |                |                         |                     |                    |                  |
| Practical DCPT refusal at 26.77m depth |      |     |      |             |              |              |              |                |                         |                     |                    |                  |
|  |      |     |      |             |              |              |              |                |                         |                     |                    |                  |
|  |      |     |      |             |              |              |              | 20<br>Shea     | 40<br>ar Stre           | 60<br>ngth (kP      | 80 10<br><b>a)</b> | 00               |

## SOIL PROFILE AND TEST DATA

FILE NO.

**PG4366** 

154 Colonnade Road South, Ottawa, Ontario K2E 7J5

**Geotechnical Investigation** Boundary Road at Highway 417 Ottawa, Ontario

### DATUM

|                                   |             |      |        |        |                |           |              |  | HOLE     | ENO.    | RH 7                                  |            |
|-----------------------------------|-------------|------|--------|--------|----------------|-----------|--------------|--|----------|---------|---------------------------------------|------------|
| BORINGS BY CME 55 Power Auger     |             |      |        | D      | DATE .         | January 4 | , 2018       |  |          |         |                                       | 1          |
| SOIL DESCRIPTION                  | PLOT        |      | SAMPLE |        |                |           | ELEV.<br>(m) | Pen. Resist. Blows/0.3m<br>● 50 mm Dia. Cone |          |         | s/0.3m<br>one                         | er<br>tion |
|                                   | TRATA       | ТҮРЕ | IUMBER | COVER! | VALUE<br>r RQD |           |              | • V  | Vater (  | Conten  | it %                                  | ezomet     |
| GROUND SURFACE                    |             |      | N      | RE     | z o            | _         |              | 20   | 40       | 60      | 80                                    | μĘΩ        |
| <b>TOPSOIL</b> 0.30               | -<br>H +    | _    |        |        |                |           | -            |  |          |         |                                       |            |
| Very loose, brown SILTY FINE 0.60 |             |      |        |        |                |           |              |  |          |         |                                       |            |
| Brown SILTY CLAY with sandy silt  |             | X ss | 1      | 83     | 2              | 1-        | _            |  |          |         |                                       |            |
| seams                             | X           |      |        |        |                |           |              |  |          |         |                                       |            |
| 2.10                              |             | ss   | 2      | 0      | 1              | 2-        | -            |  |          |         |                                       | -          |
| Loose, grey SILTY FINE SAND, 2.59 |             | 0    | З      | 75     | 1              |           |              |  |          |         |                                       |            |
|                                   |             |      | 0      | /3     | -              | 3-        | _            |  |          |         |                                       |            |
|                                   | IV.         |      |        |        |                | Ū         |              |  |          |         |                                       |            |
|                                   | X           |      |        |        |                |           |              |  |          |         |                                       |            |
|                                   |             | тw   | 4      | 42     |                | 4-        | -            |  |          |         |                                       |            |
|                                   | IX.         |      |        |        |                |           |              |  |          |         |                                       |            |
|                                   | XX          |      |        |        |                | 5-        | -            | <b></b>                                      |          |         |                                       |            |
|                                   |             | тw   | 5      | 42     |                |           |              |  |          |         | · · · · · · · · · · · · · · · · · · · |            |
|                                   | I X         |      | Ū      |        |                | 6-        | -            |  |          |         |                                       |            |
| Soft to firm, grey SILTY CLAY     | X           |      |        |        |                |           |              |  |          |         |                                       |            |
|                                   |             |      |        |        |                | 7         |              |  |          |         |                                       |            |
|                                   | X           |      |        |        |                |           |              |  |          |         |                                       |            |
|                                   |             |      |        |        |                |           |              | <b>↑</b>                                     |          |         |                                       |            |
|                                   | IV.         |      |        |        |                | 8-        | -            |  |          |         |                                       | -          |
|                                   | X           |      |        |        |                |           |              |  |          |         |                                       |            |
|                                   |             |      |        |        |                | 9-        | -            |  |          |         |                                       |            |
|                                   | IX.         |      |        |        |                |           |              |  |          |         |                                       |            |
| 10.21                             | X           |      |        |        |                | 10-       | _            |  | $\times$ |         |                                       |            |
| End of Borehole                   | <u>rraz</u> | -    |        |        |                |           |              |  |          |         |                                       |            |
|                                   |             |      |        |        |                |           |              |  |          |         |                                       |            |
|                                   |             |      |        |        |                |           |              |  |          |         |                                       |            |
|                                   |             |      |        |        |                |           |              |  |          |         |                                       |            |
|                                   |             |      |        |        |                |           |              |  |          |         |                                       |            |
|                                   |             |      |        |        |                |           |              |  |          |         |                                       |            |
|                                   |             |      |        |        |                |           |              |  |          |         |                                       |            |
|                                   |             |      |        |        |                |           |              |  |          |         |                                       |            |
|                                   |             |      |        |        |                |           |              |  |          |         |                                       |            |
|                                   |             |      |        |        |                |           |              |  |          |         |                                       |            |
|                                   |             |      |        |        |                |           |              |  |          |         |                                       |            |
|                                   |             |      |        |        |                |           |              | 20   | 40       | 60      | 80 10                                 | +<br>00    |
|                                   |             |      |        |        |                |           |              | Shea   | ar Stre  | ength ( | kPa)                                  |            |
|                                   |             |      |        |        |                |           |              | ▲ Undist                                     | urbed    | ∆ Rei   | moulded                               |            |

## SOIL PROFILE AND TEST DATA

40

Shear Strength (kPa)

20

▲ Undisturbed

60

80

△ Remoulded

100

154 Colonnade Road South. Ottawa. Ontario K2E 7.15

**Geotechnical Investigation** Boundary Road at Highway 417

### DATUN

| 154 Colonnade Noad Sodin, Ottawa, Oni |                    |            | 5      |             | Ot             | tawa, On  | itario |  |            |        |          |
|---------------------------------------|--------------------|------------|--------|-------------|----------------|-----------|--------|--|------------|--------|----------|
| DATUM                                 |                    |            |        |             |                |           |        |  | FILE NO.   | PG4366 |          |
| REMARKS                               |                    |            |        |             |                |           |        |  | HOLE NO.   |        |          |
| BORINGS BY CME 55 Power Auger         |                    |            |        | D           | ATE 、          | January 4 | , 2018 |  |            | BH 8   |          |
| SOIL DESCRIPTION                      | РГОТ               |            | SAN    | IPLE        |                | DEPTH     | ELEV.  | Pen. Resist. Blows/0.3m<br>• 50 mm Dia. Cone |            |        | er<br>on |
|                                       | TRATA              | ТҮРЕ       | UMBER  | %<br>COVERY | VALUE<br>r RQD | (11)      | (11)   | • <b>N</b>                                   | Vater Cont | tent % | ezomete  |
| GROUND SURFACE                        | ß                  |            | Z      | RE          | z <sup>o</sup> |           |        | 20   | 40 60      | 080    | in C     |
| TOPSOIL0.30                           | -/+ <del>/</del> / | -          |        |             |                |           | _      |  |            |        |          |
| Brown CLAYEY SILT with sand           |                    | ∬ss<br>∬ss | 1<br>2 | 50<br>0     | 6<br>2         | 1-        | -      |  |            |        |          |
| Loose, brown <b>FINE SAND</b> 2.90    |                    | ss         | 3      |             | 7              | 3-        | -      |  |            |        |          |
|                                       |                    | ∦ ss       | 4      |             |                | 4-        | -      |  |            |        |          |
|                                       |                    | τw         | 5      | 33          |                | 5-        | -      |  |            |        |          |
| Soft to firm, grey SILTY CLAY         |                    |            |        |             |                | 6-        | _      |  |            |        |          |
|                                       |                    | ∦ss        | 6      |             |                | 8-        | -      |  |            |        |          |
|                                       |                    |            |        |             |                | 9-        | -      |  |            |        |          |
|                                       | XX                 | -          |        |             |                | 10-       | -      |  | T          |        |          |
| ραδιτέα το 13.711 αέρτη.              |                    |            |        |             |                | 11-       | _      |  |            |        |          |
|                                       |                    |            |        |             |                | 12-       | -      |  |            |        | -        |
|                                       |                    |            |        |             |                | 14-       | _      | •  |            |        |          |
|                                       |                    |            |        |             |                | 15-       | _      |  |            |        |          |

## SOIL PROFILE AND TEST DATA

FILE NO.

**PG4366** 

154 Colonnade Road South, Ottawa, Ontario K2E 7J5

## **Geotechnical Investigation** Boundary Road at Highway 417 Ottawa, Ontario

| BOBINGS BY CME 55 Power Auger    |       |      |       | п     | ΔTF .          | lanuary 4    | 1 2018 |                      | HOLE             | NO. BH                                 | 8                                     |        |  |
|----------------------------------|-------|------|-------|-------|----------------|--------------|--------|----------------------|------------------|--|---------------------------------------|--------|--|
| SOIL DESCRIPTION                 | PLOT  |      | SAN   | лрLE  |                | DEPTH<br>(m) | ELEV.  | Pen. F               | lesist.<br>50 mm | esist. Blows/0.3m<br>0 mm Dia. Cone    |                                       |        |  |
|                                  | TRATA | ТҮРЕ | UMBER | COVER | VALUE<br>r ROD |              |        | 0                    | Water C          | Content 9                              | %                                     | ezomet |  |
| GROUND SURFACE                   | ω     |      | Z     | RE    | z <sup>o</sup> | 15-          | -      | 20                   | 40               | 60 E                                   | <u>ة</u> 00                           | ĩö     |  |
|                                  |       |      |       |       |                |              |        |                      |                  |  |                                       |        |  |
|                                  |       |      |       |       |                | 16-          | +      |                      |                  | ······································ |                                       |        |  |
|                                  |       |      |       |       |                | 17-          | -      |                      |                  |  |                                       |        |  |
|                                  |       |      |       |       |                | 18-          | -      |                      |                  |  |                                       |        |  |
|                                  |       |      |       |       |                | 19-          | -      |                      |                  |  |                                       |        |  |
|                                  |       |      |       |       |                | 20-          | -      |                      |                  | · · · · · · · · · · · · · · · · · · ·  |                                       |        |  |
|                                  |       |      |       |       |                |              |        |                      |                  |  | · · · · · · · · · · · · · · · · · · · |        |  |
|                                  |       |      |       |       |                | 21-          | -      |                      |                  |  |                                       |        |  |
|                                  |       |      |       |       |                | 22-          | -      |                      |                  |  |                                       |        |  |
|                                  |       |      |       |       |                | 23-          | -      |                      |                  |  |                                       |        |  |
|                                  |       |      |       |       |                | 24-          | -      |                      |                  |  |                                       |        |  |
| 24.51                            |       | -    |       |       |                |              |        |                      |                  |  | ••••••                                |        |  |
| Practical DCPT refusal at 24.51m |       |      |       |       |                |              |        |                      |                  |  |                                       |        |  |
|                                  |       |      |       |       |                |              |        |                      |                  |  |                                       |        |  |
|                                  |       |      |       |       |                |              |        |                      |                  |  |                                       |        |  |
|                                  |       |      |       |       |                |              |        |                      |                  |  |                                       |        |  |
|                                  |       |      |       |       |                |              |        |                      |                  |  |                                       |        |  |
|                                  |       |      |       |       |                |              |        |                      |                  |  |                                       |        |  |
|                                  |       |      |       |       |                |              |        | 20<br>She<br>▲ Undis | 40<br>ar Stre    | 60 €<br>ngth (kPa<br>∆ Remou           | <b>30 100</b><br><b>a)</b><br>Ilded   |        |  |

## SOIL PROFILE AND TEST DATA

FILE NO.

**PG4366** 

154 Colonnade Road South, Ottawa, Ontario K2E 7J5

## **Geotechnical Investigation** Boundary Road at Highway 417 Ottawa, Ontario

| DATUM |  |
|-------|--|

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|        |  |             | D   | ATE .  | January 4    | , 2018   |  |   | BII   |   |  |
|--------|--|-------------|---|--|--------------|--|--|---|---|---|--|
| PLOT   | SAMPLE                                   |             |   |  | DEPTH<br>(m) | ELEV.<br>(m)   | Pen. F   | lesist.<br>50 mm  | Blows/0.<br>Dia. Cone   | 3m<br>9   | ter<br>tion  |
| TRATA  | ТҮРЕ                                     | IUMBER      | %<br>COVER  | VALUI<br>Pr ROD  |              |  | 0  | Water (   | Content 9   | 6   | ezome  |
| 0<br>0 |  | z           | RE  | z <sup>o</sup>   | 0-           | _  | 20   | 40  | 60 8  | 0   | ë ö  |
|        |  |             |   |  | 1-           | -  |  |   |   | · · · · · · · · · · · · · · · · · · ·   |  |
|        | ss                                       | 1           | 83  | w  | 2-           | _  |  |   |   |   |  |
| 1      |  |             |   |  | 3-           | _  |  |   |   |   |  |
| 3      | TW                                       | 2           | 33  |  |              |  |  |   |   | •••••••••••••••••••••••••••••••••••••••   |  |
|        |  |             |   |  |              |  |  | 40<br>ar Stre   | 60 8<br>ength (kPa  | 0 10<br>)   | 00   |
|        |  |             |   |  |              |  |  | turbed  |   | lded  |  |
|        | CO D D D D D D D D D D D D D D D D D D D | STRATA PLOT | LIVER SAMURAL SAMU<br>SAMURAL SAMURAL S | SAWPLE         Iona       Baa       Read       Monocolspan="3">A         Baa       SSS       1       83         A       TW       2       33         A       Iona       Iona       Iona         A       TW       2       33 | DATE A       | SAMPLE       DEPTH         Balance       < | Date January 4, 2018         SAMPLE       DEPTH (m)       ELEV. (m)         N< | DATE January 4, 2018         Perture          Image | DATE January 4, 2018       DATE January 4, 2018       Pen. Resist.       No.     Water 0       20     40       0     0       1     1       1     1       20     40       1     1       1     1       20     40       1     1       20     40       1     1       20     40       1     1       20     40       1     1       1     1       20     40       1     1       20     40       1     1       1     1       1     1       2     33       1     1       1     1       1     1       1     1       1     1       1     1       1     1       1     1       1     1       1     1       1     1       1     1       1     1       1     1       1     1       1     1       1     1 | SAMPLE       DEPTH       ELEV.<br>(m)       Pen. Resist. Blows/0.3         Image: Box of the second sec | DATE       January 4, 2018       HOLE NO.       BH 8A         01       SAMPLE       DEPTH       ELEV.       Pen. Resist. Blows/0.3m         1       1       0       0       Vater Content %         20       40       60       80         1       83       W       2         1       7W       2       33         1       83       W       2         1       83       W       2         1       83       W       2         1       7W       2       33         3       3       3         20       40       60       80         20       40       60       80         1       1       1       1       1         20       40       60       80       1         20       40       60       80       1         20       40       60       80       1         20       40       60       80       1         20       40       60       80       1         20       40       60       80       1         20 <td< th=""></td<> |

## SOIL PROFILE AND TEST DATA

FILE NO.

**PG4366** 

154 Colonnade Road South, Ottawa, Ontario K2E 7J5

**Geotechnical Investigation** Boundary Road at Highway 417 Ottawa, Ontario

#### DATUM

|                                 |      |      |     |      | ATE  | lonuory F | 20010   |                               | HOLE                                  | NO. BI                   | Н9                                    |          |
|---------------------------------|------|------|-----|------|------|-----------|---------|-------------------------------|---------------------------------------|--------------------------|---------------------------------------|----------|
| BORINGS BY CIVIE 55 FOWER Auger |      |      | SVI |      |      |           | 5, 2016 | Don B                         | ociet B                               | Rlowe                    | 0.3m                                  |          |
| SOIL DESCRIPTION                | PL01 |      | JAN |      |      | DEPTH     | ELEV.   | • 5                           | 0 mm E                                | ia. Co                   | ne                                    | er<br>on |
|                                 | ATA  | ЪE   | BER | VERY | LUE  |           | (11)    |                               |                                       |                          |                                       | mete     |
|                                 | STR  | LY.T | MUM | ECO. | N VP |           |         |                               | Vater Co                              | ontent                   | %                                     | lezo     |
|                                 |      |      |     | щ    |      | 0-        | -       | 20                            | 40                                    | 60<br>:   : :            | 80                                    |          |
| Brown SIL TY SAND some clay     | THT  | -    |     |      |      |           |         |                               | • • • • • • • • • •                   |                          |                                       | ▩ 👹      |
|                                 |      |      |     | 50   |      | 1_        |         |                               |                                       |                          |                                       | 88       |
|                                 |      | 822  | I   | 50   | 4    |           |         |                               |                                       |                          |                                       |          |
|                                 |      | ss   | 2   | 0    | 2    | 0         |         |                               |                                       |                          |                                       |          |
|                                 |      |      |     |      |      | 2-        |         |                               |                                       |                          |                                       | ₩ 🕅      |
|                                 |      |      |     |      |      |           |         |                               |                                       |                          |                                       | 88       |
|                                 |      | 8    | З   | 0    |      | 3-        | -       |                               | • • • • • • • • •                     |                          |                                       |          |
|                                 |      |      | 5   | 0    |      |           |         |                               |                                       |                          |                                       | 88       |
|                                 |      | тw   | 4   | 33   |      | 4-        | -       |                               | · · · · · · · · · · · · · · · · · · · |                          | · · · · · · · · · · · · · · · · · · · |          |
| Soft to firm, grey SILTY CLAY   |      |      |     |      |      |           |         |                               |                                       |                          |                                       | 88       |
|                                 |      |      |     |      |      | 5-        | -       |                               |                                       |                          |                                       |          |
|                                 |      |      |     |      |      |           |         |                               |                                       |                          |                                       | ፼ ፼      |
|                                 |      |      |     |      |      | 6-        | -       |                               |                                       |                          |                                       | ₩ 🕅      |
|                                 |      | ΤW   | 5   | 42   |      |           |         |                               |                                       |                          |                                       |          |
|                                 |      | [    |     |      |      | 7-        | -       |                               |                                       |                          |                                       | ₿₿       |
|                                 |      |      |     |      |      |           |         | $[ \cdot \cdot \cdot \cdot ]$ |                                       |                          |                                       | ፼ ፼      |
|                                 |      |      |     |      |      | 8-        | _       |                               |                                       |                          |                                       |          |
|                                 |      |      |     |      |      | 0         |         |                               | ×                                     |                          |                                       |          |
|                                 |      |      |     |      |      | 0.        |         |                               | 7                                     |                          |                                       |          |
|                                 |      |      |     |      |      | 9         |         |                               |                                       |                          |                                       |          |
|                                 |      |      |     |      |      |           |         |                               |                                       |                          |                                       |          |
| <u>10.21</u>                    | μX   | +    |     |      |      | 10-       | -       |                               |                                       |                          |                                       |          |
| commenced at 10.21m depth. Cone |      |      |     |      |      |           |         |                               |                                       |                          |                                       |          |
| pushed to 14.3m depth.          |      |      |     |      |      | 11-       | -       |                               |                                       |                          |                                       |          |
|                                 |      |      |     |      |      |           |         |                               |                                       |                          |                                       |          |
|                                 |      |      |     |      |      | 12-       | -       |                               |                                       |                          |                                       |          |
|                                 |      |      |     |      |      |           |         |                               |                                       |                          |                                       |          |
|                                 |      |      |     |      |      | 13-       | -       |                               |                                       |                          |                                       |          |
|                                 |      |      |     |      |      |           |         |                               |                                       |                          |                                       |          |
|                                 |      |      |     |      |      | 14-       | F       |                               |                                       |                          |                                       |          |
|                                 |      |      |     |      |      |           |         |                               |                                       |                          |                                       |          |
|                                 |      |      |     |      |      | 15-       | _       |                               |                                       | <u> </u>                 | <u> </u>                              |          |
|                                 |      |      |     |      |      |           |         | 20<br>Shore                   | 40<br>ar Stror                        | 60<br>ath (1-            | 80 10<br><b>P</b> 2)                  | 00       |
|                                 |      |      |     |      |      |           |         | S⊓ea<br>▲ Undist              | urbed                                 | l <b>gtn (K</b><br>∆ Rem | ra)<br>Ioulded                        |          |
|                                 |      |      |     |      |      |           |         |                               |                                       |                          |                                       |          |

## SOIL PROFILE AND TEST DATA

154 Colonnade Road South, Ottawa, Ontario K2E 7J5

Geotechnical Investigation Boundary Road at Highway 417 Ottawa, Ontario

| DATUM                            |        |      |        |           |        |              |              |               | FILE           | NO.<br>PG4366           |       |
|----------------------------------|--------|------|--------|-----------|--------|--------------|--------------|---------------|----------------|-------------------------|-------|
| REMARKS                          |        |      |        | _         |        |              |              |               | HOLE           | NO. BH 9                |       |
| BORINGS BY CME 55 Power Auger    |        |      |        | D         | ATE    | January 5    | 6, 2018      |               |                |                         |       |
| SOIL DESCRIPTION                 | A PLOT |      | SAN    | APLE<br>것 | E o    | DEPTH<br>(m) | ELEV.<br>(m) | Pen. R<br>● 5 | esist.<br>0 mm | Blows/0.3m<br>Dia. Cone | ter   |
|                                  | STRATA | ТҮРЕ | NUMBER | COVER     | L VALU |              |              | • V           | Vater C        | Content %               | ezome |
| GROUND SURFACE                   |        |      | -      | R         | ZŬ     | 15-          | _            | 20            | 40             | 60 80                   | Ē     |
|                                  |        |      |        |           |        |              |              |               |                |                         |       |
|                                  |        |      |        |           |        | 16-          | -            | •             |                |                         | -     |
|                                  |        |      |        |           |        |              |              |               |                |                         |       |
|                                  |        |      |        |           |        | 17-          | _            |               |                |                         | -     |
|                                  |        |      |        |           |        | 10           |              |               |                |                         |       |
|                                  |        |      |        |           |        | 10-          |              |               |                |                         |       |
|                                  |        |      |        |           |        | 19-          | -            |               |                |                         | _     |
|                                  |        |      |        |           |        |              |              |               |                |                         |       |
|                                  |        |      |        |           |        | 20-          | -            | •             |                |                         | -     |
|                                  |        |      |        |           |        |              |              |               |                |                         |       |
|                                  |        |      |        |           |        | 21-          | _            |               |                |                         |       |
| 2 <u>1.7</u>                     | 1      | +    |        |           |        |              |              |               |                |                         | •     |
| Practical DCPT refusal at 21 74m |        |      |        |           |        |              |              |               |                |                         |       |
| depth                            |        |      |        |           |        |              |              |               |                |                         |       |
|                                  |        |      |        |           |        |              |              |               |                |                         |       |
|                                  |        |      |        |           |        |              |              |               |                |                         |       |
|                                  |        |      |        |           |        |              |              |               |                |                         |       |
|                                  |        |      |        |           |        |              |              |               |                |                         |       |
|                                  |        |      |        |           |        |              |              |               |                |                         |       |
|                                  |        |      |        |           |        |              |              |               |                |                         |       |
|                                  |        |      |        |           |        |              |              |               |                |                         |       |
|                                  |        |      |        |           |        |              |              |               |                |                         |       |
|                                  |        |      |        |           |        |              |              |               |                |                         |       |
|                                  |        |      |        |           |        |              |              |               |                |                         |       |
|                                  |        |      |        |           |        |              |              |               |                |                         |       |
|                                  |        |      |        |           |        |              |              |               |                |                         |       |
|                                  |        |      |        |           |        |              |              | 20            | <br>40         | 60 80 1                 |       |
|                                  |        |      |        |           |        |              |              | Shea          | ar Stre        | ngth (kPa)              |       |

| natoreonar  |              | In      | Con        | sulting  | SC                             | <b>DIL PRO</b>                     | <b>OFILE AI</b>        | ND TES                        | ST DATA                    |                |
|---|--------------|---------|------------|----------|--------------------------------|------------------------------------|------------------------|-------------------------------|----------------------------|----------------|
| 154 Colonnade Road South, Ottawa, C                                   | Ontario      | K2E 7   | Engi<br>J5 | ineers   | Geotechi<br>Boundar<br>Ottawa, | nical Inve<br>y Road at<br>Ontario | stigation<br>Highway 4 | 17                            |                            |                |
| DATUM TBM - Culvert invert provid Gateway Properties.                 | ed on        | plan. G | ieodeti    | ic eleva | tion = 76.49                   | m, provide                         | ed by East             | FILE NO.                      | PG2721                     |                |
| REMARKS   |              |         |            | DA.      | TE June 26                     | 2012                               |                        | HOLE NO                       | <sup>).</sup> TP 1         |                |
|   | E            |         | SAM        | PLE      |                                |                                    | Pen. R                 | lesist. Bl                    | ows/0.3m                   |                |
| SOIL DESCRIPTION  | A PL(        |         | щ          | RY       | DEPT<br>פַּהַ (m)              | m ELEV.                            | • 5                    | 50 mm Dia                     | a. Cone                    | omete          |
|   | STRAT        | ТУРЕ    | NUMBE      |          | VALIC<br>Pr RQ                 |                                    | • <b>v</b>             | Nater Cor                     | ntent %                    | Piezo<br>Const |
| GROUND SURFACE  | 07           |         | 4          | RI :     | z °                            | 0+76.99                            | 20                     | <b>40 6</b>                   | 50 80                      |                |
| TOPSOIL        0.2         Compact to loose, brown SILTY         SAND | 6            | G       | 1          |          |                                | 1-75.99                            |                        |                               |                            | ¥              |
| 1.8   | 0            | GGG     | 3          |          |                                | 2-74.99                            |                        |                               |                            |                |
| 3.0<br>End of Test Pit  | <u>0////</u> | 4       |            |          |                                | 3-73.99                            |                        |                               |                            |                |
| (GWL @ 1.0m depth based on field observations)                        |              |         |            |          |                                |                                    | 20<br>Shea<br>▲ Undis  | 40 €<br>ar Streng<br>turbed △ | 50 80 10<br>10<br>11 (kPa) | 00             |

| natersonar   |         | in          | Cor        | sulting   |                    | SOI                             | l pro                           | FILE AI                | ND TE                       | ST DATA                                    |                |
|--|---------|-------------|------------|-----------|--------------------|---------------------------------|---------------------------------|------------------------|-----------------------------|--|----------------|
| 154 Colonnade Road South, Ottawa, C                      | Ontario | K2E 7       | Eng<br>J5  | jineers   | Geo<br>Bou<br>Otta | otechnic<br>undary I<br>awa, Or | al Inves<br>Road at I<br>Itario | tigation<br>Highway 4  | 17                          |  |                |
| DATUM TBM - Culvert invert provid<br>Gateway Properties. | ed on   | plan. G     | ieode      | tic eleva | tion =             | 76.49m,                         | , provideo                      | d by East              | FILE NO                     | PG2721                                     |                |
| REMARKS<br>BOBINGS BY Hydraulic Shovel                   |         |             |            | ٦A        | TE.lı              | ine 26. 2                       | 2012                            |                        | HOLE N                      | <sup>o.</sup> TP 2                         |                |
|  | Ę       |             | SAN        |           |                    |                                 |                                 | Pen. R                 | esist. B                    | lows/0.3m                                  | . с            |
| SOIL DESCRIPTION   | A PLC   |             | <i>c</i> ; | ЗХ        |                    | DEPTH<br>(m)                    | ELEV.<br>(m)                    | • 5                    | 50 mm Di                    | a. Cone                                    | meter          |
|  | TRAT    | ТУРЕ        | IUMBEI     |           | VALU<br>r RQI      |                                 |                                 | • v                    | Vater Co                    | ntent %                                    | Piezo<br>Const |
| GROUND SURFACE   | 03      |             | 2          | RE        | z                  | 0-                              | -77.31                          | 20                     | 40                          | 60 80                                      |                |
| TOPSOIL  | 0       | _           |            |           |                    |                                 |                                 |                        |                             |  |                |
|  |         | ·<br>·<br>· |            |           |                    |                                 |                                 |                        |                             |  |                |
|  |         |             |            |           |                    | 1-                              | - 76.31                         |                        |                             |  |                |
| SAND   |         | . <b>G</b>  | 1          |           |                    |                                 |                                 |                        |                             |  | Σ              |
|  |         | G           | 2          |           |                    |                                 |                                 |                        |                             |  |                |
| 2.1  | 0       |             |            |           |                    | 2-                              | -75.31                          |                        |                             |  |                |
|  |         | - c         | 3          |           |                    |                                 |                                 |                        |                             |  |                |
| Firm, grey SILTY CLAY                                    |         |             | 3          |           |                    |                                 |                                 |                        |                             |  |                |
|  |         |             |            |           |                    |                                 |                                 |                        |                             |  |                |
| 3.0  |         |             |            |           |                    |                                 |                                 |                        |                             |  |                |
| End of Borehole  | VERA    | 1           |            |           |                    | 3-                              | -74.31                          |                        |                             |  |                |
| (GWL @ 1.4m depth based on field observations)           |         |             |            |           |                    |                                 |                                 |                        |                             |  |                |
|  |         |             |            |           |                    |                                 |                                 |                        |                             |  |                |
|  |         |             |            |           |                    |                                 |                                 |                        |                             |  |                |
|  |         |             |            |           |                    |                                 |                                 | 20<br>Shea<br>▲ Undist | 40<br>ar Streng<br>turbed 2 | <b>60 80 1</b><br>gth (kPa)<br>∆ Remoulded | 00             |

| natersonal   |           | In      | Con       | sulting   | S                             | <b>DIL PR</b>                     |                          | ND TES                         | T DATA                           |                 |
|--|-----------|---------|-----------|-----------|-------------------------------|-----------------------------------|--------------------------|--------------------------------|----------------------------------|-----------------|
| 154 Colonnade Road South, Ottawa   | , Ontario | K2E 7   | Eng<br>J5 | ineers    | Geotech<br>Boundar<br>Ottawa, | nical Inve<br>y Road a<br>Ontario | stigation<br>t Highway 4 | 17                             |                                  |                 |
| DATUM TBM - Culvert invert prov<br>Gateway Properties.   | ided on   | olan. G | ieodet    | ic eleva  | tion = 76.49                  | )m, provid                        | ed by East               | FILE NO.                       | PG2721                           |                 |
| REMARKS  |           |         |           |           |                               |                                   |                          | HOLE NO                        | трз                              |                 |
| BORINGS BY Hydraulic Shovel  |           |         |           | DA        | TE June 20                    | 6,2012                            |                          |                                |                                  | 1               |
| SOIL DESCRIPTION   | PLOT      |         | SAN       | IPLE<br>것 | DEPT                          | H ELEV<br>(m)                     | Pen. F                   | Resist. Blo<br>50 mm Dia       | ows/0.3m<br>I. Cone              | meter<br>uction |
|  | STRATA    | ТҮРЕ    | NUMBER    | ICOVER    | VALUI<br>Dr RQD               |                                   | 0 1                      | Water Con                      | itent %                          | Piezor          |
| GROUND SURFACE   |           |         | 4         | RI :      | z                             | 0+77.63                           | 20                       | 40 6                           | 0 80                             |                 |
| <b>FILL:</b> Brown silty clay with sand, gravel, cobbles, trace boulders   |           | G       | 1         |           |                               | 1-76.63                           |                          |                                |                                  |                 |
| 2<br>_TOPSOIL2   | 2.00      | G       | 2         |           |                               | 2-75.63                           |                          |                                |                                  | 44              |
| Very stiff to stiff, red-brown <b>SILTY</b><br><b>CLAY</b><br>- firm and grey by 3.0m depth<br>3<br>End of Test Pit<br>(GWL @ 3.0m depth based on field<br>observations) | .05       | G       | 3         |           |                               | 3-74.63                           |                          |                                |                                  | ¥               |
|  |           |         |           |           |                               |                                   | 20<br>She<br>▲ Undis     | 40 6<br>ar Strengt<br>turbed △ | 0 80 10<br>th (kPa)<br>Remoulded | - <br>00        |

| natorsonard   |        | in      | Cor       | nsulting    |               | SOI                                 | l pro                           | FILE AI               | ND TE          | ST DATA                          |          |
|---|--------|---------|-----------|-------------|---------------|-------------------------------------|---------------------------------|-----------------------|----------------|----------------------------------|----------|
| 154 Colonnade Road South, Ottawa, Or  | ntario | K2E 7   | Eng<br>J5 | gineers     | G<br>B<br>O   | eotechnic<br>oundary I<br>ttawa, Or | al Inves<br>Road at I<br>Itario | tigation<br>Highway 4 | 17             |                                  |          |
| DATUM TBM - Culvert invert provider<br>Gateway Properties.  | d on p | olan. G | ieode     | tic eleva   | ation         | = 76.49m,                           | , provideo                      | d by East             | FILE NC        | <sup>).</sup> PG272 <sup>-</sup> | 1        |
| BORINGS BY Hydraulic Shovel   |        |         |           | DA          | TE            | June 26, 2                          | 2012                            |                       | HOLE N         | <sup>ю.</sup> TP 4               |          |
|   | OT     |         | SAN       | <b>IPLE</b> |               | DEPTH                               | FLEV                            | Pen. R                | esist. B       | lows/0.3m                        | er<br>on |
| SOIL DESCRIPTION  | TA PI  | ß       | ER        | ERY         | E G           | (m)                                 | (m)                             | • 5                   | 50 mm D        | ia. Cone                         | zomete   |
|   | STRA   | ТУР     | NUMB      |             | N VAI<br>of R |                                     |                                 | 0 V<br>20             | Vater Co<br>40 | 60 80                            | Con      |
| TOPSOIL   |        | _ G     | 1         |             |               | - 0-                                | -76.33                          |                       |                |                                  |          |
| Compact, brown SILTY SAND   |        | ⊑ G     | 2         |             |               |                                     |                                 |                       |                |                                  |          |
| <u>1.20</u><br>Very stiff to stiff, red to brown <b>SILTY</b><br><b>CLAY</b><br>- firm to soft and grey by 1.6m depth<br>- silty sand seam from 2.2 to 2.6m |        | G       | 3         |             |               | 1-                                  | - 75.33                         |                       | •              |                                  |          |
| αερτη   |        | GG      | 4<br>5    |             |               | 2-                                  | -74.33                          |                       |                |                                  |          |
| End of Test Pit<br>(GWL @ 1.2m depth based on field<br>observations)  |        | G       | 6         |             |               | 3-                                  | - 73.33                         |                       |                |                                  |          |
|   |        |         |           |             |               |                                     |                                 | 20<br>Shea            | 40<br>ar Stren | 60 80<br>gth (kPa)               | 100      |

| natoreonar  |          | In                         | Cons         | ulting     | SC                                | IL PRC                             | FILE A                 | ND TES                         | <b>ST DATA</b>                  |          |
|---|----------|----------------------------|--------------|------------|-----------------------------------|------------------------------------|------------------------|--------------------------------|---------------------------------|----------|
| 154 Colonnade Road South, Ottawa, C                                       | Ontario  | К2Е 7                      | Engir<br>'J5 | neers      | Geotechn<br>Boundary<br>Ottawa, C | ical Inves<br>7 Road at<br>Ontario | stigation<br>Highway 4 | 17                             |                                 |          |
| DATUM TBM - Culvert invert provid<br>Gateway Properties.                  | ed on p  | olan. G                    | Geodetic     | c elevat   | tion = 76.49r                     | n, provide                         | d by East              | FILE NO.                       | PG2721                          |          |
| REMARKS<br>BORINGS BY Hydraulic Shovel                                    |          |                            |              | DA         | TE June 26                        | 2012                               |                        | HOLE NO                        | <sup>.</sup> TP 5               |          |
|   | OT       |                            | SAMF         | PLE        | DEDTI                             |                                    | Pen. R                 | esist. Blo                     | ows/0.3m                        | - 5      |
| SOIL DESCRIPTION  | LA PL    |                            | R            | IRY        | UCF11<br>ភ្លុស (m)                | (m)                                | • 5                    | 50 mm Dia                      | a. Cone                         | omete    |
|   | STRAJ    | ТУРЕ                       | NUMBE        |            | Pr A                              |                                    | • v                    | Vater Con                      | itent %                         | Piez     |
| GROUND SURFACE  |          |                            |              | <u>к</u> , |                                   | 77.85                              | 20                     | 40 6                           | 0 80                            |          |
| <b>FILL:</b> Brown silty clay with gravel, cobbles, boulders, trace brick |          | ×<br>×<br>×<br>×<br>×<br>× |              |            |                                   |                                    |                        |                                |                                 |          |
|   |          | G                          | 1            |            |                                   | I – 76.85                          |                        |                                |                                 |          |
| Grey to brown SILTY SAND  | 0        | G                          | 2            |            | 2                                 | 2-75.85                            |                        |                                |                                 | ⊻        |
| Very stiff to stiff, brown SILTY CLAY                                     | 0        |                            |              |            |                                   |                                    |                        |                                | 11                              | 60       |
| End of Test Pit   | <u> </u> | t                          |              |            | 3                                 | 3+74.85                            |                        |                                |                                 | <b>^</b> |
| (GWL @ 2.1m depth based on field observations)                            |          |                            |              |            |                                   |                                    |                        |                                |                                 |          |
|   |          |                            |              |            |                                   |                                    | 20<br>Shea<br>▲ Undist | 40 6<br>ar Strengt<br>turbed △ | 0 80 1<br>th (kPa)<br>Remoulded | ⊣<br>00  |

| natorsonard   |                  | in      | Cons       | sulting |                           | SOI                      | l pro                           | FILE A                | ND TES                       | <b>ST DATA</b>    |                 |
|---|------------------|---------|------------|---------|---------------------------|--------------------------|---------------------------------|-----------------------|------------------------------|-------------------|-----------------|
| 154 Colonnade Road South, Ottawa, O   | ntario           | К2Е 7   | Engi<br>J5 | neers   | Geotec<br>Bound<br>Ottawa | chnic<br>Iary I<br>a, Or | al Inves<br>Road at I<br>Itario | tigation<br>Highway 4 | 17                           |                   |                 |
| DATUM TBM - Culvert invert provide<br>Gateway Properties.                   | ed on p          | olan. G | Geodeti    | c eleva | tion = 76.                | .49m                     | , provideo                      | d by East             | FILE NO.                     | PG2721            |                 |
| BORINGS BY Hydraulic Shovel   |                  |         |            | DA      | <b>TE</b> June            | 26, 2                    | 2012                            |                       | HOLE NO                      | <sup>0</sup> TP 6 |                 |
|   | LOT              |         | SAM        | PLE     | DE                        | РТН                      | ELEV.                           | Pen. R                | esist. Blo                   | ows/0.3m          | er<br>on        |
| SOIL DESCRIPTION  | TA PI            | ы       | ER         | ERY     | ្រុំ (r                   | n)                       | (m)                             | • 5                   | 0 mm Dia                     | a. Cone           | zomet           |
|   | STRA             | алт     | NUMB       |         | N VA<br>OF R              |                          |                                 | 0 V<br>20             | Vater Cor                    | ntent %           | Con             |
| GROUND SURFACE  |                  |         |            |         |                           | 0-                       | -77.19                          |                       |                              |                   |                 |
|   |                  |         |            |         |                           |                          |                                 |                       |                              |                   |                 |
|   |                  |         |            |         |                           |                          |                                 |                       |                              |                   |                 |
|   |                  |         |            |         |                           |                          |                                 |                       |                              |                   | P               |
| <b>FILL:</b> Brown silty clay with sand, gravel, cobbles, trace boulder and |                  |         |            |         |                           |                          |                                 |                       |                              |                   |                 |
| shale   |                  |         |            |         |                           |                          |                                 |                       |                              |                   |                 |
|   |                  |         |            |         |                           |                          |                                 |                       |                              |                   |                 |
|   |                  | G       | 1          |         |                           | 1-                       | -76.19                          |                       |                              |                   |                 |
|   |                  |         |            |         |                           |                          |                                 |                       |                              |                   |                 |
| 1.3(  | ) <u>XXX</u><br> | +       |            |         |                           |                          |                                 |                       |                              |                   |                 |
| Compact to loose, red-brown SILTY   |                  |         | 2          |         |                           |                          |                                 |                       |                              |                   |                 |
| 1 7(  |                  |         | 2          |         |                           |                          |                                 |                       |                              |                   |                 |
|   |                  | G       | 3          |         |                           |                          |                                 |                       |                              | 1                 | 44 <sup>⊻</sup> |
|   |                  |         |            |         |                           |                          |                                 |                       |                              |                   |                 |
| Very stiff to stiff, brown SILTY CLAY                                       |                  |         |            |         |                           | 2-                       | -75.19                          |                       |                              |                   |                 |
| - firm and grey by 2.5m depth   |                  |         |            |         |                           |                          |                                 |                       |                              |                   | Ī               |
|   |                  |         |            |         |                           |                          |                                 |                       |                              |                   |                 |
|   |                  |         |            |         |                           |                          |                                 |                       |                              |                   |                 |
|   |                  |         |            |         |                           |                          |                                 |                       |                              |                   |                 |
|   |                  |         |            |         |                           |                          |                                 |                       |                              |                   |                 |
| 3.00  |                  |         |            |         |                           | _                        |                                 |                       |                              |                   |                 |
| End of Test Pit   |                  | -       |            |         |                           | 3-                       | -74.19                          |                       |                              |                   |                 |
| (GWL @ 1.7m depth based on field  |                  |         |            |         |                           |                          |                                 |                       |                              |                   |                 |
| observations)   |                  |         |            |         |                           |                          |                                 |                       |                              |                   |                 |
|   |                  |         |            |         |                           |                          |                                 |                       |                              |                   |                 |
|   |                  |         |            |         |                           |                          |                                 |                       |                              |                   |                 |
|   |                  |         |            |         |                           |                          |                                 |                       |                              |                   |                 |
|   |                  |         |            |         |                           |                          |                                 |                       |                              |                   |                 |
|   |                  |         |            |         |                           |                          |                                 | 20                    | 40 6                         | 60 80 1           | 1<br><b>00</b>  |
|   |                  |         |            |         |                           |                          |                                 | S⊓ea<br>▲ Undist      | ar <b>∋treng</b><br>turbed △ | Remoulded         |                 |

| natorsonard   | ור     | In      | Con       | sulting  | ting SOIL PROFILE AND TEST DATA |                                 |                                 |                        |                        |                    |                        |          |                  |
|---|--------|---------|-----------|----------|---------------------------------|---------------------------------|---------------------------------|------------------------|------------------------|--------------------|------------------------|----------|------------------|
| 154 Colonnade Road South, Ottawa, Or  | ntario | K2E 7   | Eng<br>J5 | ineers   | Geo<br>Bou<br>Otta              | otechnic<br>undary F<br>awa, On | al Inves<br>Road at H<br>Itario | tigation<br>Highway 4  | 17                     |                    |                        |          |                  |
| DATUM TBM - Culvert invert provide<br>Gateway Properties.                                   | d on p | olan. G | ieodet    | ic eleva | tion =                          | 76.49m,                         | provideo                        | d by East              | FILE                   | NO.                | PG27                   | 721      |                  |
| REMARKS<br>BORINGS BY Hydraulic Shovel  |        |         |           | DA       | TE JU                           | une 26, 2                       | 2012                            |                        | HOLE                   | E NO.              | TP 7                   | 7        |                  |
| ,<br>,  | ЕO     |         | SAM       | IPLE     |                                 |                                 |                                 | Pen. R                 | esist.                 | Blow               | /s/0.3n                | n        | - 5              |
| SOIL DESCRIPTION  | A PL   |         | Ř         | IRY      | ۲<br>۲<br>۲                     | (m)                             | (m)                             | • 5                    | 0 mm                   | Dia. (             | Cone                   |          | omete<br>tructic |
|   | STRAT  | ТУРЕ    | NUMBE     |          | or RG                           |                                 |                                 | • v                    | Vater (                | Conte              | ent %                  |          | Piez             |
| GROUND SURFACE  |        |         |           | 8        |                                 | 0-                              | -76.83                          | 20                     | 40                     | 60                 | 80                     |          |                  |
| <b>FILL:</b> Brown to grey silty sand with crushed stone, some clay and gravel              |        | = G     | 1         |          |                                 |                                 |                                 |                        |                        |                    |                        |          |                  |
| Compact to loose, red to brown SILTY SAND   |        | G       | 2         |          |                                 | 1-                              | - 75.83                         |                        |                        |                    |                        |          | ¥                |
| Very stiff to stiff, red-brown <b>SILTY</b><br><b>CLAY</b><br>- firm and grey by 2.0m depth |        | G       | 3         |          |                                 | 2-                              | -74.83                          |                        |                        |                    |                        |          |                  |
| End of Test Pit<br>(GWL @ 1.5m depth based on field<br>observations)                        |        |         |           |          |                                 | 3-                              | - 73.83                         |                        |                        |                    |                        |          |                  |
|   |        |         |           |          |                                 |                                 |                                 | 20<br>Shea<br>▲ Undist | 40<br>ar Stre<br>urbed | 60<br>ength<br>△ R | 80<br>(kPa)<br>emoulde | 10<br>ed | ю                |

| natersonard  |             | In         | Cons        | sulting    |                    | SOII                      | l Pro                 | FILE AI              | ND TES                        | ST DATA                      |           |
|--|-------------|------------|-------------|------------|--------------------|---------------------------|-----------------------|----------------------|-------------------------------|------------------------------|-----------|
| 154 Colonnade Road South, Ottawa, Ot   | ГР<br>К2Е 7 | Engi<br>J5 | neers       | Geo<br>Bou | technic<br>ndary F | al Inves<br>Road at H     | tigation<br>Highway 4 | 17                   |                               |                              |           |
| DATUM TBM - Culvert invert provide Gateway Properties.                                       | d on p      | olan. G    | ieodeti     | c elevat   | tion = $7$         | <b>wa, O</b> n<br>76.49m, | provideo              | by East              | FILE NO.                      | PG2721                       |           |
| REMARKS<br>BORINGS BY Hydraulic Shovel   |             |            |             | DAT        | re Ju              | ne 26, 2                  | 2012                  |                      | HOLE NO                       | <sup>D.</sup> TP 8           |           |
|  | LOT         |            | SAM         | PLE        | D                  | DEPTH                     | ELEV.                 | Pen. R               | lesist. Bl                    | ows/0.3m                     | er<br>ion |
| SOIL DESCRIPTION   | TA PI       | E          | BER         | /ERY       | N D D              | (m)                       | (m)                   | •:                   |                               | a. Cone                      | zomet     |
| GROUND SURFACE   | STR         | ΞЛΤ        | NUME        | RECOV      | N A                |                           |                       | ଁ \<br>20            | 40 Water Co                   | ntent %<br>60 80             | Con       |
| <b>FILL:</b> Brown silty sand with gravel, cobbles, boulders, trace brick                    |             | G          | 1           |            |                    | 0-                        | -76.60                |                      |                               |                              |           |
| FILL: Dark brown silty clay with<br>gravel   |             | GG         | 2<br>3<br>4 |            |                    | 2-                        | - 75.60               |                      |                               |                              | V         |
| 2.20<br>Very stiff to stiff, red to brown SILTY<br>CLAY<br>- firm and grey by 2.6m depth<br> |             | G          | 5           |            |                    | 3-                        | -74.60                |                      |                               | 1                            | 34        |
|  |             |            |             |            |                    |                           |                       | 20<br>She<br>▲ Undis | 40 (<br>ar Streng<br>turbed ∠ | 60 80 1<br>1 <b>th (kPa)</b> | 00        |

| natoreonar  |         | In      | Con        | sulting  | SC                                | <b>NL PRO</b>                      | <b>OFILE A</b>         | ND TES      | T DATA      |                 |
|---|---------|---------|------------|----------|-----------------------------------|------------------------------------|------------------------|-------------|-------------|-----------------|
| 154 Colonnade Road South, Ottawa, O                       | ntario  | K2E 7   | Engi<br>J5 | ineers   | Geotechr<br>Boundary<br>Ottawa, 0 | nical Inve<br>y Road at<br>Ontario | stigation<br>Highway 4 | 17          |             |                 |
| DATUM TBM - Culvert invert provide<br>Gateway Properties. | ed on j | olan. G | ieodeti    | ic eleva | tion = 76.49                      | m, provide                         | ed by East             | FILE NO.    | PG2721      |                 |
| REMARKS   |         |         |            | DA       |                                   | 2012                               |                        | HOLE NO.    | TP 9        |                 |
|   | E       |         | SAM        | PLE      |                                   | , 2012                             | Pen. F                 | lesist. Blo | ws/0.3m     |                 |
| SOIL DESCRIPTION  | A PLO   |         | ~          | 2        | DEPT                              | H ELEV.<br>(m)                     | • 5                    | 50 mm Dia   | . Cone      | meter<br>uction |
|   | TRAT    | ТҮРЕ    | UMBEF      | COVEI    | r RQI                             |                                    | 0 1                    | Nater Con   | tent %      | Piezo           |
| GROUND SURFACE  | ũ       |         | E          | : KE     |                                   | 0+76.25                            | 20                     | 40 60       | <b>) 80</b> |                 |
| TOPSOIL   |         |         |            |          |                                   |                                    |                        |             |             |                 |
| 0.30  | D       |         |            |          |                                   |                                    |                        |             |             |                 |
| Compact, brown SILTY SAND                                 |         | G       | 1          |          |                                   |                                    |                        |             |             |                 |
| - red-brown by 0.6m depth                                 |         |         |            |          |                                   |                                    |                        |             |             |                 |
| 1.00  |         | G       | 2          |          |                                   |                                    |                        |             |             | . ¥             |
| 1.00  |         |         |            |          |                                   | 1+75.25                            |                        |             |             | -               |
|   |         |         | 2          |          |                                   |                                    |                        |             |             |                 |
| Very stiff to stiff, red-brown SILTY<br>CLAY              |         | LG      | 3          |          |                                   |                                    |                        |             |             |                 |
| - firm and grey by 1.5m depth                             |         |         |            |          |                                   |                                    |                        | •           |             |                 |
| - silty sand seam at 2.2m depth                           |         |         |            |          |                                   |                                    |                        |             |             |                 |
|   |         |         |            |          |                                   | 2-74.25                            |                        |             |             |                 |
|   |         |         |            |          |                                   |                                    |                        |             |             |                 |
|   |         | G       | 4          |          |                                   |                                    |                        |             |             |                 |
|   |         |         |            |          |                                   |                                    |                        |             |             |                 |
|   |         |         |            |          |                                   |                                    |                        |             |             |                 |
|   |         |         |            |          |                                   |                                    |                        |             |             |                 |
| End of Test Pit3.0!                                       | 5/1/1   | ⊈ G     | 5          |          |                                   | 3+73.25                            |                        |             |             | -               |
| (GWL @ 0.8m depth based on field                          |         |         |            |          |                                   |                                    |                        |             |             |                 |
|   |         |         |            |          |                                   |                                    |                        |             |             |                 |
|   |         |         |            |          |                                   |                                    |                        |             |             |                 |
|   |         |         |            |          |                                   |                                    |                        |             |             |                 |
|   |         |         |            |          |                                   |                                    | 20                     | 40 60       | <u> </u>    |                 |
|   |         |         |            |          |                                   |                                    | She                    | ar Strengt  | h (kPa)     |                 |
|   |         |         |            |          |                                   |                                    |                        |             | nemoulded   |                 |

| natoreonar  |                   | In                 | Con             | sulting    |                    | SOI                             | L PRO                            | FILE AN                | ND TES              | T DATA            | _             |
|---|-------------------|--------------------|-----------------|------------|--------------------|---------------------------------|----------------------------------|------------------------|---------------------|-------------------|---------------|
| 154 Colonnade Road South, Ottawa, O   | Intario           | K2E 7              | Eng<br>J5       | ineers     | Geo<br>Pro<br>Otta | otechnic<br>p. Indus<br>awa, On | al Inves<br>strial Par<br>Itario | tigation<br>k - 5341 B | oundary I           | Road              |               |
| DATUM Ground surface elevations others and, as such, are ap                 | were ii<br>proxim | nterpol<br>nate or | lated f<br>nly. | rom top    | ograp              | hic inforr                      | mation pro                       | ovided by              | FILE NO.            | PG3287            |               |
| BORINGS BY Backhoe  |                   |                    |                 | DA         | TE JI              | uly 15, 20                      | 014                              |                        | HOLE NO.            | TP 1-14           |               |
|   | Ę                 |                    | SAN             | IPLE       |                    | DEDTU                           |                                  | Pen. R                 | esist. Blo          | ws/0.3m           | , <u> </u>    |
| SOIL DESCRIPTION  | A PLO             |                    | ~               | א <u>ג</u> | ш <sub>о</sub>     | (m)                             | ELEV.<br>(m)                     | • 5                    | 0 mm Dia.           | Cone              | mete<br>uctio |
|   | RAT               | Т                  | MBEI            | OVEF       | VALU<br>RQI        |                                 |                                  | • v                    | Vater Cont          | tent %            | iezol         |
| GROUND SURFACE  | LS                |                    | DN I            | REC        | N N N              | 0                               | 77.00                            | 20                     | 40 60               | 80                |               |
| <b>FILL:</b> Brown silty clay with topsoil, trace organics, sand and gravel |                   | G                  | 1               |            |                    | 0-                              | -77.30                           |                        |                     |                   |               |
| <b>FILL:</b> Brown sand with some silt and clay                             |                   | G                  | 2               |            |                    | 1-                              | -76.30                           |                        |                     |                   | Î<br>Î        |
| Stiff to firm, red-brown <b>SILTY CLAY</b>                                  | 3                 | G                  | 3               |            |                    | 2-                              | -75.30                           |                        |                     |                   |               |
| Firm to soft, grey <b>SILTY CLAY</b>  | 4                 | G                  | 4               |            |                    | 3-                              | -74.30                           |                        |                     |                   |               |
| - trace sandy silt seams at 4.0m<br>depth                                   |                   |                    |                 |            |                    | 4-                              | -73.30                           |                        |                     |                   |               |
| 5.13  | 8                 | G                  | 5               |            |                    | 5-                              | -72.30                           |                        |                     |                   |               |
| (GWL @ 1.45m-August 13, 2014)   |                   |                    |                 |            |                    |                                 |                                  | 20<br>Shea             | 40 60<br>ar Strengt | ) 80 1<br>h (kPa) | 00            |
|   |                   |                    |                 |            |                    |                                 |                                  | ▲ Undist               | urbed $\triangle$   | Remoulded         |               |

| natoreonard   | Con     | sulting | SOIL PROFILE AND TEST DATA |            |                  |   |              |                        |  |                                      |                 |
|---|---------|---------|----------------------------|------------|------------------|---|--------------|------------------------|--|--------------------------------------|-----------------|
| 154 Colonnade Road South, Ottawa, Ontario K2E 7J5   |         |         |                            |            |                  | Geotechnical Investigation<br>Prop. Industrial Park - 5341 Boundary Road<br>Ottawa, Ontario |              |                        |  |                                      |                 |
| DATUM Ground surface elevations v<br>others and, as such, are app<br>REMARKS              | rom top | ograph  | ic inform                  | mation pro | ovided by        | FILE NO.  | PG3287       | 1                      |  |                                      |                 |
| BORINGS BY Backhoe  |         |         |                            | DA         | TE Jul           | y 15, 20  | 014          |                        | HOLE NO.   | TP 2-14                              |                 |
|   | Ę       |         | SAN                        | IPLE       |                  | соти  |              | Pen. R                 | esist. Blov  | ws/0.3m                              |                 |
| SOIL DESCRIPTION  | A PL    |         | ~                          | X          | <u></u><br>Во    | (m)   | cccv.<br>(m) | • 50 mm Dia. Cone      |  |                                      |                 |
|   | STRAT?  | ТҮРЕ    | NUMBEI                     | ECOVEI     | I VALU<br>or RQI |   |              | • v                    | Vater Cont   | ent %                                | Piezo<br>Consti |
| GROUND SURFACE  |         |         |                            | <u></u> щ  | 4                | 0-  | -77.50       | 20                     | 40 60  | <b>80</b>                            |                 |
| FILL: Brown silty clay with sand,<br>gravel, cobbles and boulders, trace<br>crushed stone |         | G       | 1                          |            |                  |   |              |                        |  |                                      |                 |
| FILL: Brown silty sand with organics  |         | G       | 2                          |            |                  | 1-  | -76.50       |                        |  |                                      |                 |
| Firm, red-brown <b>SILTY CLAY</b>   |         | G       | 3                          |            |                  | 2-  | -75.50       |                        |  |                                      | Ŧ               |
| - red-grey by 2.7 m depth   |         | G       | 4                          |            |                  | 3-  | -74.50       |                        |  |                                      |                 |
| 4.27  |         |         |                            |            |                  | 4 -   | -73.50       |                        |  |                                      |                 |
| Grey SILTY FINE SAND, trace shells  |         | G       | 5                          |            |                  |   |              |                        | · · · · · · · · · · · · · · · · · · ·  |                                      |                 |
| Soft, grey SILTY CLAY   |         | G       | 6                          |            |                  | 5-  | -72.50       |                        |  |                                      |                 |
| End of Test Pit   |         |         |                            |            |                  |   |              |                        |  |                                      |                 |
| (GWL @ 1.47m-August 13, 2014)   |         |         |                            |            |                  |   |              |                        |  |                                      |                 |
|   |         |         |                            |            |                  |   |              | 20<br>Shea<br>▲ Undist | $\begin{array}{ccc} 40 & 60 \\ \text{ar Strength} \\ \text{urbed} & \triangle \end{array}$ | 80 1<br>n ( <b>kPa)</b><br>Remoulded | 00              |

| natorennar   | In                | Con                | sulting        | SOIL PROFILE AND TEST DATA  |       |              |            |                        |                                       |                                |                |
|--|-------------------|--------------------|----------------|---|-------|--------------|------------|------------------------|---------------------------------------|--------------------------------|----------------|
| 154 Colonnade Road South, Ottawa, O                            | Intario           | К2Е 7              | Eng<br>J5      | Ingineers Geotechnical Investigation<br>Prop. Industrial Park - 5341 Boundary Road<br>Ottawa, Ontario |       |              |            |                        |                                       | Road                           |                |
| DATUM Ground surface elevations<br>others and, as such, are ap | were in<br>proxim | nterpol<br>nate or | ated f<br>lly. | rom top   | ograp | ohic inform  | mation pro | ovided by              | FILE NO.                              | PG3287                         | ,              |
| BORINGS BY Backhoe   |                   |                    |                | DA  | TE J  | uly 15, 2(   | 014        |                        | HOLE NO.                              | TP 3-14                        |                |
|  | Ę                 |                    | SAN            | IPLE  |       | DEDTU        |            | Pen. R                 | esist. Blo                            | ws/0.3m                        |                |
| SOIL DESCRIPTION   | PLC               |                    | <u>к</u>       |   | ы .   | UEPIN<br>(m) | (m)        | • 5                    | 0 mm Dia                              | . Cone                         | netei<br>uctio |
|  | TRATA             | ТҮРЕ               | IUMBEF         | COVER   | VALU  |              |            | • v                    | Vater Con                             | tent %                         | Piezor         |
| GROUND SURFACE   |                   |                    | 4              | RE  | z     | 0-           | -76.20     | 20                     | 40 60                                 | ) <b>80</b>                    |                |
| FILL: Brown to grey silty clay, trace gravel                   | o                 | G                  | 1              |   |       | -            |            |                        |                                       |                                |                |
| Compact, red-brown CLAYEY SILT<br>to SANDY SILT0.9             | 1                 | G                  | 2              |   |       | 1-           | - 75.20    |                        |                                       |                                | ¥              |
|  |                   |                    |                |   |       |              |            |                        |                                       |                                |                |
| Stiff to firm, red-brown SILTY CLAY                            |                   |                    | 2              |   |       | 2-           | -74.20     |                        |                                       |                                |                |
|  |                   | G                  | 3              |   |       |              | 70.00      |                        |                                       |                                |                |
| Compact, grey SILTY FINE SAND                                  |                   | G                  | 4              |   |       | 3-           | - 73.20    |                        |                                       |                                |                |
| <u>3.6</u>   | 6                 |                    |                |   |       | 4-           | -72.20     |                        |                                       |                                |                |
| Firm to soft, grey <b>SILTY CLAY</b>                           |                   | G                  | 5              |   |       |              |            |                        |                                       |                                |                |
| 5.13<br>End of Test Pit  | 8                 |                    |                |   |       | 5-           | -71.20     |                        |                                       |                                |                |
| (GWL @ 0.92m-August 13, 2014)                                  |                   |                    |                |   |       |              |            |                        |                                       |                                |                |
|  |                   |                    |                |   |       |              |            | 20<br>Shea<br>▲ Undist | <b>40 60</b><br>ar Strengt<br>urbed △ | ) 80 1<br>h (kPa)<br>Remoulded | 00             |

| naterconard   | sulting           | SOIL PROFILE AND TEST DAT   |                |         |        |              |              |                   |            |                      |                  |
|---|-------------------|---|----------------|---------|--------|--------------|--------------|-------------------|------------|----------------------|------------------|
| 154 Colonnade Road South, Ottawa, Or                            | ineers            | Geotechnical Investigation<br>Prop. Industrial Park - 5341 Boundary Road<br>Ottawa, Ontario |                |         |        |              |              |                   |            |                      |                  |
| DATUM Ground surface elevations we others and, as such, are app | vere ii<br>proxim | nterpol<br>nate on  | ated f<br>lly. | rom top | ograp  | hic inform   | mation pro   | ovided by         | FILE NO.   | PG3287               |                  |
| BORINGS BY Backhoe  |                   |   |                | DA      | TE JU  | uly 15, 20   | 014          |                   | HOLE NO.   | TP 4-14              |                  |
|   | E SAMPLE          |   |                |         |        |              |              | Pen. R            | esist. Blo | ows/0.3m             |                  |
| SOIL DESCRIPTION  | PLC               |   |                |         | E e    | DEPTH<br>(m) | ELEV.<br>(m) | • 50 mm Dia. Cone |            |                      | neter<br>uctio   |
|   | STRATA            | ТҮРЕ  | NUMBER         |         | DE ROD |              |              | • v               | Vater Con  | tent %               | Piezor<br>Constr |
| GROUND SURFACE  | •                 |   |                | R       | zč     | 0-           | 76.50        | 20                | 40 60      | D 80                 |                  |
| Loose to compact, light brown                                   |                   | - G   | 1              |         |        |              |              |                   |            |                      |                  |
| <u>0.9</u> 1  |                   | G   | 2              |         |        | 1-           | - 75.50      |                   |            |                      | Ţ                |
| Stiff to firm, red-grey <b>SILTY CLAY,</b> some sand            |                   | G   | 3              |         |        | 2-           | - 74.50      |                   |            |                      |                  |
| Compact, grey <b>SILTY FINE SAND</b>                            |                   | G   | 4              |         |        | 3-           | - 73.50      |                   |            |                      |                  |
| Soft, grey SILTY CLAY   |                   | G   | 5              |         |        | 4-           | -71.50       |                   |            |                      |                  |
| End of Test Pit<br>(GWL @ 1.17m-August 13, 2014)                |                   | +   |                |         |        |              |              | <b>~</b>          |            |                      |                  |
|   |                   |   |                |         |        |              |              | Shea<br>▲ Undist  | ar Strengt | h (kPa)<br>Remoulded | UU               |

| naterennar   | sulting  | SOIL PROFILE AND TEST DATA |           |         |   |              |              |                  |                   |           |        |
|--|--|----------------------------|-----------|---------|---|--------------|--------------|------------------|-------------------|-----------|--------|
| 154 Colonnade Road South, Ottawa, O                            | ntario   | K2E 7                      | Eng<br>J5 | ineers  | Geotechnical Investigation<br>Prop. Industrial Park - 5341 Boundary Road<br>Ottawa, Ontario |              |              |                  |                   |           |        |
| DATUM Ground surface elevations others and, as such, are ap    | <b>DATUM</b> Ground surface elevations were interpolated from t others and, as such, are approximate only. |                            |           |         |   |              |              | ovided by        | FILE NO.          | PG3287    |        |
| BORINGS BY Backhoe   |  |                            |           | DA      | TE 、  | July 15, 20  | 014          |                  | HOLE NO.          | TP 5-14   |        |
|  | E  |                            | SAM       | IPLE    |   |              |              | Pen. R           | esist. Blo        | ws/0.3m   |        |
| SOIL DESCRIPTION   | DIG V  | PL(                        |           | . ×     |   | DEPTH<br>(m) | ELEV.<br>(m) | • 5              | • 50 mm Dia. Cone |           |        |
|  | STRATA   | ТҮРЕ                       | NUMBEF    | KECOVEF | N VALUI<br>or RQE   |              |              | • V              | Vater Con         | tent %    | Piezol |
| GROUND SURFACE   |  |                            |           | щ       |   | 0-           | 76.50        |                  | 40 60             |           |        |
| Loose to compact, light brown SILTY SAND                       | D  | G                          | 1         |         |   |              |              |                  |                   |           |        |
| - red-brown by 0.9m depth                                      | <b>2</b>   | G                          | 2         |         |   | 1-           | - 75.50      |                  |                   |           |        |
| Firm to soft, red-brown <b>SILTY</b><br><b>CLAY,</b> some sand |  | G                          | 3         |         |   | 2-           | -74.50       |                  |                   |           |        |
| 3.05<br>Compact, grey <b>SILTY FINE SAND</b><br><u>3.66</u>    | 5 <u>-</u>  ///<br>6   | G                          | 4         |         |   | 3-           | -73.50       |                  |                   |           |        |
|  |  |                            |           |         |   | 4-           | - 72.50      |                  |                   |           |        |
| Soft, grey SILTY CLAY  | 3  | G                          | 5         |         |   | 5-           | -71.50       |                  |                   |           |        |
| End of Test Pit  |  |                            |           |         |   |              |              | 20               | 40 60             | ) 80 1    |        |
|  |  |                            |           |         |   |              |              | Snea<br>▲ Undist | ar Strengt        | Remoulded |        |

| natoreonar  | sulting   | SOIL PROFILE AND TEST DATA |                 |          |                   |              |              |   |                                |   |                   |  |  |
|---|---|----------------------------|-----------------|----------|-------------------|--------------|--------------|---|--------------------------------|---|-------------------|--|--|
| 154 Colonnade Road South, Ottawa, Ot  | 154 Colonnade Road South, Ottawa, Ontario K2E 7J5 |                            |                 |          |                   |              |              | Geotechnical Investigation<br>Prop. Industrial Park - 5341 Boundary Road<br>Ottawa, Ontario |                                |   |                   |  |  |
| DATUM Ground surface elevations workers and, as such, are appreciated of the stand | vere ir<br>proxim                                 | nterpol<br>nate or         | lated f<br>nly. | rom top  | ograp             | hic inform   | mation pr    | ovided by   | FILE NO.                       | PG3287  |                   |  |  |
| BORINGS BY Backhoe  |   |                            |                 | DA       | TE J              | uly 15, 2(   | 014          |   | HOLE NO.                       | TP 6-14   |                   |  |  |
|   | Ę   |                            | SAN             | IPLE     |                   |              |              | Pen. R  | esist. Blo                     | ws/0.3m   |                   |  |  |
| SOIL DESCRIPTION  | PLC   |                            |                 | к        |                   | DEPTH<br>(m) | ELEV.<br>(m) | • 5   | • 50 mm Dia. Cone              |   |                   |  |  |
|   | STRATA  | ТҮРЕ                       | NUMBER          | KECOVER  | N VALUE<br>or RQD |              |              | • v   | Vater Con                      | tent %  | Piezon<br>Constri |  |  |
| GROUND SURFACE  |   |                            |                 | <u>д</u> |                   | 0-           | -76.00       | 20  | 40 60                          | <b>80</b>   |                   |  |  |
| Loose to compact, light brown <b>FINE SAND,</b> some silt   |   | G                          | 1               |          |                   |              |              |   |                                |   | Ţ                 |  |  |
| <u>0.9</u> 1  |   | G                          | 2               |          |                   | 1-           | -75.00       |   |                                |   |                   |  |  |
| Stiff to soft, red-brown <b>SILTY CLAY</b>  |   |                            |                 |          |                   |              |              |   |                                |   |                   |  |  |
| - grey by 1.2m depth  |   | G                          | 3               |          |                   | 2-           | - 74.00      |   |                                |   |                   |  |  |
| Compact, grey <b>SILTY FINE SAND</b><br>3.66  |   | G                          | 4               |          |                   | 3-           | - 73.00      |   |                                |   |                   |  |  |
| Soft, grey SILTY CLAY   |   |                            |                 |          |                   | 4-           | - 72.00      |   |                                |   |                   |  |  |
| 5.18  |   | G                          | 5               |          |                   | 5-           | -71.00       |   |                                |   |                   |  |  |
| End of Test Pit   |   |                            |                 |          |                   |              |              |   |                                |   |                   |  |  |
| (GWL @ 0.53m-August 13, 2014)   |   |                            |                 |          |                   |              |              |   |                                |   |                   |  |  |
|   |   |                            |                 |          |                   |              |              | 20<br>Shea<br>▲ Undist  | 40 60<br>ar Strengt<br>urbed △ | ) <mark>8</mark> 0 1<br><b>h (kPa)</b><br>Remoulded | 00                |  |  |

## 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<br>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   |  |  |  |
| Сс   | - | Concavity coefficient = $(D30)^2 / (D10 \times D60)$   |  |  |  |
| Cu   | - | Uniformity coefficient = D60 / D10   |  |  |  |
| Cc and Cu are used to assess the grading of sands and gravels: |   |  |  |  |  |

Well-graded gravels have: 1 < Cc < 3 and Cu > 4Well-graded sands have: 1 < Cc < 3 and Cu > 4Well-graded sands have: 1 < Cc < 3 and Cu > 6Sands 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)         |
| Сс         | - | Compression index (in effect at pressures above p'c)           |
| OC Ratio   |   | Overconsolidaton ratio = p'c / p'o                             |
| Void Ratio | D | 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 Topsoil Asphalt Peat Sand Silty Sand Fill Δ Sandy Silt Clay Silty Clay Clayey Silty Sand Glacial Till Shale Bedrock

### MONITORING WELL AND PIEZOMETER CONSTRUCTION





















#### Certificate of Analysis **Client: Paterson Group Consulting Engineers** Client PO: 23058

Order #: 1804169

Report Date: 29-Jan-2018 Order Date: 23-Jan-2018

**Project Description: PG4366** 

|                          | Client ID:<br>Sample Date:<br>Sample ID: | BH1 5'-7'<br>27-Dec-17<br>1804169-01 | BH1 7'6"-9'6"<br>03-Jan-18<br>1804169-02 | - | - |
|--------------------------|--|--------------------------------------|--|---|---|
|                          | MDL/Units                                | Soil                                 | Soil                                     | - | - |
| Physical Characteristics |  |                                      |  |   |   |
| % Solids                 | 0.1 % by Wt.                             | 79.5                                 | 53.9                                     | - | - |
| General Inorganics       |  |                                      |  |   |   |
| рН                       | 0.05 pH Units                            | 6.91                                 | 7.61                                     | - | - |
| Resistivity              | 0.10 Ohm.m                               | 20.4                                 | 51.2                                     | - | - |
| Anions                   |  |                                      |  |   |   |
| Chloride                 | 5 ug/g dry                               | 27                                   | 25                                       | - | - |
| Sulphate                 | 5 ug/g dry                               | 365                                  | 41                                       | - | - |

## **APPENDIX 2**

FIGURE 1 - KEY PLAN

FIGURE 2 - SHEAR WAVE VELOCITY PROFILE AT SHOT LOCATION 34.5 m

DRAWING PG4366-1 - TEST HOLE LOCATION PLAN

## FIGURE 1 KEY PLAN



8



Figure 2 – Shear Wave Velocity Profile at Shot Location 34.5 m

8



Figure 2 – Shear Wave Velocity Profile at Shot Location 34.5 m



| patorcoparoup  |     |           |      |         | BROCCOLINI  |  |
|--|-----|-----------|------|---------|---|--|
| patersongroup  |     |           |      |         | GEOTECHNICAL INVESTIGATION                        |  |
| consulting engineers   |     |           |      |         | PROP. WAREHOUSE COMPLEX - BOUNDARY ROAD AT HIGHWA |  |
|  |     |           |      |         | OTTAWA,   |  |
| 154 Colonnade Road South   |     |           |      |         | Title:  |  |
| Ottawa, Ontario K2E 7J5<br>Tel: (613) 226-7381 Eax: (613) 226-6344 | 0   |           |      |         | TEST HOLE LOCATION PLAN                           |  |
| 101. (010) 220-70011 ax. (010) 220-0044                            | NO. | REVISIONS | DATE | INITIAL |   |  |

|         | Scale:       |        | Date:           |  |  |
|---------|--------------|--------|-----------------|--|--|
|         |              | 1:4000 | 02/2018         |  |  |
|         | Drawn by:    |        | Report No.:     |  |  |
| Y 417   |              | RCG    | PG4366-1        |  |  |
| ONTARIO | Checked by:  |        | Dwg. No.:       |  |  |
|         |              | SD     | DC/266 1        |  |  |
|         | Approved by: |        | FG4300-1        |  |  |
|         |              | CDS    | Revision No.: 0 |  |  |