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# Geotechnical Investigation

## Proposed Residential Development
## Half Moon Bay South
## 3718 Greenbank Road - Ottawa

Prepared For

Mattamy Homes

March 17 , 2022

Report: PG5690-1 Revision 3

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# Table of Contents

# Appendices

# 1.0 Introduction

Paterson Group (Paterson) was commissioned by Mattamy Homes to conduct a geotechnical investigation for the proposed development located at 3718 Greenbank Road, in the City of Ottawa (refer to Figure 1 - Key Plan presented in Appendix 2).

The objective of the investigation was to:

- ☐ determine the subsoil and groundwater conditions at this site by means of a borehole program.
- ☐ provide geotechnical recommendations for the design of the proposed development based on the results of the boreholes and other soil information available.

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

# 2.0 Proposed Development

It is understood that the current phase of the proposed development will consist of residential condominium blocks with or without basements and a commercial block. Associated driveways, local roadways and landscaping areas are also anticipated as part of the proposed development. Specific details of the commercial block were not available at the time of issuance of this report. Therefore, our present recommendations should not be considered for the commercial block development until review of the block details can be completed by Paterson.

It is further understood that the proposed development will be serviced by future municipal water, sanitary and storm services.

# 3.0 Method of Investigation

## 3.1 Field Investigation

The initial field program for the current geotechnical investigation was carried out between February 17 and 23, 2021 and consisted of advancing a total of 12 boreholes to a maximum depth of 9.8 m below the existing grade.

A supplemental field program for the current geotechnical investigation was carried out between July 11 and 12, 2021 and consisted of advancing a total of 7 boreholes to a maximum depth of 8.2 m below the existing grade. The scope of the supplemental field program was to further delineate the fill material placed throughout the south and southwest portions of the site.

Previous investigations were completed within the general area and surroundings of the subject site and consisted of a series of boreholes and test pits advanced to a maximum depth of 9.1 m below ground surface. The borehole locations were distributed in a manner to provide general coverage of the subject site and taking into consideration current site conditions. The test holes locations and fill locations are shown on Drawings PG5690-1 - Test Hole Location Plan and PG5690-2 - Fill Delineation Plan, respectively, included in Appendix 2.

The test holes were completed using a track mounted drill operated by a two-person crew. All fieldwork was conducted under the full-time supervision of Paterson personnel under the direction of a senior engineer. The drilling procedure consisted of drilling to the required depths at the selected locations, and sampling and testing the overburden.

### Sampling and In Situ Testing

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

The Standard Penetration Test (SPT) was conducted in conjunction with the recovery of the split-spoon samples. The SPT results are recorded as “N” values on the Soil Profile and Test Data sheets.

The "N" value is the number of blows required to drive the split-spoon sampler 300 mm into the soil after a 150 mm initial penetration using a 63.5 kg hammer falling from a height of 760 mm.

The thickness of the silty sand deposit was evaluated by a dynamic cone penetration testing (DCPT) completed at BH 7-21. 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 at the test hole locations were recorded in detail in the field. Our findings are presented in the Soil Profile and Test Data sheets in Appendix 1.

### Groundwater Monitoring

Boreholes BH 1-21 to BH 12-21 were fitted with flexible piezometers to allow groundwater level monitoring. The groundwater observations are discussed in Subsection 4.3 and presented in the Soil Profile and Test Data sheets in Appendix 1.

### Sample Storage

All samples from the supplemental field program 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 otherwise directed.

## 3.2 Field Survey

The test hole locations were determined by Paterson personnel and surveyed in the field by Paterson using a handheld, high precision GPS. The ground surface elevation at each test hole location is referenced to a geodetic datum. The locations of the boreholes are presented on Drawing PG5690-1 - Test Hole Location Plan in Appendix 2.

## 3.3 Laboratory Testing

Soil samples were collected from the subject site during the investigation and were visually examined in our laboratory to review the results of the field logging. Three grain size distribution analyses were completed on selected soil samples as part of the initial field program. The results of our testing are presented in Subsection 4.2 and on Grain Size Distribution Analysis sheets presented in Appendix 1.

## 3.4 Analytical Testing

One (1) soil sample was submitted for analytical testing to assess the corrosion potential for exposed ferrous metals and the potential of sulphate attacks against subsurface concrete structures. The sample was submitted to determine the concentration of sulphate and chloride, the resistivity and the pH of the sample. The results are presented in Appendix 1 and are discussed further in Subsection 6.7.

# 4.0 Observations

## 4.1 Surface Conditions

The subject site is a former agricultural land. The bulk of the current phase of the proposed development has been recently cleared of topsoil and peat which has been stockpiled in several piles across the site. The ground surface across the subject site varies in elevation as excavations and fill stockpiles. Generally, the northern part of the site is at an approximate geodetic elevation of 105 to 108 m and slopes down to the west to an approximate elevation of 101 to 103 m, and the southern portion of the site contains fill placed to an approximate elevation of 106 to 109 m.

It should be noted that parts of the subject site had undergone excavation and in-filling activities as part of a previous sand extraction operation. Historical aerial photographs of the site indicating fill movement activities since 1976 are presented in Appendix 2. The area to the south is significantly elevated. The area to the north and west also present a steep slope where fill was encountered.

The site is bordered to the south by a park and vacant land and to the north and west by future residential developments and the east by the future Greenbank Road.

## 4.2 Subsurface Profile

Generally, the subsurface profile across the subject site consists of varying amounts of fill consisting of silty sand mixed with occasional silty clay, gravel and cobbles.

Based on the observations in the test hole logs, a significant amount of fill material is present within the south portion of the site (proposed commercial block). The fill was observed to extend across the majority of the proposed commercial block, with a thickness of 4.6 to 8.2 m and an approximate minimum geodetic elevation of 97.8 m. Fill material was also observed around boreholes BH 12-21 and BH 14-21, with a thickness of 1.5 to 2.9 m and an approximate minimum geodetic elevation of 98.4 m.

A deep deposit of compact to very dense brown silty sand to underlain the fill layer, or at ground surface. Gravel and cobbles were occasionally encountered within the silty sand layer. The silty sand was observed to be underlain by a glacial till deposit composed of dense brown sandy silt to silty sand with gravel, cobbles and boulders within BH 3-21.

Practical refusal to augering was encountered at a range between 4.6 m and 8.3 m below existing ground surface. Practical refusal to DCPT was encountered at 9.8 m below existing ground surface at BH 7-21.

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.

### Bedrock

Based on available geological mapping, the bedrock in the subject area consists of Paleozoic interbedded Sandstone and Dolomite from the March formation, with an overburden drift thickness of 10 to 15 m depth.

### Grain Size Distribution and Hydrometer Testing

Grain size distribution (sieve and hydrometer analysis) testing was completed on three selected soil samples. The results of the grain size analysis are summarized in Table 1 and presented on the Grain-Size Distribution and Hydrometer Testing Results sheets in Appendix 1.

**Table 1 - Grain Size Distribution**

| Borehole | Sample | Gravel (%) | Sand (%) | Silt and Clay (%) |
|---|---|---|---|---|
| BH2-21 | SS3 & SS4 | 1.8 | 89.4 | 8.8 |
| BH4-21 | SS4 & SS5 | 0 | 88.9 | 11.1 |
| BH8-21 | SS4 & SS5 | 46.9 | 43.1 | 10 |

## 4.3 Groundwater

Groundwater levels were measured in the groundwater monitoring wells on March 4, 2021. The piezometers in BH 7-21, BH 11-21 and BH 12-21 were damaged or buried and could not be recorded. The remaining boreholes were dry upon completion.

Long-term groundwater level can also be estimated based on the observed moisture levels, colour and consistency of the recovered soil samples. Based on these observations, the long-term groundwater table can be expected well below 8 m below existing ground surface. It should be noted that groundwater levels are subject to seasonal fluctuations. Therefore, the groundwater level could vary at the time of construction.

## 4.4 Low Impact Development Review

Based on the latest Site Servicing Plan prepared by Stantec Consulting Ltd. dated January 14, 2022, it is our understanding that Low Impact Development (LID) measures are being considered for the current phase of the proposed development. It is further understood that the proposed LID will incorporate a treatment train approach that includes an Etobicoke Exfiltration System (EES) along select roadways within the proposed development.

Upon reviewing the subsurface profile across the subject site and the site servicing plan details, it is anticipated that the subsoil below the proposed exfiltration system will generally consist of either a deep silty sand deposit with varying amounts of gravel, or fill material comprised of silty sand with varying amounts of silty clay, gavel and cobbles. The silty sand deposit has been identified within the north and central portion of the current phase, while the fill material has been generally observed within the south portion of the development.

### Hydraulic Conductivity and Infiltration Values

Hydraulic conductivity testing was not completed as part of the geotechnical investigations for the proposed development. However, testing completed at select monitoring wells directly south of the subject site as part of the Community Development Plan (CDP) determined that the hydraulic conductivity of the silty sand deposit ranged from $1.8 \times 10^{-6}$ to $4.7 \times 10^{-6}$ m/s. Hydraulic conductivity testing of the silty sand deposit was also completed on adjacent properties to the north and west of the subject site, and generally consisted of values greater than the results encountered at the monitoring wells directly south of the site. With regards to the fill material, hydraulic conductivity values have been estimated based on previous experience with similar fill composition. The hydraulic conductivity values and infiltration rates for the subsoils at the subject site have been estimated and summarized in Table 2 below, and are based on previous experience and testing in the adjacent sites. Given the subsurface profile encountered across the subject site, a conservative safety correction factor of 2.5 has been applied to the estimated infiltration rates. The safety correction factor is based on the *2010 Low Impact Development Stormwater Management Planning and Design Guide* prepared by the CVC and the TRCA.

**Table 2 - Estimated Hydraulic Conductivity and Infiltration Rates**

| Soil Type | K (m/sec) | Infiltration Rate (mm/hr) | Reduced Infiltration Rate (mm/hr) |
|---|---|---|---|
| Native Silty Sand | 1.8E-06 to 2.0E-04 | 50 to 195 | 20 to 78 |
| Fill Material | 1.0E-07 to 1.0E-04 | 25 to 160 | 10 to 64 |

## Suitability of LID

Given the estimated hydraulic conductivity and infiltration rates noted in Table 2, both the native silty sand deposit and fill material anticipated below the proposed exfiltration system are considered suitable for the use of LIDs. However, it is recommended that hydraulic conductivity testing be completed prior to detail design to confirm the estimated values discussed in the current report.

## Groundwater

Based on the groundwater levels and physical soil parameters that were measured during the field investigations, the long-term groundwater table is expected at a depth greater than 8 to 9 m below existing ground surface. As such, sufficient separation between the proposed exfiltration system and the groundwater table is anticipated at the subject site.

# 5.0 Discussion

## 5.1 Geotechnical Assessment

From a geotechnical perspective, the subject site is suitable for the proposed residential development. It is anticipated that the proposed buildings will be founded over conventional footings placed over an undisturbed compact to dense silty sand or dense glacial till bearing surface or an engineered fill pad over an approved fill subgrade bearing medium.

To adequately distribute the foundation loads in areas where the existing fill is encountered below the building footprint, a woven geotextile liner, such as Terratrack 200 or equivalent, should be placed 500 mm below design underside of footing level and extend at least 1 m horizontally beyond the footing face. A biaxial geogrid, such as Terrafix TBX2500 or equivalent, should be placed over the woven geotextile liner. A minimum 500 mm thick pad, consisting of a Granular B Type II, compacted to 98% of its SPMDD should be placed up to design underside of footing level. Prior to placement of the abovenoted engineered fill pad, it is recommended that a proof-rolling program be completed by a vibratory roller making several passes and approved by Paterson personnel over the sub-excavated area below the proposed footings.

For areas where a fill layer is encountered below the granular layer for the floor slab, it is recommended to sub-excavate 500 mm below the underside of floor slab granulars and place a woven geotextile liner, such as Terratrack 200W or equivalent, and a biaxial geogrid, such as Terrafix TBX2500 or equivalent. It is recommended that a proof-rolling program be completed by a vibratory roller making several passes and approved by Paterson personnel prior to placement of the geotextile liner and biaxial geogrid. Any poor performing areas should be removed and reinstated with a select subgrade fill compacted to 98% of its SPMDD under dry and above freezing temperatures.

The proof-rolling program should also be completed across paved areas to ensure that any poor performing soils are removed prior to pavement structure placement.

Due to the absence of a silty clay deposit, the aforementioned site will not be subjected to permissible grade raise restrictions. Also, no tree planting setback restrictions are required for the subject phase of the proposed development due to the absence of a silty clay deposit.

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

## 5.2 Site Grading and Preparation

### Stripping Depth

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

### Fill Placement

Fill used for grading beneath the proposed building areas should consist, unless otherwise specified, of clean imported granular fill, such as Ontario Provincial Standard Specifications (OPSS) Granular A or Granular B Type II. The fill should be placed in lifts of 300 mm thick or less and compacted using suitable compaction equipment for the lift thickness. Fill placed beneath the building areas should be compacted to at least 99% of the Standard Proctor Maximum Dry Density (SPMDD).

Non-specified existing fill along with site-excavated soil can be used as general landscaping fill and beneath parking areas where settlement of the ground surface is of minor concern. In landscaped areas, these materials should be spread in thin lifts and at least compacted by the tracks of the spreading equipment to minimize voids. If these materials are to be used to build up the subgrade level for areas to be paved, they should be compacted in thin lifts to a minimum density of 95% of the SPMDD.

Non-specified existing fill and site-excavated soils are not suitable for use as backfill against foundation walls unless a composite drainage blanket connected to a perimeter drainage system is provided.

### Proof Rolling

Proof rolling of the subgrade is required in areas where the existing fill, free of significant amounts of organics and deleterious materials, is encountered. It is recommended that the subgrade surface be proof-rolled **under dry conditions and in above freezing temperatures** by an adequately sized roller making several passes to achieve optimum compaction levels. The compaction program should be reviewed and approved by the geotechnical consultant at the time of construction.

## 5.3 Foundation Design

### Conventional Spread Footings

Footings placed directly on an undisturbed, compact silty sand or glacial till bearing surface can be designed using a bearing resistance value at serviceability limit states (SLS) of **150 kPa** and a factored bearing resistance value at ultimate limit states (ULS) of **225 kPa**. A geotechnical resistance factor of 0.5 was applied to the above noted bearing resistance value at ULS.

Footings placed over a minimum 500 mm thick geogrid reinforced engineered pad, consisting of a Granular A or Granular B Type II or approved granular fill alternative placed in maximum 300 mm loose lifts and compacted to 98% of its SPMDD, placed over a subgrade soil approved by the Paterson personnel at the time of construction, can be designed using a bearing resistance value at SLS of **150 kPa** and a factored bearing resistance value at ULS of **250 kPa**.

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.

Footings placed on a soil bearing surface and designed using the bearing resistance values at SLS given above will be subjected to potential post construction total and differential settlements of 25 and 20 mm, respectively.

Where the silty sand subgrade is found to be in a loose state, the contractor should compact the subgrade under dry conditions and above freezing temperatures, using suitable compaction equipment, making several passes and approved by Paterson.

### Lateral Support

The bearing medium under footing-supported structures is required to be provided with adequate lateral support with respect to excavations and different foundation levels. Adequate lateral support is provided to the in-situ bearing medium soils above the groundwater table when a plane extending down and out from the bottom edge of the footing at a minimum of 1.5H:1V passes only through in situ soil of the same or higher capacity as the bearing medium soil.

## 5.4 Design for Earthquakes

The site class for seismic site response can be taken as **Class D**. Based on the current information, including the level of groundwater table and compactness of the underlying sand layer, the soil underlying the subject site is not susceptible to liquefaction. Reference should be made to the latest revision of the 2012 Ontario Building Code for a full discussion of the earthquake design requirements.

## 5.5 Basement Slab / Slab-on-Grade Construction

With the removal of all topsoil and fill, containing significant amounts of deleterious or organic materials, the native soil and/or approved fill pad (placed as per Subsection 5.0) will be considered to be an acceptable subgrade surface on which to commence backfilling for the floor slab. Any poor performing areas should be removed and reinstated with an engineered fill, such as Granular B Type II.

For slab-on-grade areas, it is recommended that the upper 200 mm of sub-slab fill consist OPSS Granular A crushed stone. For basement slabs, it is recommended that the upper 200 mm of sub-floor fill consist of 19 mm clear crushed stone

## 5.6 Basement Wall

There are several combinations of backfill materials and retained soils that could be applicable for the basement walls of the subject structure. However, the conditions can be well-represented by assuming the retained soil consists of a material with an angle of internal friction of 30 degrees and a bulk (drained) unit weight of 18 kN/m$^3$.

Where undrained conditions are anticipated (i.e. below the groundwater level), the applicable effective (undrained) unit weight of the retained soil can be taken as 13 kN/m$^3$, where applicable. A hydrostatic pressure should be added to the total static earth pressure when using the effective unit weight.

### Lateral Earth Pressures

The static horizontal earth pressure ($p_o$) can be calculated using a triangular earth pressure distribution equal to $K_o \cdot \gamma \cdot H$ where:

$K_o$ = at-rest earth pressure coefficient of the applicable retained soil (0.5)
$\gamma$ = unit weight of fill of the applicable retained soil (kN/m$^3$)
H = height of the wall (m)

An additional pressure having a magnitude equal to $K_o \cdot q$ and acting on the entire height of the wall should be added to the above diagram for any surcharge loading, q (kPa), that may be placed at ground surface adjacent to the wall. The surcharge pressure will only be applicable for static analyses and should not be used in conjunction with the seismic loading case.

Actual earth pressures could be higher than the “at-rest” case if care is not exercised during the compaction of the backfill materials to maintain a minimum separation of 0.3 m from the walls with the compaction equipment.

### Seismic Earth Pressures

The total seismic force ($P_{AE}$) includes both the earth force component ($P_o$) and the seismic component ($\Delta P_{AE}$).

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

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

$g$ = gravity, 9.81 $m/s^2$

The peak ground acceleration, ($a_{max}$), for the Ottawa area is 0.32g according to OBC 2012. Note that the vertical seismic coefficient is assumed to be zero.

The earth force component ($P_o$) under seismic conditions can be calculated using

$P_o = 0.5\ K_o\ \gamma\ H^2$, where $K_o = 0.5$ for the soil conditions noted above.

The total earth force ($P_{AE}$) is considered to act at a height, h (m), from the base of the wall, where:

$h = \{P_o \cdot (H/3) + \Delta P_{AE} \cdot (0.6$

## 5.7 Pavement Structure

Driveways, local residential roadways, heavy truck parking/loading areas and roadways with bus traffic are anticipated at this site. The proposed pavement structures are shown in Tables 3, 4 and 5.

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 100% of the material's SPMDD using suitable vibratory equipment. Minimum Performance Graded (PG) 58-34 asphalt cement should be used for this project.

**Table 3 - Recommended Pavement Structure - Driveways and at-grade car parking areas**

| Thickness (mm) | Material Description |
|---|---|
| 50 | **Wear Course** - HL 3 or Superpave 12.5 Asphaltic Concrete |
| 150 | **BASE** - OPSS Granular A Crushed Stone |
| 300 | **SUBBASE** - OPSS Granular B Type II |
| **SUBGRADE** - Either fill, in situ soil or OPSS Granular B Type I or II material placed over in situ soil or fill | |

**Table 4 - Recommended Pavement Structure - Local Residential Roadways and Heavy Truck Parking / Loading Areas**

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

**Table 5 - Recommended Pavement Structure - Roadways with Bus Traffic**

| Thickness mm | Material Description |
|---|---|
| 40 | **Wear Course -** Superpave 12.5 Asphaltic Concrete |
| 50 | **Upper Binder Course** - Superpave 19.0 Asphaltic Concrete |
| 50 | **Lower Binder Course** - Superpave 19.0 Asphaltic Concrete |
| 150 | **BASE** - OPSS Granular A Crushed Stone |
| 600 | **SUBBASE** - OPSS Granular B Type II |
| **SUBGRADE** - Either in situ soil or OPSS Granular B Type II material placed over in situ soil | |

# 6.0 Design and Construction Precautions

## 6.1 Foundation Drainage and Backfill

### Foundation Drainage

A perimeter foundation drainage system is recommended for proposed structures. The system should consist of a 100 to 150 mm diameter, geotextile-wrapped, 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 site materials will be frost susceptible and, as such, are not recommended for re-use as backfill unless a composite drainage system (such as system Delta Drain 6000 or Miradrain G100N) connected to a perimeter drainage system is provided.

## 6.2 Protection Against Frost Action

Perimeter footings of heated structures are required to be insulated against the deleterious effect of frost action. A minimum 1.5 m thick soil cover should be provided for adequate frost protection of heated structured, or an equivalent combination of soil cover and foundation insulation.

Exterior unheated footings, such as those for isolated exterior piers and loading docks, 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 the excavations in the soil and fill overburden materials should either be cut back at acceptable slopes or should be retained by shoring systems from the start of the excavation until the structure is backfilled. It is expected that sufficient room will be available for the greater part of the excavation to be undertaken by open-cut methods (i.e. unsupported excavations).

### Unsupported Excavations

The excavation side slopes above the groundwater level extending to a maximum depth of 3 m should be cut back at 1H:1V or shallower. The shallower slope is required for excavation below groundwater level. The subsoil at this site is considered to be mainly Type 2 and 3 soil according to the Occupational Health and Safety Act and Regulations for Construction Projects.

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

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

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

## 6.4 Pipe Bedding and Backfill

Bedding and backfill materials should be in accordance with the most recent Material Specifications & 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 98% of the material’s SPMDD.

It should generally be possible to re-use the site excavated 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 1.5 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 lifts and compacted to 95% of the materials SPMDD.

## 6.5 Groundwater Control

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

### Permit to Take Water

A temporary Ministry of the Environment, Conservation and Parks (MECP) permit to take water (PTTW) may be required for this project if more than 400,000 L/day of ground and/or surface water is to be pumped during the construction phase. A minimum of 4 to 5 months should be allowed for completion of the PTTW application package and issuance of the permit by the MECP.

For typical ground or surface water volumes being pumped during the construction phase, between 50,000 to 400,000 L/day, it is required to register on the Environmental Activity and Sector Registry (EASR). A minimum of two to four weeks should be allotted for completion of the EASR registration and the Water Taking and Discharge Plan to be prepared by a Qualified Person as stipulated under O.Reg. 63/16. If a project qualifies for a PTTW based upon anticipated conditions, an EASR will not be allowed as a temporary dewatering measure while awaiting the MECP review of the PTTW application.

## 6.6 Winter Construction

Precautions must be taken if winter construction is considered for this project, where excavations are completed in proximity of existing structures which may be adversely affected due to the freezing conditions.

In the event of construction during below zero temperatures, the founding stratum should be protected from freezing temperatures by the installation of straw, propane heaters and tarpaulins or other suitable means. The base of the excavations should be insulated from sub-zero temperatures immediately upon exposure and until such time as heat is adequately supplied to the building and the footings are protected with sufficient soil cover to prevent freezing at founding level.

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

## 6.7 Corrosion Potential and Sulphate

The results on analytical testing show that the sulphate content is less than 0.1%. The results are 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 very low to slightly aggressive corrosive environment.

# 7.0 Recommendations

It is recommended that the following be completed once the master plan and site development are determined:

☐ Review detailed grading plan(s) from a geotechnical perspective.

☐ 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 placing backfilling materials.

☐ 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 Paterson's recommendations could be issued upon request, following the completion of a satisfactory material testing and observation program by the geotechnical consultant.

# 8.0 Statement of Limitations

The recommendations made in this report are in accordance with Paterson's present understanding of the project. Paterson requests permission to review the grading plan once available. Paterson's recommendations should be reviewed when the drawings and specifications are complete.

The client should be aware that any information pertaining to soils and the test hole log are furnished as a matter of general information only. Test hole descriptions or logs are not to be interpreted as descriptive of conditions at locations other than those of the test holes.

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

The present report applies only to the project described in this document. Use of this report for purposes other than those described herein or by person(s) other than Mattamy Homes or their agent(s) is not authorized without review by this firm for the applicability of our recommendations to the altered use of the report.

**Paterson Group Inc.**

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100156744
PROVINCE OF ONTARIO

Nicholas Zulinski, M.Sc., P.Geo., géo.

**Report Distribution:**

- ❑ Mattamy Homes (1 digital copy)
- ❑ Paterson Group (1 copy)

# APPENDIX 1

## SOIL PROFILE AND TEST DATA SHEETS

## SYMBOLS AND TERMS

## GRAIN SIZE DISTRIBUTION ANALYSIS

## ANALYTICAL TESTING

**patersongroup** Consulting Engineers

154 Colonnade Road South, Ottawa, Ontario K2E 7J5

# SOIL PROFILE AND TEST DATA

**Geotechnical Investigation**
**Proposed Mixed Use Development**
**3718 Greenbank Road - Ottawa, Ontraio**

**DATUM** Geodetic

**REMARKS**

**BORINGS BY** CME 55 Power Auger

**DATE** 2021 February 17

**FILE NO.** PG5690

**HOLE NO.** BH 1-21

| SOIL DESCRIPTION | SAMPLE TYPE | SAMPLE NUMBER | % RECOVERY | N VALUE or RQD |
|---|---|---|---|---|
| GROUND SURFACE | | | | |
| Compact to dense, brown **SILTY SAND** | AU | 1 | | |
| | SS | 2 | 75 | 17 |
| | SS | 3 | 75 | 14 |
| | SS | 4 | 83 | 17 |
| - Trace gravel by 3.0 m depth | SS | 5 | 83 | 13 |
| | SS | 6 | 67 | 25 |
| | SS | 7 | 75 | 11 |
| | SS | 8 | 75 | 20 |
| | SS | 9 | 83 | 27 |
| | SS | 10 | 92 | 35 |
| | SS | 11 | 83 | 24 |
| 8.99 | SS | 12 | 83 | 32 |
| End of Borehole<br>(Piezometer dry - March 4, 2021) | | | | |

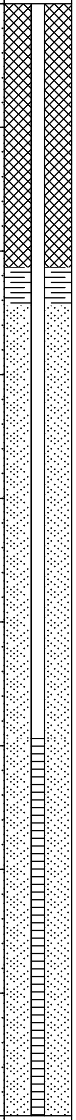
| DEPTH (m) | ELEV. (m) |
|---|---|
| 0 | 103.45 |
| 1 | 102.45 |
| 2 | 101.45 |
| 3 | 100.45 |
| 4 | 99.45 |
| 5 | 98.45 |
| 6 | 97.45 |
| 7 | 96.45 |
| 8 | 95.45 |

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

○ Water Content %

20 40 60 80

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



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## SOIL PROFILE AND TEST DATA

**Geotechnical Investigation**
**Proposed Mixed Use Development**
**3718 Greenbank Road - Ottawa, Ontraio**

**DATUM** Geodetic

**REMARKS**

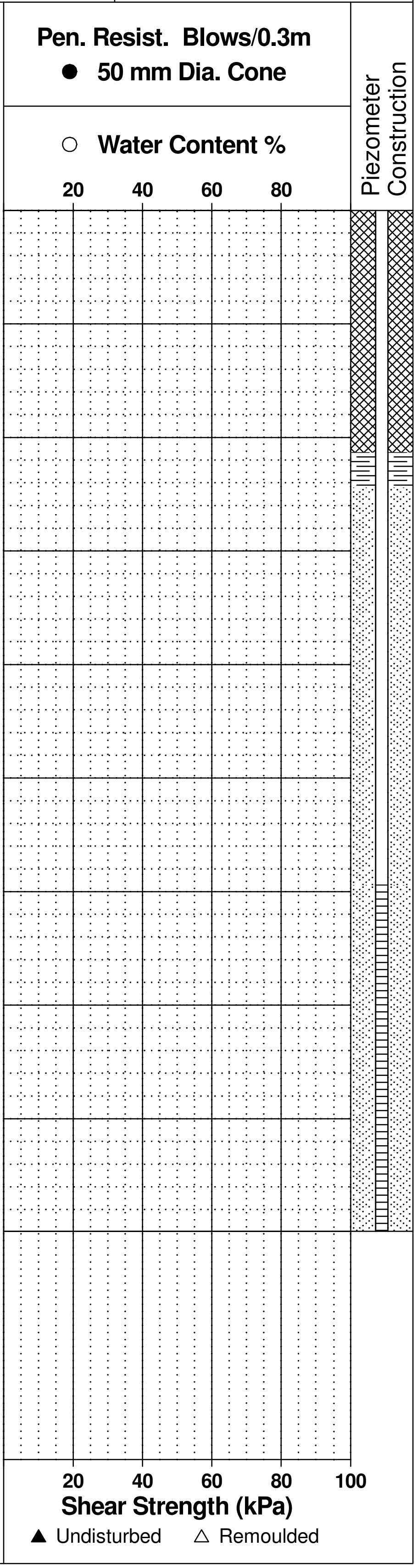
**BORINGS BY** CME 55 Power Auger

**DATE** 2021 February 17

**FILE NO.** PG5690

**HOLE NO.** BH 2-21

| SOIL DESCRIPTION | SAMPLE TYPE | SAMPLE NUMBER | SAMPLE % RECOVERY | SAMPLE N VALUE or RQD | DEPTH (m) | ELEV. (m) |
|---|---|---|---|---|---|---|
| GROUND SURFACE | | | | | 0 | 102.61 |
| Compact to dense, brown **SILTY SAND** | AU | 1 | | | | |
| | SS | 2 | 75 | 25 | 1 | 101.61 |
| | SS | 3 | 75 | 19 | 2 | 100.61 |
| | SS | 4 | 75 | 56 | | |
| | | | | | 3 | 99.61 |
| | SS | 5 | 83 | 32 | | |
| | SS | 6 | 67 | 39 | 4 | 98.61 |
| | SS | 7 | 75 | 28 | 5 | 97.61 |
| | SS | 8 | 75 | 32 | | |
| | | | | | 6 | 96.61 |
| | SS | 9 | 75 | 33 | | |
| | SS | 10 | 75 | 30 | 7 | 95.61 |
| - Trace gravel by 7.5 m depth | | | | | | |
| | SS | 11 | 75 | 37 | 8 | 94.61 |
| | SS | 12 | 75 | 30 | | |
| 8.99 | | | | | | |
| End of Borehole<br>(Piezometer dry - March 4, 2021) | | | | | | |



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# SOIL PROFILE AND TEST DATA

**Geotechnical Investigation**
**Proposed Mixed Use Development**
**3718 Greenbank Road - Ottawa, Ontraio**

**DATUM** Geodetic

**REMARKS**

**BORINGS BY** CME 55 Power Auger

**DATE** 2021 February 18

**FILE NO.** PG5690

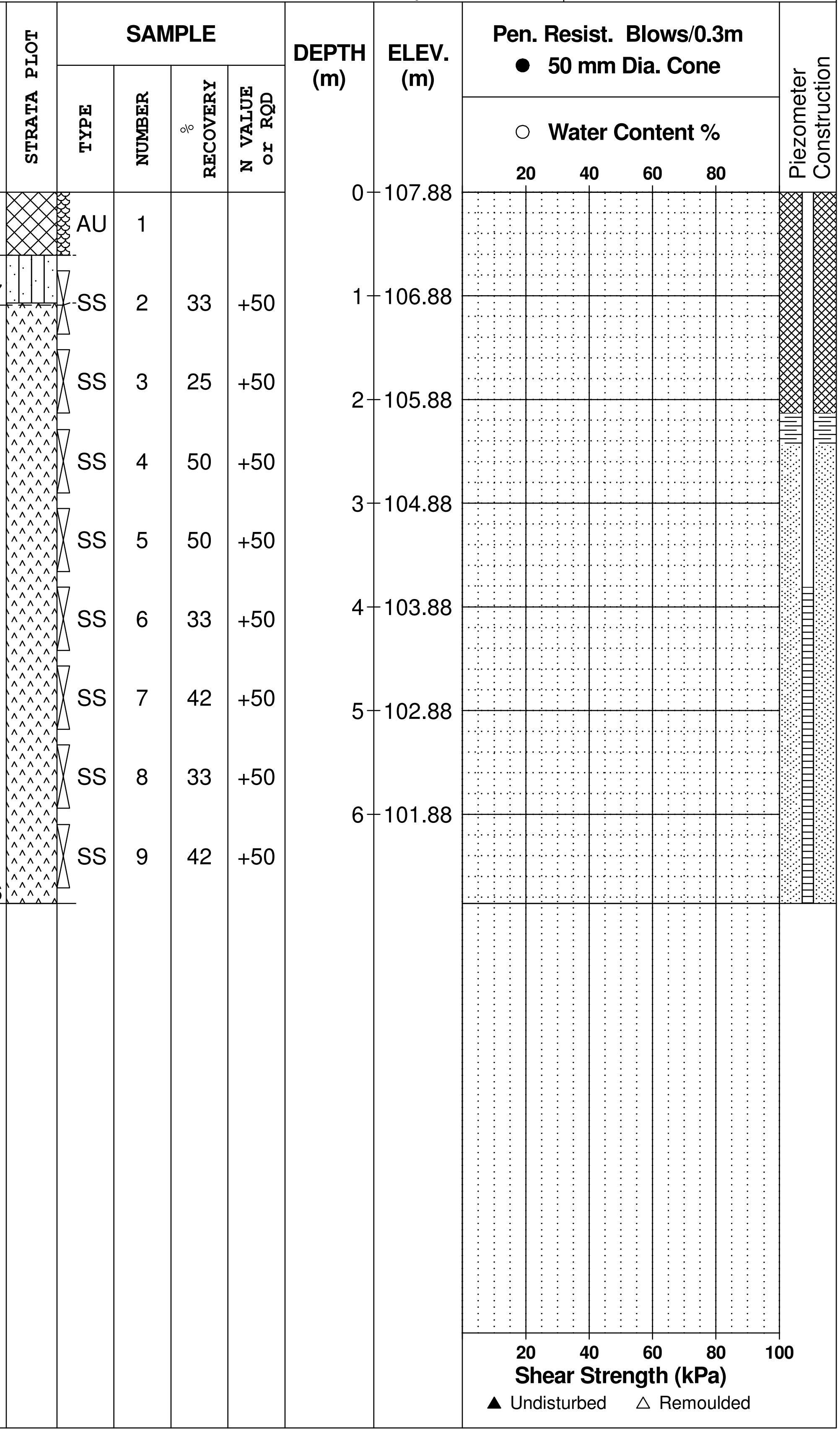
**HOLE NO.** BH 3-21

| SOIL DESCRIPTION | TYPE | NUMBER | % RECOVERY | N VALUE or RQD | DEPTH (m) | ELEV. (m) |
|---|---|---|---|---|---|---|
| GROUND SURFACE | | | | | 0 | 107.88 |
| **FILL:** Brown silty sand, some crushed stone and gravel<br>0.61 | AU | 1 | | | | |
| Dense brown **SILTY SAND** some gravel<br>1.07 | | | | | 1 | 106.88 |
| **GLACIAL TILL:** Dense brown sandy silt to silty sand with gravel, cobbles and boulders | SS | 2 | 33 | +50 | | |
| | SS | 3 | 25 | +50 | 2 | 105.88 |
| | SS | 4 | 50 | +50 | | |
| | SS | 5 | 50 | +50 | 3 | 104.88 |
| | SS | 6 | 33 | +50 | 4 | 103.88 |
| | SS | 7 | 42 | +50 | 5 | 102.88 |
| | SS | 8 | 33 | +50 | | |
| | SS | 9 | 42 | +50 | 6 | 101.88 |
| 6.86 | | | | | | |

End of Borehole

Practical refusal to augering at 6.86 m depth

(Piezometer dry - March 4, 2021)



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# SOIL PROFILE AND TEST DATA

**Geotechnical Investigation**
**Proposed Mixed Use Development**
**3718 Greenbank Road - Ottawa, Ontraio**

**DATUM** Geodetic

**FILE NO.** PG5690

**REMARKS**

**HOLE NO.** BH 4-21

**BORINGS BY** CME 55 Power Auger

**DATE** 2021 February 18

| SOIL DESCRIPTION | SAMPLE TYPE | NUMBER | % RECOVERY | N VALUE or RQD | DEPTH (m) | ELEV. (m) |
|---|---|---|---|---|---|---|
| GROUND SURFACE | | | | | 0 | 105.21 |
| **FILL:** Brown silty sand some clay, gravel, cobbles, trace topsoil | AU | 1 | | | | |
| 0.76 | | | | | | |
| Compact to dense, brown **SILTY SAND** | SS | 2 | 50 | 14 | 1 | 104.21 |
| | SS | 3 | 50 | 27 | 2 | 103.21 |
| | SS | 4 | 83 | 28 | | |
| | SS | 5 | 83 | 25 | 3 | 102.21 |
| | SS | 6 | 83 | 30 | 4 | 101.21 |
| | SS | 7 | 83 | 28 | 5 | 100.21 |
| | SS | 8 | 83 | 34 | | |
| | SS | 9 | 83 | 35 | 6 | 99.21 |
| | SS | 10 | 83 | 29 | 7 | 98.21 |
| | SS | 11 | 75 | 25 | 8 | 97.21 |
| | SS | 12 | 58 | 31 | | |
| 8.99 | | | | | | |
| End of Borehole<br>(Piezometer dry - March 4, 2021) | | | | | | |

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

○ Water Content %
20 40 60 80

Piezometer Construction

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

**patersongroup** Consulting Engineers

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# SOIL PROFILE AND TEST DATA

**Geotechnical Investigation**
**Proposed Mixed Use Development**
**3718 Greenbank Road - Ottawa, Ontraio**

**DATUM** Geodetic

**REMARKS**

**BORINGS BY** CME 55 Power Auger

**DATE** 2021 February 18

**FILE NO.** PG5690

**HOLE NO.** BH 5-21

| SOIL DESCRIPTION | SAMPLE TYPE | SAMPLE NUMBER | % RECOVERY | N VALUE or RQD | DEPTH (m) | ELEV. (m) |
|---|---|---|---|---|---|---|
| GROUND SURFACE | | | | | 0 | 105.57 |
| **FILL:** Brown silty sand with clay, gravel, trace topsoil | AU | 1 | | | | |
| 0.81 | | | | | | |
| Compact to dense, reddish brown **SILTY SAND** | SS | 2 | 58 | 25 | 1 | 104.57 |
| | SS | 3 | 58 | 7 | 2 | 103.57 |
| - Brown by 2.2 m depth | SS | 4 | 83 | 14 | | |
| | SS | 5 | 83 | 9 | 3 | 102.57 |
| | SS | 6 | 58 | 18 | 4 | 101.57 |
| | SS | 7 | 83 | 32 | 5 | 100.57 |
| | SS | 8 | 100 | 16 | | |
| | SS | 9 | 83 | 11 | 6 | 99.57 |
| | SS | 10 | 75 | 19 | 7 | 98.57 |
| | SS | 11 | 75 | 23 | 8 | 97.57 |
| | SS | 12 | 75 | 24 | | |
| 8.99 | | | | | | |
| End of Borehole | | | | | | |
| (Piezometer dry - March 4, 2021) | | | | | | |

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

○ Water Content %

20 40 60 80

Piezometer Construction

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

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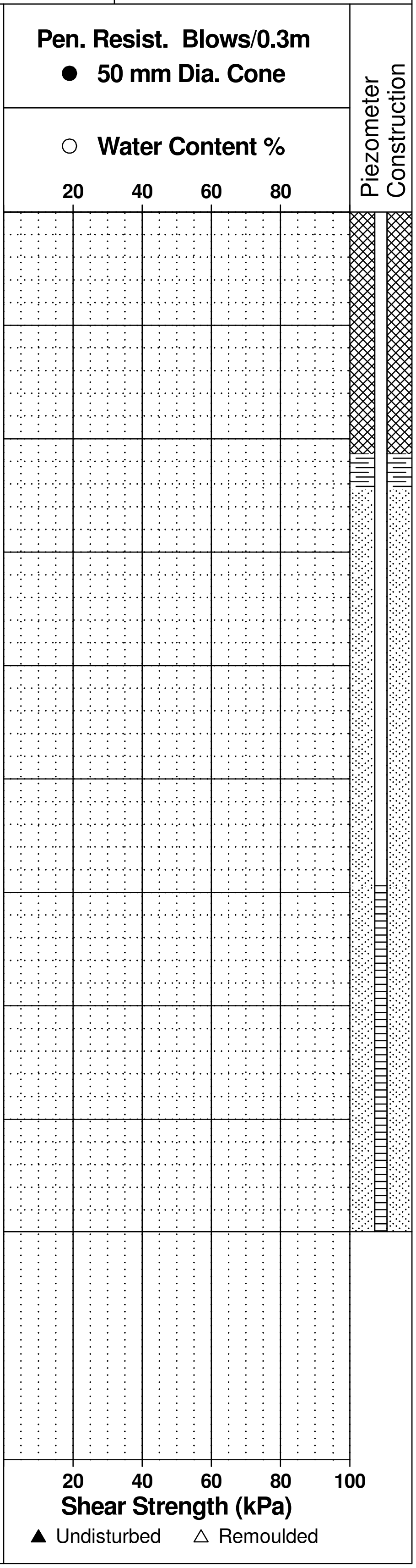
# SOIL PROFILE AND TEST DATA

**Geotechnical Investigation**
**Proposed Mixed Use Development**
**3718 Greenbank Road - Ottawa, Ontraio**

**DATUM** Geodetic
**FILE NO.** PG5690
**REMARKS**
**HOLE NO.** BH 6-21
**BORINGS BY** CME 55 Power Auger
**DATE** 2021 February 19

| SOIL DESCRIPTION<br>GROUND SURFACE | SAMPLE TYPE | SAMPLE NUMBER | SAMPLE % RECOVERY | SAMPLE N VALUE or RQD | DEPTH (m) | ELEV. (m) |
|---|---|---|---|---|---|---|
| **FILL:** Brown silty sand<br>0.61 | AU | 1 | | | 0 | 103.25 |
| Compact to dense brown **SILTY SAND** | SS | 2 | 75 | 46 | 1 | 102.25 |
| | SS | 3 | 58 | 22 | | |
| | | | | | 2 | 101.25 |
| | SS | 4 | 75 | 25 | | |
| | | | | | 3 | 100.25 |
| | SS | 5 | 75 | 23 | | |
| | SS | 6 | 67 | 29 | 4 | 99.25 |
| | SS | 7 | 67 | 28 | 5 | 98.25 |
| | SS | 8 | 67 | 26 | | |
| | | | | | 6 | 97.25 |
| | SS | 9 | 75 | 27 | | |
| | SS | 10 | 67 | 22 | 7 | 96.25 |
| | SS | 11 | 67 | 22 | 8 | 95.25 |
| 8.99 | SS | 12 | 67 | 20 | | |
| End of Borehole<br>(Piezoemter dry - March 4, 2021) | | | | | | |



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# SOIL PROFILE AND TEST DATA

**Geotechnical Investigation**
**Proposed Mixed Use Development**
**3718 Greenbank Road - Ottawa, Ontraio**

**DATUM** Geodetic

**REMARKS**

**BORINGS BY** CME 55 Power Auger

**DATE** 2021 February 19

**FILE NO.** PG5690

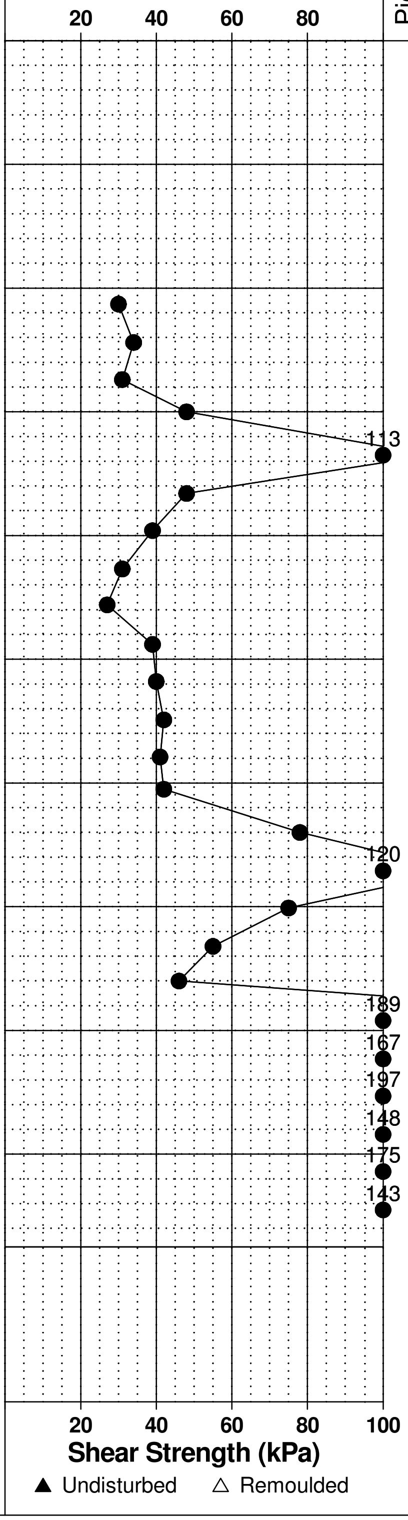
**HOLE NO.** BH 7-21

| SOIL DESCRIPTION | STRATA PLOT | SAMPLE TYPE | SAMPLE NUMBER | SAMPLE % RECOVERY | SAMPLE N VALUE or RQD | DEPTH (m) | ELEV. (m) |
|---|---|---|---|---|---|---|---|
| **GROUND SURFACE** | | | | | | 0 | 103.78 |
| **FILL:** Brown silty sand, some gravel | | AU | 1 | | | | |
| 0.84 | | | | | | | |
| | | | | | | 1 | 102.78 |
| Compact to dense, brown **SILTY SAND** | | SS | 2 | 50 | 25 | | |
| | | SS | 3 | 75 | 28 | | |
| | | | | | | 2 | 101.78 |
| Dynamic Cone Penetration Test commenced at 2.13 m depth. | | SS | 4 | 75 | 17 | | |
| | | | | | | 3 | 100.78 |
| | | SS | 5 | 75 | 17 | | |
| | | | | | | 4 | 99.78 |
| | | SS | 6 | 67 | 20 | | |
| - Trace gravel by 4.5 m depth | | SS | 7 | 67 | 53 | | |
| | | | | | | 5 | 98.78 |
| | | SS | 8 | 67 | 45 | | |
| | | | | | | 6 | 97.78 |
| | | SS | 9 | 67 | 23 | | |
| - Some gravel by 6.7 m depth | | | | | | | |
| | | | | | | 7 | 96.78 |
| | | SS | 10 | 75 | 49 | | |
| | | SS | 11 | 67 | 83 | | |
| | | | | | | 8 | 95.78 |
| | | SS | 12 | 75 | 57 | | |
| | | | | | | 9 | 94.78 |
| Practical refusal to augering 8.99 m depth | | | | | | | |
| 9.75 | | | | | | | |
| End of Borehole | | | | | | | |
| Practical refusal to DCPT at 9.75 m depth | | | | | | | |

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

○ Water Content %

Piezometer Construction



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# SOIL PROFILE AND TEST DATA

**Geotechnical Investigation**
**Proposed Mixed Use Development**
**3718 Greenbank Road - Ottawa, Ontraio**

**DATUM** Geodetic
**REMARKS**
**BORINGS BY** CME 55 Power Auger
**DATE** 2021 February 22
**FILE NO.** PG5690
**HOLE NO.** BH 8-21

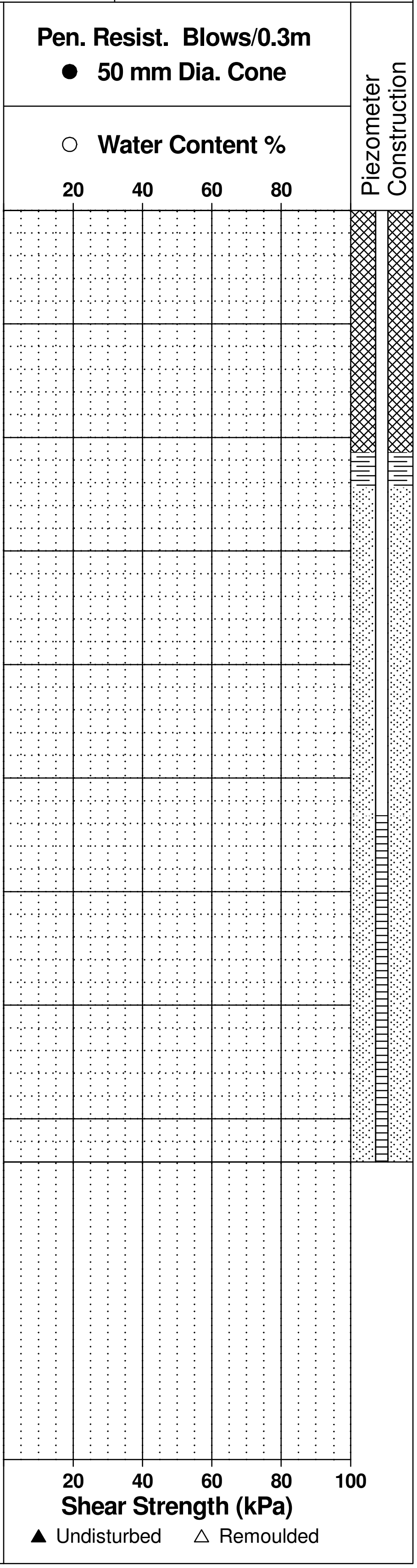
| SOIL DESCRIPTION | TYPE | NUMBER | % RECOVERY | N VALUE or RQD |
|---|---|---|---|---|
| GROUND SURFACE | | | | |
| **FILL:** Brown silty sand with gravel and crushed stone (to 0.61) | AU | 1 | | |
| Compact to dense, brown **SILTY SAND** with gravel and cobbles | SS | 2 | 75 | 47 |
| | SS | 3 | 75 | 55 |
| | SS | 4 | 50 | 45 |
| | SS | 5 | 50 | 51 |
| | SS | 6 | 50 | 56 |
| | SS | 7 | 33 | 49 |
| | SS | 8 | 50 | 61 |
| | SS | 9 | 50 | 24 |
| | SS | 10 | 33 | 31 |
| | SS | 11 | 50 | 51 |
| (to 8.38) | | | | |

| DEPTH (m) | ELEV. (m) |
|---|---|
| 0 | 106.13 |
| 1 | 105.13 |
| 2 | 104.13 |
| 3 | 103.13 |
| 4 | 102.13 |
| 5 | 101.13 |
| 6 | 100.13 |
| 7 | 99.13 |
| 8 | 98.13 |

End of Borehole

Practical refusal to augering at 8.38 m depth

(Piezometer dry - March 4, 2021)



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# SOIL PROFILE AND TEST DATA

**Geotechnical Investigation**
**Proposed Mixed Use Development**
**3718 Greenbank Road - Ottawa, Ontraio**

**DATUM** Geodetic

**REMARKS**

**BORINGS BY** CME 55 Power Auger

**DATE** 2021 February 22

**FILE NO.** PG5690

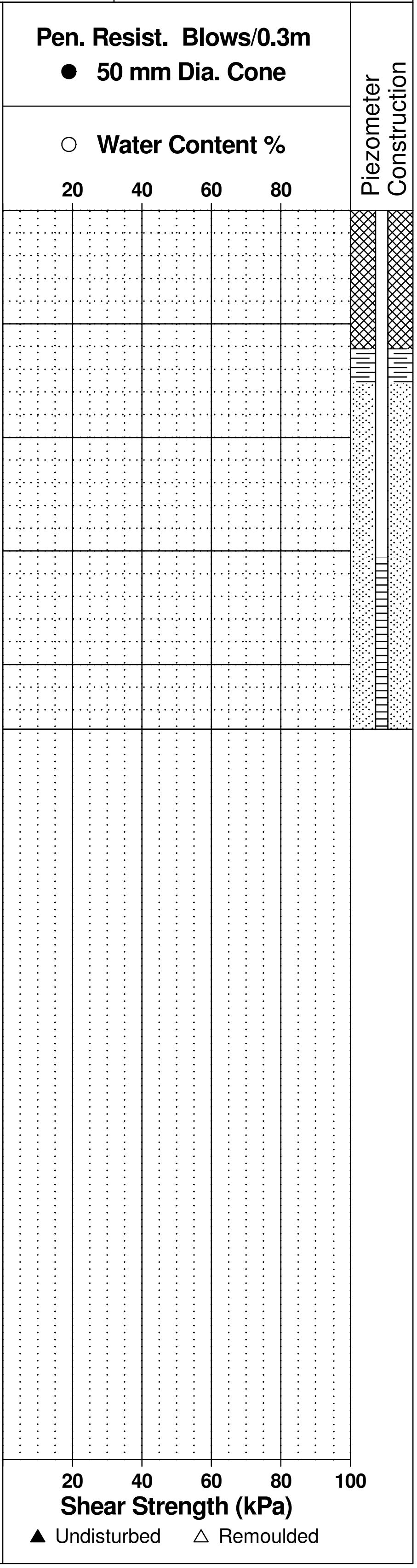
**HOLE NO.** BH 9-21

| SOIL DESCRIPTION | Depth to base (m) | SAMPLE TYPE | NUMBER | % RECOVERY | N VALUE or RQD | DEPTH (m) | ELEV. (m) |
|---|---|---|---|---|---|---|---|
| GROUND SURFACE | | | | | | 0 | 109.17 |
| **ORGANICS** | 0.05 | | | | | | |
| **FILL:** Brown silty sand with gravel | 0.69 | AU | 1 | | | | |
| **FILL:** Brown silty clay with sand, gravel, cobbles, trace topsoil | | SS | 2 | 17 | 21 | 1 | 108.17 |
| | | SS | 3 | 25 | 11 | 2 | 107.17 |
| | | SS | 4 | 8 | 4 | | |
| | | SS | 5 | 50 | 7 | 3 | 106.17 |
| | | SS | 6 | 17 | 26 | 4 | 105.17 |
| | 4.57 | | | | | | |

End of Borehole

Practical refusal to augering at 4.57 m depth

(Piezometer dry - March 4, 2021)



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# SOIL PROFILE AND TEST DATA

**Geotechnical Investigation**
**Proposed Mixed Use Development**
**3718 Greenbank Road - Ottawa, Ontraio**

**DATUM** Geodetic

**FILE NO.** PG5690

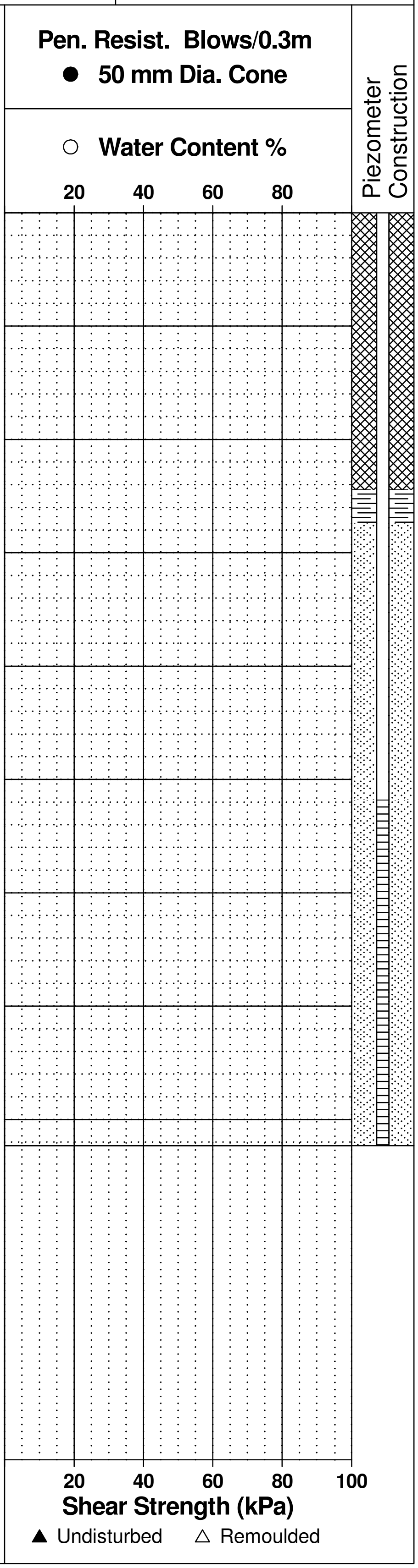
**REMARKS**

**HOLE NO.** BH10-21

**BORINGS BY** CME 55 Power Auger

**DATE** 2021 February 23

| SOIL DESCRIPTION | SAMPLE TYPE | NUMBER | % RECOVERY | N VALUE or RQD | DEPTH (m) | ELEV. (m) |
|---|---|---|---|---|---|---|
| GROUND SURFACE | | | | | 0 | 107.98 |
| **TOPSOIL** 0.05 | | | | | | |
| **FILL:** Brown to grey silty clay with sand, gravel, cobbles, trace topsoil | AU | 1 | | | | |
| | SS | 2 | 42 | 12 | 1 | 106.98 |
| | SS | 3 | 42 | 5 | 2 | 105.98 |
| | SS | 4 | 17 | 3 | | |
| | SS | 5 | 33 | 5 | 3 | 104.98 |
| | SS | 6 | 25 | 5 | 4 | 103.98 |
| 5.49 | SS | 7 | 50 | 10 | 5 | 102.98 |
| **FILL:** Brown silty sand, some gravel 6.02 | SS | 8 | 33 | 7 | 6 | 101.98 |
| **FILL:** Brown to grey silty clay with sand, gravel, trace wood and organics | SS | 9 | 42 | 8 | | |
| | SS | 10 | 33 | 6 | 7 | 100.98 |
| 8.23 | SS | 11 | 4 | 9 | 8 | 99.98 |
| End of Borehole | | | | | | |
| (Piezometer dry - March 4, 2021) | | | | | | |



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# SOIL PROFILE AND TEST DATA

**Geotechnical Investigation**
**Proposed Mixed Use Development**
**3718 Greenbank Road - Ottawa, Ontraio**

**DATUM** Geodetic

**FILE NO.** PG5690

**REMARKS**

**HOLE NO.** BH11-21

**BORINGS BY** CME 55 Power Auger

**DATE** 2021 February 23

| SOIL DESCRIPTION | SAMPLE TYPE | SAMPLE NUMBER | SAMPLE % RECOVERY | SAMPLE N VALUE or RQD | DEPTH (m) | ELEV. (m) |
|---|---|---|---|---|---|---|
| **GROUND SURFACE** | | | | | | |
| **TOPSOIL** 0.05 | | | | | 0 | 105.87 |
| **FILL:** Brown silty clay some sand, gravel, trace topsoil | AU | 1 | | | | |
| - Wood fragments present at 0.9 m depth | SS | 2 | 50 | 4 | 1 | 104.87 |
| | SS | 3 | 33 | 5 | 2 | 103.87 |
| | SS | 4 | 50 | 6 | | |
| 3.51 | SS | 5 | 42 | 23 | 3 | 102.87 |
| **FILL:** Brown silty sand with gravel, trace clay | SS | 6 | 8 | 28 | 4 | 101.87 |
| 5.03 | SS | 7 | 33 | 21 | 5 | 100.87 |
| **FILL:** Brown silty clay with sand, gravel, cobbles, trace organics | SS | 8 | 25 | 11 | | |
| - Increasing sand with depth | SS | 9 | 33 | 5 | 6 | 99.87 |
| | SS | 10 | 17 | +50 | 7 | 98.87 |
| 7.54<br>**FILL:** Brown silty sand with gravel, trace topsoil<br>8.23 | SS | 11 | 42 | 28 | 8 | 97.87 |
| Compact brown **SILTY SAND** with gravel, trace cobbles<br>9.14 | SS | 12 | 42 | 67 | 9 | 96.87 |
| End of Borehole<br>(Piezometer destroyed - March 4, 2021) | SS | 13 | 0 | +50 | | |

Pen. Resist. Blows/0.3m
● 50 mm Dia. Cone
○ Water Content %
20 40 60 80

Piezometer Construction

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

**patersongroup** Consulting Engineers

154 Colonnade Road South, Ottawa, Ontario K2E 7J5

# SOIL PROFILE AND TEST DATA

**Geotechnical Investigation**
**Proposed Mixed Use Development**
**3718 Greenbank Road - Ottawa, Ontraio**

**DATUM** Geodetic

**FILE NO.** PG5690

**REMARKS**

**HOLE NO.** BH12-21

**BORINGS BY** CME 55 Power Auger

**DATE** 2021 February 23

| SOIL DESCRIPTION | STRATA PLOT | SAMPLE | | | | DEPTH (m) | ELEV. (m) | Pen. Resist. Blows/0.3m ● 50 mm Dia. Cone<br>○ Water Content % | Piezometer Construction |
|---|---|---|---|---|---|---|---|---|---|
| | | TYPE | NUMBER | % RECOVERY | N VALUE or RQD | | | 20 40 60 80 | |
| GROUND SURFACE | | | | | | 0 | 101.30 | | |
| **FILL:** Brown silty sand with gravel, trace clay | | AU | 1 | | | | | | |
| | | | | | | 1 | 100.30 | | |
| | | SS | 2 | 50 | 64 | | | | |
| | | SS | 3 | 50 | 69 | | | | |
| | | | | | | 2 | 99.30 | | |
| | | SS | 4 | 42 | 28 | | | | |
| 2.90 | | | | | | | | | |
| End of Borehole<br>(Piezometer destroyed - March 4, 2021) | | | | | | | | | |

20 40 60 80 100

**Shear Strength (kPa)**

▲ Undisturbed △ Remoulded

**patersongroup** Consulting Engineers

154 Colonnade Road South, Ottawa, Ontario K2E 7J5

# SOIL PROFILE AND TEST DATA

**Geotechnical Investigation**
**Barrhaven South Urban Expansion**
**Ottawa, Ontario**

**DATUM** Geodetic elevations interpolated from City of Ottawa basemap.

**FILE NO.** **PG3607**

**REMARKS**

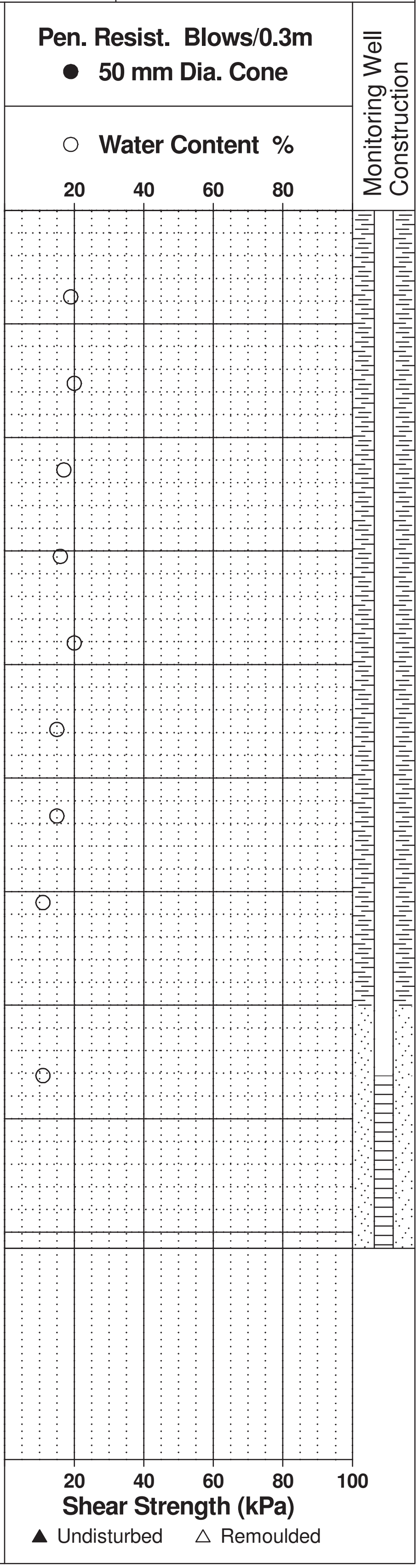
**HOLE NO.** **BH 5-15**

**BORINGS BY** CME 75 Power Auger

**DATE** December 10, 2015

| SOIL DESCRIPTION | STRATA PLOT | SAMPLE TYPE | SAMPLE NUMBER | SAMPLE % RECOVERY | SAMPLE N VALUE or RQD |
|---|---|---|---|---|---|
| GROUND SURFACE | | | | | |
| **FILL:** Grey silty sand with clay, gravel and wood | ▨ | SS | 1 | 42 | 13 |
| | | SS | 2 | 25 | 21 |
| | | SS | 3 | 33 | 5 |
| | | SS | 4 | 42 | 4 |
| | | SS | 5 | 42 | 3 |
| | | SS | 6 | 42 | 3 |
| | | SS | 7 | 17 | 5 |
| | | SS | 8 | 25 | 37 |
| | | SS | 9 | 0 | 50+ |
| | | SS | 10 | 58 | 9 |
| 9.14 | | SS | 11 | 0 | 1 |
| End of Borehole<br>(BH dry to 9.14m depth - July 28, 2016) | | | | | |

| DEPTH (m) | ELEV. (m) |
|---|---|
| 0 | 108.75 |
| 1 | 107.75 |
| 2 | 106.75 |
| 3 | 105.75 |
| 4 | 104.75 |
| 5 | 103.75 |
| 6 | 102.75 |
| 7 | 101.75 |
| 8 | 100.75 |
| 9 | 99.75 |



**patersongroup** Consulting Engineers

154 Colonnade Road South, Ottawa, Ontario K2E 7J5

# SOIL PROFILE AND TEST DATA

**Geotechnical Investigation**
**Barrhaven South Urban Expansion**
**Ottawa, Ontario**

**DATUM** Geodetic elevations interpolated from City of Ottawa basemap.

**REMARKS**

**BORINGS BY** Backhoe

**DATE** December 2, 2015

**FILE NO.** PG3607

**HOLE NO.** TP 1-15

| SOIL DESCRIPTION | STRATA PLOT | SAMPLE TYPE | SAMPLE NUMBER | SAMPLE % RECOVERY | SAMPLE N VALUE or RQD | DEPTH (m) | ELEV. (m) | Pen. Resist. Blows/0.3m ● 50 mm Dia. Cone<br>○ Water Content % | Piezometer Construction |
|---|---|---|---|---|---|---|---|---|---|
| **GROUND SURFACE** | | | | | | 0 | 105.10 | | |
| **TOPSOIL** 0.10 | | G | 1 | | | | | | |
| | | | | | | 1 | 104.10 | | |
| Compact, brown **SILTY SAND**, trace boulders and cobbles | | G | 2 | | | | | | |
| | | | | | | 2 | 103.10 | | |
| 3.00 | | | | | | 3 | 102.10 | | |
| End of Test Pit<br>(TP dry upon completion) | | | | | | | | | |

Water Content %: 20 40 60 80

Shear Strength (kPa): 20 40 60 80 100

▲ Undisturbed △ Remoulded

**patersongroup** Consulting Engineers
154 Colonnade Road South, Ottawa, Ontario K2E 7J5

# SOIL PROFILE AND TEST DATA

**Geotechnical Investigation**
**Barrhaven South Urban Expansion**
**Ottawa, Ontario**

**DATUM** Geodetic elevations interpolated from City of Ottawa basemap.

**REMARKS**

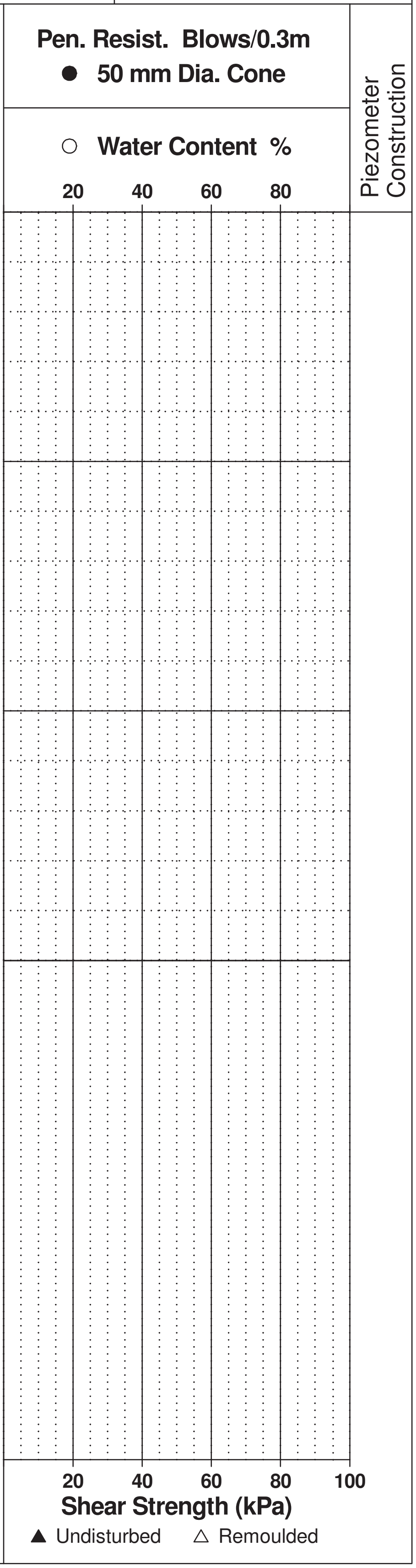
**BORINGS BY** Backhoe

**DATE** December 2, 2015

**FILE NO.** PG3607

**HOLE NO.** TP 2-15

| SOIL DESCRIPTION | STRATA PLOT | SAMPLE TYPE | SAMPLE NUMBER | SAMPLE % RECOVERY | SAMPLE N VALUE or RQD | DEPTH (m) | ELEV. (m) |
|---|---|---|---|---|---|---|---|
| GROUND SURFACE | | | | | | 0 | 106.80 |
| **TOPSOIL** 0.10 | | | | | | | |
| | | G | 1 | | | | |
| | | | | | | 1 | 105.80 |
| Compact, brown **SILTY SAND** | | | | | | | |
| | | | | | | 2 | 104.80 |
| | | G | 2 | | | | |
| 3.00 | | | | | | 3 | 103.80 |
| End of Test Pit<br>(TP dry upon completion) | | | | | | | |



**patersongroup** Consulting Engineers

154 Colonnade Road South, Ottawa, Ontario K2E 7J5

# SOIL PROFILE AND TEST DATA

**Geotechnical Investigation**
**Barrhaven South Urban Expansion**
**Ottawa, Ontario**

**DATUM** Geodetic elevations interpolated from City of Ottawa basemap.

**FILE NO.** **PG3607**

**REMARKS**

**HOLE NO.** **TP 8-15**

**BORINGS BY** Backhoe

**DATE** December 1, 2015

| SOIL DESCRIPTION | STRATA PLOT | SAMPLE TYPE | SAMPLE NUMBER | SAMPLE % RECOVERY | SAMPLE N VALUE or RQD | DEPTH (m) | ELEV. (m) | Pen. Resist. Blows/0.3m ● 50 mm Dia. Cone ○ Water Content % (20 40 60 80) | Piezometer Construction |
|---|---|---|---|---|---|---|---|---|---|
| GROUND SURFACE | | | | | | 0 | 109.30 | | |
| Dense, brown **SILTY SAND** | | G | 1 | | | 1 | 108.30 | | |
| | | | | | | 2 | 107.30 | | |
| 3.00 | | G | 2 | | | 3 | 106.30 | | |
| End of Test Pit<br>(TP dry upon completion) | | | | | | | | | |

Shear Strength (kPa): 20 40 60 80 100

▲ Undisturbed △ Remoulded

**patersongroup** Consulting Engineers

154 Colonnade Road South, Ottawa, Ontario K2E 7J5

# SOIL PROFILE AND TEST DATA

**Geotechnical Investigation**
**Barrhaven South Urban Expansion**
**Ottawa, Ontario**

**DATUM** Geodetic elevations interpolated from City of Ottawa basemap.

**REMARKS**

**BORINGS BY** Backhoe

**DATE** December 2, 2015

**FILE NO.** PG3607

**HOLE NO.** TP 9-15

| SOIL DESCRIPTION | STRATA PLOT | SAMPLE TYPE | SAMPLE NUMBER | SAMPLE % RECOVERY | SAMPLE N VALUE or RQD | DEPTH (m) | ELEV. (m) | Pen. Resist. Blows/0.3m ● 50 mm Dia. Cone / ○ Water Content % (20 40 60 80) | Piezometer Construction |
|---|---|---|---|---|---|---|---|---|---|
| GROUND SURFACE | | | | | | 0 | 108.40 | | |
| TOPSOIL 0.20 | | | | | | | | | |
| Brown **SILTY SAND**, trace cobbles | | G | 1 | | | 1 | 107.40 | | |
| | | | | | | 2 | 106.40 | | |
| 3.00 | | G | 2 | | | 3 | 105.40 | | |
| End of Test Pit<br>(TP dry upon completion) | | | | | | | | | |

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

# SYMBOLS AND TERMS

## SOIL DESCRIPTION

Behavioural properties, such as structure and strength, take precedence over particle gradation in describing soils. Terminology describing soil structure are as follows:

| | | |
|---|---|---|
| Desiccated | - | having visible signs of weathering by oxidation of clay minerals, shrinkage cracks, etc. |
| Fissured | - | having cracks, and hence a blocky structure. |
| Varved | - | composed of regular alternating layers of silt and clay. |
| Stratified | - | composed of alternating layers of different soil types, e.g. silt and sand or silt and clay. |
| Well-Graded | - | Having wide range in grain sizes and substantial amounts of all intermediate particle sizes (see Grain Size Distribution). |
| Uniformly-Graded | - | Predominantly of one grain size (see Grain Size Distribution). |

The standard terminology to describe the relative strength of cohesionless soils is the compactness condition, usually inferred from the results of the Standard Penetration Test (SPT) ‘N’ value. The SPT N value is the number of blows of a 63.5 kg hammer, falling 760 mm, required to drive a 51 mm O.D. split spoon sampler 300 mm into the soil after an initial penetration of 150 mm. An SPT N value of “P” denotes that the split-spoon sampler was pushed 300 mm into the soil without the use of a falling hammer.

| Compactness Condition | ‘N’ Value | Relative Density % |
|---|---|---|
| Very Loose | <4 | <15 |
| Loose | 4-10 | 15-35 |
| Compact | 10-30 | 35-65 |
| Dense | 30-50 | 65-85 |
| Very Dense | >50 | >85 |

The standard terminology to describe the strength of cohesive soils is the consistency, which is based on the undisturbed undrained shear strength as measured by the in situ or laboratory shear vane tests, unconfined compression tests, or occasionally by the Standard Penetration Test (SPT). Note that the typical correlations of undrained shear strength to SPT N value (tabulated below) tend to underestimate the consistency for sensitive silty clays, so Paterson reviews the applicable split spoon samples in the laboratory to provide a more representative consistency value based on tactile examination.

| Consistency | Undrained Shear Strength (kPa) | ‘N’ Value |
|---|---|---|
| Very Soft | <12 | <2 |
| Soft | 12-25 | 2-4 |
| Firm | 25-50 | 4-8 |
| Stiff | 50-100 | 8-15 |
| Very Stiff | 100-200 | 15-30 |
| Hard | >200 | >30 |

## SYMBOLS AND TERMS (continued)

## SOIL DESCRIPTION (continued)

Cohesive soils can also be classified according to their “sensitivity”. The sensitivity, $S_t$, is the ratio between the undisturbed undrained shear strength and the remoulded undrained shear strength of the soil. The classes of sensitivity may be defined as follows:

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

## ROCK DESCRIPTION

The structural description of the bedrock mass is based on the Rock Quality Designation (RQD).

The RQD classification is based on a modified core recovery percentage in which all pieces of sound core over 100 mm long are counted as recovery. The smaller pieces are considered to be a result of closely-spaced discontinuities (resulting from shearing, jointing, faulting, or weathering) in the rock mass and are not counted. RQD is ideally determined from NQ or larger size core. However, it can be used on smaller core sizes, such as BQ, if the bulk of the fractures caused by drilling stresses (called “mechanical breaks”) are easily distinguishable from the normal in situ fractures.

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

## SAMPLE TYPES

| | | |
|---|---|---|
| SS | - | Split spoon sample (obtained in conjunction with the performing of the Standard Penetration Test (SPT)) |
| TW | - | Thin wall tube or Shelby tube, generally recovered using a piston sampler |
| G | - | "Grab" sample from test pit or surface materials |
| AU | - | Auger sample or bulk sample |
| WS | - | Wash sample |
| RC | - | Rock core sample (Core bit size BQ, NQ, HQ, etc.). Rock core samples are obtained with the use of standard diamond drilling bits. |

## SYMBOLS AND TERMS (continued)

### PLASTICITY LIMITS AND GRAIN SIZE DISTRIBUTION

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

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

Cc - Concavity coefficient = $(D30)^2 / (D10 \times D60)$
Cu - Uniformity coefficient = $D60 / D10$

Cc and Cu are used to assess the grading of sands and gravels:
Well-graded gravels have: $1 < Cc < 3$ and $Cu > 4$
Well-graded sands have: $1 < Cc < 3$ and $Cu > 6$
Sands and gravels not meeting the above requirements are poorly-graded or uniformly-graded.
Cc and Cu are not applicable for the description of soils with more than 10% silt and clay (more than 10% finer than 0.075 mm or the #200 sieve)

### CONSOLIDATION TEST

$p'_o$ - Present effective overburden pressure at sample depth
$p'_c$ - Preconsolidation pressure of (maximum past pressure on) sample
Ccr - Recompression index (in effect at pressures below $p'_c$)
Cc - Compression index (in effect at pressures above $p'_c$)

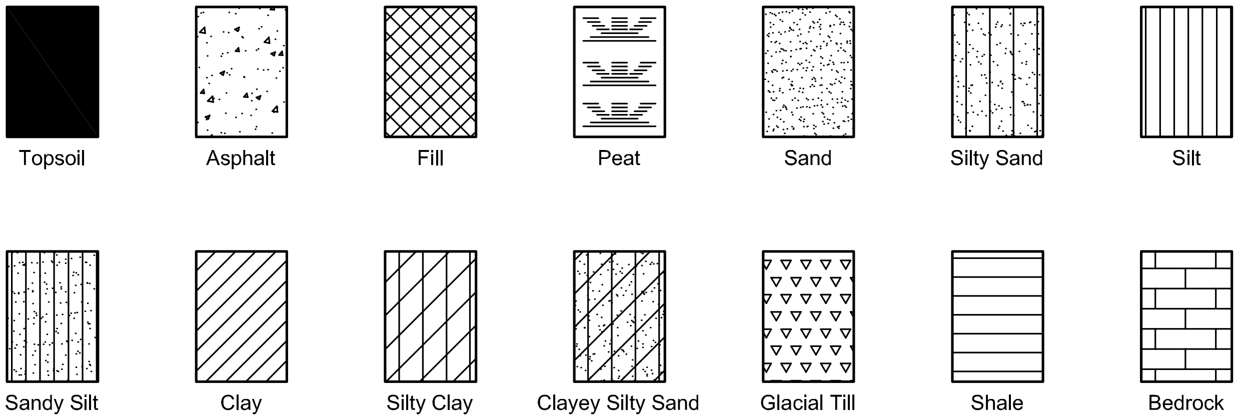
OC Ratio Overconsolidaton ratio = $p'_c / p'_o$
Void Ratio Initial sample void ratio = volume of voids / volume of solids
Wo - Initial water content (at start of consolidation test)

### PERMEABILITY TEST

k - Coefficient of permeability or hydraulic conductivity is a measure of the ability of water to flow through the sample. The value of k is measured at a specified unit weight for (remoulded) cohesionless soil samples, because its value will vary with the unit weight or density of the sample during the test.

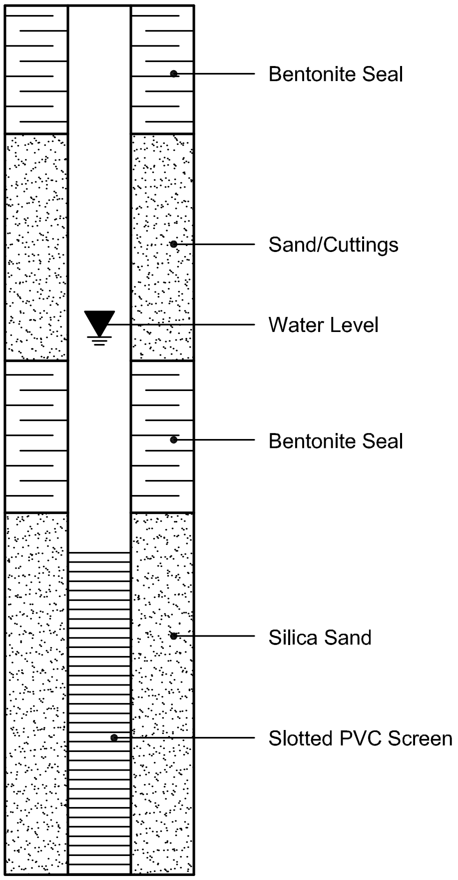
## SYMBOLS AND TERMS (continued)

### STRATA PLOT

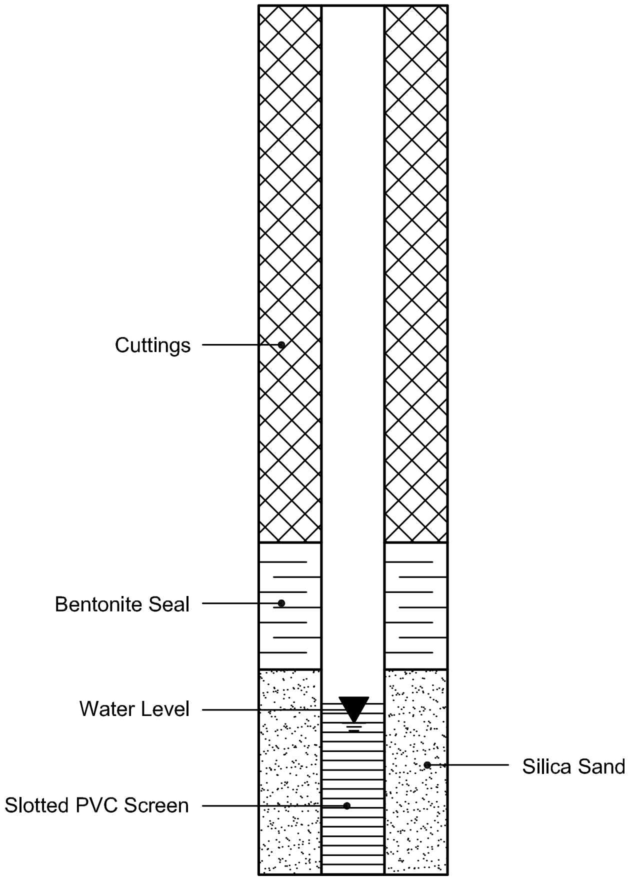


### MONITORING WELL AND PIEZOMETER CONSTRUCTION

MONITORING WELL CONSTRUCTION



PIEZOMETER CONSTRUCTION



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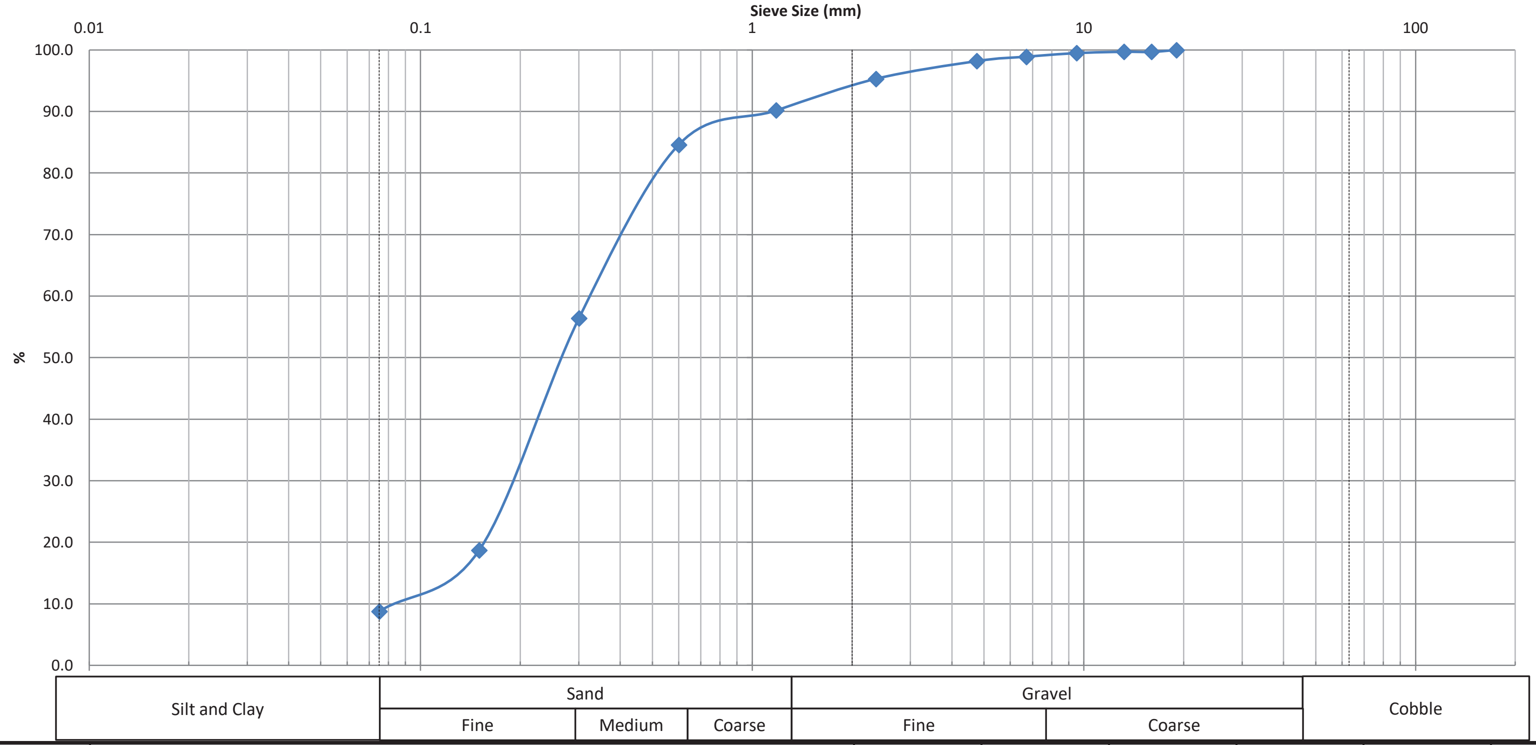
## SIEVE ANALYSIS
## ASTM C136

| | | | | | |
|---|---|---|---|---|---|
| CLIENT: | Mattamy Homes | DESCRIPTION: | Soil | FILE NO: | PG5690 |
| CONTRACT NO.: | - | SPECIFICATION: | **Silty Sand** | LAB NO: | 23721 |
| PROJECT: | 3718 Greenbank Road | INTENDED USE: | - | DATE RECEIVED: | 25-Mar-21 |
| | | PIT OR QUARRY: | in-Situ | DATE TESTED: | 26-Mar-21 |
| DATE SAMPLED: | 17-Feb-21 | SOURCE LOCATION: | BH2-21 SS3 & SS4 | DATE REPORTED: | 29-Mar-21 |
| SAMPLED BY: | G. Paterson | SAMPLE LOCATION: | 1.5 - 2.9 m | TESTED BY: | DK |



| Identification | Soil Classification | | | | MC(%) | LL | PL | PI | Cc | Cu |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | 1.38 | 3.9 |
| | D100 | D60 | D30 | D10 | Gravel (%) | Sand (%) | | Silt (%) | | Clay (%) |
| | 19.0 | 0.32 | 0.19 | 0.082 | 1.8 | 89.4 | | 8.8 | | |

**Comments:**

| REVIEWED BY: | **Curtis Beadow** | **Joe Fosyth, P. Eng.** |
|---|---|---|

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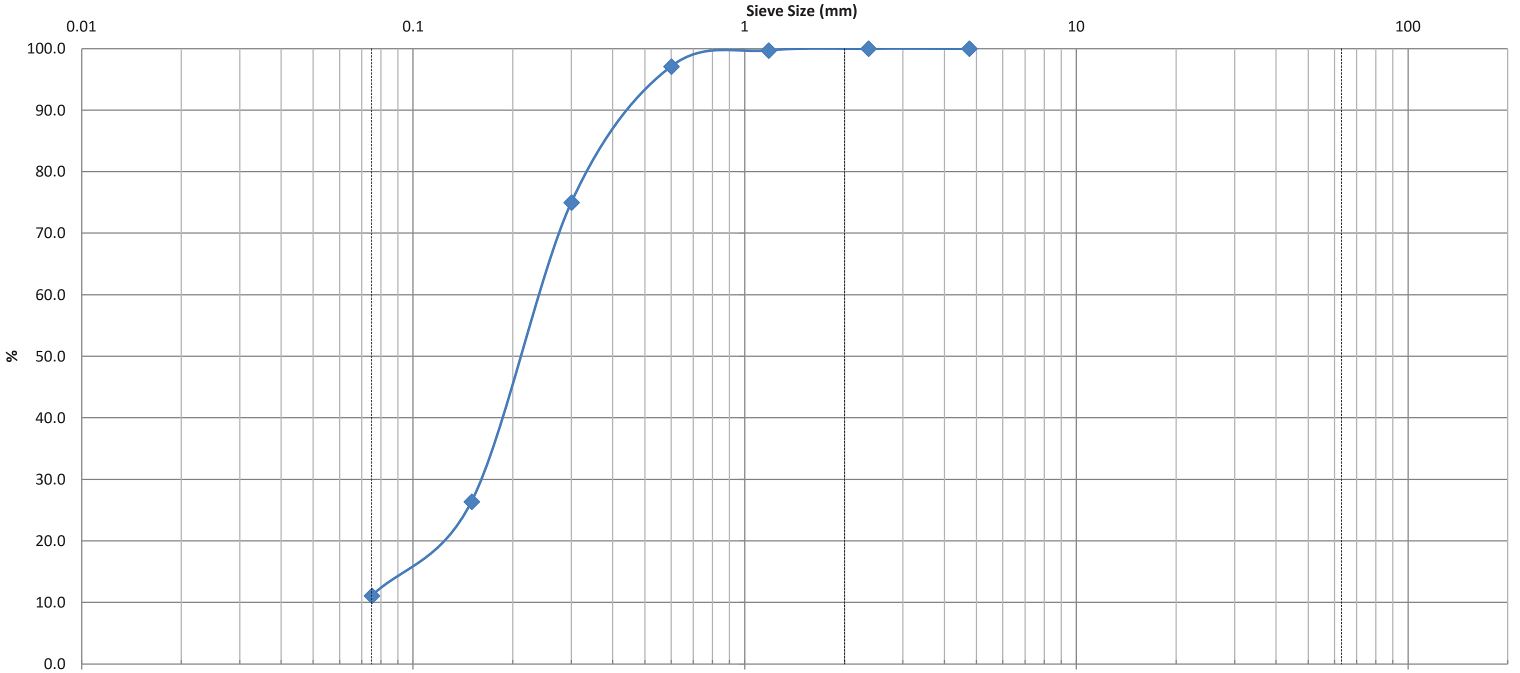
## SIEVE ANALYSIS
## ASTM C136

| | | | | | |
|---|---|---|---|---|---|
| CLIENT: | Mattamy Homes | DESCRIPTION: | Soil | FILE NO: | PG5690 |
| CONTRACT NO.: | - | SPECIFICATION: | **Silty Sand** | LAB NO: | 23722 |
| PROJECT: | 3718 Greenbank Road | INTENDED USE: | - | DATE RECEIVED: | 25-Mar-21 |
| | | PIT OR QUARRY: | in-Situ | DATE TESTED: | 26-Mar-21 |
| DATE SAMPLED: | 17-Feb-21 | SOURCE LOCATION: | BH4-21 SS4 & SS5 | DATE REPORTED: | 29-Mar-21 |
| SAMPLED BY: | G. Paterson | SAMPLE LOCATION: | 2.29 - 3.66 m | TESTED BY: | DK |



| | | | | | | |
|---|---|---|---|---|---|---|
| Silt and Clay | Sand | | | Gravel | | Cobble |
| | Fine | Medium | Coarse | Fine | Coarse | |

| Identification | Soil Classification | | | | MC(%) | LL | PL | PI | Cc | Cu |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | 1.80 | 3.3 |
| | D100 | D60 | D30 | D10 | Gravel (%) | Sand (%) | Silt (%) | | Clay (%) | |
| | 4.8 | 0.23 | 0.17 | 0.07 | 0.0 | 88.9 | 11.1 | | | |

**Comments:**

| REVIEWED BY: | Curtis Beadow | Joe Fosyth, P. Eng. |
|---|---|---|

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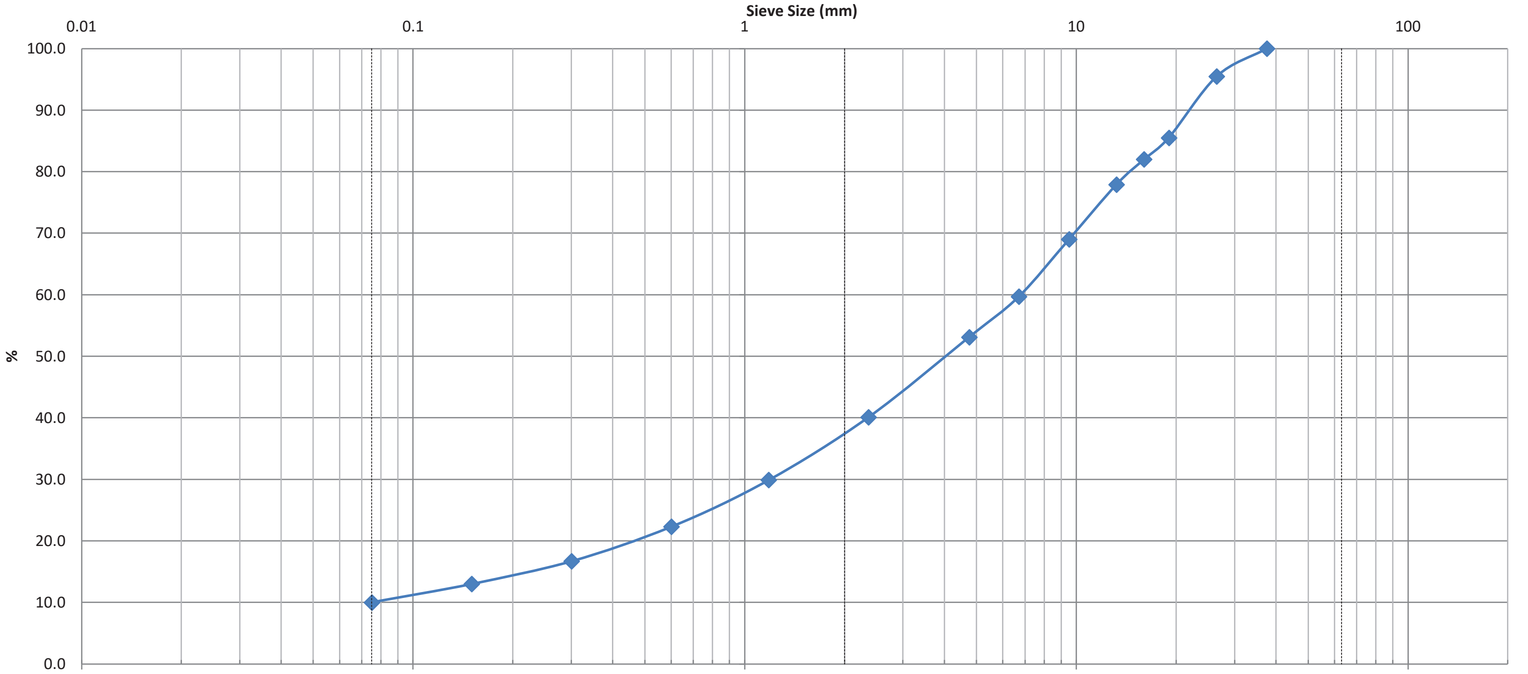
## SIEVE ANALYSIS
## ASTM C136

| | | | | | |
|---|---|---|---|---|---|
| CLIENT: | Mattamy Homes | DESCRIPTION: | Soil | FILE NO: | PG5690 |
| CONTRACT NO.: | - | SPECIFICATION: | **Silty Sand** | LAB NO: | 23723 |
| PROJECT: | 3718 Greenbank Road | INTENDED USE: | - | DATE RECEIVED: | 25-Mar-21 |
| | | PIT OR QUARRY: | in-Situ | DATE TESTED: | 26-Mar-21 |
| DATE SAMPLED: | 17-Feb-21 | SOURCE LOCATION: | BH8-21 SS4 & SS5 | DATE REPORTED: | 29-Mar-21 |
| SAMPLED BY: | G. Paterson | SAMPLE LOCATION: | 2.29 - 3.66 m | TESTED BY: | DK |



| Silt and Clay | Sand | | | Gravel | | Cobble |
|---|---|---|---|---|---|---|
| | Fine | Medium | Coarse | Fine | Coarse | |

| Identification | Soil Classification | MC(%) | LL | PL | PI | Cc | Cu |
|---|---|---|---|---|---|---|---|
| | | | | | | 3.54 | 104.6 |

| D100 | D60 | D30 | D10 | Gravel (%) | Sand (%) | Silt (%) | Clay (%) |
|---|---|---|---|---|---|---|---|
| 37.5 | 6.8 | 1.25 | 0.065 | 46.9 | 43.1 | 10.0 | |

**Comments:**

| REVIEWED BY: | **Curtis Beadow** | **Joe Fosyth, P. Eng.** |
|---|---|---|

Certificate of Analysis

Report Date: 25-Feb-2021

**Client: Paterson Group Consulting Engineers**

Order Date: 19-Feb-2021

**Client PO: 31927**

**Project Description: PG5690**

| | **Client ID:** | BH7-21-SS5 | - | - | - |
|---|---|---|---|---|---|
| | **Sample Date:** | 19-Feb-21 09:00 | - | - | - |
| | **Sample ID:** | 2108430-01 | - | - | - |
| | **MDL/Units** | Soil | - | - | - |
| **Physical Characteristics** | | | | | |
| % Solids | 0.1 % by Wt. | 95.7 | - | - | - |
| **General Inorganics** | | | | | |
| pH | 0.05 pH Units | 7.30 | - | - | - |
| Resistivity | 0.10 Ohm.m | 143 | - | - | - |
| **Anions** | | | | | |
| Chloride | 5 ug/g dry | 7 | - | - | - |
| Sulphate | 5 ug/g dry | <5 | - | - | - |

# APPENDIX 2

FIGURE 1 - KEY PLAN

FIGURE 2 TO 5 - AERIAL PHOTOGRAPHS

DRAWING PG5690-1 - TEST HOLE LOCATION PLAN

# FIGURE 1

## KEY PLAN

# FIGURE 2

Aerial Photograph - 1976

# FIGURE 3

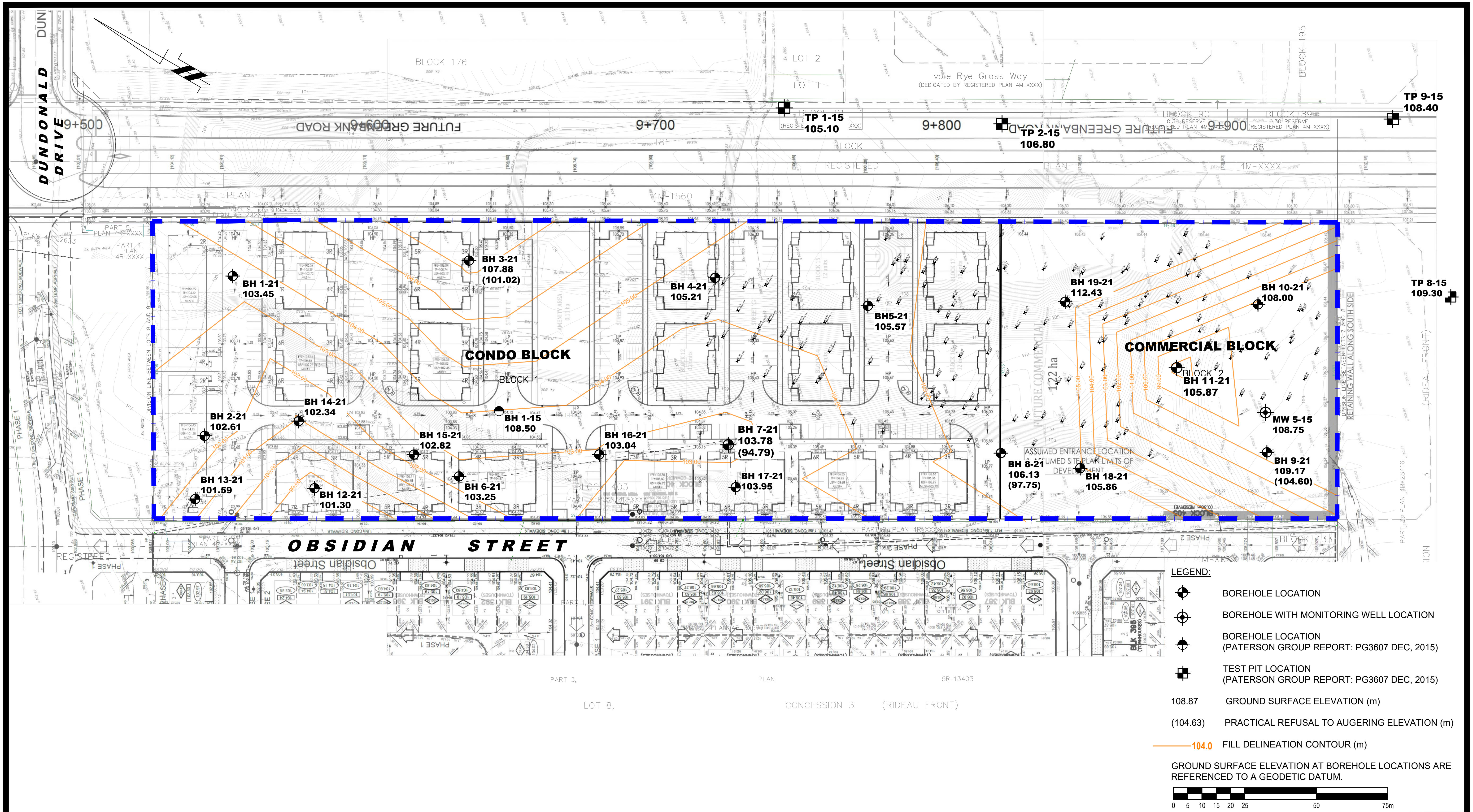
Aerial Photograph - 2002

# FIGURE 4

Aerial Photograph - 2008

# FIGURE 5

## Aerial Photograph - 2019



LEGEND:

⊕ BOREHOLE LOCATION

⊕ BOREHOLE WITH MONITORING WELL LOCATION

⊕ BOREHOLE LOCATION
(PATERSON GROUP REPORT: PG3607 DEC, 2015)

▣ TEST PIT LOCATION
(PATERSON GROUP REPORT: PG3607 DEC, 2015)

108.87 GROUND SURFACE ELEVATION (m)

(104.63) PRACTICAL REFUSAL TO AUGERING ELEVATION (m)

—104.0 FILL DELINEATION CONTOUR (m)

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

**patersongroup**
**consulting engineers**

154 Colonnade Road South
Ottawa, Ontario K2E 7J5
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| NO. | REVISIONS | DATE | INITIAL |
|---|---|---|---|
| 1 | REVISED TO INCLUDE NEW 2021 TEST PITS | 14/07/2021 | OC |

MATTAMY HOMES
GEOTECHNICAL INVESTIGATION
HALF MOON BAY - SOUTH

OTTAWA, ONTARIO

Title:

# TEST HOLE LOCATION PLAN

Scale: 1:1250
Date: 03/2021
Drawn by: JM
Report No.: PG5690-1
Checked by: OC
Dwg No.: PG5690-1
Approved by: DJG
Revision No.: 1

p:\autocad drawings\geotechnical\pg56xx\pg5690\pg5690-1 (rev)-thlp.dwg