

Geotechnical  
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Noise and Vibration  
Studies

## Geotechnical Investigation

Proposed Mixed-Use Development  
216 McArthur Avenue  
Ottawa, Ontario

Prepared For

Cassidy E.W. Construction

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Report: PG6061-1

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## 1.0 Introduction

Paterson Group (Paterson) was commissioned by Cassidy E.W. Construction Consultant Ltd. to conduct a geotechnical investigation for the proposed mixed-use development to be located at 216 McArthur Avenue in the City of Ottawa (reference should be made to Figure 1 - Key Plan in Appendix 2 of this report).

The objectives of the geotechnical investigation were to:

- Determine the subsoil and groundwater conditions at this site by means of boreholes.
- Provide geotechnical recommendations pertaining to the design of the proposed development including construction considerations which may affect the design.

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

Investigating the presence or potential presence of contamination on the subject property was not part of the scope of work of the present investigation. Therefore, the present report does not address environmental issues.

## 2.0 Proposed Development

Based on the available drawings, it is understood that the proposed development will consist of a 3-storey mixed use building with one basement level. It is understood that the basement level will consist of residential spaces and will not consist of an underground parking level.

Associated walkways and hardscaped margins are also anticipated as part of the development. It is expected that the proposed building will be municipally serviced.

It is further understood that the existing building throughout the subject site will be demolished as part of the proposed development.

## **3.0 Method of Investigation**

### **3.1 Field Investigation**

#### **Field Program**

The field program for the current geotechnical investigation was carried out on January 21, 2022 and consisted of 3 boreholes which were advanced to a maximum depth of 2.1 m below the existing ground surface. The test hole locations were distributed in a manner to provide general coverage of the subject site, taking into consideration underground utilities and site features. The borehole locations are shown on Drawing PG6061-1 - Test Hole Location Plan included in Appendix 2.

The boreholes were drilled using a low clearance drill rig 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 advancing each test hole to the required depths at the selected locations and sampling the overburden.

#### **Sampling and In Situ Testing**

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

The Standard Penetration Test (SPT) was conducted in conjunction with the recovery of the split-spoon samples. The SPT results are recorded as “N” values on the Soil Profile and Test Data sheets. The “N” value is the number of blows required to drive the split-spoon sampler 300 mm into the soil after a 150 mm initial penetration using a 63.5 kg hammer falling from a height of 760 mm.

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

#### **Groundwater**

All boreholes were fitted with flexible standpipe piezometers to allow for groundwater level monitoring. Groundwater level observations are discussed in Section 4.3 and are presented in the Soil Profile and Test Data sheets in Appendix 1.

### **Sample Storage**

All samples will be stored in the laboratory for a period of one (1) month after issuance of this report. They will then be discarded unless we are otherwise directed.

### **3.2 Field Survey**

The borehole locations were selected by Paterson to provide general coverage of the proposed development taking into consideration the existing site features and underground utilities. The test hole locations and ground surface elevation at each test hole location were surveyed by Paterson using a handheld GPS and referenced to a geodetic datum. The locations of the boreholes and ground surface elevation at each borehole location are presented on Drawing PG6061-1 - Test Hole Location Plan in Appendix 2.

### **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. Soil samples will be stored for a period of one month after this report is completed, unless otherwise directed.

## 4.0 Observations

### 4.1 Surface Conditions

The subject site is currently occupied by a two-storey residential building with a basement level. A paved parking lane and parking area were noted along the west portion and rear of the current building, respectively.

The site is bordered by McArthur Avenue to the north, residential dwellings to the east and south, and by a mixed-use building to the west. The ground surface at the subject site is relatively flat and at grade with the surrounding roadways and buildings.

### 4.2 Subsurface Profile

Generally, the soil profile encountered at the test hole locations consisted of a thin layer of asphaltic concrete, underlain by a fill layer, followed by a silty sand deposit.

The fill was generally observed to consist of a thin layer of crushed stone. The fill was observed to an approximate depth of 0.2 m below ground surface at all borehole locations. A deposit of loose to compact, brown silty sand was observed below the fill layer. The silty sand layer extended to a depth of approximately 2.1 m below the ground surface at all boreholes. Some rock fragments were encountered at depths between 1.7 and 2.0 m for the remainder of each of the boreholes.

Practical refusal to augering was encountered at all boreholes at an approximate depth of 2.1 m below the existing ground surface.

Reference should be made to the Soil Profile and Test Data sheets in Appendix 1 for the details of the soil profile encountered at each test hole location.

#### **Bedrock**

Based on available geological mapping, the bedrock in the subject area consists of Paleozoic Shale of the Billings formation, with an overburden drift thickness of 1 to 2 m.

### 4.3 Groundwater

Groundwater levels were measured on January 26, 2022 within the installed piezometers. At that time, the piezometers were dry. However, it should be noted that groundwater levels are subject to seasonal fluctuations. Therefore, the groundwater level could vary at the time of construction.

## **5.0 Discussion**

### **5.1 Geotechnical Assessment**

The subject site is considered suitable for the proposed development, from a geotechnical perspective. The proposed building may be founded on conventional spread footings placed on the undisturbed, surface sounded bedrock.

It is anticipated that bedrock removal will be required to complete the basement level and/or site servicing works. All contractors should be prepared for bedrock removal.

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.

Existing foundation walls and other construction debris should be entirely removed from within the proposed building perimeter. Under paved areas, existing construction remnants such as foundation walls should be excavated to a minimum of 1 m below grade.

Due to the anticipated founding level for the proposed building, it is expected that the existing overburden material will be excavated from within the proposed building footprint.

#### **Bedrock Removal**

Bedrock removal can be accomplished by hoe ramming where the bedrock is weathered and/or where only small quantities of the bedrock need to be removed. Sound bedrock may be removed by line drilling in conjunction with controlled blasting and/or hoe ramming.

Prior to considering blasting operations, the blasting effects on the existing services, buildings, and other structures should be addressed. A pre-blast or pre-construction survey of the existing structures located in the proximity of the blasting operations should be carried out prior to commencing site activities.



The extent of the survey should be determined by the blasting consultant and should be sufficient to respond to any inquiries or claims related to the blasting operations.

### **Vibration Considerations**

Construction operations could cause vibrations, and possibly, sources of nuisance to the community. Therefore, means to reduce the vibration levels as much as possible should be incorporated in the construction operations to maintain a cooperative environment.

The following construction equipment could be a source of vibrations: piling rig, hoe ram, compactor, dozer, crane, truck traffic, etc. Vibrations, whether it is caused by blasting operations or by construction operations, could be the cause of the source of detrimental vibrations on the nearby buildings and structures. Therefore, it is recommended that all vibrations be limited.

Two parameters determine the recommended vibration limit: the maximum peak particle velocity and the frequency. For low frequency vibrations, the maximum allowable peak particle velocity is less than that for high frequency vibrations. As a guideline, the peak particle velocity should be less than 15 mm/s between frequencies of 4 to 12 Hz, and 50 mm/s above a frequency of 40 Hz (interpolate between 12 and 40).

These guidelines are for current construction standards. Considering that these guidelines are above perceptible human level and, in some cases, could be very disturbing to some people, it is recommended that a pre-construction survey be completed to minimize the risks of claims during or following the construction of the proposed building.

### **Fill Placement**

Fill used for grading beneath the proposed development should consist, unless otherwise specified, 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 buildings 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 lifts with a maximum thickness of 300 mm and 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.

If excavated rock is used as exterior fill, it should be suitably fragmented to produce a well-graded material, similar to a 150 mm minus crushed stone material and approved by the geotechnical consultant. Where the crushed bedrock is open graded, a blinding layer of finer granular fill and/or a woven geotextile may be required to prevent adjacent finer materials from migrating into the voids, with associated loss of ground and settlements. This can be assessed at the time of construction.

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**

### **Bearing Resistance Values**

Footings placed on clean, surface sounded bedrock can be designed using a factored bearing resistance value at ultimate limit states (ULS) of **1,500 kPa**, incorporating a geotechnical resistance factor of 0.5.

A clean, surface-sounded bedrock bearing surface should be free of loose materials and have no near surface seams, voids, fissures, or open joints which can be detected from surface sounding with a rock hammer.

### **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 sound bedrock bearing medium when a plane extending down and out from the bottom edges of the footing at a minimum of 1H:6V (or flatter) passes only through sound bedrock or a material of the same or higher capacity as the bedrock, such as concrete. A weathered bedrock bearing medium will require a lateral support zone of 1H:1V (or flatter).

## Settlement

Footings bearing on an acceptable bedrock bearing surface and designed for the bearing resistance values provided above will be subjected to negligible potential post-construction total and differential settlements.

## 5.4 Design for Earthquakes

The site class for seismic site response can be taken as **Class C** for foundations constructed at the subject site. If a higher seismic site class is required, such as Class A or B, a site-specific shear wave velocity test may be completed to accurately determine the applicable seismic site classification for foundation design of the proposed building, as presented in Table 4.1.8.4.A of the 2012 Ontario Building Code (OBC 2012).

The soils underlying the subject site are 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 Construction

With the removal of all topsoil, and fill containing significant amounts of deleterious or organic materials, the existing fill or native soil approved by the geotechnical consultant at the time of excavation will be considered an acceptable subgrade surface on which to commence backfilling for slab-on-grade construction for auxiliary structures, and the glacial till and/or bedrock will be a suitable bearing medium for support of the basement slab.

It is recommended that the upper 200 mm of sub-slab fill for the basement level consists of 19 mm clear crushed stone.

Any poor performing areas should be sub-excavated and reinstated using OPSS Granular B Type II. All backfill material within the footprint of the proposed building should be placed in maximum 300 mm thick loose layers and compacted to at least 98% of its SPMDD.

## 5.6 Basement Wall

There are several combinations of backfill materials and retained soils that could be applicable for the basement walls of the proposed basement space. However, the conditions can be well-represented by assuming the retained soil consists of a material with an angle of internal friction of 30 degrees and a bulk (drained) unit weight of 20 kN/m<sup>3</sup>.

Two distinct conditions, static and seismic, must be reviewed for design calculations. The parameters for design calculations for the two conditions are presented below.

### Static 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 material

$\gamma$  = unit weight of fill of the applicable retained soil (kN/m<sup>3</sup>)

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<sup>3</sup>)

H = height of the wall (m)

g = gravity, 9.81 m/s<sup>2</sup>

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

The earth force component ( $P_o$ ) under seismic conditions can be calculated using  $P_o = 0.5 K_o \gamma H^2$ , where  $K_o = 0.5$  for the soil conditions noted above.

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

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

The earth forces calculated are unfactored. For the ULS case, the earth loads should be factored as live loads, as per OBC 2012.

## 5.7 Pavement Design

Although car parking areas are not anticipated as part of the proposed development based on the current plans, the hard landscaping walkway and car-only pavement structures presented in the following tables could be used for design purposes, if required.

<b>Table 1 – Recommended Hard Landscaping – Pedestrian Walkways</b>	
<b>Thickness (mm)</b>	<b>Material Description</b>
Specified by Others	<b>Wear Course</b> – Interlocking Stone/Brick Pavers or Cast-in-Place Concrete
25 to 40	<b>Leveling Course (Pavers Only)</b> – Stone Dust or Sand
300	<b>BASE</b> – OPSS Granular A
<b>SUBGRADE</b> – Either fill, in-situ soil, or OPSS Granular B Type I or II material placed over in-situ soil or bedrock.	

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

Minimum Performance Graded (PG) 58-34 asphalt cement should be used for this project. If soft spots develop in the subgrade during compaction or due to construction traffic, the affected areas should be 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 99% of the material's SPMD using suitable vibratory equipment.

Subgrades for walkways against the buildings should be sloped to divert water towards the buildings foundation drainage system.

## **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 basement space. The system should consist of a 150 mm diameter perforated and corrugated plastic pipe, surrounded on all sides by 150 mm of 19 mm clear crushed stone, which is placed at the footing level around the exterior perimeter of the basement walls. The pipe should have a positive outlet, such as gravity connection to the storm sewer or to a sump pit.

#### **Foundation Backfill**

Backfill against the exterior sides of the basement 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 placement as backfill against the foundation walls unless used in conjunction with a composite drainage system, such as Delta Drain 6000 or Miradrain G100N. Imported granular materials, such as clean sand or OPSS Granular B Type I granular material, should be placed for this purpose.

### **6.2 Protection of Footings Against Frost Action**

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

Exterior unheated footings, such as those for isolated exterior piers and unheated storage structures, are more prone to deleterious movement associated with frost action and require additional protection, such as soil cover of 2.1 m, or an equivalent combination of soil cover and foundation insulation.

However, sound bedrock bearing mediums are not considered as frost susceptible, such that footings placed directly on sound bedrock would not require the minimum soil cover, as referenced above, to mitigate the migration of frost.

### **6.3 Excavation Side Slopes**

The side slopes of shallow excavations anticipated at this site should either be cut back at acceptable slopes or be retained by temporary shoring systems from the start of the excavation until the structure is backfilled.

## **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 flatter. The flatter slope is required for excavation below groundwater level. The subsoil at this site is considered to be mainly a Type 2 and 3 soil according to the Occupational Health and Safety Act and Regulations for Construction Projects.

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

Excavation side slopes around the building excavation should be protected from erosion by surface water and rainfall events and drying during drier weather by the use of secured tarpaulins spanning the length of the side slopes, or other means of erosion protection along their footprint. Efforts should also be made to maintain dry surfaces at the bottom of the excavation footprints and along the bottom of soil side slopes to prevent disturbance to the toe of the slope. Additional measures may be recommended at the time of construction by the geotechnical consultant.

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

## **6.4 Pipe Bedding and Backfill**

Bedding and backfill materials should be in accordance with the most recent Material Specifications and Standard Detail Drawings from the department of Public Works and Services, Infrastructure Services Branch of the City of Ottawa.

At least 150 mm of OPSS Granular A should be used for pipe bedding for sewer and water pipes when placed on soil subgrade. Should bedrock be encountered at the bedding level, the bedding layer should be increased to a minimum thickness of 300 mm. The material should be placed in maximum 300 mm thick lifts and compacted to a minimum of 99% of its SPMDD. 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 99% of the material's standard Proctor maximum dry density.

Where hard surface areas are considered above the trench backfill, the trench backfill material within the frost zone (about 1.8 m below finish grade) should match the soils exposed at the trench walls to reduce the potential differential frost heaving. The trench backfill should be placed in maximum 300 mm thick loose lifts and compacted to a minimum of 95% of the material's SPMDD. All cobbles larger than 200 mm in their longest direction should be segregated from re-use as trench backfill.

## **6.5 Groundwater Control**

### **Groundwater Control for Building Construction**

Based on our observations, it is anticipated that groundwater infiltration into the excavations should be low 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 Environment, Conservation and Parks (MECP) permit to take water (PTTW) may be required if more than 400,000 L/day of ground and/or surface water are to be pumped during the construction phase. At least 4 to 5 months should be allowed for completion of the application and issuance of the permit by the MECP.

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



## **6.6 Winter Construction**

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

The subsoil conditions at this site consist of frost susceptible materials. In the presence of water and freezing conditions, ice could form within the soil mass. Heaving and settlement upon thawing could occur.

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

All efforts should be taken to prevent the bearing medium of frost susceptible soils supporting neighboring structures from freezing. Provisions, such as use of propane heaters, tarpaulins and other suitable means should be carried to mitigate the migration of frost to load-bearing soils in proximity to the excavation perimeter.

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

## 7.0 Recommendations

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

- Review of servicing plans and details from a geotechnical perspective.
- Observation of all bearing surfaces prior to the placement of concrete.
- Sampling and testing of the concrete and fill materials.
- Periodic observation of the condition of unsupported excavation side slopes in excess of 3 m in height, if applicable.
- Review of the installation of the foundation drainage system.
- Observation of all subgrades prior to backfilling.
- Field density tests to determine the level of compaction achieved.
- Sampling and testing of the bituminous concrete including mix design reviews.

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

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

## 8.0 Statement of Limitations

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

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

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

The present report applies only to the project described in this document. Use of this report for purposes other than those described herein or by person(s) other than Cassidy E.W. Construction Consultant Ltd. or their agents is not authorized without review by Paterson for the applicability of our recommendations to the alternative use of the report.

### Paterson Group Inc.



Drew Petahtegoose, B. Eng.



David J. Gilbert, P. Eng.

### Report Distribution:

- Cassidy E.W. Construction Consultant Ltd. (email copy)
- Paterson Group (1 copy)

# APPENDIX 1

## SOIL PROFILE AND TEST DATA SHEETS SYMBOLS AND TERMS

DATUM Geodetic

REMARKS

BORINGS BY CME-55 Low Clearance Drill

DATE January 21, 2022

FILE NO. **PG6061**

HOLE NO. **BH 1-22**

SOIL DESCRIPTION	STRATA PLOT	SAMPLE				DEPTH (m)	ELEV. (m)	Pen. Resist. Blows/0.3m ● 50 mm Dia. Cone				Piezometer Construction	
		TYPE	NUMBER	RECOVERY %	N VALUE or RQD			20	40	60	80		
<b>GROUND SURFACE</b>													
Asphaltic concrete	0.05					0	63.11						
<b>FILL:</b> Crushed stone	0.23	AU	1										
Loose, brown <b>SILTY SAND</b>		SS	2	75	7	1	62.11						
- rock fragments by 2.0m depth		SS	3	50	9	2	61.11						
End of Borehole	2.13												
Practical refusal to augering at 2.13m depth. (BH dry - January 26, 2022)													

○ Water Content %

20 40 60 80 100  
**Shear Strength (kPa)**

▲ Undisturbed    △ Remoulded

DATUM Geodetic

REMARKS

BORINGS BY CME-55 Low Clearance Drill

DATE January 21, 2022

FILE NO. **PG6061**

HOLE NO. **BH 2-22**

SOIL DESCRIPTION	STRATA PLOT	SAMPLE				DEPTH (m)	ELEV. (m)	Pen. Resist. Blows/0.3m ● 50 mm Dia. Cone				Piezometer Construction	
		TYPE	NUMBER	RECOVERY %	N VALUE or RQD			20	40	60	80		
<b>GROUND SURFACE</b>						0	62.82						
Asphaltic concrete	0.03												
<b>FILL:</b> Crushed stone	0.25	AU	1										
Loose to compact, brown <b>SILTY SAND</b>		SS	2	25	7	1	61.82						
- rock fragments by 1.75m depth		SS	3	79	14	2	60.82						
End of Borehole	2.13												
Practical refusal to augering at 2.13m depth. (BH dry - January 26, 2022)													

○ Water Content %

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 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.

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

### SAMPLE TYPES

SS	-	Split spoon sample (obtained in conjunction with the performing of the Standard Penetration Test (SPT))
TW	-	Thin wall tube or Shelby tube
PS	-	Piston sample
AU	-	Auger sample or bulk sample
WS	-	Wash sample
RC	-	Rock core sample (Core bit size AXT, BXL, etc.). Rock core samples are obtained with the use of standard diamond drilling bits.

## SYMBOLS AND TERMS (continued)

### GRAIN SIZE DISTRIBUTION

MC%	-	Natural moisture content or water content of sample, %
LL	-	Liquid Limit, % (water content above which soil behaves as a liquid)
PL	-	Plastic limit, % (water content above which soil behaves plastically)
PI	-	Plasticity index, % (difference between LL and PL)
Dxx	-	Grain size which xx% of the soil, by weight, is of finer grain sizes These grain size descriptions are not used below 0.075 mm grain size
D10	-	Grain size at which 10% of the soil is finer (effective grain size)
D60	-	Grain size at which 60% of the soil is finer
Cc	-	Concavity coefficient = $(D_{30})^2 / (D_{10} \times D_{60})$
Cu	-	Uniformity coefficient = $D_{60} / D_{10}$

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

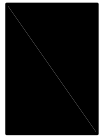
$p'_o$	-	Present effective overburden pressure at sample depth
$p'_c$	-	Preconsolidation pressure of (maximum past pressure on) sample
Ccr	-	Recompression index (in effect at pressures below $p'_c$ )
Cc	-	Compression index (in effect at pressures above $p'_c$ )
OC Ratio		Overconsolidation ratio = $p'_c / p'_o$
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.
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## SYMBOLS AND TERMS (continued)

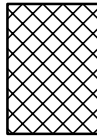
### STRATA PLOT



Topsoil



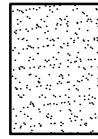
Asphalt



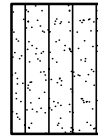
Fill



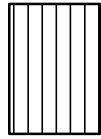
Peat



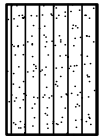
Sand



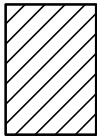
Silty Sand



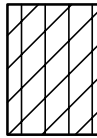
Silt



Sandy Silt



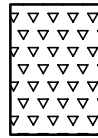
Clay



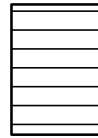
Silty Clay



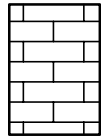
Clayey Silty Sand



Glacial Till



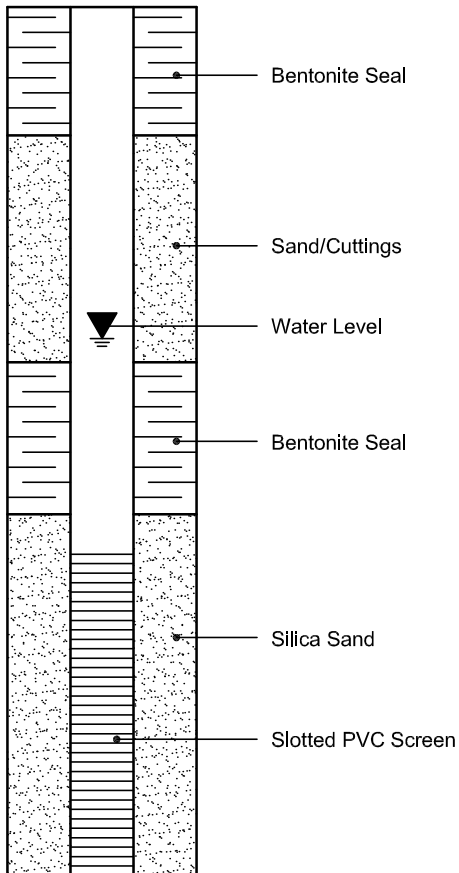
Shale



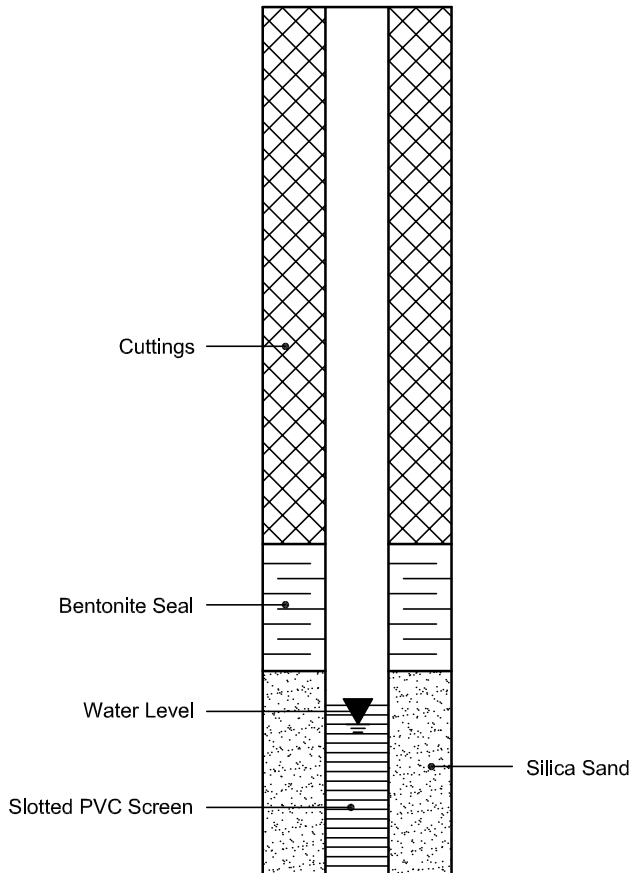
Bedrock

### MONITORING WELL AND PIEZOMETER CONSTRUCTION

#### MONITORING WELL CONSTRUCTION



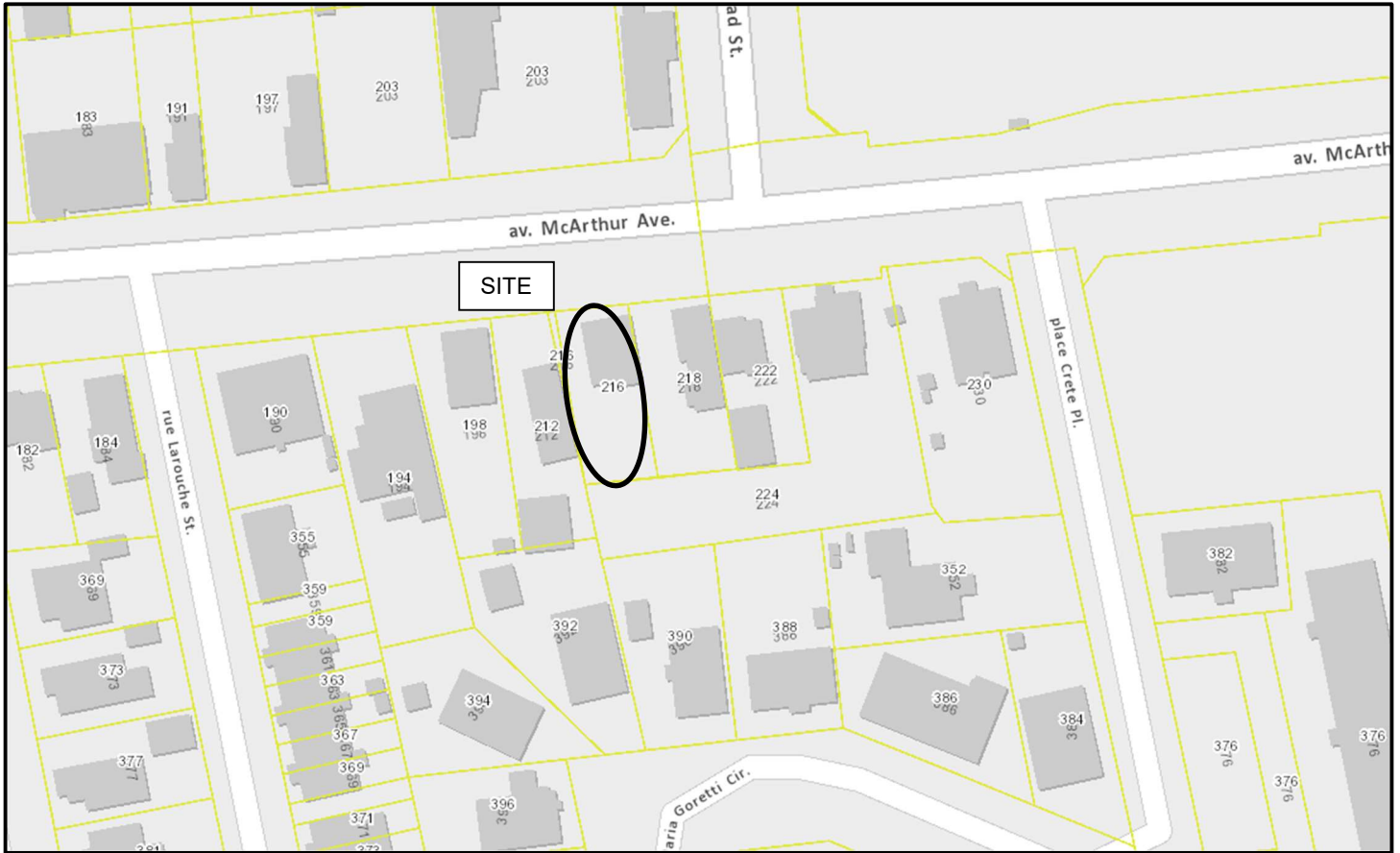
#### PIEZOMETER CONSTRUCTION



# APPENDIX 2

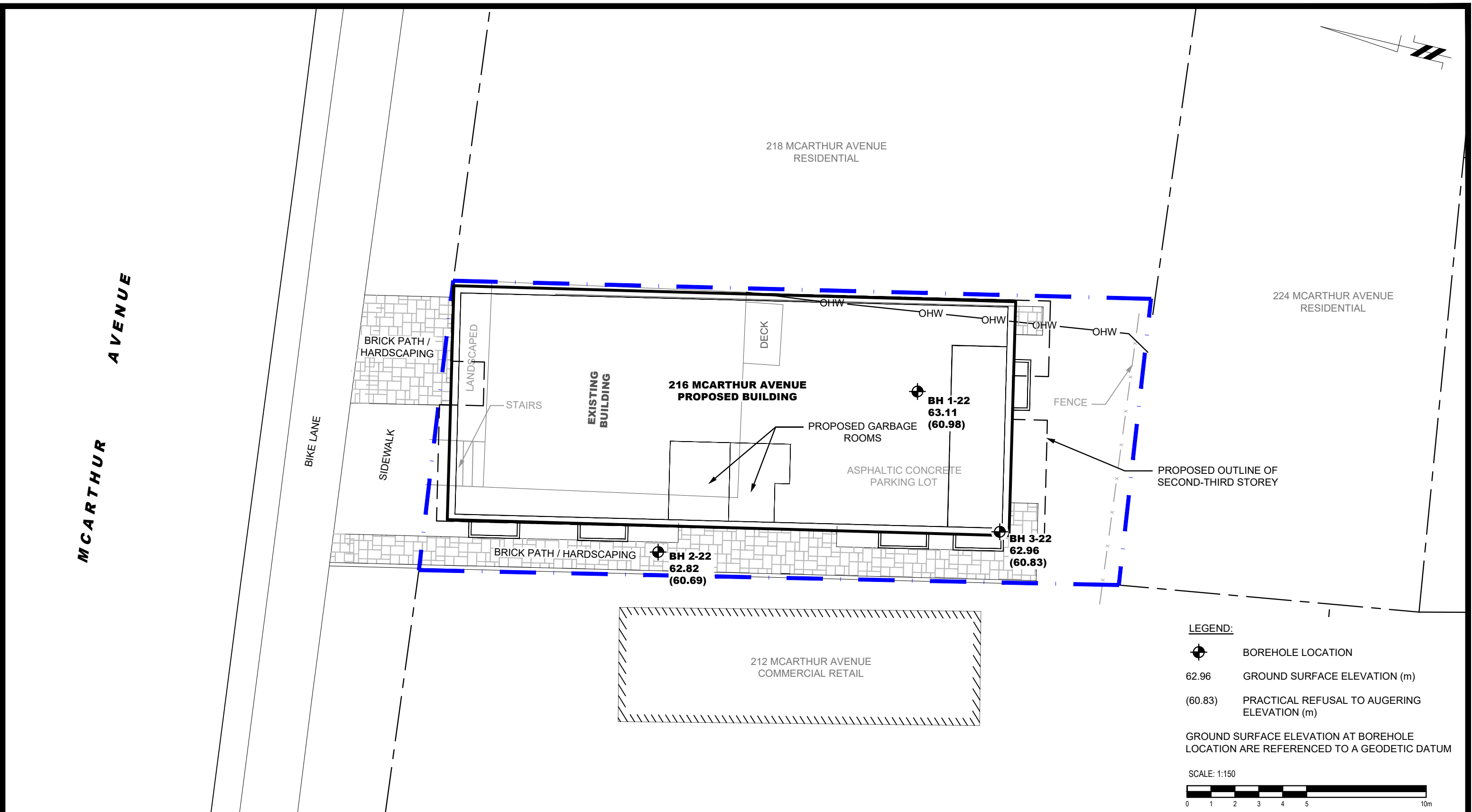
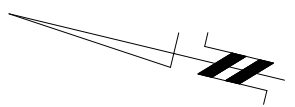
FIGURE 1 – KEY PLAN

DRAWING PG6061-1 – TEST HOLE LOCATION PLAN



**FIGURE 1**

**KEY PLAN**



**LEGEND:**

- BOREHOLE LOCATION
- 62.96 GROUND SURFACE ELEVATION (m)
- (60.83) PRACTICAL REFUSAL TO AUGERING ELEVATION (m)

GROUND SURFACE ELEVATION AT BOREHOLE LOCATION ARE REFERENCED TO A GEODETIC DATUM

SCALE: 1:150

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NO.	REVISIONS	DATE	INITIAL

CASSIDY E.W. CONSTRUCTION CONSULTANT LTD.  
GEOTECHNICAL INVESTIGATION  
PROPOSED MIXED-USE DEVELOPMENT  
216 MCARTHUR AVENUE

OTTAWA, ONTARIO

**TEST HOLE LOCATION PLAN**

Scale:	1:150	Date:	01/2022
Drawn by:	YA	Report No.:	PG6061-1
Checked by:	FC	Dwg. No.:	<b>PG6061-1</b>
Approved by:	DJG	Revision No.:	

p:\autocad drawings\geotechnical\pg6061\pg6061-1-test hole location plan.dwg