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Geotechnical Investigation

Proposed Commercial Building
9 - 17 Colonnade Road
Ottawa, Ontario

Prepared For

BBS Construction (Ontario) Ltd.

October 10, 2018

Report: PG4637-1

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Appendices

1.0 Introduction

Paterson Group (Paterson) was commissioned by BBS Construction (Ontario) Ltd. to conduct a geotechnical investigation for the proposed commercial building to be located along 9 - 17 Colonnade Road, in the City of Ottawa, Ontario (refer to Figure 1 - Key Plan in Appendix 2).

The objectives of the current investigation were to:

❏ Obtain subsurface soil and groundwater information by means of boreholes completed within the subject site.

❏ Provide geotechnical recommendations for 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. This report contains our findings and includes geotechnical recommendations pertaining to the design and construction of the subject development as understood at the time of writing this report.

2.0 Proposed Development

Based on the available drawings at the time of issuance of this report, it is understood that the proposed project will consist of an automobile body shop of slab on grade construction with associated access lanes, at-grade parking areas and landscaped areas. It is also anticipated that the proposed building will be municipally serviced.

3.0 Method of Investigation

3.1 Field Investigation

Field Program

The field program for the current investigation was completed on September 17, 2018. At that time, 5 boreholes were drilled to a maximum depth of 6.5 m below existing grade. A previous geotechnical investigation was completed by others in 2006 which included 2 boreholes within the subject site. The borehole locations completed by Paterson were chosen to provide general coverage for the proposed development. The locations of the boreholes are shown on Drawing PG4637-1 - Test Hole Location Plan included in Appendix 2.

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

Sampling and In Situ Testing

Soil samples from the boreholes were recovered from the auger flights or a 50 mm diameter split-spoon sampler. All soil samples were visually inspected and classified on site. The auger and split spoon samples were placed in sealed plastic bags and transported to our laboratory for further 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 overburden soil thickness was evaluated during the course of the investigation by dynamic cone penetration testing (DCPT) at borehole BH 3-18. The DCPT consists of driving a steel drill rod, equipped with a 50 mm diameter cone at its tip, using a 63.5 kg hammer falling from a height of 760 mm. The number of blows required to drive the cone into the soil is recorded for each 300 mm depth increment.

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 presented in Appendix 1.

Groundwater

Flexible polyethylene standpipes were installed in all boreholes to permit monitoring of the groundwater levels subsequent to the completion of the sampling program.

Sample Storage

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

3.2 Field Survey

The location and ground surface elevation at each borehole location were surveyed by Paterson personnel. The ground surface elevation at each borehole location was surveyed with respect to a temporary benchmark (TBM), consisting of the top spindle of the fire hydrant located at the site entrance within the west portion of the site. An assumed elevation of 100 m was assigned to the TBM. The borehole locations and ground surface elevation at the borehole locations along with the TBM location are presented on Drawing PG4637-1 - Test Hole Location Plan in Appendix 2.

3.3 Laboratory Testing

All soil samples were recovered from the subject site and visually examined in our laboratory to review the soil investigation results.

3.4 Analytical Testing

One 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 analyzed to determine the concentrations of sulphate and chloride, the resistivity and the pH of the sample. The analytical test results are presented in Appendix 1 and discussed in Subsection 6.7.

4.0 Observations

4.1 Surface Conditions

Currently, the subject site is used as an automobile storage yard with a generally gravel-covered surface. The ground surface at the site is relatively flat and at grade with Colonnade Road. It should be noted that the east portion of the site is currently undeveloped and grass covered.

The subject site is bordered by a Canada Post building to the east, Merivale High School to the north, vacant lands to the west and Colonnade Road to the south.

4.2 Subsurface Profile

Overburden

Generally, the subsurface soil profile encountered at the borehole locations from the ground surface downward consists of an approximate 0.3 to 0.4 m thickness of crushed stone fill. At borehole BH5-18, an approximate 1.4 m thickness of brown silty clay fill was encountered underlying the crushed stone.

A compact, brown silty sand deposit was encountered underlying the fill at approximate depths of 0.3 to 1.7 m below the existing ground surface, and extending to the surface of a glacial till deposit at depths of 3.8 to 5.3 m. The glacial till deposit was observed to consist of compact to dense, grey silty sand to clayey silt with varying amounts of gravel, cobbles and boulders.

Practical refusal to augering was encountered at boreholes BH 1-18 and BH 2-18 at 5.0 and 6.5 m depth, respectively. Also, practical refusal to dynamic cone penetration testing (DCPT) was encountered at borehole BH 3-18 at a 7.4 m depth. Specific details of the subsoil profile at each test hole location are presented on the Soil Profile and Test Data sheets in Appendix 1.

Bedrock

Based on available geological mapping, the subject site is located in an area where the bedrock consists of shale of the Rockcliffe formation with an approximate drift thickness of 5 to 10 m.

4.3 Groundwater

Based on groundwater level readings acquired from the standpipe piezometers, field observations at the time of drilling, and the recovered soil samples' moisture levels, consistency and colouring, the long-term groundwater table can be expected between a 3 and 4 m depth below existing ground surface. It should be noted that groundwater levels are subject to seasonal fluctuations. Therefore, groundwater levels could vary at the time of construction.

5.0 Discussion

5.1 Geotechnical Assessment

From a geotechnical perspective, the subject site is adequate for the proposed commercial building. It is anticipated that the proposed building will be founded on conventional shallow footings placed on an undisturbed, compact silty sand bearing surface.

The above and other considerations are 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 the proposed building, paved areas, pipe bedding and other settlement sensitive structures.

Fill Placement

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

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

5.3 Foundation Design

Bearing Resistance Values

Footings placed over an undisturbed, compact silty sand 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.

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.

Settlement

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

Lateral Support

The bearing medium under footing-supported structures is required to be provided with adequate lateral support with respect to excavations and different foundation levels. Adequate lateral support is provided to a compact to dense silty sand bearing medium when a plane extending down and out from the bottom edge of the footing at a minimum of 1.5H:1V (or flatter) passes only through in situ soil or engineered fill.

5.4 Design for Earthquakes

The site class for seismic site response can be taken as **Class C** for the foundations considered at this site. The soils underlying the subject site are not susceptible to liquefaction. Refer to the latest revision of the 2012 Ontario Building Code for a full discussion of the earthquake design requirements.

5.5 Slab on Grade Construction

With the removal of topsoil and deleterious fill, such as those containing organic materials, within the footprint of the proposed building, the native soil surface is considered to be an acceptable subgrade surface on which to commence backfilling for floor slab construction. Any soft areas should be removed and backfilled with appropriate backfill material. OPSS Granular A or Granular B Type II, with a maximum particle size of 50 mm, are recommended for backfilling below the floor slab.

It is recommended that the upper 200 mm of sub-floor fill consist of Granular A crushed stone. All backfill materials 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 Pavement Structure

For design purposes, the pavement structure presented in the following tables could be used for the design of car only parking areas and access lanes, if required.

Table 1 - Recommended Pavement Structure - Car Only Parking Areas

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

Table 2 - Recommended Pavement Structure
Access Lanes and Heavy Truck Parking Areas

Thickness (mm)	Material Description
40	**Wear Course -** HL-3 or Superpave 12.5 Asphaltic Concrete
50	**Binder Course -** HL-8 or Superpave 19.0 Asphaltic Concrete
150	**BASE** - OPSS Granular A Crushed Stone
450	**SUBBASE** - OPSS Granular B Type II
	SUBGRADE - In situ soil, or OPSS Granular B Type I or II material placed over in situ soil

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

If soft spots develop in the subgrade during compaction or due to construction traffic, the affected areas should be excavated and replaced with OPSS Granular B Type II material.

The pavement granular base and subbase should be placed in maximum 300 mm thick lifts and compacted to a minimum of 98% of the material's SPMDD using suitable vibratory equipment.

6.0 Design and Construction Precautions

6.1 Foundation Drainage and Backfill

Foundation Drainage

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

Foundation Backfill

Backfill against the exterior sides of the foundation walls should consist of free-draining, non frost susceptible granular materials. The greater part of the site excavated materials will be frost susceptible and, as such, are not recommended for re-use as backfill against the foundation walls, unless used in conjunction with a drainage geocomposite, such as Miradrain G100N or Delta Drain 6000, connected to the perimeter foundation drainage system. Imported granular materials, such as clean sand or OPSS Granular B Type I granular material, should otherwise be used for this purpose.

6.2 Protection of Footings Against Frost Action

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

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

6.3 Excavation Side Slopes

The excavations for the proposed development will be through fill and native silty sand material. The subsurface soil is considered to be mainly a Type 2 or 3 soil according to the Occupational Health and Safety Act and Regulations for Construction Projects. For excavations to depths of approximately 3 m, above the groundwater level, the excavation side slopes should be stable in the short term at 1H:1V. Shallower slopes should be provided for deeper excavations or for excavation below the groundwater level. Where such side slopes are not permissible or practical, temporary shoring should be installed.

The slope cross-sections recommended above are for temporary slopes. Excavated soil should not be stockpiled directly at the top of excavations and heavy equipment should be maintain safe working distance from the excavation sides.

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

A trench box is recommended to be installed at all times to protect personnel working in trenches with steep or vertical sides. Services are expected to be installed by “cut and cover” methods and excavations should not remain open for extended periods of time.

6.4 Pipe Bedding and Backfill

The pipe bedding for sewer and water pipes should consist of at least 150 mm of OPSS Granular A material. The material should be placed in maximum 300 mm thick lifts and compacted to a minimum of 95% of the SPMDD. The bedding material should extend at least to the spring line of the pipe.

The cover material, which should consist of OPSS Granular A, should extend from the spring line of the pipe to at least 300 mm above the obvert of the pipe. The material should be placed in maximum 300 mm thick lifts and compacted to a minimum of 95% of the SPMDD.

Where hard surface areas are considered above the trench backfill, the trench backfill material within the frost zone (about 1.8 m below finished grade) should match the soils exposed at the trench walls to minimize differential frost heaving. The trench backfill should be placed in maximum 300 mm thick loose lifts and compacted to a minimum of 95% of the SPMDD.

6.5 Groundwater Control

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

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

For typical ground or surface water volumes being pumped during the construction phase, 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 MOECC review of the PTTW application.

Impacts on Neighbouring Properties

Based on the proximity of neighbouring buildings, the proposed development will not negatively impact the neighbouring structures. It should be noted that issues are not expected with respect to groundwater lowering that would cause long term adverse effects to adjacent structures surrounding the proposed building.

6.6 Winter Construction

Precautions should be considered if construction occurs during the winter. The subsurface soil conditions 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. The base of the excavations should be insulated from sub-zero temperatures immediately upon exposure and until 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 winter without introducing frost in the excavation subgrade base or walls. Precautions should be considered if such activities are to be completed during sub-zero temperatures.

6.7 Corrosion Potential and Sulphate

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

7.0 Recommendations

The following material testing and observation program should be performed by a geotechnical consultant and is required for the foundation design data provided herein to be applicable:

- ❏ Observation of all bearing surfaces prior to the placement of concrete.
- ❏ Sampling and testing of the concrete and fill materials used.
- ❏ Periodic observation of the condition of unsupported excavation side slopes in excess of 3 m in height, if applicable.
- ❏ Observation of all subgrades prior to backfilling, and follow-up field density tests to determine the level of compaction achieved.
- ❏ Sampling and testing of the bituminous concrete including mix design reviews.

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

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 BBS Construction (Ontario) 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.

LICENSED PROFESSIONAL ENGINEER
Oct. 10, 2018
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PROVINCE OF ONTARIO

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Report Distribution

- ❏ BBS Construction (Ontario) Ltd. (3 copies)
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APPENDIX 1

SOIL PROFILE AND TEST DATA SHEETS

SYMBOLS AND TERMS

BOREHOLE LOGS BY OTHERS

ANALYTICAL TESTING RESULTS

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154 Colonnade Road South, Ottawa, Ontario K2E 7J5

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Prop. Commercial Building - 9 to17 Colonnade Road
Ottawa, Ontario

DATUM TBM - Top spindle of fire hydrant located at the entrance to the subject site. An arbitrary elevation of 100.00m was assigned to the TBM.

REMARKS

BORINGS BY CME 55 Power Auger

DATE September 17, 2018

FILE NO. PG4637

HOLE NO. BH 1-18

SOIL DESCRIPTION	Depth to base (m)	SAMPLE TYPE	NUMBER	% RECOVERY	N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	99.99
Crushed stone (25mm minus)	0.18	AU	1				
Crushed stone (100mm minus)	0.28						
Compact, reddish brown **SILTY SAND** - light brown by 1.5m depth	3.81	SS	2	88	16	1	98.99
		SS	3	88	16	2	97.99
		SS	4	88	12	3	96.99
		SS	5	75	10		
GLACIAL TILL: Dense, brown silty sand with gravel, cobbles and boulders	5.00	SS	6	50	35	4	95.99
		SS	7	100	50+	5	94.99

End of Borehole

Practical refusal to augering at 5.00m depth

(GWL @ 3.05m - Sept. 20, 2017)

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

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

Piezometer Construction

patersongroup Consulting Engineers

154 Colonnade Road South, Ottawa, Ontario K2E 7J5

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Prop. Commercial Building - 9 to17 Colonnade Road
Ottawa, Ontario

DATUM TBM - Top spindle of fire hydrant located at the entrance to the subject site. An arbitrary elevation of 100.00m was assigned to the TBM.

REMARKS

BORINGS BY CME 55 Power Auger

DATE September 17, 2018

FILE NO. PG4637

HOLE NO. BH 2-18

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	% RECOVERY	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	99.48		
Crushed stone (25mm minus) 0.15		AU	1						
Crushed stone (100mm minus) 0.30									
		SS	2	62	12	1	98.48		
		SS	3	100	11	2	97.48		
Compact, light brown **SILTY SAND**		SS	4	88	16				
		SS	5	83	12	3	96.48		▼
		SS	6	71	11	4	95.48		
- grey by 4.4m depth		SS	7	79	10	5	94.48		
5.33									
GLACIAL TILL: Grey clayey silt, some sand, trace gravel and cobbles 6.10		SS	8	75	21	6	93.48		
GLACIAL TILL: Grey sandy silt, trace clay and gravel, occasional cobbles 6.50		SS	9	100	50+				

End of Borehole

Practical refusal to augering at 6.50m depth

(GWL @ 3.25m - Sept. 20, 2017)

Shear Strength (kPa): 20 40 60 80 100

▲ Undisturbed △ Remoulded

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154 Colonnade Road South, Ottawa, Ontario K2E 7J5

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Prop. Commercial Building - 9 to17 Colonnade Road
Ottawa, Ontario

DATUM TBM - Top spindle of fire hydrant located at the entrance to the subject site. An arbitrary elevation of 100.00m was assigned to the TBM.

REMARKS

BORINGS BY CME 55 Power Auger

DATE September 17, 2018

FILE NO. PG4637

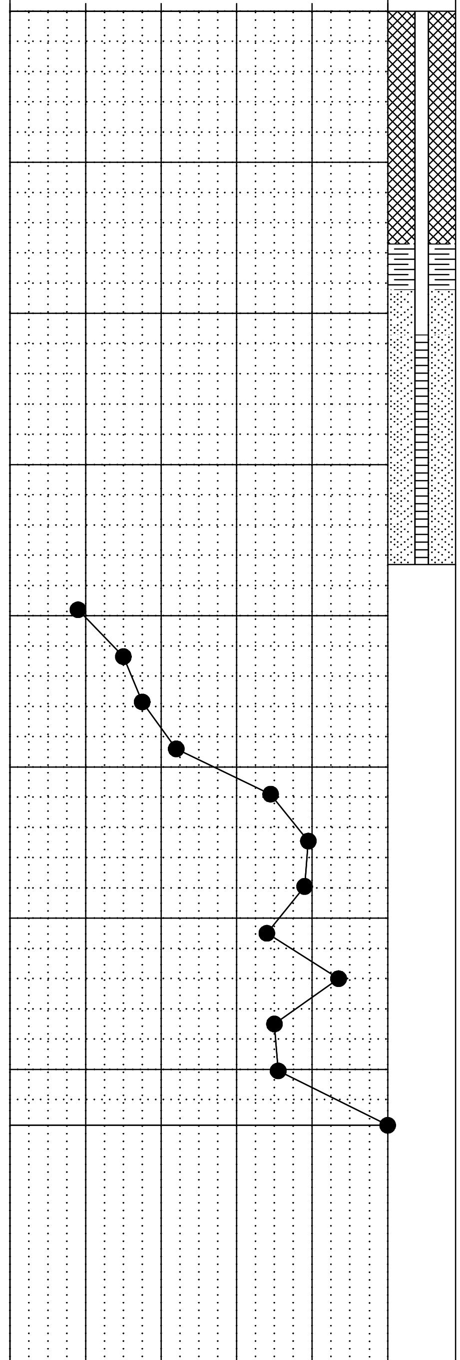
HOLE NO. BH 3-18

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	% RECOVERY	N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	98.74
Crushed stone (25mm minus) 0.20							
Crushed stone (100mm minus), some sand 0.40		AU	1				
Compact, light brown **SILTY SAND**		SS	2	71	15	1	97.74
		SS	3	75	10	2	96.74
		SS	4	71	14		
3.66		SS	5	75	12	3	95.74
Dynamic Cone Penetration Test commenced at 3.66m depth.						4	94.74
						5	93.74
						6	92.74
7.37						7	91.74
End of Borehole Practical DCPT refusal at 7.37m depth (Piezometer blocked and dry at 2.03m depth - Sept. 20, 2018)							

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

Piezometer Construction

patersongroup Consulting Engineers

154 Colonnade Road South, Ottawa, Ontario K2E 7J5

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Prop. Commercial Building - 9 to17 Colonnade Road
Ottawa, Ontario

DATUM TBM - Top spindle of fire hydrant located at the entrance to the subject site. An arbitrary elevation of 100.00m was assigned to the TBM.

REMARKS

BORINGS BY CME 55 Power Auger

DATE September 17, 2018

FILE NO. PG4637

HOLE NO. BH 4-18

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	% RECOVERY	N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	99.30
Crushed stone (25mm minus) 0.18							
Crushed stone (100mm minus), some sand 0.36		AU	1				
Compact, light brown **SILTY SAND**		SS	2	79	19	1	98.30
		SS	3	88	9	2	97.30
		SS	4	79	11	3	96.30
3.66		SS	5	75	15		
End of Borehole (Piezometer blocked and dry at 2.51m depth - Sept. 20, 2018)							

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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154 Colonnade Road South, Ottawa, Ontario K2E 7J5

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Prop. Commercial Building - 9 to17 Colonnade Road
Ottawa, Ontario

DATUM TBM - Top spindle of fire hydrant located at the entrance to the subject site. An arbitrary elevation of 100.00m was assigned to the TBM.

REMARKS

BORINGS BY CME 55 Power Auger

DATE September 17, 2018

FILE NO. PG4637

HOLE NO. BH 5-18

SOIL DESCRIPTION	Depth of change (m)	SAMPLE TYPE	NUMBER	% RECOVERY	N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	99.55
Crushed stone (25mm minus)	0.15						
Crushed stone (100mm minus), some sand	0.30	AU	1				
FILL: Brown silty clay, some sand	1.68	SS	2	71	10	1	98.55
Compact, reddish brown **SILTY SAND**		SS	3	75	12	2	97.55
		SS	4	79	19		
- grey by 2.2m depth	3.66	SS	5	79	19	3	96.55
End of Borehole							
(Piezometer blocked and dry at 2.76m depth - Sept. 20, 2018)							

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

SYMBOLS AND TERMS

SOIL DESCRIPTION

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

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

The standard terminology to describe the strength of cohesionless soils is the relative density, usually inferred from the results of the Standard Penetration Test (SPT) 'N' value. The SPT N value is the number of blows of a 63.5 kg hammer, falling 760 mm, required to drive a 51 mm O.D. split spoon sampler 300 mm into the soil after an initial penetration of 150 mm.

Relative Density	'N' Value	Relative Density %
Very Loose	<4	<15
Loose	4-10	15-35
Compact	10-30	35-65
Dense	30-50	65-85
Very Dense	>50	>85

The standard terminology to describe the strength of cohesive soils is the consistency, which is based on the undisturbed undrained shear strength as measured by the in situ or laboratory vane tests, penetrometer tests, unconfined compression tests, or occasionally by Standard Penetration Tests.

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

SYMBOLS AND TERMS (continued)

SOIL DESCRIPTION (continued)

Cohesive soils can also be classified according to their “sensitivity”. The sensitivity is the ratio between the undisturbed undrained shear strength and the remoulded undrained shear strength of the soil.

Terminology used for describing soil strata based upon texture, or the proportion of individual particle sizes present is provided on the Textural Soil Classification Chart at the end of this information package.

ROCK DESCRIPTION

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

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

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

SAMPLE TYPES

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

SYMBOLS AND TERMS (continued)

GRAIN SIZE DISTRIBUTION

MC%	-	Natural moisture content or water content of sample, %
LL	-	Liquid Limit, % (water content above which soil behaves as a liquid)
PL	-	Plastic limit, % (water content above which soil behaves plastically)
PI	-	Plasticity index, % (difference between LL and PL)
Dxx	-	Grain size which xx% of the soil, by weight, is of finer grain sizes These grain size descriptions are not used below 0.075 mm grain size
D10	-	Grain size at which 10% of the soil is finer (effective grain size)
D60	-	Grain size at which 60% of the soil is finer
Cc	-	Concavity coefficient = $(D30)^2 / (D10 \times D60)$
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

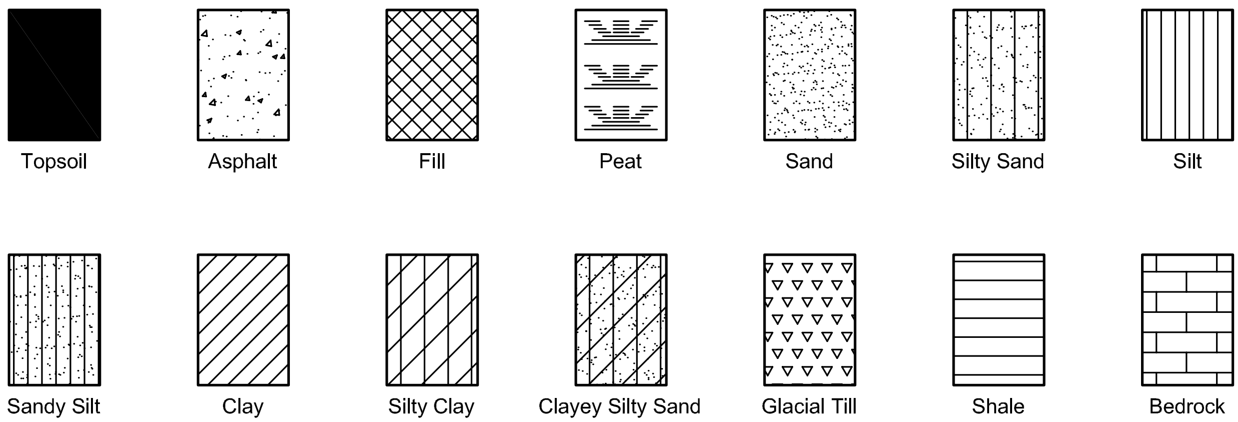
p'_o	-	Present effective overburden pressure at sample depth
p'_c	-	Preconsolidation pressure of (maximum past pressure on) sample
Ccr	-	Recompression index (in effect at pressures below p'_c)
Cc	-	Compression index (in effect at pressures above p'_c)
OC Ratio		Overconsolidaton ratio = p'_c / p'_o
Void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

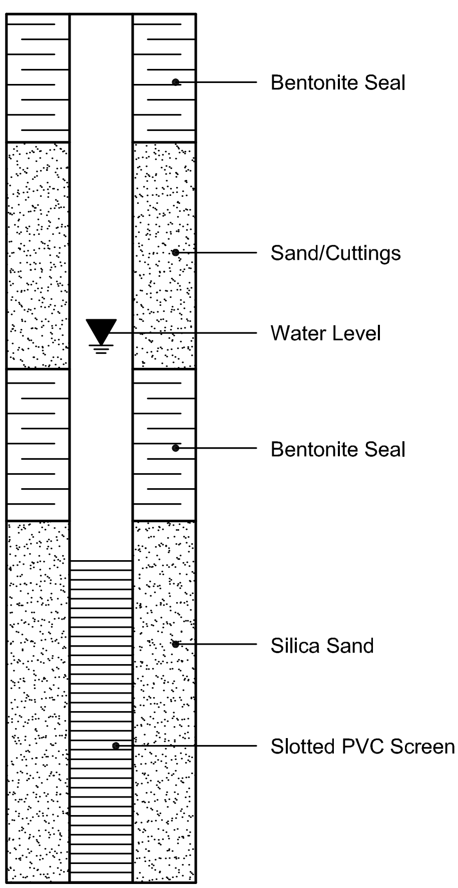
SYMBOLS AND TERMS (continued)

STRATA PLOT

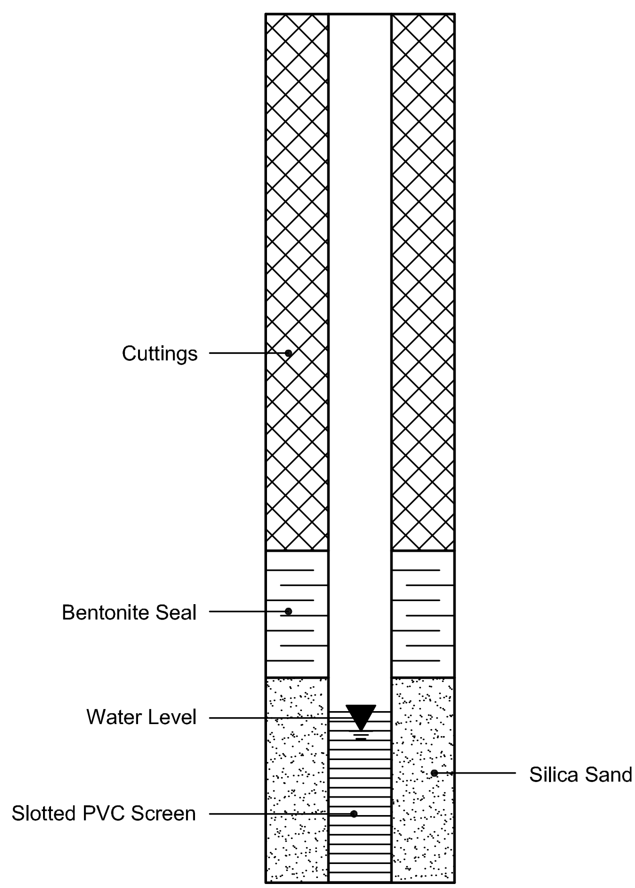


MONITORING WELL AND PIEZOMETER CONSTRUCTION

MONITORING WELL CONSTRUCTION



PIEZOMETER CONSTRUCTION



PROJECT: 06-1120-033

RECORD OF BOREHOLE: BH 06-3

SHEET 1 OF 1

LOCATION: See Site Plan

BORING DATE: Mar. 29, 2006

DATUM: Geodetic

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES: NUMBER	TYPE	BLOWS/0.3m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20 40 60 80); SHEAR STRENGTH Cu, kPa nat V. + Q - ● rem V. ⊕ U - O (20 40 60 80)	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-6} 10^{-5} 10^{-4} 10^{-3}); WATER CONTENT PERCENT Wp ⊢—⊖W—⊣ Wl (20 40 60 80)	ADDITIONAL LAB TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		GROUND SURFACE		85.07							
0	Power Auger 200mm Diam. (Hollow Stem)	TOPSOIL, trace gravel		0.00							
		Compact brown stratified fine SAND with occasional silty sand seams and layers		84.77 / 0.30							
1					1	50 DO	16				
2		Compact brown stratified fine SAND, trace silt		83.24 / 1.83	2	50 DO	16				
					3	50 DO	22				
3					4	50 DO	19				
4		Compact grey faintly stratified SILTY fine SAND		80.96 / 4.11	5	50 DO	27				
					6	50 DO	75			M	
5		Very dense grey SANDY SILT, some gravel, clay, numerous cobbles (GLACIAL TILL)		80.19 / 4.88							
		End of Borehole Auger Refusal		79.34 / 5.73							
6											
7											
8											
9											
10											

DEPTH SCALE

1 : 50

Golder Associates

LOGGED: D.J.S.

CHECKED: J.A.S.

[redacted]

RECORD OF BOREHOLE L-20

LOCATION See Figure 1 BORING DATE JULY 24 & 25, 1975 DATUM GEODETIC

SAMPLER HAMMER WEIGHT 140 LB., DROP 30 IN. PENETRATION TEST HAMMER WEIGHT 140 LB., DROP 30 IN.

STA. 387+50 25' LT. ℄ SEWER

BORING METHOD	ELEV'N. DEPTH	SOIL PROFILE DESCRIPTION	STRAT. PLOT	SAMPLES NUMBER	TYPE	BLOWS/FT.	ELEVATION SCALE	DYNAMIC PENETRATION RESISTANCE, BLOWS/FT. 20 40 60 80 / SHEAR STRENGTH Cu., LB./SQ.FT. NAT. V. - + Q - ● REM. V. - ⊕ U. - O	COEFFICIENT OF PERMEABILITY, K, CM./SEC. 1x10 1x10 1x10 1x10 / WATER CONTENT, PERCENT Wp W WL	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
							290				
POWER AUGER 8" DIAM. (HOLLOW STEM)	280.9	GROUND SURFACE						TOPSOIL			GROUND SURFACE
	0.2 / 278.4	SILTY CLAY (CRUST)					280				
	2.5	BROWN TO GREY FINE SAND TRACE SILT AND GRAVEL					270				PLASTIC TUBING
	257.9 / 23.	GREY SANDY SILT WITH GRAVEL (SANDY SILT TILL)					260				SAND BACKFILL
ROTARY DRILL, BX CORE	29.3	SOUND GREY SANDSTONE & LIMESTONE BEDROCK		1	BX RC	–	250	35			
	243.7 / 37.2 / 243.4	FRACTURED BEDROCK		2	"	–		100 / 26			
	37.5	SOUND LIME-STONE BEDROCK SOME SHALE INTERBEDS		3		–		22			STANDPIPE
	43	END OF HOLE		4		–	240	41 / 25			
							230				W.L. IN STANDPIPE AT ELEV. 258.0 OCT. 3, 1975

R Q D (%)
% DRILL WATER RETURN
% CORE RECOVERY

15 ◆ 5 Percent axial strain at failure
10

VERTICAL SCALE
1 IN. TO 10 FT.

Golder Associates

DRAWN GF
CHECKED PBM

G.A[redacted]

Project No. 73759

RECORD OF BOREHOLE M-1 & M-2

LOCATION See Figure 1 BORING DATE AUGUST 11, 1973 DATUM GEODETIC

SAMPLER HAMMER WEIGHT 140 LB., DROP 30 IN. PENETRATION TEST HAMMER WEIGHT 140 LB., DROP 30 IN.

BORING METHOD	SOIL PROFILE: ELEV'N / DEPTH	SOIL PROFILE: DESCRIPTION	STRAT. PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: BLOWS/FT	ELEVATION SCALE	DYNAMIC PENETRATION RESISTANCE, BLOWS/FT. (20, 40, 60, 80); SHEAR STRENGTH Cu., LB./SQ.FT. (500, 1000, 1500, 2000) NAT. V - + Q - ● REM. V. - ⊕ U - O	COEFFICIENT OF PERMEABILITY, K, CM./SEC. (1x10, 1x10, 1x10, 1x10); WATER CONTENT, PERCENT Wp W WL	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
								B.H. M-1 STA. 31+00, ℄ SEWER			
	279.0	GROUND SURFACE					280				GROUND SURFACE
POWER AUGER 8" DIAM. (HOLLOW STEM)	0.7	TOPSOIL									
		COMPACT BROWN TO GREY FINE SAND, TRACE SILT AND GRAVEL		1	2" DO	11					PLASTIC TUBING
				2	"	16	270				
				3	"	16					BACKFILL
	261.0 18.0	GREY SANDY SILT TILL					260				
ROTARY DRILLING BX CORE	19.5 256.0			4	BX RC	—		92 / 75 / 19			STANDPIPE
	23.0	END OF HOLE						R.Q.D. (%) EST. % DRILL WATER RETURN % CORE RECOVERY			W.L. IN STANDPIPE AT ELEV. 268.2 OCT. 3, 1973
		SOUND GREY SANDSTONE BEDROCK, SOME LIMESTONE					250				
								B.H. M-2 STA. 32+90, ℄ SEWER			
		TOPSOIL									
	278.6	GROUND SURFACE					280				
POWER AUGER 8" DIAM. (HOLLOW STEM)	0.5										
		COMPACT BROWN TO GREY FINE SAND, TRACE SILT		1	2" DO	12	270				
	266.1			2	"	12					
	12.5	GREY SANDY SILT TILL									
ROTARY DRILLING BX CORE	14.1			3	BX RC	—		78 / 100 / 50			
	258.5			4	"	—		59 / 0 / 0			
	19.1	END OF HOLE					260	R.Q.D. (%) EST. % DRILL WATER RETURN % CORE RECOVERY			
		FRACTURED SANDSTONE BEDROCK SOME LIMESTONE					250				

0 / 15 / 5 / 10 Percent axial strain at failure

VERTICAL SCALE 1 IN. TO 10 FT.

Golder Associates

DRAWN D.N.

CHECKED [illegible]

	Client ID:	BH2-18-SS2	-	-	-
	Sample Date:	09/17/2018 09:00	-	-	-
	Sample ID:	1838129-01	-	-	-
	MDL/Units	Soil	-	-	-
Physical Characteristics					
% Solids	0.1 % by Wt.	86.8	-	-	-
General Inorganics					
pH	0.05 pH Units	7.33	-	-	-
Resistivity	0.10 Ohm.m	41.3	-	-	-
Anions					
Chloride	5 ug/g dry	6	-	-	-
Sulphate	5 ug/g dry	141	-	-	-

APPENDIX 2

FIGURE 1 - KEY PLAN

DRAWING PG4637-1 - TEST HOLE LOCATION PLAN

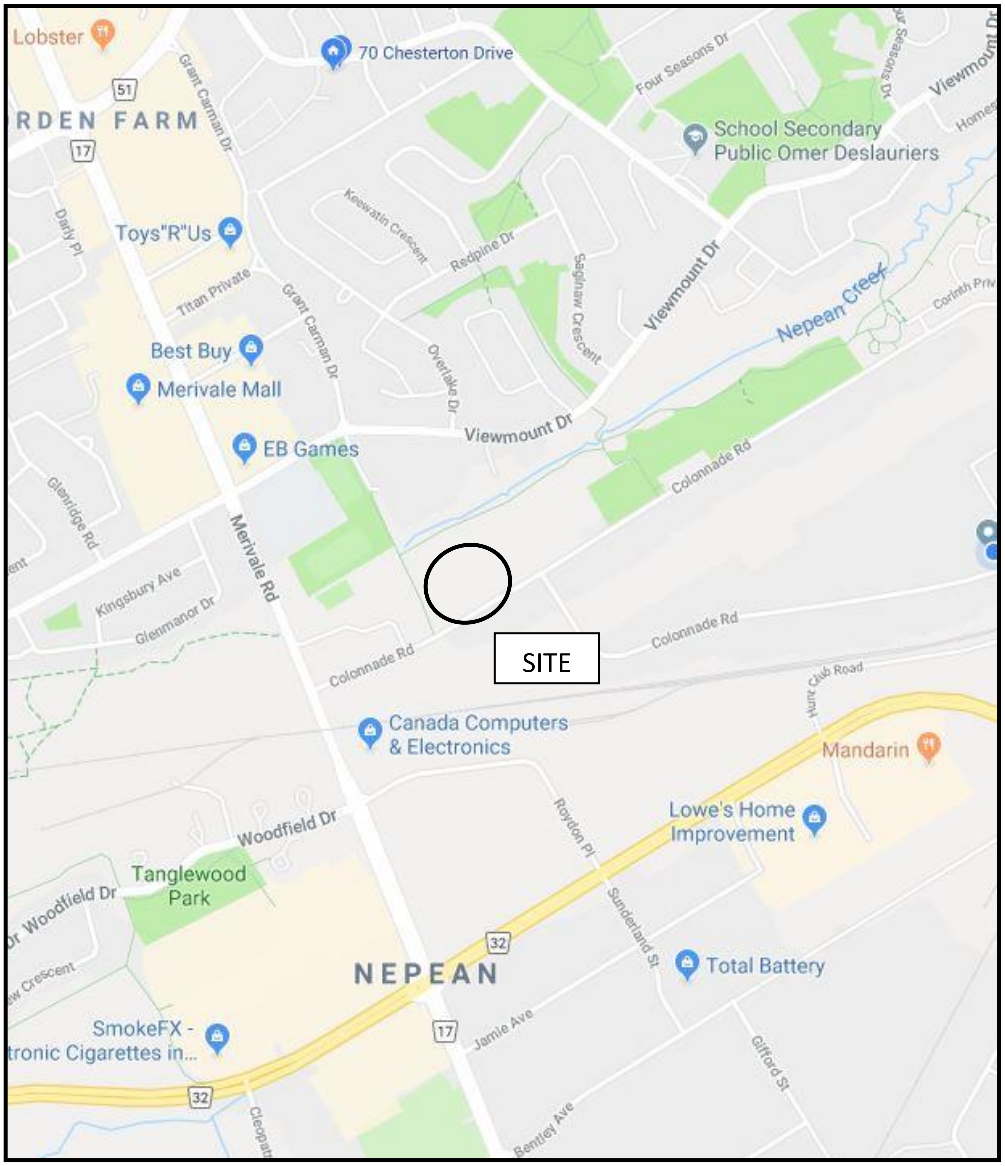
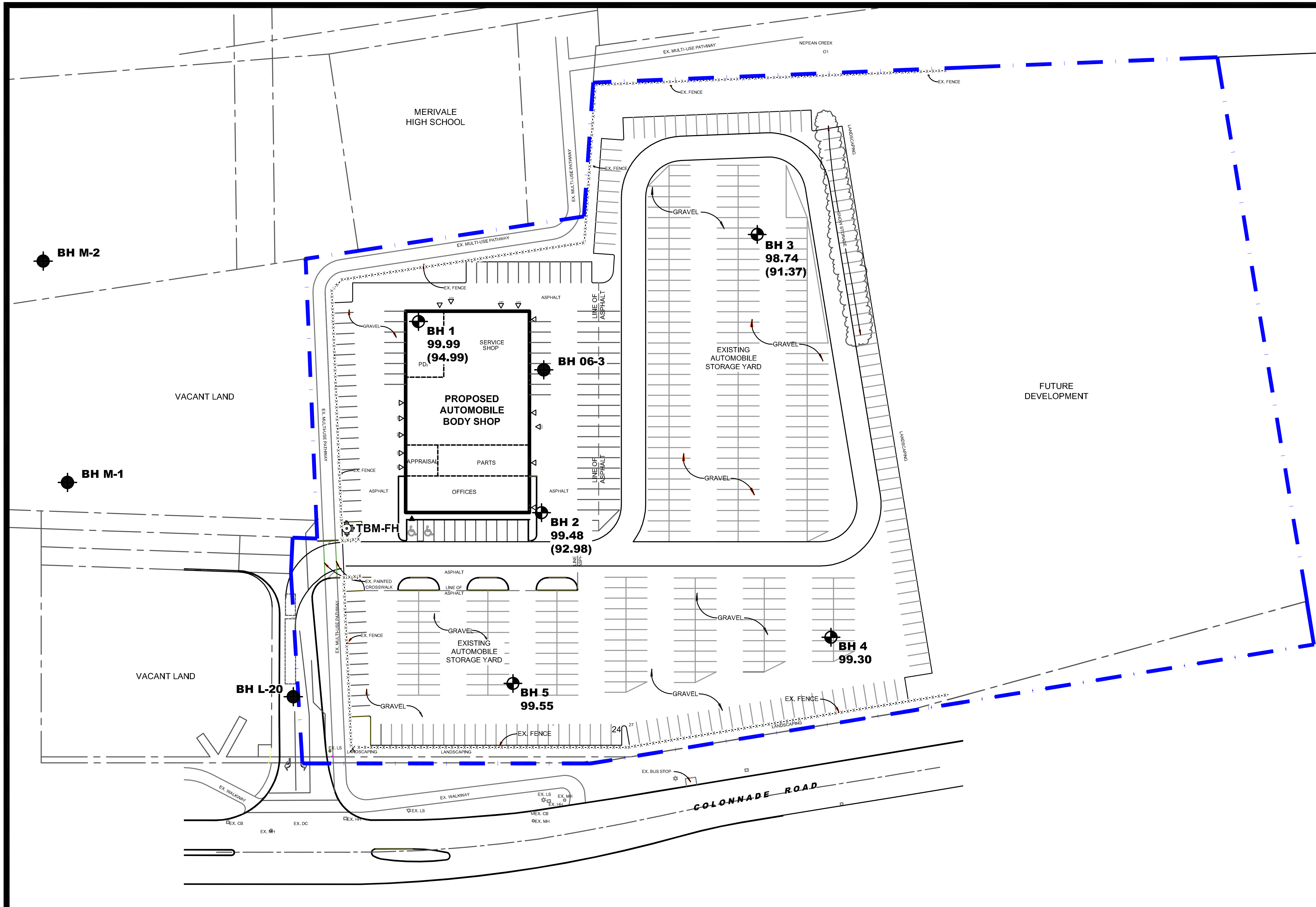


FIGURE 1

KEY PLAN



LEGEND:

BOREHOLE LOCATION

BOREHOLE BY OTHERS LOCATION

99.48 GROUND SURFACE ELEVATION (m)

(92.98) PRACTICAL REFUSAL TO AUGERING / DCPT ELEVATION (m)

BASE PLAN PROVIDED BY KWC ARCHITECTS INC.

TBM - TOP SINDLE OF FIRE HYDRANT LOCATED AT THE ENTRANCE OF THE SUBJECT SITE. AN ARBITRARY ELEVATION OF 100.00m WAS ASSIGNED TO THE TBM.

SCALE: 1:1000

0 10 20 30 40 50m 75m

p:\autocad drawings\geotechnical\pg46xx\pg4637-1.dwg

patersongroup
consulting engineers

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

NO.	REVISIONS	DATE	INITIAL
0			

BBS CONSTRUCTION (ONTARIO) INC.

GEOTECHNICAL INVESTIGATION
PROPOSED COMMERCIAL BUILDING - 9-17 COLONNADE ROAD
KEMPTVILLE, ONTARIO

Title:
TEST HOLE LOCATION PLAN

Scale:	1:1000	Date:	09/2018
Drawn by:	RCG	Report No.:	PG4637-1
Checked by:	RG	Dwg. No.:	PG4637-1
Approved by:	DJG	Revision No.:	0