Geotechnical Engineering

Environmental Engineering

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Geotechnical Investigation

Proposed Apartment Building
15 Larch Street, Ontario

Prepared For

Avenyn Capital Partners LP.

February 11, 2022

Report: PG6071-1

Revision 1

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1.0 Introduction

Paterson Group (Paterson) was commissioned by Avenyn Capital Partners LP to conduct a geotechnical investigation for the proposed apartment building to be located at 15 Larch Street in the City of Ottawa (refer to Figure 1 - Key Plan in Appendix 2 of this report).

The objective of the geotechnical investigation was to:

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

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

2.0 Proposed Development

Based on the available drawings, it is understood that the proposed development will consist of a 4-storey apartment building occupying the majority of the site. Associated paved access lanes, parking areas, and landscaped areas are also anticipated as part of the development. It is anticipated that the site will be municipally serviced.

3.0 Method of Investigation

3.1 Field Investigation

Field Program

The field program for the current geotechnical investigation was carried out on January 12, 2022 and consisted of advancing a total of one (1) borehole (BH 4) to a maximum depth of 7.2 m below existing ground surface. A previous geotechnical investigation was also completed on subject site on August 31 and September 1, 2020. At that time, a total of three (3) boreholes (BH 1, BH 2, and BH 3) were advanced to a maximum depth of 10.4 m below existing ground surface. The test hole locations were determined by Paterson personnel and distributed in a manner to provide general coverage of the subject site and taking into consideration underground utilities and site features. The test hole locations are shown on Drawing PG6071-1 - Test Hole Location Plan included in Appendix 2.

BH 4 was completed using a portable drill while BH 1, BH 2, and BH 3 were completed 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 drilling to the required depth at the selected location 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 initially 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 AU and SS, respectively, on the Soil Profile and Test Data sheets in Appendix 1.

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

Rock samples were recovered from all boreholes drilled during the current investigation (BH 1 through BH 4) using a core barrel and diamond drilling techniques. The bedrock samples were classified on site, placed in hard cardboard core boxes and transported to Paterson’s laboratory. The depths at which rock core samples were recovered from the boreholes are presented as RC on the Soil Profile and Test Data sheets in Appendix 1.

The recovery value and a Rock Quality Designation (RQD) value were calculated for each drilled section of bedrock and are presented on the borehole logs. The recovery value is the length of the bedrock sample recovered over the length of the drilled section. The RQD value is the total length of intact rock pieces longer than 100 mm over the length of the core run. The values indicate the bedrock quality.

Subsurface conditions observed in the test holes were recorded in detail in the field. Reference should be made to the Soil Profile and Test Data sheets presented in Appendix 1 for specific details of the soil profile encountered at the test holes locations.

Groundwater

All boreholes were fitted with 51 mm diameter PVC groundwater monitoring wells to permit monitoring of the groundwater levels subsequent to the completion of the sampling program. The groundwater observations are discussed in Subsection 4.3 and presented in the Soil Profile and Test Data sheets in Appendix 1.

Monitoring Well Installation

Typical monitoring well construction details are described below:

- 3.0 m of slotted 51 mm diameter PVC screen at the base of the boreholes.
- 51 mm diameter PVC riser pipe from the top of the screen to the ground surface.
- No. 3 silica sand backfill within annular space around screen.
- 300 mm thick bentonite hole plug directly above PVC slotted screen.
- Clean backfill from top of bentonite plug to the ground surface.

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 test hole 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 high precision handheld GPS and referenced to a geodetic datum. The location of the test holes and ground surface elevation at each test hole location are presented on Drawing PG6071-1 - 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. One (1) Atterberg limit test and one (1) shrinkage test were completed on selected soil samples. All test results are presented in Subsection 4.2 and on Atterberg Limit's Result sheet 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 samples. The results are presented in Appendix 1 and are discussed further in Subsection 6.8.

4.0 Observations

4.1 Surface Conditions

The majority of the subject site is currently occupied by a two-storey residential building with associated side and back yards, paved walkway, and asphalt covered parking lot. In addition, a one storey warehouse currently used as a wood workshop occupies the eastern portion of the site. The ground surface across the subject site is generally level and at grade with neighbouring lots and streets.

The site is bordered by Gladstone Avenue (vacant landscaped area) to the west, Larch Street followed by residential dwellings to the south, and by residential dwellings to the east and north.

4.2 Subsurface Profile

Overburden

Generally, the soil profile at the test hole locations consists of topsoil and/or concrete slab and/or fill overlying stiff to very stiff brown silty clay deposit, followed by compact to dense sandy silty to silty sand, underlain by bedrock. Gravel was encountered within the silty sand/sandy silt layer at the location of BH 1. The bedrock was cored in all boreholes at depths between 6.17 to 7.47 m below existing ground surface, with an average RQD value ranging from 73 to 100%. This is indicative of a good to excellent quality bedrock within the footprint of the proposed building.

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

Bedrock

Based on available geological mapping, and on our coring records, the bedrock in this area consists of limestone and shale of the Verulam Formation with an overburden drift thickness of 5 to 10 m depth.

Atterberg Limit Tests

One selected silty clay sample was submitted for Atterberg Limit testing. The test results indicate that the silty clay is classified as clay of High Plasticity (CH) in accordance with the Unified Soil Classification System. The results are summarized in Table 1 and presented in Appendix 1.

Table 1 - Summary of Atterberg Limits Test Results				
Test Hole	**Sample No.**	**Liquid Limit (%)**	**Plastic Limit (%)**	**Plasticity Index (%)**
BH 4-22	SS4	16	11	5

Shrinkage Test

The shrinkage limit and shrinkage ratio of the tested silty clay sample (BH 4 - SS4) were found to be 9.46% and 2.198, respectively.

4.3 Groundwater

The groundwater levels were recorded within the monitoring wells during the current investigation on January 17, 2022. The recorded groundwater levels are presented in Table 2 below and are further noted on the Soil Profile and Test Data sheets in Appendix 1.

Table 2 - Measured Groundwater Levels				
Test Hole Number	**Ground Surface Elevation (m)**	**Measured Groundwater Level**		**Dated Recorded**
		Depth (m)	**Elevation (m)**	
BH 2	60.08	6.08	54.00	January 17, 2022
BH 3	59.17	5.07	54.10	
BH 4	59.27	5.34	53.93	
Note: The ground surface elevation at each borehole location was surveyed using a handheld GPS and are referenced to a geodetic datum.				

Long-term groundwater levels can also be estimated based on the observed colour and consistency of the recovered soil samples. Based on these observations, it is estimated that the long-term groundwater table can be expected at approximately 5 to 6 m below the ground surface.

However, it should be noted that groundwater levels are subject to seasonal fluctuations and therefore could vary during time of construction.

5.0 Discussion

5.1 Geotechnical Assessment

From a geotechnical perspective, the subject site is considered satisfactory for the proposed residential building. It is recommended that the proposed residential building be founded on conventional spread footings placed on the undisturbed stiff to very stiff brown silty clay bearing surface or on undisturbed compact to dense brown silty sand/sandy silt bearing surface.

Removal of concrete elements is likely to be encountered due to the demolition of the existing structures on site. In addition, tree roots may also be encountered at the north and west ends of the site, and these shall be removed as well.

Where the subgrade consists of silty sand/sandy silt formation, proof rolling by a vibratory roller should be completed within the footprint of the proposed building and any associated pavement structures to eliminate the presence of loose soils at subgrade level and bearing surfaces.

Due to the presence of a silty clay deposit within the subject site, a permissible grade raise restriction is required for the site. Where the proposed grades for the proposed development exceed our permissible grade raise recommendations, light weight fill will be required to achieve the proposed grades.

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 significant amounts of organic materials, or construction debris/remnants 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 building perimeter. Under paved areas, existing construction remnants, such as foundation walls, should be excavated to a minimum of 1 m below final grade.

Fill Placement

Fill placed 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. The imported fill material should be tested and approved prior to delivery. The fill should be placed in maximum 300 mm thick loose lifts and compacted by suitable compaction equipment. Fill placed beneath the building should be compacted to a minimum of 98% of the standard Proctor maximum dry density (SPMDD).

Non-specified existing fill along with site-excavated soil could be placed as general landscaping fill where settlement of the ground surface is of minor concern. These materials should be spread in lifts with a maximum thickness of 300 mm and compacted by the tracks of the spreading equipment to minimize voids. Non-specified existing fill and site-excavated soils are not suitable for placement as backfill against foundation walls, unless used in conjunction with a geocomposite drainage membrane, such as Miradrain G100N or Delta Drain 6000.

Proof Rolling

It is expected that site grading and preparation will consist of stripping of the soils containing significant amounts of organic materials. The contractor should take appropriate precautions to avoid disturbing the subgrade and bearing surfaces from construction and worker traffic. Any loose or disturbed areas within the subgrade level, below the proposed footings is recommended to be proof-rolled **under dry conditions and 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. In poor performing areas, consideration may be given to removing the poor performing soil and replace with an approved engineered fill such as OPSS Granular A or Granular B Type II compacted to a minimum 98% of the material's SPMDD.

5.3 Foundation Design

Bearing Design Values (Conventional Shallow Foundation)

Isolated footings placed on the undisturbed, compact to dense brown silty sand to sandy silt can be designed using a bearing resistance value at serviceability limit states (SLS) of **200 kPa** and a factored bearing resistance value at ultimate limit states (ULS) of **300 kPa**, incorporating a geotechnical resistance factor of 0.5.

Where the silty sand is noted to be in a loose state of compaction, a proof-rolling program, witnessed by Paterson personnel, is recommended to be completed over the bearing surfaces.

Strip and pad footings, up to 3 m wide, placed on an undisturbed, very stiff to stiff silty clay bearing surface can be designed using a bearing resistance value at SLS of **200 kPa** and a factored bearing resistance value at ULS of **300 kPa** incorporating a geotechnical factor of 0.5

An undisturbed soil bearing surface consists of one from which all topsoil and deleterious material, such as loose, frozen or disturbed soil, whether in situ or not, have been removed in dry conditions, 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.

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 stiff silty clay 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.

Permissible Grade Raise Recommendation

Based on the test hole coverage and results of the undrained shear strength testing completed within the underlying cohesive soils, a permissible grade raise restriction of **2.0 m** is recommended for design purposes.

If higher than permissible grade raises are required, preloading with or without a surcharge, lightweight fill, and/or other measures should be investigated to reduce the risks of unacceptable long-term 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. 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 Floor Slab Construction

With the removal of all topsoil and deleterious fill within the footprint of the proposed building, the existing soil subgrade, which is reviewed and approved by Paterson personnel at the time of construction, will be considered an acceptable subgrade upon which to commence backfilling for floor slab construction.

The upper 200 mm of sub-slab fill should consist of an OPSS Granular A material for slab-on-grade construction. All backfill material within the proposed building footprint should be placed in maximum 300 mm lifts and compacted to a minimum of 98% of the SPMDD. Any soft subgrade areas should be removed and backfilled with appropriate backfill material, such as OPSS Granular B Type II, with a maximum particle size of 50 mm.

5.6 Pavement Design

Permeable Pavement Structures

It is understood that a permeable paver parking area is being considered for the car-only parking areas located in close proximity to the proposed residential building. Based on this, it is anticipated that the overall make-up of the permeable pavement structure will be specified by others specializing in permeable pavement construction. However, should an additional subbase course be required to underlay the recommended pavement structures, the following is recommended for car-only parking areas, access lanes, and heavy-truck park areas:

Table 3 – Recommended Permeable Pavement Structure
Car Only Parking Areas

Thickness (mm)	Material Description
-	**Permeable Paver Structure (as per manufacturer specifications)**
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 or fill.	

Table 4– Recommended Permeable Pavement Structure
Access Lanes and Heavy Truck Parking Areas

Thickness (mm)	Material Description
-	**Permeable Paver Structure (as per manufacturer specifications)**
500	**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.	

Paved Pavement Structures

The following pavement structures may be considered for design:

Table 5 – Recommended Pavement Structure – Car Only Parking Areas	
Thickness (mm)	**Material Description**
50	**Wear Course –** HL-3 or Superpave 12.5 Asphaltic Concrete
150	**BASE –** OPSS Granular A Crushed Stone
300	**SUBBASE –** OPSS Granular B Type II
Subgrade – Either fill, in-situ soil, or OPSS Granular B Type I or II material placed over in-situ soil, or fill.	

Table 6 – 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	**Wear Course –** HL-8 or Superpave 19 Asphaltic Concrete
150	**BASE –** OPSS Granular A Crushed Stone
450	**SUBBASE –** OPSS Granular B Type II
Separation Layer	**Woven Geotextile –** Terrafix 200W or equivalent
SUBGRADE – Either fill, in-situ soil, or OPSS Granular B Type I or II material placed over in-situ soil or fill.	

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

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

6.0 Design and Construction Precautions

6.1 Foundation Drainage and Backfill

Foundation Drainage

It is recommended that a perimeter foundation drainage system be provided for the proposed building. The system should consist of a 150 mm diameter perforated corrugated plastic pipe wrapped in a geosock, 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 clear stone should be wrapped in a non-woven geotextile. The pipe should have a positive outlet, such as a gravity connection to the storm sewer or sump pump pit.

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 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.

Concrete Sidewalks and Walkways

Backfill material below sidewalks and walkway subgrade areas throughout the subject site, including along the building, should be provided with a minimum 300 mm thick layer of OPSS Granular A or OPSS Granular B Type II crushed stone. This material should be placed in maximum 300 mm thick loose lifts and compacted to a minimum of 98% of the materials SPMDD. The subgrade for walkway structures against the building should be shaped to promote drawings towards the buildings perimeter drainage system.

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 1.5 m thick soil cover (or insulation equivalent) should be provided in this regard.

Other exterior unheated footings, such as those for isolated exterior piers and retaining walls, are more prone to deleterious movement associated with frost action. These should be provided with a minimum 2.1 m thick soil cover (or insulation equivalent).

6.3 Excavation Side Slopes

The side slopes of excavations in the overburden materials should be either cut back at acceptable slopes or should be retained by shoring systems from the start of the excavation until the structure is backfilled. It is assumed that sufficient room will be available for the greater part of the excavation to be undertaken by open-cut methods (i.e. unsupported excavations). Where space restrictions exist, or to reduce the trench width, the excavation can be carried out within the confines of a fully braced steel trench box.

Unsupported Side Slopes

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.

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

It should generally be possible to re-use the upper portion of the dry to moist (not wet) silty clay and silty sand above the cover material if the excavation and filling operations are carried out in dry weather conditions. Any stones greater than 200 mm in their longest dimension should be removed from these materials prior to placement. Well fractured bedrock should be acceptable as backfill for the lower portion of the trenches when the excavation is within bedrock provided the rock fill is placed only from at least 300 mm above the top of the service pipe and that all stones are 300 mm or smaller in their longest dimension.

The backfill material within the frost zone (about 1.8 m below finished grade) should match the soils exposed at the trench walls to reduce potential differential frost heaving. The backfill should be placed in maximum 225 mm thick loose lifts and compacted to a minimum of 95% of the material's SPMDD.

6.5 Groundwater Control

Groundwater Control for Building Construction

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

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 4 to 5 months should be allowed for completion of the PTTW application package and issuance of the permit by the MECP.

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

6.6 Winter Construction

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

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

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

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

6.7 Landscaping Considerations

Tree Planting Setbacks

In accordance with the City of Ottawa Tree Planting in Sensitive Marine Clay Soils (2017 Guidelines), Paterson completed a soils review of the site to determine applicable tree planting setbacks. Atterberg limits testing was completed for recovered silty clay samples at selected locations throughout the subject site. The above noted test results were completed between design underside of footing elevation and a 3.5 m depth below finished grade. The results of our testing are presented in Tables 1 and 2 in Subsection 4.1 and in Appendix 1.

Since the modified plasticity limit (PI) does not exceed 40%, large trees (mature height over 14 m) can be planted at the subject site provided a tree to foundation setback equal to the full mature height of the tree can be provided (e.g. in a park or other green space).

According to the City of Ottawa Tree Planting Guidelines, tree planting setback limits may be reduced to 4.5 m for small (mature tree height up to 7.5m) and medium size trees (mature tree height 7.5 m to 14 m) provided that the following conditions are met:

- The underside of footing (USF) extends to 2.1 m or greater below the lowest finished grade within 10 m from the tree, as measured from the center of the tree trunk and verified by means of the Grading Plan as indicated procedural changes below.

- A small tree must be provided with a minimum of 25 m^3 of available soil volume while a medium tree must be provided with a minimum of 30 m^3 of available soil volume, as determined by the Landscape Architect. The developer is to ensure that the soil is generally un-compacted when backfilling in street tree planting locations.

- The tree species must be small (mature tree height up to 7.5 m) to medium size (mature tree height 7.5 m to 14 m) as confirmed by the Landscape Architect.

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

- Grading surrounding the tree must promote drainage to the tree root zone (in such a manner as not to be detrimental to the tree).

6.8 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 low to slightly aggressive corrosive environment.

7.0 Recommendations

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

- Review the grading plan from a geotechnical perspective.
- Observation of all bearing surfaces prior to the placement of concrete.
- Periodic observation of the condition of unsupported excavation side slopes in excess of 3 m in height, if applicable.
- Sampling and testing of the concrete and fill materials used.
- 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 Avenyn Capital Partners Inc. 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.

Feb 11, 2022
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Report Distribution:

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APPENDIX 1

SOIL PROFILE AND TEST DATA SHEETS

SYMBOLS AND TERMS

ATTERBERG LIMITS TESTING RESULTS

ANALYTICAL TESTING RESULTS

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154 Colonnade Road South, Ottawa, Ontario K2E 7J5

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Proposed Apartment Building - 15 Larch Street
Ottawa, Ontario

DATUM Geodetic

FILE NO. PG6071

REMARKS

HOLE NO. BH 1

BORINGS BY CME-55 Low Clearance Drill **DATE** August 31, 2020

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	NUMBER	% RECOVERY	N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	60.05
TOPSOIL (to 0.30)		AU	1				
Very stiff, brown **SILTY CLAY** (to 3.05)		SS	2	75	11	1	59.05
		SS	3	100	11	2	58.05
		SS	4	100	7		
Compact, grey **SILTY SAND-GRAVEL,** some clay (to 5.33)		SS	5	92	10	3	57.05
		SS	6	29	21	4	56.05
		SS	7	50	16	5	55.05
Dense to compact, grey **SILTY SAND-GRAVEL** (to 7.47)		SS	8	58	39	6	54.05
		SS	9	71	25		
		SS	10	83	10	7	53.05
BEDROCK: Fair to excellent quality, grey limestone (to 10.44)		RC	1	95	73	8	52.05
						9	51.05
		RC	2	100	100	10	50.05
End of Borehole							
(Monitoring well blocked - Sept. 4, 2020)							

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

○ Water Content %
20 40 60 80

Monitoring Well 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 Apartment Building - 15 Larch Street
Ottawa, Ontario

DATUM Geodetic

REMARKS

BORINGS BY CME-55 Low Clearance Drill

DATE August 31, 2020

FILE NO. PG6071

HOLE NO. BH 2

SOIL DESCRIPTION	Depth to base (m)	SAMPLE TYPE	NUMBER	% RECOVERY	N VALUE or RQD
GROUND SURFACE					
TOPSOIL	0.25	AU	1		
Very stiff, brown **SILTY CLAY**	3.05	SS	2	100	6
		SS	3	100	5
		SS	4	100	6
Compact, brown **SANDY SILT**	3.80	SS	5	62	23
Dense, grey **SILTY SAND-GRAVEL**	4.50	SS	6	54	49
Dense, grey **SILTY SAND**	6.48	SS	7	50	49
		SS	8	71	31
		SS	9	80	50+
BEDROCK: Excellent quality, grey limestone	9.17	RC	1	100	100
		RC	2	100	76
End of Borehole					
(GWL @ 6.08m - Jan. 17, 2022)					

DEPTH (m)	ELEV. (m)
0	60.08
1	59.08
2	58.08
3	57.08
4	56.08
5	55.08
6	54.08
7	53.08
8	52.08
9	51.08

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

○ Water Content %

20 40 60 80

Monitoring Well 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 Apartment Building - 15 Larch Street
Ottawa, Ontario

DATUM Geodetic

REMARKS

BORINGS BY CME-55 Low Clearance Drill **DATE** September 1, 2020

FILE NO. PG6071

HOLE NO. BH 3

SOIL DESCRIPTION	Depth to base (m)	SAMPLE TYPE	NUMBER	% RECOVERY	N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	59.17
FILL: Brown silty sand with concrete and crushed stone	0.60	AU	1				
Very stiff, brown **SILTY CLAY**	1.52	SS	2	100	13	1	58.17
Compact, brown **SANDY SILT**	2.29	SS	3	100	17	2	57.17
Dense, brown **SILTY SAND,** trace clay and gravel	6.65	SS	4	58	41	3	56.17
		SS	5	88	30	4	55.17
		SS	6	83	22	5	54.17
		SS	6	82	50+	6	53.17
		SS	8	71	13		
		SS	9	63	50+		
BEDROCK: Excellent quality, grey limestone	8.56	RC	1	100	93	7	52.17
		RC	3	100	94	8	51.17
End of Borehole							
(GWL @ 5.07m - Jan. 17, 2022)							

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

○ Water Content %

20 40 60 80

Monitoring Well 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 Apartment Building - 15 Larch Street
Ottawa, Ontario

DATUM Geodetic

REMARKS

BORINGS BY Portable Drill

DATE January 12, 2022

FILE NO. PG6071

HOLE NO. BH 4

SOIL DESCRIPTION	Bottom depth (m)	SAMPLE TYPE	NUMBER	% RECOVERY	N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	59.27
Concrete slab	0.13	AU	1				
FILL: Crushed stone	0.25	SS	2	93			
FILL: Brown silty clay, trace gravel	0.63						
Stiff, brown **SILTY CLAY to CLAYEY SILT,** trace gravel	1.83	SS	3	95		1	58.27
		SS	4	96			
Compact, brown **SILTY SAND-GRAVEL**	2.44	SS	5	100		2	57.27
Compact, brown **SANDY SILT**	6.17	SS	6	45		3	56.27
		SS	7	50		4	55.27
						5	54.27
						6	53.27
BEDROCK: Grey limestone	7.24	RC	1			7	52.27

End of Borehole

(GWL @ 5.34m - Jan. 17, 2022)

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

○ Water Content %
20 40 60 80

Monitoring Well 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 x D60)
Cu	-	Uniformity coefficient = D60 / D10

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

CONSOLIDATION TEST

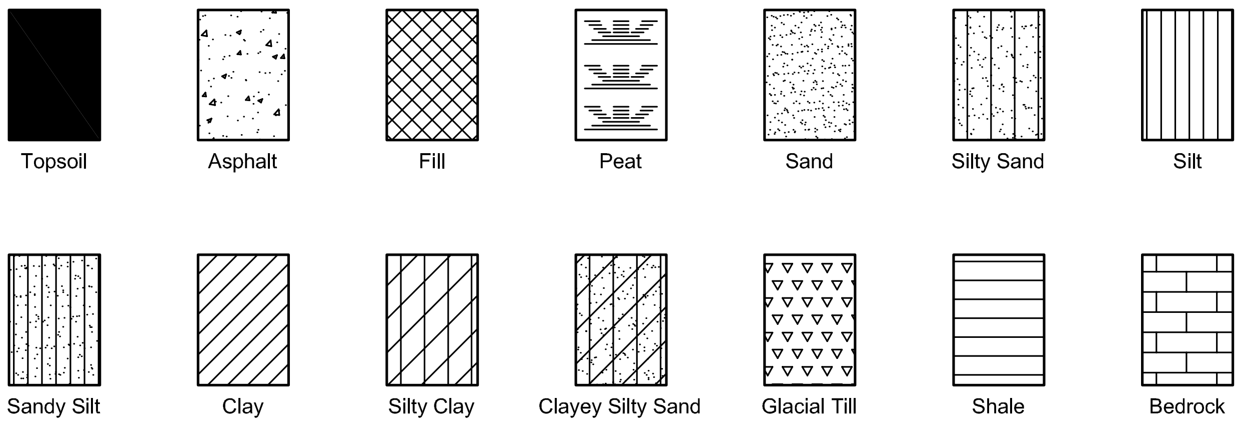
p'_o	-	Present effective overburden pressure at sample depth
p'_c	-	Preconsolidation pressure of (maximum past pressure on) sample
Ccr	-	Recompression index (in effect at pressures below p'_c)
Cc	-	Compression index (in effect at pressures above p'_c)
OC Ratio		Overconsolidaton ratio = p'_c / p'_o
Void Ratio		Initial sample void ratio = volume of voids / volume of solids
Wo	-	Initial water content (at start of consolidation test)

PERMEABILITY TEST

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

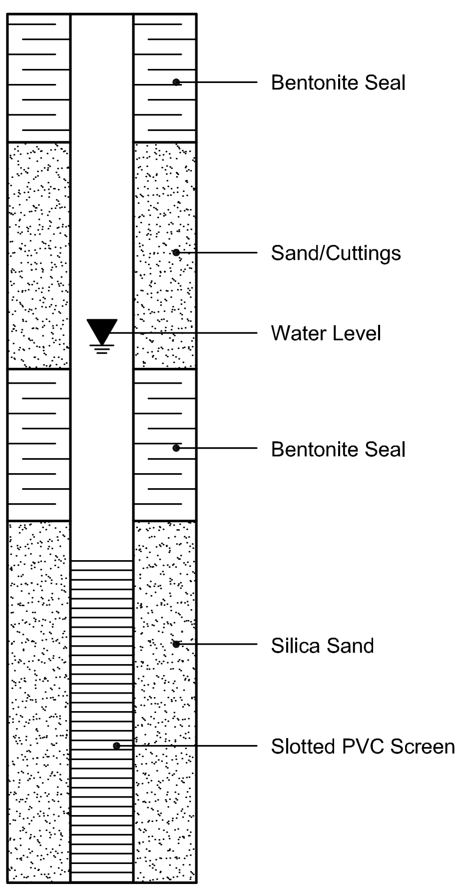
SYMBOLS AND TERMS (continued)

STRATA PLOT

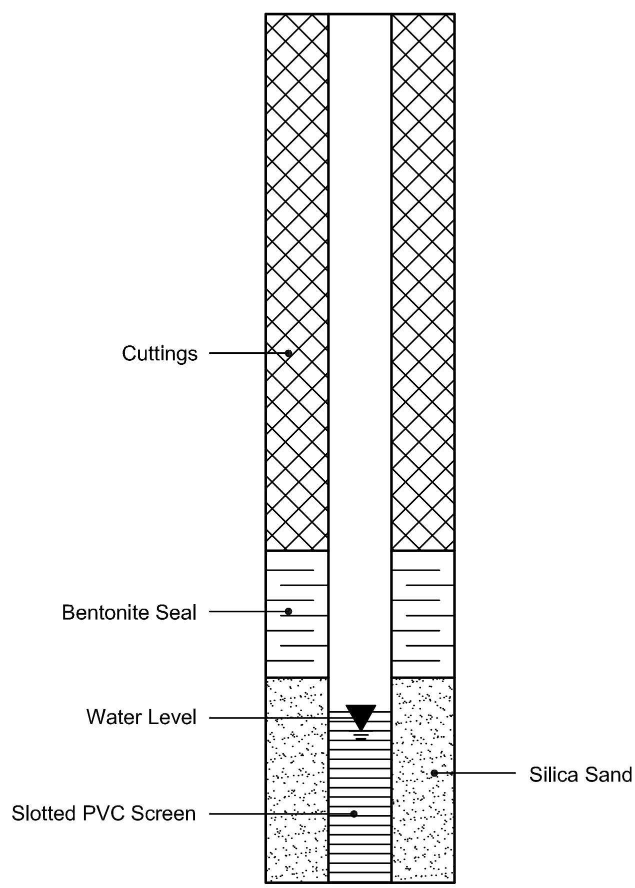


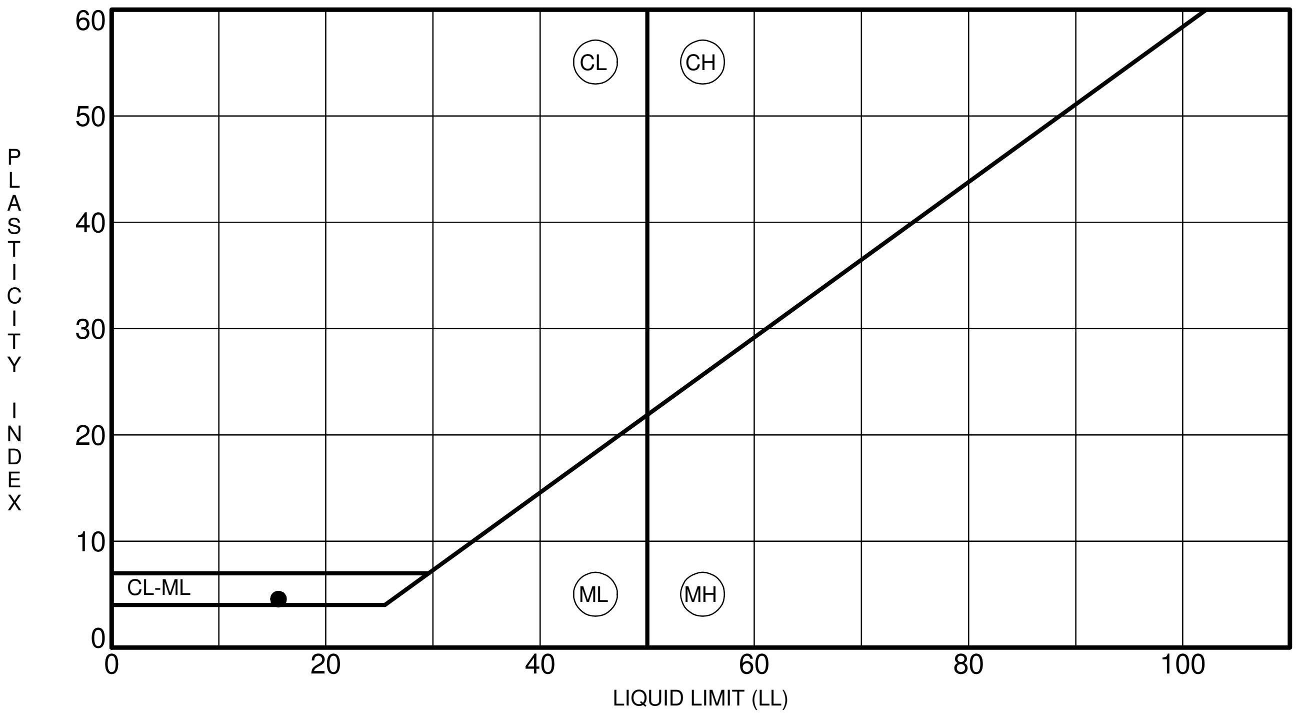
MONITORING WELL AND PIEZOMETER CONSTRUCTION

MONITORING WELL CONSTRUCTION



PIEZOMETER CONSTRUCTION





	Specimen Identification		LL	PL	PI	Fines	Classification
●	**BH 4**	**SS4**	**16**	**11**	**5**		**CL-ML - Inorganic clays of low plasticity**

CLIENT **Avenyn Capital Partners LP**

FILE NO. **PG6071**

PROJECT **Geotechnical Investigation - Proposed Apartment Building - 15 Larch Street**

DATE **12 Jan 22**

patersongroup Consulting Engineers

154 Colonnade Road South, Ottawa, Ontario K2E 7J5

ATTERBERG LIMITS' RESULTS

PARACEL LABORATORIES LTD.

Order #: 2205151

Certificate of Analysis

Client: Paterson Group Consulting Engineers

Client PO: 33765

Report Date: 31-Jan-2022

Order Date: 13-Jan-2022

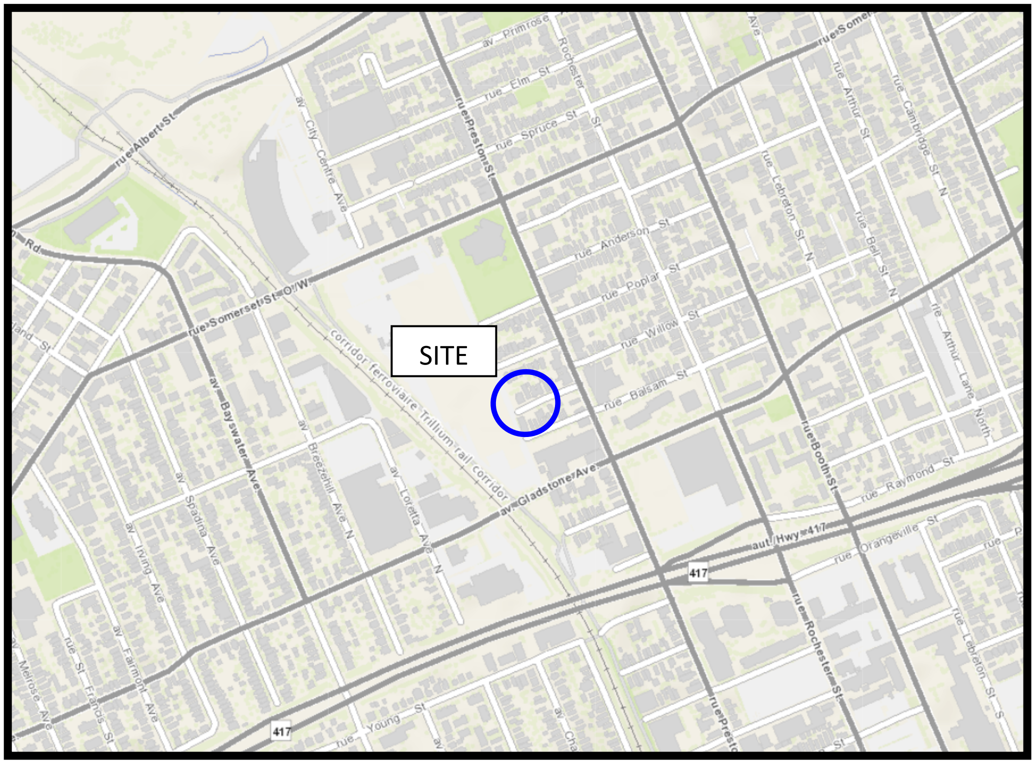
Project Description: PG6071

	MDL/Units				
Client ID:		BH4-22-SS3	-	-	-
Sample Date:		12-Jan-22 09:00	-	-	-
Sample ID:		2205151-01	-	-	-
		Soil	-	-	-
Physical Characteristics					
% Solids	0.1 % by Wt.	74.7	-	-	-
General Inorganics					
pH	0.05 pH Units	7.57	-	-	-
Resistivity	0.10 Ohm.m	46.6	-	-	-
Anions					
Chloride	5 ug/g dry	23	-	-	-
Sulphate	5 ug/g dry	26	-	-	-

APPENDIX 2

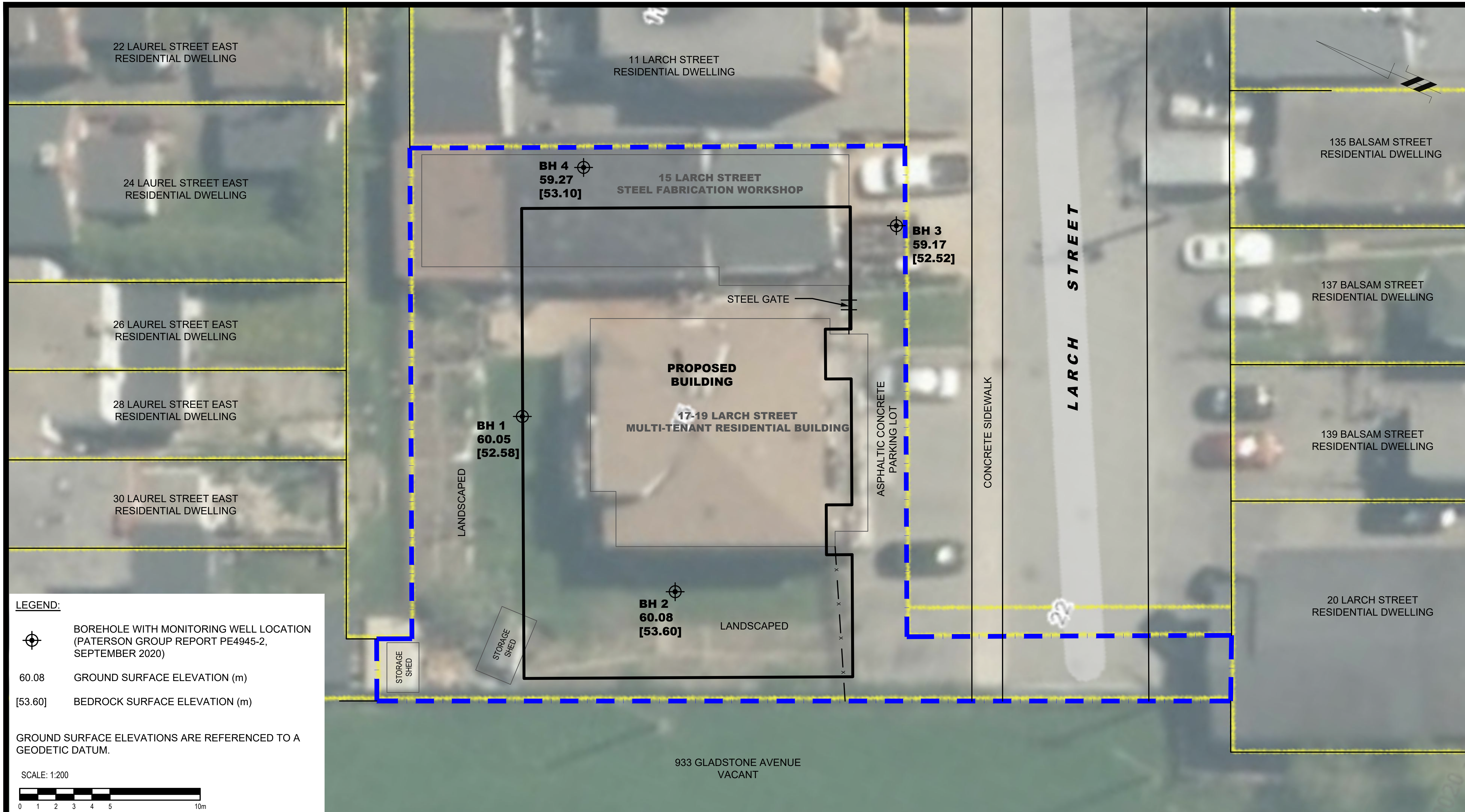
FIGURE 1 – KEY PLAN

DRAWING PG6071-1 – TEST HOLE LOCATION PLAN



<u>FIGURE 1</u>

KEY PLAN



LEGEND:

⌖	BOREHOLE WITH MONITORING WELL LOCATION (PATERSON GROUP REPORT PE4945-2, SEPTEMBER 2020)
60.08	GROUND SURFACE ELEVATION (m)
[53.60]	BEDROCK SURFACE ELEVATION (m)

GROUND SURFACE ELEVATIONS ARE REFERENCED TO A GEODETIC DATUM.

SCALE: 1:200

0 1 2 3 4 5 10m

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NO.	REVISIONS	DATE	INITIAL

GOWLING WLG
GEOTECHNICAL INVESTIGATION
PROPOSED APARTMENT BUILDING
15 LARCH STREET

OTTAWA, ONTARIO

Title:

TEST HOLE LOCATION PLAN

Scale: 1:200	Date: 01/2022
Drawn by: YA	Report No.: PG6071-1
Checked by: MS	Dwg. No.: PG6071-1
Approved by: DJG	Revision No.:

p:\autocad drawings\geotechnical\pg60xx\pg6071\pg6071-1-test hole location plan.dwg