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Geotechnical Investigation

Proposed Mosque and Community Recreation Centre
3095 Albion Road
Ottawa, Ontario

Prepared For

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November 19, 2015

Report PG3635-1

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1.0 Introduction

Paterson Group (Paterson) was commissioned by Mr. Akram Farhat to conduct a geotechnical investigation for the proposed Mosque and Community Recreation Centre to be located at 3095 Albion Road in the City of Ottawa, Ontario (refer to Figure 1 - Key Plan in Appendix 2).

The objectives of the current investigation were to:

❏ Determine the subsurface soil and groundwater conditions based on historical test hole information and by means of our current boreholes.

❏ Provide geotechnical recommendations for the design of the proposed development including construction considerations which may affect the design.

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

2.0 Proposed Project

It is understood that the proposed Mosque and Community Recreation Centre will consist of a three to four storey structure with a basement level and associated parking areas, access lanes and landscaped areas.

3.0 Method of Investigation

3.1 Field Investigation

Field Program

The field program for the current geotechnical investigation was conducted on October 1, 2015. At that time, a total of three (3) boreholes were advanced to a maximum depth of 10 m below existing ground surface. The borehole locations were distributed in a manner to provide general coverage of the subject site taking into consideration site features and underground municipal services. The locations of the test holes are presented on Drawing PG3635-1 - Test Hole Location Plan included in Appendix 2. Test hole locations completed during our previous geotechnical investigation are also presented in Drawing PG3635-1 - Test Hole Location Plan.

The boreholes for the current investigation were completed by a track mounted 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 from the geotechnical division. The drilling procedure consisted of augering to the required depths at select locations, sampling and testing the overburden.

Sampling and In Situ Testing

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

The Standard Penetration Test (SPT) was conducted and 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.

Undrained shear strength readings were conducted in cohesive soils.

Overburden thickness was also evaluated during the course of the investigation by Dynamic Cone Penetration Test (DCPT) at BH 2 and BH 3. The DCPT consists of driving a steel drill rod, equipped with a 50 mm diameter cone at the tip, and 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 at each 300 mm increment.

The subsurface conditions observed in the test holes were recorded in detail in the field. The soil profiles are presented on the Soil Profile and Test Data sheets in Appendix 1.

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

3.2 Field Survey

The test hole locations were selected, determined in the field and surveyed by Paterson. Ground surface elevation at each test hole location was referenced to a temporary benchmark (TBM), consisting of a vertical control monument No. 3453 on a plan prepared by Annis, O'Sullivan, Vollebekk Ltd. with a geodetic elevation of 87.59 m.

The location of the TBM, test holes and ground surface elevation at each of the test hole location are presented on Drawing PG3635-1 - Test Hole Location Plan in Appendix 2.

3.3 Laboratory Testing

Soil samples were recovered from the subject site and visually examined in the laboratory to review the field logs.

3.4 Analytical Testing

One (1) soil sample was submitted for analytical testing to assess the potential for exposed ferrous metals and the potential of sulphate attacks against subsurface concrete structures. The sample was analyzed to determine its concentration of sulphate and chloride along with its resistivity and pH. The laboratory test results are shown in Appendix 1 and the results are discussed in Subsection 6.7.

4.0 Observations

4.1 Surface Conditions

The subject site is a vacant parcel of land with a gravel covered area within the central portion of the site. The remainder of the site is overgrown with brush and trees. The site is relatively flat and approximately at grade with the neighbouring properties and the adjacent roadway. The site is bordered to the north by a commercial slab-on-grade structure with asphalt covered car parking, access lanes and landscaping areas. The site is bordered to the east by undeveloped land, to the west by Albion Road and to the south by a municipal service alignment followed by Canadian Pacific Railway.

4.2 Subsurface Profile

The subsurface profile at the test hole locations generally consist of a fill layer, consisting of a brown silty sand with gravel, crushed stone, crushed concrete, some clay and trace asphalt, varying in depths between 0.8 to 2.2 m overlying a loose to compact, native silty sand, which in turn is underlain by a firm, grey silty clay extending to depths ranging between 3.7 to 6.9 m. A compact to dense, glacial till, consisting of a grey silty sand with clay, gravel, cobbles, trace boulders, was encountered below the firm grey silty clay deposit at each borehole location.

Practical refusal to DCPT was encountered at BH 2 and BH 3 at a depth of 10.1 and 9.3 m, respectively. Refer to the Soil Profile and Test Data sheets in Appendix 1 for specific details of the soil profiles encountered at each test hole location.

Based on available geological mapping, bedrock in the area of the subject site consists of limestone and shale of the Carlsbad Formation. The overburden drift thickness is estimated to be between 5 and 10 m depth.

4.3 Groundwater

The groundwater levels (GWL) recovered on October 8, 2015 are presented in Table 1 below. It should be noted that surface water can become perched within backfilled boreholes, which can lead to higher than normal groundwater readings. Long-term groundwater levels can also be estimated based on field observations of the recovered soil samples, such as moisture levels, consistency and colouring. Based on these field observations, the long-term groundwater level is anticipated at a 2 to 3 m depth below existing ground surface. It should be noted that the groundwater levels are subject to seasonal fluctuations. Therefore, the groundwater levels could vary at the time of construction.

Table 1 - Summary of Groundwater Level Readings

Borehole Number	Ground Elevation, m	Groundwater Levels, m		Recording Date
		Depth	Elevation	
BH 1	86.53	3.75	82.78	October 8, 2015
BH 2	86.34	1.52	84.82	October 8, 2015
BH 3	86.89	2.81	84.08	October 8, 2015

Note:
- ❑ Ground surface elevation at each test hole location was referenced to a temporary benchmark (TBM) consisting of a vertical control monument No. 3453 on plan prepared by Annis, O'Sullivan, Vollebekk Ltd. with a geodetic elevation of 87.59 m.

5.0 Discussion

5.1 Geotechnical Assessment

From a geotechnical perspective, the subject site is considered satisfactory for the proposed development. It is expected that the proposed building will be constructed over a conventional shallow foundation. Consideration could be given to leaving the existing fill, free of deleterious materials, below the building footprint, outside of the lateral support zone of the footings. However, the existing fill should be proof-rolled at the time of construction and approved by the geotechnical consultant based on the fill performance at that time. Poor performing areas should be removed and replaced with an approved engineered fill.

Due to the presence of the sensitive silty clay layer, the proposed development will be subjected to grade raise restrictions.

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 any buildings and other settlement sensitive structures. It is anticipated that the existing fill, free of deleterious material, can be left in place below the proposed building footprint, outside of lateral support zones for the footings, and below the proposed parking area and access lane. However, it is recommended that the existing fill layer be proof-rolled several times and approved by the geotechnical consultant at the time of construction. Any poor performing areas should be removed and replaced with an approved fill.

Fill Placement

Fill placed for grading beneath the proposed building, unless otherwise specified, such as the existing fill layer, should consist of clean imported granular fill, such as Ontario Provincial Standard Specifications (OPSS) Granular A or Granular B Type II. The fill should be tested and approved prior to delivery to the site. The fill should be placed in lifts with a maximum loose lift thickness of 300 mm and compacted with suitable compaction equipment. Fill placed beneath the building areas 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 is a minor concern. These materials should be spread in maximum lift thickness of 300 mm and at a minimum compacted by the tracks of the spreading equipment to minimize voids. If these materials are to be placed to increase the subgrade level for areas to be paved, the backfill should be compacted in thin lifts to a minimum density of 95% of the SPMDD. Non-specified existing fill and site-excavated soils are not suitable for placement as backfill against foundation walls, unless a geocomposite drainage membrane is installed, such as Miradrain G100N or Delta Drain 6000. Consideration should also be given to placing and compacting a non-frost susceptible, granular fill against the exterior side of the foundation walls to limit frost heave issues for sensitive areas, such as perimeter sidewalks or exterior entrance slabs.

5.3 Foundation Design

Spread Footing Foundation

Footings founded on an undisturbed, compact silty sand bearing surface should be designed using a bearing resistance value at serviceability limit states (SLS) of **80 kPa** and a factored bearing resistance value at ultimate limit states (ULS) of **150 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.

The bearing resistance value at SLS will be subjected to potential post-construction total and differential settlements of 25 and 15 mm, respectively.

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

Permissible Grade Raise Restrictions

Consideration must be given to potential settlements which could occur due to the presence of the silty clay deposit and the combined loads from the proposed footings, any groundwater lowering effects, and grade raise fill. The foundation loads to be considered for the settlement case are the continuously applied loads which consist of the unfactored dead loads and the portion of the unfactored live load that is considered to be continuously applied. A minimum value of 50% of the live load is often recommended by Paterson.

Due to the presence of the underlying silty clay layer, a permissible grade raise restriction of **0.6 m** above existing ground surface is recommended in the immediate area of settlement sensitive structures, such as the proposed building. 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

Foundations constructed at the subject site can be designed using a seismic site response **Class D** as defined in the Ontario Building Code 2012 (OBC 2012; Table 4.1.8.4.A). A higher site class, such as Class C could be applicable for foundation design. However, the higher site class would have to be determined based on site-specific shear wave velocity testing. The soils underlying the site are not susceptible to liquefaction based on the fines content, compactness of the underlying layers and Ottawa seismic design peak ground acceleration as per OBC 2012.

5.5 Basement Slab

With the removal of all topsoil and fill containing deleterious materials, within the footprint of the proposed building, the native soil surface or existing fill approved by the geotechnical consultant at the time of construction will be considered to be an acceptable subgrade surface on which to commence backfilling for the floor slab. The upper 200 mm of sub-slab fill should consist of 19 mm clear crushed stone for a basement slab. All backfill material within the footprint of the proposed building should be placed in maximum 300 mm thick loose lifts and compacted to a minimum of 98% of the SPMDD.

Any soft areas should be removed and backfilled with appropriate backfill material. OPSS Granular B Type II, with a maximum particle size of 50 mm, are recommended for backfilling below the floor slab.

5.6 Pavement Structure

Car only parking and heavy truck parking areas, as well as, access lanes are anticipated. The proposed pavement structures are presented in Tables 2 and 3.

Table 2 - 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 3 - 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 SPMDD with suitable vibratory equipment.

Pavement Structure Drainage

Satisfactory performance of the pavement structure is largely dependent on the contact zone between the subgrade material and the base stone in a dry condition. Failure to provide adequate drainage under conditions of heavy wheel loading could result in the subgrade soil being pumped into the voids in the stone subbase, thereby reducing load bearing capacity.

Due to the impervious nature of the subgrade materials consideration should be given to installing subdrains during the pavement construction. These drains should be installed at each catch basin, be at least 3 m long and should extend in four orthogonal directions or longitudinally when placed along a curb. The subdrain inverts should be approximately 300 mm below subgrade level. The subgrade surface should be shaped to promote water flow to the drainage lines.

6.0 Design and Construction Precautions

6.1 Foundation Drainage and Backfill

A perimeter foundation drainage system is recommended to be provided for proposed structure. The system should consist of a 150 mm diameter, geotextile-wrapped, perforated, corrugated, plastic pipe, surrounded on all sides by 150 mm of 10 mm clear crushed stone, placed at the footing level around the exterior perimeter of the structure. The pipe should have a positive outlet, such as a gravity connection to the storm sewer.

Backfill against the exterior sides of the foundation walls should consist of free-draining, non frost susceptible granular materials. The site materials will be frost susceptible and, as such, are not recommended for placement as backfill unless a composite drainage system (such as system Platon or Miradrain G100N) connected to a drainage system is provided.

6.2 Protection of Footings Against Frost Action

Perimeter footings of heated structures are recommended to be insulated against the deleterious effects of frost action. A minimum of 1.5 m of soil cover alone, or a combination of soil cover and 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 side slopes of excavations in the overburden materials should either be excavated to acceptable slopes or retained by a shoring systems from the beginning of the excavation until the structure is backfilled. It is anticipated that sufficient room will be available for the greater part of the excavation to be constructed by open-cut methods (i.e. unsupported excavations). Temporary shoring may be required where sufficient space is unavailable.

The subsurface soil is considered to be mainly Type 2 and 3 soil according to the Occupational Health and Safety Act and Regulations for Construction Projects. 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 the groundwater level.

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

Bedding and backfill materials should be in accordance with the most recent Material Specifications and Standard Detail Drawings from the City of Ottawa.

The pipe bedding for sewer and water pipes should consist of at least 150 mm of OPSS Granular A material. Where the bedding is located within the firm grey silty clay, the thickness of the bedding material should be increased to a minimum of 300 mm. The material should be placed in maximum 300 mm thick lifts and compacted to a minimum of 95% of its SPMDD. The bedding material should extent at least to the spring line of the pipe.

Generally, the silty clay should be possible to place the moist (not wet) brown silty clay above the cover material if the excavation and backfilling operations are completed in dry weather conditions. Wet silty clay materials will be difficult to compact due to the high water contents.

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 consist of 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.

To reduce long-term lowering of the groundwater level at this site, clay seals should be provided in the service trenches. The seals should be at least 1.5 m long (in the trench direction) and should extend from trench wall to trench wall. The seals should extend from the frost line and fully penetrate the bedding, subbedding and cover material. The barriers should consist of relatively dry and compactable brown silty clay placed in maximum 225 mm thick loose layers and compacted to a minimum of 95% of the SPMDD. The clay seals should be placed at the site boundaries and at strategic locations at no more than 60 m intervals in the service trenches.

6.5 Groundwater Control

Due to the relatively impervious nature of the underlying silty clay deposit, it is anticipated that groundwater infiltration into the excavations should be low and controllable using open sumps. A perched groundwater condition may be encountered within the overlying fill material and silty sand deposit which may produce significant temporary groundwater infiltration levels. Pumping from open sumps should be sufficient to control the groundwater influx through the sides of shallow excavations.

A temporary MOE permit to take water (PTTW) will be required for this project if more than 50,000 L/day are to be pumped during the construction phase. A minimum of 4 to 5 months should be allowed for completion of the application and issuance of the permit by the MOE.

6.6 Winter Construction

Precautions must be considered if this project is completed in the winter. The subsurface soil 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. The base of the excavations should be insulated from sub-zero temperatures immediately upon exposure and until such time as heat is adequately supplied to the building and the footings are protected with sufficient soil cover to prevent freezing at founding level.

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

6.7 Corrosion Potential and Sulphate

The analytical test results are presented in Table 4 along with industry standards for the applicable threshold values. The results are indicative that Type 10 Portland cement (Type GU).

Table 4 - Corrosion Potential

Parameter	Laboratory Results	Threshold	Commentary
	BH2-SS4		
Chloride	194 µg/g	Chloride content less than 400 mg/g	Negligible concern
pH	7.52	pH value less than 5.0	Neutral Soil
Resistivity	20.3 ohm.m	Resistivity greater than 1,500 ohm.cm	Low to Moderate Aggressive
Sulphate	82 µg/g	Sulphate value greater than 1 mg/g	Negligible Concern

6.8 Landscaping Considerations

Tree Planting Restrictions

The proposed building is located in a moderate sensitivity area with respect to planting trees due to the presence of the silty clay deposit. Trees to be placed within 4 m of the foundation wall should consist of low water demanding trees with shallow roots systems that extend less than 1.5 m below ground surface. Trees placed greater than 4 m from the foundation wall may consist of typical street trees, which are typically moderate water demand species with roots extending to a maximum 2 m depth.

It is well documented in the literature, and is our experience, that fast-growing trees located near buildings founded on cohesive soils that shrink on drying can result in long-term differential settlements of the structures. Tree varieties that have the most pronounced effect on foundations are seen to consist of poplars, willows and some maples (i.e. Manitoba Maples) and, as such, should not be considered in the landscaping design.

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

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

8.0 Statement of Limitations

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

A geotechnical investigation of this nature is a limited sampling of a site. The recommendations are based on information gathered at the specific test locations and can only be extrapolated to an undefined limited area around the test locations. Should any conditions at the site be encountered which differ from those at the test locations, we request notification immediately in order to permit reassessment of our recommendations.

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

Paterson Group Inc.

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Report Distribution:

- ❑ Mr. Akram Farhat (3 copies)
- ❑ Paterson Group (1 copy)

APPENDIX 1

SOIL PROFILE AND TEST DATA SHEETS

SYMBOLS AND TERMS

ANALYTICAL TEST RESULTS

patersongroup Consulting Engineers

154 Colonnade Road South, Ottawa, Ontario K2E 7J5

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Prop. Mosque/Community Centre - 3095 Albion Road
Ottawa, Ontario

DATUM TBM - Vertical control monument No. 3453 on plan prepared by Annis, O'Sullivan, Vollebekk Ltd. with a geodetic elevation of 87.59m.

REMARKS

BORINGS BY CME 55 Power Auger

DATE October 1, 2015

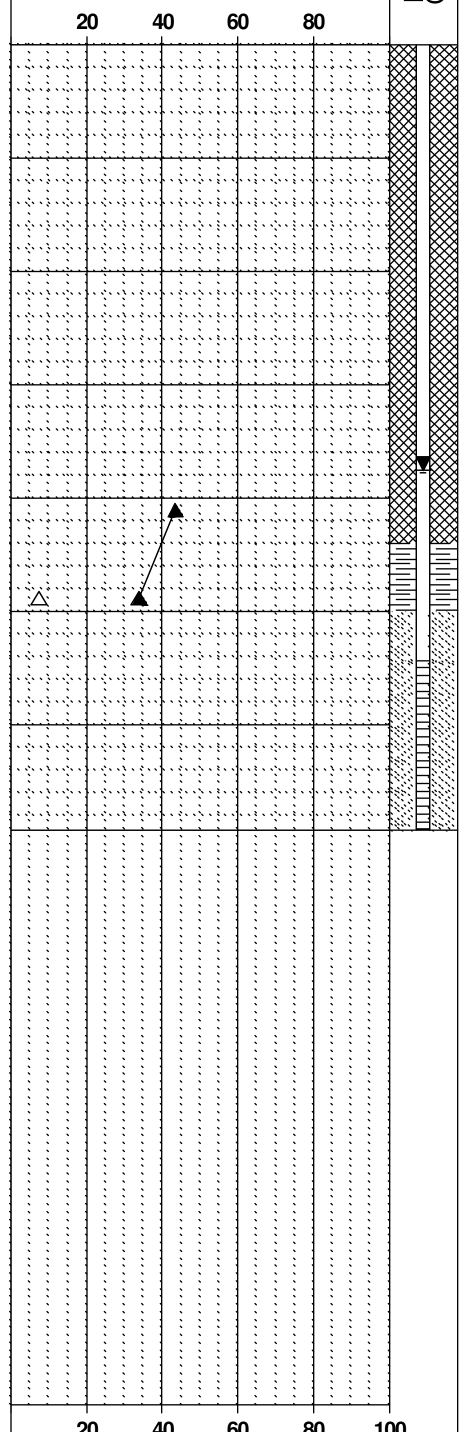
FILE NO. PG3635

HOLE NO. BH 1

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	86.53
FILL: Dark brown silty sand, some gravel, trace asphalt		SS	1	62	8		
		SS	2	79	9	1	85.53
- with shale by 1.2m depth		SS	3	54	15		
2.18						2	84.53
Very loose, brown **SILTY SAND**							
2.59		SS	4	0	3		
Firm, grey **SILTY CLAY,** trace sand		SS	5	100	W	3	83.53
						4	82.53
4.93						5	81.53
GLACIAL TILL: Dark grey silty clay with sand, gravel and shale		SS	6	46	5	6	80.53
		SS	7	54	7		
6.93		SS	8	100	50+		
End of Borehole							
(GWL @ 3.75m-Oct. 8, 2015)							

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

○ **Water Content %**



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. Mosque/Community Centre - 3095 Albion Road
Ottawa, Ontario

DATUM TBM - Vertical control monument No. 3453 on plan prepared by Annis, O'Sullivan, Vollebekk Ltd. with a geodetic elevation of 87.59m.

REMARKS

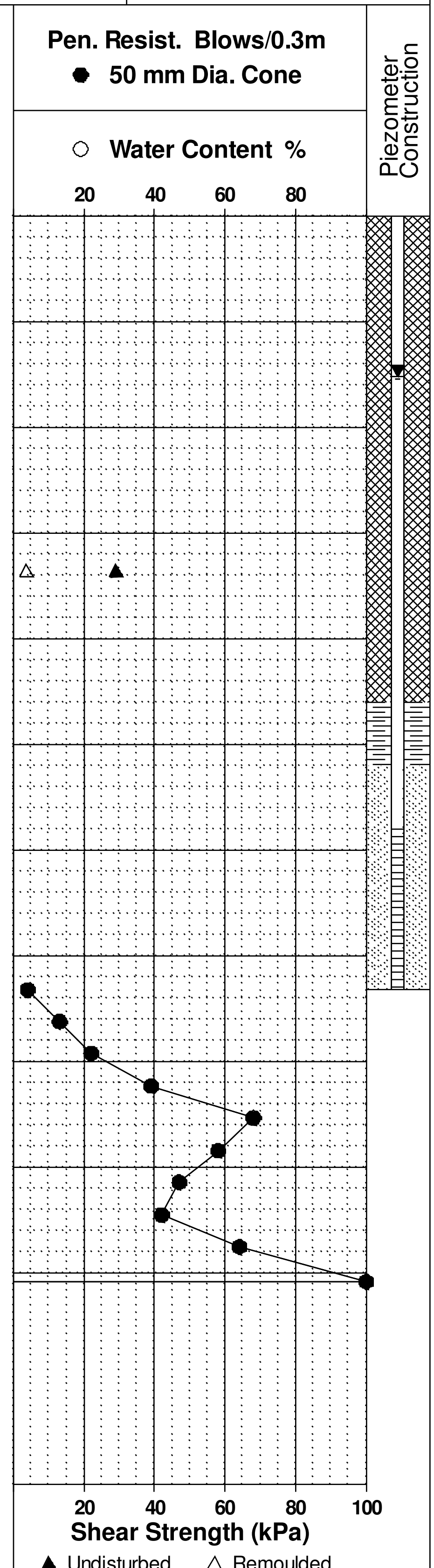
BORINGS BY CME 55 Power Auger

DATE October 1, 2015

FILE NO. PG3635

HOLE NO. BH 2

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	NUMBER	% RECOVERY	N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	86.34
FILL: Brown silty sand with gravel, concrete, asphalt, some clay		SS	1	67	20		
1.12		SS	2	75	12	1	85.34
Compact to loose, brown **SILTY SAND**		SS	3	62	8	2	84.34
2.49		SS	4	83	4		
Firm, grey **SILTY CLAY,** trace sand						3	83.34
3.66						4	82.34
GLACIAL TILL: Dark grey silty clay with sand and gravel		SS	5	71	4	5	81.34
		SS	6	42	6	6	80.34
		SS	7	58	5		
7.32		SS	8	71	14	7	79.34
Dynamic Cone Penetration Test commenced at 7.32m depth						8	78.34
Inferred **GLACIAL TILL**						9	77.34
10.08						10	76.34
End of Borehole							
Practical DCPT refusal at 10.08m depth							
(GWL @ 1.52m-Oct. 8, 2015)							



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154 Colonnade Road South, Ottawa, Ontario K2E 7J5

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Prop. Mosque/Community Centre - 3095 Albion Road
Ottawa, Ontario

DATUM TBM - Vertical control monument No. 3453 on plan prepared by Annis, O'Sullivan, Vollebekk Ltd. with a geodetic elevation of 87.59m.

REMARKS

BORINGS BY CME 55 Power Auger

DATE October 1, 2015

FILE NO. PG3635

HOLE NO. BH 3

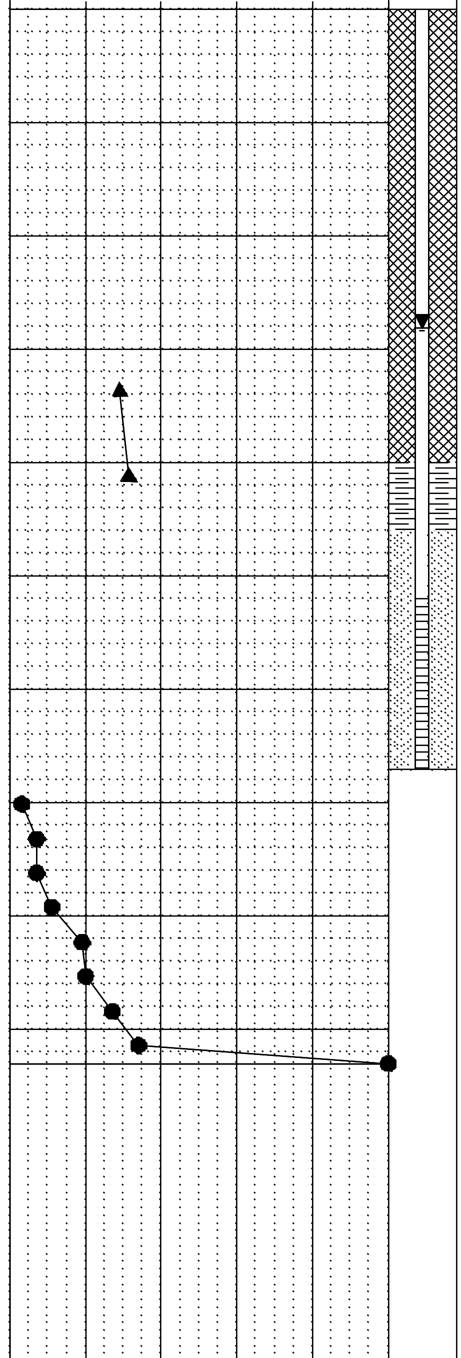
SOIL DESCRIPTION	Depth to base (m)	SAMPLE TYPE	NUMBER	% RECOVERY	N VALUE or RQD
GROUND SURFACE					
FILL: Brown silty sand with gravel, asphalt, some clay	0.81	SS	1	67	19
Loose, brown **SILTY SAND** - grey by 2.0m depth	2.57	SS	2	75	9
		SS	3	83	10
		SS	4	100	5
Firm, grey **SILTY CLAY,** trace sand	4.22				
GLACIAL TILL: Dark grey silty clay with sand and gravel	6.70	SS	5	79	4
		SS	6	71	4
		SS	7	4	6
Dynamic Cone Penetration Test commenced at 6.70m depth Inferred **GLACIAL TILL**	9.30				
End of Borehole Practical DCPT refusal at 9.30m depth (GWL @ 2.81m-Oct. 8, 2015)					

DEPTH (m)	ELEV. (m)
0	86.89
1	85.89
2	84.89
3	83.89
4	82.89
5	81.89
6	80.89
7	79.89
8	78.89
9	77.89

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
Proposed Commercial Buildings-3091 Albion Road N.
Ottawa, Ontario

DATUM TBM - Finished floor level of existing building at front entrance. Geodetic elevation = 87.81m.

REMARKS

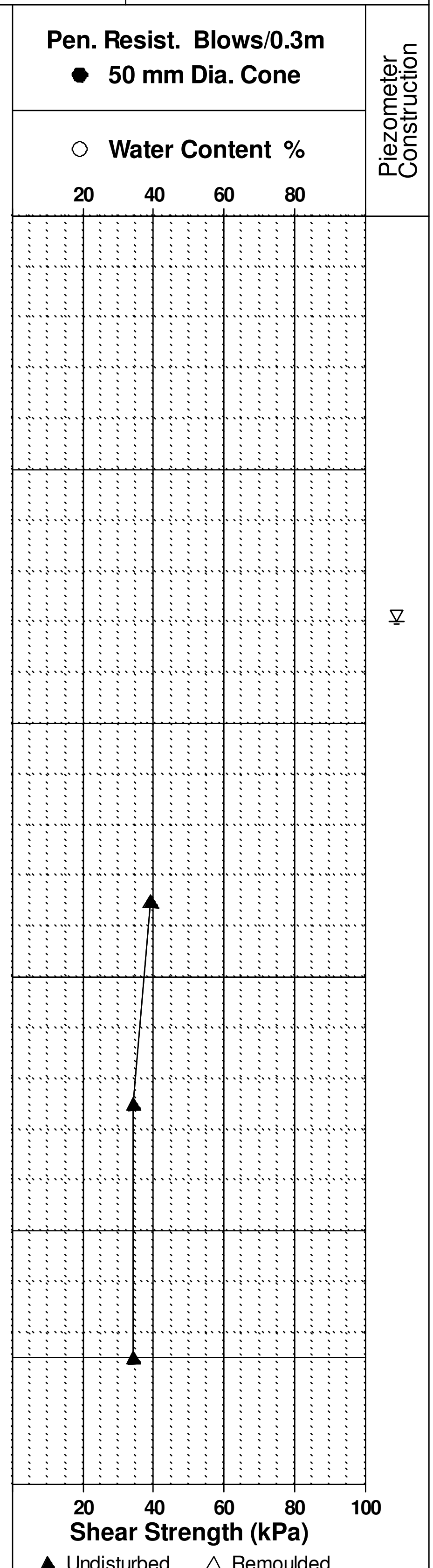
BORINGS BY Backhoe

DATE March 11, 2009

FILE NO. PG1837

HOLE NO. TP 1

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	% RECOVERY	N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	87.00
FILL: Grey silty sand, some clay		G	1				
0.50		G	2			1	86.00
FILL: Brown silty sand							
1.50		G	3			2	85.00
Loose, brown **SAND**, some gravel and cobbles		G	4				
2.60		G	5			3	84.00
Firm, brown **SILTY CLAY**		G	6			4	83.00
4.50		G	7				
End of Test Pit							
(GWL infiltration @ 1.6m depth)							



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Proposed Commercial Buildings-3091 Albion Road N.
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REMARKS

BORINGS BY Backhoe

DATE March 11, 2009

FILE NO. PG1837

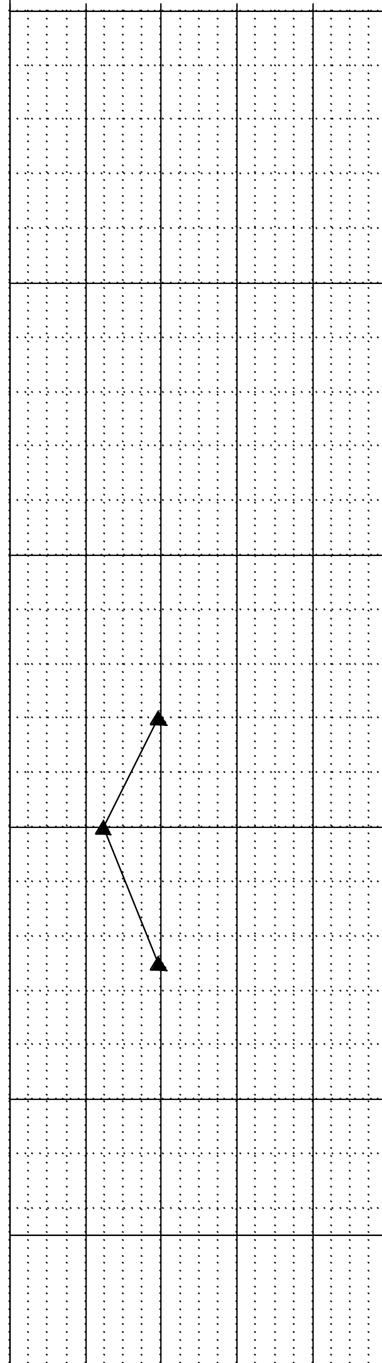
HOLE NO. TP 2

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	% RECOVERY	N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	86.94
FILL: Brown silty sand with cobbles and wood		G	1				
0.87							
Loose, brown **SAND**						1	85.94
		G	2				
- some gravel and cobbles by 1.8m depth		G	3				
						2	84.94
		G	4				
2.50							
Firm, grey **SILTY CLAY**		G	5				
		G	6			3	83.94
		G	7				
						4	82.94
4.50							
End of Test Pit							
(GWL infiltration @ 1.6m depth)							

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

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SOIL PROFILE AND TEST DATA

Geotechnical Investigation
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Ottawa, Ontario

DATUM TBM - Finished floor level of existing building at front entrance. Geodetic elevation = 87.81m.

REMARKS

BORINGS BY Backhoe

DATE March 11, 2009

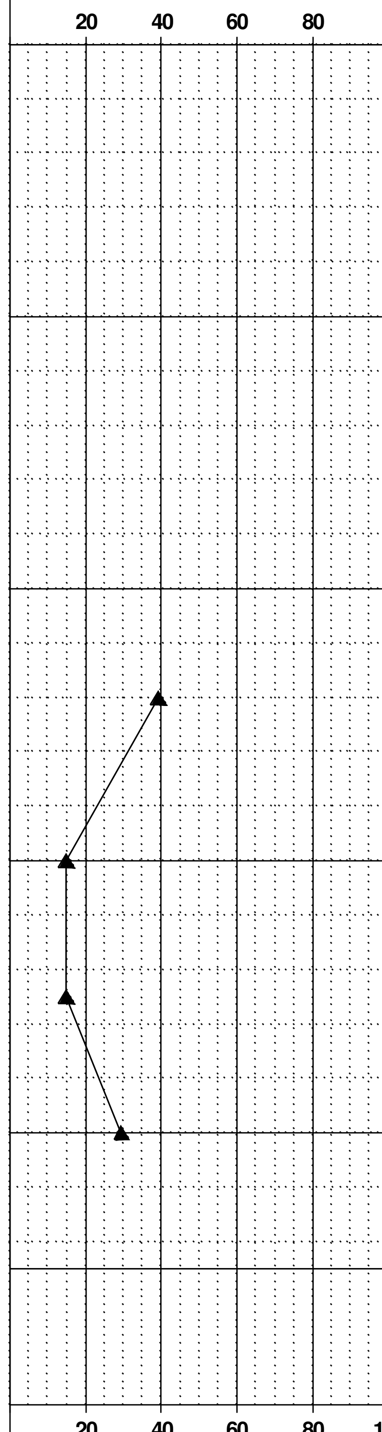
FILE NO. PG1837

HOLE NO. TP 3

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	% RECOVERY	N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	87.04
FILL: Crushed stone (to 0.25)		G	1				
FILL: Brown silty sand, some clay and gravel (to 1.20)		G	2			1	86.04
Brown **SAND**, some gravel - trace clay by 1.5m depth (to 2.20)		G	3				
		G	4			2	85.04
Firm to soft, grey **SILTY CLAY** (to 4.50)		G	5				
		G	6			3	84.04
		G	7				
		G	8			4	83.04
End of Test Pit (GWL infiltration @ 2.2m depth)							

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

○ Water Content %



Shear Strength (kPa)
▲ Undisturbed △ Remoulded

Piezometer Construction

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SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Proposed Commercial Buildings-3091 Albion Road N.
Ottawa, Ontario

DATUM TBM - Finished floor level of existing building at front entrance. Geodetic elevation = 87.81m.

REMARKS

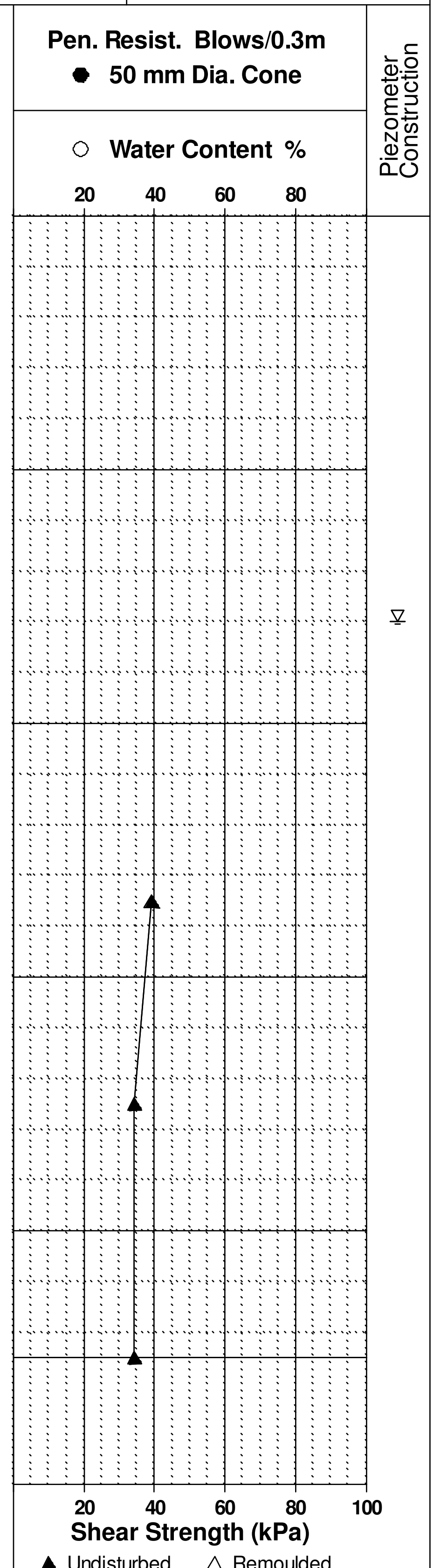
BORINGS BY Backhoe

DATE March 11, 2009

FILE NO. PG1837

HOLE NO. TP 1

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	% RECOVERY	N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	87.00
FILL: Grey silty sand, some clay		G	1				
0.50		G	2				
FILL: Brown silty sand						1	86.00
1.50		G	3				
Loose, brown **SAND**, some gravel and cobbles						2	85.00
2.60		G	4				
Firm, brown **SILTY CLAY**		G	5				
		G	6			3	84.00
						4	83.00
4.50		G	7				
End of Test Pit							
(GWL infiltration @ 1.6m depth)							



patersongroup Consulting Engineers

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SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Proposed Commercial Buildings-3091 Albion Road N.
Ottawa, Ontario

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REMARKS

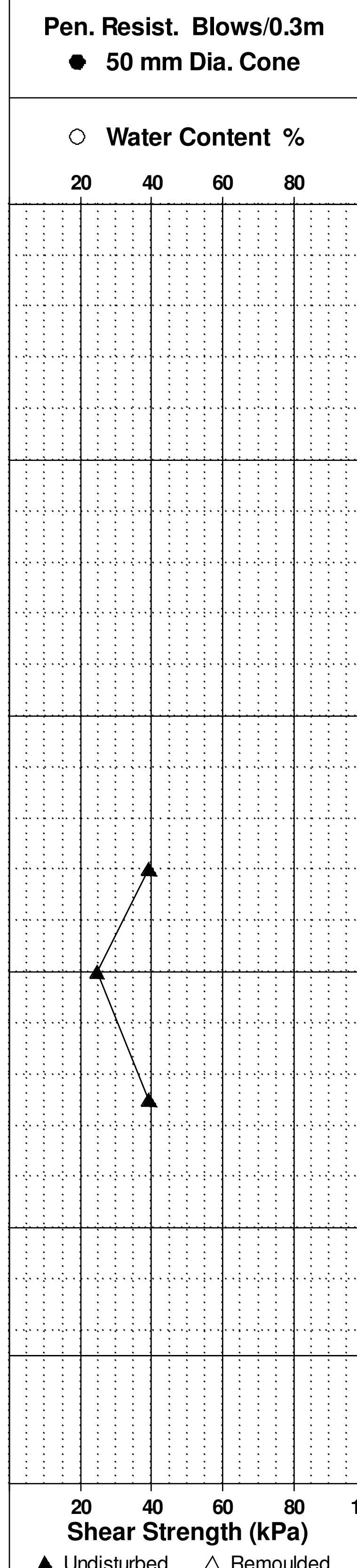
BORINGS BY Backhoe

DATE March 11, 2009

FILE NO. PG1837

HOLE NO. TP 2

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	% RECOVERY	N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	86.94
FILL: Brown silty sand with cobbles and wood		G	1				
0.87							
Loose, brown **SAND**						1	85.94
		G	2				
- some gravel and cobbles by 1.8m depth		G	3				
						2	84.94
		G	4				
2.50							
Firm, grey **SILTY CLAY**		G	5				
		G	6			3	83.94
		G	7				
						4	82.94
4.50							
End of Test Pit							
(GWL infiltration @ 1.6m depth)							



Piezometer Construction

patersongroup Consulting Engineers

154 Colonnade Road South, Ottawa, Ontario K2E 7J5

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Proposed Commercial Buildings-3091 Albion Road N.
Ottawa, Ontario

DATUM TBM - Finished floor level of existing building at front entrance. Geodetic elevation = 87.81m.

REMARKS

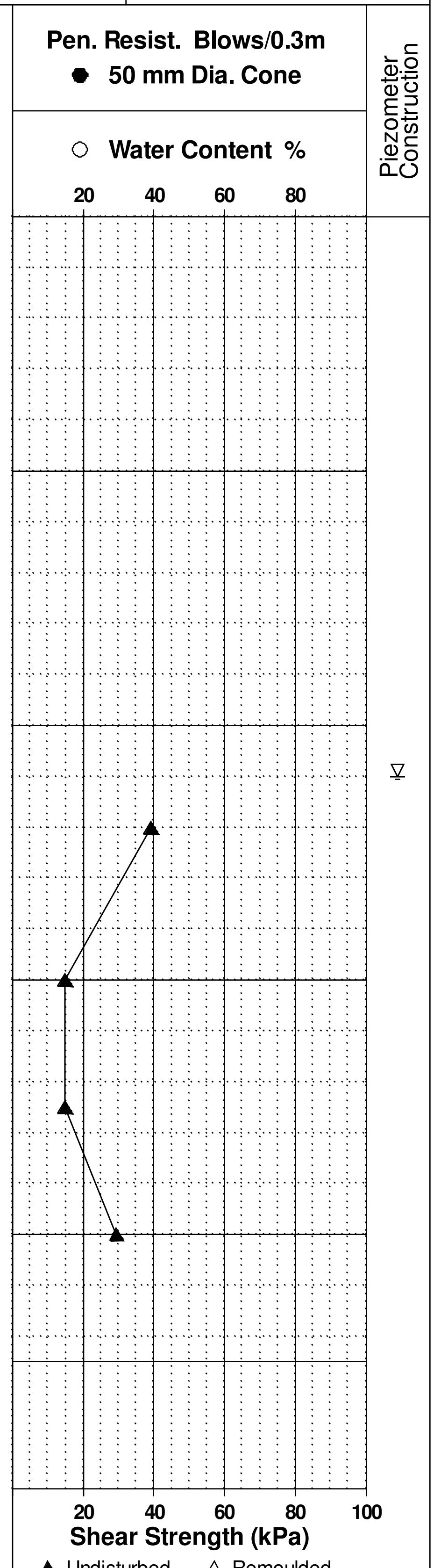
BORINGS BY Backhoe

DATE March 11, 2009

FILE NO. PG1837

HOLE NO. TP 3

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	% RECOVERY	N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	87.04
FILL: Crushed stone (to 0.25)		G	1				
FILL: Brown silty sand, some clay and gravel (to 1.20)		G	2			1	86.04
Brown **SAND**, some gravel - trace clay by 1.5m depth (to 2.20)		G	3				
		G	4			2	85.04
Firm to soft, grey **SILTY CLAY** (to 4.50)		G	5				
		G	6			3	84.04
		G	7				
		G	8			4	83.04
End of Test Pit (GWL infiltration @ 2.2m depth)							



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

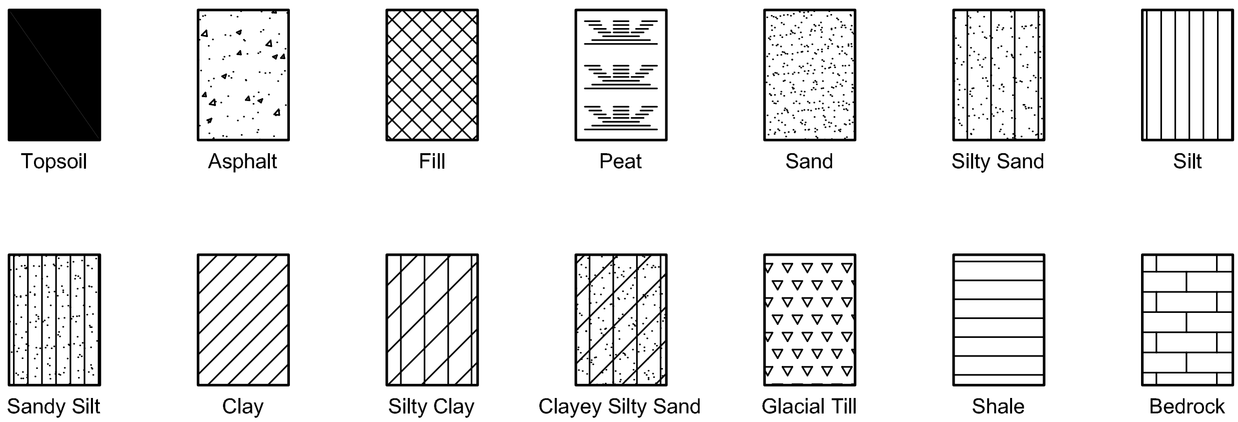
p'_o	-	Present effective overburden pressure at sample depth
p'_c	-	Preconsolidation pressure of (maximum past pressure on) sample
Ccr	-	Recompression index (in effect at pressures below p'_c)
Cc	-	Compression index (in effect at pressures above p'_c)
OC Ratio		Overconsolidaton ratio = p'_c / p'_o
Void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

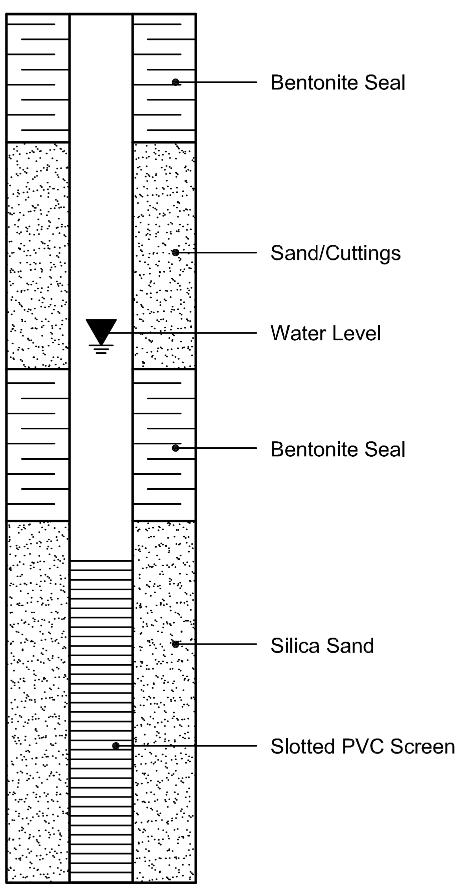
SYMBOLS AND TERMS (continued)

STRATA PLOT

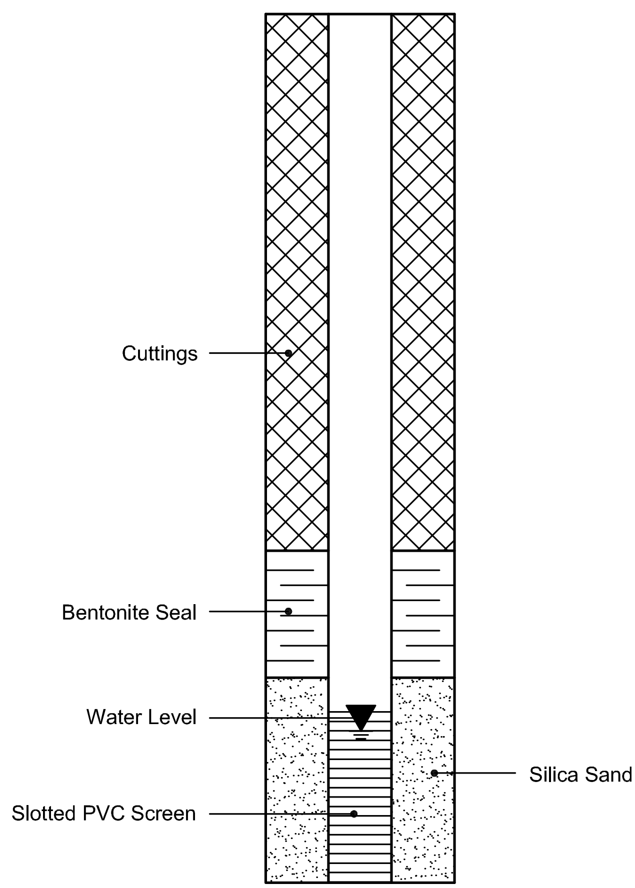


MONITORING WELL AND PIEZOMETER CONSTRUCTION

MONITORING WELL CONSTRUCTION



PIEZOMETER CONSTRUCTION



Certificate of Analysis

Client: **Paterson Group Consulting Engineers**

Client PO: 18438

Report Date: 07-Oct-2015

Order Date:5-Oct-2015

Project Description: PG3635

	Client ID:	BH2 SS3	-	-	-
	Sample Date:	01-Oct-15	-	-	-
	Sample ID:	1541048-01	-	-	-
	MDL/Units	Soil	-	-	-
Physical Characteristics					
% Solids	0.1 % by Wt.	84.3	-	-	-
General Inorganics					
pH	0.05 pH Units	7.52	-	-	-
Resistivity	0.10 Ohm.m	20.3	-	-	-
Anions					
Chloride	5 ug/g dry	194	-	-	-
Sulphate	5 ug/g dry	82	-	-	-

APPENDIX 2

FIGURE 1 - KEY PLAN

DRAWING PG3635-1 - TEST HOLE LOCATION PLAN

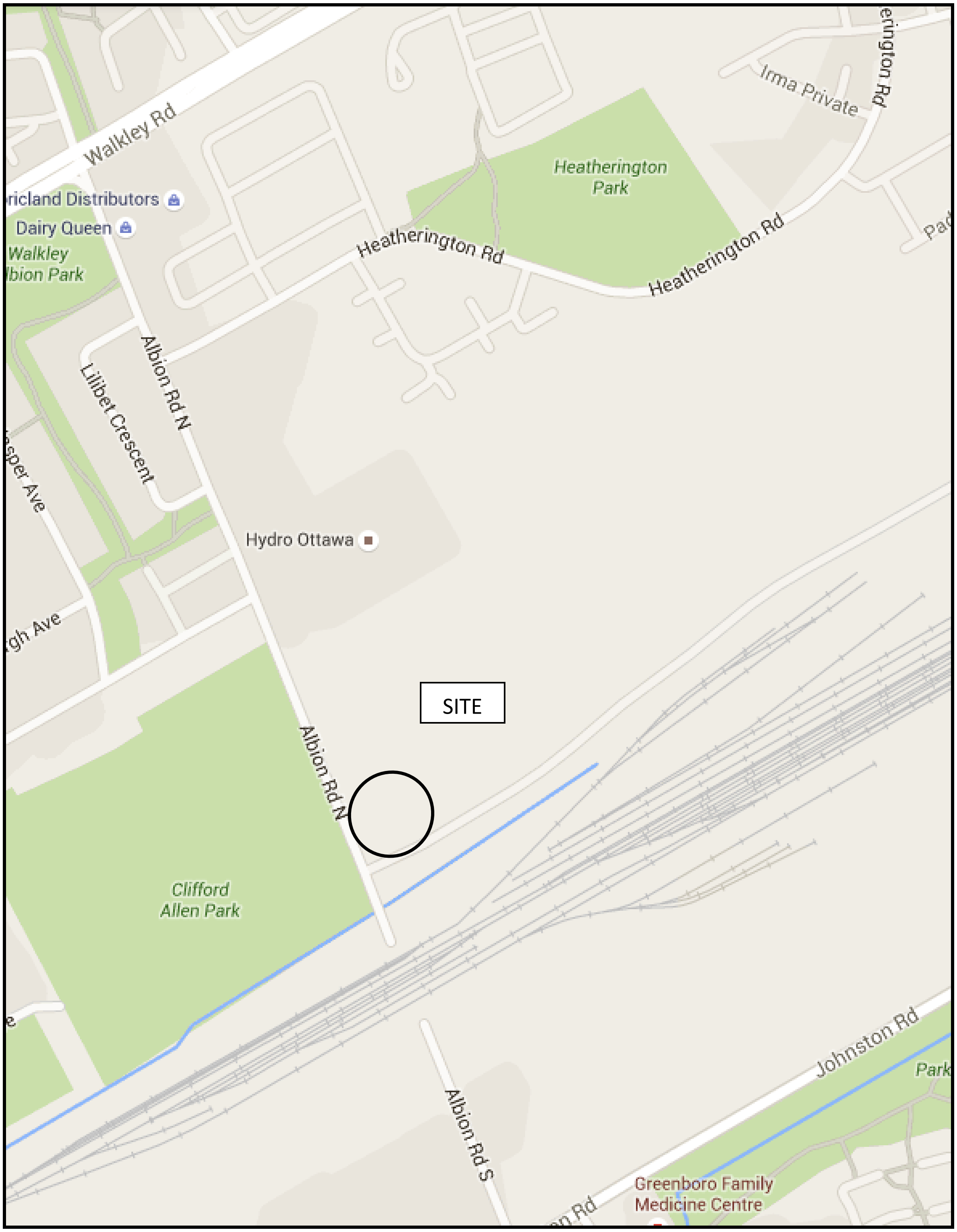
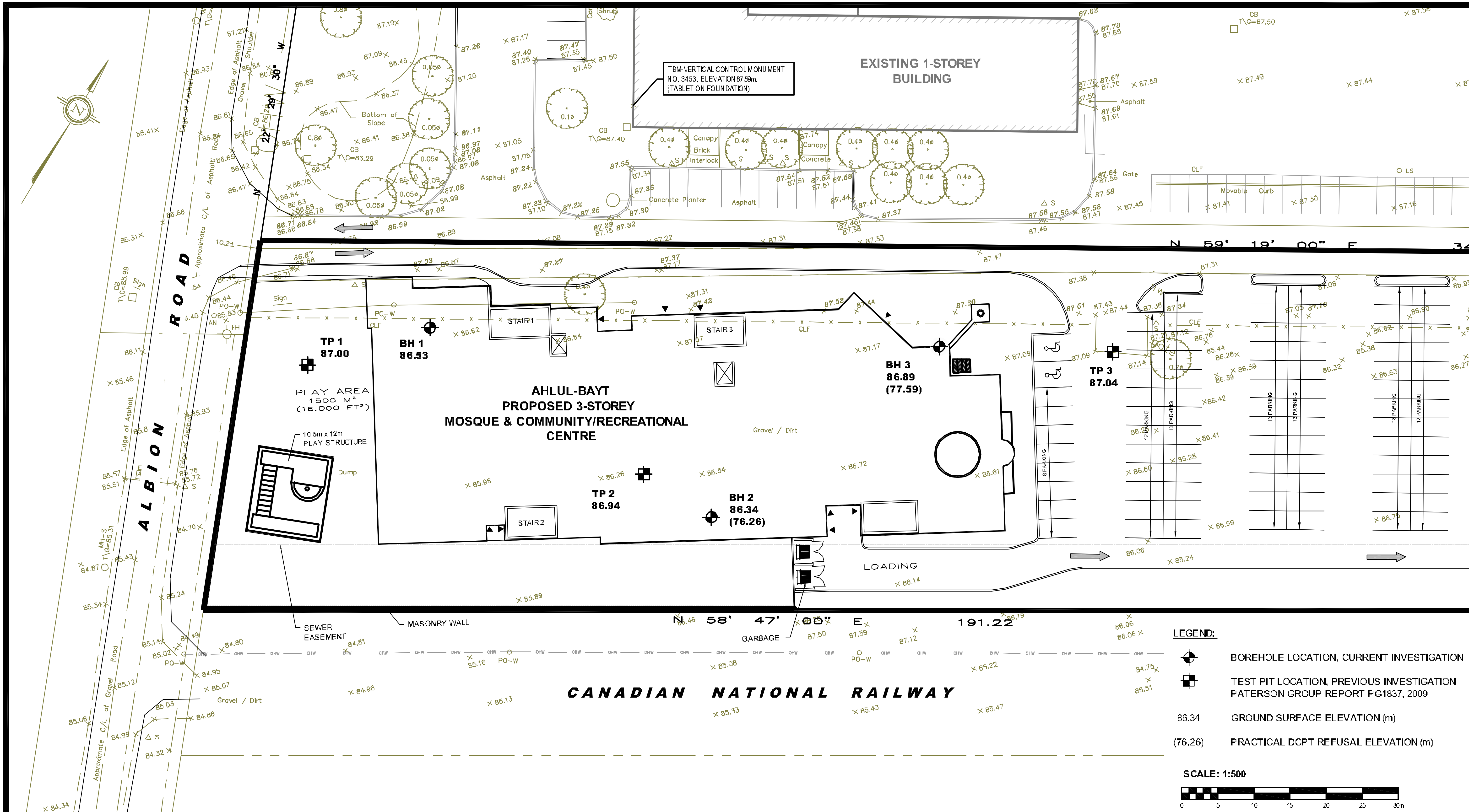


FIGURE 1

KEY PLAN



patersongroup
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NO.	REVISIONS	DATE	INITIAL

AKRAM FARHET

GEOTECHNICAL INVESTIGATION
PROP. MOSQUE & COMMUNITY CENTRE - 3095 ALBION ROAD
OTTAWA, ONTARIO

Title:

TEST HOLE LOCATION PLAN

Scale: 1:500	Date: 10/2015
Drawn by: MPG	Report No.: PG3635-1
Checked by: RG	**PG3635-1**
Approved by: DJG	Revision No.:

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