Geotechnical Engineering

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Hydrogeology

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Geotechnical Investigation
Proposed Commercial Development
Hazeldean Road at Huntmar Drive
Ottawa, Ontario

Prepared For

North American (Goulbourne)
Limited Partnership

May 25, 2016

Report: PG1899-2

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Appendices

1.0 Introduction

Paterson Group (Paterson) was commissioned by North American (Goulbourne) Limited Partnership (North American) to conduct a geotechnical investigation for the commercial development located at the northeast corner of the intersection of Huntmar Drive and Hazeldean 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 subsoil and groundwater conditions at this site by means of 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. It contains our findings and includes geotechnical recommendations pertaining to the design and construction of the subject developments as they are understood at the time of writing this report.

2.0 Proposed Development

It is understood that the current phase of the commercial development will consist of several buildings of slab on grade construction. Associated access lanes, parking and landscaped areas are also anticipated.

3.0 Method of Investigation

3.1 Field Investigation

The field program for the current investigation was carried on April 26, 2016. At that time, six (6) boreholes were extended to a maximum depth of 6.4 m. A previous investigation was carried between July 7 and 13, 2009. At that time, eighteen (18) boreholes were extended to a maximum depth of 9.8 m. The test hole locations were distributed across the subject site in a manner to provide general coverage of the proposed buildings. The borehole locations were selected and located in the field by Paterson. The test hole locations are shown on Drawing PG1899-2 - Test Hole Location Plan included in Appendix 2.

The boreholes were put down using a track-mounted auger drill rig operated by a crew of two. All fieldwork was conducted under the full-time supervision of personnel from Paterson's geotechnical division under the direction of a senior engineer. The testing procedure consisted of augering to the required depths at the selected locations and sampling the overburden.

Sampling and In Situ Testing

Soil samples were collected from the boreholes using a 50 mm diameter split-spoon (SS) sampler, using 73 mm diameter thin walled (TW) Shelby tubes in conjunction with a piston sampler, or the auger flights. All soil samples were visually inspected and initially classified on site. The split-spoon samples were placed in sealed plastic bags and the Shelby tubes were sealed at both ends on site. All samples were transported to our laboratory for further examination and classification. The depths at which the split-spoon, Shelby tube, and auger samples were recovered from the test holes are shown as SS, TW, and AU, respectively, on the Soil Profile and Test Data sheets presented in Appendix 1.

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

Undrained shear strength testing was carried out in cohesive soils using a field vane apparatus.

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 of this report.

Groundwater

A flexible standpipe was installed in all boreholes, except BHs 3, 5 and 16, to permit monitoring of the groundwater levels subsequent to the completion of the sampling program.

3.2 Field Survey

The test hole locations for the current investigation were determined in the field by Paterson personnel with consideration of existing site features. It should be noted that the ground surface elevations at the borehole locations are referenced to a temporary benchmark (TBM), consisting of the top of a fire hydrant located northeast of CRU A. A geodetic elevation of 102.38 m was provided for the TBM. The borehole locations for the previous investigation were surveyed by Fairhall, Moffatt & Woodland Limited. The locations and ground surface elevation at the borehole locations are presented on Drawing PG1899-2 - Test Hole Location Plan in Appendix 2.

3.3 Laboratory Testing

All soil samples recovered from the subject site were examined in our laboratory to review the results of the field logging.

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

3.4 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 6.7.

4.0 Observations

4.1 Surface Conditions

The ground surface at the subject site currently consists of asphaltic concrete and or granular fill, with several commercial buildings constructed during the previous development phases of the subject site. The ground surface at the subject site is relatively flat gradually slopes downward to the south. The subject site is approximately at grade with Huntmar Road and Hazeldean Road.

4.2 Subsurface Profile

Generally, the soil profile at the test holes consists of asphaltic concrete and/or granular fill, such as crushed stone and/or silty sand with gravel and cobbles. Very stiff to stiff brown silty clay crust was encountered below the abovenoted fill layers followed by a firm grey silty clay layer. Practical refusal to dynamic cone penetration testing was completed at BHs 4, 6, 11 and 14, at depths varying between 11 and 15 m. Reference should be made to the Soil Profile and Test Data sheets in Appendix 1 for specific details of the soil profile encountered at each test hole location.

Based on available geological mapping, the subject site consists of interbedded dolostone and limestone of the Gull River formation to depth ranging between 3 to 15 m.

Silty Clay

Two (2) samples of silty clay were subjected to unidimensional consolidation (oedometer) testing. The test results are presented in Subsection 5.3 and the Consolidation Test sheets in Appendix 1. The consolidation test results indicate that the silty clay is overconsolidated with overconsolidation ratios (OCR) for the tested samples varying between 1.9 and 2.1. The OCR is the ratio of the preconsolidation pressure to the effective pressure at the sample depth. This is further discussed in Subsection 5.3.

One (1) silty clay sample was submitted for Atterberg Limits testing. The tested material was classified as inorganic clays of low plasticity (CL). The results are summarized in Table 1 and presented on the Atterberg Limits results sheet in Appendix 1.

Table 1 - Summary of Atterberg Limits Tests

Sample	Moisture Content %	Liquid Limit %	Plastic Limit %	Plasticity Index %	Classification
BH 11 TW 2	41.6	30	18	12	CL

4.3 Groundwater

The measured groundwater levels at the borehole locations are presented in Table 2. It should be noted that groundwater readings could be influenced by surface water infiltrating the backfilled boreholes. The groundwater level can also be estimated based on moisture levels and colour of the recovered soil samples. Based on these observations at the borehole locations, the permanent groundwater table is expected to be between 3 and 4 m depth. It should be noted that groundwater levels are subject to seasonal fluctuations. Therefore, the groundwater level could vary at the time of construction.

Table 2
Summary of Groundwater Level Readings

Test Hole Number	Ground Elevation, m	Groundwater Levels, m		Recording Date
		Depth	Elevation	
BH1-16	102.08	1.92	100.16	May 3, 2016
BH2-16	102.11	3.62	98.49	May 3, 2016
BH3-16	102.04	2.91	99.13	May 3, 2016
BH4-16	101.83	Dry	n/a	May 3, 2016
BH5-16	101.50	2.20	99.30	May 3, 2016
BH6-16	101.75	3.19	98.56	May 3, 2016
PG1988-1R - February 24, 2012				
BH 1	102.81	1.76	101.05	July 16, 2009
BH 2	102.55	2.28	100.27	July 16, 2009
BH 4	101.98	2.51	99.47	July 16, 2009
BH 6	102.74	1.93	100.81	July 16, 2009
BH 7	102.46	2.03	100.43	July 16, 2009
BH 8	101.92	1.50	100.42	July 16, 2009
BH 9	101.68	1.52	100.16	July 16, 2009

Table 2
Summary of Groundwater Level Readings (continued)

Test Hole Number	Ground Elevation, m	Groundwater Levels, m		Recording Date
		Depth	Elevation	
BH 10	101.54	1.55	99.99	July 16, 2009
BH 11	101.34	1.40	99.94	July 16, 2009
BH 12	101.15	1.42	99.73	July 16, 2009
BH 13	100.95	0.60	100.35	July 16, 2009
BH 14	100.24	0.52	99.72	July 16, 2009
BH 15	100.76	1.61	99.15	July 16, 2009
BH 17	101.55	1.27	100.28	July 16, 2009
BH 18	100.47	1.58	98.89	July 16, 2009

Note:

❏ The ground surface elevations are referenced to a temporary benchmark (TBM), consisting of the top of a fire hydrant to be located northeast of CRU A. A geodetic elevation of 102.38 m was provided for the TBM.

5.0 Discussions

5.1 Geotechnical Assessment

From a geotechnical perspective, the subject site is considered suitable for the proposed commercial development. It is anticipated that all structures will be founded on conventional shallow footings placed on the undisturbed, stiff to very stiff silty clay. However, due to the presence of a silty clay layer, the proposed development will be subjected to grade raise restrictions.

Our permissible grade raise recommendations are discussed in Subsection 5.3. 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.

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

5.2 Site Grading and Preparation

Stripping Depth

Topsoil, deleterious fill, such as those containing organic materials, and construction debris should be stripped from under any buildings and other settlement sensitive structures.

Fill Placement

Fill used for grading beneath the building areas should consist, unless otherwise specified, of clean imported granular fill, such as Ontario Provincial Standard Specifications (OPSS) Granular A or Granular B Type II. This material should be tested and approved prior to delivery to the site. The fill should be placed in lifts no greater than 300 mm thick and compacted using suitable compaction equipment for the lift thickness. Fill placed beneath the buildings and paved areas should be compacted to at least 98% of its standard Proctor maximum dry density (SPMDD).

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

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

5.3 Foundation Design

Strip footings, up to 3 m wide, and pad footings, up to 5 m wide, placed on an undisturbed, stiff silty clay bearing surface can be designed using a bearing resistance value at serviceability limit states (SLS) of **150 kPa** and a factored bearing resistance value at ultimate limit states (ULS) of **225 kPa**. A geotechnical resistance factor of 0.5 was applied to the bearing resistance value at ULS.

An undisturbed soil bearing surface consists of one from which all topsoil and deleterious materials, such as loose, frozen or disturbed soil, have been removed, in the dry, prior to the placement of concrete for footings.

Footings founded on the silty clay will experience up to 25 mm of total settlement and 15 mm of differential settlement.

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 very stiff to stiff silty clay above groundwater table when a plane extending down and out from the bottom edge of the fooring at a minimum of 1.5H:1V passes only through in situ soil of the same or higher capacity as the bearing medium soil.

Settlement/Grade Raise

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.

Generally, the potential long term settlement is evaluated based on the compressibility characteristics of the silty clay. These characteristics are estimated in the laboratory by conducting unidimensional consolidation tests on undisturbed soil samples collected using Shelby tubes in conjunction with a piston sampler. Two (2) site specific consolidation tests are being carried out for this project. The results of the consolidation tests are included in Appendix 1 to the present report.

Value p'_c is the preconsolidation pressure of the sample and p'_o is the effective overburden pressure. The difference between these values is the available preconsolidation. The increase in stress on the soil due to the cumulative effects of the fill surcharge, the footing pressures, the slab loadings and the lowering of the groundwater should not exceed the available preconsolidation if unacceptable settlements are to be avoided.

The values C_{cr} and C_c are the recompression and compression indices, respectively, and are a measure of the compressibility of the soil due to stress increases below and above the preconsolidation pressures. The higher values for the C_c, as compared to the C_{cr}, illustrate the increased settlement potential above, as compared to below, the preconsolidation pressure.

It should be noted that the values of p'_c, p'_o, C_{cr} and C_c are determined using standard engineering practices and are estimates only. In addition, natural variations within the soil deposit would also affect the results. Furthermore, the p'_o parameter is directly influenced by the groundwater level. While the groundwater levels were measured at the time of the fieldwork, the levels vary with time and this has an impact on the available preconsolidation. Lowering the groundwater level increases the p'_o and therefore reduces the available preconsolidation. Unacceptable settlements could be induced by a significant lowering of the groundwater level. The p'_o values for the consolidation tests carried out for the present investigation are based on the long term groundwater level being 0.5 m above the bottom of the silty clay crust. The level of the groundwater level is based on the colour and undrained shear strength profile of the silty clay.

For design purposes, the total and differential settlements associated with the combination of grade raises and footing loading conditions using the bearing resistance values are estimated to be 25 and 20 mm, respectively. A post-development groundwater lowering of 0.5 m was assumed.

Table 3
Summary of Consolidation Test Results

Borehole No.	Sample	Depth (m)	p'_c (kPa)	p'_o (kPa)	C_{cr}	C_c	Q (*)
BH 11	TW 2	4.99	148	70	0.013	0.674	A
BH 18	TW 4	5.07	126	65	0.013	0.466	A

* - Q - Quality assessment of sample - G: Good A: Acceptable P: Likely disturbed

To reduce potential long term liabilities, consideration should be given to provide means to reduce long term groundwater lowering (e.g. clay dykes, restriction on planting around the structures, etc). It should be noted that building on silty clay deposits increases the likelihood of building movements and therefore of cracking. The use of steel reinforcement in foundations placed at key structural locations will tend to reduce foundation cracking as compared to unreinforced foundations.

Based on our laboratory and field testing results, a permissible grade raise restriction of 1.2 m is recommended for the subject site.

If higher grade raises and/or higher loading conditions are required, post construction settlements can be reduced by several methods. The following options can be considered:

❏ preloading and surcharging
❏ lightweight fill (LWF)

5.4 Design for Earthquakes

The site class for seismic site response is a **Class D** for the foundations considered. The soils underlying the subject site are not susceptible to liquefaction. Reference should be made to the latest revision of the Ontario Building Code 2012 (OBC 2012; Table 4.1.8.4 A) for a full discussion of the earthquake design requirements.

5.5 Slab-on-Grade Construction

With the removal of the topsoil layer and fill containing organic matter, within the footprint of the proposed building, the native soil surface will be considered to be an acceptable subgrade on which to commence backfilling for floor slab construction.

Any soft areas should be removed and backfilled with appropriate backfill material prior to placing any fill. OPSS Granular B Type II, with a maximum particle size of 50 mm, are recommended for backfilling below the floor slab. It is recommended that the upper 200 mm of sub-floor fill consists of OPSS Granular A crushed stone for slab on grade construction. All backfill material within the footprint of the proposed building should be placed in maximum 300 mm thick loose layers and compacted to at least 98% of its SPMDD.

5.6 Pavement Design

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

Table 4 - Recommended Pavement Structure
Car Only Parking Areas

Thickness mm	Material Description
50	**WEAR COURSE -** Superpave 12.5 Asphaltic Concrete
150	**BASE** - OPSS Granular A Crushed Stone
300	**SUBBASE** - OPSS Granular B Type II

SUBGRADE - Either in situ soil, fill or OPSS Granular B Type I or II material placed over in situ soil or fill.

Table 5 - Recommended Pavement Structure
Access Lanes, Fire Routes and Heavy Truck Parking Areas

Thickness mm	Material Description
40	**WEAR COURSE -** Superpave 12.5 Asphaltic Concrete
50	**BINDER COURSE -** Superpave 19.0 Asphaltic Concrete
150	**BASE** - OPSS Granular A Crushed Stone
400	**SUBBASE** - OPSS Granular B Type II
SUBGRADE - Either in situ soil, fill 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. Weak subgrade conditions may be experienced over service trench fill materials.

The pavement granular base and subbase should be placed in maximum 300 mm thick lifts and compacted to a minimum of 100% of the material’s SPMDD using suitable vibratory equipment.

Pavement Structure Drainage

Satisfactory performance of the pavement structure is largely dependent on keeping 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 can result in the fine subgrade soil being pumped into the voids in the stone subbase, thereby reducing its load carrying capacity.

In areas where silty clay is encountered at subgrade, consideration should be given to installing subdrains during the pavement construction as per City of Ottawa standards. The subdrain inverts should be approximately 300 mm below subgrade level. The subgrade surface should be crowned to promote water flow to the drainage lines.

6.0 Design and Construction Precautions

6.1 Foundation Drainage and Backfill

It is recommended that a perimeter foundation drainage system be provided for the proposed structures. The system should consist of a 100 mm to 150 mm diameter 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 or sump pit.

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

6.2 Protection Against Frost Action

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

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 soil and fill overburden materials should either be cut back at acceptable slopes or should be retained by shoring systems from the start of the excavation until the structure is backfilled. It is 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).

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 Type 2 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 side walls.

6.4 Pipe Bedding and Backfill

The pipe bedding for sewer and water pipes should consist of at least 150 mm of OPSS Granular A material. 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.

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

It should generally be possible to re-use the moist (not wet) brown silty clay above the cover material if the excavation and filling operations are carried out in dry weather conditions. Wet silty clay materials will be difficult to re-use, as the high water contents make compacting impractical without an extensive drying period.

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

The groundwater infiltration into the excavations should be low and controllable with 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.

A temporary MOE permit to take water (PTTW) may be required for this project if more than 50,000 L/day is 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

The subsoil conditions at this site mostly consist of frost susceptible materials. In presence of water and freezing conditions ice could form within the soil mass. Heaving and settlement upon thawing could occur. Precautions should be taken if winter construction is considered for this project.

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.

The trench excavations should be carried out in a manner that will avoid the introduction of frozen materials into the trenches. As well, pavement construction is difficult during winter. The subgrade consists of frost susceptible soils which will experience total and differential frost heaving as the work takes place. In addition, the introduction of frost, snow or ice into the pavement materials, which is difficult to avoid, could adversely affect the performance of the pavement structure. Additional information could be provided, if required.

6.7 Corrosion Potential and Sulphate

The analytical testing results are presented in Table 6 along with industry standards for the applicable threshold values. These results are indicative that Type 10 Portland cement (Type GU, or normal cement) would be appropriate for this site.

Table 6 - Corrosion Potential

Parameter	Laboratory Results	Threshold	Commentary
	BH6 SS2		
Chloride	66 µg/g	Chloride content less than 400 mg/g	Negligible concern
pH	7.5	pH value less than 5.0	Neutral Soil
Resistivity	21.8 ohm.m	Resistivity greater than 1,500 ohm.cm	Moderate Corrosion Potential
Sulphate	251 µg/g	Sulphate value greater than 1 mg/g	Negligible Concern

6.8 Landscaping Considerations

The proposed development is located in a moderate sensitivity area with respect to tree plantings over a silty clay deposit. It is recommended that trees 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 depth of 2 m below ground surface.

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, they should not be considered in the landscaping design.

7.0 Recommendations

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

- Review master grading plan from a geotechnical perspective, once available.
- Review detailed grading plan(s) 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.
- Observation of all subgrades prior to backfilling and follow-up field density tests to ensure that the specified level of compaction has been 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 material testing and observation program by the geotechnical consultant.

8.0 Statement of Limitations

The recommendations made in this report are in accordance with our present understanding of the project. The client should be aware that any information pertaining to soils and all test hole logs are furnished as a matter of general information only and test hole descriptions or logs are not to be interpreted as descriptive of conditions at locations other than those of the test holes.

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 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 North American (Goulbourne) Limited Partnership Limited or their agent(s) are not authorized without review by this firm for the applicability of our recommendations to the altered use of the report.

Paterson Group Inc.

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Report Distribution:

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APPENDIX 1

SOIL PROFILE AND TEST DATA SHEETS

SYMBOLS AND TERMS

CONSOLIDATION TESTING RESULTS

ATTERBERG LIMIT TESTING RESULTS

ANALYTICAL TESTING RESULTS

patersongroup Consulting Engineers

154 Colonnade Road South, Ottawa, Ontario K2E 7J5

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Proposed Commercial Development-Hazeldean Road
Ottawa, Ontario

DATUM TBM - Top spindle of fire hydrant. Geodetic elevation = 102.38m.

REMARKS

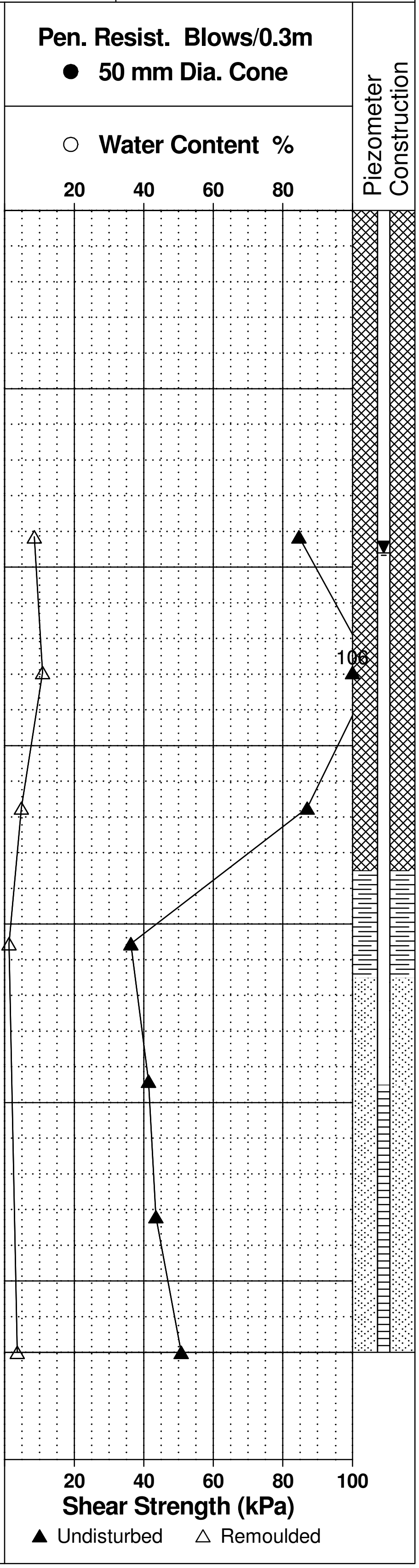
BORINGS BY CME 55 Power Auger

DATE April 26, 2016

FILE NO. PG1899

HOLE NO. BH 1-16

SOIL DESCRIPTION		SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	102.08
Asphaltic concrete	0.06						
FILL: Crushed stone	0.51	AU AU	1 2				
Very stiff to stiff, brown **SILTY CLAY,** trace sand		SS	3	4	2	1	101.08
						2	100.08
						3	99.08
- firm to stiff and grey by 3.8m depth						4	98.08
						5	97.08
						6	96.08
End of Borehole	6.40						
(GWL @ 1.92m-May 3, 2016)							



patersongroup Consulting Engineers

154 Colonnade Road South, Ottawa, Ontario K2E 7J5

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Proposed Commercial Development-Hazeldean Road
Ottawa, Ontario

DATUM TBM - Top spindle of fire hydrant. Geodetic elevation = 102.38m.

FILE NO. PG1899

REMARKS

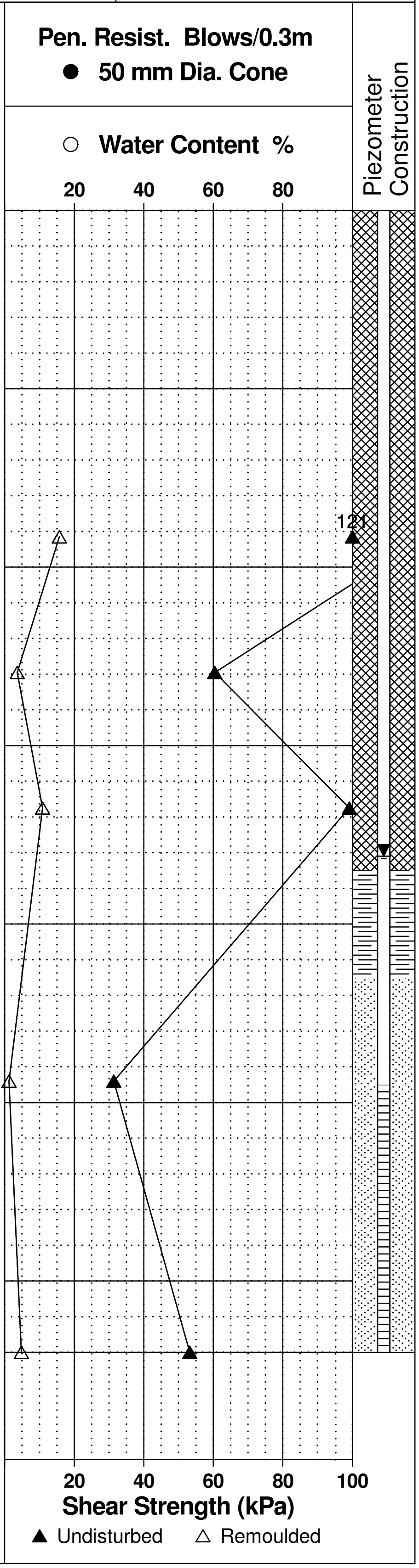
HOLE NO. BH 2-16

BORINGS BY CME 55 Power Auger

DATE April 26, 2016

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD
GROUND SURFACE					
Crushed stone 0.15		AU	1		
FILL: Silty sand with gravel and cobbles 0.90					
Very stiff to stiff, brown **SILTY CLAY,** trace sand - firm to stiff and grey by 4.0m depth 6.40		SS	2	46	27
End of Borehole (GWL @ 3.62m-May 3, 2016)					

DEPTH (m)	ELEV. (m)
0	102.11
1	101.11
2	100.11
3	99.11
4	98.11
5	97.11
6	96.11



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SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Proposed Commercial Development-Hazeldean Road
Ottawa, Ontario

DATUM TBM - Top spindle of fire hydrant. Geodetic elevation = 102.38m.

FILE NO. PG1899

REMARKS

HOLE NO. BH 3-16

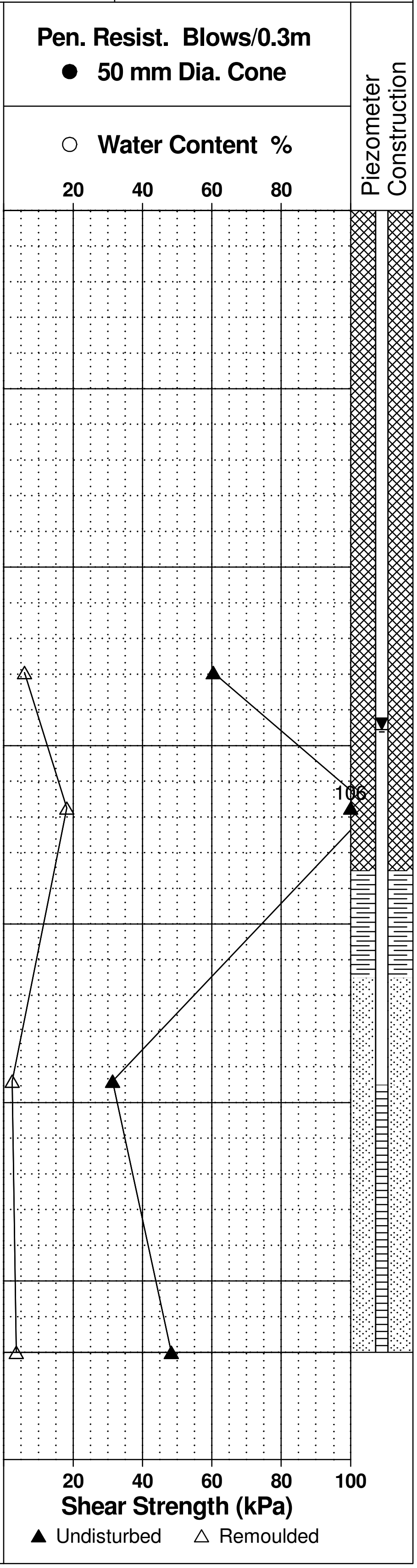
BORINGS BY CME 55 Power Auger

DATE April 26, 2016

SOIL DESCRIPTION	Depth to base (m)
GROUND SURFACE	
Crushed stone	0.15
FILL: Brown silty sand with gravel and cobbles	0.85
Very stiff to stiff, brown **SILTY CLAY,** trace sand - firm and grey by 4.0m depth	6.40
End of Borehole (GWL @ 2.91m-May 3, 2016)	

SAMPLE TYPE	NUMBER	% RECOVERY	N VALUE or RQD
SS	1	42	37
SS	2	21	5

DEPTH (m)	ELEV. (m)
0	102.04
1	101.04
2	100.04
3	99.04
4	98.04
5	97.04
6	96.04



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SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Proposed Commercial Development-Hazeldean Road
Ottawa, Ontario

DATUM TBM - Top spindle of fire hydrant. Geodetic elevation = 102.38m.

REMARKS

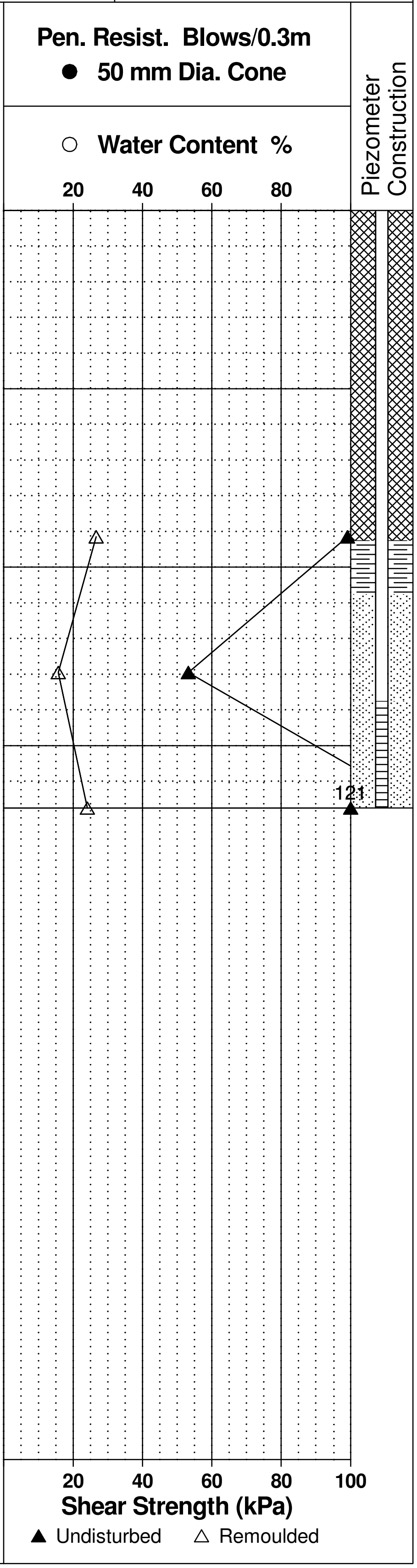
BORINGS BY CME 55 Power Auger

DATE April 26, 2016

FILE NO. PG1899

HOLE NO. BH 4-16

SOIL DESCRIPTION	STRATA PLOT	SAMPLE				DEPTH (m)	ELEV. (m)
		TYPE	NUMBER	% RECOVERY	N VALUE or RQD		
GROUND SURFACE						0	101.83
FILL: Brown silty sand with gravel		AU	1				
		SS	2	42	14	1	100.83
1.32							
Stiff to very stiff, brown **SILTY CLAY,** trace sand						2	99.83
						3	98.83
3.35							
End of Borehole							
(BH dry - May 3, 2016)							



SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Proposed Commercial Development-Hazeldean Road
Ottawa, Ontario

DATUM TBM - Top spindle of fire hydrant. Geodetic elevation = 102.38m.

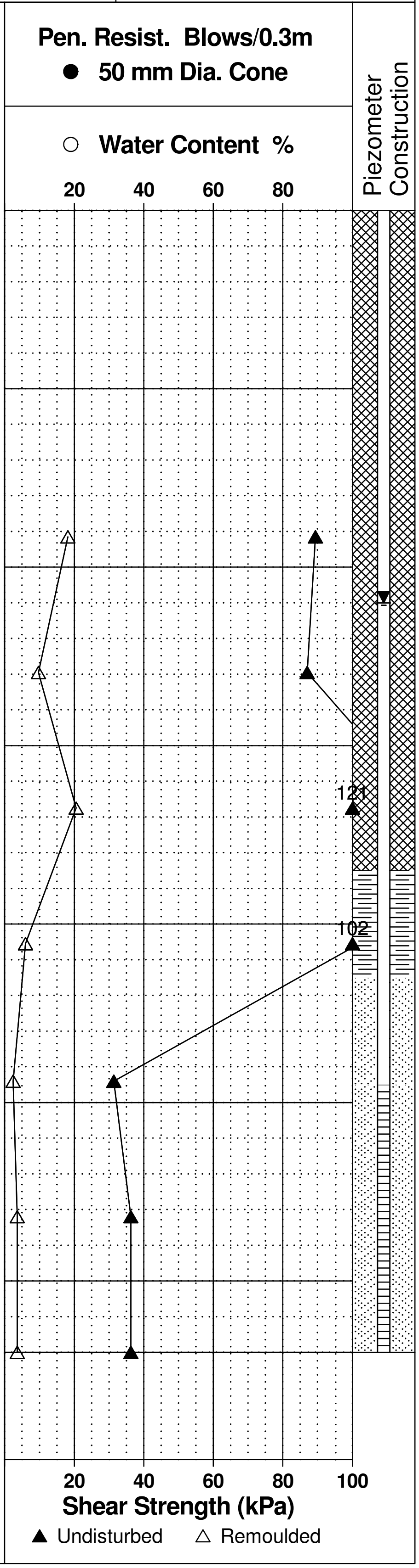
FILE NO. **PG1899**

REMARKS

HOLE NO. **BH 5-16**

BORINGS BY CME 55 Power Auger **DATE** April 26, 2016

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	101.50
FILL: Brown silty sand with gravel		AU	1				
0.86		SS	2	42	9	1	100.50
Stiff to very stiff, brown **SILTY CLAY,** trace sand						2	99.50
						3	98.50
- firm and grey by 4.3m depth						4	97.50
						5	96.50
						6	95.50
6.40							
End of Borehole (GWL @ 2.20m-May 3, 2016)							



SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Proposed Commercial Development-Hazeldean Road
Ottawa, Ontario

DATUM TBM - Top spindle of fire hydrant. Geodetic elevation = 102.38m.

FILE NO. PG1899

REMARKS

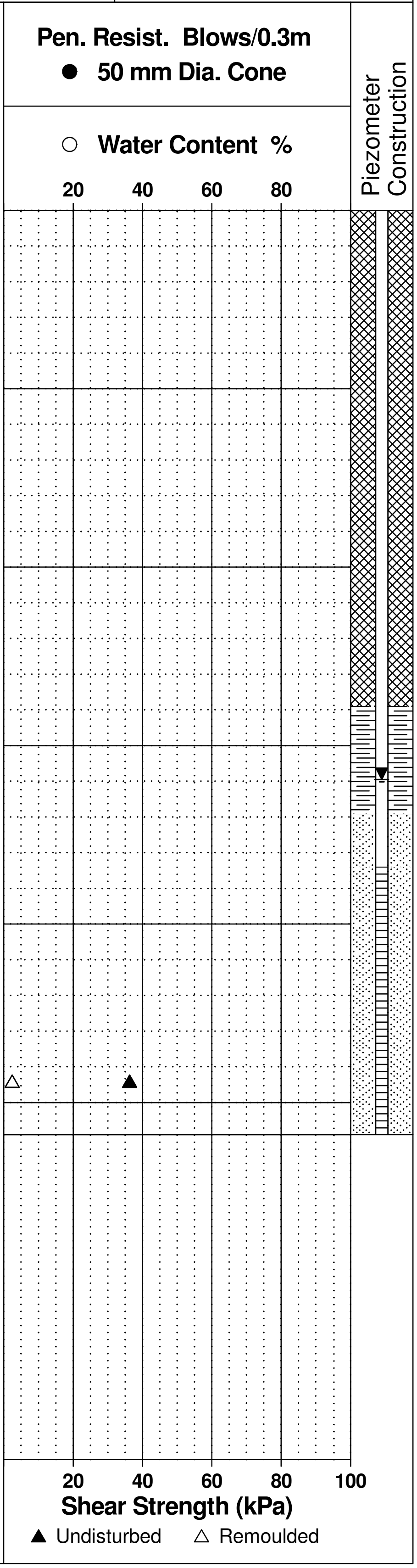
HOLE NO. BH 6-16

BORINGS BY CME 55 Power Auger

DATE April 26, 2016

SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NUMBER	% RECOVERY	N VALUE or RQD
GROUND SURFACE				
FILL: Brown silty sand with gravel and cobbles	AU	1		
	SS	2	62	17
1.30				
Very stiff to stiff, brown **SILTY CLAY** with sand	SS	3	67	7
	SS	4	100	4
	SS	5	100	2
	SS	6	100	2
- firm and grey by 4.5m depth	SS	7	100	P
5.18				
End of Borehole (GWL @ 3.19m-May 3, 2016)				

DEPTH (m)	ELEV. (m)
0	101.75
1	100.75
2	99.75
3	98.75
4	97.75
5	96.75



SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Proposed Commercial Development-Hazeldean Road
Ottawa, Ontario

DATUM Ground surface elevations provided by Fairhall, Moffatt & Woodland Ltd.

REMARKS

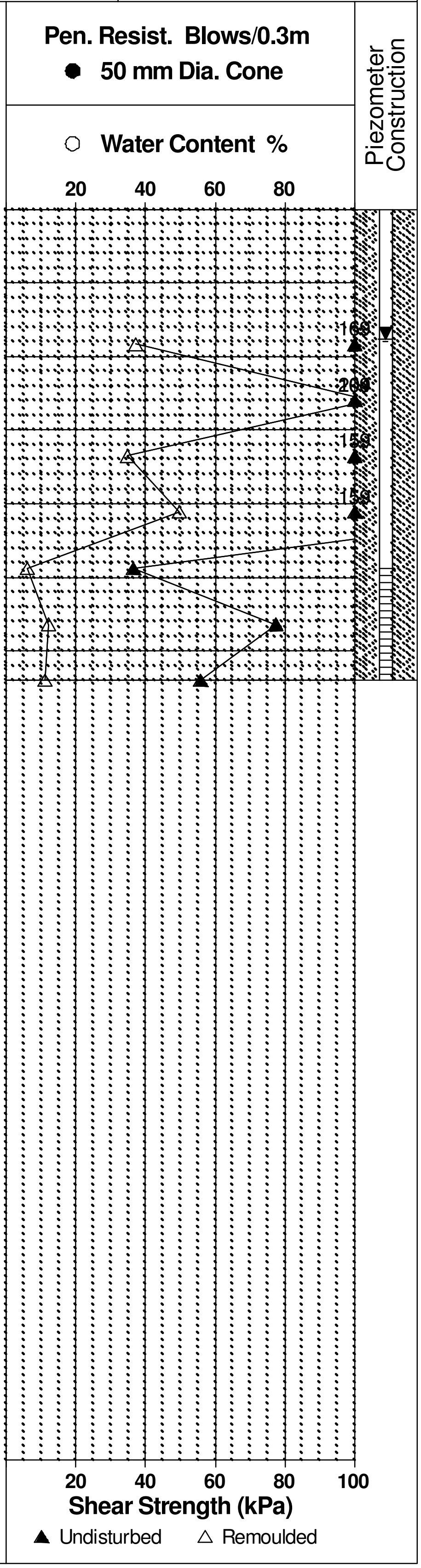
BORINGS BY CME 55 Power Auger

DATE 13 July 2009

FILE NO. PG1899

HOLE NO. BH 1

SOIL DESCRIPTION	STRATA PLOT	SAMPLE				DEPTH (m)	ELEV. (m)
		TYPE	NUMBER	% RECOVERY	N VALUE or RQD		
GROUND SURFACE						0	102.81
TOPSOIL 0.13		AU	1				
		SS	2	58	8	1	101.81
Hard to very stiff, brown **SILTY CLAY**, trace sand and sand seams						2	100.81
						3	99.81
- very stiff to stiff and grey by 2.8m depth						4	98.81
						5	97.81
6.40						6	96.81
End of Borehole (GWL @ 1.76m-July 16/09)							



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SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Proposed Commercial Development-Hazeldean Road
Ottawa, Ontario

DATUM Ground surface elevations provided by Fairhall, Moffatt & Woodland Ltd.

REMARKS

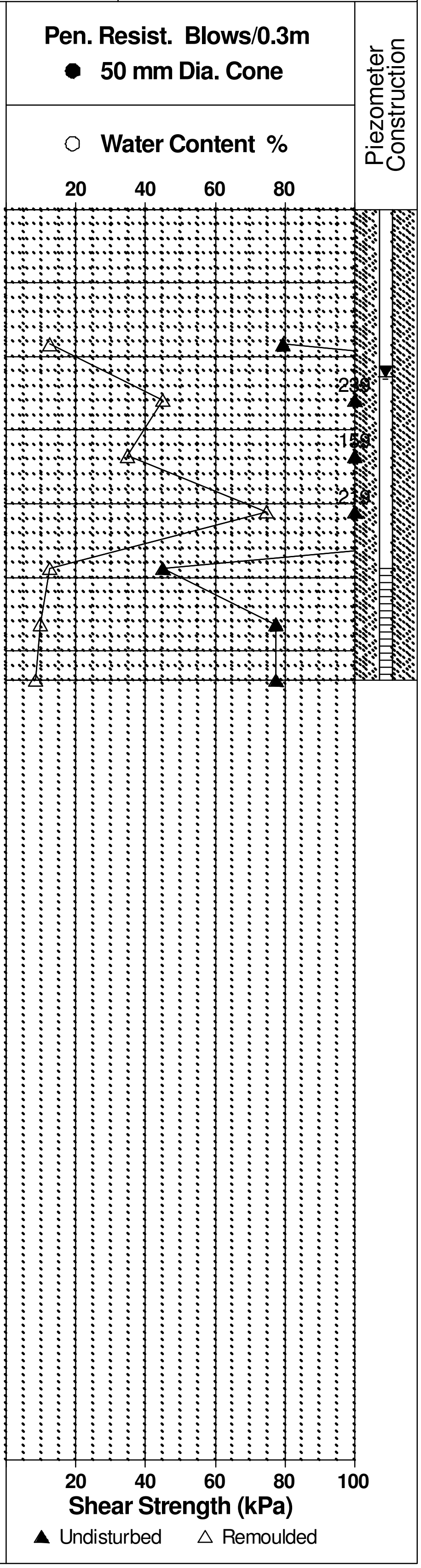
BORINGS BY CME 55 Power Auger

DATE 13 July 2009

FILE NO. PG1899

HOLE NO. BH 2

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	102.55
TOPSOIL 0.15							
		SS	1		5	1	101.55
						2	100.55
Hard to very stiff, brown **SILTY CLAY** , trace sand and sand seams						3	99.55
- firm to stiff and grey by 4.3m depth						4	98.55
						5	97.55
6.40						6	96.55
End of Borehole (GWL @ 2.28m-July 16/09)							



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SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Proposed Commercial Development-Hazeldean Road
Ottawa, Ontario

DATUM Ground surface elevations provided by Fairhall, Moffatt & Woodland Ltd.

REMARKS

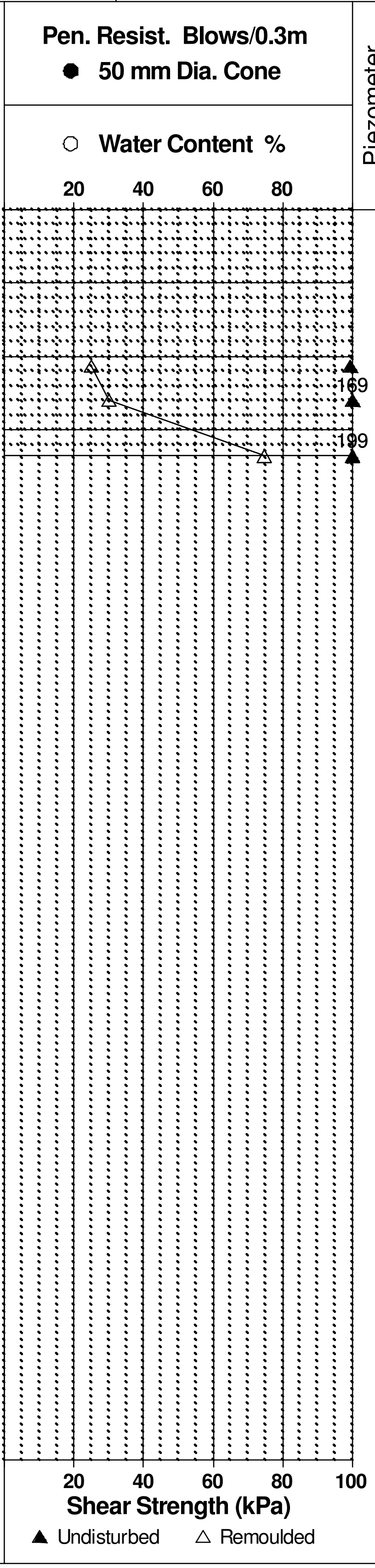
BORINGS BY CME 55 Power Auger

DATE 13 July 2009

FILE NO. PG1899

HOLE NO. BH 3

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	102.59
TOPSOIL 0.15							
Brown **CLAYEY SILT**, some sand 0.69		SS	1		8	1	101.59
Very stiff, brown **SILTY CLAY**						2	100.59
3.35						3	99.59
End of Borehole							



Piezometer Construction

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SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Proposed Commercial Development-Hazeldean Road
Ottawa, Ontario

DATUM Ground surface elevations provided by Fairhall, Moffatt & Woodland Ltd.

FILE NO. **PG1899**

REMARKS

HOLE NO. **BH 4**

BORINGS BY CME 55 Power Auger

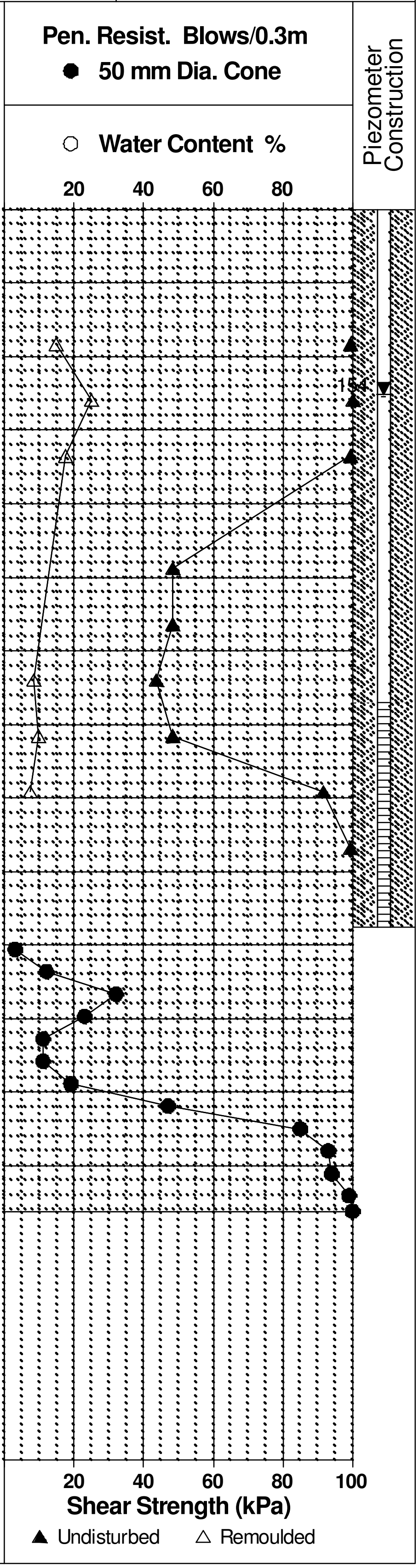
DATE 8 July 2009

SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE					0	101.98
FILL: Silty clay wtih gravel and topsoil	AU	1				
0.91	SS	2		5	1	100.98
Very stiff to stiff, brown **SILTY CLAY**, trace sand					2	99.98
- grey-brown by 2.0m depth					3	98.98
	TW	3	100		4	97.98
- firm to stiff and grey by 3.7m depth					5	96.98
					6	95.98
					7	94.98
8.15					8	93.98
GLACIAL TILL: Stiff, grey clayey silt with sand, gravel , cobbles and boulders, trace clay					9	92.98
9.75	SS	4		2		
Dynamic Cone Penetration Test commenced @ 9.75m depth					10	91.98
					11	90.98
Inferred **GLACIAL TILL**					12	89.98
					13	88.98
13.62						

End of Borehole

Practical refusal to DCPT @ 13.62m depth

(GWL @ 2.51m-July 16/09)



SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Proposed Commercial Development-Hazeldean Road
Ottawa, Ontario

DATUM Ground surface elevations provided by Fairhall, Moffatt & Woodland Ltd.

REMARKS

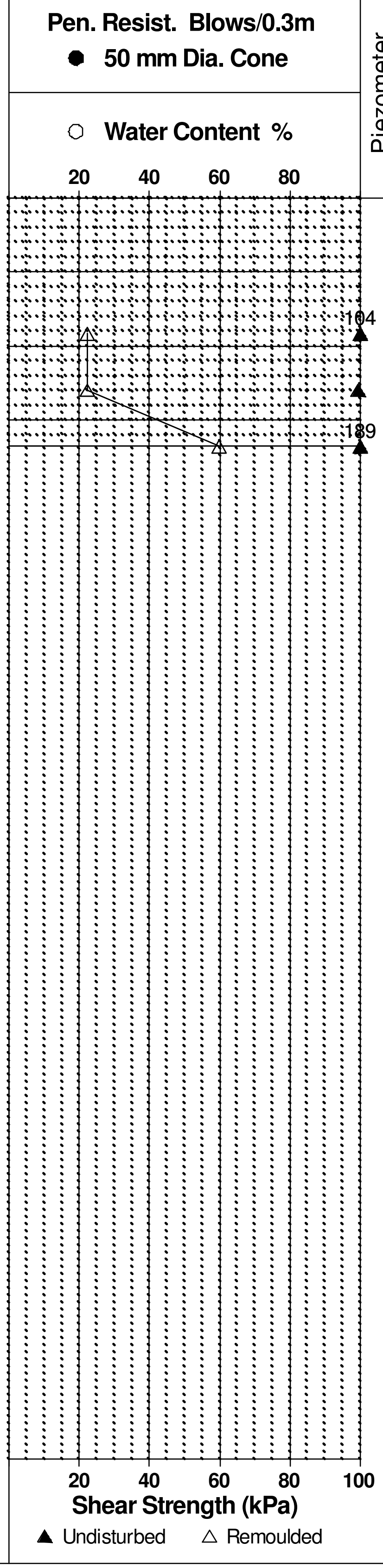
BORINGS BY CME 55 Power Auger

DATE 7 July 2009

FILE NO. PG1899

HOLE NO. BH 5

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	102.27
TOPSOIL 0.20							
Very stiff, brown **SILTY CLAY** with some sand		SS	1		5	1	101.27
						2	100.27
3.35						3	99.27
End of Borehole							



Piezometer Construction

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SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Proposed Commercial Development-Hazeldean Road
Ottawa, Ontario

DATUM Ground surface elevations provided by Fairhall, Moffatt & Woodland Ltd.

REMARKS

BORINGS BY CME 55 Power Auger

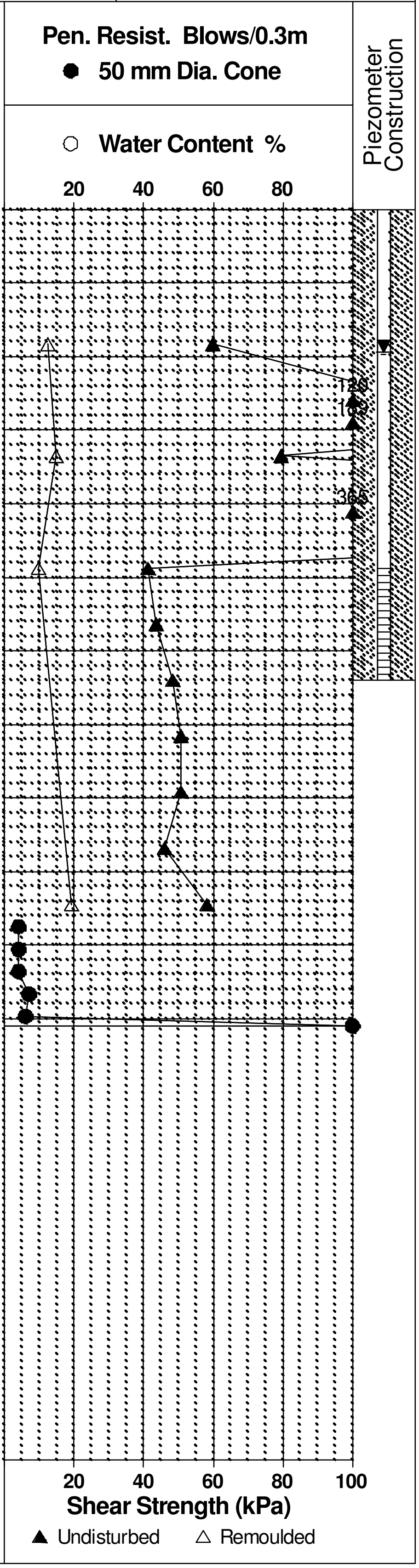
DATE 7 July 2009

FILE NO. PG1899

HOLE NO. BH 6

SOIL DESCRIPTION		TYPE	NUMBER	% RECOVERY	N VALUE or RQD
GROUND SURFACE					
FILL: Silty sand with gravel	0.30	AU	1		
FILL: Black silty clay with sand	0.53	SS	2	100	4
Stiff, mottled brown **SILTY CLAY** , some sand seams - firm to stiff and grey by 3.6m depth	9.45				
Dynamic Cone Penetration Test commenced @ 9.45m depth	11.10				
End of Borehole Practical refusal to DCPT @ 11.10m depth (GWL @ 1.93m-July 16/09)					

DEPTH (m)	ELEV. (m)
0	102.74
1	101.74
2	100.74
3	99.74
4	98.74
5	97.74
6	96.74
7	95.74
8	94.74
9	93.74
10	92.74
11	91.74



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SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Proposed Commercial Development-Hazeldean Road
Ottawa, Ontario

DATUM Ground surface elevations provided by Fairhall, Moffatt & Woodland Ltd.

REMARKS

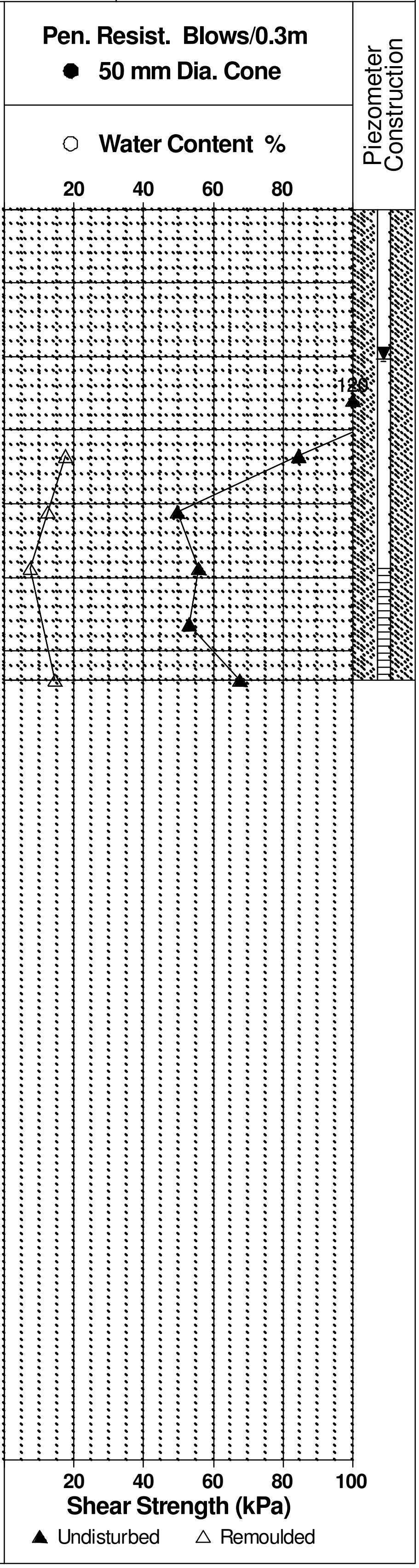
BORINGS BY CME 55 Power Auger

DATE 7 July 2009

FILE NO. **PG1899**

HOLE NO. **BH 7**

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	102.46
FILL: Gravel 0.08		AU	1				
TOPSOIL 0.69							
FILL: Brown silty clay with sand and topsoil 1.45		SS	2	25	7	1	101.46
Very stiff to stiff, grey-brown **SILTY CLAY** with some sand - grey by 3.6m depth		SS	3	100	2	2	100.46
						3	99.46
						4	98.46
						5	97.46
6.40						6	96.46
End of Borehole (GWL @ 2.03m-July 16/09)							



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SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Proposed Commercial Development-Hazeldean Road
Ottawa, Ontario

DATUM Ground surface elevations provided by Fairhall, Moffatt & Woodland Ltd.

FILE NO. **PG1899**

REMARKS

HOLE NO. **BH 8**

BORINGS BY CME 55 Power Auger

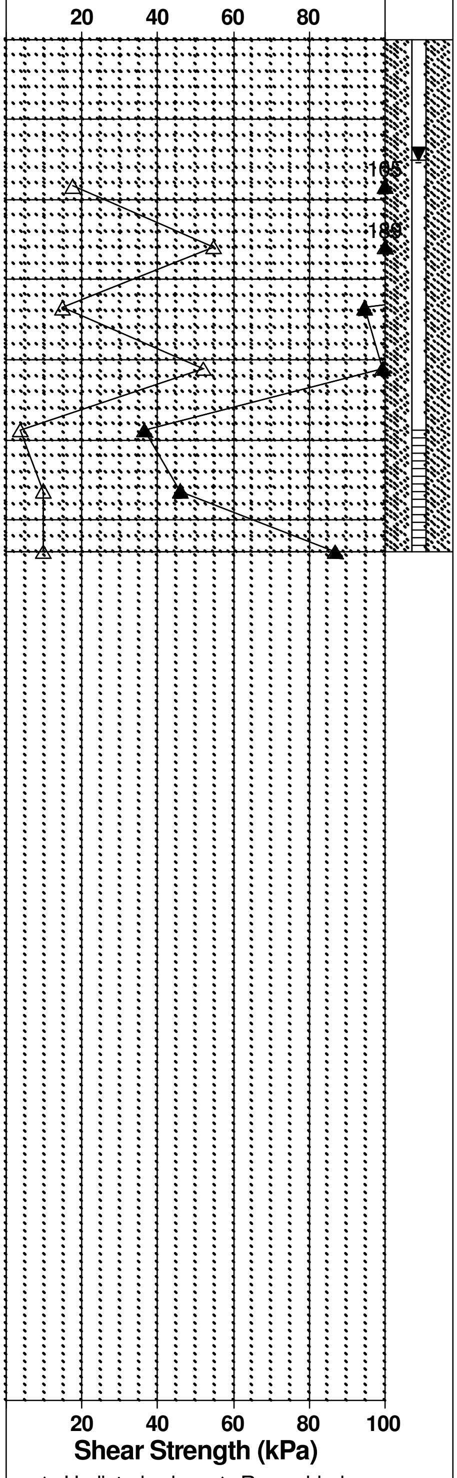
DATE 9 July 2009

SOIL DESCRIPTION	SAMPLE TYPE	NUMBER	% RECOVERY	N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE					0	101.92
TOPSOIL 0.30	AU	1				
	SS	2		4	1	100.92
					2	99.92
Very stiff to stiff, brown **SILTY CLAY** with some sand					3	98.92
- firm to stiff and grey by 3.6m depth	SS	3	92	P	4	97.92
					5	96.92
6.40					6	95.92
End of Borehole						
(GWL @ 1.50m-July 16/09)						

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

○ **Water Content %**

Piezometer Construction



Shear Strength (kPa)
▲ Undisturbed △ Remoulded

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SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Proposed Commercial Development-Hazeldean Road
Ottawa, Ontario

DATUM Ground surface elevations provided by Fairhall, Moffatt & Woodland Ltd.

FILE NO. PG1899

REMARKS

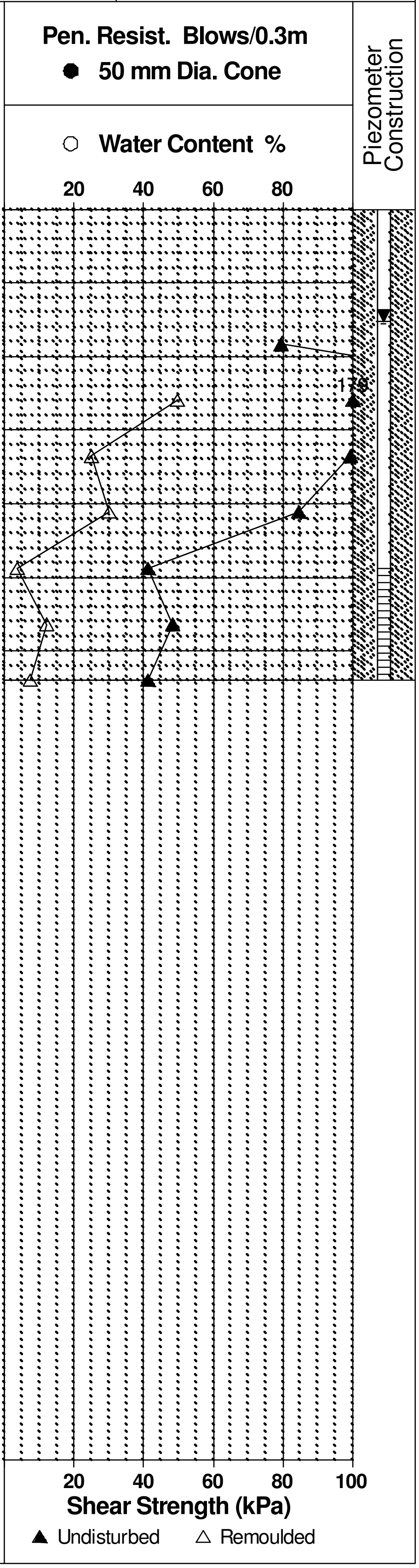
HOLE NO. BH 9

BORINGS BY CME 55 Power Auger

DATE 9 July 2009

SOIL DESCRIPTION	TYPE	NUMBER	% RECOVERY	N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE					0	101.68
TOPSOIL 0.18						
Loose, brown **SILTY SAND**, some clay 0.63	SS	1		4	1	100.68
					2	99.68
Very stiff to stiff, brown **SILTY CLAY**					3	98.68
- firm and grey by 3.6m depth					4	97.68
					5	96.68
					6	95.68
6.40	AU	2				
End of Borehole						

(GWL @ 1.52m-July 16/09)



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SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Proposed Commercial Development-Hazeldean Road
Ottawa, Ontario

DATUM Ground surface elevations provided by Fairhall, Moffatt & Woodland Ltd.

REMARKS

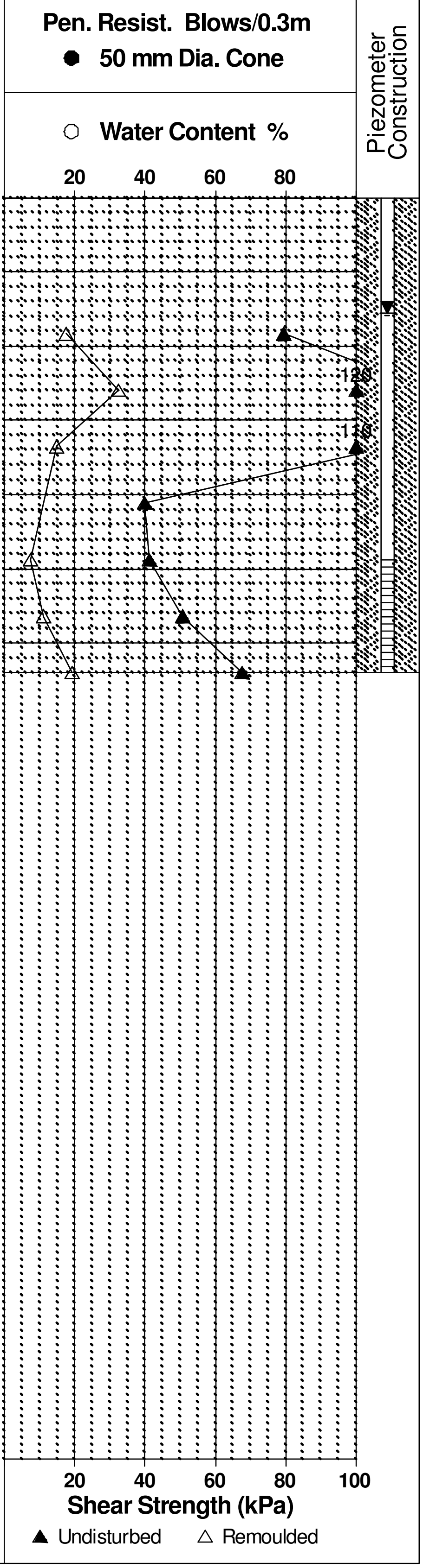
BORINGS BY CME 55 Power Auger

DATE 8 July 2009

FILE NO. PG1899

HOLE NO. BH10

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	101.54
TOPSOIL 0.20		AU	1				
Loose, brown **SANDY SILT** with clay 0.69		SS	2	92	7	1	100.54
Stiff to very stiff, brown **SILTY CLAY**							
- grey-brown by 2.0m depth						2	99.54
						3	98.54
- firm to stiff and grey by 3.8m depth						4	97.54
						5	96.54
6.40						6	95.54
End of Borehole (GWL @ 1.55m-July 16/09)							



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SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Proposed Commercial Development-Hazeldean Road
Ottawa, Ontario

DATUM Ground surface elevations provided by Fairhall, Moffatt & Woodland Ltd.

REMARKS

BORINGS BY CME 55 Power Auger

DATE 8 July 2009

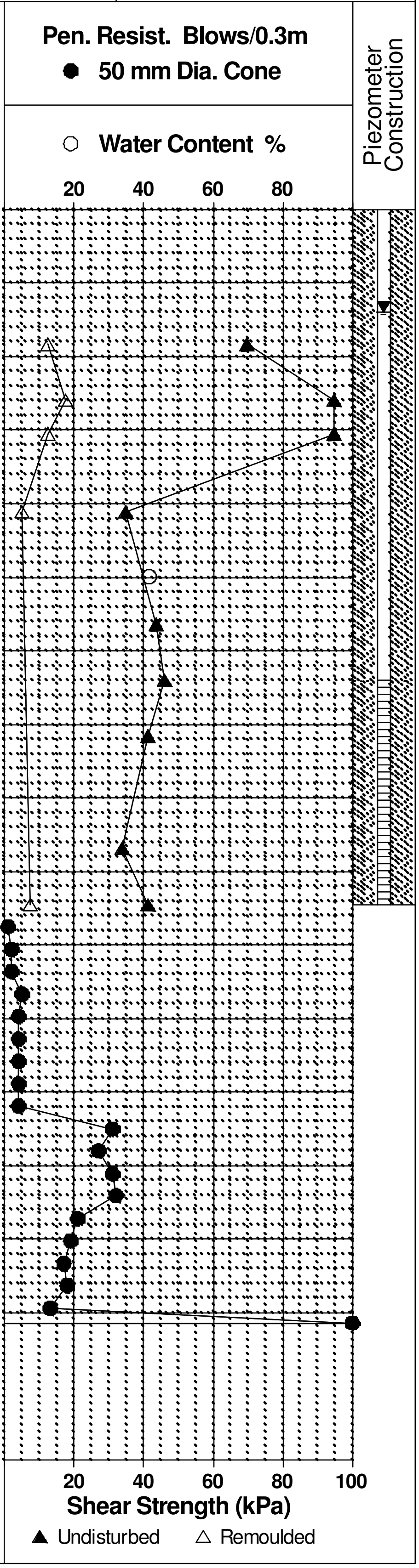
FILE NO. PG1899

HOLE NO. BH11

SOIL DESCRIPTION	Depth (m)
GROUND SURFACE	
TOPSOIL	0.20
Loose, brown **SILTY SAND** with some clay	1.45
Stiff, brown **SILTY CLAY** - grey-brown by 2.6m depth - stiff to firm and grey by 3.6m depth	9.45
Dynamic Cone Penetration Test commenced @ 9.45m depth Inferred grey **SILTY CLAY**	12.20
Inferred **GLACIAL TILL**	15.14
End of Borehole Practical refusal to DCPT @ 15.14m depth (GWL @ 1.40m-July 16/09)	

SAMPLE TYPE	NUMBER	% RECOVERY	N VALUE or RQD
SS	1	100	4
TW	2	100	
TW	3	100	

DEPTH (m)	ELEV. (m)
0	101.34
1	100.34
2	99.34
3	98.34
4	97.34
5	96.34
6	95.34
7	94.34
8	93.34
9	92.34
10	91.34
11	90.34
12	89.34
13	88.34
14	87.34
15	86.34



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SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Proposed Commercial Development-Hazeldean Road
Ottawa, Ontario

DATUM Ground surface elevations provided by Fairhall, Moffatt & Woodland Ltd.

REMARKS

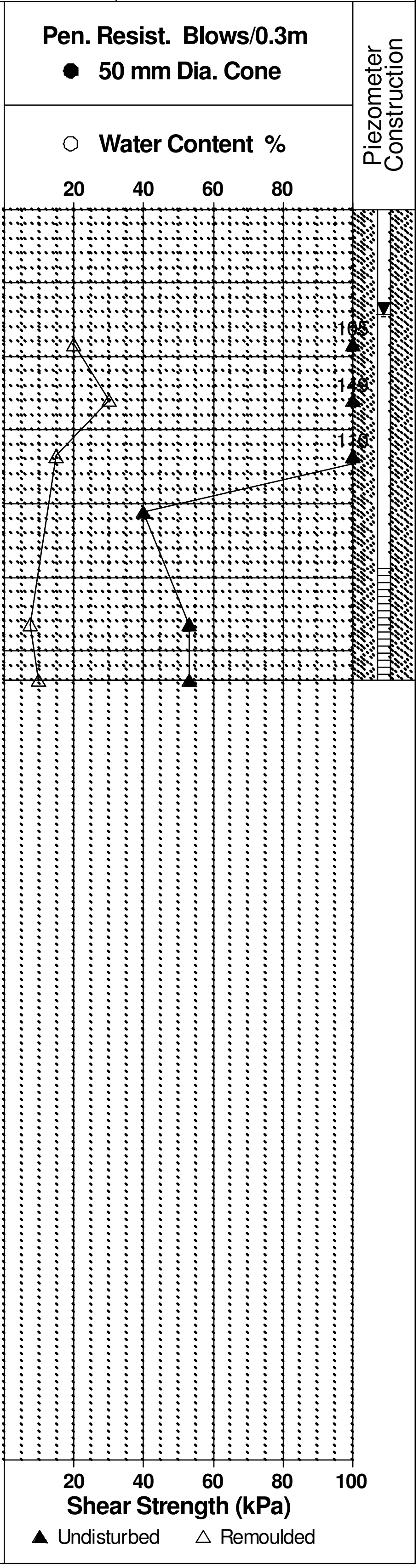
BORINGS BY CME 55 Power Auger

DATE 8 July 2009

FILE NO. PG1899

HOLE NO. BH12

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	101.15
TOPSOIL 0.25							
Loose, brown **SILTY SAND** with clay 0.69		SS	1	75	4	1	100.15
Very stiff to stiff, brown **SILTY CLAY**						2	99.15
- grey-brown by 2.5m depth						3	98.15
- firm and grey by 3.6m depth						4	97.15
		TW	2	100		5	96.15
						6	95.15
6.40		AU	3				
End of Borehole (GWL @ 1.42m-July 16/09)							



Shear Strength (kPa)

▲ Undisturbed △ Remoulded

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SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Proposed Commercial Development-Hazeldean Road
Ottawa, Ontario

DATUM Ground surface elevations provided by Fairhall, Moffatt & Woodland Ltd.

FILE NO. **PG1899**

REMARKS

HOLE NO. **BH13**

BORINGS BY CME 55 Power Auger

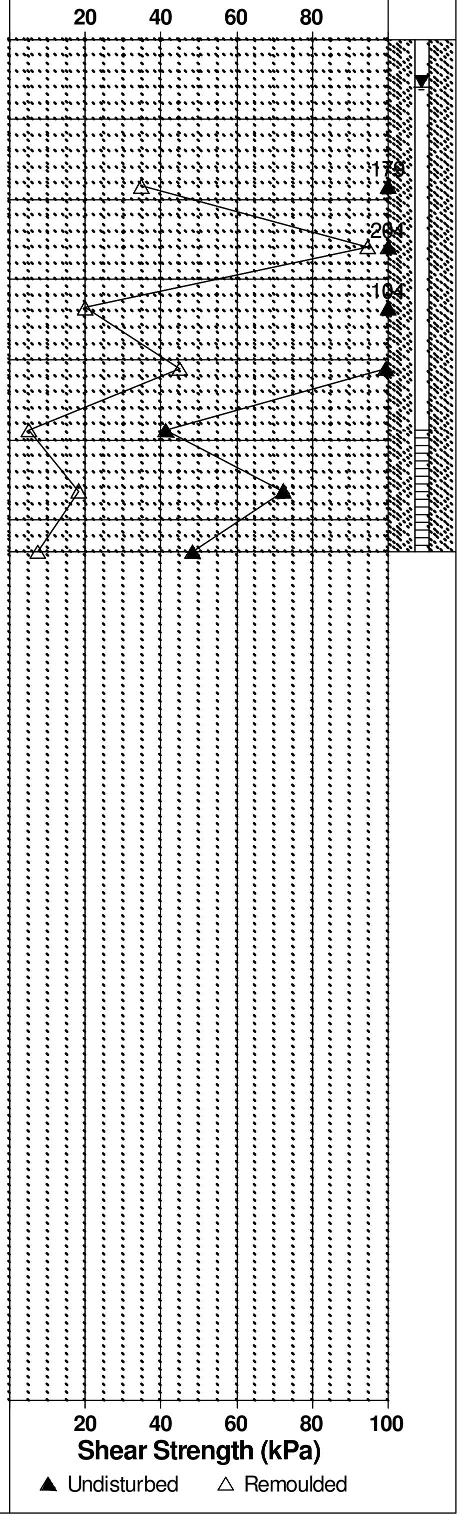
DATE 10 July 2009

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	100.95
TOPSOIL 0.23		AU	1				
Very stiff, brown **SILTY CLAY** - stiff and grey by 3.6m depth		SS	2		4	1	99.95
						2	98.95
						3	97.95
						4	96.95
						5	95.95
6.40		AU	3			6	94.95
End of Borehole (GWL @ 0.60m-July 16/09)							

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

○ **Water Content %**

Piezometer Construction



Shear Strength (kPa)

▲ Undisturbed △ Remoulded

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SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Proposed Commercial Development-Hazeldean Road
Ottawa, Ontario

DATUM Ground surface elevations provided by Fairhall, Moffatt & Woodland Ltd.

FILE NO. **PG1899**

REMARKS

HOLE NO. **BH14**

BORINGS BY CME 55 Power Auger

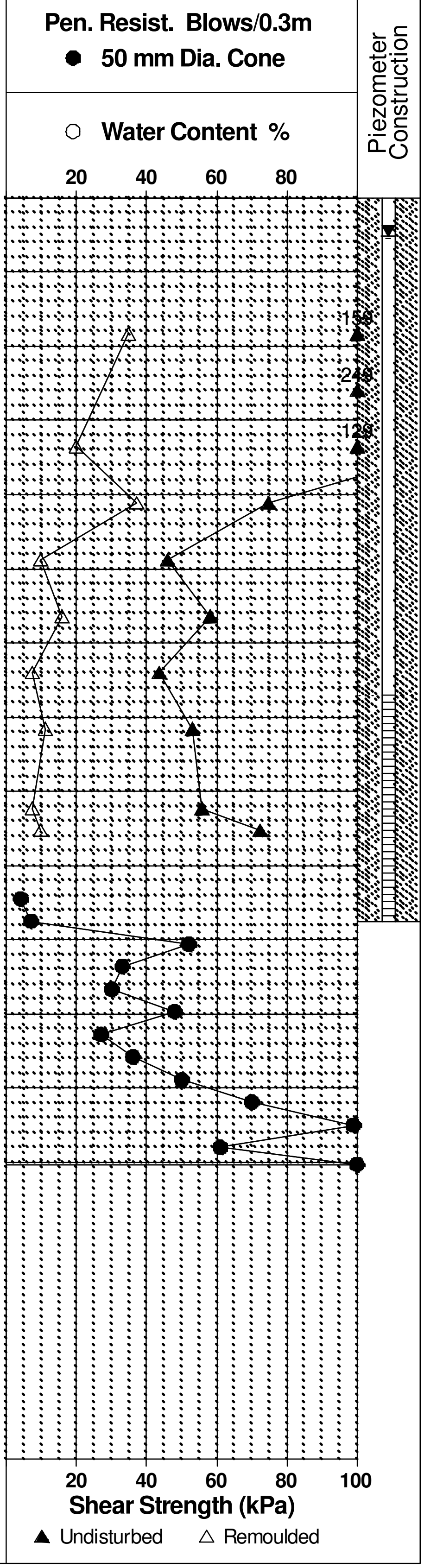
DATE 10 July 2009

SOIL DESCRIPTION		SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	100.24
TOPSOIL	0.15	AU	1				
Very loose, brown **SANDY SILT** with some topsoil	0.23	SS	2		3	1	99.24
Hard to very stiff, brown **SILTY CLAY** with some sand seams						2	98.24
						3	97.24
- grey-brown by 2.8m depth						4	96.24
- stiff and grey by 3.6m depth						5	95.24
						6	94.24
						7	93.24
						8	92.24
GLACIAL TILL: Stiff, grey silty clay with sand, gravel, cobbles and boulders	8.84 9.75	SS	3		16	9	91.24
Dynamic Cone Penetration Test commenced @ 9.75m depth						10	90.24
						11	89.24
Inferred **GLACIAL TILL**						12	88.24
	13.03					13	87.24

End of Borehole

Practical refusal to DCPT @ 13.03m depth

(GWL @ 0.52m-July 16/09)



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154 Colonnade Road South, Ottawa, Ontario K2E 7J5

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Proposed Commercial Development-Hazeldean Road
Ottawa, Ontario

DATUM Ground surface elevations provided by Fairhall, Moffatt & Woodland Ltd.

REMARKS

BORINGS BY CME 55 Power Auger **DATE** 10 July 2009

FILE NO. PG1899

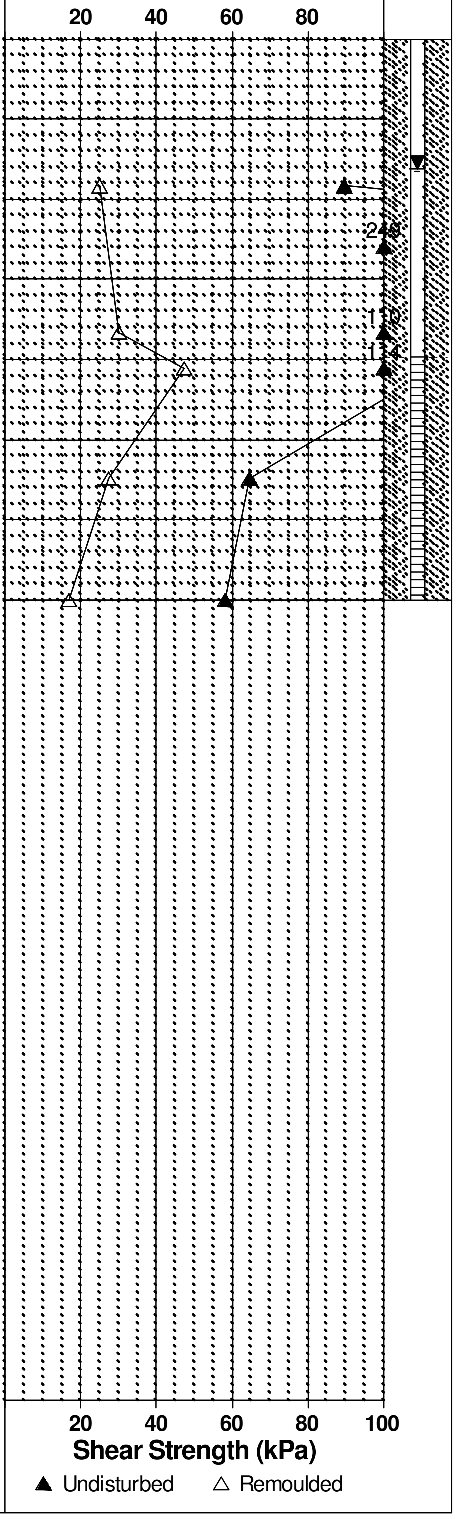
HOLE NO. BH15

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	100.76
FILL: Grey-brown silty clay with sand, gravel, cobbles and boulders 0.60		AU	1				
		SS	2		5	1	99.76
Hard to very stiff, brown **SILTY CLAY**						2	98.76
- grey-brown by 2.8m depth						3	97.76
- stiff and grey by 4.3m depth						4	96.76
		SS	3	100	2	5	95.76
		TW	4	29		6	94.76
		TW	5	67			
7.01						7	93.76
End of Borehole (GWL @ 1.61m-July 16/09)							

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

○ Water Content %

Piezometer Construction



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SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Proposed Commercial Development-Hazeldean Road
Ottawa, Ontario

DATUM Ground surface elevations provided by Fairhall, Moffatt & Woodland Ltd.

REMARKS

BORINGS BY CME 55 Power Auger

DATE 9 July 2009

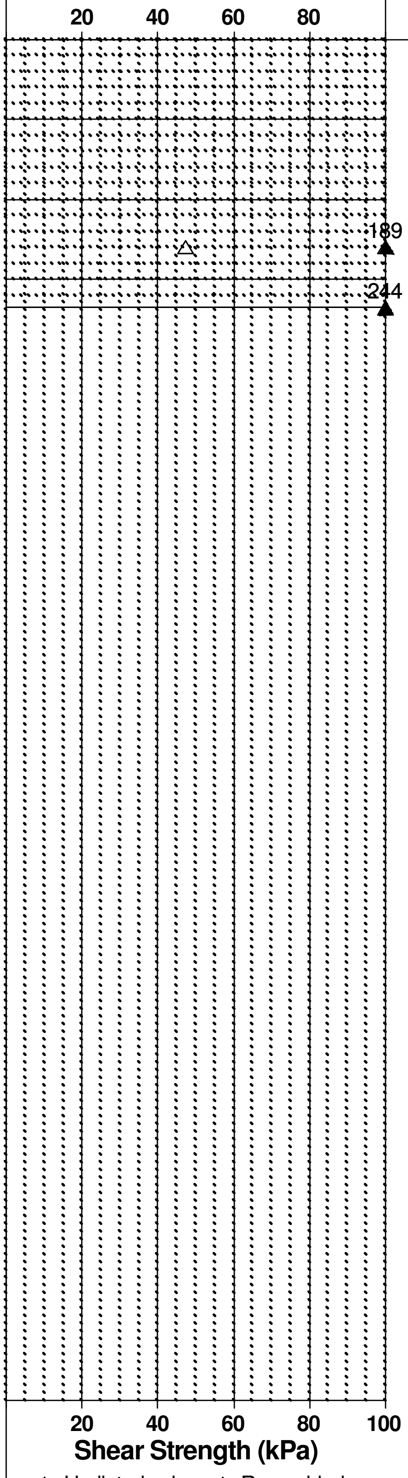
FILE NO. PG1899

HOLE NO. BH16

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	100.88
FILL: Silty sand with gravel 0.15		AU	1				
TOPSOIL 0.23							
Very stiff to hard, brown **SILTY CLAY**		SS	2	42	7	1	99.88
		SS	3	50	4	2	98.88
- grey-brown by 2.8m depth						3	97.88
3.35							
End of Borehole							

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 Development-Hazeldean Road
Ottawa, Ontario

DATUM Ground surface elevations provided by Fairhall, Moffatt & Woodland Ltd.

REMARKS

BORINGS BY CME 55 Power Auger

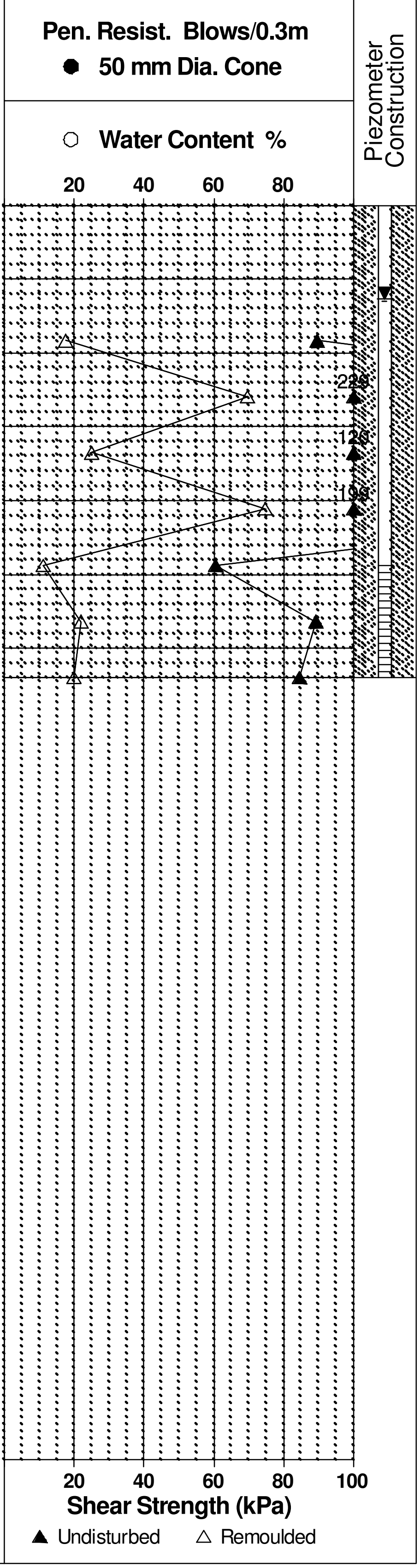
DATE 9 July 2009

FILE NO. PG1899

HOLE NO. BH17

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD
GROUND SURFACE					
FILL: Silty clay with gravel 0.08					
TOPSOIL 0.20					
		SS	1		
Hard to very stiff, brown **SILTY CLAY** with some sand seams - stiff by 4.3m depth					
		AU	2		
6.40					
End of Borehole (GWL @ 1.27m-July 16/09)					

DEPTH (m)	ELEV. (m)
0	101.55
1	100.55
2	99.55
3	98.55
4	97.55
5	96.55
6	95.55



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SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Proposed Commercial Development-Hazeldean Road
Ottawa, Ontario

DATUM Ground surface elevations provided by Fairhall, Moffatt & Woodland Ltd.

FILE NO. **PG1899**

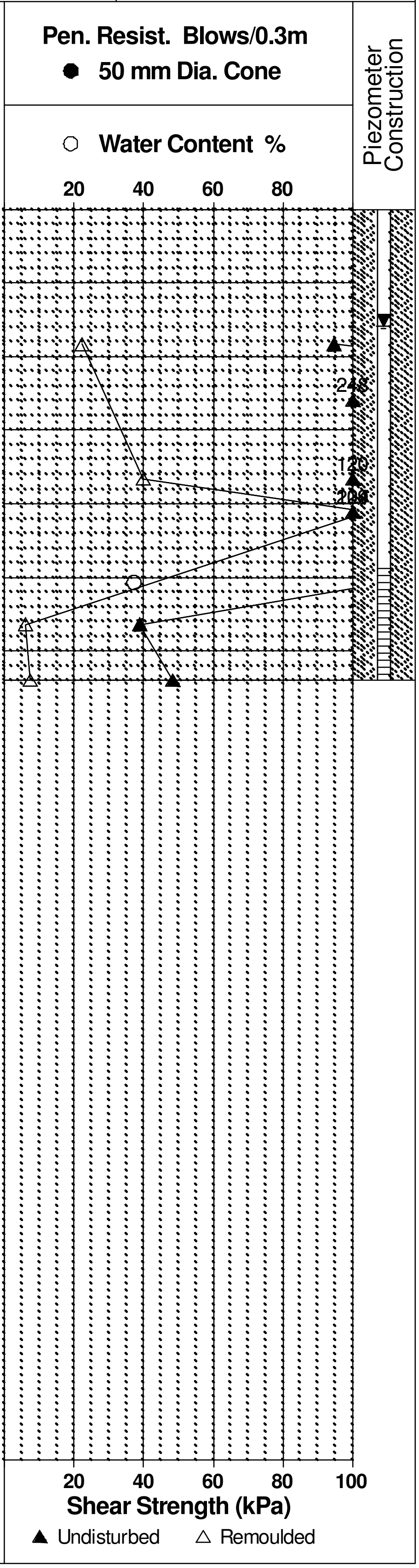
REMARKS

HOLE NO. **BH18**

BORINGS BY CME 55 Power Auger

DATE 13 July 2009

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	100.47
TOPSOIL 0.20		AU	1				
		SS	2	50	7	1	99.47
Hard to very stiff, brown **SILTY CLAY**						2	98.47
- grey-brown by 2.8m depth						3	97.47
		SS	3			4	96.47
- firm and grey by 3.7m depth		TW	4	100		5	95.47
6.40						6	94.47
End of Borehole (GWL @ 1.58m-July 16/09)							



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)

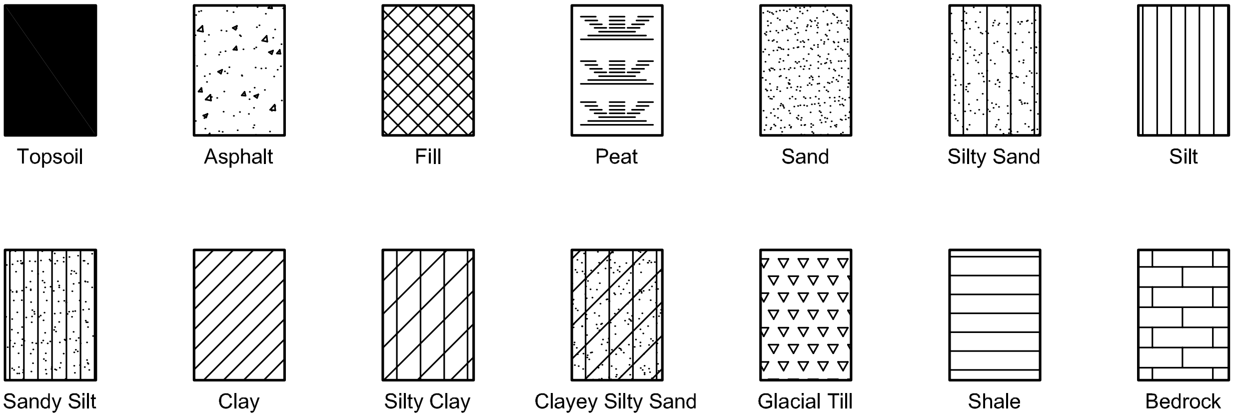
OC Ratio Overconsolidaton ratio = p'_c / p'_o
Void Ratio Initial sample void ratio = volume of voids / volume of solids
Wo - Initial water content (at start of consolidation test)

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.

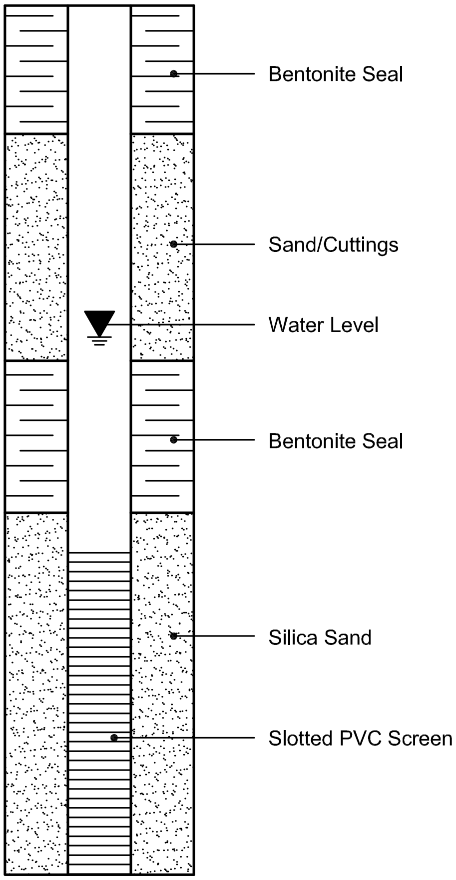
SYMBOLS AND TERMS (continued)

STRATA PLOT

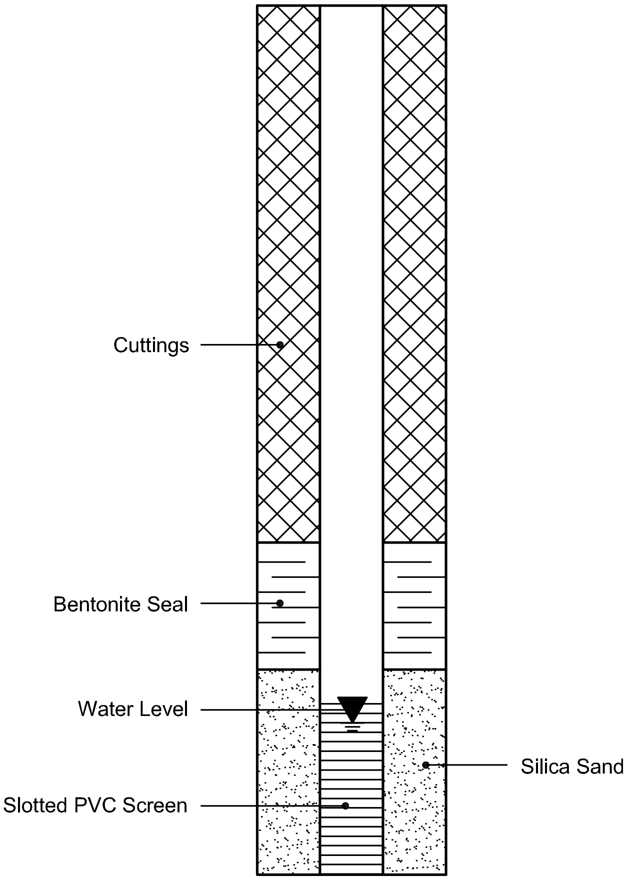


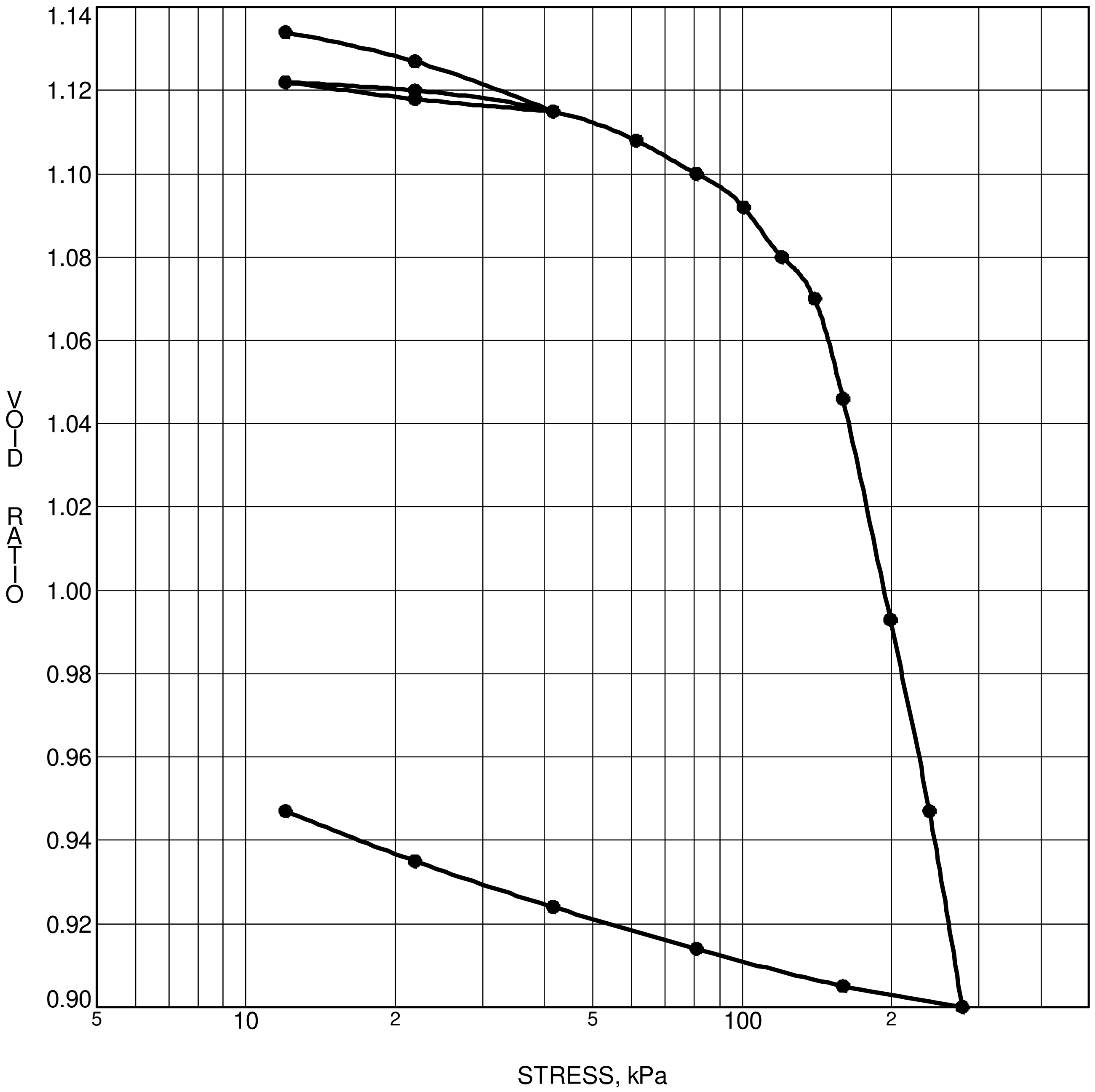
MONITORING WELL AND PIEZOMETER CONSTRUCTION

MONITORING WELL CONSTRUCTION



PIEZOMETER CONSTRUCTION





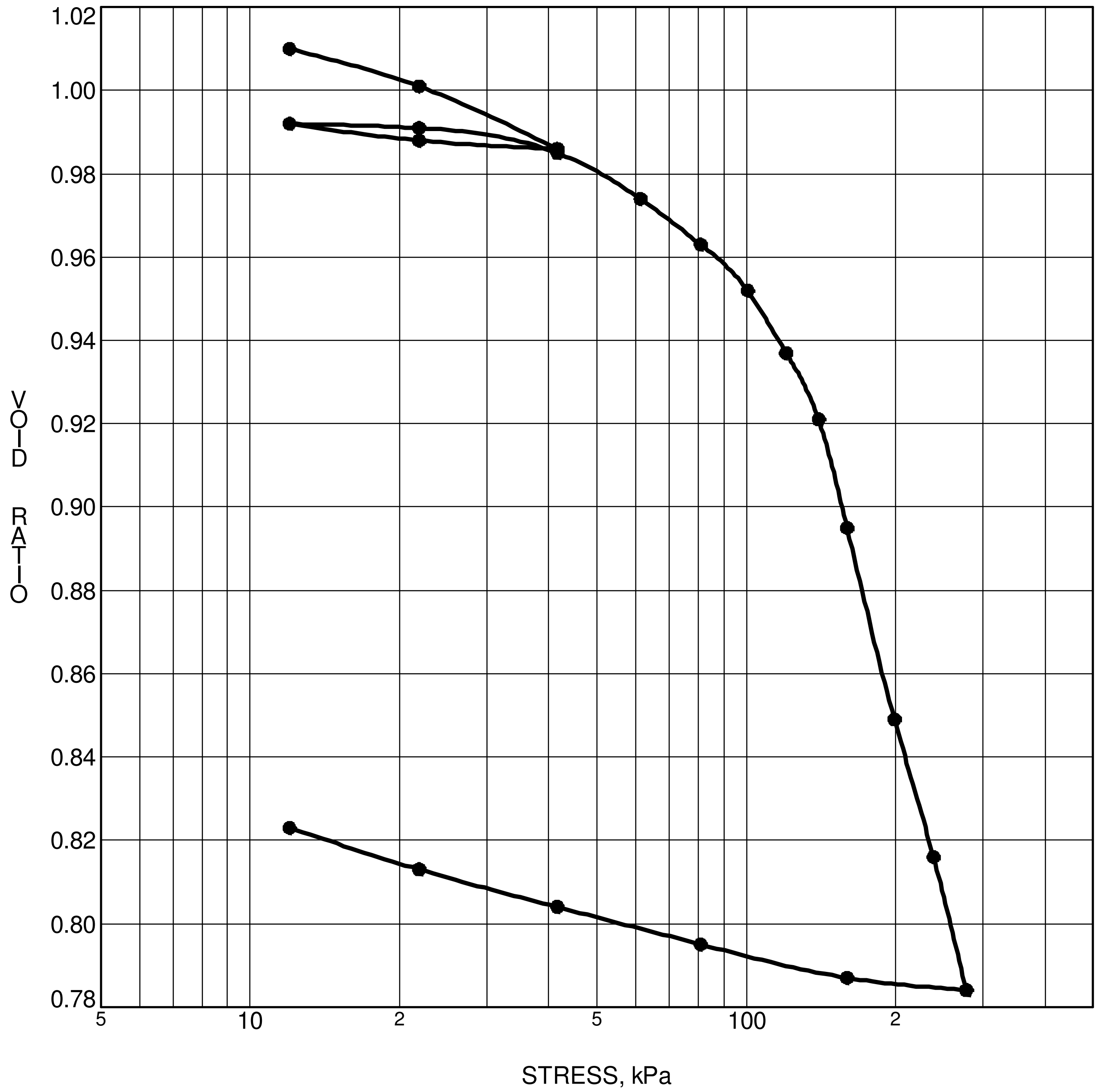
CONSOLIDATION TEST DATA SUMMARY					
Borehole No.	**BH11**	p'_o	**70** kPa	Ccr	**0.013**
Sample No.	**TW 2**	p'_c	**148** kPa	Cc	**0.674**
Sample Depth	**4.99** m	OC Ratio	**2.1**	Wo	**41.6** %
Sample Elev.	**96.35** m	Void Ratio	**1.143**	Unit Wt.	**17.7** kN/m^3

CLIENT	**Centrecorp Management Services Limited**	FILE NO.	**PG1899**
PROJECT	**Geotechnical Investigation - Proposed Commercial Development-Hazeldean Road**	DATE	**07/17/2009**

patersongroup **Consulting Engineers**

154 Colonnade Road South, Ottawa, Ontario K2E 7J5

CONSOLIDATION TEST



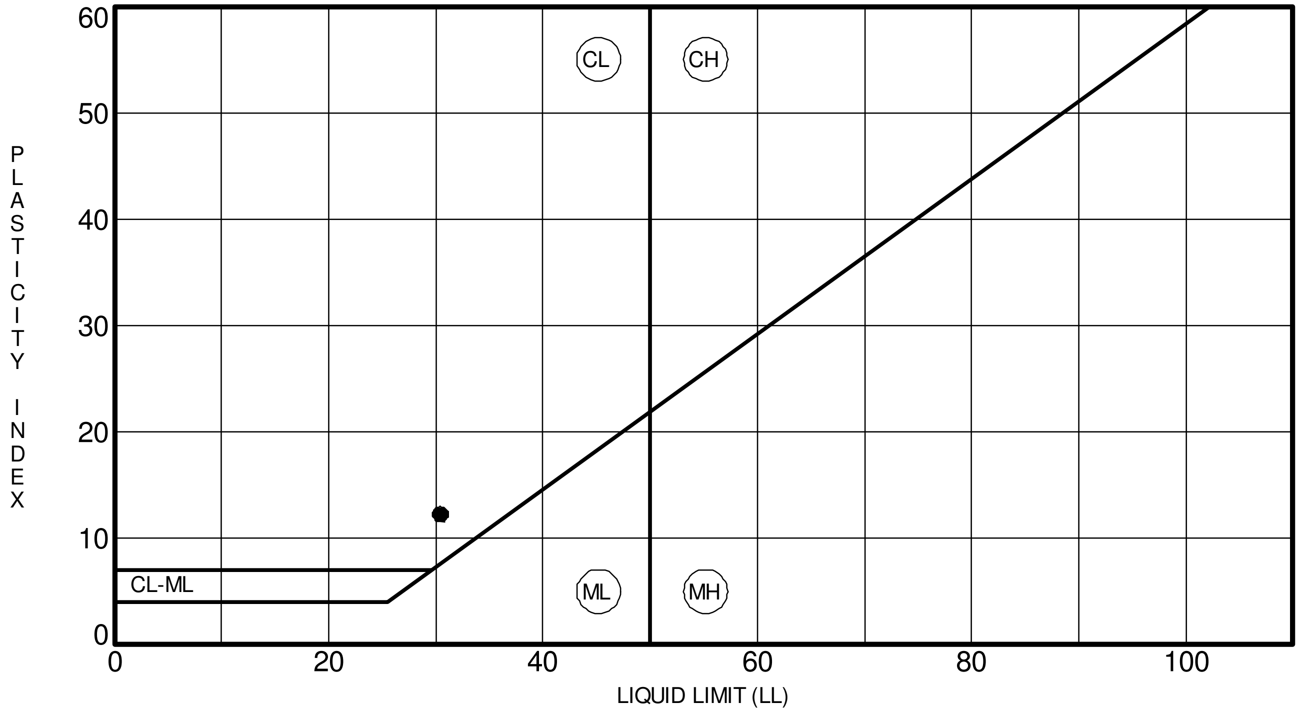
CONSOLIDATION TEST DATA SUMMARY					
Borehole No.	**BH18**	p'o	**65** kPa	Ccr	**0.013**
Sample No.	**TW 4**	p'c	**126** kPa	Cc	**0.466**
Sample Depth	**5.07** m	OC Ratio	**1.9**	Wo	**37.2** %
Sample Elev.	**95.40** m	Void Ratio	**1.024**	Unit Wt.	**18.2** kN/m 3

CLIENT	**Centrecorp Management Services Limited**	FILE NO.	**PG1899**
PROJECT	**Geotechnical Investigation - Proposed Commercial Development-Hazeldean Road**	DATE	**07/17/2009**

patersongroup **Consulting Engineers**

154 Colonnade Road South, Ottawa, Ontario K2E 7J5

CONSOLIDATION TEST



	Specimen Identification	LL	PL	PI	Fines	Classification
●	**BH11**	**30**	**18**	**12**		**CL-Inorganic clays of low plasticity (TW 2)**

CLIENT **Centrecorp Management Services Limited**

PROJECT **Geotechnical Investigation - Proposed Commercial Development-Hazeldean Road**

FILE NO. **PG1899**

DATE **8 Jul 09**

patersongroup **Consulting Engineers**

154 Colonnade Road South, Ottawa, Ontario K2E 7J5

ATTERBERG LIMITS' RESULTS

Certificate of Analysis

Client: Paterson Group Consulting Engineers

Client PO: 17631

Report Date: 16-May-2016

Order Date: 10-May-2016

Project Description: PG1899

	Client ID:	BH6-SS2	-	-	-
	Sample Date:	26-Apr-16	-	-	-
	Sample ID:	1620196-01	-	-	-
	MDL/Units	Soil	-	-	-
Physical Characteristics					
% Solids	0.1 % by Wt.	75.5	-	-	-
General Inorganics					
pH	0.05 pH Units	7.50	-	-	-
Resistivity	0.10 Ohm.m	21.8	-	-	-
Anions					
Chloride	5 ug/g dry	66	-	-	-
Sulphate	5 ug/g dry	251	-	-	-

APPENDIX 2

FIGURE 1 - KEY PLAN

DRAWING PG1899-2 - TEST HOLE LOCATION PLAN

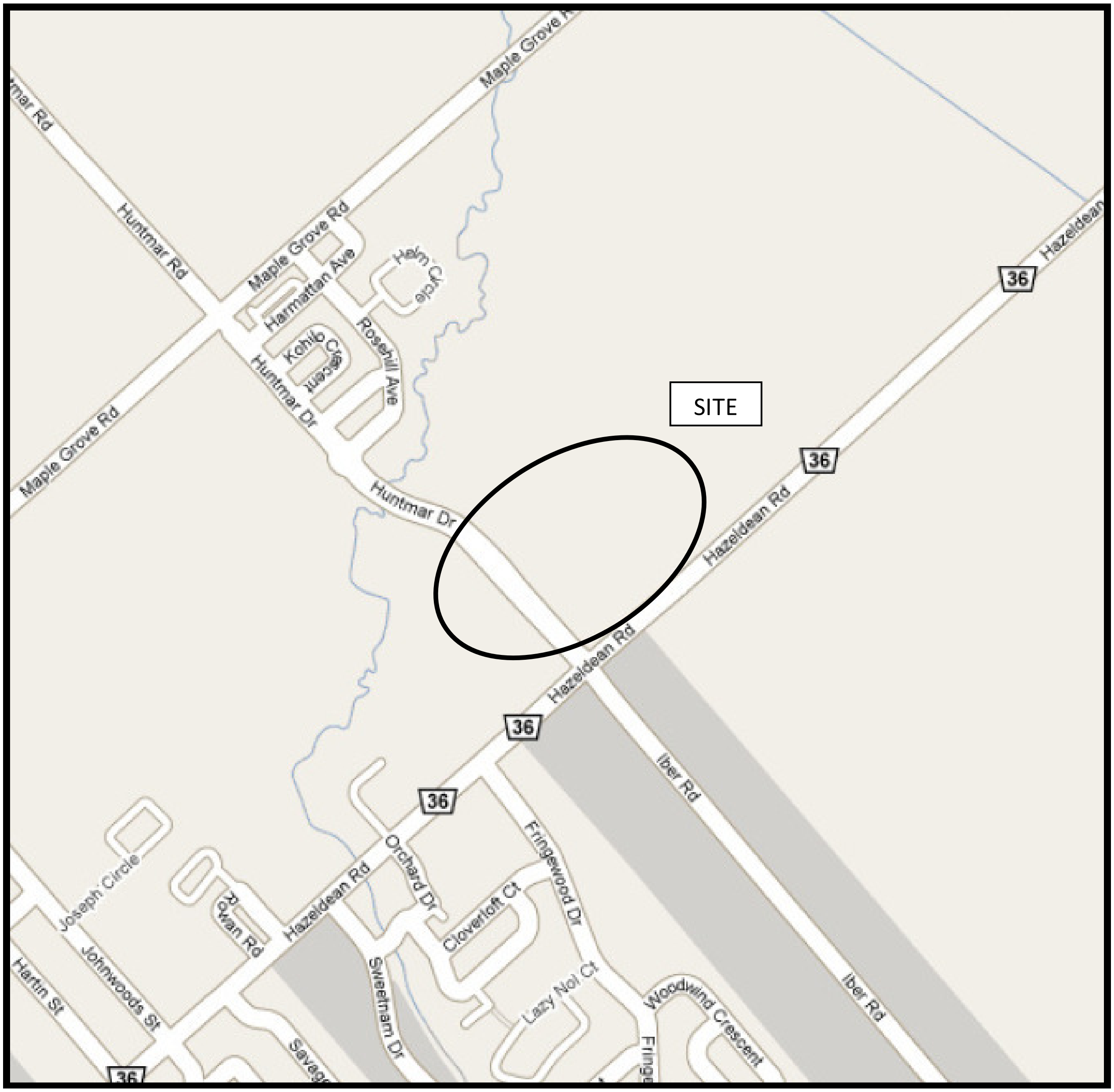
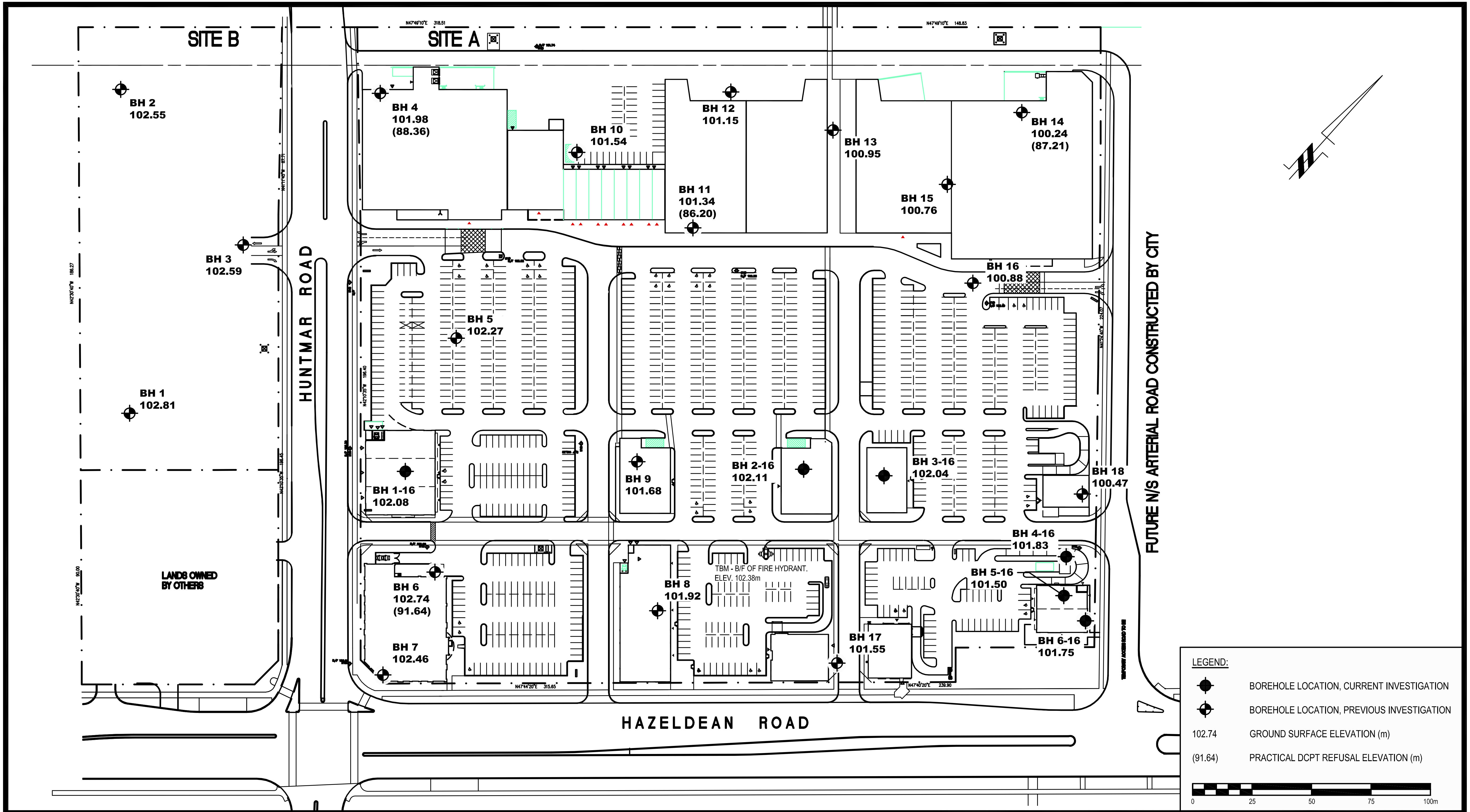


FIGURE 1

KEY PLAN



patersongroup
consulting engineers

154 Colonnade Road South
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Tel: (613) 226-7381 Fax: (613) 226-6344

NO.	REVISIONS	DATE	INITIAL
0			

NORTH AMERICAN (GOULBOURNE) LIMITED PARTNERSHIP
GEOTECHNICAL INVESTIGATION
PROP. COMMERICAL DEVELOPMENT - HAZELDEAN ROAD
OTTAWA, ONTARIO

Title:
TEST HOLE LOCATION PLAN

Scale: 1:1500
Date: 05/2016
Drawn by: MPG
Report No.: PG1899
Checked by: FA
Dwg. No.: PG1899-2
Approved by: DJG
Revision No.: 0

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