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Geotechnical Investigation

Proposed Residential Development
3387 Borrisokane Road
Ottawa

Prepared For

Glenview Homes (Cedarview) Ltd.

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Report: PG3621-1 Revision 5

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Appendices

1.0 Introduction

Paterson Group (Paterson) was commissioned by Glenview Homes (Cedarview) Ltd. (Glenview) to conduct a geotechnical investigation for the proposed residential development to be located at 3387 Borrisokane Road (formerly Cedarview Road), in the City of Ottawa (refer to Figure 1 - Key Plan presented in Appendix 2).

The objective of the investigation was to:

❑ determine the subsoil and groundwater conditions at this site by means of boreholes and test pits.

❑ provide geotechnical recommendations for the design of the proposed development including construction considerations which may affect its design.

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

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

2.0 Proposed Development

It is understood that the proposed development will consist of residential housing along associated driveways, local roadways and park areas. Also, a school site, neighbourhood commercial buildings and a stormwater management pond are to be constructed within the subject site.

3.0 Method of Investigation

3.1 Field Investigation

Field Program

The field program for the original geotechnical investigation was carried out between April 5 to 9, 2011. At that time, nine (9) boreholes were drilled to a maximum depth of 10 m to provide general coverage across the subject site.

A supplemental geotechnical investigation was completed on September 24, 2015. At that time, seven (7) test pits were excavated to depths ranging from 3.1 to 3.5 m. The locations of the boreholes and test pits are shown on Drawing PG3621-1 - Test Hole Location Plan included in Appendix 2.

The boreholes were put down using a track-mounted auger drill rig operated by a two person crew and the test pits were excavated using a rubber-tired backhoe. 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 and 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 from the auger flights. Grab samples (G) were also collected from the sidewalls of the test pits. 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, auger samples and grab samples were recovered from the test holes are shown as SS, TW, AU and G, 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

Flexible standpipes were installed in all boreholes to permit monitoring of the groundwater levels subsequent to the completion of the sampling program. Groundwater infiltration levels were noted during the open excavation of the test pits.

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 borehole and test pit locations were selected by Paterson personnel to provide general coverage of the site. The locations of the boreholes and test pits were determined in the field by Paterson personnel using a hand-held GPS unit. The ground surface elevations at the test pit and borehole locations were interpolated based on topographic survey mapping prepared by Annis O’Sullivan Vollebekk in December 2015.

The location of the test holes and ground surface elevations at the test hole locations are presented on Drawing PG3621-1 - Test Hole Location Plan, included in Appendix 2.

3.3 Laboratory Testing

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

Six (6) Shelby tube samples were submitted for unidimensional consolidation and two (2) samples for Atterberg limits testing.

The results of the consolidation testing are presented on the Consolidation Test sheets presented in Appendix 1 and are further discussed in Sections 4 and 5.

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 sample. The results are presented in Appendix 1 and are discussed further in Subsection 6.8.

4.0 Observations

4.1 Surface Conditions

At the time of the geotechnical investigation, the subject site consisted of agricultural land bordered to the south and east by a drainage ditch and a thin tree line followed by former agricultural land. The site is bordered to the north by vacant land (to the north of which is the Jock River) and to the west by Borrisokane Road followed by agricultural land. The general topography of the subject site is relatively flat, and slopes gradually downward towards the Jock River located to the north of the subject site.

At the time of issuance of this report, a settlement surcharge program is underway within the northeast portion of the site. The outline of the current surcharge program is presented in Drawing PG3621-2 - Settlement Plate Location Plan and Drawing PG3621-3 - Permissible Grade Raise Plan in Appendix 2. The ground surface within this area has been raised to be well above the proposed finished grades as part of the surcharge program. Also, fill is currently being imported to the southeast portion of the site to raise the ground surface to pregrade elevation and upon completion of the surcharge program for the northeast area, fill from the northeast area surcharge program will be moved to the southeast area to achieve the design surcharge fill elevation and begin the settlement surcharge program for this area.

4.2 Subsurface Profile

Generally, the subsoil profile encountered at the test hole locations consists of a topsoil/organic cultivated layer followed by a silty sand layer overlying a sensitive silty clay deposit. Reference should be made to the Soil Profile and Test Data sheets in Appendix 1 for specific details of the soil profiles encountered at each test hole location. Also, the approximate interface between the weathered brown silty clay crust and the saturated grey silty clay deposit has been identified on the Soil Profile and Test Data sheets.

Based on available geological mapping, the bedrock in this area mostly consists of dolomite of the Oxford formation with an overburden drift thickness of 10 to 25 m depth.

Silty Clay

A total of six (6) samples of silty clay were subjected to unidimensional consolidation (oedometer) testing. The test results are presented in Subsection 5.3 and on 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 1.6 and 2.3. 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.

Two (2) silty clay samples were submitted for Atterberg Limits testing. The tested material was classified as Inorganic Clays of Low to Medium 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 8 - TW 3	19.6	29	20	10	CL
BH 9 - TW 3	21.7	29	22	8	CL

4.3 Groundwater

The observed groundwater infiltration levels in the test pits are presented in Table 2. The groundwater level readings within the piezometers at the borehole locations are presented in the Soil Profile and Test Data sheets in Appendix 1. It is important to note that groundwater level readings could be influenced by surface water infiltrating the backfilled borehole. The long-term groundwater table can also be estimated based on the observed colour and consistency of the recovered soil samples. Based on these observations, it is estimated that the long-term groundwater level can be expected between 2 to 2.5 m depth and varies between 89.9 to 90.7 m elevation across the site. The long-term groundwater levels at the test hole locations have been identified on the Soil Profile and Test Data Sheets in Appendix 1. It should be noted that groundwater levels are subject to seasonal fluctuations, however the long-term groundwater levels identified on the Soil Profile and Test Data Sheets took into consideration the seasonal fluctuations.

Table 2 - Summary of Groundwater Level Observations

Borehole Number	Measured Groundwater Level	Observation Date
	Depth (m)	
TP1	1.70	September 24, 2015
TP2	1.90	September 24, 2015
TP3	2.00	September 24, 2015
TP4	1.80	September 24, 2015
TP5	2.00	September 24, 2015
TP6	1.50	September 24, 2015
TP 7	2.00	September 24, 2015

5.0 Discussion

5.1 Geotechnical Assessment

From a geotechnical perspective, the subject site is satisfactory for the proposed residential development. Due to the presence of the sensitive silty clay layer, the proposed development will be subjected to grade raise restrictions.

Permissible grade raise recommendations are discussed in Subsection 5.3 and permissible grade raise areas are presented in Drawing PG3621-3 - Permissible Grade Raise Plan in Appendix 2. 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.

Based on the current preliminary grading information, a settlement surcharge program has been designed to permit conventional housing construction without use of lightweight fill around the subject buildings. If the proposed grading design is altered, it is recommended that Paterson review the surcharge program to ensure that the current program is still sufficient.

Settlement Surcharge Program

The subject site has been sub-divided into three areas (Phase 1, Phase 2 and Phase 3) as part of a staged surcharge program designed due to the permissible grade raise exceedances across the site. The areas are outlined in Drawing PG3621-2-Settlement Plate Location Plan in Appendix 2. Also, details of the surcharge program are presented below.

- ❏ The phase 1 surcharge loading has recently been completed as of July 2016 and settlement monitoring is currently ongoing. The pre-grade elevation is approximately 93.0 m and the elevation of the top of the surcharge pile is approximately 95.5 m.
- ❏ Select subgrade material is currently being imported to phase 2 to bring the area up to the pre-grade elevation of approximately 93.0 m. Once the pre-grade elevation has been achieved and approved by Paterson, an additional 3.2 m of surcharge will be placed up to the elevation of approximately 96.2 m. Once the surcharge pile construction has been completed, periodic settlement survey monitoring will commence.
- ❏ Construction of the settlement surcharge pile within phase 3 has not commenced at this time.

5.2 Site Grading and Preparation

Stripping Depth

Topsoil and deleterious fill, such as those containing organic materials, should be stripped from under any buildings, paved areas, pipe bedding and other settlement sensitive structures.

Fill Placement

Fill used for grading beneath the building areas should consist, unless otherwise specified, of clean imported granular fill, such as Ontario Provincial Standard Specifications (OPSS) Granular A or Granular B Type II. This material should be tested and approved prior to delivery to the site. The fill should be placed in lifts no greater than 300 mm thick and compacted using suitable compaction equipment for the lift thickness. Fill placed beneath the building 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 and beneath parking areas where settlement of the ground surface is of minor concern. In landscaped areas, 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

Based on the results of the geotechnical investigation, lightly loaded structures, such as the anticipated residential buildings could be founded on shallow footings bearing a compact silty sand, stiff brown silty clay or engineered fill. It is anticipated that the proposed school and commercial buildings of slab-on-grade construction can also be constructed over conventional shallow footings.

Bearing Resistance Values

Using continuously applied loads, strip footings, up to 2.5 m wide, and pad footings, up to 4 m wide, placed on an undisturbed, stiff silty clay or compact silty sand bearing surface can be designed using a bearing resistance value at serviceability limit states (SLS) for **75 kPa** and a factored bearing resistance value at ultimate limit states (ULS) of **150 kPa**. Footings placed on an engineered fill bearing surface approved by the geotechnical consultant can be designed using a bearing resistance value at SLS of **100 kPa** and a factored bearing resistance value at ULS of **200 kPa**. A geotechnical resistance factor of 0.5 was applied to the bearing resistance value at ULS. As previously noted in Subsection 5.2, consideration of the impact on recommendations for LWF for the proposed buildings due to the increased loads from engineered fill will be reviewed by Paterson on a lot by lot basis at the time of construction.

The above noted bearing resistance values should be considered applicable for footings placed on engineered fill as described below. Where proposed underside of footing elevations are above native soils, footings can be placed on engineered fill, consisting of an OPSS Granular A or Granular B Type II materials compacted to 98% of its SPMDD and placed in maximum 300 mm loose lifts. Alternatively, footings can be placed on a 5 MPa lean concrete in-filled trench, which extends to an undisturbed, native soil bearing surface. The trench should extend a minimum of 150 mm beyond the face of the footings.

The bearing resistance values are provided on the assumption that the footings will be placed on undisturbed soil bearing surfaces. An undisturbed soil bearing surface consists of one 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.

Lateral Support

The bearing medium is required to be provided with adequate lateral support with respect to excavations and different foundation levels. Adequate lateral support is provided to a bearing medium when a plane extending down and out from the bottom edge of the foundation at a minimum of 1.5H:1V, passes only through in situ soil, engineered fill or concrete, of the same or higher capacity as the soil.

Settlement/Grade Raise

Consideration must also 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. For dwellings, a minimum value of 50% of the live load is often recommended by Paterson.

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. Six (6) site specific consolidation tests were carried out for this project. The results of the consolidation tests are presented in Table 3 and in Appendix 1.

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.

Table 3 - Summary of Consolidation Test Results

Borehole No.	Sample	Depth (m)	p'_c (kPa)	p'_o (kPa)	C_{cr}	C_c	Q (*)
BH 4	TW 7	4.87	80	50	0.024	0.338	A
BH 5	TW 3	4.38	85	46	0.020	0.795	G
BH 6	TW 3	5.92	88	57	0.017	1.185	A
BH 7	TW 4	4.3	70	43	0.017	1.061	G
BH 8	TW 3	3.43	81	36	0.017	0.973	G
BH 9	TW 3	5.93	111	51	0.021	1.130	G

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

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 at 0.5 m below the existing groundwater table. The level of the groundwater table is based on the colour and undrained shear strength profile of the silty clay.

The total and differential settlements will be dependent of the characteristics of the buildings. For design purposes, the total and differential settlements are estimated to be 25 and 20 mm, respectively. A post-development groundwater lowering of 0.5 m was assumed.

The potential post construction total and differential settlements are dependent on the position of the long term groundwater level when building over deposits of compressible silty clay. While efforts can be made to reduce the impacts of the development on the long term level of the groundwater by placing clay dykes in the service trenches, reducing the sizes of paved areas, leaving green spaces to allow for groundwater recharge, limiting planting of trees to areas away from the buildings, it is not economically possible to control the level of the groundwater.

To reduce potential long term liabilities, consideration should be given to accounting for a larger groundwater lowering and to provide means to reduce long term groundwater lowering (e.g. clay dykes, restriction on planting around the dwellings, 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.

Permissible grade raise areas are presented in Drawing PG3621-3 - Permissible Grade Raise Plan in Appendix 2.

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

- ❑ preloading and surcharging
- ❑ lightweight fill (LWF)

Bearing resistance values for footing designs should be determined on a lot per lot basis at the time of construction.

5.4 Design for Earthquakes

The site class for seismic site response can be taken as **Class E** for the foundations considered at this site. The soils underlying the proposed shallow foundations are not susceptible to liquefaction for the local seismicity. Reference should be made to the latest revision of the 2012 Ontario Building Code for a full discussion of the earthquake design requirements.

5.5 Basement Slab

With the removal of all topsoil and deleterious fill, containing organic matter within the footprints of the proposed buildings, the undisturbed native soil or approved engineered fill 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. 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-slab fill consist of 19 mm clear crushed stone.

5.6 Pavement Structure

For design purposes, the pavement structure presented in the following tables could be used for the design of car parking areas and access lanes/local residential streets and minor collectors.

Table 4 - Recommended Pavement Structure - Car Parking Areas

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

Table 5 - Recommended Pavement Structure - Local Residential Roadways

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

Table 6 - Recommended Pavement Structure - Minor Collector with Bus Traffic

Thickness mm	Material Description	Traffic Category
40	**Wear Course -** Superpave 12.5 Asphaltic Concrete	D
50	**Binder Course** - Superpave 19.0 Asphaltic Concrete	
50	**Binder Course** - Superpave 19.0 Asphaltic Concrete	
150	**BASE** - OPSS Granular A Crushed Stone	
600	**SUBBASE** - OPSS Granular B Type II	
	SUBGRADE - Either in situ soil or OPSS Granular B Type II material placed over in situ soil	

Minimum Performance Graded (PG) 58-34 asphalt cement should be used for this project. For minor collectors, Minimum Performance Graded (PG) 64-34 asphalt cement is recommended for the wear course layer.

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. This may require the use of a geotextile, thicker subbase or other measures that can be recommended at the time of construction as part of the field observation program.

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.

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 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 proposed structures. 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 or direct the collected water to the building sump pit, which should be connected 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 re-use as backfill unless a composite drainage system (such as system Platon or Miradrain G100N) connected to a drainage system is provided.

6.2 Protection Against Frost Action

Perimeter footings of heated structures are required to be insulated against the deleterious effect of frost action. A minimum 1.5 m thick soil cover (or equivalent) 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. The recommended minimum thickness of soil cover is 2.1 m (or equivalent).

6.3 Excavation Side Slopes

Excavations for the proposed development will be mostly through sandy silt and/or clayey silt/silty clay. Above the groundwater level, for excavations to depths of approximately 3 m, the excavation side slopes should be stable in the short term at 1H:1V. Flatter slopes could be required for deeper excavations or for excavation below the groundwater level. Where such side slopes are not permissible or practical, temporary shoring should be used. The subsoil at this site is considered to be mainly a Type 2 and 3 soil according to the Occupational Health and Safety Act and Regulations for Construction Projects.

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

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

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

6.4 Pipe Bedding and Backfill

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

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 as directed by the geotechnical consultant at the time of construction. 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 extend at least to the spring line of the pipe.

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

Construction Phase

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

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

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

Groundwater Control Using Sump Pits

It is understood that the proposed residential buildings within the subject site will include a basement level and sump pit and pump installed below the basement slab to provide an outlet for any storm water or spring melt water collected from the perimeter foundation drainage system. Based on our observations of the recovered soil samples from the borehole locations, the long-term groundwater level varies between 89.9 to 90.7 m elevation across the site. Refer to the Soil Profile and Test Data Sheets in Appendix 1 for the long-term groundwater level at the specific test hole locations. It is recommended that the design underside of footing elevation be placed at least 0.3 m above the long-term groundwater level to ensure adequate separation between the design underside of footing elevation. It is anticipated that the subject site is suitable for a development, which includes the use of sump pumps, from a geotechnical perspective provided the above noted separation distance is adhered to.

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 Landscaping and Outdoor Structure Considerations

Tree Planting Restrictions

The proposed residential dwellings are located in a moderate to high sensitivity area with respect to tree plantings over a silty clay deposit. It is recommended that trees placed within 4.5 m of the foundation wall consist of low water demanding trees with shallow roots systems that extend less than 1.5 m below ground surface. Trees placed greater than 4.5 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, they should not be considered in the landscaping design.

Swimming Pools

The in-situ soils are considered to be acceptable for swimming pools. Above ground swimming pools must be placed at least 4 m away from the residence foundation and neighbouring foundations. Otherwise, pool construction is considered routine, and can be constructed in accordance with the manufacturer`s requirements.

Aboveground Hot Tubs

If consideration is given to construction of an aboveground hot tub, a geotechnical consultant should be retained by the homeowner to review the site conditions. Additional grading around the hot tub should not exceed permissible grade raises. Otherwise, hot tub construction is considered routine, and can be constructed in accordance with the manufacturer’s specifications.

Installation of Decks or Additions

If consideration is given to construction of a deck or addition, a geotechnical consultant should be retained by the homeowner to review the site conditions. Additional grading around proposed deck or addition should not exceed permissible grade raises. Otherwise, standard construction practices are considered acceptable.

6.8 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
	TP5-GR5		
Chloride	8 µg/g	Chloride content less than 400 mg/g	Negligible concern
pH	7.55	pH value less than 5.0	Neutral Soil
Resistivity	62.5 ohm.m	Resistivity greater than 1,500 ohm.cm	Low to Moderate Corrosion Potential
Sulphate	17 µg/g	Sulphate value greater than 1 mg/g	Negligible Concern

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 placing backfilling materials.

☐ 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. We request that we be permitted to review the grading plan once available and our recommendations when the drawings and specifications are complete.

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. The extent of the limited area depends on the soil, bedrock and groundwater conditions, as well the history of the site reflecting natural, construction, and other activities. 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 Glenview Homes (Cedarview) Ltd. 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.

LICENSED PROFESSIONAL ENGINEER
May 1-2017
D. J. GILBERT
100116130
PROVINCE OF ONTARIO

David J. Gilbert, P.Eng.

Carlos P. Da Silva, P.Eng.

Report Distribution:

☐ Glenview Homes (Cedarview) Ltd. (3 copies)
☐ Paterson Group (1 copy)

APPENDIX 1

SOIL PROFILE AND TEST DATA SHEETS

SYMBOLS AND TERMS

UNIDIMENSIONAL CONSOLIDATION TEST RESULTS

ATTERBERG LIMITS' RESULTS

ANALYTICAL TESTING RESULTS

patersongroup Consulting Engineers

154 Colonnade Road South, Ottawa, Ontario K2E 7J5

SOIL PROFILE AND TEST DATA

Preliminary Geotechnical Investigation
Proposed Residential Development - Cedarview Road
Ottawa, Ontario

DATUM Ground surface elevations based on Annis, O'Sullivan, Vollebekk Ltd. topographic survey plan (12/2015).

REMARKS

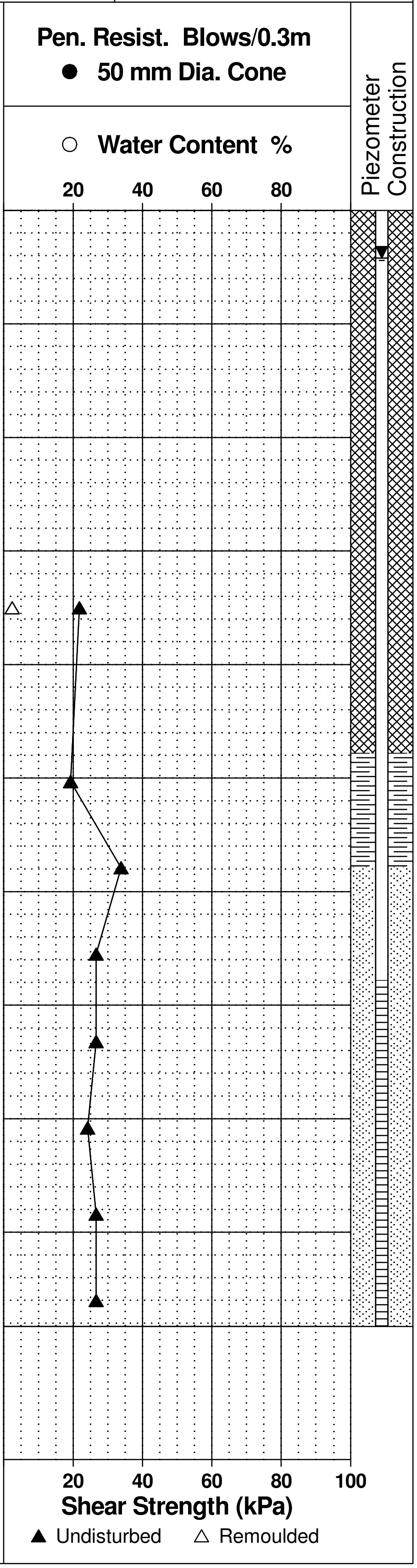
BORINGS BY CME 55 Power Auger

DATE April 5, 2011

FILE NO. PG1604

HOLE NO. BH 1

SOIL DESCRIPTION		TYPE	NUMBER	% RECOVERY	N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	91.80
TOPSOIL	0.30						
Loose, brown **SILTY SAND,** trace clay		SS	1	67	7	1	90.80
Long-term Groundwater Level	1.45						90.10
Firm, brown **SILTY CLAY,** trace sand	2.21	SS	2	100	0	2	89.80
Interface between weathered silty clay crust and saturated grey silty clay		SS	3	100	0		89.60
						3	88.80
		TW	4	100		4	87.80
						5	86.80
Soft to firm, grey **SILTY CLAY**						6	85.80
						7	84.80
						8	83.80
						9	82.80
	9.83						
End of Borehole (GWL @ 0.42m-Apr. 25/11)							



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Ottawa, Ontario

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REMARKS

BORINGS BY CME 55 Power Auger

DATE April 5, 2011

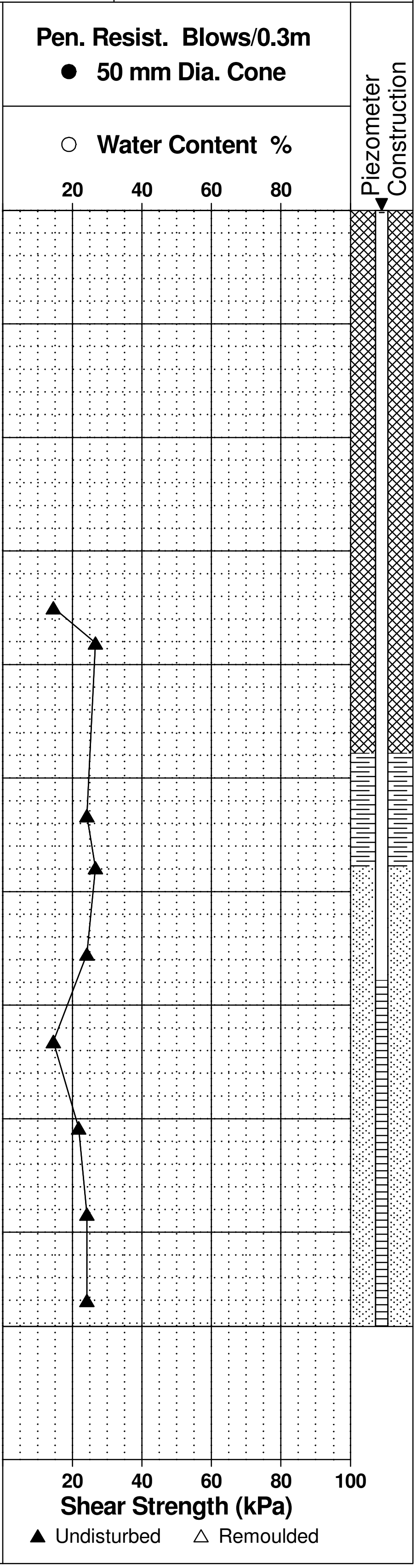
FILE NO. PG1604

HOLE NO. BH 2

SOIL DESCRIPTION	Depth to base (m)
GROUND SURFACE	
TOPSOIL	0.25
Very loose, brown **SILTY SAND,** trace clay **Long-term Groundwater Level**	1.45
Firm, brown **SILTY CLAY,** trace sand	2.21
Interface between weathered silty clay crust and saturated grey silty clay Firm to soft, grey **SILTY CLAY**	9.83
End of Borehole (GWL @ ground surface - Apr. 25/11)	

SAMPLE TYPE	NUMBER	% RECOVERY	N VALUE or RQD
SS	1	67	3
SS	2	100	1
SS	3	100	1
TW	4	100	

DEPTH (m)	ELEV. (m)
0	91.60
1	90.60
	89.90
2	89.60
	89.40
3	88.60
4	87.60
5	86.60
6	85.60
7	84.60
8	83.60
9	82.60



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REMARKS

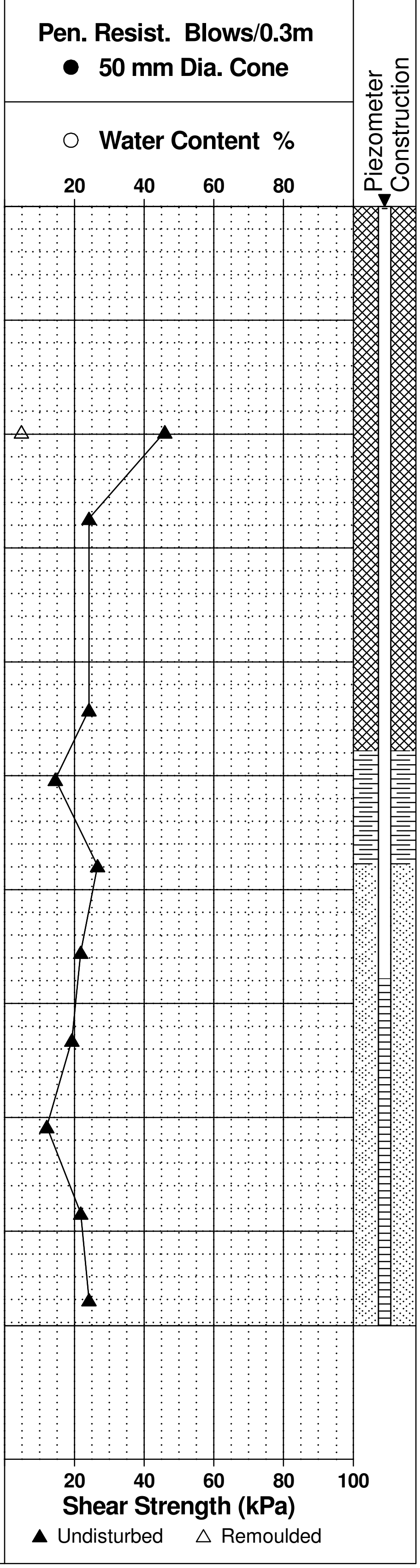
BORINGS BY CME 55 Power Auger

DATE April 6, 2011

FILE NO. PG1604

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	91.60
TOPSOIL 0.36							
Very loose, brown **SILTY SAND,** trace clay		SS	1	67	3	1	90.60
Long-term Groundwater Level 1.45							89.90
Firm, brown **SILTY CLAY,** trace sand 2.21						2	89.60
Interface between weathered silty clay crust and saturated grey silty clay							89.40
						3	88.60
		TW	2	100			
						4	87.60
						5	86.60
Firm to soft, grey **SILTY CLAY**						6	85.60
						7	84.60
						8	83.60
						9	82.60
9.83							
End of Borehole (GWL @ ground surface - Apr. 25/11)							



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REMARKS

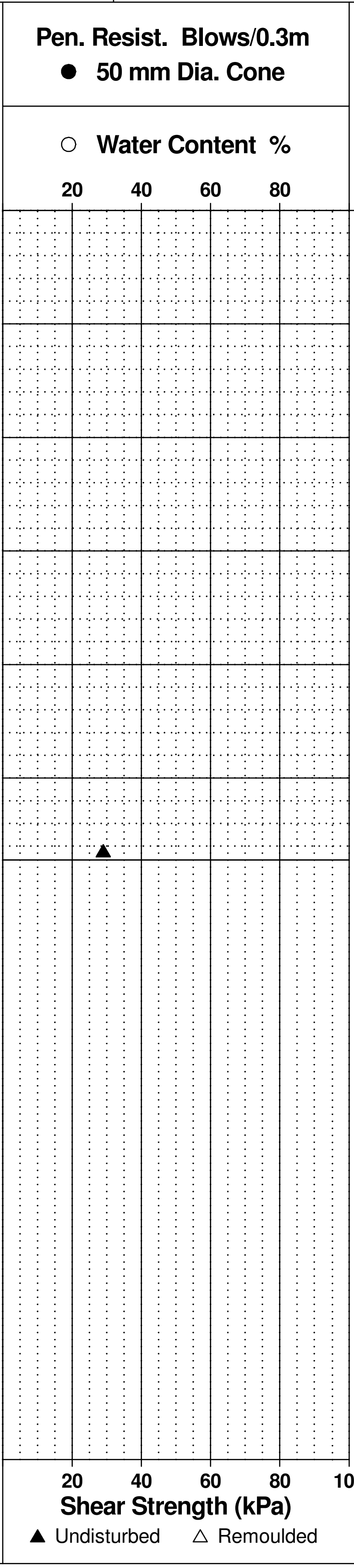
BORINGS BY CME 55 Power Auger

DATE April 6, 2011

FILE NO. PG1604

HOLE NO. BH 3A

SOIL DESCRIPTION		STRATA PLOT	SAMPLE				DEPTH (m)	ELEV. (m)
			TYPE	NUMBER	% RECOVERY	N VALUE or RQD		
GROUND SURFACE								
TOPSOIL	0.36						0	91.60
Very loose, brown **SILTY SAND,** trace clay							1	90.60
Long-term Groundwater Level	1.45							**89.90**
Firm, brown **SILTY CLAY,** trace sand	2.21						2	89.60
Interface between weathered silty clay crust and saturated grey silty clay								**89.40**
							3	88.60
Firm, grey **SILTY CLAY**							4	87.60
			TW	1	100		5	86.60
	5.72							
End of Borehole								



Piezometer Construction

SOIL PROFILE AND TEST DATA

Preliminary Geotechnical Investigation
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Ottawa, Ontario

DATUM Ground surface elevations based on Annis, O'Sullivan, Vollebekk Ltd. topographic survey plan (12/2015).

REMARKS

BORINGS BY CME 55 Power Auger

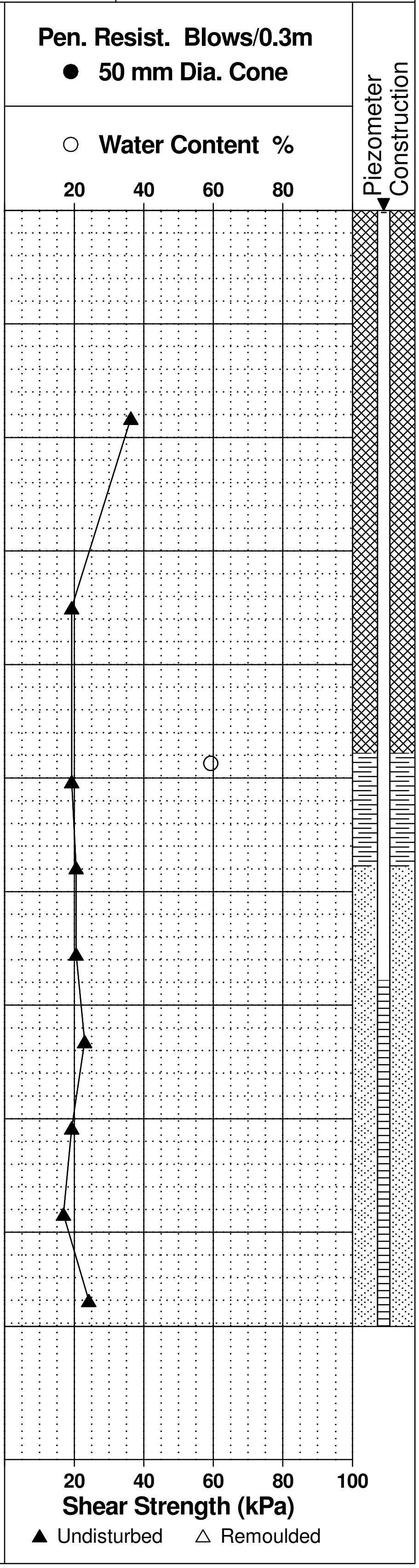
DATE April 6, 2011

FILE NO. PG1604

HOLE NO. BH 4

SOIL DESCRIPTION		SAMPLE TYPE	SAMPLE NUMBER	% RECOVERY	N VALUE or RQD
GROUND SURFACE					
TOPSOIL	0.36				
Loose, brown **SILTY SAND,** trace clay **Long-term Groundwater Level**	1.45	SS	1	42	5
Firm, brown **SILTY CLAY,** trace sand	2.21	SS	2		
Interface between weathered silty clay crust and saturated grey silty clay		TW	3	100	
Soft, grey **SILTY CLAY**	9.83	TW	4	100	
End of Borehole (GWL @ ground surface - Apr. 25/11)					

DEPTH (m)	ELEV. (m)
0	91.70
1	90.70
	90.00
2	89.70
	89.50
3	88.70
4	87.70
5	86.70
6	85.70
7	84.70
8	83.70
9	82.70



SOIL PROFILE AND TEST DATA

Preliminary Geotechnical Investigation
Proposed Residential Development - Cedarview Road
Ottawa, Ontario

DATUM Ground surface elevations based on Annis, O'Sullivan, Vollebekk Ltd. topographic survey plan (12/2015).

REMARKS

BORINGS BY CME 55 Power Auger

DATE April 8, 2011

FILE NO. PG1604

HOLE NO. BH 5

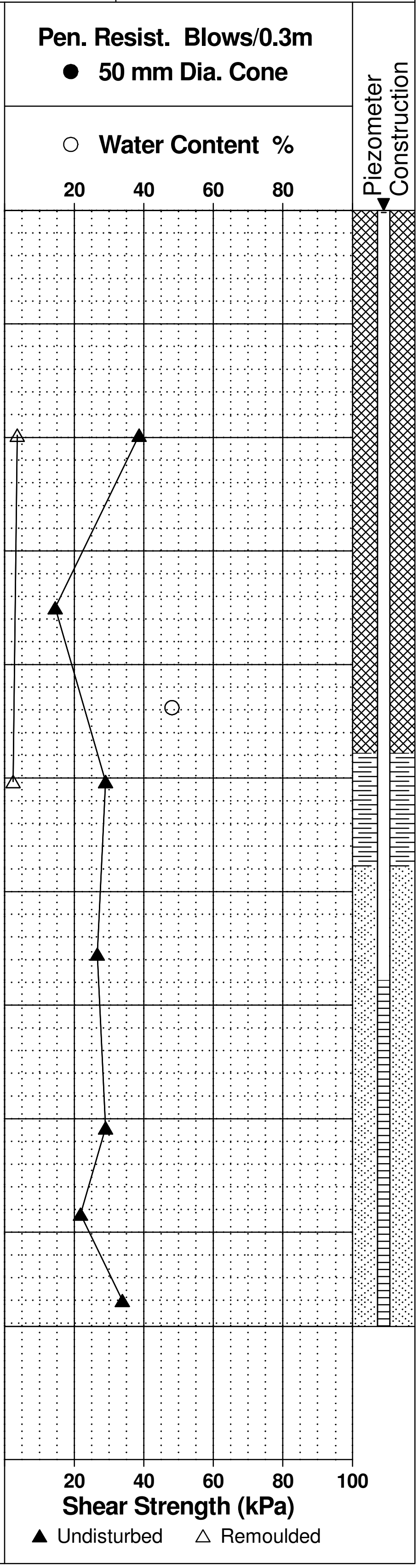
SOIL DESCRIPTION			SAMPLE TYPE	NUMBER	% RECOVERY	N VALUE or RQD
GROUND SURFACE						
TOPSOIL	0.36					
Loose, brown **SILTY SAND,** trace clay	0.97					
Firm, brown **SILTY CLAY,** trace sand			SS	1	62	5
	2.00		SS	2	100	
Firm, grey **SILTY CLAY**			TW	3	100	
			TW	4	100	
	9.83		TW	5	92	
End of Borehole						

Long-term Groundwater Level 90.20

Interface between weathered silty clay crust and saturated grey silty clay 89.70

(GWL @ ground surface - Apr. 25/11)

DEPTH (m)	ELEV. (m)
0	91.70
1	90.70
2	89.70
3	88.70
4	87.70
5	86.70
6	85.70
7	84.70
8	83.70
9	82.70



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SOIL PROFILE AND TEST DATA

Preliminary Geotechnical Investigation
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Ottawa, Ontario

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REMARKS

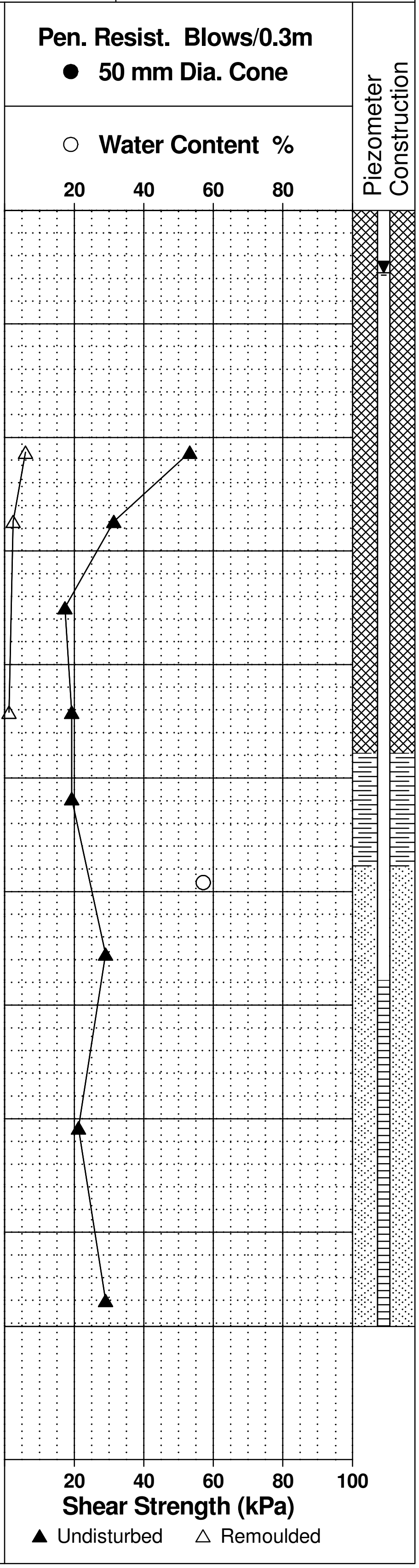
BORINGS BY CME 55 Power Auger

DATE April 7, 2011

FILE NO. PG1604

HOLE NO. BH 6

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	91.80
TOPSOIL 0.36							
Loose, brown **SILTY SAND,** trace clay		SS	1	67	6	1	90.80
Long-term Groundwater Level 1.45							**89.90**
Firm, brown **SILTY CLAY,** trace sand 2.26		SS	2	58		2	89.80
Interface between weathered silty clay crust and saturated grey silty clay							**89.40**
						3	88.80
						4	87.80
						5	86.80
Firm to soft, grey **SILTY CLAY**		TW	3	100		6	85.80
		TW	4	100		7	84.80
		TW	5	100		8	83.80
9.83						9	82.80
End of Borehole (GWL @ 0.55m-Apr. 25/11)							



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REMARKS

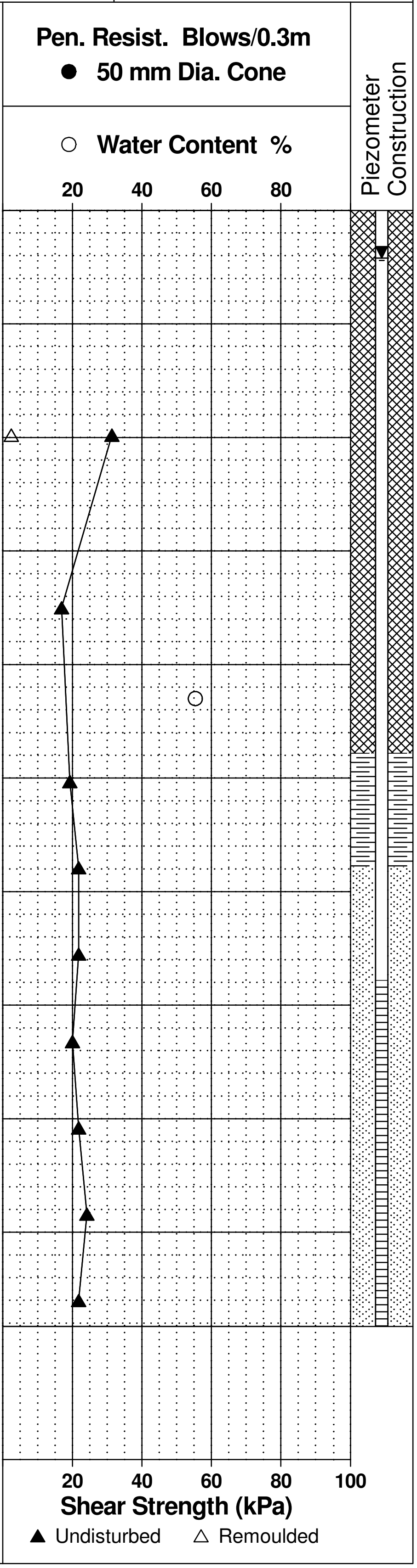
BORINGS BY CME 55 Power Auger

DATE April 7, 2011

FILE NO. PG1604

HOLE NO. BH 7

SOIL DESCRIPTION GROUND SURFACE	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)
TOPSOIL 0.38					0	91.90
Loose, brown **SILTY SAND,** trace clay	SS	1	50	4	1	90.90
Long-term Groundwater Level 1.45						**90.40**
Firm, brown **SILTY CLAY,** trace sand 1.98	SS	2			2	89.90
Interface between weathered silty clay crust and saturated grey silty clay						**89.90**
	TW	3	100			
					3	88.90
	TW	4	100		4	87.90
					5	86.90
Firm to soft, grey **SILTY CLAY**					6	85.90
					7	84.90
					8	83.90
					9	82.90
9.83 End of Borehole (GWL @ 0.42m-Apr. 25/11)						



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SOIL PROFILE AND TEST DATA

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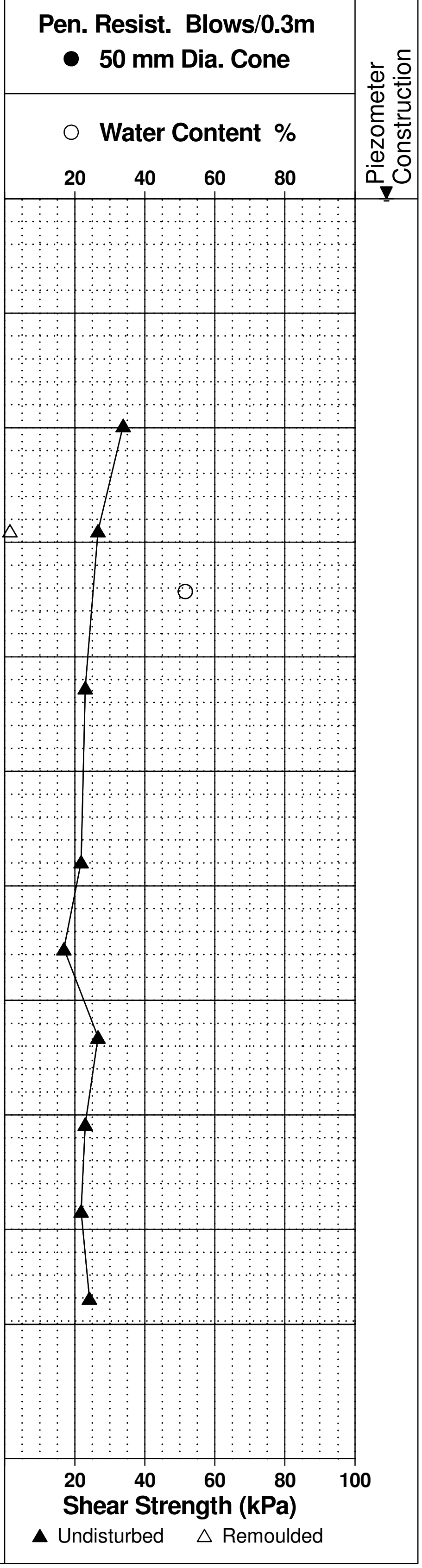
REMARKS

BORINGS BY CME 55 Power Auger **DATE** April 6, 2011

FILE NO. PG1604

HOLE NO. BH 8

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	92.00
TOPSOIL 0.36							
Loose, brown **SILTY SAND,** trace clay		SS	1	67	7	1	91.00
Long-term Groundwater Level 1.45						90.20	90.70
		SS	2			2	90.00
Interface between weathered silty clay crust and saturated grey silty clay						3	89.00
		TW	3	100			
						4	88.00
		TW	4	0			
						5	87.00
Firm to soft, grey **SILTY CLAY**						6	86.00
						7	85.00
						8	84.00
						9	83.00
9.83							
End of Borehole (GWL @ ground surface - Apr. 25/11)							



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REMARKS

BORINGS BY CME 55 Power Auger

DATE April 7, 2011

FILE NO. PG1604

HOLE NO. BH 9

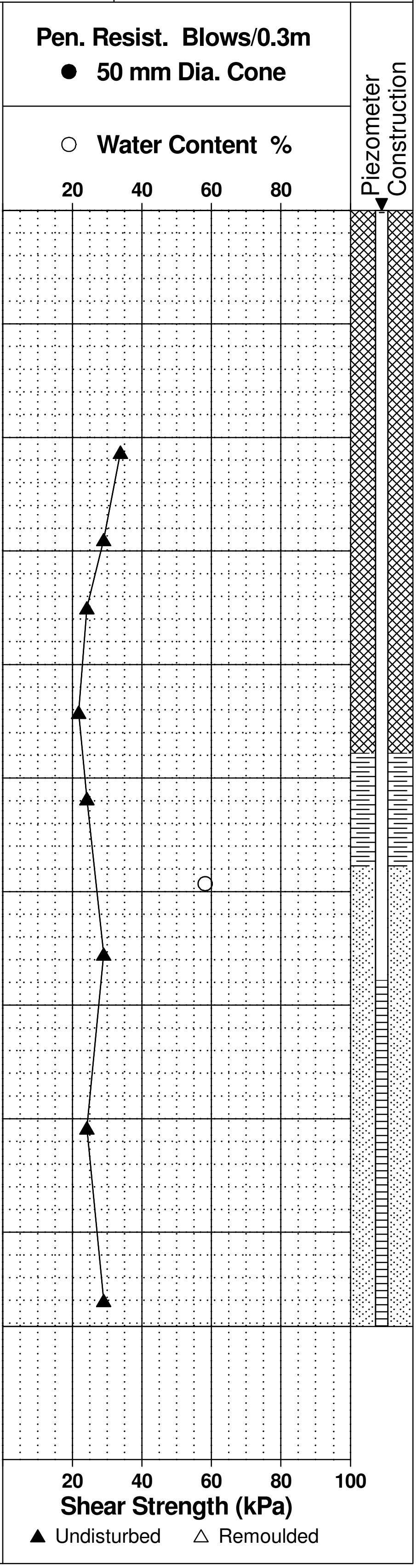
SOIL DESCRIPTION	Bottom depth (m)	TYPE	NUMBER	% RECOVERY	N VALUE or RQD
GROUND SURFACE					
TOPSOIL	0.36				
Loose, brown **SILTY SAND,** trace clay	1.45	SS	1	75	5
Firm, brown **SILTY CLAY,** trace sand	1.83	SS	2	92	
Firm, grey **SILTY CLAY**	9.83	TW	3	100	
		TW	4	100	
		TW	5	100	
End of Borehole					

Long-term Groundwater Level 90.50

Interface between weathered silty clay crust and saturated grey silty clay 90.00

(GWL @ ground surface - Apr. 25/11)

DEPTH (m)	ELEV. (m)
0	92.00
1	91.00
2	90.00
3	89.00
4	88.00
5	87.00
6	86.00
7	85.00
8	84.00
9	83.00



SOIL PROFILE AND TEST DATA

Geotechnical Review
Cedarview Road - Leikin / Henderson Lands
Ottawa, Ontario

DATUM Ground surface elevations based on Annis, O'Sullivan, Vollebekk Ltd. topographic survey plan (12/2015).

REMARKS

BORINGS BY Backhoe

DATE September 24, 2015

FILE NO. PG3621

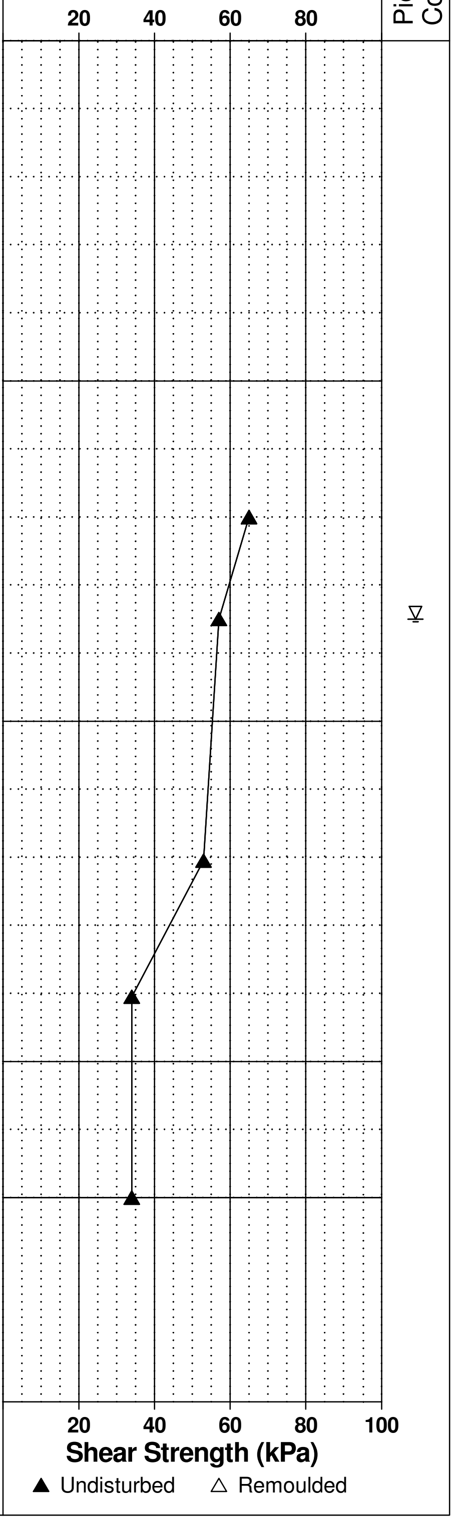
HOLE NO. TP 1

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	91.40
TOPSOIL 0.30							
Loose to compact, brown **SILTY SAND,** trace clay 1.20						1	90.40
Stiff to firm, brown **SILTY CLAY** **Long-term Groundwater Level** 1.70							89.90
Interface between weathered silty clay crust and saturated grey silty clay						2	89.40 89.40
Firm, grey **SILTY CLAY**		G	1				
		G	2			3	88.40
3.40 End of Test Pit (GWL @ 1.7m depth based on field observations)							

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

○ Water Content %

Piezometer Construction



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SOIL PROFILE AND TEST DATA

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REMARKS

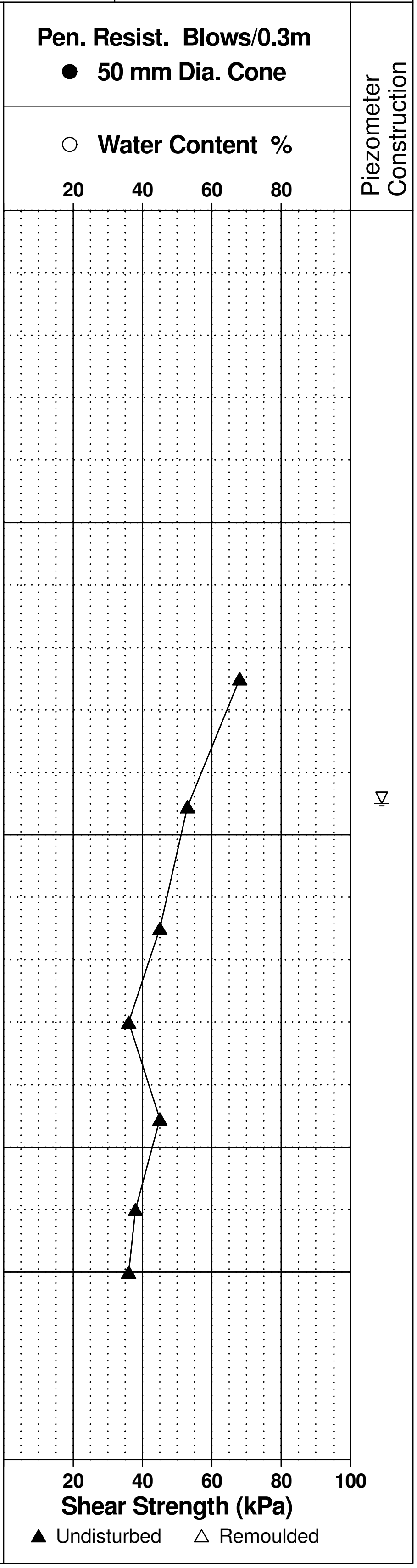
BORINGS BY Backhoe

DATE September 24, 2015

FILE NO. PG3621

HOLE NO. TP 2

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	91.85
TOPSOIL 0.30							
		G	1				
						1	90.85
Stiff to firm, brown **SILTY CLAY,** trace sand							
Long-term Groundwater Level							**90.10**
		G	2			2	89.85
Interface between weathered silty clay crust and saturated grey silty clay							**89.60**
2.50							
Firm, grey **SILTY CLAY**							
		G	3			3	88.85
3.40							
End of Test Pit (GWL @ 1.9m depth based on field observations)							



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REMARKS

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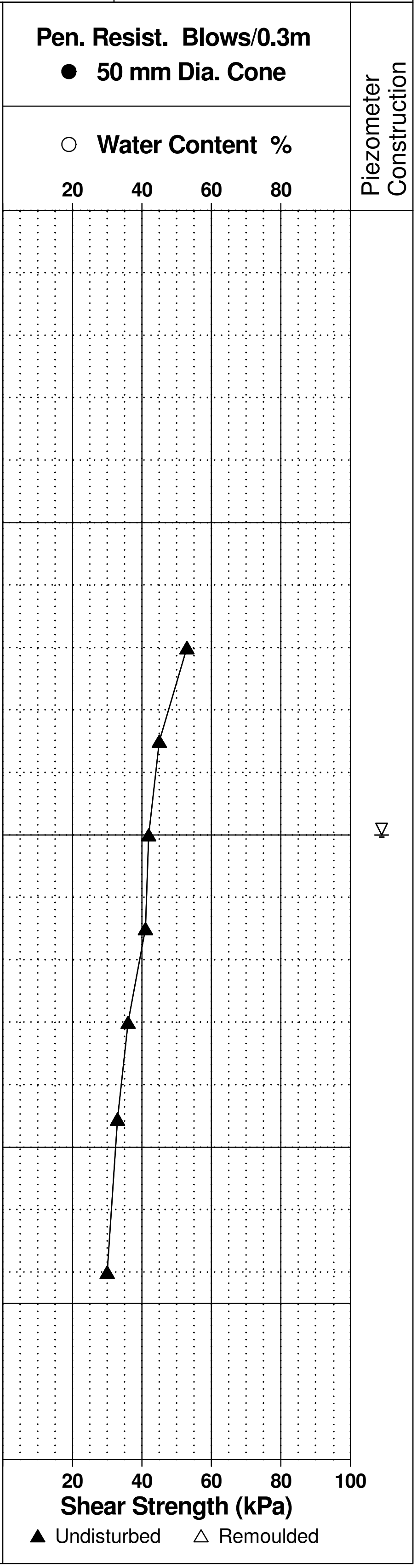
DATE September 24, 2015

FILE NO. **PG3621**

HOLE NO. **TP 3**

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	91.90
TOPSOIL — 0.45							
Loose, brown **SILTY SAND,** trace clay		G	1				
						1	90.90
Long-term Groundwater Level							**90.40**
1.40 — Stiff to firm, brown **SILTY CLAY** - with sand seams and shells by 1.5m depth		G	2				
1.80							
						2	89.90
Interface between weathered silty clay crust and saturated grey silty clay							**89.90**
Firm, grey **SILTY CLAY**							
		G	3			3	88.90
3.50 — End of Test Pit (GWL @ 2.0m depth based on field observations)							



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REMARKS

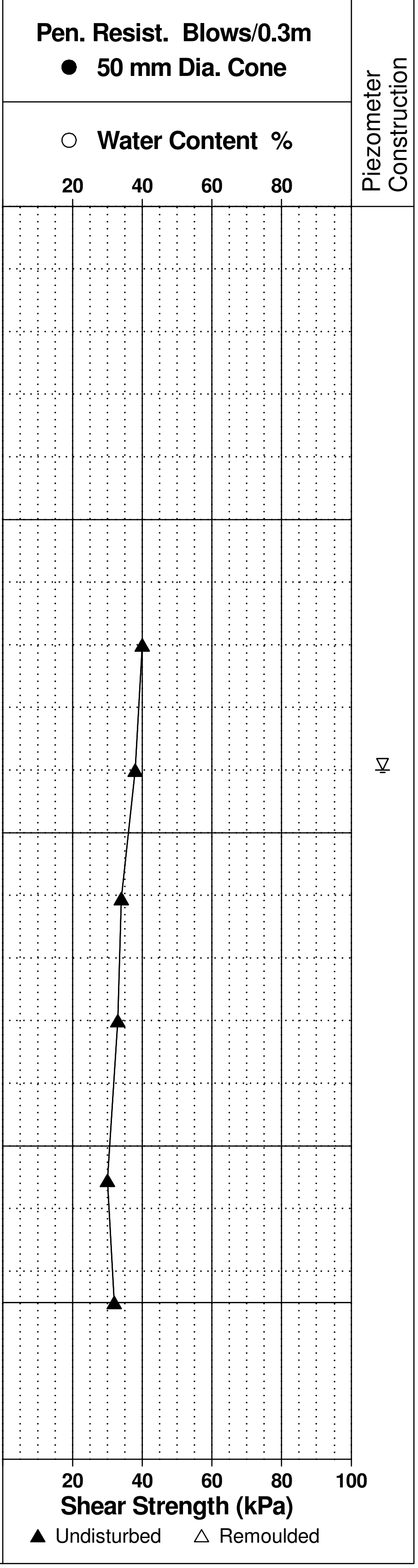
BORINGS BY Backhoe

DATE September 24, 2015

FILE NO. PG3621

HOLE NO. TP 4

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	91.60
TOPSOIL 0.30							
Loose, brown **SILTY SAND,** trace clay 1.40						1	90.60
Long-term Groundwater Level							**90.20**
Firm, brown **SILTY CLAY** 1.90							**89.70**
Interface between weathered silty clay crust and saturated grey silty clay						2	89.60
		G	1				
Firm, grey **SILTY CLAY**						3	88.60
		G	2				
3.50 End of Test Pit (GWL @ 1.8m depth based on field observations)							



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REMARKS

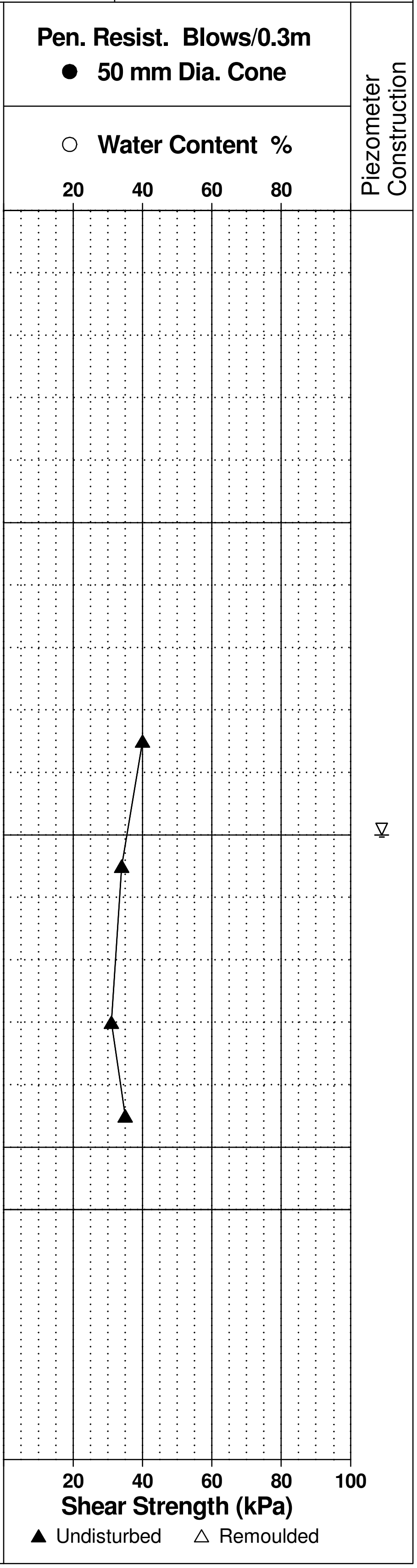
BORINGS BY Backhoe

DATE September 24, 2015

FILE NO. **PG3621**

HOLE NO. **TP 5**

SOIL DESCRIPTION		SAMPLE TYPE	SAMPLE NUMBER	% RECOVERY	N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	92.00
TOPSOIL	0.20						
Loose, brown **SILTY SAND,** some clay		G	1				
		G	2			1	91.00
Long-term Groundwater Level							**90.50**
	1.70						
Firm, brown **SILTY CLAY**	2.00						**90.00**
						2	90.00
Interface between weathered silty clay crust and saturated grey silty clay		G	3				
Firm, grey **SILTY CLAY**						3	89.00
	3.20						
End of Test Pit (GWL @ 2.0m depth based on field observations)							



patersongroup Consulting Engineers

154 Colonnade Road South, Ottawa, Ontario K2E 7J5

SOIL PROFILE AND TEST DATA

Geotechnical Review
Cedarview Road - Leikin / Henderson Lands
Ottawa, Ontario

DATUM Ground surface elevations based on Annis, O'Sullivan, Vollebekk Ltd. topographic survey plan (12/2015).

REMARKS

BORINGS BY Backhoe

DATE September 24, 2015

FILE NO. PG3621

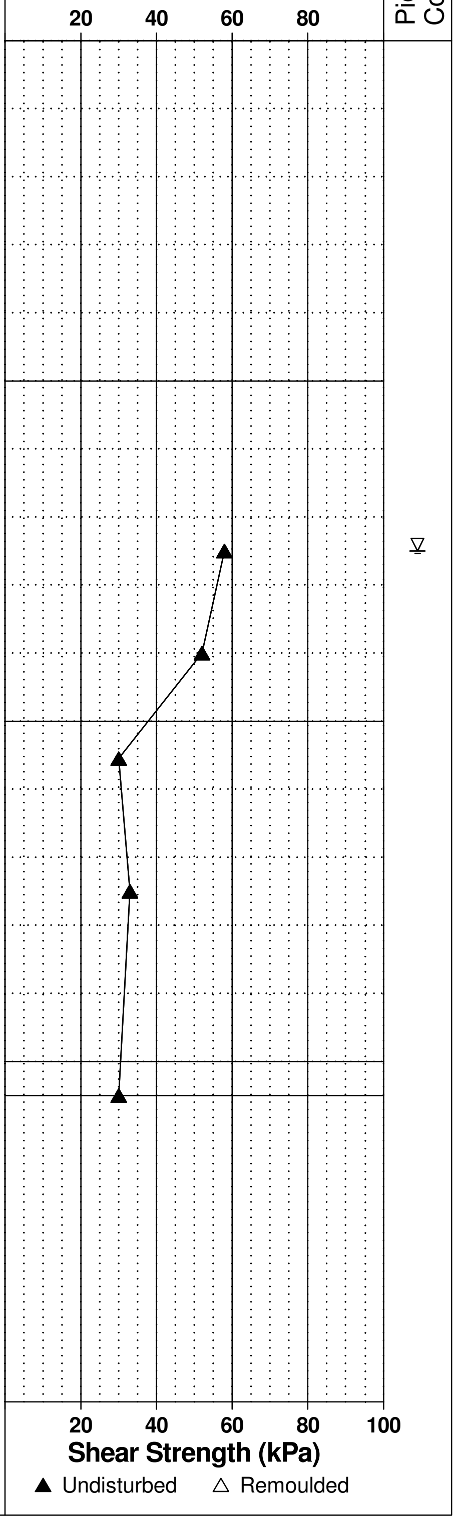
HOLE NO. TP 6

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	91.80
TOPSOIL — 0.30							
						1	90.80
Stiff to firm, brown **SILTY CLAY,** trace sand							
Long-term Groundwater Level							90.40
Interface between weathered silty clay crust and saturated grey silty clay							89.90
						2	89.80
— 2.20		G	1				
Firm, grey **SILTY CLAY**							
						3	88.80
— 3.10							
End of Test Pit (GWL @ 1.5m depth based on field observations)							

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

○ Water Content %

Piezometer Construction



SOIL PROFILE AND TEST DATA

Geotechnical Review
Cedarview Road - Leikin / Henderson Lands
Ottawa, Ontario

DATUM Ground surface elevations based on Annis, O'Sullivan, Vollebekk Ltd. topographic survey plan (12/2015).

REMARKS

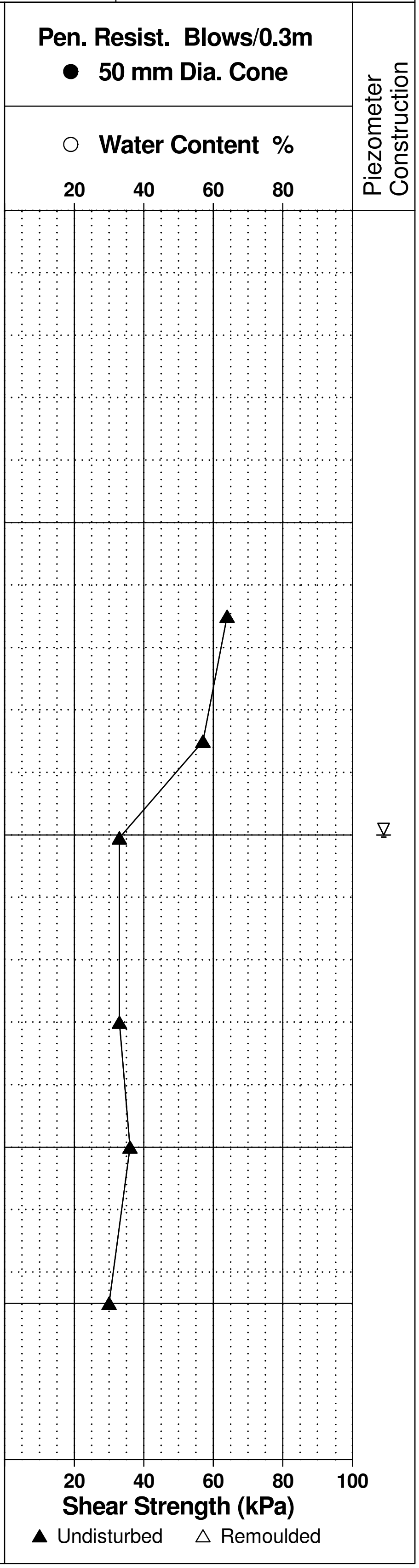
BORINGS BY Backhoe

DATE September 24, 2015

FILE NO. PG3621

HOLE NO. TP 7

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	92.00
TOPSOIL 0.40	■						
Brown **SILTY SAND,** trace clay and sand seams	⁚					1	91.00
Long-term Groundwater Level 1.50	⁚						**90.50**
Stiff to firm, brown **SILTY CLAY,** trace sand - grey by 2.0m depth 2.00	▨						**90.00**
Interface between weathered silty clay crust and saturated grey silty clay	▨	G	1			2	90.00
Firm, grey **SILTY CLAY** 3.50	▨					3	89.00
End of Test Pit (GWL @ 2.0m depth based on field observations)							



SYMBOLS AND TERMS

SOIL DESCRIPTION

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

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

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

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

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

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

SYMBOLS AND TERMS (continued)

SOIL DESCRIPTION (continued)

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

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

ROCK DESCRIPTION

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

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

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

SAMPLE TYPES

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

SYMBOLS AND TERMS (continued)

GRAIN SIZE DISTRIBUTION

MC% - Natural moisture content or water content of sample, %
LL - Liquid Limit, % (water content above which soil behaves as a liquid)
PL - Plastic limit, % (water content above which soil behaves plastically)
PI - Plasticity index, % (difference between LL and PL)

Dxx - Grain size which xx% of the soil, by weight, is of finer grain sizes
These grain size descriptions are not used below 0.075 mm grain size
D10 - Grain size at which 10% of the soil is finer (effective grain size)
D60 - Grain size at which 60% of the soil is finer

Cc - Concavity coefficient = $(D30)^2 / (D10 \times D60)$
Cu - Uniformity coefficient = D60 / D10

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

CONSOLIDATION TEST

p'_o - Present effective overburden pressure at sample depth
p'_c - Preconsolidation pressure of (maximum past pressure on) sample
Ccr - Recompression index (in effect at pressures below p'_c)
Cc - Compression index (in effect at pressures above p'_c)

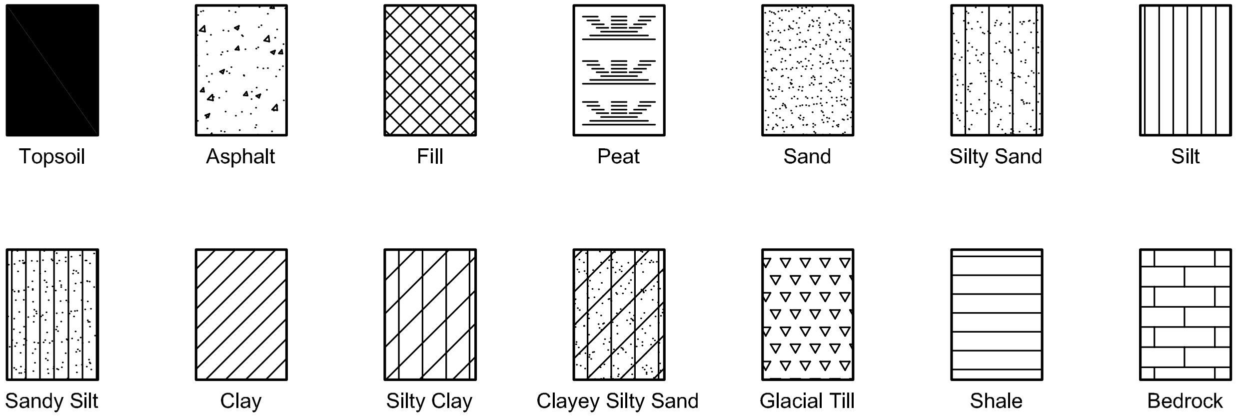
OC Ratio Overconsolidaton ratio = p'_c / p'_o
Void Ratio Initial sample void ratio = volume of voids / volume of solids
Wo - Initial water content (at start of consolidation test)

PERMEABILITY TEST

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

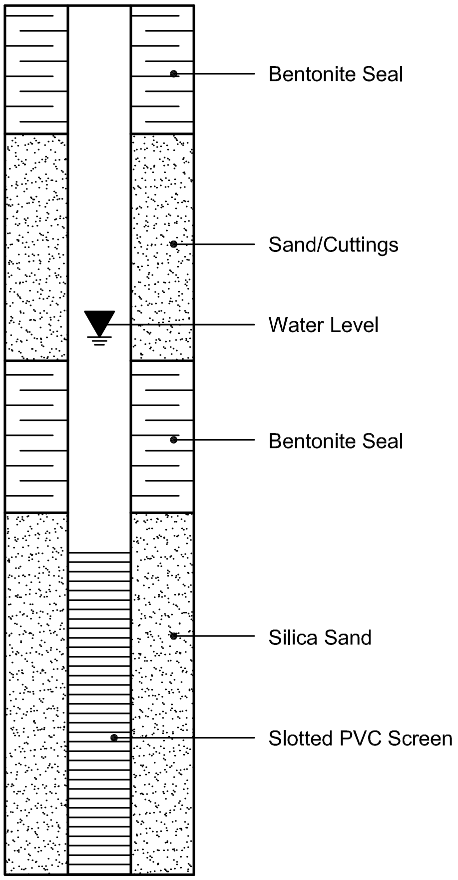
SYMBOLS AND TERMS (continued)

STRATA PLOT

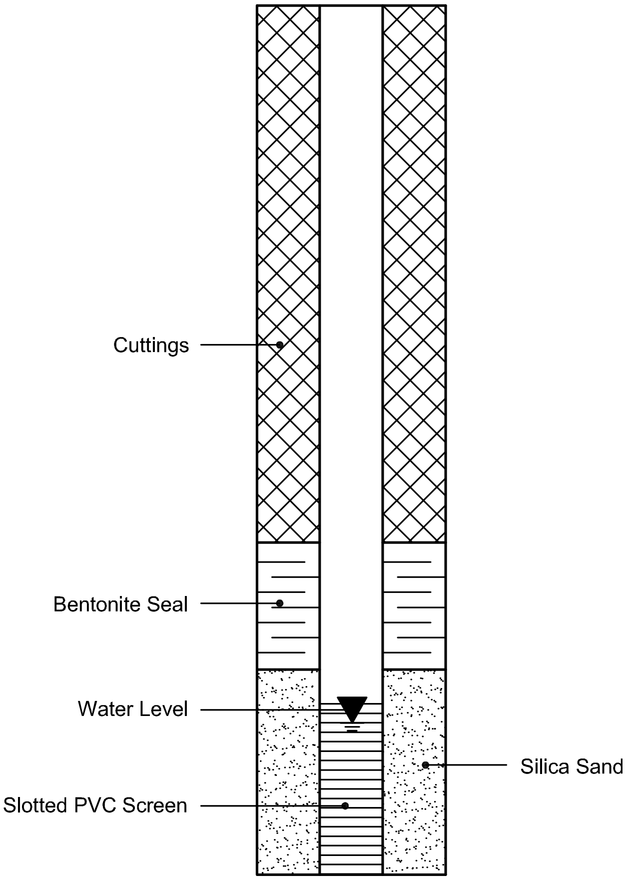


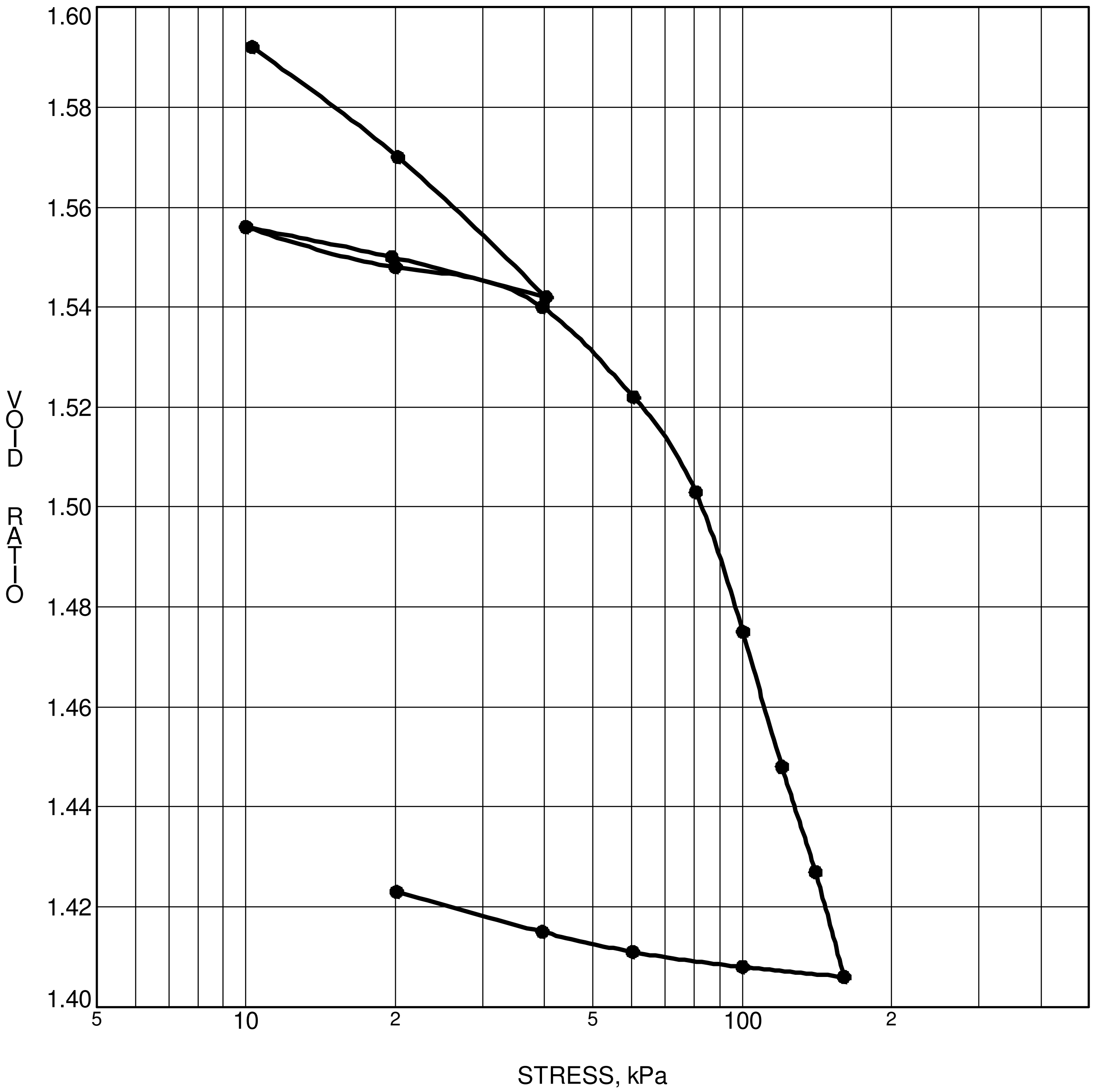
MONITORING WELL AND PIEZOMETER CONSTRUCTION

MONITORING WELL CONSTRUCTION



PIEZOMETER CONSTRUCTION





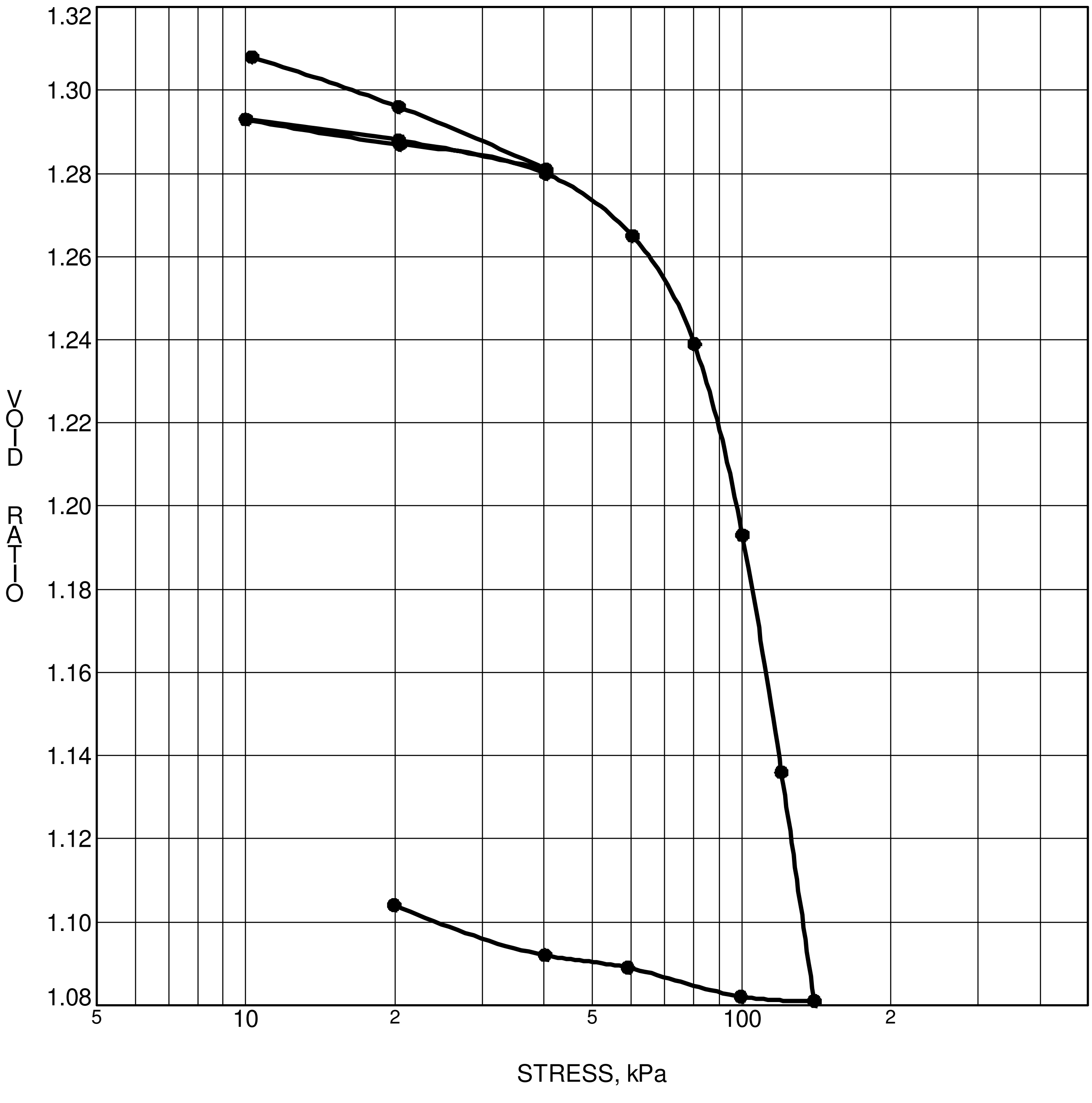
CONSOLIDATION TEST DATA SUMMARY										
Borehole No.	**BH 4**		p'_o	**49.6**	kPa	Ccr	**0.024**	
Sample No.	**TW 4**		p'_c	**80**	kPa	Cc	**0.338**	
Sample Depth	**4.87**	m	OC Ratio	**1.6**		Wo	**59.3**	%
Sample Elev.		m	Void Ratio	**1.63**		Unit Wt.	**16.6**	kN/m^3

CLIENT	**Leitrim Group**	FILE NO.	**PG1604**
PROJECT	**Preliminary Geotechnical Investigation - Proposed Residential Development - Cedarview Road**	DATE	**04/11/2011**

patersongroup **Consulting Engineers**

28 Concouse Gate, Unit 1, Ottawa, Ontario K2E 7T7

CONSOLIDATION TEST



CONSOLIDATION TEST DATA SUMMARY					
Borehole No.	**BH 5**	p'_o	**46** kPa	Ccr	**0.020**
Sample No.	**TW 3**	p'_c	**85** kPa	Cc	**0.795**
Sample Depth	**4.38** m	OC Ratio	**1.8**	Wo	**48.1** %
Sample Elev.	m	Void Ratio	**1.323**	Unit Wt.	**18.0** kN/m^3

CLIENT **Leitrim Group**

FILE NO. **PG1604**

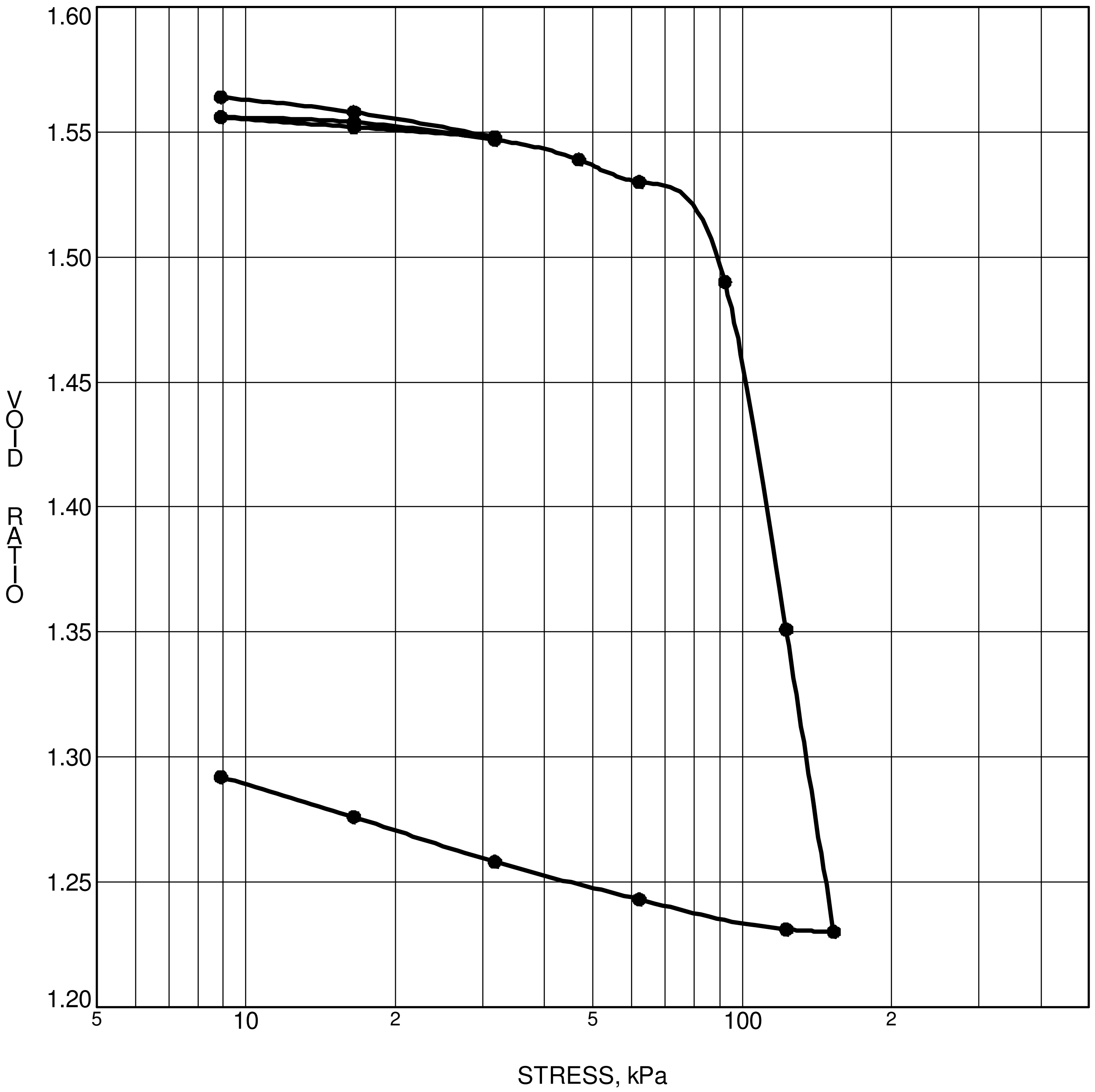
PROJECT **Preliminary Geotechnical Investigation - Proposed Residential Development - Cedarview Road**

DATE **04/11/2011**

patersongroup **Consulting Engineers**

28 Concouse Gate, Unit 1, Ottawa, Ontario K2E 7T7

CONSOLIDATION TEST



CONSOLIDATION TEST DATA SUMMARY					
Borehole No.	**BH 6**	p'_o	**56.6** kPa	Ccr	**0.017**
Sample No.	**TW 3**	p'_c	**88** kPa	Cc	**1.185**
Sample Depth	**5.92** m	OC Ratio	**1.6**	Wo	**57.1** %
Sample Elev.	m	Void Ratio	**1.571**	Unit Wt.	**16.5** kN/m^3

CLIENT **Leitrim Group**

FILE NO. **PG1604**

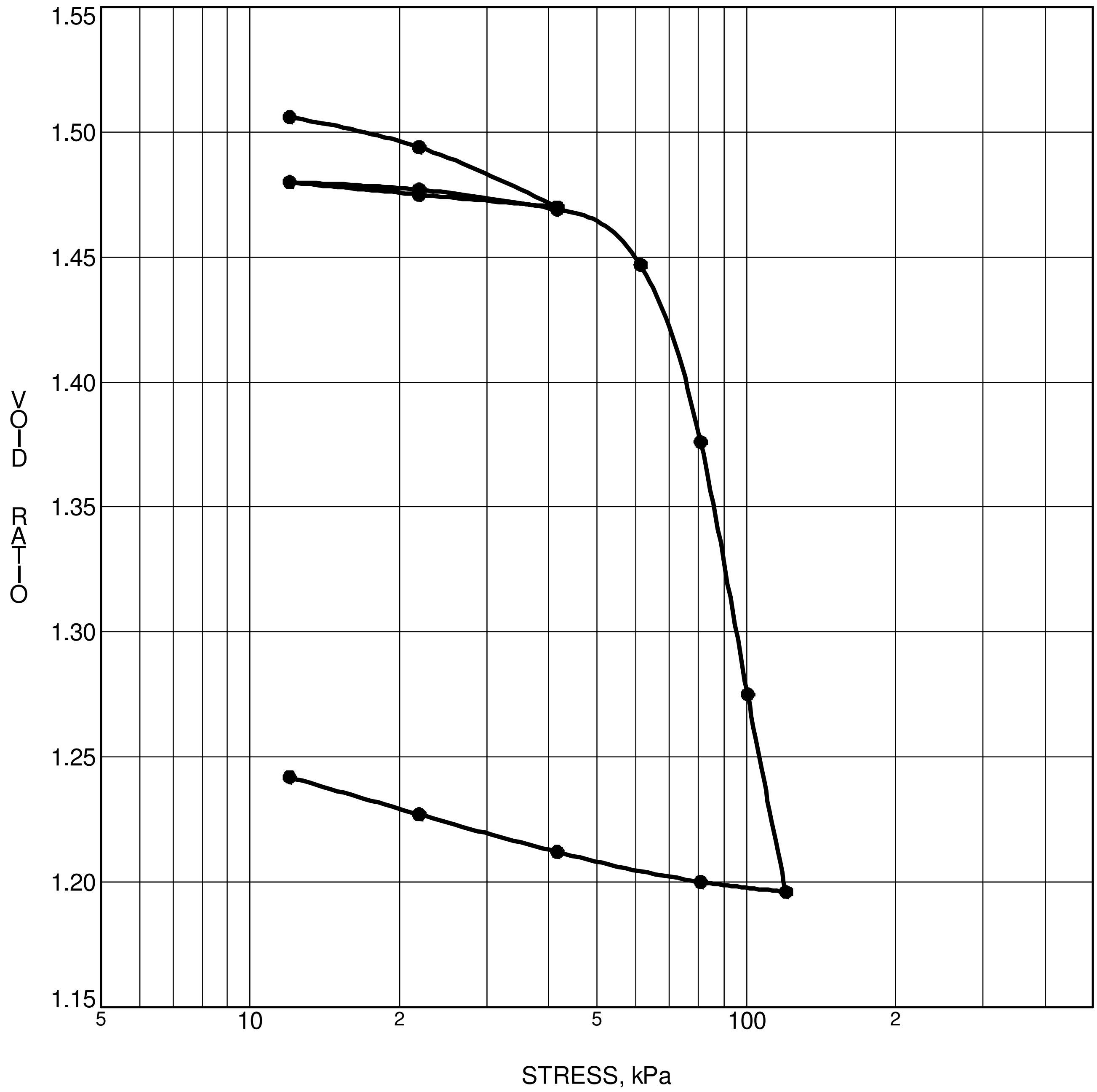
PROJECT **Preliminary Geotechnical Investigation - Proposed Residential Development - Cedarview Road**

DATE **04/13/2011**

patersongroup **Consulting Engineers**

28 Concouse Gate, Unit 1, Ottawa, Ontario K2E 7T7

CONSOLIDATION TEST



CONSOLIDATION TEST DATA SUMMARY					
Borehole No.	**BH 7**	p'$_o$	**43.3** kPa	Ccr	**0.017**
Sample No.	**TW 4**	p'$_c$	**70** kPa	Cc	**1.061**
Sample Depth	**4.30** m	OC Ratio	**1.6**	Wo	**55.4** %
Sample Elev.	m	Void Ratio	**1.523**	Unit Wt.	**16.5** kN/m^3

CLIENT **Leitrim Group**

PROJECT **Preliminary Geotechnical Investigation - Proposed Residential Development - Cedarview Road**

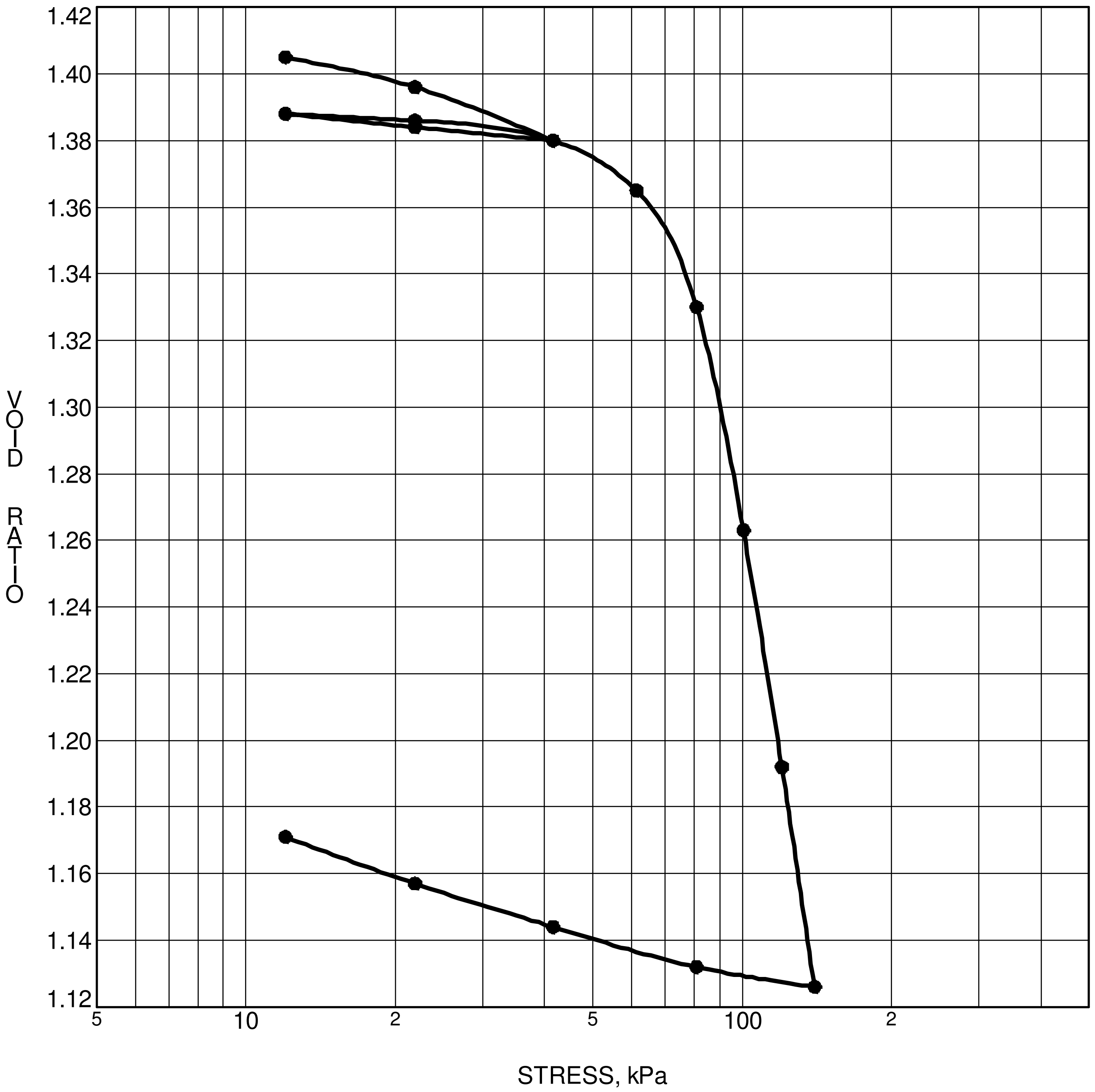
FILE NO. **PG1604**

DATE **04/13/2011**

patersongroup **Consulting Engineers**

28 Concouse Gate, Unit 1, Ottawa, Ontario K2E 7T7

CONSOLIDATION TEST



CONSOLIDATION TEST DATA SUMMARY					
Borehole No.	**BH 8**	p'_o	**35.8** kPa	Ccr	**0.017**
Sample No.	**TW 3**	p'_c	**81** kPa	Cc	**0.973**
Sample Depth	**3.43** m	OC Ratio	**2.3**	Wo	**51.6** %
Sample Elev.	m	Void Ratio	**1.418**	Unit Wt.	**17.0** kN/m ^{3}

CLIENT **Leitrim Group**

FILE NO. **PG1604**

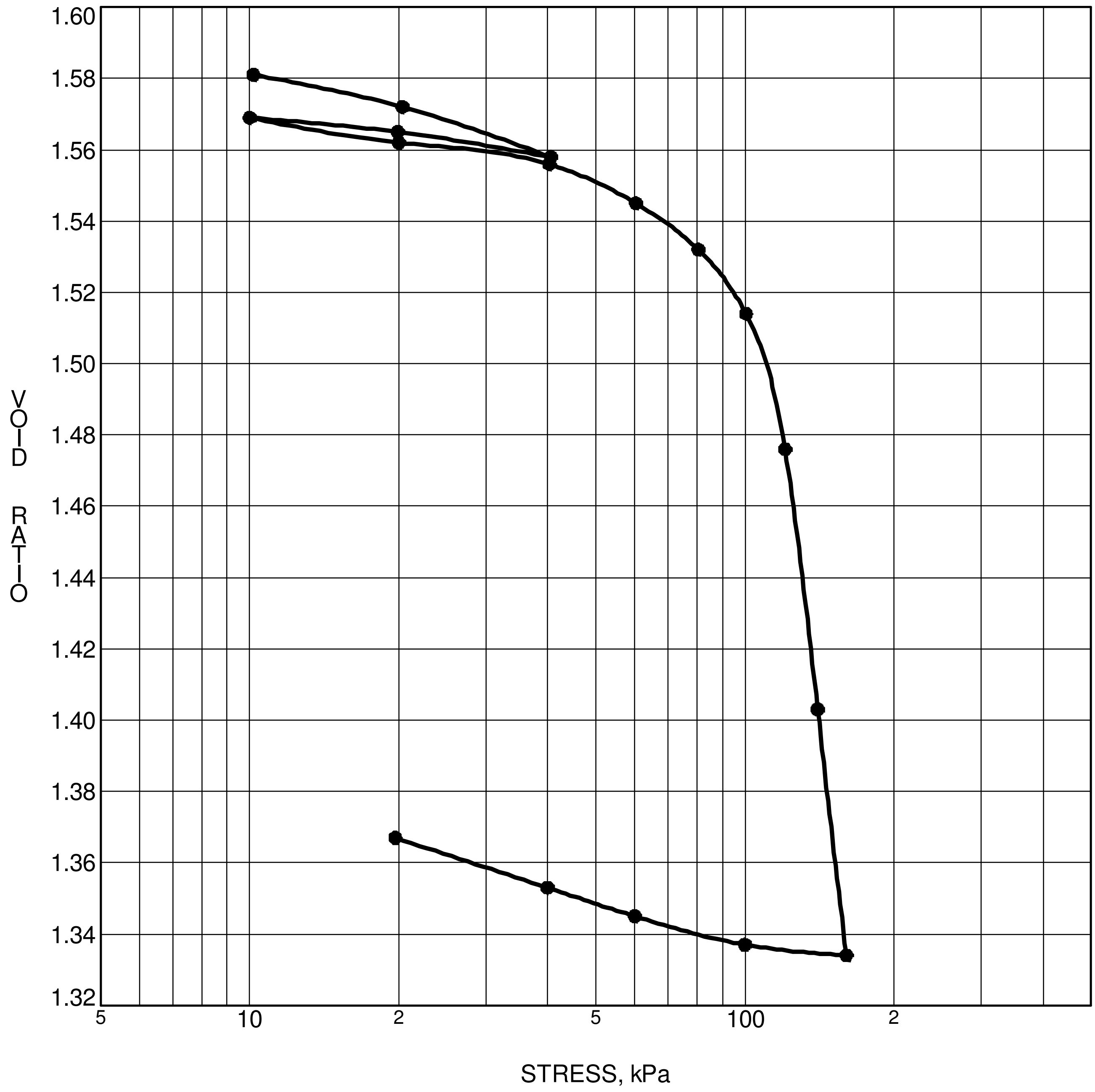
PROJECT **Preliminary Geotechnical Investigation - Proposed Residential Development - Cedarview Road**

DATE **04/13/2011**

patersongroup **Consulting Engineers**

28 Concouse Gate, Unit 1, Ottawa, Ontario K2E 7T7

CONSOLIDATION TEST



CONSOLIDATION TEST DATA SUMMARY

Borehole No.	**BH 9**		p'_o	**51.3**	kPa	Ccr	**0.021**	
Sample No.	**TW 3**		p'_c	**111**	kPa	Cc	**1.130**	
Sample Depth	**5.93**	m	OC Ratio	**2.2**		Wo	**58.2**	%
Sample Elev.		m	Void Ratio	**1.601**		Unit Wt.	**16.6**	kN/m^3

CLIENT **Leitrim Group**

FILE NO. **PG1604**

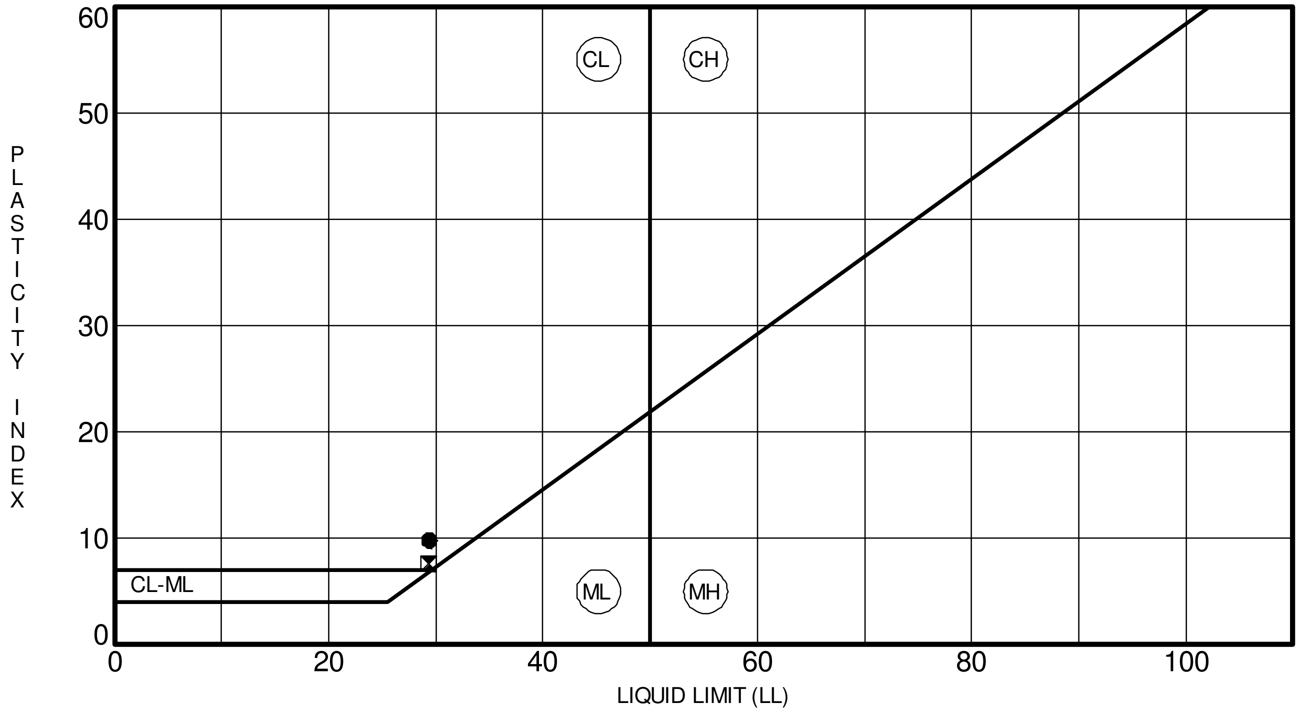
PROJECT **Preliminary Geotechnical Investigation - Proposed Residential Development - Cedarview Road**

DATE **04/11/2011**

patersongroup **Consulting Engineers**

28 Concouse Gate, Unit 1, Ottawa, Ontario K2E 7T7

CONSOLIDATION TEST



	Specimen Identification		LL	PL	PI	Fines	Classification
●	**BH 8**	**TW 3**	**29**	**20**	**10**		**CL-Inorganic clays of low to medium plasticity**
⧗	**BH 9**	**TW 3**	**29**	**22**	**8**		**CL-Inorganic clays of low to medium plasticity**

CLIENT **Leitrim Group**

FILE NO. **PG1604**

PROJECT **Preliminary Geotechnical Investigation - Proposed Residential Development - Cedarview Road**

DATE **7 Apr 11**

patersongroup **Consulting Engineers**

28 Concouse Gate, Unit 1, Ottawa, Ontario K2E 7T7

ATTERBERG LIMITS' RESULTS

Certificate of Analysis

Report Date: 28-Apr-2011

Client: **Paterson Group Consulting Engineers**

Order Date:21-Apr-2011

Client PO: 10682

Project Description: PG1604

	Client ID:	BH6 SS2	-	-	-
	Sample Date:	07-Apr-11	-	-	-
	Sample ID:	1117187-01	-	-	-
	MDL/Units	Soil	-	-	-
Physical Characteristics					
% Solids	0.1 % by Wt.	77.0	-	-	-
General Inorganics					
pH	0.05 pH Units	7.55	-	-	-
Resistivity	0.10 Ohm.m	62.5	-	-	-
Anions					
Chloride	5 ug/g dry	8	-	-	-
Sulphate	5 ug/g dry	17	-	-	-

APPENDIX 2

FIGURE 1 - KEY PLAN

DRAWING PG3621-1 - TEST HOLE LOCATION PLAN

DRAWING PG3621-2 - SETTLEMENT PLATE LOCATION PLAN

DRAWING PG3621-3 - PERMISSIBLE GRADE RAISE PLAN

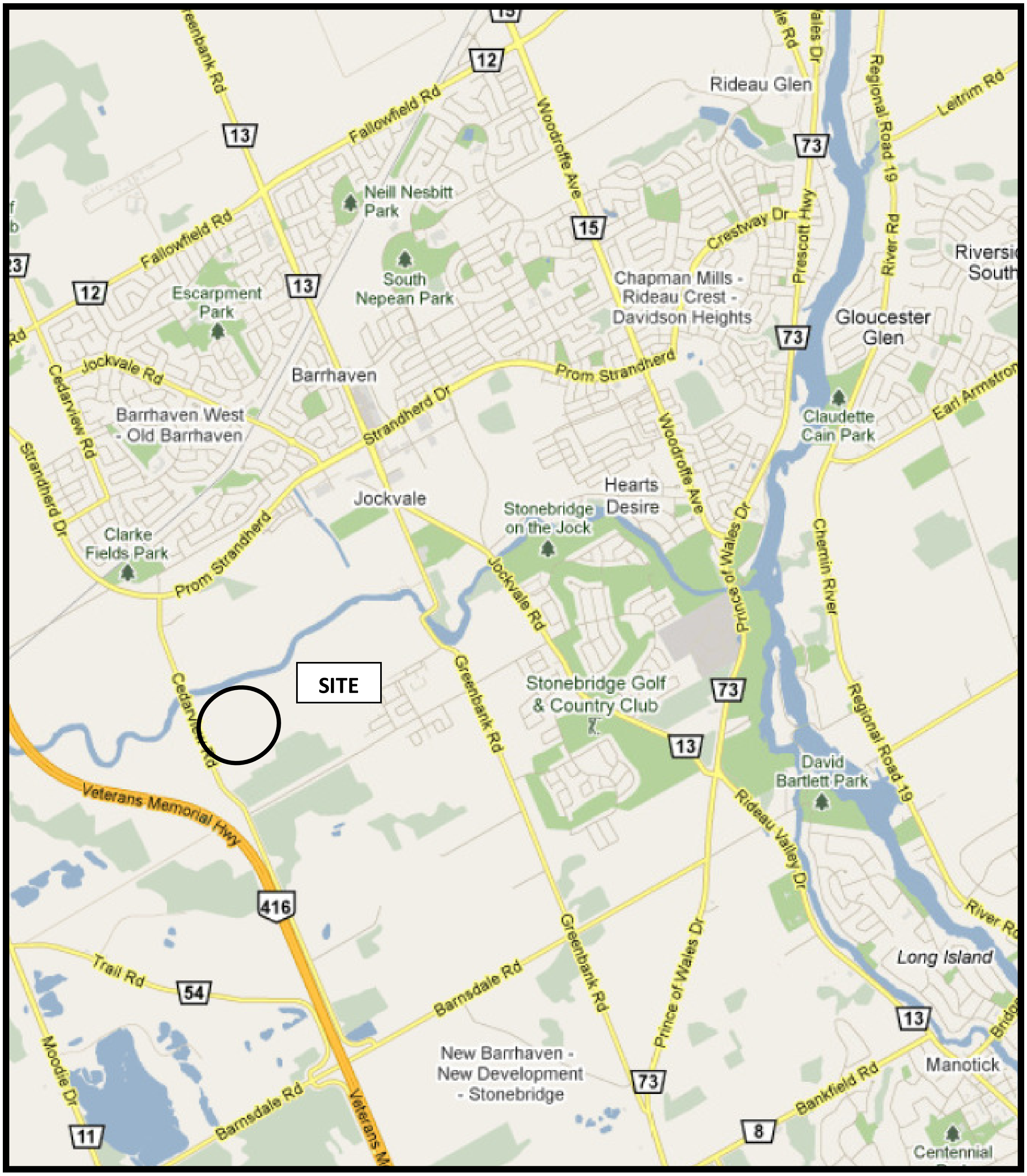
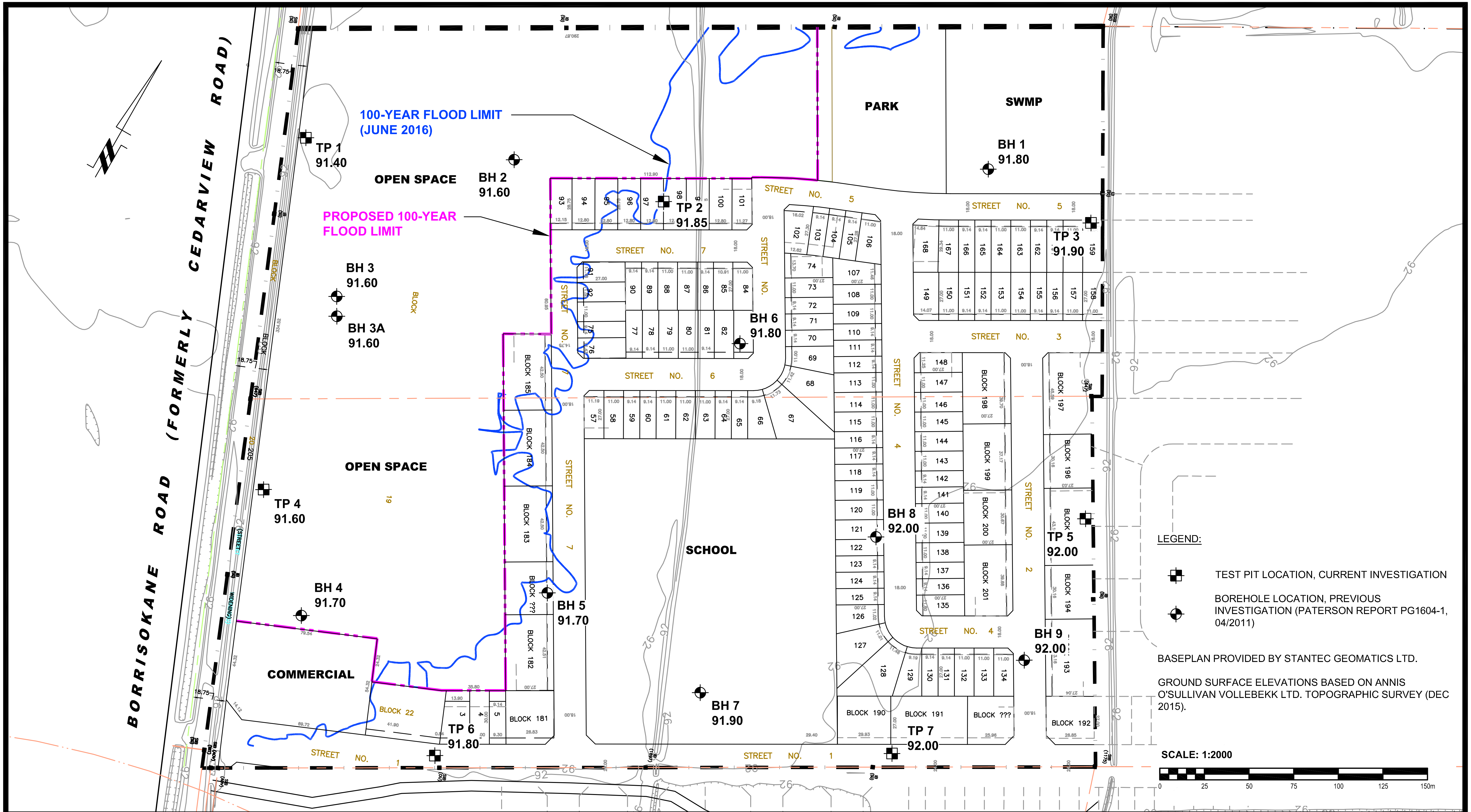


FIGURE 1

KEY PLAN



LEGEND:

▣	TEST PIT LOCATION, CURRENT INVESTIGATION
⊕	BOREHOLE LOCATION, PREVIOUS INVESTIGATION (PATERSON REPORT PG1604-1, 04/2011)

BASEPLAN PROVIDED BY STANTEC GEOMATICS LTD.

GROUND SURFACE ELEVATIONS BASED ON ANNIS O'SULLIVAN VOLLEBEKK LTD. TOPOGRAPHIC SURVEY (DEC 2015).

SCALE: 1:2000

0 25 50 75 100 125 150m

patersongroup
consulting engineers

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

NO.	REVISIONS	DATE	INITIAL
2	BASE PLAN UPDATED	28/04/2017	DJG
1	BASE PLAN UPDATED	29/09/2016	FA

GLENVIEW HOMES (CEDARVIEW) LIMITED

PROPOSED RESIDENTIAL DEVELOPMENT
3387 BORRISOKANE ROAD

OTTAWA, ONTARIO

Title:

TEST HOLE LOCATION PLAN

Scale: 1:2000	Date: 09/2016
Drawn by: RCG	Report No.: PG3621
Checked by: CB	Dwg. No.: PG3621-1
Approved by: DJG	Revision No.: 2

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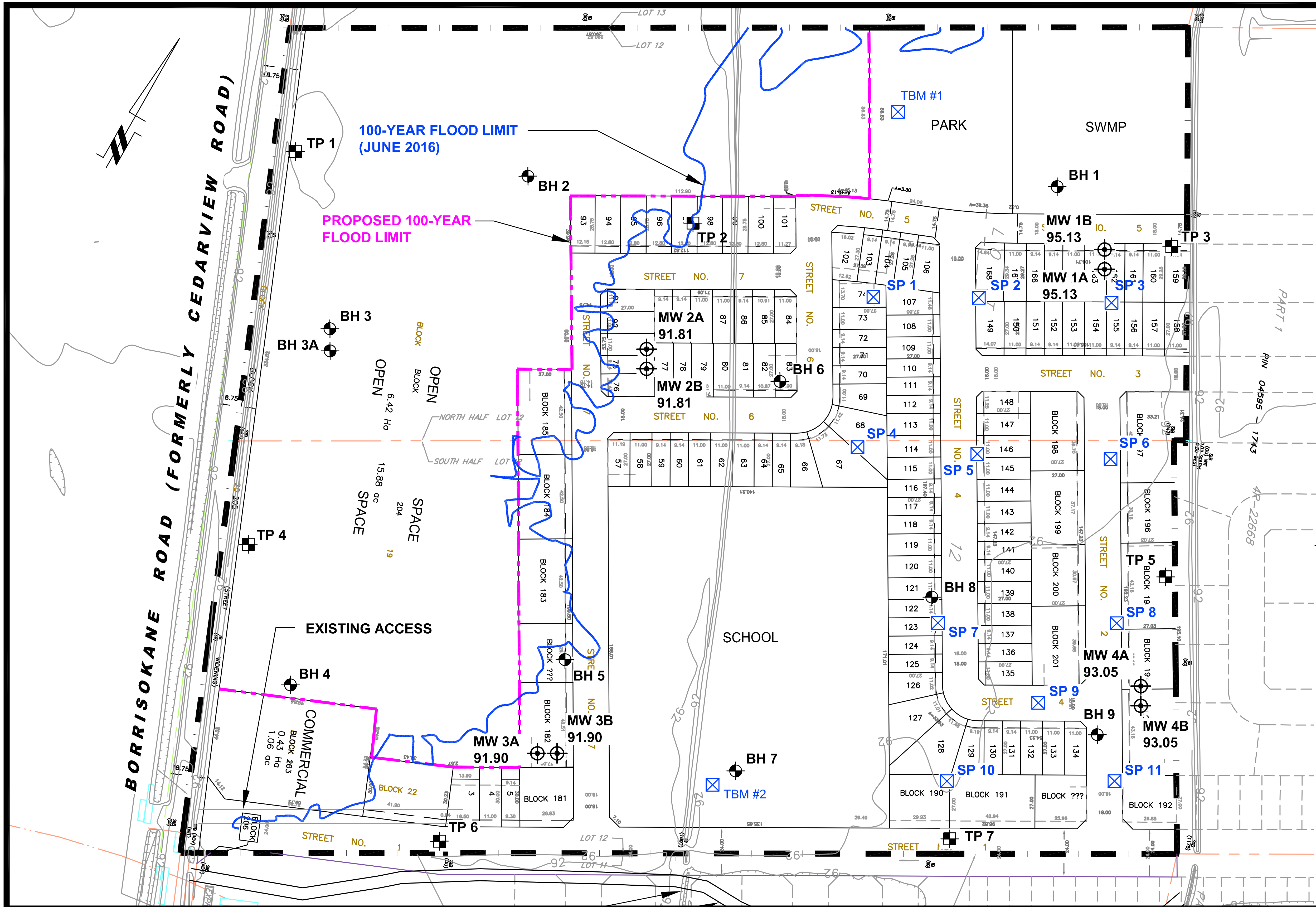

LEGEND:

▣	TEST PIT LOCATION (PATERSON GROUP REPORT PG3621-1, 09/2015)
⊕	BOREHOLE LOCATION (PATERSON REPORT PG1604-1
☒	APPROXIMATE SETTLEMENT PLATE LOCATION
⊕	MONITORING WELL LOCATION

TBM #1: TOP OF ROD OF SETTLEMENT PLATE NEAR NORTH PROPERTY CORNER ALONG SILT FENCE

TBM #2: TOP OF ROD OF SETTLEMENT PLATE NEAR THE SOUTH-CENTRAL PORTION OF THE PROPERTY

BASE PLAN PROVIDED BY DSEL.

SCALE: 1:2000

0 25 50 75 100 125 150m

patersongroup
consulting engineers

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

NO.	REVISIONS	DATE	INITIAL
4	BASE PLAN UPDATED	08/05/2017	RG
3	BASE PLAN UPDATED & MONITORING WELL ADDED	27/03/2017	RG
2	UPDATED TO INCLUDE TBM #2	29/11/2016	RG
1	ADDITIONAL SETTLEMENT PLATES PLACED IN PHASE II	25/11/2016	RG

GLENVIEW HOMES
SETTLEMENT SURCHARGE MONITORING PROGRAM
3387 BORRISOKANE ROAD
OTTAWA, ONTARIO

Title:
SETTLEMENT PLATE LOCATION PLAN

Scale: 1:2000
Date: 11/2016
Drawn by: RCG
Report No.: PG3621
Checked by: RG
Dwg. No.: **PG3621-2**
Approved by: RG
Revision No.: 4

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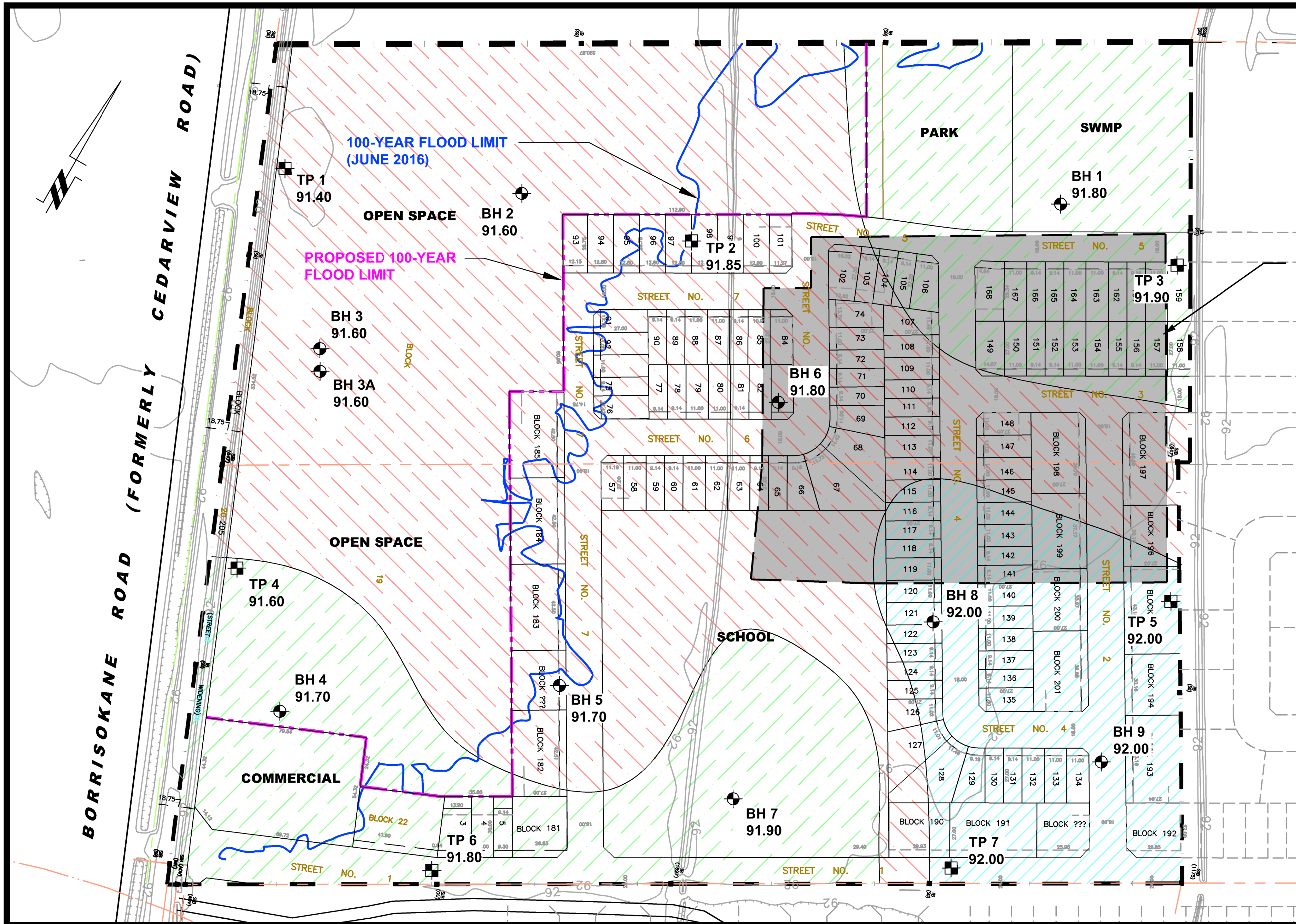

PERMISSIBLE GRADE RAISE:

🟩 UP TO 0.6m

🟥 UP TO 1.0m

🟦 UP TO 1.2m

LEGEND:

⊞ TEST PIT LOCATION, CURRENT INVESTIGATION

⊕ BOREHOLE LOCATION, PREVIOUS INVESTIGATION (PATERSON REPORT PG1604-1, 04/2011)

BASEPLAN PROVIDED BY STANTEC GEOMATICS LTD.

GROUND SURFACE ELEVATIONS BASED ON ANNIS O'SULLIVAN VOLLEBEKK LTD. TOPOGRAPHIC SURVEY (DEC 2015).

SCALE: 1:2000

0 25 50 75 100 125 150m

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patersongroup
consulting engineers

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

NO.	REVISIONS	DATE	INITIAL
2	BASE PLAN UPDATED	28/04/2017	DJG
1	BASE PLAN UPDATED	29/09/2016	FA

GLENVIEW HOMES (CEDARVIEW) LIMITED
PROPOSED RESIDENTIAL DEVELOPMENT
3387 BORRISOKANE ROAD

OTTAWA, ONTARIO

Title:

PERMISSIBLE GRADE RAISE PLAN

Scale: 1:2000
Date: 09/2016
Drawn by: RCG
Report No.: PG3621
Checked by: CB
Dwg. No.: PG3621-3
Approved by: DJG
Revision No.: 2