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Geotechnical Engineering

Environmental Engineering

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Building Science

Archaeological Services

Geotechnical Investigation

Proposed Commercial Development
Half Moon Bay - Cambrian Road
Ottawa, Ontario

Prepared For

Metro Ontario Inc.
and DIR Investments

July 29, 2020

Report: PG2037-1 - Revision 1

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1.0 Introduction

Paterson Group (Paterson) was commissioned by Metro Ontario Inc. and DIR Investments to conduct a geotechnical investigation for the proposed commercial development to be located along Cambrian Road within the Half Moon Bay development, in the City of Ottawa, Ontario (refer to Figure 1 - Key Plan in Appendix 2).

The objectives of the current investigation were:

- ❏ determine the subsoil and groundwater conditions at this site by means of boreholes,
- ❏ to provide geotechnical recommendations pertaining to design of the proposed development including construction considerations which may affect the design.

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

Investigating the presence or potential presence of contamination on the subject property was not part of the scope of work of this present investigation.

2.0 Proposed Development

It is understood that the proposed commercial development will be located to the east of the intersection of Cambrian Road and future Greenbank Road. According to the latest available conceptual drawing provided by Metro Ontario Inc., the north parcel located at the northeast corner of the intersection consists of two (2) commercial buildings and a bank of slab-on-grade construction.

The south parcel located at the southeast corner of the intersection consists of three (3) commercial buildings (Retail A, Retail B and Retail C) with an adjoining Metro Food Store to Retail A within the south portion of the parcel. Associated access lanes, parking and landscaped areas are also anticipated.

It is further understood that the proposed development will be serviced with municipal water and sewer.

3.0 Method of Investigation

3.1 Field Investigation

Field Program

The field program for the geotechnical investigation was carried out on March 1 to 3, 2010. At that time, seven (7) boreholes were completed across the subject site. The test hole locations were chosen by Paterson in a manner to provide general coverage of the subject site. The locations of the test holes are shown on Drawing PG2037-1 - Test Hole Location Plan included in Appendix 2. Borehole and test pit locations completed as part of previous investigations have been included in our current investigation and are presented in Drawing PG2037-1 - Test Hole Location Plan in Appendix 2 and in Soil Profile and Test Data sheets in Appendix 1.

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

Sampling and In Situ Testing

Soil samples were recovered from the auger flights, a 50 mm diameter split-spoon sampler, or a 73 mm diameter thin walled Shelby tube in combination with a piston sampler. The split-spoon samples were classified on site and placed in sealed plastic bags. The Shelby tubes were sealed at both ends. All samples were transported to our laboratory. The depths at which the auger flight, split-spoon, and Shelby tube samples were recovered from the boreholes are depicted as AU, SS, and TW, respectively, on the Soil Profile and Test Data sheets in Appendix 1.

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

Undrained shear strength testing, using a vane apparatus, was carried out at regular intervals of depth in cohesive soils.

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

The thickness of the overburden was evaluated by dynamic cone penetration testing (DCPT) at BH 2. The DCPT consists of driving a steel drill rod, equipped with a 50 mm diameter cone at its tip, using a 63.5 kg hammer falling from a height of 760 mm. The number of blows required to drive the cone into the soil is recorded for each 300 mm increment.

Groundwater

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

Sample Storage

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

3.2 Field Survey

The test hole locations were selected in the field by Paterson personnel in a manner to provide general coverage of the proposed development taking into consideration site features. The ground surface elevations at the test hole locations and the test hole locations were surveyed by Annis, O'Sullivan and Vollebekk. It is understood that all elevations are referenced to a geodetic datum. The locations and ground surface elevations of the test holes are presented on Drawing PG2037-1 - Test Hole Location Plan 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. Three (3) Shelby tube samples were submitted for unidimensional consolidation. The results of the consolidation testing are discussed in Subsection 5.3 and are presented in Appendix 1.

4.0 Observations

4.1 Surface Conditions

At the present time, the south portion of the subject parcel located to the southeast of the intersection of Cambrian Road and future Greenbank Road is currently undergoing a surcharge settlement monitoring program initiated in July, 2020 upon completion of the previous test fill monitoring program from November, 2016 to June, 2020. The current settlement surcharge monitoring program is located within the footprint of the proposed Metro Building and adjoining Retail A. Details of the ongoing settlement surcharge monitoring program is further illustrated on Drawing PG2037-3 - Settlement Surcharge Monitoring Program. The remaining portion of the south parcel is approximately at grade with the Cambrian Road and overlain by varying thickness of fill material.

The portion of the subject site north of Cambrian Road is relatively flat and undeveloped aside from construction access roads from Cambrian Road to the Half Moon Bay development. The north parcel was observed to be covered with fill extending to depths varying between 1.4 m to 2.0 m according to BH 6 and BH 7.

4.2 Subsurface Profile

Generally, the soil conditions encountered at the test hole locations consist of a silty clay with gravel fill overlying a sensitive silty clay deposit. Glacial till was encountered below the silty clay deposit at BH 1, BH 2, BH 5 to BH 7 at depths varying between 5.2 m and 8.4 m depth. Practical refusal to DCPT was encountered at a 13 m depth at BH 2. Reference should be made to the Soil Profile and Test Data sheets in Appendix 1 for the details of the soil profile encountered at each test hole.

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 15 m depth.

4.3 Groundwater

A standpipe was installed in all boreholes for the current investigation. The groundwater level (GWL) readings are presented in Table 1. It is important to note that groundwater level readings could be influenced by surface water infiltrating the backfilled borehole. 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 groundwater table is expected between a 1 to 2 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 1 - Summary of Groundwater Level Readings

Borehole Number	Ground Elevation (m)	Groundwater Levels (m)		Recording Date
		Depth	Elevation	
BH 1	92.99	0.52	92.47	March 8, 2010
BH 2	94.07	1.47	92.60	March 8, 2010
BH 3	93.83	1.18	92.65	March 8, 2010
BH 4	93.74	2.58	91.16	March 8, 2010
BH 5	93.75	1.64	92.11	March 8, 2010
BH 6	94.09	2.40	91.69	March 8, 2010
BH 7	93.78	2.04	91.74	March 8, 2010

Note: The ground surface elevations at the test hole locations were surveyed by Annis, O'Sullivan and Vollebekk. It is understood all elevations are referenced to a geodetic datum.

5.0 Discussion

5.1 Geotechnical Assessment

From a geotechnical perspective, the subject site is satisfactory for the proposed development. It is expected that footings will be placed over a stiff silty clay or reinforced granular pad to increase the bearing capacity for areas where soft soil conditions are encountered at footing level.

Permissible grade raise restrictions are required for this site due to the underlying silty clay deposit. Due to the anticipated permissible grade raise exceedance for the Metro and adjoining Retail A building, a settlement surcharge program was initiated for a portion of the future Metro building in November 2016. The remainder of the surcharge program for the future Metro and adjoining Retail A building has been initiated in July 2020. Details of the surcharge program are discussed in Subsection 5.3.

The above and other considerations are discussed in the following paragraphs

5.2 Site Grading and Preparation

Stripping Depth

Topsoil and fill, containing deleterious 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 buildings should be compacted to at least 98% of its standard Proctor maximum dry density (SPMDD).

An assessment of the existing fill should be carried out to determine suitability for reuse within the future parking areas. Existing fill, free of significant amounts of organic materials, should be proof-rolled using a sheepsfoot roller making several passes and approved by Paterson personnel at the time of construction. Any poor performing areas should be removed and reinstated with a Granular B Type II compacted to 98% of its SPMDD.

Furthermore, the fill can also be assessed by the geotechnical consultant at the time of construction, once the footing excavations are completed and a large area of the fill is exposed. If the fill is considered to be acceptable by the geotechnical consultant, it could be left in place below the floor slab (but only outside the zones of influence of the footings). The zone of influence of a footing is considered to extend out and down from the bottom edges of the footing, at a slope of 1H:1V or shallower, to the in situ soil.

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

Conventional Spread Footings

Pad footings, up to 5 m wide, and strip footings, up to 2.5 m wide, placed over an undisturbed, stiff silty clay bearing surface can be designed using a bearing resistance value at SLS of **100 kPa** and a factored bearing resistance value at ULS of **250 kPa**.

For areas where soft soil conditions or existing fill is encountered at footing level, it is recommended to place a reinforced granular pad over an approved subgrade surface. The reinforced granular pad should extend at least 500 mm below design USF level and extend at least 1.5 m horizontally beyond the footing face. A woven geotextile liner, such as Terratrack 200 or equivalent, followed by a biaxial geogrid, consisting of a Geosynthetics TBX2500 or equivalent, over the sub-excavated surface. A Granular B Type II placed in maximum 300 mm loose lifts and compacted to 98% of its SPMDD should be placed up to design USF level and cover the biaxial geogrid layer. Footings placed over an approved reinforced granular pad can be designed using a bearing resistance value at SLS of **100 kPa** and a factored bearing resistance value at ULS of **250 kPa**.

A geotechnical resistance factor of 0.5 was applied to the above noted bearing resistance values at ULS. Footings designed using the above-noted bearing resistance value at SLS will be subjected to potential post-construction total and differential settlements of 25 and 20 mm, respectively.

An undisturbed soil bearing surface consists of a surface from which all topsoil and deleterious materials, such as loose, frozen or disturbed soil, whether in situ or not, have been removed, in the dry, prior to the placement of concrete for footings.

Lateral Support

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

Permissible Grade Raise Recommendations

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. Three (3) site specific consolidation tests were completed for this project and seven (7) consolidation tests were completed for previous investigations. The results of the consolidation tests are presented Table 4 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.

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.

Table 2 - Summary of Consolidation Test Results

Borehole No.	Sample	Depth (m)	p'_c (kPa)	p'_o (kPa)	C_{cr}	C_c	Q (*)
BH 1	TW 3	4.4	111	39	0.016	1.94	G
BH 4	TW 6	7.5	98	64	0.010	0.506	G
BH 6	TW 4	4.2	69	28	0.017	0.954	G
BH 31-08	TW 6	5.7	61	25	0.014	0.912	G
BH 3-07	TW 3	2.5	81	34	0.014	0.55	G
BH 3-07	TW 4	4.2	71	45	0.013	0.253	A
BH 4-07	TW 5	4.9	100	54	0.013	0.834	G
BH 6B-06	TW 1	2.7	101	32	0.014	1.527	G
BH 7-07	TW 4	5.8	120	66	0.015	1.263	G
BH 10-07	TW 5	5	100	56	0.023	2.626	G

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

Our permissible grade raise recommendations are based on the results of the consolidation testing and subsoil conditions noted at the current borehole locations. It should be noted that the overburden presssure for the consolidation testing excludes the existing fill layer at surface. Our permissible grade raise areas are presented in Drawing PG2037-2 - Test Hole Location Plan in Appendix 2.

A post-development groundwater lowering of 0.5 m was considered for our permissible grade raise restrictions. To reduce potential long term liabilities, consideration should be given to accounting for a larger groundwater lowering and to providing 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.

Settlement Surcharge Monitoring Program

A settlement surcharge monitoring program is underway for the proposed Metro Building and adjoining Retail A Building (refer to Drawing PG2037-3 - Settlement Surcharge Monitoring Program in Appendix 2). The surcharge program was initiated in November 2016 within the northeast portion of the future Metro building. That portion of the surcharge program was deemed completed in June 2020. At that time, the surcharge material located above the design finished floor slab was removed and placed to build up the subgrade level across the remainder of the building footprint. Details of the settlement surcharge monitoring program for the current surcharge program are presented below:

- The existing fill and underlying topsoil were stripped from within the building footprint to expose the in situ silty clay bearing medium.
- A select subgrade material (SSM) was brought up to approximately 500 mm below the inferred finished concrete floor slab, capped with 350 mm of OPSS Granular B Type II. The remaining surcharge material consisted of the excess generated from the previous surcharge program and fill material to satisfy the recommended 2 m surcharge height above the inferred finished floor elevation of 94.50 m.
- Six (6) settlement plates identified as SP1 to SP6 were strategically installed within the surcharge program to monitor settlement.
- One (1) temporary benchmark (TBM) was installed in the southeast corner of the site.
- Settlement will be monitored on a monthly basis throughout the duration of the surcharge program.

5.4 Design for Earthquakes

The proposed buildings can be designed using a seismic site response **Class E** as defined in the Ontario Building Code 2012 (OBC 2012; Table 4.1.8.4.A) for foundations considered at this site. A higher site class, such as **Class D**, could be applicable for this subject site. However, this should be confirmed with site specific shear wave velocity testing. The soils underlying the site are not susceptible to liquefaction.

5.5 Slab on Grade Construction

With the removal of topsoil and fill, containing organic materials, within the footprint of the proposed buildings, the native soil surface or or existing fill, approved by the geotechnical consultant, will be considered to be an acceptable subgrade surface on which to commence backfilling for slab on grade construction. Any soft areas should be removed and backfilled with appropriate backfill material. OPSS Granular A or Granular B Type II 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. All backfill materials within the footprint of the proposed buildings should be placed in maximum 300 mm thick loose layers and compacted to at least 98% of its SPMDD.

5.6 Pavement Structure

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

Table 3 - Recommended Pavement Structure - Car Only Parking Areas

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

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

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

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

If soft spots develop in the subgrade during compaction or due to construction traffic, the affected areas should be excavated and replaced with OPSS Granular B Type 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 silty clay subgrade materials, consideration should be given to installing subdrains during the pavement construction as per City of Ottawa standards. The sub-drain 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 buildings. The system should consist of a 100 to 150 mm diameter, geotextile wrapped, perforated, corrugated, plastic pipe, surrounded on all sides by 150 mm of 10 to 19 mm clear crushed stone, placed at the footing level around the exterior perimeter of the structure. The pipe should have a positive outlet, such as a gravity connection to the storm sewer.

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

6.2 Protection of Footings Against Frost Action

Perimeter footings of heated structures are required to be insulated against the deleterious effect of frost action. A minimum of 1.5 m thick soil cover (or equivalent) should be provided in this regard.

A minimum of 2.1 m thick soil cover (or equivalent) should be provided for exterior unheated footings, not thermally connected to a heated space, such as exterior columns and/or wing walls.

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

Excavated soil should not be stockpiled directly at the top of excavations and heavy equipment should be kept away from the excavation sides.

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

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

6.4 Pipe Bedding and Backfill

At least 150 mm of OPSS Granular A should be used for pipe bedding for sewer and water pipes. The bedding should extend to the spring line of the pipe. Cover material, from the spring line to at least 300 mm above the obvert of the pipe should consist of OPSS Granular A. The bedding and cover materials should be placed in maximum 225 mm thick lifts compacted to a minimum of 95% of the material's SPMDD.

Generally, it should be possible to re-use the silty sand and silty clay above the cover material if the excavation and filling operations are carried out in dry weather conditions.

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 where services are completed within the silty clay deposit, 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

It is anticipated that groundwater infiltration into the excavations should be controllable using open sumps. 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 Environment, Conservation and Parks (MECP) permit to take water (PTTW) may be required if more than 400,000 L/day of ground and/or surface water are to be pumped during the construction phase. At least 4 to 5 months should be allowed for completion of the application and issuance of the permit by the MECP.

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

6.6 Winter Construction

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

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

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

7.0 Recommendations

It is a requirement for the foundation design data provided herein to be applicable that a materials testing and observation services program including the following aspects be performed by the geotechnical consultant.

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

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

8.0 Statement of Limitations

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

A soils investigation is a limited sampling of a site. Should any conditions at the site be encountered which differ from those at the test locations, we request immediate notification 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 Metro Ontario Inc. and DIR Investments or their agents is not authorized without review by Paterson for the applicability of our recommendations to the alternative use of the report.

Paterson Group Inc.

Richard Groniger, C. Tech.

David J. Gilbert, P.Eng.

Report Distribution:

- ❑ Metro Ontario Inc. (3 copies)
- ❑ Paterson Group (1 copy)

APPENDIX 1

SOIL PROFILE AND TEST DATA SHEETS

SYMBOLS AND TERMS

CONSOLIDATION TESTING SHEETS

patersongroup Consulting Engineers

28 Concourse Gate, Unit 1, Ottawa, ON K2E 7T7

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Proposed Commercial Development-Cambrian Road
Ottawa, Ontario

DATUM Ground surface elevations at test hole locations provided by Annis, O'Sullivan, Vollebekk Ltd.

REMARKS

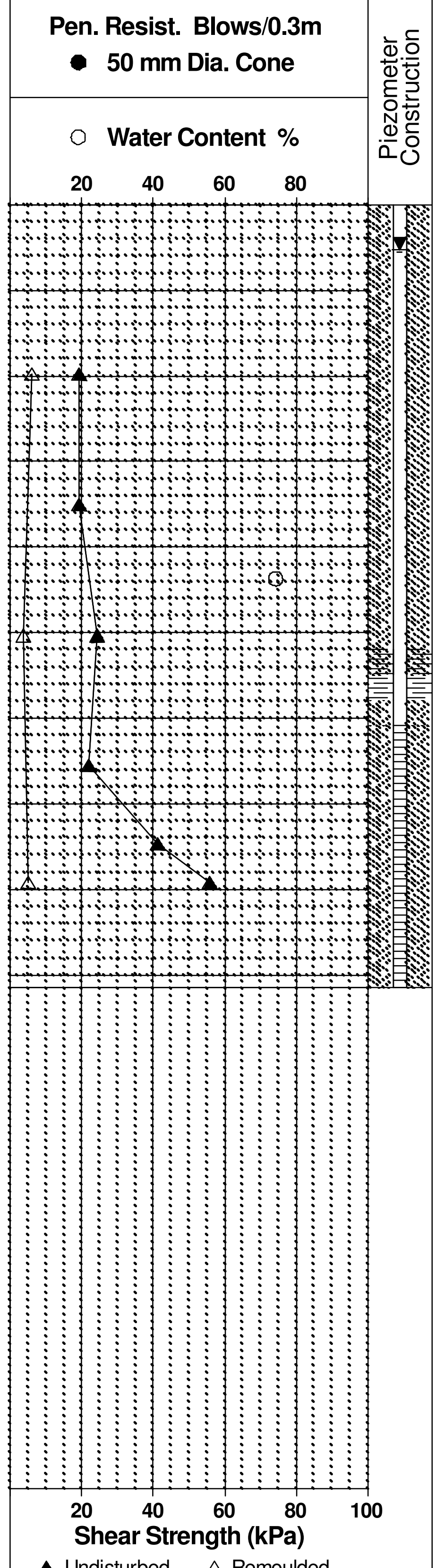
BORINGS BY CME 55 Power Auger

DATE 1 March 2010

FILE NO. PG2037

HOLE NO. BH 1

SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NUMBER	% RECOVERY	N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE					0	92.99
TOPSOIL 0.28						
Brown **SILTY SAND** with clay 0.60						
Stiff, grey-brown **SILTY CLAY** with sand seams 1.52	SS	1	100	2	1	91.99
					2	90.99
	TW	2	94			
					3	89.99
					4	88.99
Soft, grey **SILTY CLAY,** some to trace sand seams	TW	3	94			
					5	87.99
	TW	4	100			
					6	86.99
- firm to stiff by 7.0m depth					7	85.99
8.38					8	84.99
GLACIAL TILL: Stiff/compact, grey silty clay with sand, gravel, cobbles and boulders 9.14	SS	5	25	9	9	83.99
End of Borehole						
(GWL @ 0.52m-March 8/10)						



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28 Concourse Gate, Unit 1, Ottawa, ON K2E 7T7

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Proposed Commercial Development-Cambrian Road
Ottawa, Ontario

DATUM Ground surface elevations at test hole locations provided by Annis, O'Sullivan, Vollebekk Ltd.

REMARKS

BORINGS BY CME 55 Power Auger

DATE 1 March 2010

FILE NO. PG2037

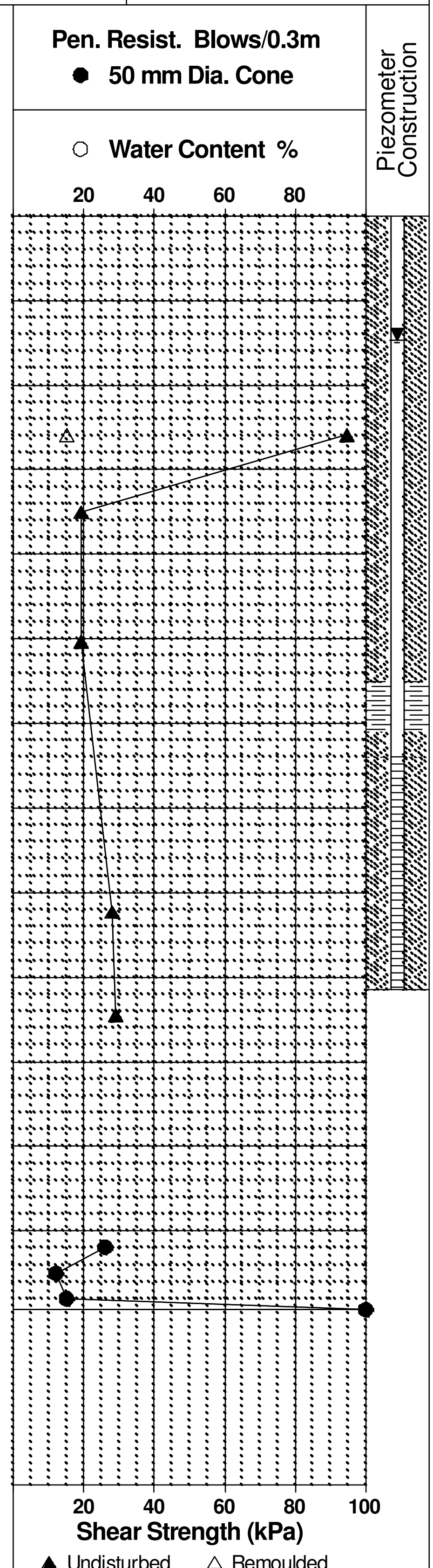
HOLE NO. BH 2

SOIL DESCRIPTION		SAMPLE TYPE	NUMBER	% RECOVERY	N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	94.07
FILL: Brown silty clay with sand, gravel and topsoil, trace wood	1.80	SS	1	42	4	1	93.07
Loose, grey-brown **SILTY SAND,** trace clay	2.29	SS	2	42	4	2	92.07
Stiff, grey-brown **SILTY CLAY,** some sand	2.90					3	91.07
Soft to firm, grey **SILTY CLAY,** some to trace sand seams	9.45	TW	3	92		4	90.07
						5	89.07
						6	88.07
		TW	4	0		7	87.07
		TW	5	100			
						8	86.07
						9	85.07
Dynamic Cone Penetration Test commenced @ 9.45m depth. Cone pushed to 11.3m depth.	12.93					10	84.07
						11	83.07
						12	82.07
End of Borehole							

End of Borehole

Practical DCPT refusal @ 12.93m depth

(GWL @ 1.47m-March 8/10)



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28 Concourse Gate, Unit 1, Ottawa, ON K2E 7T7

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Proposed Commercial Development-Cambrian Road
Ottawa, Ontario

DATUM Ground surface elevations at test hole locations provided by Annis, O'Sullivan, Vollebekk Ltd.

REMARKS

BORINGS BY CME 55 Power Auger

DATE 2 March 2010

FILE NO. PG2037

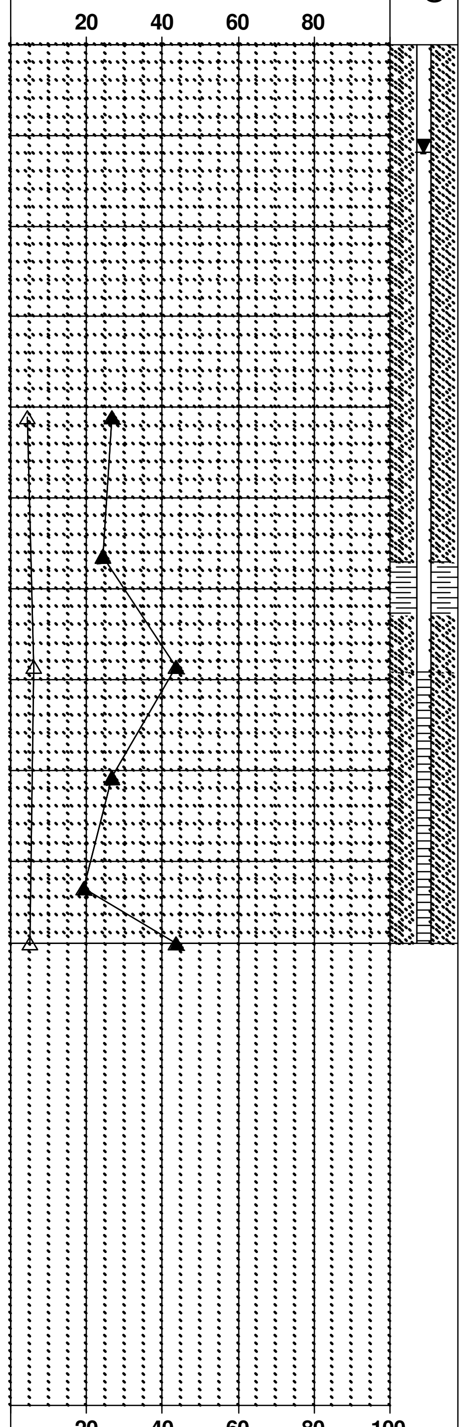
HOLE NO. BH 3

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	% RECOVERY	N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	93.83
FILL: Brown silty clay with topsoil		SS	1	38	4	1	92.83
1.73							
TOPSOIL		SS	2	42	3	2	91.83
1.85							
Very loose, brown to grey **SILTY SAND**							
2.21							
Firm to stiff, brown **SILTY CLAY** with sand and sand seams		SS	3	83	1	3	90.83
2.97							
Firm, grey **SILTY CLAY,** some to trace sand seams		TW	4	96		4	89.83
		TW	5	96		5	88.83
		TW	6	98		6	87.83
						7	86.83
						8	85.83
						9	84.83
9.91							
End of Borehole							
(GWL @ 1.18m-March 8/10)							

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

○ Water Content %

Piezometer Construction



Shear Strength (kPa)
▲ Undisturbed △ Remoulded

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28 Concourse Gate, Unit 1, Ottawa, ON K2E 7T7

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Proposed Commercial Development-Cambrian Road
Ottawa, Ontario

DATUM Ground surface elevations at test hole locations provided by Annis, O'Sullivan, Vollebekk Ltd.

REMARKS

BORINGS BY CME 55 Power Auger

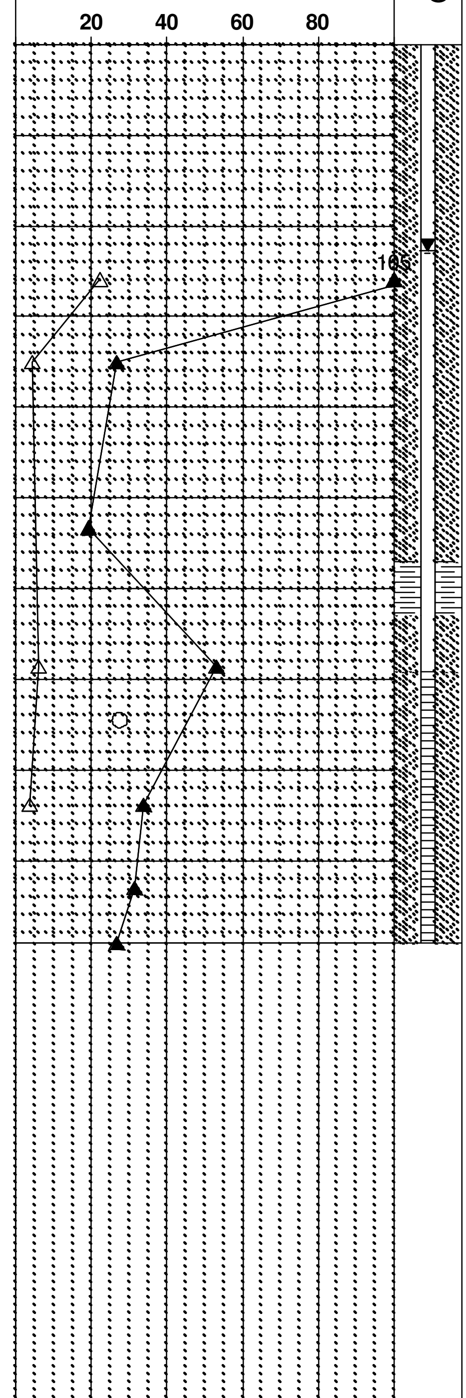
DATE 2 March 2010

FILE NO. PG2037

HOLE NO. BH 4

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	% RECOVERY	N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	93.74
FILL: Brown silty clay with sand, gravel, cobbles and boulders — 1.45		SS	1	50	6	1	92.74
Very stiff, brown **SILTY CLAY,** some sand and sand seams — 2.90		SS	2	67	13	2	91.74
						3	90.74
Firm, grey **SILTY CLAY,** some to trace sand seams		TW	3	0		4	89.74
		TW	4	0			
						5	88.74
		TW	5	83		6	87.74
						7	86.74
		TW	6	67		8	85.74
9.91						9	84.74
End of Borehole							
(GWL @ 2.58-March 8/10)							

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



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

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28 Concourse Gate, Unit 1, Ottawa, ON K2E 7T7

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Proposed Commercial Development-Cambrian Road
Ottawa, Ontario

DATUM Ground surface elevations at test hole locations provided by Annis, O'Sullivan, Vollebekk Ltd.

REMARKS

BORINGS BY CME 55 Power Auger

DATE 2 March 2010

FILE NO. PG2037

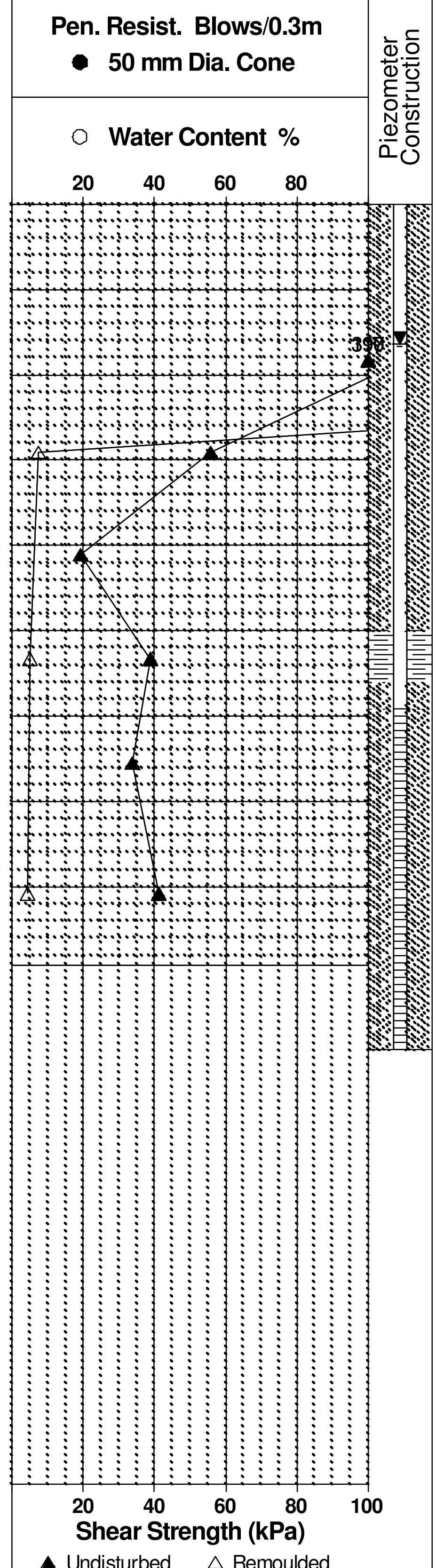
HOLE NO. BH 5

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	% RECOVERY	N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	93.75
FILL; Brown silty clay, some sand, gravel and cobbles		SS	1	75	4	1	92.75
1.32							
Very stiff to stiff, brown **SILTY CLAY**						2	91.75
2.97						3	90.75
Soft to firm, grey **SILTY CLAY,** trace sand seams		TW	2	96			
		TW	3	92		4	89.75
						5	88.75
						6	87.75
						7	86.75
8.15						8	85.75
GLACIAL TILL: Very stiff/compact, grey silty clay with sand, gravel, cobbles and boulders		SS	4	17	16		
8.92							

End of Borehole

Practical refusal @ 8.92m depth

(GWL @ 1.64m-March 8/10)



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SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Proposed Commercial Development-Cambrian Road
Ottawa, Ontario

DATUM Ground surface elevations at test hole locations provided by Annis, O'Sullivan, Vollebekk Ltd.

REMARKS

BORINGS BY CME 55 Power Auger

DATE 3 March 2010

FILE NO. PG2037

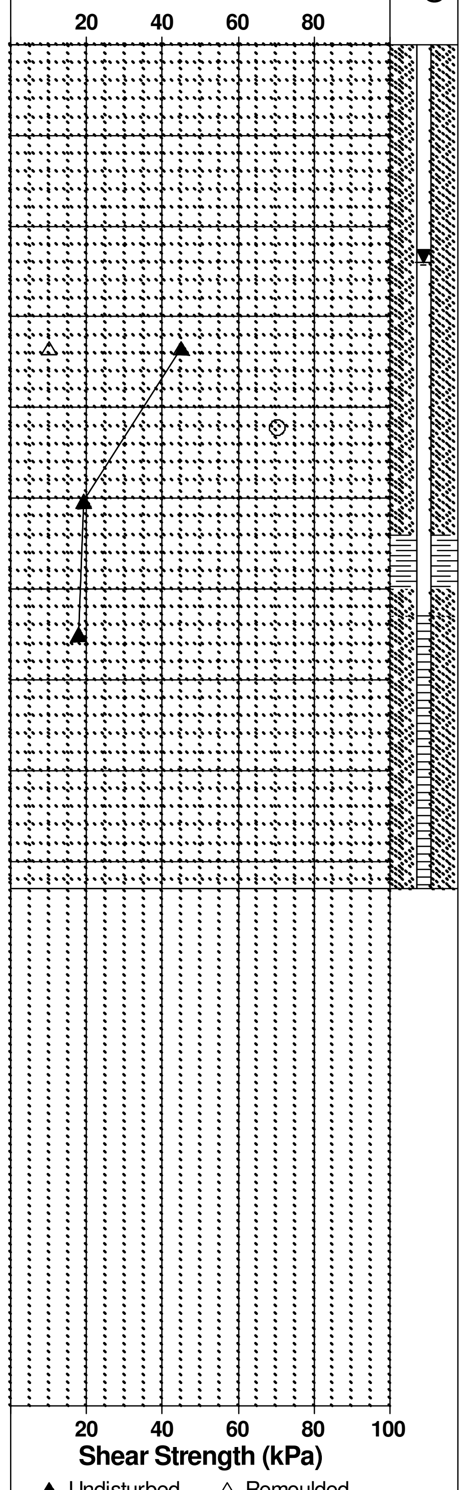
HOLE NO. BH 6

SOIL DESCRIPTION	SAMPLE TYPE	NUMBER	% RECOVERY	N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE					0	94.09
FILL: Brown silty clay, some sand, with gravel, cobbles, trace boulders (to 1.37)	SS	1	33	5	1	93.09
FILL: Brown silty sand with gravel, cobbles, trace boulders (to 1.98)	SS	2	50	34	2	92.09
Firm to stiff, brown **SILTY CLAY** with sand seams (to 3.96)	SS	3	83	4	3	91.09
Soft, grey **SILTY CLAY** (to 6.50)	TW	4	100		4	90.09
					5	89.09
	TW	5	100		6	88.09
GLACIAL TILL: Stiff/compact, grey silty clay with sand, gravel, cobbles and boulders (to 9.30)					7	87.09
	SS	6	4	3	8	86.09
	SS	7	50	4	9	85.09
End of Borehole						
(GWL @ 2.40m-March 8/10)						

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

○ Water Content %

Piezometer Construction



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28 Concourse Gate, Unit 1, Ottawa, ON K2E 7T7

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Proposed Commercial Development-Cambrian Road
Ottawa, Ontario

DATUM Ground surface elevations at test hole locations provided by Annis, O'Sullivan, Vollebekk Ltd.

REMARKS

BORINGS BY CME 55 Power Auger

DATE 3 March 2010

FILE NO. PG2037

HOLE NO. BH 7

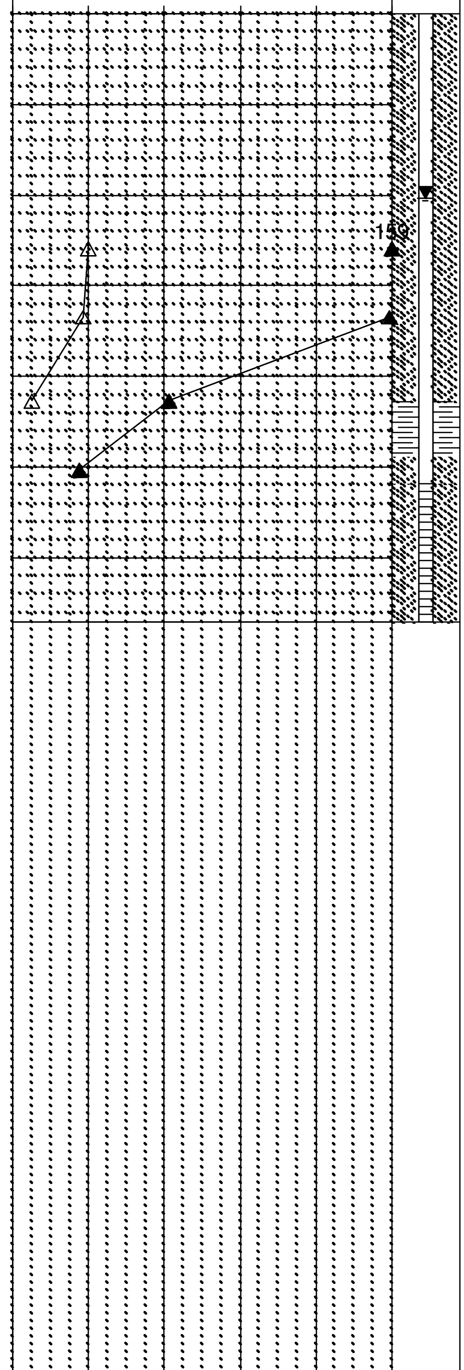
SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	% RECOVERY	N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	93.78
FILL: Brown silty clay, some sand and gravel 0.60							
FILL: Brown silty sand with gravel, cobbles and boulders 1.45		SS	1	50	50+	1	92.78
Very stiff to stiff, brown **SILTY CLAY** with sand and sand seams 3.66		SS	2	42	8	2	91.78
						3	90.78
Firm to soft, grey **SILTY CLAY** 5.20						4	89.78
						5	88.78
GLACIAL TILL: Stiff/compact, grey silty clay with sand, gravel, cobbles and boulders		SS	3	12	5	6	87.78
6.70		SS	4	25	14		
End of Borehole							
(GWL @ 2.04m-March 8/10)							

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

○ Water Content %

20 40 60 80

Piezometer Construction



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

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28 Concourse Gate, Unit 1, Ottawa, ON K2E 7T7

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Proposed Residential Development-Half Moon Bay
Ottawa, Ontario

DATUM Ground surface elevation at borehole locations provided by JD Barnes.

FILE NO. PG1618

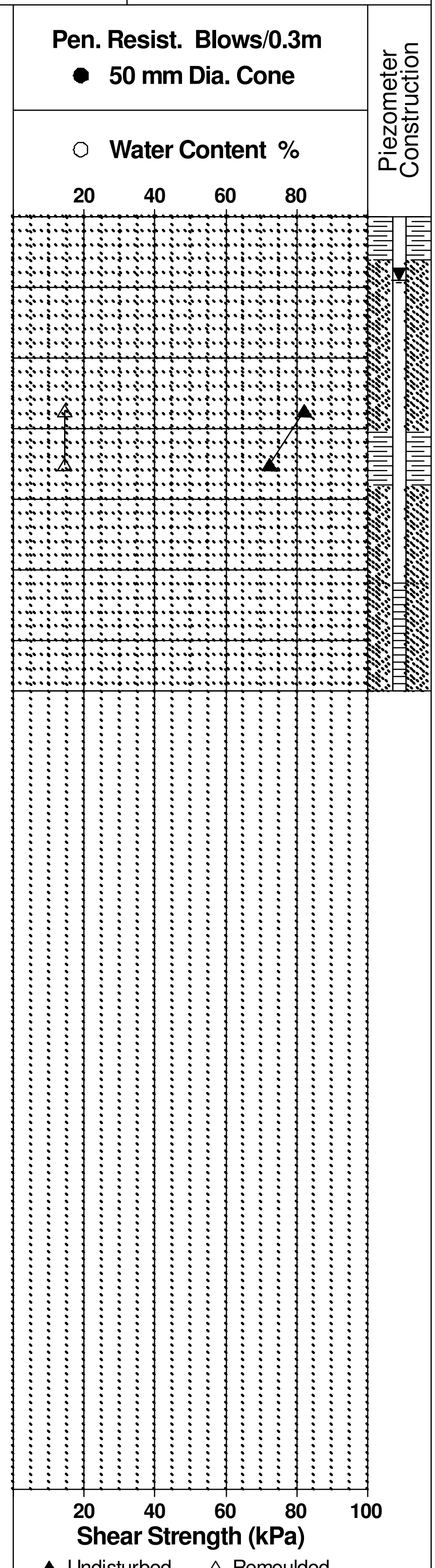
REMARKS

HOLE NO. BH26-08

BORINGS BY CME 55 Power Auger

DATE 20 February 2008

SOIL DESCRIPTION	Strata depth (m)	SAMPLE TYPE	NUMBER	% RECOVERY	N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	92.99
TOPSOIL	0.15	AU	1				
Brown **CLAYEY SILT**, some sand		SS	2	83	4	1	91.99
	2.13	SS	3	100	5	2	90.99
Firm to stiff brown **SILTY CLAY**						3	89.99
-grey by 3.1m depth	3.66						
		SS	4	67	9	4	88.99
GLACIAL TILL: Loose to compact, grey silty clay with gravel, cobbles and boulders		SS	5	67	4	5	87.99
						6	86.99
	6.71	SS	6	50	19		
End of Borehole							
(GWL @ 0.90m-Apr. 9/08)							



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28 Concourse Gate, Unit 1, Ottawa, ON K2E 7T7

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Proposed Residential Development-Half Moon Bay
Ottawa, Ontario

DATUM Ground surface elevation at borehole locations provided by JD Barnes.

FILE NO. **PG1618**

REMARKS

HOLE NO. **BH31-08**

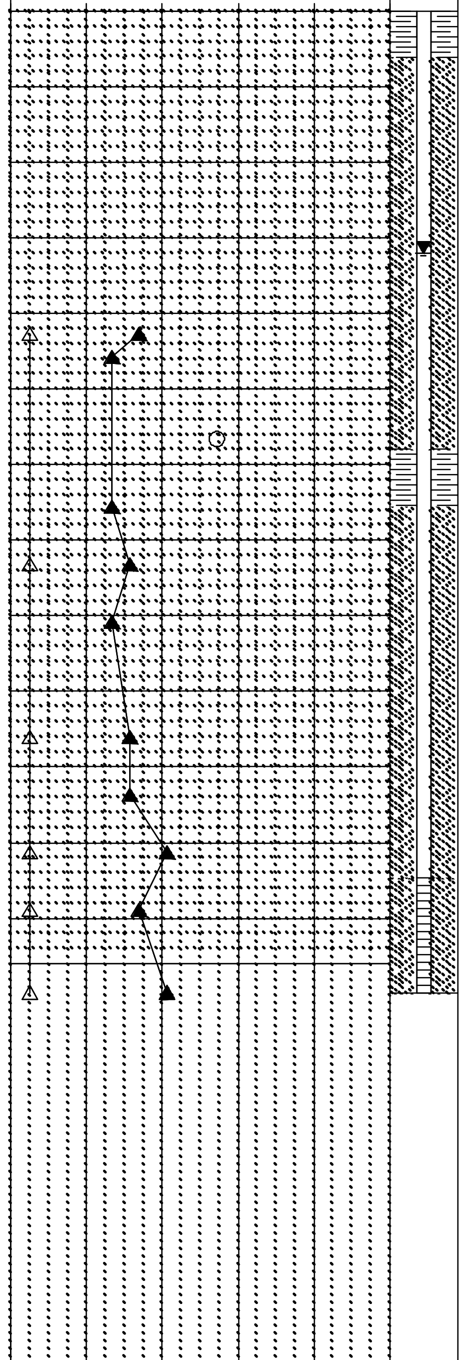
BORINGS BY CME 55 Power Auger **DATE** 31 March 2008

SOIL DESCRIPTION	SAMPLE TYPE	NUMBER	% RECOVERY	N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE					0	95.02
FILL: Brown silty sand with gravel and cobbles	AU	1				
	SS	2	8	2	1	94.02
	SS	3	67	8	2	93.02
	SS	4	25	10		
3.05					3	92.02
Grey **CLAYEY SILT** with sand	SS	5	100	8		
3.66						
Firm, brown **SILTY CLAY**					4	91.02
-grey by 4.3m depth					5	90.02
	TW	6	100			
					6	89.02
					7	88.02
					8	87.02
	TW	7	0			
					9	86.02
					10	85.02
					11	84.02
					12	83.02
12.98						
End of Borehole						
(GWL @ 3.21m-Apr. 9/08)						

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

○ Water Content %

20 40 60 80



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

Piezometer Construction

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SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Proposed Residential Development-Half Moon Bay
Ottawa, Ontario

DATUM Ground surface elevation at borehole locations provided by JD Barnes.

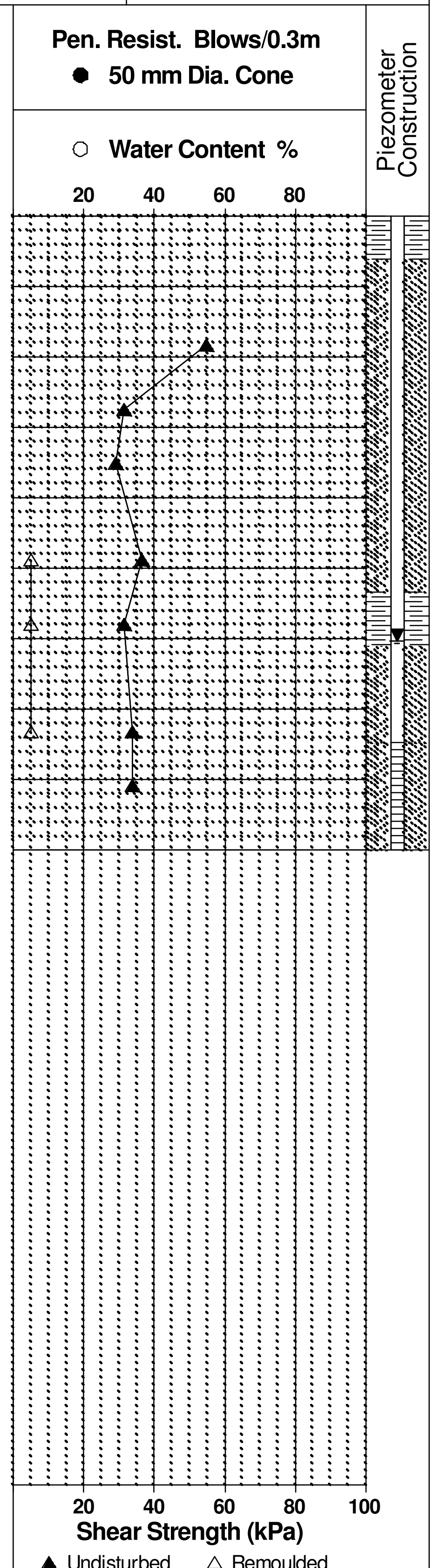
FILE NO. PG1618

REMARKS

HOLE NO. BH34-08

BORINGS BY CME 55 Power Auger **DATE** 31 March 2008

SOIL DESCRIPTION	Strata depth (m)	SAMPLE TYPE	NUMBER	% RECOVERY	N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	92.68
FILL: Brown silty sand with gravel	0.61						
Brown **CLAYEY SAND**	1.22	SS	1	0	6	1	91.68
Stiff, brown **SILTY CLAY**		SS	2		100		
- firm and grey by 1.7m depth						2	90.68
						3	89.68
		TW	3	88		4	88.68
						5	87.68
						6	86.68
		TW	4	100		7	85.68
						8	84.68
	8.92	SS	5	25	24		
End of Borehole							
(GWL @ 6.03m-Apr. 9/08)							



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28 Concourse Gate, Unit 1, Ottawa, ON K2E 7T7

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Proposed Residential Development-Half Moon Bay
Ottawa, Ontario

DATUM Ground surface elevations provided by J.D. Barnes Limited.

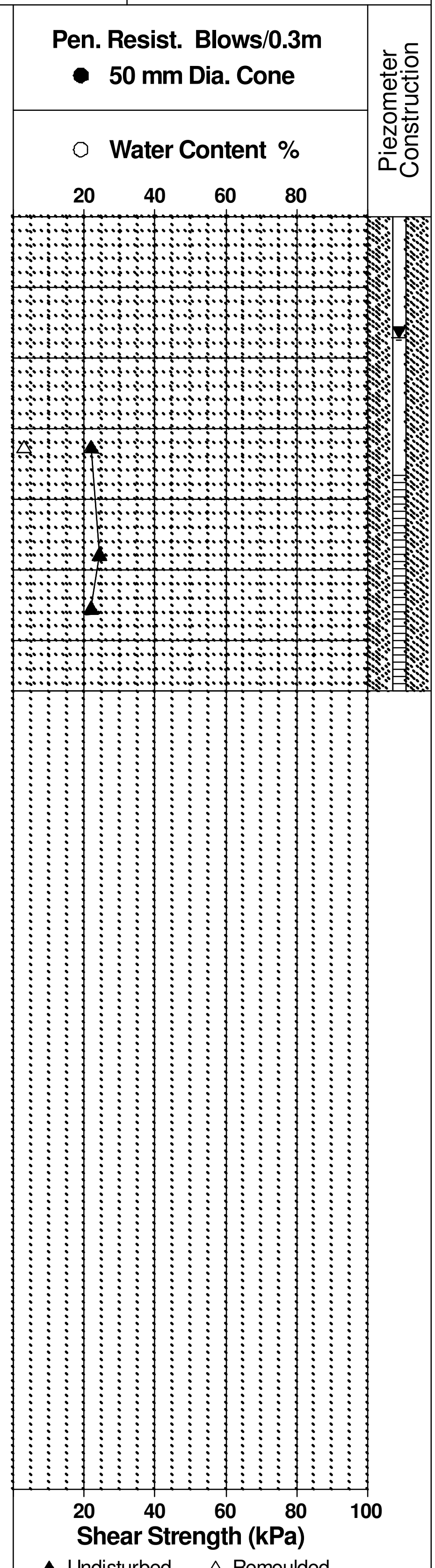
FILE NO. PG0177

REMARKS

HOLE NO. BH 3-07

BORINGS BY CME 75 Power Auger **DATE** 22 June 2007

SOIL DESCRIPTION	Depth to base (m)	SAMPLE TYPE	NUMBER	% RECOVERY	N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	92.67
TOPSOIL	0.36						
Loose, brown **SILTY SAND**, trace clay	1.52	SS	1	50	4	1	91.67
Firm, brown **SILTY CLAY**, some sand seams - soft and grey by 2.3m depth	6.25	SS	2	75	1	2	90.67
		TW	3	88		3	89.67
		TW	4	92		4	88.67
						5	87.67
						6	86.67
GLACIAL TILL: Stiff, grey silty clay with gravel, cobbles	6.71	SS	5	17	9		
End of Borehole (GWL @ 1.72-June 29/07)							



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SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Proposed Residential Development-Half Moon Bay
Ottawa, Ontario

DATUM Ground surface elevations provided by J.D. Barnes Limited.

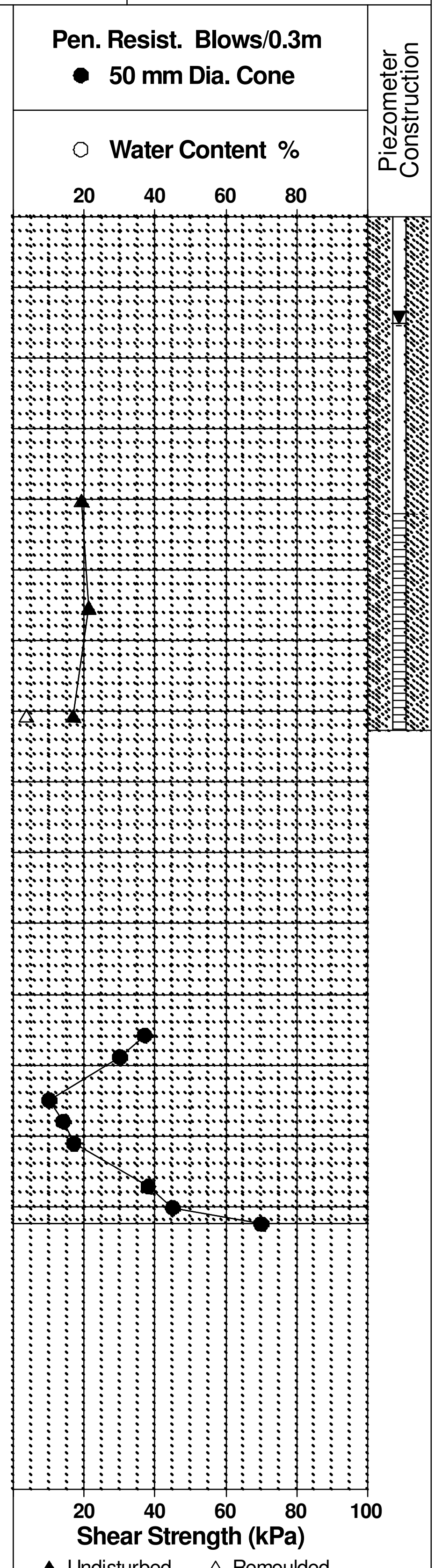
REMARKS

BORINGS BY CME 75 Power Auger **DATE** 22 June 2007

FILE NO. PG0177

HOLE NO. BH 4-07

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	% RECOVERY	N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	92.67
TOPSOIL 0.30							
Loose, brown **SILTY SAND**, trace clay		SS	1	100	3	1	91.67
1.98		SS	2	50	1	2	90.67
		SS	3	100	1		
		TW	4	96		3	89.67
						4	88.67
Firm to soft, grey **SILTY CLAY**, some sand		TW	5	96		5	87.67
						6	86.67
		SS	6	25	1		
7.26						7	85.67
Dynamic Cone Penetration Test commenced @ 7.26m depth. Cone pushed to 11.6m depth						8	84.67
						9	83.67
						10	82.67
						11	81.67
						12	80.67
						13	79.67
						14	78.67
14.25							
End of Borehole							
(GWL @ 1.51-June 29/07)							



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28 Concourse Gate, Unit 1, Ottawa, ON K2E 7T7

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Proposed Residential Development-Half Moon Bay
Ottawa, Ontario

DATUM Ground surface elevations provided by J.D. Barnes Limited.

REMARKS

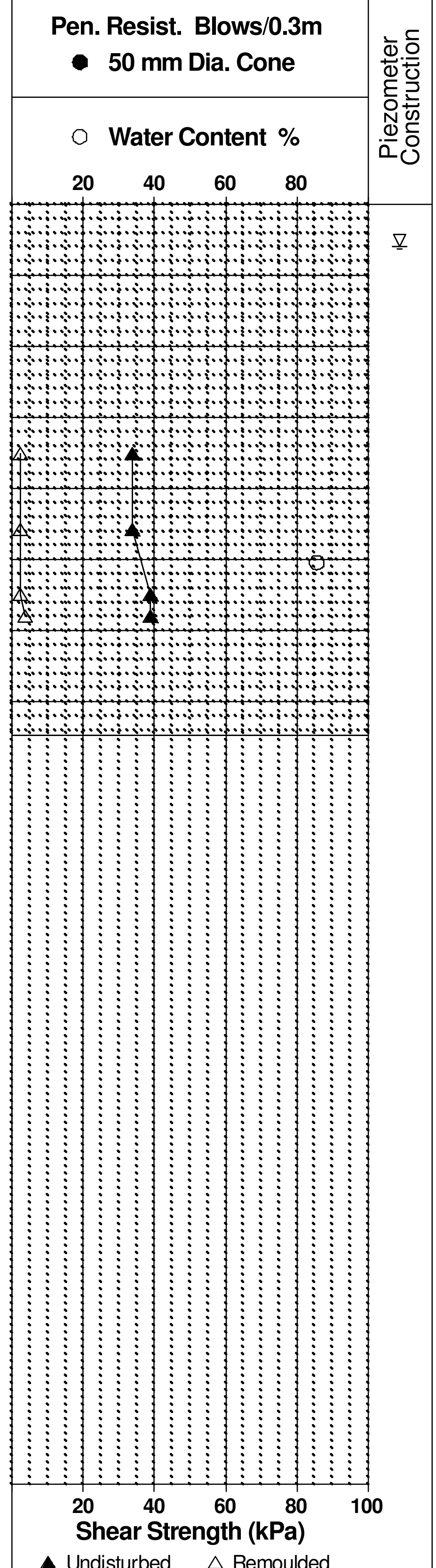
BORINGS BY CME 75 Power Auger

DATE 6 December 2007

FILE NO. PG0177

HOLE NO. BH10-07

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	92.98
Stiff, brown **SILTY CLAY**, some sand - firm and grey by 2.7m depth		AU	1				
		SS	2	100	3	1	91.98
		SS	3	100	3	2	90.98
		SS	4	100	1	3	89.98
						4	88.98
		TW	5	100		5	87.98
6.65						6	86.98
		SS	6	100	1		
GLACIAL TILL: Grey silty clay with gravel, cobbles 7.47		SS	7	75	14	7	85.98
End of Borehole (Open hole GWL @ 0.6m depth)							



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SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Proposed Residential Development-Half Moon Bay
Ottawa, Ontario

DATUM Ground surface elevations provided by J.D. Barnes Limited.

FILE NO. PG0177

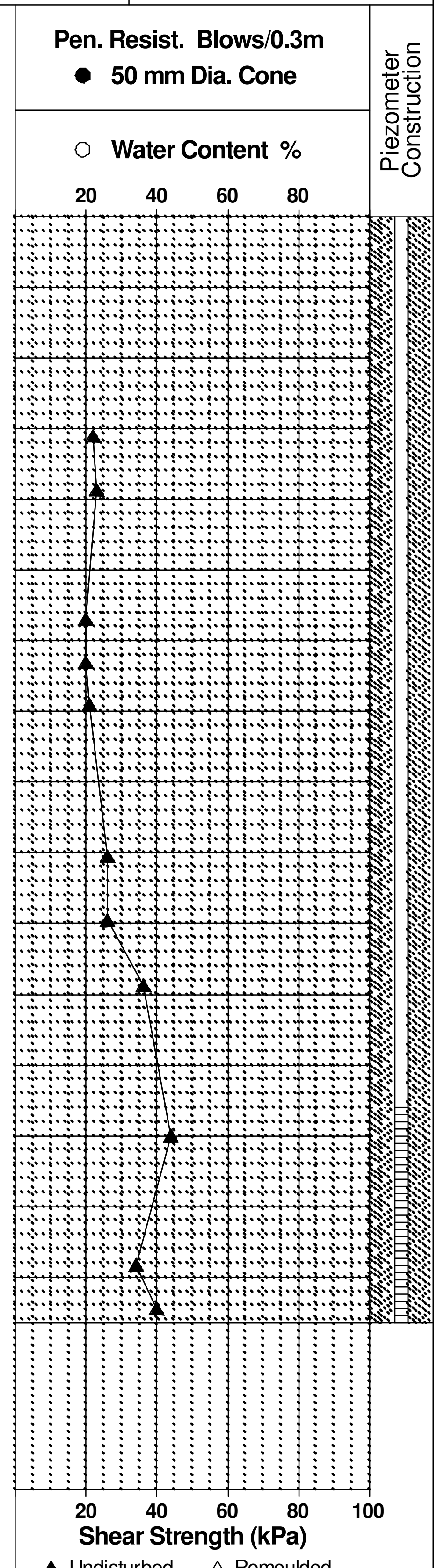
REMARKS

HOLE NO. BH23-06

BORINGS BY CME 75 Power Auger

DATE 12 January 2007

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	% RECOVERY	N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	92.75
TOPSOIL 0.28							
Loose, brown **SILTY SAND**, trace clay 0.60							
Soft, brown **SILTY CLAY** with sand		SS	1	50	3	1	91.75
		SS	2	50	1	2	90.75
- grey by 1.6m depth		TW	3	100			
						3	89.75
		SS	4	100	1		
						4	88.75
		TW	5	100			
						5	87.75
						6	86.75
						7	85.75
- firm by 7.6m depth		TW	6	100			
						8	84.75
						9	83.75
		SS	7	100	1		
						10	82.75
						11	81.75
						12	80.75
		SS	8	100	1		
						13	79.75
		TW	9	100			
						14	78.75
						15	77.75
15.65							
End of Borehole (Standpipe damaged - Feb. 5/07)							



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SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Proposed Residential Development-Half Moon Bay
Ottawa, Ontario

DATUM Ground surface elevations provided by J.D. Barnes Limited.

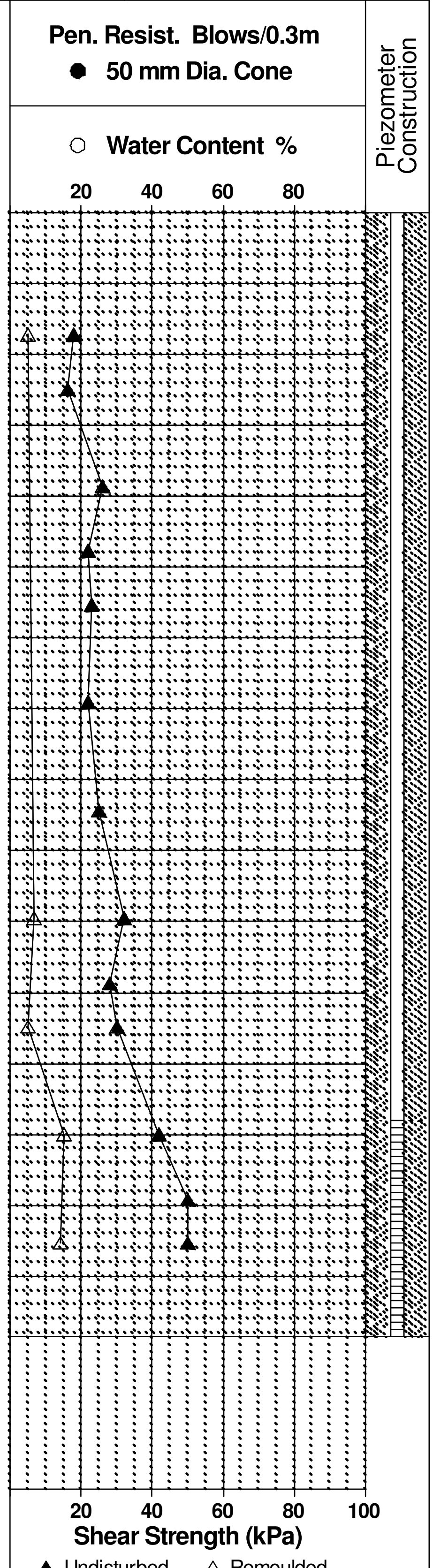
FILE NO. PG0177

REMARKS

HOLE NO. BH24-06

BORINGS BY CME 75 Power Auger **DATE** 11 January 2007

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	NUMBER	% RECOVERY	N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	93.08
TOPSOIL 0.33							
Soft, brown **SILTY CLAY** with sand		SS	1	50	2	1	92.08
- grey by 1.7m depth						2	91.08
		TW	2	79		3	90.08
						4	89.08
						5	88.08
		TW	3	100		6	87.08
						7	86.08
		SS	4	100	1	8	85.08
- firm by 9.0m depth		TW	5	100		9	84.08
						10	83.08
						11	82.08
		SS	6	100	3	12	81.08
- stiff by 13.4m depth						13	80.08
						14	79.08
15.24						15	78.08
GLACIAL TILL: Compact, grey silty sand with clay, gravel, cobbles and boulders 15.85		SS	7	50	20		
End of Borehole (GWL @ 950mm above ground surface - Feb. 5/07)							



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

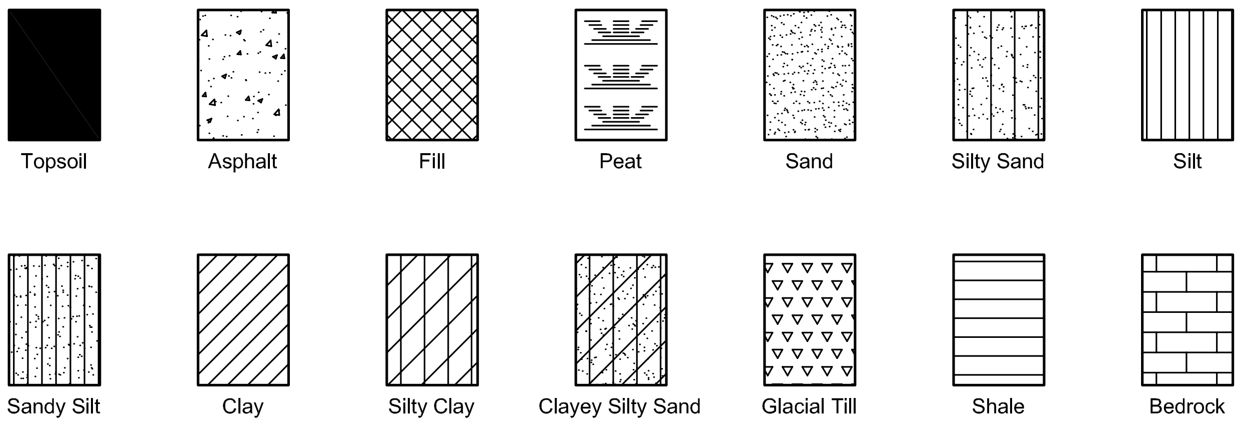
p'_o	-	Present effective overburden pressure at sample depth
p'_c	-	Preconsolidation pressure of (maximum past pressure on) sample
Ccr	-	Recompression index (in effect at pressures below p'_c)
Cc	-	Compression index (in effect at pressures above p'_c)
OC Ratio		Overconsolidaton ratio = p'_c / p'_o
Void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

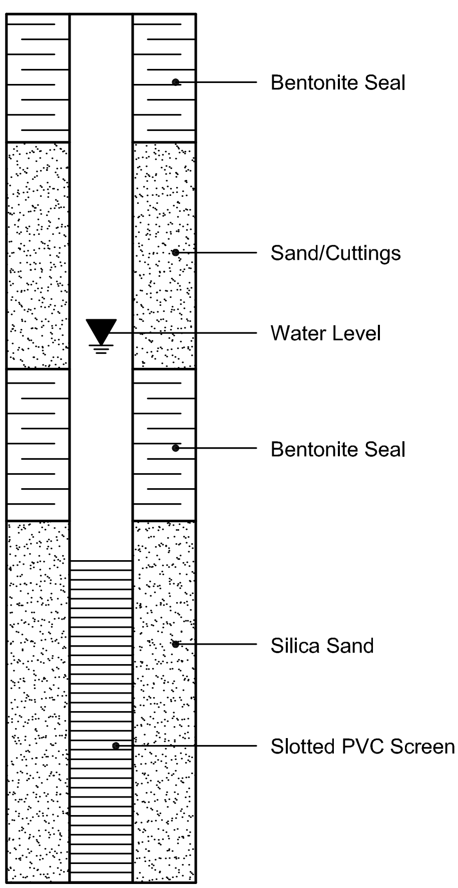
SYMBOLS AND TERMS (continued)

STRATA PLOT

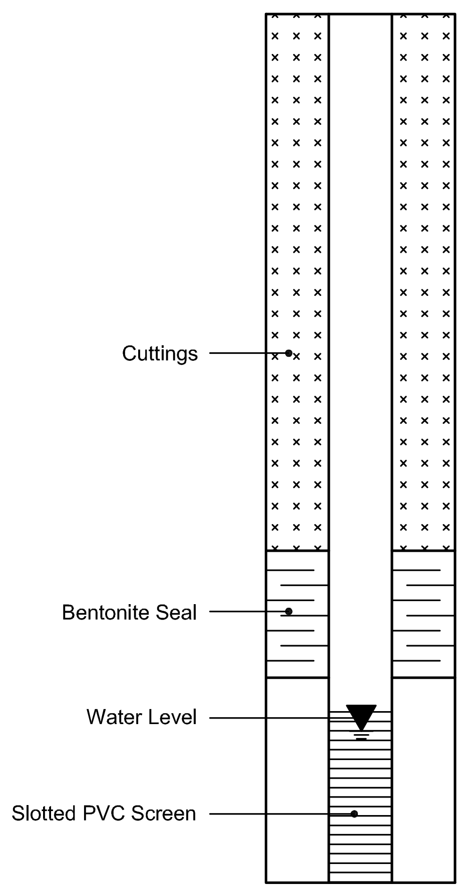


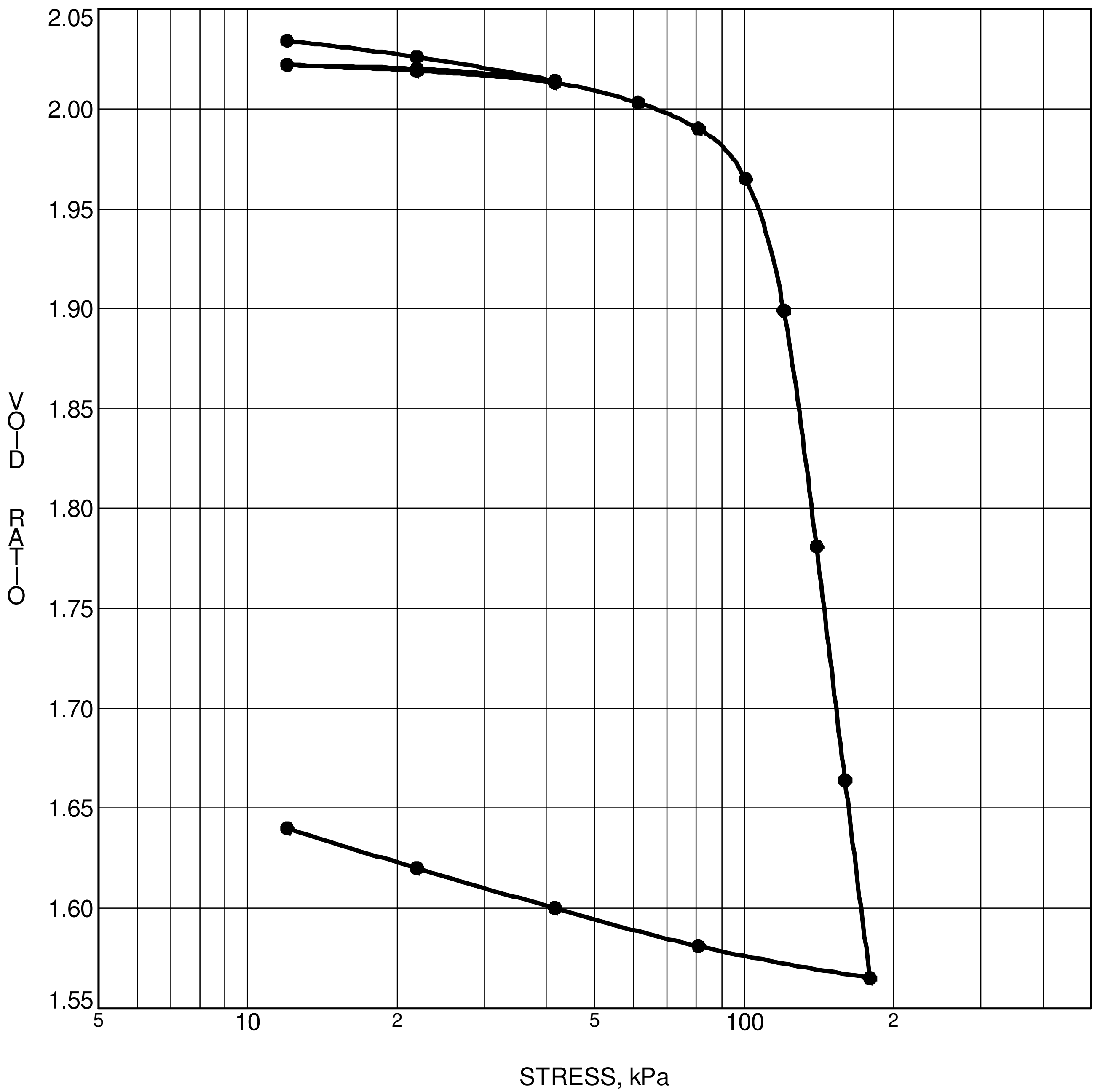
MONITORING WELL AND PIEZOMETER CONSTRUCTION

MONITORING WELL CONSTRUCTION



PIEZOMETER CONSTRUCTION





CONSOLIDATION TEST DATA SUMMARY					
Borehole No.	**BH 1**	p'_o	**39** kPa	Ccr	**0.016**
Sample No.	**TW 3**	p'_c	**111** kPa	Cc	**1.940**
Sample Depth	**4.37** m	OC Ratio	**2.8**	Wo	**74.2** %
Sample Elev.	**88.62** m	Void Ratio	**2.042**	Unit Wt.	**15.5** kN/m^3

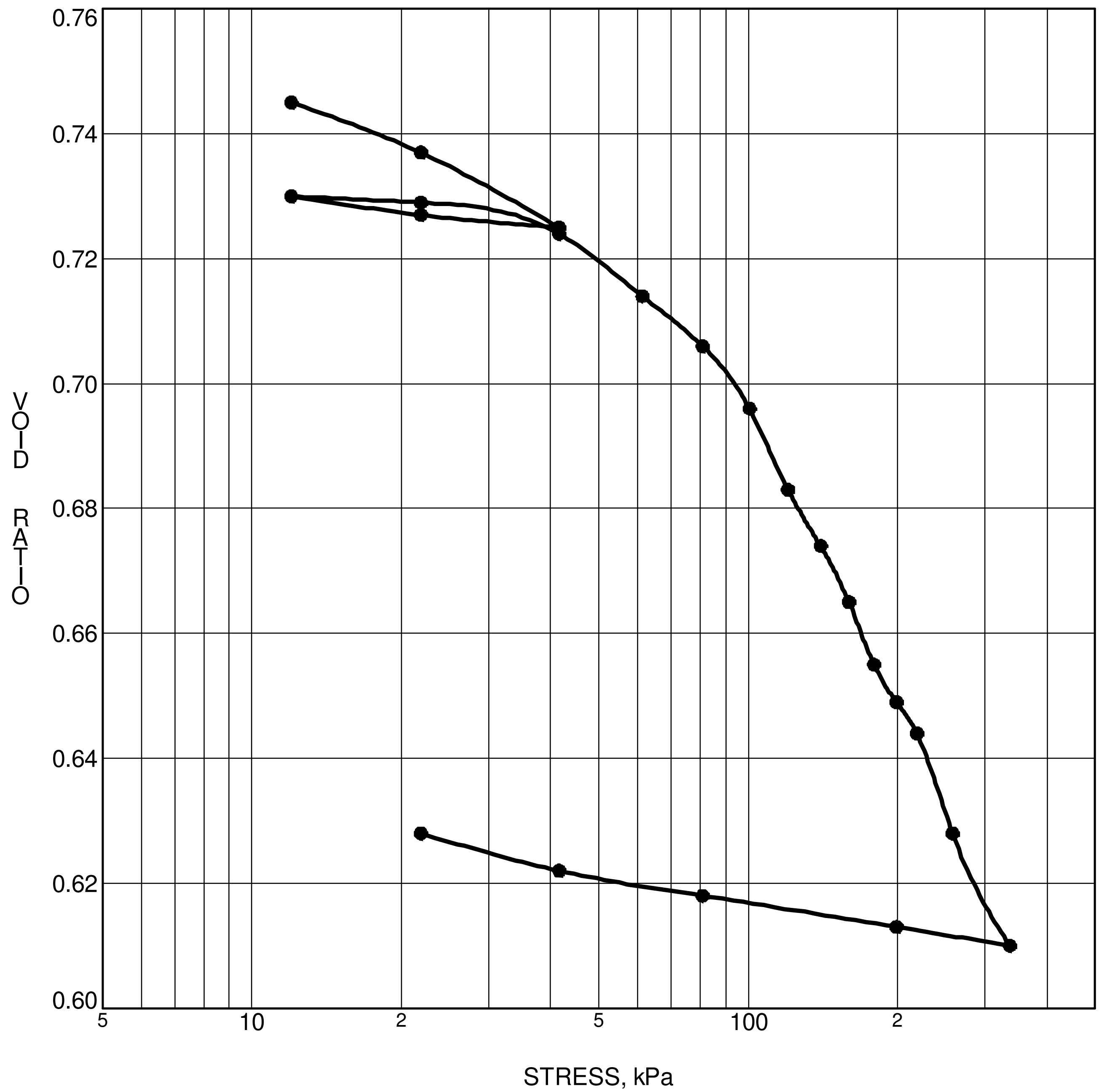
Note: Overburden stress calculated from original ground surface (elev. ~92.0m)

CLIENT	**Metro Richelieu & DIR Investments**	FILE NO.	**PG2037**
PROJECT	**Geotechnical Investigation - Proposed Commercial Development-Cambrian Road**	DATE	**03/10/2010**

patersongroup **Consulting Engineers**

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

CONSOLIDATION TEST



CONSOLIDATION TEST DATA SUMMARY					
Borehole No.	**BH 4**	p'_o	**64** kPa	Ccr	**0.010**
Sample No.	**TW 6**	p'_c	**98** kPa	Cc	**0.506**
Sample Depth	**7.45** m	OC Ratio	**1.5**	Wo	**27.5** %
Sample Elev.	**86.29** m	Void Ratio	**0.755**	Unit Wt.	**19.8** kN/m^3

Note: Overburden stress calculated from original ground surface (elev. ~92.0m)

CLIENT **Metro Richelieu & DIR Investments**

FILE NO. **PG2037**

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

DATE **03/11/2010**

patersongroup **Consulting Engineers**

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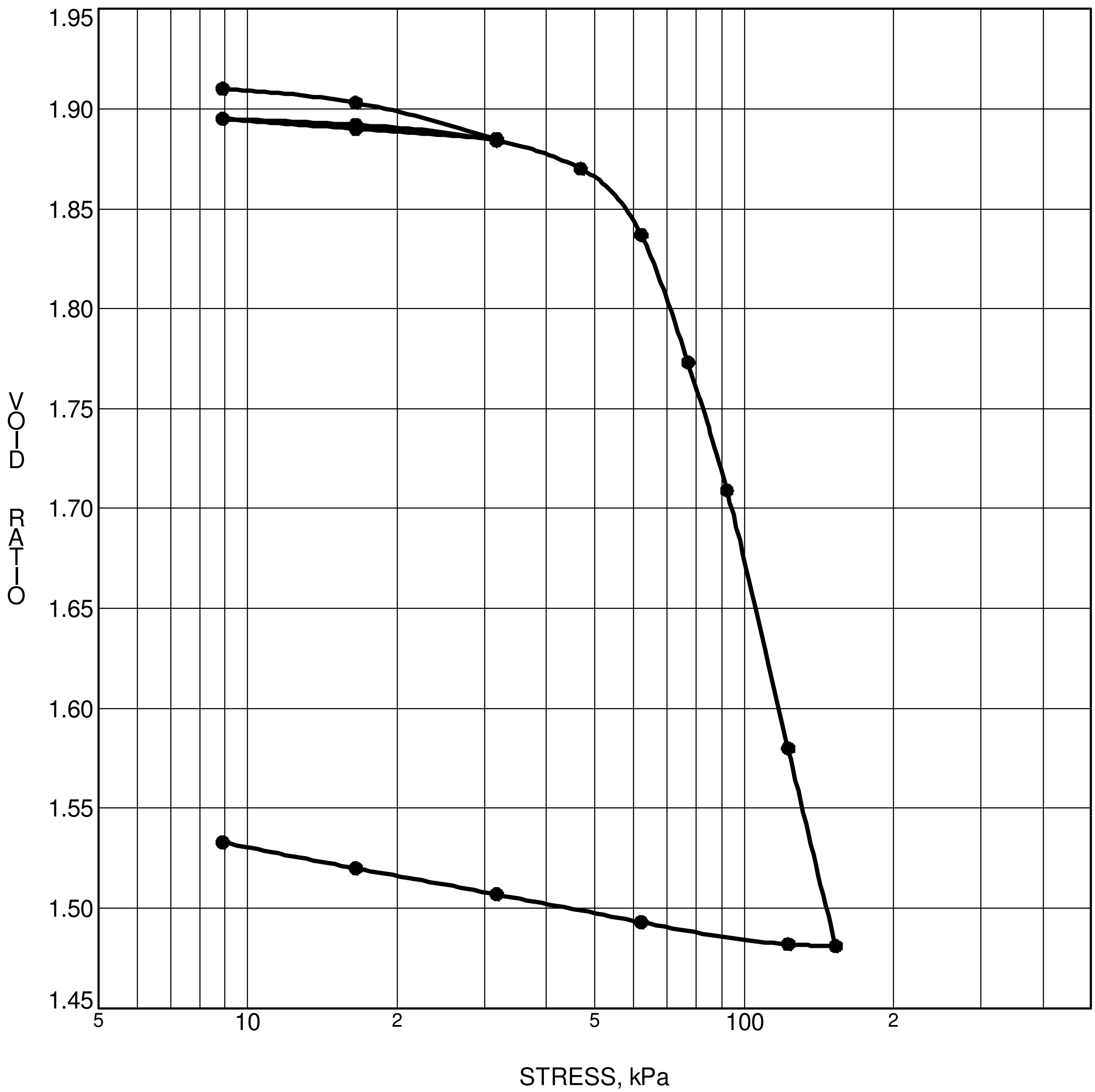
CONSOLIDATION TEST



CONSOLIDATION TEST DATA SUMMARY					
Borehole No.	**BH 6**	p'_o	**28** kPa	Ccr	**0.017**
Sample No.	**TW 4**	p'_c	**69** kPa	Cc	**0.954**
Sample Depth	**4.22** m	OC Ratio	**2.5**	Wo	**70.4** %
Sample Elev.	**89.87** m	Void Ratio	**1.935**	Unit Wt.	**15.5** kN/m^3

Note: Overburden stress calculated from original ground surface (elev. ~92.0m)

CLIENT	**Metro Richelieu & DIR Investments**	FILE NO.	**PG2037**
PROJECT	**Geotechnical Investigation - Proposed Commercial Development-Cambrian Road**	DATE	**03/11/2010**

patersongroup **Consulting Engineers**

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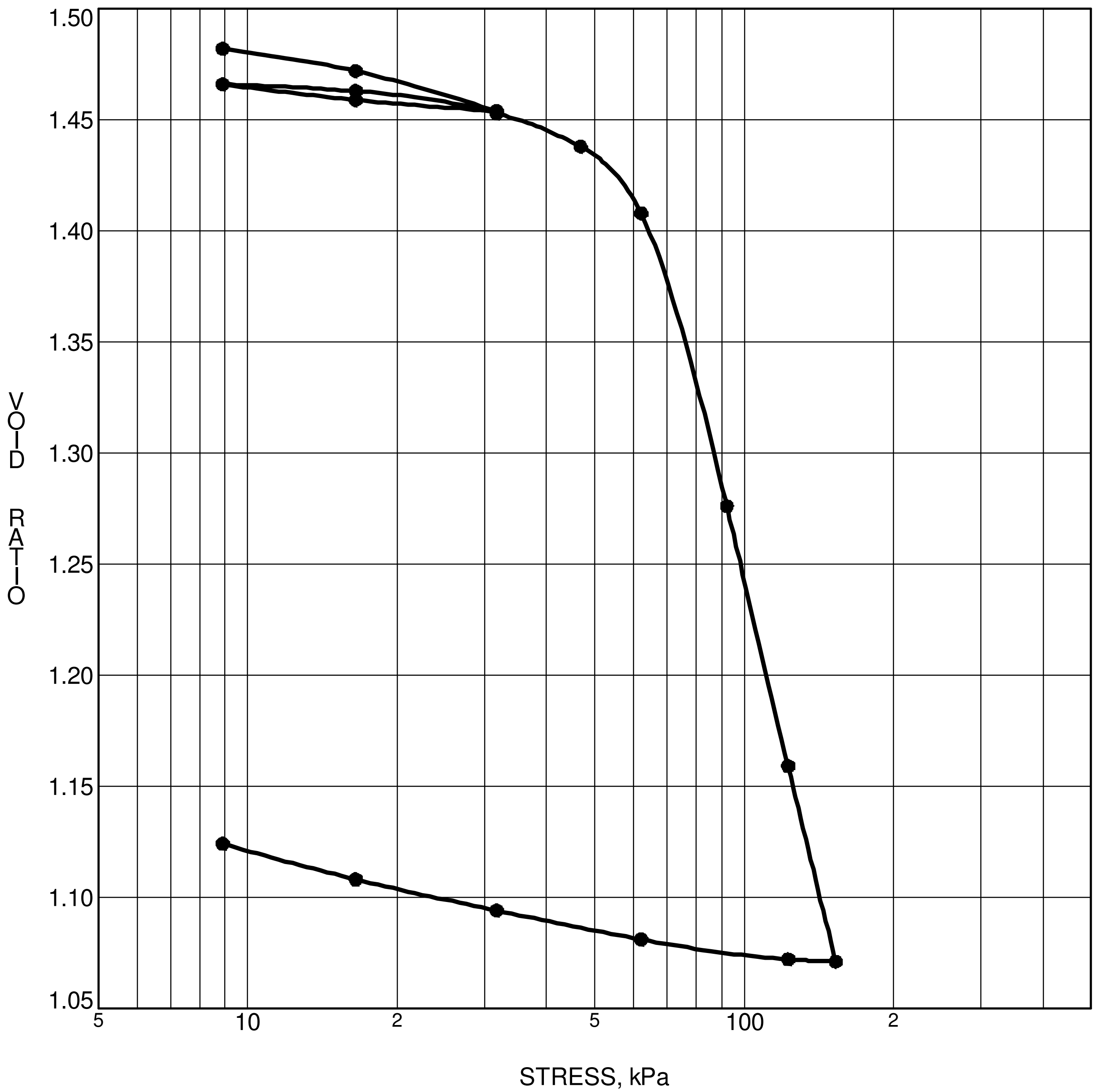
CONSOLIDATION TEST



CONSOLIDATION TEST DATA SUMMARY					
Borehole No.	**BH31-08**	p'_o	**25** kPa	Ccr	**0.014**
Sample No.	**TW 6**	p'_c	**61** kPa	Cc	**0.912**
Sample Depth	**5.66** m	OC Ratio	**2.4**	Wo	**54.3** %
Sample Elev.	**89.36** m	Void Ratio	**1.494**	Unit Wt.	**16.9** kN/m^3

NOTE: Overburden stress calculated from original ground surface

CLIENT	**Mattamy Homes**	FILE NO.	**PG1618**
PROJECT	**Geotechnical Investigation - Proposed Residential Development-Half Moon Bay**	DATE	**April 14/08**

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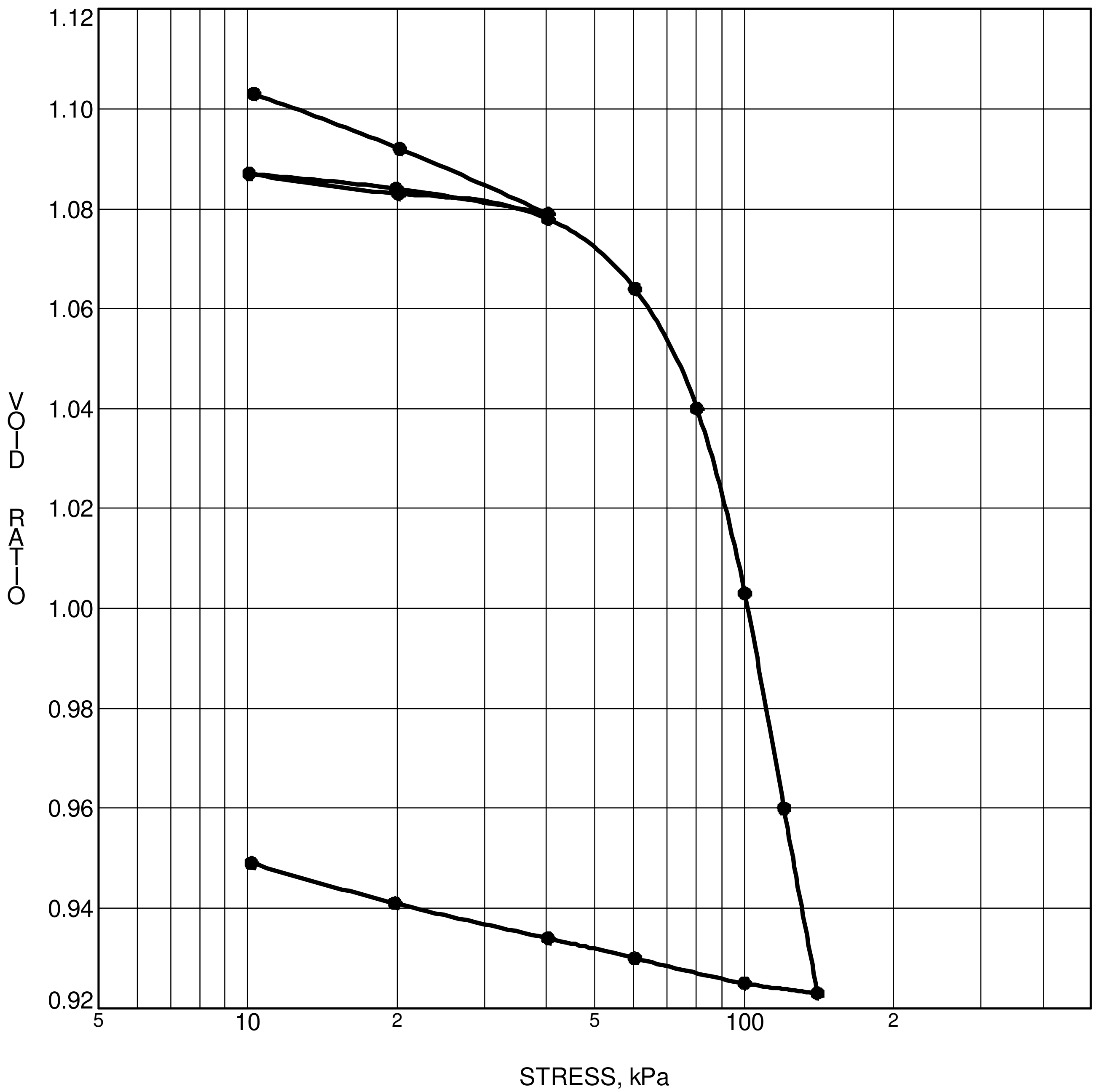
CONSOLIDATION TEST



CONSOLIDATION TEST DATA SUMMARY					
Borehole No.	**BH 3-07**	p'_o	**34** kPa	Ccr	**0.014**
Sample No.	**TW 3**	p'_c	**81** kPa	Cc	**0.550**
Sample Depth	**2.54** m	OC Ratio	**2.4**	Wo	**40.6** %
Sample Elev.	**90.13** m	Void Ratio	**1.115**	Unit Wt.	**17.9** kN/m^3

CLIENT **Mattamy Homes**

FILE NO. **PG0177**

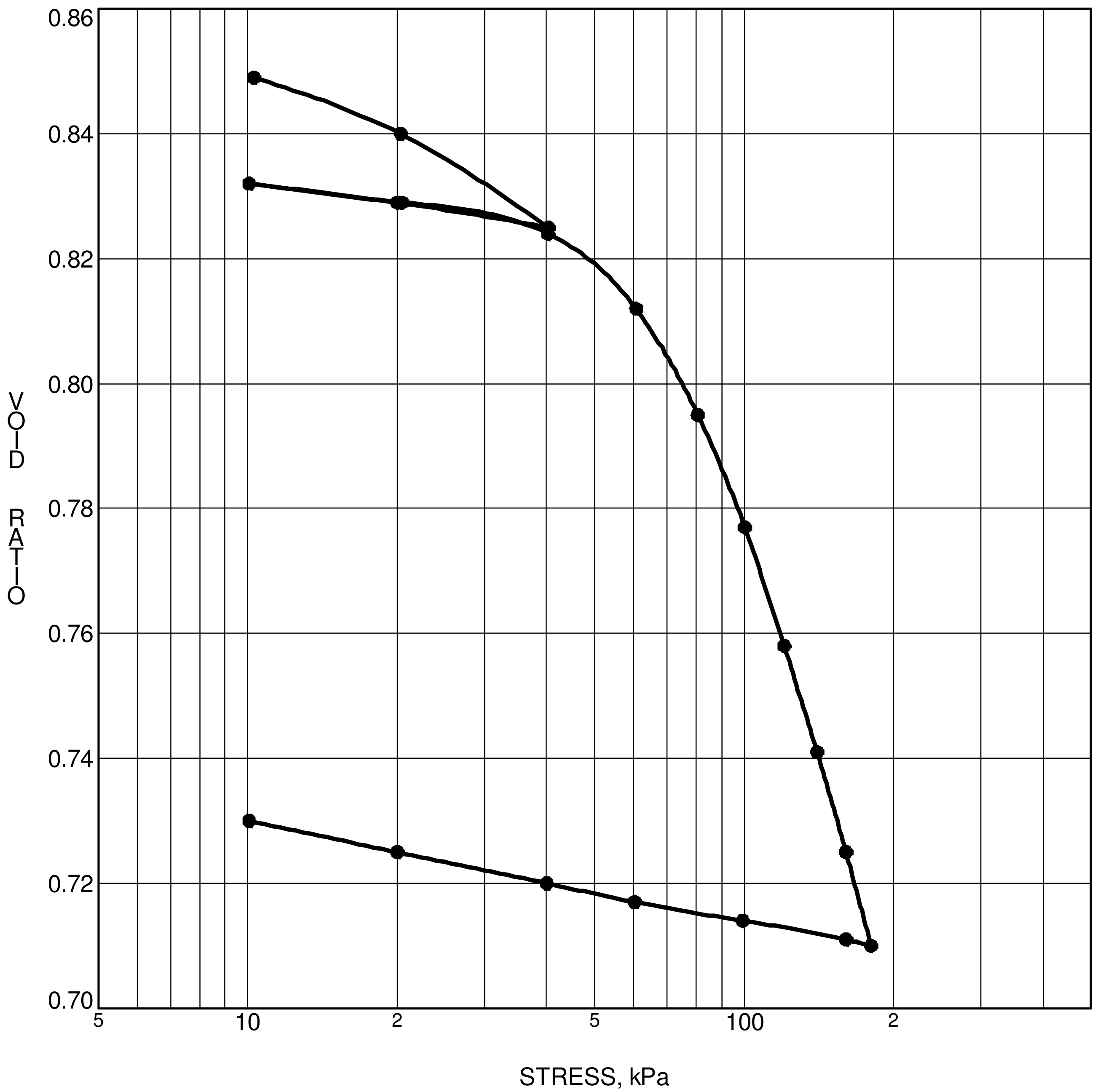
PROJECT **Geotechnical Investigation - Proposed Residential Development-Half Moon Bay**

DATE **07/31/2007**

patersongroup **Consulting Engineers**

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

CONSOLIDATION TEST



CONSOLIDATION TEST DATA SUMMARY					
Borehole No.	**BH 3-07**	p'_o	**45** kPa	Ccr	**0.013**
Sample No.	**TW 4**	p'_c	**71** kPa	Cc	**0.253**
Sample Depth	**4.19** m	OC Ratio	**1.6**	Wo	**31.5** %
Sample Elev.	**88.48** m	Void Ratio	**0.866**	Unit Wt.	**19.0** kN/m^3

CLIENT	**Mattamy Homes**	FILE NO.	**PG0177**
PROJECT	**Geotechnical Investigation - Proposed Residential Development-Half Moon Bay**	DATE	**07/27/2007**

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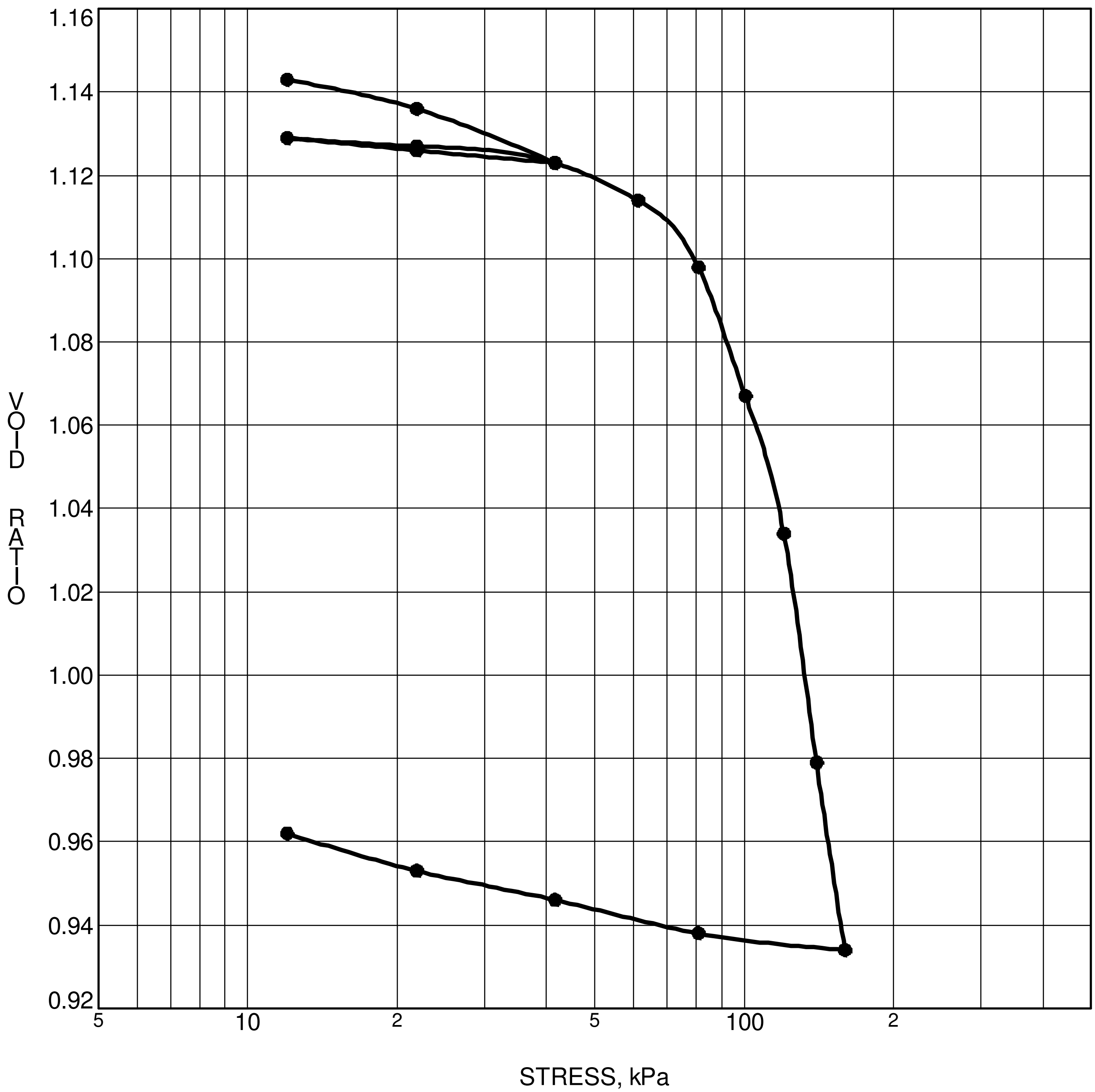
CONSOLIDATION TEST



CONSOLIDATION TEST DATA SUMMARY					
Borehole No.	BH 4-07	p'_o	54 kPa	Ccr	0.013
Sample No.	TW 5	p'_c	100 kPa	Cc	0.834
Sample Depth	4.88 m	OC Ratio	1.9	Wo	41.9 %
Sample Elev.	87.79 m	Void Ratio	1.153	Unit Wt.	17.8 kN/m^3

CLIENT	**Mattamy Homes**	FILE NO.	**PG0177**
PROJECT	**Geotechnical Investigation - Proposed Residential Development-Half Moon Bay**	DATE	**07/18/2007**

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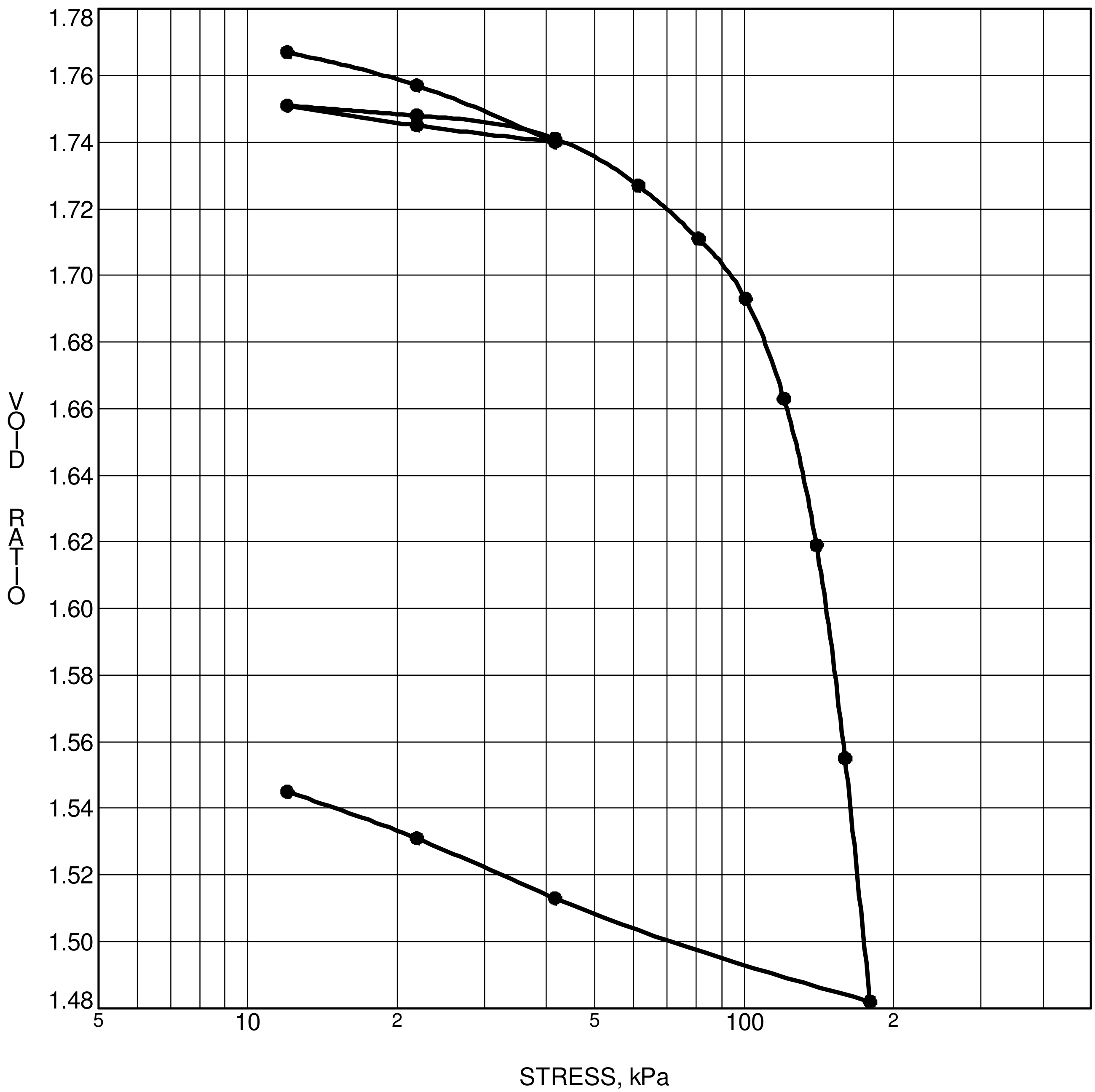
CONSOLIDATION TEST



CONSOLIDATION TEST DATA SUMMARY					
Borehole No.	**BH 7-07**	p'_o	**66** kPa	Ccr	**0.015**
Sample No.	**TW 4**	p'_c	**120** kPa	Cc	**1.263**
Sample Depth	**5.79** m	OC Ratio	**1.8**	Wo	**64.6** %
Sample Elev.	**88.47** m	Void Ratio	**1.777**	Unit Wt.	**16.0** kN/m^3

CLIENT **Mattamy Homes**

PROJECT **Geotechnical Investigation - Proposed Residential Development-Half Moon Bay**

FILE NO. **PG0177**

DATE **11/12/07**

patersongroup **Consulting Engineers**

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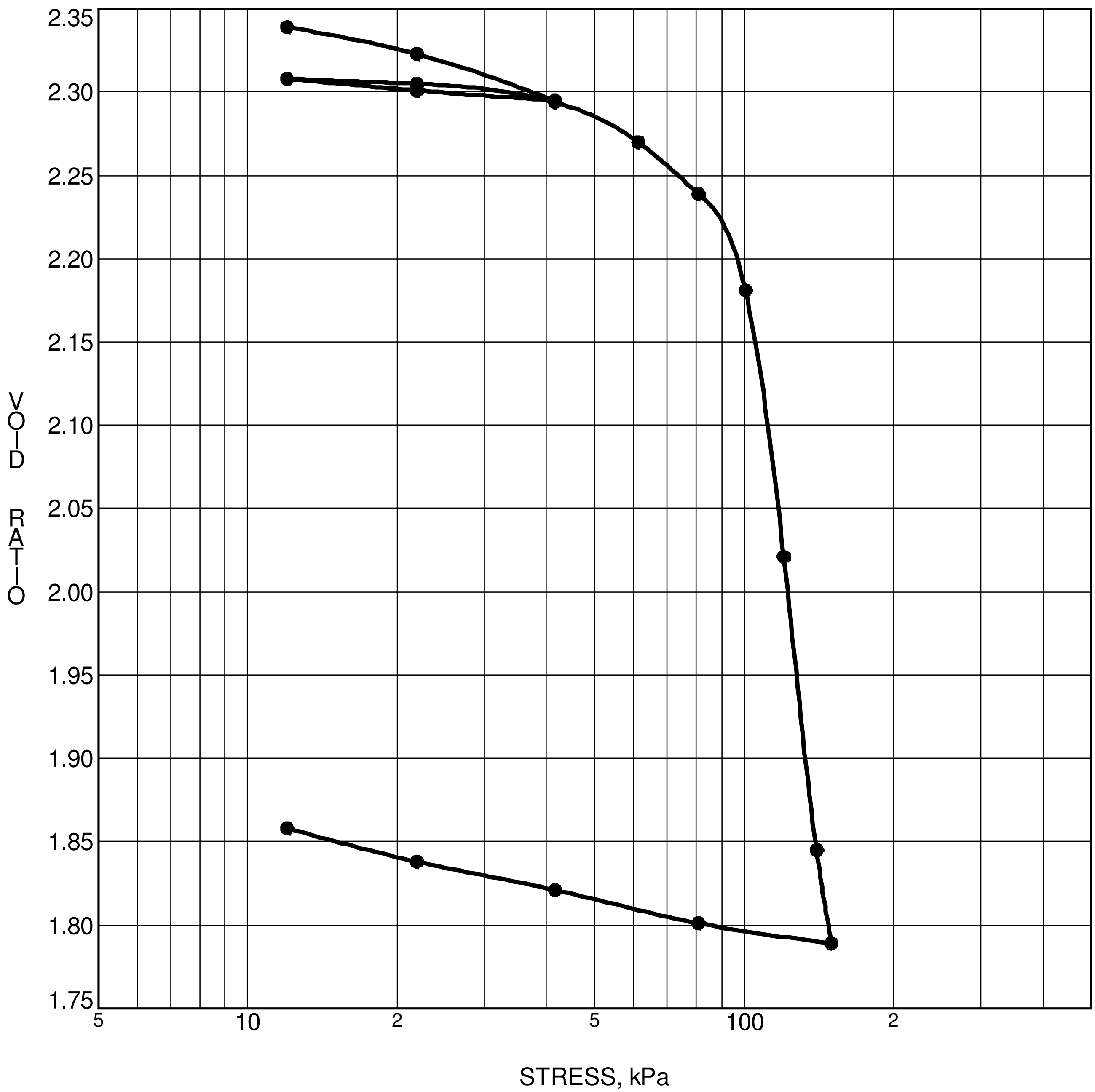
CONSOLIDATION TEST



CONSOLIDATION TEST DATA SUMMARY					
Borehole No.	**BH10-07**	p'_o	**56** kPa	Ccr	**0.023**
Sample No.	**TW 5**	p'_c	**100** kPa	Cc	**2.626**
Sample Depth	**5.04** m	OC Ratio	**1.8**	Wo	**85.7** %
Sample Elev.	**87.94** m	Void Ratio	**2.356**	Unit Wt.	**14.9** kN/m^3

CLIENT	**Mattamy Homes**	FILE NO.	**PG0177**
PROJECT	**Geotechnical Investigation - Proposed Residential Development-Half Moon Bay**	DATE	**18/12/07**

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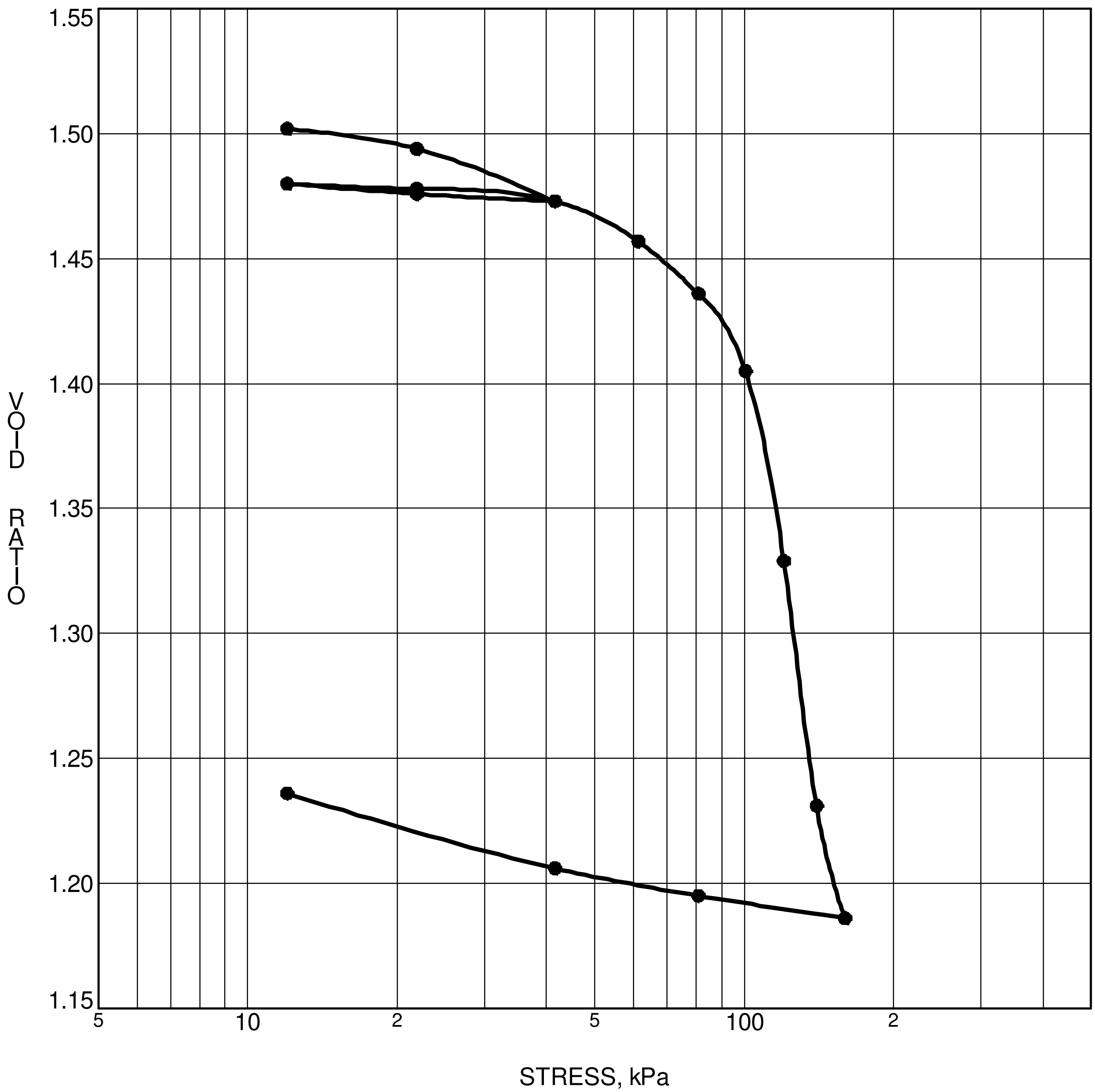
CONSOLIDATION TEST



CONSOLIDATION TEST DATA SUMMARY					
Borehole No.	**BH 6B-06**	p'_o	**32** kPa	Ccr	**0.014**
Sample No.	**TW 1**	p'_c	**101** kPa	Cc	**1.527**
Sample Depth	**2.67** m	OC Ratio	**3.2**	Wo	**54.9** %
Sample Elev.	**89.98** m	Void Ratio	**1.51**	Unit Wt.	**16.6** kN/m^3

CLIENT	**Mattamy Homes**	FILE NO.	**PG0177**
PROJECT	**Geotechnical Investigation - Proposed Residential Development-Half Moon Bay**	DATE	**02/20/2007**

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CONSOLIDATION TEST

APPENDIX 2

FIGURE 1 - KEY PLAN

DRAWING PG2037-1 - TEST HOLE LOCATION PLAN

DRAWING PG2037-2 - PERMISSIBLE GRADE RAISE PLAN

DRAWING PG2037-3 - SETTLEMENT SURCHARGE MONITORING PROGRAM

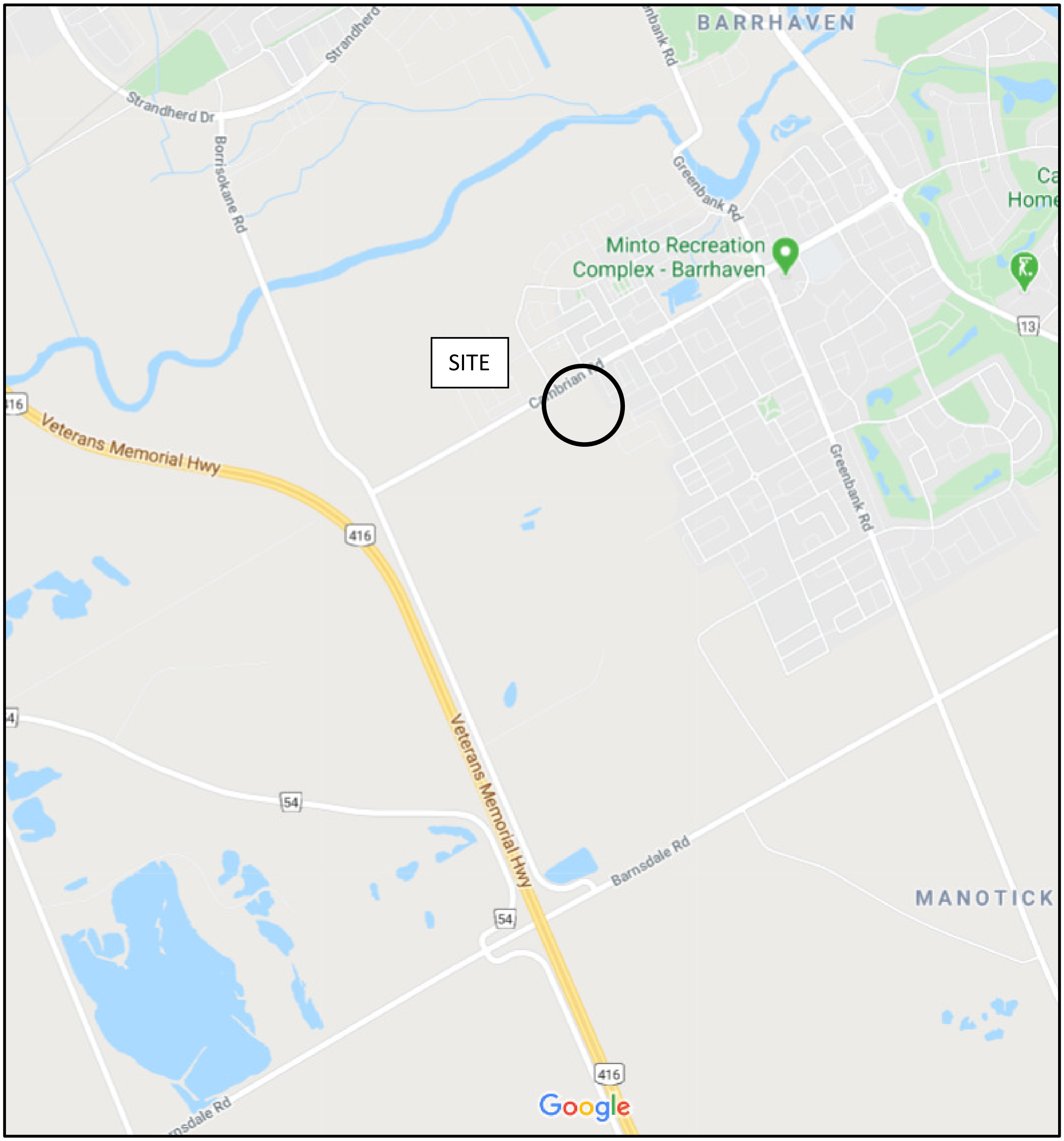
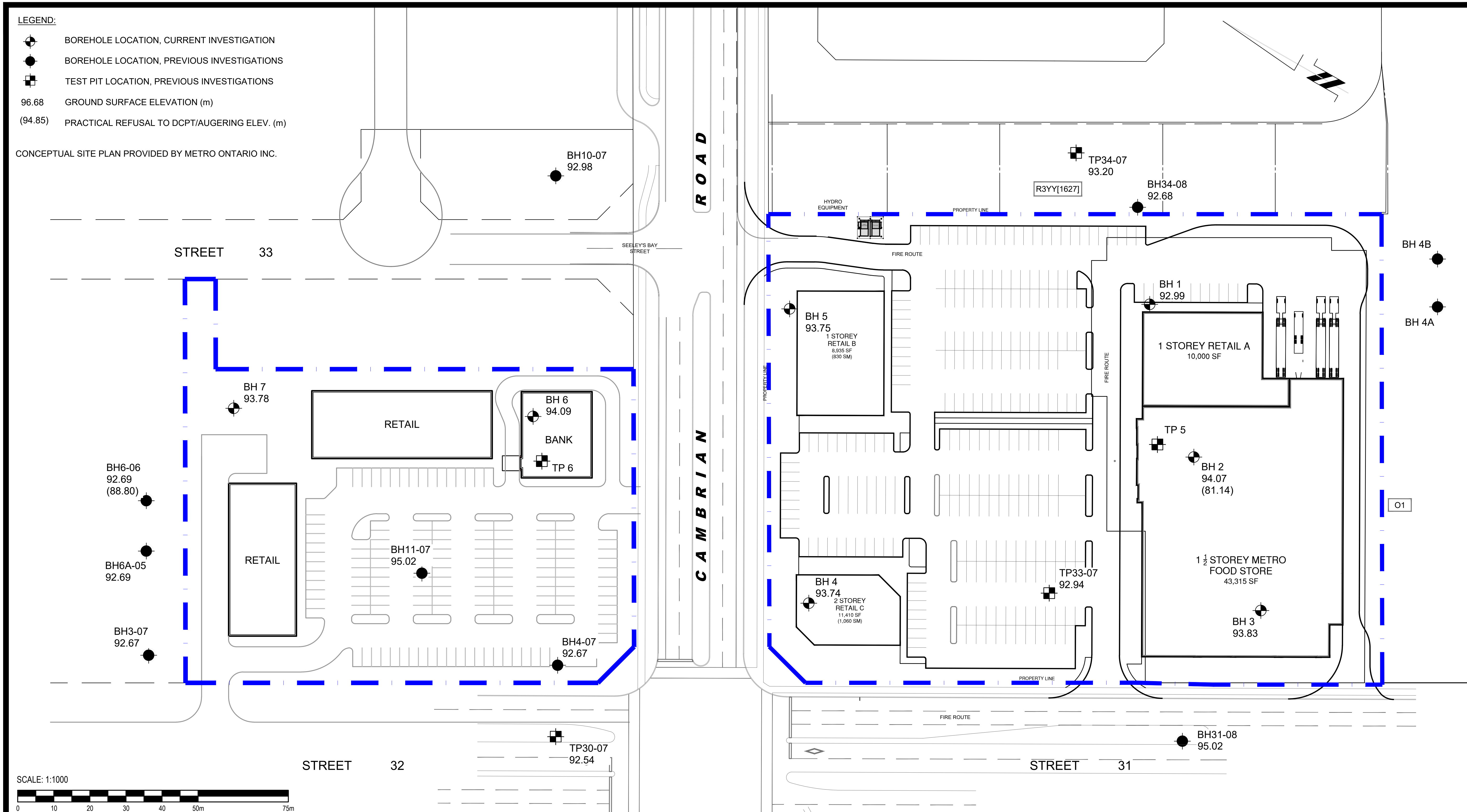


FIGURE 1

KEY PLAN



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Tel: (613) 226-7381 Fax: (613) 226-6344

NO.	REVISIONS	DATE	INITIAL
1	UPDATED TO LATEST CONCEPTUAL PLAN	28/07/2020	RG

METRO ONTARIO INC.

PROPOSED COMMERCIAL DEVELOPMENT
CAMBRIAN ROAD AT FUTURE GREENBANK ROAD (3853 CAMBRIAN ROAD)
OTTAWA, ONTARIO

Title:
TEST HOLE LOCATION PLAN

Scale: 1:1000
Date: 07/2020
Drawn by: RCG
Report No.: PG2037-1 REV.1
Checked by: DP
PG2037-1
Approved by: DJG
Revision No.: 1

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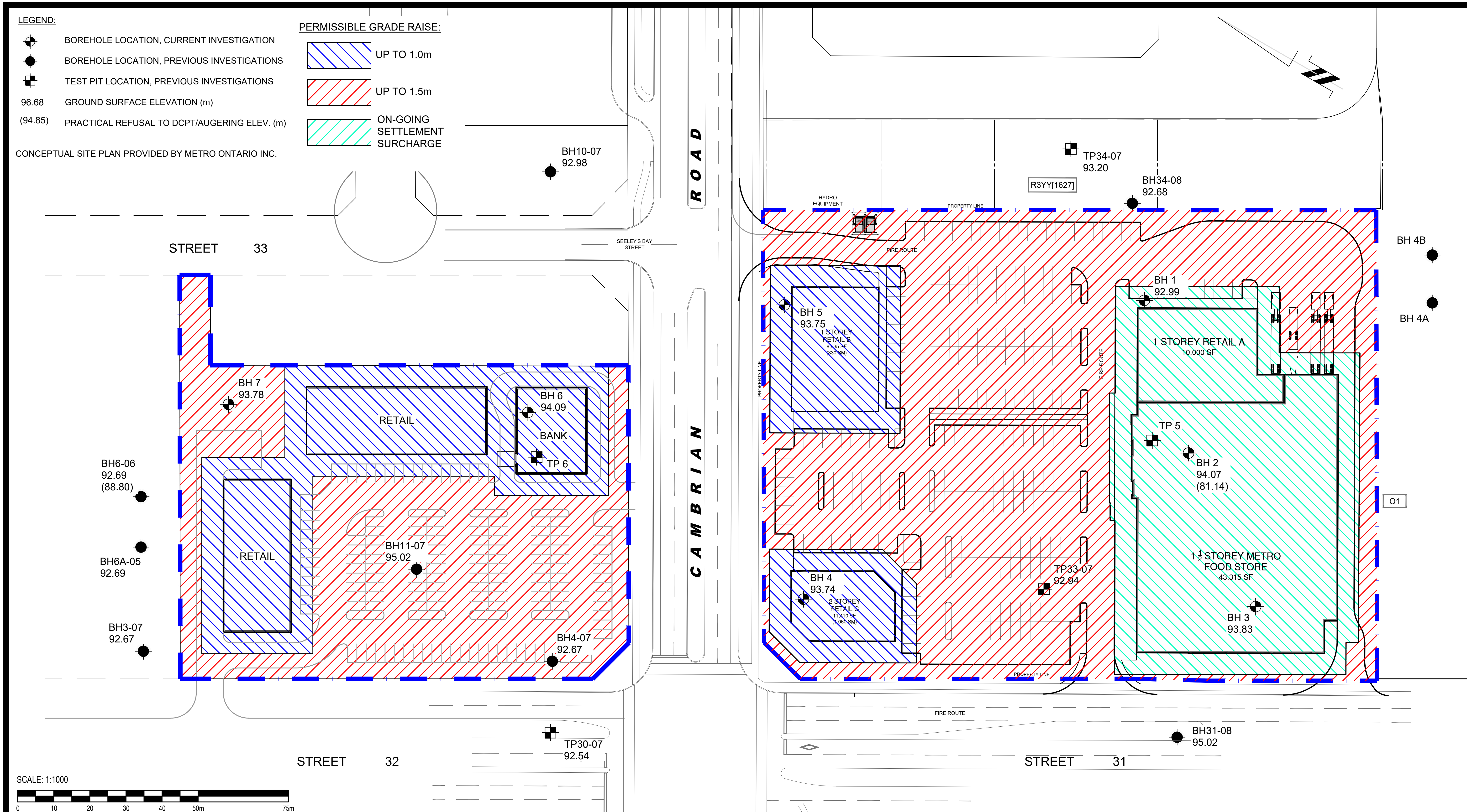

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NO.	REVISIONS	DATE	INITIAL
1	UPDATED TO LATEST CONCEPTUAL PLAN	28/07/2020	RG

METRO ONTARIO INC.

PROPOSED COMMERCIAL DEVELOPMENT
CAMBRIAN ROAD AT FUTURE GREENBANK ROAD (3853 CAMBRIAN ROAD)
OTTAWA, ONTARIO

Title:

PERMISSIBLE GRADE RAISE PLAN

Scale:	1:1000	Date:	07/2020
Drawn by:	RCG	Report No.:	PG2037-1 REV.1
Checked by:	OC		PG2037-2
Approved by:	DJG	Revision No.:	1

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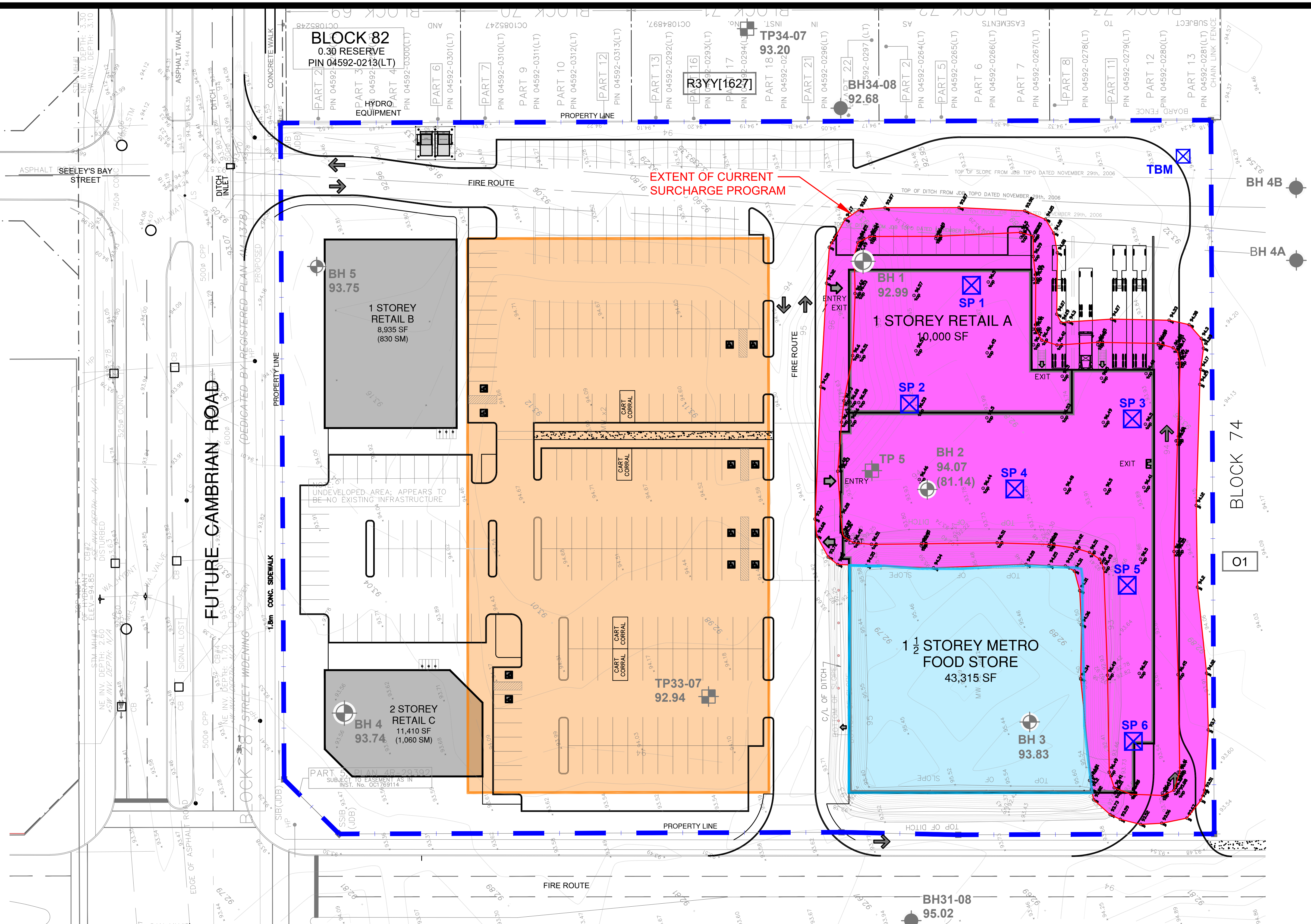

LEGEND:

- BOREHOLE LOCATION, CURRENT INVESTIGATION
- BOREHOLE LOCATION, PREVIOUS INVESTIGATIONS
- TEST PIT LOCATION, PREVIOUS INVESTIGATIONS
- APPROX. LOCATION OF SETTLEMENT PLATE SP1 - SP6
- 96.68 GROUND SURFACE ELEVATION (m)
- (94.85) PRACTICAL REFUSAL TO DCPT/AUGERING ELEV. (m)
- 92.79 TOPOGRAPHIC SURVEY PROVIDED BY J.D BARNES (2006)
- 95.46 BASEPLAN TOPOGRAPHIC LEGAL SURVEY PROVIDED BY J.D BARNES (NOV. 2019)
- top 96.5 AS-BUILT SURCHARGE PROGRAM ELEVATION PROVIDED BY ASL (JULY, 2020)

CONCEPTUAL SITE PLAN PROVIDED BY METRO ONTARIO INC.

PAD A1 - CONSISTING OF OPSS GRANULAR B TYPE II CRUSHED STONE PLACE AS PART OF THE PREVIOUS SETTLEMENT SURCHARGE PROGRAM EXTENDED UP TO GEODETIC ELEVATION = 95.70m AT THE TIME OF PLACEMENT (NOVMEBER 2016 - JUNE 2020)

PAD A2 - CONSISTING OF EXCESS FILL GENERATED FROM THE REMOVAL OF THE EXISTING FILL FROM WITHIN THE AREA OF PAD A1 PRIOR TO THE PLACEMENT OF THE ENGINEERED FILL. THE CLAYEY FILL WAS STOCKPILED WITHIN THE PROPOSED PARKING AREA UP TO GEODETIC ELEVATION = 94.00m TO 94.70m AT THE TIME OF PLACEMENT (NOVEMBER 2016 - JUNE 2020)

ONGOING SURCHARGE MONITORING PROGRAM CONSISTING OF APPROVED SUGRADE MATERIAL, OPSS GRANULAR B TYPE II CRUSHED STONE GENERATED FROM THE REMOVAL OF SURCHARGE MATERIAL FROM PAD A1, AND APPROVED SUBGRADE MATERIAL GENERATED FROM THE REMOVAL OF PAD A2. THE ONGOING SURCHARGE MONITORING PROGRAM EXTENDS UP TO GEODETIC ELEVATION = 96.50 m AT THE TIME OF PLACEMENT (JULY 2020)

0 10 20 30 50m

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NO.	REVISIONS	DATE	INITIAL
1	AS BUILT TOPO PROVIDED BY ASL ADDED TO PLAN	27/07/2020	RG

METRO ONTARIO INC.

PROPOSED COMMERCIAL DEVELOPMENT
CAMBRIAN ROAD AT FUTURE GREENBANK ROAD (3853 CAMBRIAN ROAD)
OTTAWA, ONTARIO

Title:
SETTLEMENT SURCHARGE MONITORING PROGRAM

Scale: 1:750	Date: 07/2020
Drawn by: RCG	Report No.: PG2037-1 REV.1
Checked by: OC	PG2037-3
Approved by: DJG	Revision No.: 1

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