Geotechnical Investigation
Proposed Residential Development
1098 Ogilvie Road and
1178 Cummings Avenue
Ottawa, Ontario

Prepared For
6770967 Canada Inc.

December 12, 2011
Report: PG2463-1
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APPENDICES

Appendix 1  Soil Profile and Test Data Sheets
            Symbols and Terms
            Analytical Testing Results

Appendix 2  Figure 1 - Key Plan
            Drawing PG2463-1 - Test Hole Location Plan
1.0 INTRODUCTION

Paterson Group (Paterson) was commissioned by 6770967 Canada Inc. to conduct a geotechnical investigation for the proposed residential development to be located southwest of Ogilvie Road and Cummings Avenue intersection. The subject site consists of 1098 Ogilvie Road and 1178 Cummings Avenue, in the City of Ottawa, Ontario (refer to Figure 1 - Key Plan in Appendix 2).

The objective of the current investigation was to:

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

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

Investigating the presence or potential presence of contamination on the subject property was part of the scope of work of this present investigation. A Phase I-II Environmental Site Assessment (ESA) was conducted by Paterson for the subject site. The results and recommendations of the Phase I-II - ESA are presented under separate cover.

2.0 PROPOSED DEVELOPMENT

It is understood that the proposed residential development will consist of several townhouse style dwellings. It is expected that the development will be municipally serviced with local paved roadways, car parking and landscaped areas.
3.0 METHOD OF INVESTIGATION

3.1 Field Investigation

Field Program

The field program for the investigation was conducted on August 26, 2011. A previous investigation was completed by John D. Paterson and Associates in February 2003 for the subject site. The locations of all test holes are illustrated on Drawing PG2463-1 - Test Hole Location Plan included in Appendix 2.

The boreholes were drilled using a track-mounted auger drill rig operated by a two person crew. The test hole procedure consisted of augering to the required depth at the selected locations and sampling the subsurface soils. All fieldwork was conducted under the full-time supervision of personnel from Paterson’s geotechnical division under the direction of a senior engineer.

Sampling and In Situ Testing

Soil samples were collected from the boreholes using a 50 mm diameter split-spoon sampler or from the auger flights. The split-spoon and auger samples were classified on site and placed in sealed plastic bags. All samples were transported to our laboratory for further examination and classification. The depths at which the split-spoon and grab samples were recovered from the boreholes are shown as SS and AU, respectively, on the Soil Profile and Test Data sheets presented in Appendix 1.

Standard Penetration Testing (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.

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

Two (2) 19 mm PVC groundwater monitoring wells were installed at BH 1 and BH 5 and a flexible PVC standpipes was installed in the remaining 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. The samples collected from the site during the previous investigations have already been discarded.

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 subject site, taking into consideration site features. The boreholes were surveyed with respect to a temporary benchmark (TBM), consisting of the top of a manhole cover located along the centerline of Cummings Avenue, south of Ogilvie Road intersection. An geodetic elevation of 69.47 m was provided for the TBM by Rosalie J. Hill Architect and Development Consultant. The test hole locations, ground surface elevations at the test hole locations and TBM location are presented in Drawing PG2463-1 - Test Hole Location Plan in Appendix 2.

3.3 Laboratory Testing

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

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 analyzed to determine the concentrations of sulphate and chloride, the resistivity and the pH of the sample. The analytical test results are presented in Appendix 1 and discussed in Subsection 6.7.
4.0 OBSERVATIONS

4.1 Surface Conditions

At the time of the field program, the subject site is vacant with grass, brush and trees covering the majority of the subject site. The site is approximately at grade surrounding roadways and the neighboring properties.

4.2 Subsurface Profile

Generally, the subsurface profile observed at the test hole locations, consists of topsoil and/or fill overlying native soils consisting of silty sand or silty clay. Black shale bedrock was encountered at each test hole, at depths ranging from 1.5 to 2.8 m. Specific details of the soil profile at each test hole location can be seen on the Soil Profile and Test Data sheets in Appendix 1.

Based on available geological mapping, the subject site is located in an area where the bedrock consists of shale from the Billings formation. The overburden drift thickness ranges from 2 to 5 m.

4.3 Groundwater

Groundwater levels (GWLs) were measured in the monitoring wells and piezometers installed in the boreholes and results are summarized in Table 1. BH 2 and BH 4 were noted to be dry at the time of completion. It should be noted that groundwater levels are subject to seasonal fluctuations. Therefore, the groundwater levels could vary at the time of construction.

<table>
<thead>
<tr>
<th>Test Hole Number</th>
<th>Ground Surface Elevation (m)</th>
<th>Groundwater Levels (m)</th>
<th>Date</th>
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<tr>
<td>BH 1</td>
<td>68.75</td>
<td>5.33</td>
<td>63.42 September 2, 2011</td>
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<tr>
<td>BH 3</td>
<td>70.35</td>
<td>Dry</td>
<td>n/a September 2, 2011</td>
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<tr>
<td>BH 5</td>
<td>70.15</td>
<td>5.82</td>
<td>64.33 September 2, 2011</td>
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</table>
5.0 DISCUSSION

5.1 Geotechnical Assessment

From a geotechnical perspective, the subject site is considered adequate for the proposed residential development. It is expected that shallow foundations will be founded on the bedrock surface or an undisturbed stiff silty clay/clayey silt bearing surface.

The existing fill, free of deleterious and significant amounts of organic materials, could be assessed at the time of construction by the geotechnical consultant, once the footing excavations are completed and a large area of the fill is exposed. If the fill is found satisfactory, the fill located outside the zones of influence of the footings could be left in place.

The above and other considerations are discussed in the following paragraphs.

5.2 Site Grading and Preparation

Stripping Depth

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

Bedrock Removal

Bedrock removal can be accomplished by hoe ramming where only a small quantity of the bedrock needs to be removed. Sound bedrock may be removed by line drilling and controlled blasting and/or hoe ramming.

Excavation side slopes in sound bedrock can be conducted using almost vertical side walls. A minimum 1 m horizontal ledge, should be left between the bottom of the overburden excavation and the top of the bedrock surface to provide an area to allow for potential sloughing.
Fill Placement

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

Non-specified existing fill along with site-excavated soil can be used as general landscaping fill where settlement of the ground surface is of minor concern. These materials should be spread in thin lifts and be compacted at minimum 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 the respective SPMDD. Non-specified existing fill and site-excavated soils are not suitable for use as backfill against foundation walls, unless placed in conjunction with a composite drainage blanket.

5.3 Foundation Design

Footings placed on a clean, surface sounded shale bedrock surface, a factored bearing resistance value at ultimate limit states (ULS) of 750 kPa, incorporating a geotechnical resistance factor of 0.5, and a bearing resistance value at serviceability limit states (SLS) of 500 kPa. The settlement associated with the bearing resistance value at SLS is expected to be negligible.

A clean, surface-sounded bedrock bearing surface should be free of loose materials, and have no near surface seams, voids, fissures or open joints which can be detected from surface sounding with a rock hammer.

Footings placed an undisturbed, stiff silty clay/clayey silt bearing surface can be designed using a bearing resistance value at SLS of 125 kPa and a factored bearing resistance value at ULS of 180 kPa. Footings designed using the bearing resistance value at SLS given above 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.
Where a building is founded partly on bedrock and partly on soil bearing media, it is recommended to decrease the bearing resistance values by 25% for the footings placed on soil bearing media to reduce the potential long term total and differential settlements. At, the soil/bedrock and bedrock/soil transitions, it is recommended that the upper 0.5 m of the bedrock be removed for a minimum length of 2 m (on the bedrock side) and replaced with nominally compacted OPSS Granular A or Granular B Type II material. The width of the subexcavation should be at least the proposed footing width plus 0.5 m. Steel reinforcement, extending at least 3 m beyond both sides of the 2 m long transition, should be placed in the top part of the footings and foundation walls.

**Lateral Support**

The bearing medium under footing-supported structures is required to be provided with adequate lateral support. Adequate lateral support is provided to a stiff silty clay/clayey silt bearing medium when a plane extending down and out from the bottom edge of the footing, at a minimum of 1.5H:1V. Near vertical slopes can be used for unfractured bedrock bearing media; a 1.5H:1V slope can be used for fractured bedrock.

### 5.4 Design for Earthquakes

The site class for seismic site response can be taken as **Site Class C** for the foundations considered. A higher site class, such as Class A or B, may be appropriate for the subject site. However, site specific shear wave velocity test should be conducted for confirmation. Reference should be made to the latest revision of the 2006 Ontario Building Code for a full discussion of the earthquake design requirements. The soils underlying the proposed shallow foundations are not susceptible to liquefaction.

### 5.5 Basement Slab

With the removal of all topsoil and deleterious materials, within the footprint of the proposed buildings, the native soil surface will be considered to be an acceptable subgrade surface on which to commence backfilling for the floor slab. Alternatively, the existing fill, free of deleterious and significant amounts of organic materials, could be assessed at the time of construction by the geotechnical consultant, once the footing excavations are completed and a large area of the fill is exposed. If the fill is found to be satisfactory, the fill located outside the zones of influence of the footings could be left in place.
The upper 150 mm of sub-slab fill should consist of 19 mm clear stone for a basement slab. All backfill material within the footprint of the proposed buildings should be placed in maximum 300 mm thick loose lifts and compacted to at least 98% of the SPMDD.

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

5.6 **Pavement Design**

Car parking and local roadways are anticipated. The proposed pavement structures are shown in Tables 2 and 3.

<p>| Table 2 - Recommended Pavement Structure - Car Only Parking Areas |
|-----------------------|---------------------------|</p>
<table>
<thead>
<tr>
<th>Thickness (mm)</th>
<th>Material Description</th>
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<tr>
<td>50</td>
<td>Wear Course - HL-3 or Superpave 12.5 Asphaltic Concrete</td>
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<tr>
<td>150</td>
<td>BASE - OPSS Granular A Crushed Stone</td>
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<tr>
<td>300</td>
<td>SUBBASE - OPSS Granular B Type II</td>
</tr>
</tbody>
</table>

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

<p>| Table 3 - Recommended Pavement Structure - Local Roadways |
|-----------------------|---------------------------|</p>
<table>
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<th>Thickness (mm)</th>
<th>Material Description</th>
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<tr>
<td>40</td>
<td>Wear Course - HL-3 or Superpave 12.5 Asphaltic Concrete</td>
</tr>
<tr>
<td>50</td>
<td>Binder Course - HL-8 or Superpave 19.0 Asphaltic Concrete</td>
</tr>
<tr>
<td>150</td>
<td>BASE - OPSS Granular A Crushed Stone</td>
</tr>
<tr>
<td>400</td>
<td>SUBBASE - OPSS Granular B Type II</td>
</tr>
</tbody>
</table>

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

Minimum Performance Graded (PG) 58-34 asphalt cement should be used for this project.
If soft spots develop in the subgrade during compaction or due to construction traffic, the affected areas should be excavated and replaced with OPSS Granular B Type II material.

The pavement granular base and subbase should be placed in maximum 300 mm thick lifts and compacted to a minimum of 98% of the SPMDD using suitable compaction equipment.
6.0 DESIGN AND CONSTRUCTION PRECAUTIONS

6.1 Foundation Drainage and Backfill

A perimeter drainage system is recommended for the proposed structures. The system should consist of a 100 to 150 mm diameter perforated corrugated plastic pipe, surrounded on all sides by 150 mm of 10 mm clear crushed stone, placed at the footing level around the exterior perimeter of the structure. The pipe should have a positive outlet, such as a gravity connection to the storm sewer.

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 other exterior unheated footings.

For footings founded directly on sound bedrock where sufficient soil cover is not available, insulation can be used to protect the footing from frost penetration.

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 retained by shoring systems from the start of the excavation until the structure is backfilled. It is assumed that sufficient room will be available for the greater part of the excavation to be undertaken by open-cut methods (i.e. unsupported excavations).
The excavation side slopes above the groundwater level extending to a maximum depth of 3 m should be cut back at 1H:1V or flatter. The flatter slope is required for excavation below groundwater level. The subsurface soil is considered to be mainly a Type 2 and Type 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.

A trench box is recommended at all times to protect personnel working in trenches with steep or vertical sides. The expectation is 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 SPMDD.

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 SPMDD.

6.5 Groundwater Control

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.

It is anticipated that pumping from open sumps will be sufficient to control the groundwater influx through the sides of the excavations.
6.6 Winter Construction

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

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

Trench excavations and pavement construction are 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 conducted during freezing conditions. Additional information could be provided, if required.

6.7 Corrosion Potential and Sulphate

The results of analytical testing show that the sulphate content is less than 0.1%. This result is indicative that Type 10 Portland cement (normal cement) would be appropriate for this site. The chloride content and the pH of the sample indicate that they are not significant factors in creating a corrosive environment for exposed ferrous metals, whereas the resistivity is indicative of a aggressive to very aggressive corrosive environment.

6.8 Protection of Potential Expansive Bedrock

It is possible that expansive shale will be encountered at the subject site. A potential for heaving and rapid deterioration of the shale bedrock exists at this site. To reduce the long term deterioration of the shale, exposure of the bedrock surface to oxygen should be kept as low as possible. The bedrock surface within the proposed building footprint should be protected from excessive dewatering and exposure to ambient air. To accomplish this a 50 mm thick concrete mud slab should be placed on the exposed bedrock surface within a 48 hour period of being exposed. A 15 MPa lean concrete may be used.

The excavated sides of the exposed bedrock should be sprayed with a bituminous emulsion to seal bedrock from exposure to air and dewatering.
Another option for protecting the shale from deterioration is placing granular fill over the exposed surface within a 48 hour period after exposure. Preventing the dewatering of the shale bedrock will also prevent the rapid deterioration and expansion of the shale bedrock. This can be accomplished by spraying bituminous emulsion as noted above.
7.0 RECOMMENDATIONS

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

- Observation of all bearing surfaces prior to the placement of concrete.
- Sampling and testing of the concrete and fill materials used.
- Observation of all subgrades prior to backfilling.
- Field density tests to determine the level of compaction achieved.
- Sampling and testing of the bituminous concrete including mix design reviews.

A report confirming that these works have been conducted in general accordance with our recommendations could be issued upon the completion of a satisfactory inspection program by the geotechnical consultant.
8.0 STATEMENT OF LIMITATIONS

The recommendations made in this report are in accordance with our present understanding of the project. Our recommendations should be reviewed when the project drawings and specifications are complete.

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 that we be notified 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 6770967 Canada Inc. or their agent(s) is not authorized without review by this firm for the applicability of our recommendations to the altered use of the report.

Paterson Group Inc.

Joe Forsyth, EIT.

David J. Gilbert, P.Eng.

Report Distribution:

- 6770967 Canada Inc. (3 copies)
- Paterson Group (1 copy)
APPENDIX 1

SOIL PROFILE AND TEST DATA SHEETS

SYMBOLS AND TERMS

ANALYTICAL TESTING RESULTS
**SOIL PROFILE AND TEST DATA**

Geotechnical Investigation
Proposed Residential Development-Ogilvie Road
Ottawa, Ontario

**DATUM**
TBM - Top of manhole located on centreline of Cummings Avenue, south of Ogilvie Road. Geodetic elevation = 69.47m.

**REMARKS**

**BORINGS BY**
CME 55 Power Auger

**DATE**
26 August 2011

**FILE NO.**
PG2463

**HOLE NO.**
BH 1

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**SOIL DESCRIPTION**

**GROUND SURFACE**

**FILL:** Brown silty sand with gravel, cobbles and brick

**BEDROCK:** Black shale

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**SAMPLE**

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<th>ELEV. (m)</th>
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**End of Borehole**

(GWL @ 5.33m-Sept. 2/11)
Geotechnical Investigation
Proposed Residential Development-Ogilvie Road
Ottawa, Ontario

DATUM: TBM - Top of manhole located on centreline of Cummings Avenue, south of Ogilvie Road. Geodetic elevation = 69.47m.

BORINGS BY: CME 55 Power Auger

DATE: 26 August 2011

SOIL PROFILE AND TEST DATA

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SOIL DESCRIPTION

GROUND SURFACE

Compact, brown SILTY SAND, trace gravel and clay

BEDROCK: Black shale

End of Borehole

Pen. Resist. Blows/0.3m

- 50 mm Dia. Cone

Water Content %

Piezometer Construction

Shear Strength (kPa)

- Undisturbed
- Remoulded

File No.: PG2463

Hole No.: BH 2
# Geotechnical Investigation

**Proposed Residential Development-Ogilvie Road**

**Ottawa, Ontario**

## BORINGS BY: CME 55 Power Auger

## SAMPLE

<table>
<thead>
<tr>
<th>STRATA PLOT</th>
<th>NUMBER</th>
<th>TYPE</th>
<th>RECOVERY</th>
<th>N VALUE or RQD</th>
<th>PEN. RESIST. BLOWS/0.3m</th>
</tr>
</thead>
<tbody>
<tr>
<td>GROUND SURFACE</td>
<td>TOPSOIL</td>
<td>SS 1</td>
<td>19</td>
<td></td>
<td></td>
</tr>
<tr>
<td>FILL: Brown silty sand with gravel</td>
<td>SS 2</td>
<td>18</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>SS 3</td>
<td>6</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Grey CLAYEY SILT, trace gravel</td>
<td>SS 4</td>
<td>52</td>
<td>6</td>
<td></td>
<td></td>
</tr>
<tr>
<td>BEDROCK: Black shale</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

## SOIL DESCRIPTION

- **TOPSOIL**: 0.10 m
- **FILL**: Brown silty sand with gravel
- **GROUT**: Grey CLAYEY SILT, trace gravel
- **BEDROCK**: Black shale
- **End of Borehole** (BH dry - Sept. 2/11)

## Pen. Resist. Blows/0.3m

- 50 mm Dia. Cone

## Soil Profile and Test Data

<table>
<thead>
<tr>
<th>DATE</th>
<th>26 August 2011</th>
</tr>
</thead>
</table>

## Water Content %

<table>
<thead>
<tr>
<th>BH 3</th>
</tr>
</thead>
</table>

## Shear Strength (kPa)

- Undisturbed
- Remoulded
### SOIL PROFILE AND TEST DATA

#### Geotechnical Investigation
Proposed Residential Development-Ogilvie Road
Ottawa, Ontario

<table>
<thead>
<tr>
<th>FILE NO.</th>
<th>PG2463</th>
</tr>
</thead>
<tbody>
<tr>
<td>HOLE NO.</td>
<td>BH 4</td>
</tr>
</tbody>
</table>

#### DATUM
TBM - Top of manhole located on centreline of Cummings Avenue, south of Ogilvie Road. Geodetic elevation = 69.47m.

#### REMARKS

<table>
<thead>
<tr>
<th>BORINGS BY</th>
<th>CME 55 Power Auger</th>
</tr>
</thead>
<tbody>
<tr>
<td>DATE</td>
<td>26 August 2011</td>
</tr>
</tbody>
</table>

#### SOIL DESCRIPTION

<table>
<thead>
<tr>
<th>STRATA PLOT</th>
<th>SAMPLE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type</td>
<td>Number</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>GROUND SURFACE</th>
</tr>
</thead>
</table>

- **TOPSOIL**
  - AU 1
  - AU 2
- **Brown SILTY SAND with gravel**
  - SS 3 100 50+
- **BEDROCK**: Black shale
  - 1.52
- End of Borehole

#### Pen. Resist. Blows/0.3m

- **Shear Strength (kPa)**
- **50 mm Dia. Cone**
- **Water Content %**
- **Piezometer Construction**
- **Undisturbed**
- **Remoulded**
SOIL PROFILE AND TEST DATA
Geotechnical Investigation
Proposed Residential Development-Ogilvie Road
Ottawa, Ontario

DATUM TBM - Top of manhole located on centreline of Cummings Avenue, south of Ogilvie Road. Geodetic elevation = 69.47m.

REMARKS

BORINGS BY CME 55 Power Auger

DATE 26 August 2011

FILE NO. PG2463
HOLE NO. BH 5

SOIL DESCRIPTION
GROUND SURFACE

FILL: Brown silty sand with gravel, some clay

FILL: Grey sandy silt with wood chips

FILL: Grey silty clay with sand and gravel

TOPSOIL
Grey SILTY CLAY with shale

BEDROCK: Black shale

End of Borehole
(GWL @ 5.82m-Sept. 1/11)
### Soil Profile & Test Data

**Phase I-II Environmental Site Assessment**
1098 Oglivie Road
Ottawa, Ontario

**Borings by CME 75 Power Auger**

**Date:** 27 Feb 03

<table>
<thead>
<tr>
<th>STRATA PLOT</th>
<th>SAMPLE</th>
<th>DEPTH (m)</th>
<th>ELEV. (m)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### Ground Surface

- **Asphaltic concrete:** 0.04
  - **FILL:** Black clayey silt, some sand, gravel and organic matter
  - 0.60

**Remarks:**
Practical auger refusal to augering @ 0.60m depth

#### Pen. Resist. Blows/0.3m
- 50 mm Dia. Cone

<table>
<thead>
<tr>
<th>Pen. Resist. Blows/0.3m</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lower Explosive Limit %</td>
</tr>
</tbody>
</table>

- 20 40 60 80

#### Monitoring Well Construction

- Gastech 1314 Rdg. (ppm)
**SOIL PROFILE & TEST DATA**

**BORINGS BY** CME 75 Power Auger

**DATE** 27 FEB 03

---

**SOIL DESCRIPTION**

**GROUND SURFACE**

**FILL:** Black clayey silt with organic matter

**BEDROCK:** Weathered shale

End of Borehole

Practical refusal to augering @ 1.42m depth

<table>
<thead>
<tr>
<th>STRATA PLOT</th>
<th>SAMPLE</th>
<th>DEPTH (m)</th>
<th>ELEV. (m)</th>
<th>% RECOVERY</th>
<th>N VALUE or RQD</th>
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</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>0</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>AU</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>SS</td>
<td>4</td>
<td>1.22</td>
<td>50</td>
<td>29</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>1.42</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

---

**Pen. Resist. Blows/0.3m**

- 50 mm Dia. Cone

**Lower Explosive Limit %**

- 20
- 40
- 60
- 80

---

**Monitoring Well Construction**

**Gastech 1314 Rgd. (ppm)**

- Full Gas Resp.
- Methane Elim.
SOIL PROFILE & TEST DATA
Phase I-II Environmental Site Assessment
1098 Ogilvie Road
Ottawa, Ontario

FILE NO. E2593
HOLE NO. BH 2

BORINGS BY CME 75 Power Auger

DATE 28 FEB 03

SOIL DESCRIPTION

<table>
<thead>
<tr>
<th>STRATA PLOT</th>
<th>SAMPLE</th>
<th>DEPTH (m)</th>
<th>ELEV. (m)</th>
<th>Pen. Resist. Blows/0.3m</th>
<th>Monitoring Well Construction</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>TYPE</th>
<th>NUMBER</th>
<th>% RECOVERY</th>
<th>N. VALUE</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>SS</td>
<td>5</td>
<td>50</td>
<td>29</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SS</td>
<td>6</td>
<td>50</td>
<td>23</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SS</td>
<td>7</td>
<td>25</td>
<td>50+</td>
<td></td>
<td></td>
</tr>
<tr>
<td>XSS</td>
<td>8</td>
<td>17</td>
<td>50+</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

GROUND SURFACE

FILL: Black clayey silt with shale layer and rock fragments

BEDROCK: Weathered shale

End of Borehole

Gastech 1314 Rdg. (ppm)
**SOIL PROFILE & TEST DATA**

**Phase I-II Environmental Site Assessment**
1098 Orléans Road
Ottawa, Ontario

**DATUM**

**REMARKS**

**BORINGS BY CME 75 Power Auger**

**DATE** 28 FEB 03

<table>
<thead>
<tr>
<th>STRATA PLOT</th>
<th>SAMPLE</th>
<th>PEN. RESIST. BLOWS/0.3m</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>&quot;50 mm Dia. Cone&quot;</td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>Lower Explosive Limit %</strong></td>
</tr>
<tr>
<td></td>
<td></td>
<td>20  40  60  80</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>DEPTH (m)</th>
<th>ELEV. (m)</th>
<th>PEN. RESIST. BLOWS/0.3m</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0</td>
<td>&quot;50 mm Dia. Cone&quot;</td>
</tr>
<tr>
<td>1</td>
<td>1</td>
<td>&quot;50 mm Dia. Cone&quot;</td>
</tr>
<tr>
<td>2</td>
<td>2</td>
<td>&quot;50 mm Dia. Cone&quot;</td>
</tr>
<tr>
<td>2.67</td>
<td>2.67</td>
<td>&quot;50 mm Dia. Cone&quot;</td>
</tr>
</tbody>
</table>

**SOIL DESCRIPTION**

**GROUND SURFACE**

FILL: Black clayey silt with organic matter

**BEDROCK: Weathered shale with silty clay layers**

**End of Borehole**

Practical refusal to augering @ 2.67m depth

**Monitoring Well Construction**

**Gastech 1314 Rdg. (ppm)**

### Soil Profile & Test Data

**Phase I-II Environmental Site Assessment**

**1098 Ogilvie Road**

Ottawa, Ontario

**Datum**

**Remarks**

**Borings by CME 75 Power Auger**

**Date:** 28 Feb 03

**File No.:** E2593

**Hole No.:** BH 4

---

#### Soil Description

<table>
<thead>
<tr>
<th>Strata Plott</th>
<th>Sample</th>
<th>Depth (m)</th>
<th>Elev. (m)</th>
<th>Pen. Resist. Blows/0.3m</th>
</tr>
</thead>
<tbody>
<tr>
<td>GROUND SURFACE</td>
<td>SS 13</td>
<td>0.0</td>
<td>0.0</td>
<td>50</td>
</tr>
<tr>
<td></td>
<td>SS 14</td>
<td>1.0</td>
<td>1.0</td>
<td>62</td>
</tr>
<tr>
<td></td>
<td>SS 15</td>
<td>2.0</td>
<td>2.0</td>
<td>54</td>
</tr>
</tbody>
</table>

**Remarks:**

- **Fill:** Black to brown clayey silt with organic matter, some sand.
- **End of Borehole:** Practical refusal to augering @ 2.26m depth.

---

**Lower Explosive Limit %**

- 20
- 40
- 60
- 80

**Monitoring Well Construction**

- **Gastech 1314 Rdg. (ppm):**
  - ▲ Full Gas Resp.
  - △ Methane Elim.

---

**Notes:**

- **DATE:** 28 Feb 03
- **FILE NO.:** E2593
- **HOLE NO.:** BH 4
## Soil Profile & Test Data

**Phase I-II Environmental Site Assessment**

**John D. Paterson & Associates Ltd.**

28 Concourse Gate, Unit 1, Nepean, Ont. K2E 7T7

**1098 Ogilvie Road**

**Ottawa, Ontario**

**File No.:** E2593

**Hole No.:** BH 5

### Datum

**Remarks**

**Borings by:** CME 75 Power Auger

**Date:** 28 Feb 03

### Soil Description

<table>
<thead>
<tr>
<th>Strata Plot</th>
<th>Sample</th>
<th>Depth (m)</th>
<th>Elev. (m)</th>
<th>Pen. Resist. Blows/0.3m</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>GROUND SURFACE</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>SS</td>
<td>16</td>
<td>54</td>
<td>29</td>
</tr>
<tr>
<td>FILL: Black to brown clayey silt with some sand</td>
<td>SS</td>
<td>17</td>
<td>62</td>
<td>29</td>
</tr>
<tr>
<td></td>
<td>SS</td>
<td>18</td>
<td>60</td>
<td>50+</td>
</tr>
<tr>
<td>BEDROCK: Weathered shale</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**End of Borehole**

(GWL @ 3.36m-March 6/03)

**Gastech 1314 Rdg. (ppm)**

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.

<table>
<thead>
<tr>
<th>Relative Density</th>
<th>‘N’ Value</th>
<th>Relative Density %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Very Loose</td>
<td>&lt;4</td>
<td>&lt;15</td>
</tr>
<tr>
<td>Loose</td>
<td>4-10</td>
<td>15-35</td>
</tr>
<tr>
<td>Compact</td>
<td>10-30</td>
<td>35-65</td>
</tr>
<tr>
<td>Dense</td>
<td>30-50</td>
<td>65-85</td>
</tr>
<tr>
<td>Very Dense</td>
<td>&gt;50</td>
<td>&gt;85</td>
</tr>
</tbody>
</table>

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.

<table>
<thead>
<tr>
<th>Consistency</th>
<th>Undrained Shear Strength (kPa)</th>
<th>‘N’ Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Very Soft</td>
<td>&lt;12</td>
<td>&lt;2</td>
</tr>
<tr>
<td>Soft</td>
<td>12-25</td>
<td>2-4</td>
</tr>
<tr>
<td>Firm</td>
<td>25-50</td>
<td>4-8</td>
</tr>
<tr>
<td>Stiff</td>
<td>50-100</td>
<td>8-15</td>
</tr>
<tr>
<td>Very Stiff</td>
<td>100-200</td>
<td>15-30</td>
</tr>
<tr>
<td>Hard</td>
<td>&gt;200</td>
<td>&gt;30</td>
</tr>
</tbody>
</table>
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.

<table>
<thead>
<tr>
<th>RQD %</th>
<th>ROCK QUALITY</th>
</tr>
</thead>
<tbody>
<tr>
<td>90-100</td>
<td>Excellent, intact, very sound</td>
</tr>
<tr>
<td>75-90</td>
<td>Good, massive, moderately jointed or sound</td>
</tr>
<tr>
<td>50-75</td>
<td>Fair, blocky and seamy, fractured</td>
</tr>
<tr>
<td>25-50</td>
<td>Poor, shattered and very seamy or blocky, severely fractured</td>
</tr>
<tr>
<td>0-25</td>
<td>Very poor, crushed, very severely fractured</td>
</tr>
</tbody>
</table>

SAMPLE TYPES

<table>
<thead>
<tr>
<th>CODE</th>
<th>SAMPLE TYPE</th>
</tr>
</thead>
<tbody>
<tr>
<td>SS</td>
<td>Split spoon sample (obtained in conjunction with the performing of the Standard Penetration Test (SPT))</td>
</tr>
<tr>
<td>TW</td>
<td>Thin wall tube or Shelby tube</td>
</tr>
<tr>
<td>PS</td>
<td>Piston sample</td>
</tr>
<tr>
<td>AU</td>
<td>Auger sample or bulk sample</td>
</tr>
<tr>
<td>WS</td>
<td>Wash sample</td>
</tr>
<tr>
<td>RC</td>
<td>Rock core sample (Core bit size AXT, BXL, etc.). Rock core samples are obtained with the use of standard diamond drilling bits.</td>
</tr>
</tbody>
</table>
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 = \( \left( \frac{D30}{D10 \times D60} \right)^2 \)
- **Cu**: Uniformity coefficient = \( \frac{D60}{D10} \)

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
- **Cc**: Compression index (in effect at pressures above \( p'_{c} \))
- **Ccr**: Recompression index (in effect at pressures below \( p'_{c} \))

**OC Ratio**: Overconsolidation ratio = \( \frac{p'_{c}}{p'_{o}} \)

**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.
<table>
<thead>
<tr>
<th>Physical Characteristics</th>
<th></th>
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</thead>
<tbody>
<tr>
<td>% Solids</td>
<td>0.1 % by Wt.</td>
<td>92.8</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>General Inorganics</th>
<th></th>
<th></th>
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</thead>
<tbody>
<tr>
<td>pH</td>
<td>0.1 pH Unit</td>
<td>7.0</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Resistivity</td>
<td>0.10 Ohm.m</td>
<td>27.7</td>
<td>-</td>
<td>-</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Anions</th>
<th></th>
<th></th>
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<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Chloride</td>
<td>5 ug/g dry</td>
<td>125</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Sulfate</td>
<td>5 ug/g dry</td>
<td>64</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>
APPENDIX 2

FIGURE 1 - KEY PLAN

DRAWING PG2463-1 - TEST HOLE LOCATION PLAN
FIGURE 1
KEY PLAN