# GEOTECHNICAL INVESTIGATION
# PROPOSED ADDITIONS
# SCUGOG DEPOT
# DURHAM REGION, ONTARIO

**Prepared for:**

**REGION OF MUNCIPALITY OF DURHAM**

By:

**SPL CONSULTANTS LIMITED**

Project: 1449-110
March 25, 2013

SPL Consultants Limited
Geotechnical Environmental Materials Hydrogeology

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**Drawings**

## 1. INTRODUCTION

SPL Consultants Limited (SPL) was retained by The Regional Municipality of Durham to undertake a geotechnical investigation for the proposed addition to the existing building as well as of the construction of exterior foundations for equipment such as electrical substation at Scugog Depot, located in Durham Region, Ontario.

It is understood that the proposed building will be a low rise structure with slab on grade and will have the same finished floor elevation of the existing building. The finished floor elevation of the existing building and electrical substation is not known to us at the time of writing this report. The location of the electrical substation is also not known to us.

The purpose of this investigation was to determine the subsurface conditions at five (5) borehole locations and from the findings in the boreholes make engineering recommendations for the following:

1. Foundations
2. Floor slabs and permanent drainage
3. Excavations and backfill
4. Earth pressures
5. Earthquake considerations
6. Pavements

This report is provided on the basis of the terms of reference presented above and on the assumption that the design will be in accordance with the applicable codes and standards. If there are any changes in the design features relevant to the geotechnical analyses, or if any questions arise concerning the geotechnical aspects of the codes and standards, this office should be contacted to review the design. It may then be necessary to carry out additional borings and reporting before the recommendations of this office can be relied upon.

The site investigation and recommendations follow generally accepted practice for geotechnical consultants in Ontario. The format and contents are guided by client specific needs and economics and do not conform to generalized standards for services. Laboratory testing for most part follows ASTM or CSA Standards or modifications of these standards that have become standard practice.

This report has been prepared for The Regional Municipality of Durham. Third party use of this report without SPL consent is prohibited. The limitation conditions presented in this report form an integral part of the report and they must be considered in conjunction with this report.

## 2. FIELD AND LABORATORY WORK

Five boreholes (BH12-1 to BH12- 5, see Drawing 1 for location plan) were drilled at the subject site. Boreholes BH12-1 to BH12-4 were drilled to depth of 8.1 m and Borehole BH12-5 was drilled to a depth of 3.5 m. Boreholes BH12-2 and BH12-4 were drilled close to the existing building and other boreholes

were drilled away from the existing building line. The boreholes were drilled with solid stem continuous flight auger equipment by a drilling sub-contractor, under the direction and supervision of SPL Consultants Limited personnel. Samples were retrieved at regular intervals with a 50 mm O.D. split-barrel sampler driven with a hammer weighing 624 N and dropping 760 mm in accordance with the Standard Penetration Test (SPT) method. The samples were logged in the field and returned to the SPL Consultants Limited laboratory for detailed examination by the project engineer and for laboratory testing. The soil samples were tested for moisture contents.

Water level observations were made during drilling and in the open boreholes at the completion of the drilling operations.

The ground surface elevations at the borehole locations were measured by SPL personnel.

## 3. SITE AND SUBSURFACE CONDITIONS

The borehole location plan is shown on Drawing 1. The subsurface conditions in the boreholes are presented on the individual borehole logs (Drawings 2 to 6) and are summarized in the following paragraphs.

**Asphalt / Fill Material:** All boreholes were drilled on the paved surface and encountered 30 to 40 mm of surficial asphalt layer. Fill material was encountered in all boreholes below the asphalt layer which consists of sand and extends to the depths varying from 0.8 to 4.6 m below ground surface. The fill material was found to be generally in a compact to very loose state with occasional dense layers. Fill material was found wet just below the surface at the location of Borehole BH12-2 and is believed to the perched water.

The explored depth of fill in the boreholes is listed on Table 1 below.

**Table 1: Depth of Fill Materials in Boreholes**

| Borehole No. | Depth of Fill (m) | Elevation of Bottom of Fill (m) |
|---|---|---|
| BH12-1 | 0.8 | 339.1 |
| BH12-2 | 2.4 | 337.5 |
| BH12-3 | 4.6 | 335.2 |
| BH12-4 | 3.1 | 336.9 |
| BH12-5 | 3.2 | 336.6 |

**Native Soils:** Below the fill materials, the native soils encountered in the boreholes consist of sand/silty sand and sandy silt and extends to the maximum explored depth of 8.1 m in the boreholes. These sandy

deposits were found to be generally in a compact to dense state with occasional very dense layers with measured SPT 'N' values ranging from 11 to more than 50 blows per 300 mm penetration.

**Groundwater Conditions:**

All boreholes were found dry within the maximum explored depth of 8.1 m during and upon completion of drilling.

## 4. FOUNDATIONS

It is understood that the proposed building will be a low rise structure with slab on grade and will have the same finished floor elevation of the existing building. The finished floor elevation of the existing building and electrical substation is not known to us at the time of writing this report. The location of the electrical substation is also not known to us.

The depth of the existing fill explored in the boreholes ranged from 0.8 m (BH12-1) to 4.6 m (BH12-3). The existing fill materials are considered not suitable for supporting foundations of the proposed structures.

Based on the borehole information, the proposed building and the exterior foundations for electrical substation can be supported by adopting any foundation options given below.

- Spread and strip footings founded on engineered fill or
- Spread and strip footings founded on undisturbed native soil
- Helical Piles

### 4.1 Footings on Engineered Fill

The proposed building can be supported by spread and strip footings founded on engineered fill for a bearing capacity of 150 kPa at the serviceability limit states (SLS) and for a factored geotechnical resistance of 225 kPa at the ultimate limit states (ULS), provided all requirements on Appendix A are adhered to. Prior to the placement of the engineered fill, all of the existing fill and surficially softened native soils must be removed and the exposed surface proof rolled. Any soft spots revealed during proof rolling must be sub-excavated and re-engineered. The engineered fill consisting of approved inorganic material must be compacted to 100% Standard Proctor Maximum Dry Density throughout. To reduce the risk of improperly placed engineered compacted fill, full-time supervision of the contractor is essential. Despite full time supervision, it has been found that contractors frequently bulldoze loose fill into areas and compact only the surface. The inspector, either busy on other portions of the site or absent during "off hours" will be unaware of this condition. For this reason, we cannot guarantee the performance of the engineered fill, and this guarantee must be the responsibility of the contractor. The owner and his representatives must accept the risk involved in the use of engineered fill and offset this

risk with the monetary savings of avoiding deep foundations. This potential problem must be recognized and discussed at a pre-construction meeting. Procedures can then be instigated to reduce the risk of settlement resulting from un-compacted fill.

### 4.2 Footings on Native Soils

The proposed structures can be supported by conventional footings founded on the undisturbed sand for a bearing capacity of 200 kPa at SLS (serviceability limit states), and for a factored geotechnical resistance of 300 kPa at ULS (ultimate limit states).

The bearing values and the corresponding founding elevations of the native soils at the borehole locations are summarized on Table 2.

**Table 2: Bearing Values and Founding Levels of Footings**

| BH No. | Founding Soil | Bearing Capacity at SLS (kPa) | Factored Geotechnical Resistance at ULS (kPa) | Minimum Depth below Existing Ground (m) | Founding Level At or Below Elevation (m) |
|---|---|---|---|---|---|
| BH12-1 | Sand | 200 | 300 | 1.2 | 338.7 |
| BH12-2 | Sand | 200 | 300 | 3.0 | 336.9 |
| BH12-3 | Sand | 200 | 300 | 4.7 | 335.1 |
| BH12-4 | Sand | 200 | 300 | 3.2 | 336.8 |
| BH12-5 | Sand | 200 | 300 | 3.3 | 336.5 |

### 4.3 Helical Piles

The extended conventional footings or footings on engineered fill may not be a practical option, if the existing footings are founded at higher elevation, for the building addition. The alternate option is to support the building on helical piles.

The helical piles are generally designed as end bearing and the friction from the upper fill and loose soil must be ignored. The helical piles must be extended to at least 2 to 3 m into the native dense sandy soils. Typical Bearing capacity values of 100 to 300 KN per pile at SLS (i.e. 150 to 450 kN per pile at ULS) are available, depending on the size and depth of the piles. A specialized contractor must be retained to design and install helical piles. Bearing capacity and other design details regarding helical piles can be

discussed with the specialized contractor. Field load testing of piles is suggested to confirm the design bearing capacity. The test helical pile should be loaded to at least 2 times the design bearing capacity at ULS.

### 4.4 Other Comments on Foundations

Footings designed to the specified bearing capacity at the serviceability limit states (SLS) are expected to settle less than 25 mm total and 19 mm differential.

All footings exposed to seasonal freezing conditions must have at least 1.2 metres of soil cover for frost protection.

Where it is necessary to place footings at different levels, the upper footing is founded below an imaginary 10 horizontal to 7 vertical line drawn up from the base of the lower footing. The lower footing is installed first to help minimize the risk of undermining the upper footing.

It should be noted that the recommended bearing capacities have been calculated by SPL Consultants Limited from the borehole information for the design stage only. The investigation and comments are necessarily on-going as new information of the underground conditions becomes available. For example, more specific information is available with respect to conditions between boreholes when foundation construction is underway. The interpretation between boreholes and the recommendations of this report must therefore be checked through field inspections provided by SPL Consultants Limited to validate the information for use during the construction stage.

## 5. FLOOR SLAB AND PERMANENT DRAINAGE

It is assumed that floor loads will not exceed 15 kPa. The existing fill is in compact state in the upper levels and becomes loose with depth. The fill has been in-place for a long time and therefore most of the settlement due to its own weight has already occurred. The fill can be used to support the floor slab, if the subgrade is thoroughly proof-rolled to detect any loose or soft areas. These areas can be sub-excavated and replaced with engineered fill. With this option, there is some risk of cracking of floor slab. If the owners don't want to assume any risk, then all fill must be removed and replaced with engineered fill. The backfill required to raise the grade can consist of inorganic soil, placed in shallow lifts and compacted to at least 98 percent of Standard Proctor Maximum Dry Density (SPMDD).

For the design of the floor slab, a value of 20 MPa/m can be used for the coefficient of subgrade reaction ($k_t$).

A moisture barrier consisting of at least 200 mm of 19 mm clear crushed stone should be installed under the floor slab.

If the floor slab is more than about 300 mm higher than the exterior grade then perimeter drainage is not considered to be necessary. If the floor is lower then the perimeter drainage system shown on Drawing 7 is recommended.

## 6. EXCAVATIONS AND BACKFILL

Excavations can be carried out with heavy hydraulic backhoe. Based on the borehole information, no major problems with groundwater anticipated for the installation of foundations. Seepage is expected to enter into the excavations from the fill material especially in Borehole BH12-2, which can be removed by pumping from sumps.

Possible large obstructions can also be anticipated in the fill material. Provisions must be made in the excavation contract for the removal of obstructions in the fill material.

All excavations must be carried out in accordance with the most recent Occupational Health and Safety Act (OHSA). In accordance with OHSA, the existing fill and very loose sandy soils can be classified as Type 3 Soil above groundwater table.

Select inorganic fill and the native soils free from topsoil and organics can be used as general construction backfill. Loose lifts of soil, which are to be compacted, should not exceed 200 mm. Underfloor fill should be compacted to at least 98 percent of Standard Proctor Maximum Dry Density (SPMDD).

Imported granular fill, which can be compacted with hand held equipment, should be used in confined areas.

It should be noted that the excavated soils are subject to moisture content increase during wet weather which would make these materials too wet for adequate compaction. Stockpiles should be compacted at the surface or be covered with tarpaulins to minimize moisture uptake.

## 7. EARTH PRESSURES

The lateral earth pressures acting on the walls may be calculated from the following expression:

$$p = K(\gamma h + q)$$

where, $p$ = Lateral earth pressure in kPa acting at depth h

$K$ = Earth pressure coefficient, assumed to be 0.40 for vertical walls and horizontal backfill for permanent construction

$\gamma$ = Unit weight of backfill, a value of 21 kN/m$^3$ may be assumed

$h$ = Depth to point of interest in metres

q = Equivalent value of surcharge on the ground surface in kPa

The above expression assumes that the perimeter drainage system prevents the build up of any hydrostatic pressure behind the wall.

## 8. EARTHQUAKE CONSIDERATIONS

Based on the existing borehole information and according to Table 4.1.8.4.A of OBC 2006, the subject site for the proposed buildings can be classified as 'Class D' for seismic site response.

## 9. PAVEMENTS

The recommended pavement structures provided in Table 3 are based upon an estimate of the subgrade soil properties determined from visual examination and textural classification of the soil samples. The values may need to be adjusted based on the city /regional standards. Consequently, the recommended pavement structures should be considered for preliminary design purposes only. A functional design life of eight to ten years has been used to establish the pavement recommendations. This represents the number of years to the first rehabilitation, assuming regular maintenance is carried out. If required, a more refined pavement structure design can be performed based on specific traffic data and design life requirements and will involve specific laboratory tests to determine frost susceptibility and strength characteristics of the subgrade soils, as well as specific data input from the client.

**Table 3: Recommended Pavement Structure Thickness**

| Pavement Layer | Compaction Requirements | Light Duty Parking (Cars) | Heavy Duty Parking (Delivery Trucks) |
|---|---|---|---|
| Asphaltic Concrete | 92.0 to 96.5% Maximum Relative Density (MRD) | 40 mm HL 3 or SP 12.5<br>40 mm HL 8 or SP 19.0 | 40 mm HL 3 or SP 12.5<br>80 mm HL 8 or SP 19.0 |
| OPSS Granular A Base (or 20mm Crusher Run Limestone) | 100% SPMDD* | 150 mm | 150 mm |
| OPSS Granular B (or 50mm Crusher Run Limestone) | 100% SPMDD | 200 mm | 300 mm |

* Denotes Standard Proctor Maximum Dry Density, ASTM-D698
The subgrade must be compacted to 98% SPMDD for at least the upper 300 mm unless accepted by SPL Consultants Limited.

The long term performance of the pavement structure is highly dependent upon the subgrade support conditions. Stringent construction control procedures should be maintained to ensure uniform subgrade moisture and density conditions are achieved. In addition, the need for adequate drainage

cannot be over-emphasized. The finished pavement surface and underlying subgrade should be free of depressions and should be sloped (preferably at a minimum grade of two percent) to provide effective surface drainage toward catch basins. Surface water should not be allowed to pond adjacent to the outside edges of pavement areas. Subdrains should be installed to intercept excess subsurface moisture and prevent subgrade softening. This is particularly important in heavy-duty pavement areas.

Additional comments on the construction of parking areas and access roadways are as follows:

1) As part of the subgrade preparation, proposed parking areas and access roadways should be stripped of topsoil and other obvious objectionable material. Fill required to raise the grades to design elevations should conform to backfill requirements outlined in previous sections of this report. The subgrade should be properly shaped, crowned then proof-rolled in the full time presence of a representative of this office. Soft or spongy subgrade areas should be sub-excavated and properly replaced with suitable approved backfill compacted to 98% SPMDD.

2) The locations and extent of sub-drainage required within the paved areas should be reviewed by this office in conjunction with the proposed lot grading. Assuming that satisfactory crossfalls in the order of two percent have been provided, subdrains extending from and between catch basins may be satisfactory. In the event that shallower crossfalls are considered, a more extensive system of sub-drainage may be necessary and should be reviewed by SPL Consultants Limited.

3) The most severe loading conditions on light-duty pavement areas and the subgrade may occur during construction. Consequently, special provisions such as restricted access lanes, half-loads during paving, etc., may be required, especially if construction is carried out during unfavourable weather.

4) It is recommended that SPL Consultants Limited be retained to review the final pavement structure designs and drainage plans prior to construction to ensure that they are consistent with the recommendations of this report.

## 10. CHEMICAL TEST RESULTS

A selected six (6) soil samples were submitted to AGAT Laboratory Group to evaluate their environmental quality with respect to on-site reuse or off-site disposal relative to the MOE Soil Standards (O.Reg. 153, 347 Section XV.1 of the EPA). These samples were tested for metals, general and inorganic parameters . The chemical testing results will be submitted in a separate letter.

## 11. GENERAL COMMENTS

SPL Consultants Limited should be retained for a general review of the final design and specifications to verify that this report has been properly interpreted and implemented. If not accorded the privilege of making this review, SPL Consultants Limited will assume no responsibility for interpretation of the recommendations in the report.

The comments given in this report are intended only for the guidance of design engineers. The number of boreholes required to determine the localized underground conditions between boreholes affecting construction costs, techniques, sequencing, equipment, scheduling, etc., would be much greater than has been carried out for design purposes. Contractors bidding on or undertaking the works should, in this light, decide on their own investigations, as well as their own interpretations of the factual borehole and test pit results, so that they may draw their own conclusions as to how the subsurface conditions may affect them.

## 12. LIMITATIONS OF REPORT

This report is intended solely for the Client named. The material in it reflects our best judgment in light of the information available to SPL Consultants Limited at the time of preparation. Unless otherwise agreed in writing by SPL Consultants Limited, it shall not be used to express or imply warranty as to the fitness of the property for a particular purpose. No portion of this report may be used as a separate entity, it is written to be read in its entirety.

The conclusions and recommendations given in this report are based on information determined at the test hole locations. The information contained herein in no way reflects on the environment aspects of the project, unless otherwise stated. Subsurface and groundwater conditions between and beyond the test holes may differ from those encountered at the test hole locations, and conditions may become apparent during construction, which could not be detected or anticipated at the time of the site investigation. The benchmark and elevations used in this report are primarily to establish relative elevation differences between the test hole locations and should not be used for other purposes, such as grading, excavating, planning, development, etc.

The design recommendations given in this report are applicable only to the project described in the text and then only if constructed substantially in accordance with the details stated in this report.

The comments made in this report on potential construction problems and possible methods are intended only for the guidance of the designer. The number of test holes may not be sufficient to determine all the factors that may affect construction methods and costs. For example, the thickness of surficial topsoil or fill layers may vary markedly and unpredictably. The contractors bidding on this project or undertaking the construction should, therefore, make their own interpretation of the factual information presented and draw their own conclusions as to how the subsurface conditions may affect their work. This work has been undertaken in accordance with normally accepted geotechnical engineering practices.

Any use which a third party makes of this report, or any reliance on or decisions to be made based on it, are the responsibility of such third parties. SPL Consultants Limited accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions based on this report.

We accept no responsibility for any decisions made or actions taken as a result of this report unless we are specifically advised of and participate in such action, in which case our responsibility will be as agreed to at that time.

We trust that the information contained in this report is satisfactory. Should you have any questions, please do not hesitate to contact this office.

**SPL CONSULTANTS LIMITED**


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# Drawings



| | | | | | |
|---|---|---|---|---|---|
| Client: | Regional Municipality of Durham | | | Project No: 1449-110 | Drawing No: 1 |
| Drawn: | AQ | Approved: | NW | Title: | Borehole Location Plan |
| Date: | March 2013 | Scale: | NTS | Project: | Geotechnical investigation- Building addition, Scugog Depots, Clarington, Durham, ON |
| Original Size: | Tabloid | Rev: | N/A | SPL Consultants Limited<br>Geotechnical Environmental Materials Hydrogeology | |

# Drawing 1A: Notes On Sample Descriptions

1. All sample descriptions included in this report generally follow the Unified Soil Classification. Laboratory grain size analyses provided by SPL also follow the same system. Different classification systems may be used by others, such as the system by the International Society for Soil Mechanics and Foundation Engineering (ISSMFE). Please note that, with the exception of those samples where a grain size analysis and/or Atterberg Limits testing have been made, all samples are classified visually. Visual classification is not sufficiently accurate to provide exact grain sizing or precise differentiation between size classification systems.

ISSMFE SOIL CLASSIFICATION

| CLAY | SILT | | | SAND | | | GRAVEL | | | COBBLES | BOULDERS |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | FINE | MEDIUM | COARSE | FINE | MEDIUM | COARSE | FINE | MEDIUM | COARSE | | |


EQUIVALENT GRAIN DIAMETER IN MILLIMETRES

| CLAY (PLASTIC) TO | FINE | MEDIUM | CRS. | FINE | COARSE |
|---|---|---|---|---|---|
| SILT (NONPLASTIC) | SAND | | | GRAVEL | |

UNIFIED SOIL CLASSIFICATION

2. Fill: Where fill is designated on the borehole log it is defined as indicated by the sample recovered during the boring process. The reader is cautioned that fills are heterogeneous in nature and variable in density or degree of compaction. The borehole description may therefore not be applicable as a general description of site fill materials. All fills should be expected to contain obstruction such as wood, large concrete pieces or subsurface basements, floors, tanks, etc., none of these may have been encountered in the boreholes. Since boreholes cannot accurately define the contents of the fill, test pits are recommended to provide supplementary information. Despite the use of test pits, the heterogeneous nature of fill will leave some ambiguity as to the exact composition of the fill. Most fills contain pockets, seams, or layers of organically contaminated soil. This organic material can result in the generation of methane gas and/or significant ongoing and future settlements. Fill at this site may have been monitored for the presence of methane gas and, if so, the results are given on the borehole logs. The monitoring process does not indicate the volume of gas that can be potentially generated nor does it pinpoint the source of the gas. These readings are to advise of the presence of gas only, and a detailed study is recommended for sites where any explosive gas/methane is detected. Some fill material may be contaminated by toxic/hazardous waste that renders it unacceptable for deposition in any but designated land fill sites; unless specifically stated the fill on this site has not been tested for contaminants that may be considered toxic or hazardous. This testing and a potential hazard study can be undertaken if requested. In most residential/commercial areas undergoing reconstruction, buried oil tanks are common and are generally not detected in a conventional preliminary geotechnical site investigation.

3. Till: The term till on the borehole logs indicates that the material originates from a geological process associated with glaciation. Because of this geological process the till must be considered heterogeneous in composition and as such may contain pockets and/or seams of material such as sand, gravel, silt or clay. Till often contains cobbles (60 to 200 mm) or boulders (over 200 mm). Contractors may therefore encounter cobbles and boulders during excavation, even if they are not indicated by the borings. It should be appreciated that normal sampling equipment cannot differentiate the size or type of any obstruction. Because of the horizontal and vertical variability of till, the sample description may be applicable to a very limited zone; caution is therefore essential when dealing with sensitive excavations or dewatering programs in till materials.

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Geotechnical Environmental Materials Hydrogeology

# LOG OF BOREHOLE BH12-1

PROJECT: Geotechnical Investigation- Scugog Depots
CLIENT: The Regional Municipality of Durham
PROJECT LOCATION: Durham Region
DATUM: Geodetic
BH LOCATION:

**DRILLING DATA**
Method: Solid Stem Auger
Diameter: 115 mm
Date: Mar/13/2013

REF. NO.: 1449-110
ENCL NO.: 2

| (m) ELEV / DEPTH | DESCRIPTION | STRATA PLOT | SAMPLES NUMBER | SAMPLES TYPE | SAMPLES "N" BLOWS 0.3 m | GROUND WATER CONDITIONS | ELEVATION | DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH (kPa) ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE & Sensitivity × LAB VANE (50 100 150 200 250) | PLASTIC LIMIT $w_P$ / NATURAL MOISTURE CONTENT $w$ / LIQUID LIMIT $w_L$ — WATER CONTENT (%) (10 20 30) | POCKET PEN. (Cu) (kPa) | NATURAL UNIT WT (Mg/m³) | REMARKS AND GRAIN SIZE DISTRIBUTION (%) GR SA SI CL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 339.9 | | | | | | | | | | | | |
| 339.8 | **ASPHALT:** 40mm | | | | | | | | | | | |
| | **FILL:** sand, trace silt, brown, moist, loose | | 1 | AS | | | | | ○ | | | |
| 339.1 | | | | | | | | | | | | |
| 0.8 | **SAND:** trace silt, brown, moist, compact | | 2 | SS | 26 | | 339 | | ○ | | | |
| | | | 3 | SS | 21 | | 338 | | ○ | | | |
| 337.6 | | | | | | | | | | | | |
| 2.3 | **SILTY SAND:** brown, moist, dense to very dense | | 4 | SS | 36 | | | | ○ | | | |
| | | | 5 | SS | 50 | | 337 | | ○ | | | |
| | | | | | | | 336 | | | | | |
| | | | 6 | SS | 46 | | 335 | | ○ | | | |
| 334.4 | | | | | | | | | | | | |
| 5.5 | **SAND:** trace silt, brown, moist, dense | | | | | | 334 | | | | | |
| | | | 7 | SS | 41 | | | | ○ | | | |
| | | | | | | | 333 | | | | | |
| 331.8 | | | 8 | SS | 46 | | 332 | | ○ | | | |
| 8.1 | **END OF THE BOREHOLE**<br>Notes:<br>1) Borehole dry and open upon completion. | | | | | | | | | | | |

SPL SOIL LOG 1449-110.GPJ SPL.GDT 25/3/13

GROUNDWATER ELEVATIONS
Shallow/ Single Installation ▽ ▼ Deep/Dual Installation ▽ ▼

GRAPH NOTES: $+^3$, $\times^3$: Numbers refer to Sensitivity ○ $^{\varepsilon=3\%}$ Strain at Failure

SPL Consultants Limited
Geotechnical Environmental Materials Hydrogeology

# LOG OF BOREHOLE BH12-2

PROJECT: Geotechnical Investigation- Scugog Depots
CLIENT: The Regional Municipality of Durham
PROJECT LOCATION: Durham Region
DATUM: Geodetic
BH LOCATION:

**DRILLING DATA**
Method: Solid Stem Auger
Diameter: 115 mm
Date: Mar/13/2013

REF. NO.: 1449-110
ENCL NO.: 3

| (m) ELEV / DEPTH | DESCRIPTION | STRATA PLOT | NUMBER | TYPE | "N" BLOWS 0.3 m | GROUND WATER CONDITIONS | ELEVATION |
|---|---|---|---|---|---|---|---|
| 339.9 | | | | | | | |
| 339.8 0.1 | **ASPHALT:** 30mm<br>**FILL:** sand, trace silt, trace gravel, brown, wet, compact to very loose | | 1 | AS | | | |
| | very moist at 0.8m | | 2 | SS | 16 | | 339 |
| | moist at 1.5m | | 3 | SS | 2 | | 338 |
| 337.5 2.4 | **SAND:** trace silt, brown, moist, compact to dense | | 4 | SS | 11 | | 337 |
| | | | 5 | SS | 20 | | 336 |
| | | | 6 | SS | 34 | | 335 |
| 334.4 5.5 | **SANDY SILT:** brown, moist, compact | | 7 | SS | 17 | | 334 |
| 332.9 7.0 | **SAND:** trace silt, brown, moist, dense | | 8 | SS | 39 | | 333 |
| 331.8 8.1 | **END OF THE BOREHOLE**<br>Notes:<br>1) Borehole dry and open upon completion. | | | | | | 332 |

DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100)
SHEAR STRENGTH (kPa) (50 100 150 200 250)
○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE & Sensitivity × LAB VANE
PLASTIC LIMIT $w_P$ | NATURAL MOISTURE CONTENT $w$ | LIQUID LIMIT $w_L$
WATER CONTENT (%) (10 20 30)
POCKET PEN (Cu) (kPa)
NATURAL UNIT WT (Mg/m³)
REMARKS AND GRAIN SIZE DISTRIBUTION (%) GR SA SI CL

SPL SOIL LOG 1449-110.GPJ SPL.GDT 25/3/13

GROUNDWATER ELEVATIONS
Shallow/ Single Installation ▽ ▼ Deep/Dual Installation ▽ ▼

GRAPH NOTES: $+^3$, $\times^3$: Numbers refer to Sensitivity ○ $\varepsilon$=3% Strain at Failure

SPL Consultants Limited
Geotechnical Environmental Materials Hydrogeology

# LOG OF BOREHOLE BH12-3

PROJECT: Geotechnical Investigation- Scugog Depots
CLIENT: The Regional Municipality of Durham
PROJECT LOCATION: Durham Region
DATUM: Geodetic
BH LOCATION:

**DRILLING DATA**
Method: Solid Stem Auger
Diameter: 115 mm
Date: Mar/13/2013

REF. NO.: 1449-110
ENCL NO.: 4

| (m) ELEV / DEPTH | DESCRIPTION | STRATA PLOT | NUMBER | TYPE | "N" BLOWS 0.3 m | GROUND WATER CONDITIONS | ELEVATION |
|---|---|---|---|---|---|---|---|
| 339.8 / 0.0 | **ASPHALT:** 30mm | | | | | | |
| | **FILL:** sand, silty, trace gravel, brown, moist, dense to loose | | 1 | AS | | | |
| | | | 2 | SS | 36 | | 339 |
| | | | 3 | SS | 18 | | 338 |
| | seams of silt at 2.3 m | | 4 | SS | 12 | | 337 |
| | | | 5 | SS | 5 | | 336 |
| 335.2 / 4.6 | **SAND:** trace silt, brown, moist, compact to dense | | 6 | SS | 18 | | 335 |
| | | | 7 | SS | 24 | | 334 |
| | | | 8 | SS | 40 | | 333 |
| 331.7 / 8.1 | **END OF THE BOREHOLE** | | | | | | 332 |
| | Notes: 1) Borehole dry and open upon completion. | | | | | | |

DYNAMIC CONE PENETRATION RESISTANCE PLOT
20 40 60 80 100

SHEAR STRENGTH (kPa)
○ UNCONFINED + FIELD VANE & Sensitivity
● QUICK TRIAXIAL × LAB VANE
50 100 150 200 250

PLASTIC LIMIT $w_P$ | NATURAL MOISTURE CONTENT $w$ | LIQUID LIMIT $w_L$
WATER CONTENT (%)
10 20 30

POCKET PEN (Cu) (kPa)
NATURAL UNIT WT (Mg/m³)
REMARKS AND GRAIN SIZE DISTRIBUTION (%)
GR SA SI CL

SPL SOIL LOG 1449-110.GPJ SPL.GDT 25/3/13

GROUNDWATER ELEVATIONS
Shallow/ Single Installation ▽ ▼ Deep/Dual Installation ▼ ▼

GRAPH NOTES
+3, ×3: Numbers refer to Sensitivity
○ ε=3% Strain at Failure

SPL Consultants Limited
Geotechnical Environmental Materials Hydrogeology

# LOG OF BOREHOLE BH12-4

PROJECT: Geotechnical Investigation- Scugog Depots
CLIENT: The Regional Municipality of Durham
PROJECT LOCATION: Durham Region
DATUM: Geodetic
BH LOCATION:

**DRILLING DATA**
Method: Solid Stem Auger
Diameter: 115 mm
Date: Mar/13/2013

REF. NO.: 1449-110
ENCL NO.: 5

| (m) ELEV / DEPTH | DESCRIPTION | STRATA PLOT | SAMPLES NUMBER | TYPE | "N" BLOWS/0.3 m | GROUND WATER CONDITIONS | ELEVATION | DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH (kPa) ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE & Sensitivity × LAB VANE (50 100 150 200 250) | PLASTIC LIMIT $w_P$ / NATURAL MOISTURE CONTENT $w$ / LIQUID LIMIT $w_L$ WATER CONTENT (%) (10 20 30) | POCKET PEN (Cu) (kPa) | NATURAL UNIT WT (Mg/m³) | REMARKS AND GRAIN SIZE DISTRIBUTION (%) GR SA SI CL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 340.0 | **ASPHALT:** 30mm | | | | | | | | | | | |
| 340.0 | **FILL:** sand, trace silt, trace gravel, brown, moist, compact to very loose | | 1 | AS | | | | | ○ | | | |
| | | | 2 | SS | 16 | | 339 | | ○ | | | |
| | | | 3 | SS | 17 | | | | ○ | | | |
| | | | 4 | SS | WH | | 338 | | ○ | | | |
| 336.9 | | | | | | | 337 | | | | | |
| 3.1 | **SAND:** trace silt, brown, moist, compact to very dense | | 5 | SS | 24 | | | | ○ | | | |
| | | | 6 | SS | 33 | | 336 | | ○ | | | |
| | | | 7 | SS | 38 | | 335 | | ○ | | | |
| | clayey silt pockets at 7.6 m | | 8 | SS | 62 | | 334 | | ○ | | | |
| 331.9 | | | | | | | 333 | | | | | |
| 8.1 | **END OF THE BOREHOLE** | | | | | | 332 | | | | | |

Notes:
1) Borehole dry and open upon completion.

GROUNDWATER ELEVATIONS
Shallow/ Single Installation ▽ ▼ Deep/Dual Installation ▽ ▼

GRAPH NOTES: $+^3$, $\times^3$: Numbers refer to Sensitivity ○ $\varepsilon$=3% Strain at Failure

SPL SOIL LOG 1449-110.GPJ SPL.GDT 25/3/13

SPL Consultants Limited
Geotechnical Environmental Materials Hydrogeology

# LOG OF BOREHOLE BH12-5

PROJECT: Geotechnical Investigation- Scugog Depots
CLIENT: The Regional Municipality of Durham
PROJECT LOCATION: Durham Region
DATUM: Geodetic
BH LOCATION:

**DRILLING DATA**
Method: Solid Stem Auger
Diameter: 115 mm
Date: Mar/13/2013

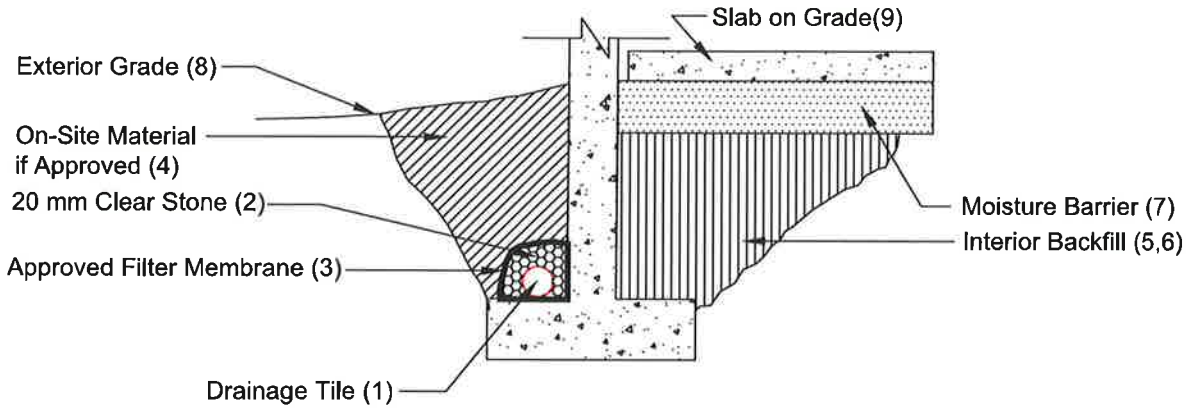
REF. NO.: 1449-110
ENCL NO.: 6

| SOIL PROFILE | | | SAMPLES | | | GROUND WATER CONDITIONS | ELEVATION | DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH (kPa) ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE & Sensitivity × LAB VANE (50 100 150 200 250) | PLASTIC LIMIT $w_P$ — NATURAL MOISTURE CONTENT $w$ — LIQUID LIMIT $w_L$ / WATER CONTENT (%) (10 20 30) | POCKET PEN. (Cu) (kPa) | NATURAL UNIT WT (kg/m³) | REMARKS AND GRAIN SIZE DISTRIBUTION (%) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (m) ELEV / DEPTH | DESCRIPTION | STRATA PLOT | NUMBER | TYPE | "N" BLOWS 0.3 m | | | | | | | GR SA SI CL |
| 339.8 | | | | | | | | | | | | |
| 339.6 0.2 | **ASPHALT:** 30mm | | | | | | | | | | | |
| | **FILL:** sand, trace silt, trace gravel, brown, very moist, dense to very loose | | 1 | AS | | | 339 | | ○ | | | |
| | | | 2 | SS | 35 | | | | ○ | | | |
| | trace to some silt at 1.5 m | | 3 | SS | 7 | | 338 | | ○ | | | |
| | | | 4 | SS | 2 | | 337 | | ○ | | | |
| 336.6 3.2 | | | | | | | | | | | | |
| 336.3 3.5 | **SAND:** trace silt, brown, moist, compact | | 5 | SS | 15 | | | | ○ | | | |
| | **END OF THE BOREHOLE** | | | | | | | | | | | |
| | Notes:<br>1) Borehole dry and open upon completion. | | | | | | | | | | | |

SPL SOIL LOG 1449-110.GPJ SPL.GDT 25/3/13

GROUNDWATER ELEVATIONS
Shallow/ Single Installation ▽ ▼ Deep/Dual Installation ▼ ▼

GRAPH NOTES + 3, × 3: Numbers refer to Sensitivity ○ ε=3% Strain at Failure




EXTERIOR FOOTING

**Notes**

1. Drainage tile to consist of 100 mm (4") diameter weeping tile or equivalent perforated pipe leading to a positive sump or outlet.
2. 20 mm (3/4") clear stone - 150 mm (6") top and side of drain. If drain is not on footing, place100 mm (4 inches) of stone below drain .
3. Wrap the clear stone with an approved filter membrane (Terrafix 270R or equivalent).
4. The on-site material, if approved, can be used as backfill.
5. The interior fill may be any clean non-organic soil which can be compacted to the specified density in this confined space.
6. Do not use heavy compaction equipment within 450 mm (18") of the wall. Do not fill or compact within 1.8 m (6') of the wall unless fill is placed on both sides simultaneously.
7. Moisture barrier to be at least 200 mm (8") of compacted clear 20 mm (3/4") stone or equivalent free draining material. A vapour barrier may be required for specialty floors.
8. Exterior grade to slope away from building.
9. Slab on grade should not be structurally connected to the wall or footing.
10. Review the geotechnical report for specific details.

## DRAINAGE AND BACKFILL RECOMMENDATIONS
## Slab on Grade Construction Without Underfloor Drainage
(not to scale)

# APPENDIX-A

## GENERAL REQUIREMENTS FOR ENGINEERED FILL

Compacted imported soil that meets specific engineering requirements and is free of organics and debris and that has been continually monitored on a full-time basis by a qualified geotechnical representative is classified as engineered fill. Engineered fill that meets these requirements and is bearing on suitable native subsoil can be used for the support of foundations.

Imported soil used as engineered fill can be removed from other portions of a site or can be brought in from other sites. In general, most of Ontario soils are too wet to achieve the 100% Standard Proctor Maximum Dry Density (SPMDD) and will require drying and careful site management if they are to be considered for engineered fill. Imported non-cohesive granular soil is preferred for all engineered fill. For engineered fill, we recommend use of OPSS Granular 'B' sand and gravel fill material.

Adverse weather conditions such as rain make the placement of engineered fill to the required degree of density difficult or impossible; engineered fill cannot be placed during freezing conditions, i.e. normally not between December 15 and April 1 of each year.

The location of the foundations on the engineered fill pad is critical and certification by a qualified surveyor that the foundations are within the stipulated boundaries is mandatory. Since layout stakes are often damaged or removed during fill placement, offset stakes must be installed and maintained by the surveyors during the course of fill placement so that the contractor and engineering staff are continually aware of where the engineered fill limits lie. Excavations within the engineered fill pad must be backfilled with the same conditions and quality control as the original pad.

To perform satisfactorily, engineered fill requires the cooperation of the designers, engineers, contractors and all parties must be aware of the requirements. The minimum requirements are as follows, however, the geotechnical report must be reviewed for specific information and requirements.

1. Prior to site work involving engineered fill, a site meeting to discuss all aspects must be convened. The surveyor, contractor, design engineer and geotechnical engineer must attend the meeting. At this meeting, the limits of the engineered fill will be defined. The contractor must make known where all fill material will be obtained from and samples must be provided to the geotechnical engineer for review, and approval before filling begins.

2. Detailed drawings indicating the lower boundaries as well as the upper boundaries of the engineered fill must be available at the site meeting and be approved by the geotechnical engineer.

3. The building footprint and base of the pad, including basements, garages, etc. must be defined by offset stakes that remain in place until the footings and service connections are all constructed. Confirmation that the footings are within the pad, service lines are in place, and that the grade conforms to drawings, must be obtained by the owner in writing from the surveyor and SPL Consultants Limited. Without this confirmation no responsibility for the performance of the structure can be accepted by SPL Consultants Limited. Survey drawing of the pre and post fill location and elevations will also be required.

4. The area must be stripped of all topsoil and fill materials. Subgrade must be proof-rolled. Soft spots must be dug out. The stripped native subgrade must be examined and approved by a SPL Consultants Limited engineer prior to placement of fill.

5. The approved engineered fill material must be compacted to 100% Standard Proctor Maximum Dry Density throughout. Engineered fill should not be placed during the winter months. Engineered fill compacted to 100% SPMDD will settle under its own weight approximately 0.5% of the fill height and the structural engineer must be aware of this settlement. In addition to the settlement of the fill, additional settlement due to consolidation of the underlying soils from the structural and fill loads will occur and should be evaluated prior to placing the fill.

6. Full-time geotechnical inspection by SPL Consultants Limited during placement of engineered fill is required. Work cannot commence or continue without the presence of the SPL Consultants Limited representative.

7. The fill must be placed such that the specified geometry is achieved. Refer to the attached sketches for minimum requirements. Take careful note that the projection of the compacted pad beyond the footing at footing level is a minimum of 2 m. The base of the compacted pad extends 2 m plus the depth of excavation beyond the edge of the footing.

8. A bearing capacity of 150 kPa at SLS (225 kPa at ULS) can be used provided that all conditions outlined above are adhered to. A minimum footing width of 500 mm (20 inches) is suggested and footings must be provided with nominal steel reinforcement.

9. All excavations must be done in accordance with the Occupational Health and Safety Regulations of Ontario.

10. After completion of the engineered fill pad a second contractor may be selected to install footings. The prepared footing bases must be evaluated by engineering staff from SPL Consultants Limited prior to footing concrete placements. All excavations must be backfilled under full time supervision by SPL Consultants Limited to the same degree as the engineered fill pad. Surface water cannot be allowed to pond in excavations or to be trapped in clear stone backfill. Clear stone backfill can only be used with the approval of SPL Consultants Limited.

11. After completion of compaction, the surface of the engineered fill pad must be protected from disturbance from traffic, rain and frost. During the course of fill placement, the engineered fill must be smooth-graded, proof-rolled and sloped/crowned at the end of each day, prior to weekends and any stoppage in work in order to promote rapid runoff of rainwater and to avoid any ponding surface water. Any stockpiles of fill intended for use as engineered fill must also be smooth-bladed to promote runoff and/or protected from excessive moisture take up.

12. If there is a delay in construction, the engineered fill pad must be inspected and accepted by the geotechnical engineer. The location of the structure must be reconfirmed that it remains within the pad.

13. The geometry of the engineered fill as illustrated in these General Requirements is general in nature. Each project will have its own unique requirements. For example, if perimeter

sidewalks are to be constructed around the building, then the projection of the engineered fill beyond the foundation wall may need to be greater.

14. These guidelines are to be read in conjunction with SPL Consultants Limited report attached.