Geotechnical Design Report

Proposed Building Addition at 8560 Campeau Drive, Ottawa, ON



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1.0 INTRODUCTION

Stantec Consulting Ltd. (Stantec) was retained by the Carpenters' Local 93 Training Centre Association to provide geotechnical engineering services for the design of a building addition to the existing building at 8560 Campeau Drive in Ottawa, Ontario (the Site). The Site location is shown on Drawing No. 1, and the footprint of the existing building and proposed addition are shown on Drawing No. 2 in Appendix B. The new building addition will consist of a single storey structure with an approximate building footprint of 1,243 m².

Limitations associated with this report and its contents are provided in the statement of conditions included in Appendix A.

2.0 BACKGROUND DOCUMENTS

Stantec previously issued a geotechnical investigation report titled "Detailed Geotechnical Investigation Report, Proposed Development Campeau Drive & Palladium Drive, Block 22, Ottawa, ON" dated December 2014. The 2014 report was prepared for the design and construction of the existing building at the Site.

A copy of the structural set of as-built drawings for the existing building were provided. The drawings indicated the building is supported on shallow strip and spread footings founded approximately 1.5 m below ground level. The foundation sizes range from 750 mm wide strip footings to 3000 mm by 3000 mm spread footings. The foundations were placed on a 75 mm to 100 mm thick mud slab over native clay subgrade.

3.0 SCOPE OF WORK

The scope of work is to prepare a geotechnical report for the proposed building addition which includes the following:

- A summary of the available geotechnical information from previous investigations
- Borehole logs and rock core logs
- Laboratory test results
- A borehole location plan
- Geotechnical resistances (ULS and SLS) for shallow foundations
- Excavation and backfill requirements
- Frost protection recommendations
- Site preparation recommendations
- Groundwater level estimates or measurements
- Seismic site classification according to the 2012 Ontario Building Code (OBC)
- Pavement recommendations for the proposed access road and parking areas



4.0 **RESULTS OF 2014 GEOTECHNICAL INVESTIGATION**

The following sections provide a summary of the subsurface conditions and laboratory test results encountered during the 2014 Geotechnical Investigation.

In general, the subsurface soil profile at the borehole locations consisted of topsoil underlain by fat to lean clay overlying, till over, limestone bedrock. Detailed descriptions of the subsurface soil conditions are presented on the Boreholes Records provided in Appendix C. Laboratory test results are shown on the Borehole Records as well as in Appendix D.

The borehole records depict conditions at a particular location and at the particular times indicated. The boreholes were advanced prior to the construction of the existing building, the construction of the building, associated underground services and pavement surfaces have altered the subsurface conditions.

An explanation of the symbols and terms used on the Borehole Records also provided in Appendix C.

4.1 SUBSURFACE SOIL CONDITIONS

The following sections summarize the soil and groundwater conditions.

4.1.1 Topsoil

The topsoil was encountered in all boreholes and ranged from approximately 150 to 600 mm in thickness.

This layer was removed during the construction of the existing building and pavement surfaces.

4.1.2 Fat to lean Clay (CH to CL)

A deposit of clay was encountered in all the boreholes. In boreholes BH14-6, BH14-7, BH14-8 and BH14-9 the clay layer extended to the elevations between 94.5 and 95.3 m. In borehole BH14-3 the results of the Dynamic Cone penetration Test inferred a termination elevation of 93.7 m for the clay layer. A layer of sand was observed in boreholes BH14-1, BH14-2, BH14-3 and BH14-6.

The consistency of the clay material ranged from firm to very stiff as indicated by the measured in-situ shear strengths of 30 kPa to greater than 100 kPa.

The moisture content of the clay ranged from 21% to 57%.

Grain size analysis and Atterberg limit tests were carried out on select samples of the clay. The grain size distribution of the clay indicated a soil composition of 0 to 1% gravel, 1 to 7% sand, 42 to 51% silt and 47 to 55% clay. The plastic and liquid limits of the clay ranged between 18 and 23, and 37 and 66, respectively. The grain size distribution curves and the plasticity chart are shown in Figures 1 and 3, Appendix D.

This material was classified as a fat to lean clay (CH to CL) in accordance with the Unified Soil Classification System (USCS).



4.1.3 Silt (ML)

A 0.8 m thick silt layer was encountered beneath the clay layer in borehole BH14-9. The compactness of silt layer was very loose as indicated by the 'N' value from the standard penetration test (SPT). The moisture content of layer was 56%. One Atterberg Limit test performed on this material yielded non-plastic result.

4.1.4 Till (SC-SM, SM, ML)

A till deposit was encountered beneath the clay layer in boreholes BH14-6, BH14-8 and BH14-9. The till layer was encountered at elevations between 93.8 m and 95.3 m and extended to elevations between 91.0 and 92.6 m.

The compactness of the till material ranged from very loose to dense as indicated by the 'N' values from the standard penetration test (SPT). The moisture content of the till was 9 to 27%.

The results from the grain size analysis of this layer are shown in Figure 2, Appendix D and indicate a soil composition of 19% gravel, 47% sand, 26% silt size and 8% clay size.

This material in borehole BH14-6 was classified as a silty clayey sand with gravel (SC-SM) in accordance with the USCS.

The till material encountered in boreholes BH14-8 and BH14-9 can be classified as clayey silt (ML) and silty sand (SM) respectively.

4.1.5 Bedrock

Grey limestone bedrock was confirmed by coring in boreholes BH14-7 and BH14-9. The depth to bedrock was approximately 7.6 and 10.5 m (elevation 94.4 and 91.0 m) below ground surface in boreholes BH14-7 and BH14-9 respectively. The limestone had a flat joint orientation with very close to medium spacing.

The total core recovery (TCR) was 51 to100%. Rock Quality Designation (RQD) varied from 46 to 100% which shows poor to excellent bedrock quality. The unconfined compressive strength of four rock sample ranged between 82 and 116 MPa. The rock can be classified as strong to very strong rock. Photos of the rock core and the field bedrock core logs are shown in Appendix C.



4.2 GROUNDWATER

Groundwater was observed at the time of drilling in the open boreholes. The inferred and measured groundwater levels are shown in Table 4.1.

| Borehole No. | Depth (m) | Elevation (m) |
|--------------|----------------|---------------|
| BH14-1 | 2.7 (Inferred) | 99.9 |
| BH14-2 | 3.0 (Inferred) | 99.3 |
| BH14-3 | 2.3 (Inferred) | 100.1 |
| BH14-4 | 3.4 (Inferred) | 98.6 |
| BH14-5 | 3.7 (Inferred) | 98.2 |
| BH14-6 | 2.3 (Inferred) | 99.7 |
| BH14-8 | Below 3.7 | N/A |

 Table 4.1: Inferred and Measured Groundwater Levels

The inferred groundwater levels could be influenced from the drilling. Fluctuations due to seasonal variations or precipitation events should be anticipated.

5.0 DISCUSSIONS AND RECOMMENDATIONS

5.1 GENERAL

It is understood that the existing building is supported by shallow spread and strip footings founded on the native clay. To reduce differential settlement between the existing building and proposed building addition, the addition should also be designed and constructed with shallow spread and strip footings at the same depths of the existing building foundations.

The conditions observed at the borehole locations is considered acceptable for shallow foundations for lightly loaded structures.

Existing fill material beneath the footprint of the proposed addition will need to be removed and replaced with compacted Structural Fill. Addition guidance for site preparation is provided in Section 5.2

5.2 SITE PREPARATION

5.2.1 Grading

A grade raise is not proposed at the location of the building addition.

5.2.2 Building Shallow Foundations

All existing pavement, fill, and organic material should be excavated and removed from beneath the building foundations. Bearing soils will require inspection by geotechnical personnel to verify design



bearing pressures. Building foundations should be placed directly on the undisturbed native soil or on Structural Fill placed on native soils.

Structural Fill should be used to raise the grade where required. Structural Fill should consist of OPSS Granular B Type II or OPSS Granular A. It should be placed in lifts no thicker than 300 mm and compacted to at least 100% Standard Proctor maximum dry density (SPMDD).

It is recommended that a 75 mm to 100 mm thick layer of lean concrete (mud slab) be placed on the foundation subgrade to protect it from disturbance during construction.

5.2.3 Floor Slab

All pavement structures, fill and organic material and other deleterious materials should be entirely removed from beneath the slab. Prepared subgrades should be inspected by geotechnical personnel prior to placement of fill or concrete. A layer of free draining granular material such as OPSS Granular A at least 200 mm in thickness should be placed immediately beneath the floor slab for leveling, drainage and support purposes. This material should be compacted to at least 100% Standard Proctor maximum dry density.

5.2.4 Re-Use of Site Generated Material

The overburden soils observed on site consist primarily of clay. The existing site materials will not be reusable as grading fills or subgrade fill. It is noted that compaction is highly dependent on the moisture content of the material, thus the amount of re-useable material will be dependent on the natural moisture content, weather conditions and the construction techniques at the time of excavation and placement.

5.3 FOUNDATIONS

5.3.1 Shallow Foundations

We have calculated the resistances at Ultimate Limits States (ULS) and Serviceability Limits States (SLS) for spread (square) and strip footings. The values are provided below in Table 5.1.

| Founding Element | Footing Width (m) | Factored Geotechnical Resistance at ULS (kPa) | Geotechnical Resistance at SLS (kPa) |
|---------------------------------------------|----------------------|-----------------------------------------------------|--------------------------------------------|
| Spread footing on clay crust ⁽¹⁾ | 1.0 to 3.0 | 200 | 100 |
| Strip footing on clay crust ⁽¹⁾ | 0.5 to 2.0 | 160 | 100 |
| Spread footing on firm clay ⁽²⁾ | 1.0 to 3.0 | 130 | 100 |
| Strip footing on firm clay ⁽²⁾ | 0.5 to 2.0 | 110 | 100 |

Table 5.1: Geotechnical Resistance for Shallow Footings

Notes:

(1) The underside of footings is placed at the geodetic elevation 99.0 m or higher.

(2) The underside of footings is placed below geodetic elevation 99.0 m.



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The factored geotechnical bearing resistance at ULS incorporates a resistance factor of 0.5. The geotechnical reactions at SLS were developed consistent with a total settlement of 25 mm and includes the effects of a 1 m grade raise; the increase to the soil stress in the clay deposit is not expected to exceed 80% of the preconsolidation pressure of the clay.

The unfactored horizontal resistance of spread footings may be calculated using the following unfactored coefficients of friction:

- 0.55 between OPSS Granular A and cast-in-place concrete
- 0.30 between clay and cast-in-place concrete

A resistance factor against sliding of 0.8 should be applied to obtain the resistance at ULS.

5.3.2 Frost Penetration Depth

All perimeter and interior footings within 1 m distance from the exterior walls require a minimum frost protection equivalent to a soil cover of 1.5 m for protection against frost action.

Footings in unheated areas or exterior footings should have a minimum frost protection equivalent to a soil cover of at least 1.8 m.

5.4 FLOOR SLAB

The recommendations provided herein are based on the assumption that the average net slab loads will not exceed 12 kPa. Should a greater average load be proposed, the recommendations must be reviewed.

The floor slab constructed as recommended above may be designed using a soil modulus of subgrade reaction, k, of 20 MPa/m. Non-structural slab-on-grade units should float independently of all load-bearing walls and columns.

Where construction is undertaken during winter months, floor slab subgrades should be protected from freezing. Alternatively, the floor slab subgrade must be completely thawed then proof rolled prior to placing concrete.

The native soils at this site are susceptible to frost heave. If wide building openings to the exterior are proposed such as loading bays, a 100 m thick layer of insulation should be installed beneath the floor slab to prevent frost heave. The compressive strength of the insulations should be selected based on the floors slab load with consideration for insulation creep settlement. Alternatively, the floor slab should be placed on a 1.2 m thick pad of compacted Structural Fill.

5.5 TEMPORARY EXCAVATIONS & GROUNDWATER CONTROL

The overburden soils should be classified as Type 3 soil as defined by the Occupational Health and Safety Act and Regulations for Construction Projects. Within Type 3 soils, open cut excavations must be sloped no steeper than one horizontal to one vertical (1H:1V) from the bottom of the trench.



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Excavations should not extend below the underside of existing foundations.

Groundwater and/or surface run-off may be encountered during excavation and construction. It is expected that groundwater may be controlled by sump and pumping methods. The clay deposit encountered in the borehole is a low permeability material. It is anticipated that construction activities and groundwater dewatering can be carried out at less than 50,000 L/day.

The proposed building addition and site modifications are not expected to have long term impacts to the local groundwater level. The proposed construction is not anticipated to cause soil settlement related to groundwater lowering.

The quality of groundwater that may be removed during the construction activities should be assessed at that time to determine if it may be disposed of directly to the local sanitary/storm sewer without treatment, under a permit that would be required from the City of Ottawa Sewer Use Program. Construction contractor has the responsibility to obtain a permit under the City of Ottawa Sewer Program and testing/discharge of water to sanitary or storm sewer. Discharge of pumped groundwater to the environment is not considered.

It is recommended that a 75 mm to 100 mm thick layer of lean concrete be placed on the subgrade of temporary excavations to protect the subgrade from disturbance.

5.6 ASPHALT PAVEMENTS AND CONCRETE SIDEWALKS

The proposed development includes asphalt parking areas and access roads. It is anticipated that the parking area will be used by cars and the access roads will be used infrequently by small delivery trucks (2 to 3 ale trucks). The recommended pavement structures are illustrated in Table 5.2.

| Material | Standard Duty Parking Areas | Heavy Duty Fire and Truck Routes | Compaction Requirements |
|----------------------------------|--------------------------------|-------------------------------------|----------------------------|
| SP 12.5 (surface course asphalt) | 50 mm | 40 mm | 92 % MTRD |
| SP 19 (base course asphalt) | | 50 mm | 92 % MTRD |
| OPSS Granular A Base | 150 mm | 150 mm | 100 % SPMDD |
| OPSS Granular B Type II Sub-base | 500 mm | 500 mm | 100 % SPMDD |

Table 5.2: Recommended Asphalt Pavement Structure Design

In preparation for construction of new pavements, the finished sub-grade surface should be proof-rolled and compacted to identify the presence of soft, wet, or deflecting areas; such areas should be removed and replaced with approved engineered fill.

The finished sub-grade surface must be compacted to achieve a minimum of 95% of the materials SPMDD immediately prior to placement of the granular materials.

5.6.1 General Pavement Comments

The finished sub-grade surface should be graded to promote positive drainage away from the pavements. It is recommended that the sub-grade surface be sloped towards catch basin structures at a minimum cross-fall of 2% across the parking lots and reduced to 1% along the perimeter curb line. Sub-drain stubs



with a minimum length of 3 m extending from the catch basin and manhole locations are recommended at low points in the sub-grade to prevent ponding of water and promote positive drainage.

In transition zones between different pavement structures, such as between the heavy duty and standard duty pavements, the installation of supplementary drainage is suggested to minimize the potential for future distress. The supplementary drainage can consist of the installation of sub-drains, placed a minimum of 100 mm below the finished surface of the sub-grade. The sub-drain can consist of a perforated flexible pipe, with geotextile sock, backfilled with clear stone on all sides, and extended to the closest manhole to provide a positive outfall.

5.6.2 Concrete Sidewalks

The design and construction of the sidewalks slabs should include a granular base layer consisting of a minimum of 200 mm of compacted OPSS Granular A. The design should also include positive drainage away from the edge of the building and beyond the limits of the concrete. Frost heave of sidewalks could be reduced by constructing frost tapers and extending the granular base to 1.2 m below ground surface.

5.7 SEISMIC CONSIDERATIONS

The site soils are not considered to be susceptible to soil liquefaction.

Geophysics GPR International Inc. was retained to perform a Multi-Channel Analysis of Surface waves (MASW) testing to determine the shear wave velocity variation of soil and bedrock in the top 30 m of the overburden. The MASW surveys were carried out on August 14, 2014. The detailed report of the MASW test and the corresponding results are shown in Appendix E.

The results of MASW report show that the average (harmonic mean) shear wave velocity in top 30 m of soil and bedrock is 476 m/sec and therefore the recommended site classification for seismic site response for this site is Site Class C in accordance with Table 4.1.8.4. A of the 2012 Ontario Building Code.

5.8 CEMENT TYPE AND CORROSION POTENTIAL

Two samples of the native soil were submitted to Paracel Laboratories in Ottawa, Ontario for analysis of pH, water soluble sulphate and chloride concentrations, and resistivity. The analysis results are summarized in Table 5.3.

The pH, resistivity and chloride concentration provide an indication of the degree of corrosiveness of the subsurface environment. The results are provided to aid in the selection of coatings and corrosion protection systems for items such as steel pipe in contact with the soil and groundwater at the site.

The concentration of soluble sulphate provides an indication of the degree of sulphate attack that is expected for concrete in contact with soil and groundwater at the site. The soluble sulphate concentrations for the two samples indicate that a low degree of sulphate attack is expected for concrete in contact with soil and water. General Use (GU) Portland cement is therefore considered suitable for use at this site.



| Borehole No. | Sample No. | Depth (m) | рН | Chloride (µg/g) | Sulphate (µg/g) | Resistivity (Ohm-m) |
|--------------|------------|-----------|------|--------------------|--------------------|------------------------|
| BH14-2 | SS-2 | 1.52-2.13 | 7.64 | <5 | 15 | 40.8 |
| BH14-5 | SS-3 | 2.28-2.89 | 7.75 | <5 | 8 | 44.3 |

Table 5.3: Results of Chemical Analysis

5.9 TREE PLANTING RESTRICTIONS

The soil at the site is considered "Sensitive Marine Clay" which is sensitive to settlement from the water demand from trees. The selection and planting of trees should follow the City of Ottawa guidelines for tree planting in "Sensitive Marine Clay".

5.10 PIPE BEDDING AND BACKFILL

Service line construction should be in accordance with City of Ottawa specifications.

Bedding for new watermains and storm sewers should be in accordance with City of Ottawa typical details. It is recommended that a minimum of 150 mm of OPSS Granular A material be placed below the pipe invert as bedding material. At locations where soft/loose subgrades are encountered, consideration should be given to increasing the thickness of the bedding material to 300 mm to 400 mm. Granular pipe backfill, placed above the invert should also consist of OPSS Granular A material. These materials should be compacted to at least 98% of Standard Proctor Maximum Dry Density (SPMDD).

Impervious clay seals should be installed in pipe trenches as per the City of Ottawa Standard Detail Drawing S8. Seals should be installed at a 50 m spacing along the utility trenches.

Trench backfill placed within the upper 1.5 m should be compatible in nature to the soils exposed in the trench walls, or alternatively 3H:1V frost tapers should be constructed within the upper 1.5 m zone. These materials should be compacted to a minimum of 95% SPMDD. Below 1.5 m, the trench backfill should consist of compactable site generated materials or imported OPSS Select Subgrade Material. These materials should be compacted to a minimum of 95% SPMDD.

It should be noted that reuse of the site generated material will be highly dependent on the materials' moisture content at time of placement. Backfill should be compacted in lifts not exceeding 300 mm.

Existing services that cross above the proposed pipes will need to be supported. The Contractor should be responsible for designing and providing these supports in accordance with pipe or utility manufacturer's specifications. Special attention should be given for pressurized systems, in regard to unconfined or exposed lengths of pipe. Temporary excavation support may need to be modified at these service crossings.



6.0 CLOSURE

The conclusions in the Report are Stantec's professional opinion, as of the time of the Report, and concerning the scope described in the Report. The opinions in the document are based on conditions and information existing at the time the document was published and do not take into account any subsequent changes. The Report relates solely to the specific project for which Stantec was retained and the stated purpose for which the Report was prepared. The Report is not to be used or relied on for any variation or extension of the project, or for any other project or purpose, and any unauthorized use or reliance is at the recipient's own risk.

Stantec has assumed all information received from the Client and third parties in the preparation of the Report to be correct. While Stantec has exercised a customary level of judgment or due diligence in the use of such information, Stantec assumes no responsibility for the consequences of any error or omission contained therein.

This Report is intended solely for use by the Client in accordance with Stantec's contract with the Client. While the Report may be provided to applicable authorities having jurisdiction and others for whom the Client is responsible, Stantec does not warrant the services to any third party. The report may not be relied upon by any other party without the express written consent of Stantec, which may be withheld at Stantec's discretion.

Yours very truly,

STANTEC CONSULTING LTD.

Chris McGrath, P.Eng.







7.0 **REFERENCES**

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APPENDIX A

A.1 STATEMENT OF GENERAL CONDITIONS



STATEMENT OF GENERAL CONDITIONS

<u>USE OF THIS REPORT</u>: This report has been prepared for the sole benefit of the Client or its agent and may not be used by any third party without the express written consent of Stantec Consulting Ltd. and the Client. Any use which a third party makes of this report is the responsibility of such third party.

<u>BASSOF THE REPORT</u>: The information, opinions, and/or recommendations made in this report are in accordance with Stantec Consulting Ltd.'s present understanding of the site specific project as described by the Client. The applicability of these is restricted to the site conditions encountered at the time of the investigation or study. If the proposed site specific project differs or is modified from what is described in this report or if the site conditions are altered, this report is no longer valid unless Stantec Consulting Ltd. is requested by the Client to review and revise the report to reflect the differing or modified project specifics and/or the altered site conditions.

<u>STANDARD OF CARE</u> Preparation of this report, and all associated work, was carried out in accordance with the normally accepted standard of care in the state or province of execution for the specific professional service provided to the Client. No other warranty is made.

<u>INTERPRETATION OF STE CONDITIONS</u> Soil, rock, or other material descriptions, and statements regarding their condition, made in this report are based on site conditions encountered by Stantec Consulting Ltd. at the time of the work and at the specific testing and/or sampling locations. Classifications and statements of condition have been made in accordance with normally accepted practices which are judgmental in nature; no specific description should be considered exact, but rather reflective of the anticipated material behavior. Extrapolation of in situ conditions can only be made to some limited extent beyond the sampling or test points. The extent depends on variability of the soil, rock and groundwater conditions as influenced by geological processes, construction activity, and site use.

<u>VARYING OR UNEXPECTED CONDITIONS</u> Should any site or subsurface conditions be encountered that are different from those described in this report or encountered at the test locations, Stantec Consulting Ltd. must be notified immediately to assess if the varying or unexpected conditions are substantial and if reassessments of the report conclusions or recommendations are required. Stantec Consulting Ltd. will not be responsible to any party for damages incurred as a result of failing to notify Stantec Consulting Ltd. that differing site or subsurface conditions are present upon becoming aware of such conditions.

<u>PLANNING, DESGN, OR CONSTRUCTION</u>: Development or design plans and specifications should be reviewed by Stantec Consulting Ltd., sufficiently ahead of initiating the next project stage (property acquisition, tender, construction, etc), to confirm that this report completely addresses the elaborated project specifics and that the contents of this report have been properly interpreted. Specialty quality assurance services (field observations and testing) during construction are a necessary part of the evaluation of sub-subsurface conditions and site preparation works. Ste work relating to the recommendations included in this report should only be carried out in the presence of a qualified geotechnical engineer; Stantec Consulting Ltd. cannot be responsible for site work carried out without being present.



APPENDIX B

- B.1 DRAWING NO. 1 KEY PLAN
- **B.2** DRAWING NO. 2 BOREHOLE LOCATION PLAN





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Ottawa, ON, Canada K2C 3G4 www.stantec.com



APPENDIX C

- C.1 SYMBOLS AND TERMS USED ON BOREHOLE AND TEST PIT RECORDS
- C.2 BOREHOLE RECORDS
- C.3 FIELD BEDROCK CORE LOGS
- C.4 ROCKCORE PHOTOGRAPHS
- C.5 VIBRATING WIRE PIEZOMETER CALIBRATION SHEET



SYMBOLS AND TERMS USED ON BOREHOLE AND TEST PIT RECORDS

SOIL DESCRIPTION

Terminology describing common soil genesis:

| Topsoil | - mixture of soil and humus capable of supporting vegetative growth | | |
|---------|-----------------------------------------------------------------------------------------|--|--|
| Peat | - mixture of visible and invisible fragments of decayed organic matter | | |
| Till | - unstratified glacial deposit which may range from clay to boulders | | |
| Fill | - material below the surface identified as placed by humans (excluding buried services) | | |

Terminology describing soil structure:

| Desiccated | - having visible signs of weathering by oxidization 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 successions of different soil types, e.g. silt and sand |
| Layer | - > 75 mm in thickness |
| Seam | - 2 mm to 75 mm in thickness |
| Parting | - < 2 mm in thickness |

Terminology describing soil types:

The classification of soil types are made on the basis of grain size and plasticity in accordance with the Unified Soil Classification System (USCS) (ASTM D 2487 or D 2488). The classification excludes particles larger than 76 mm (3 inches). The USCS provides a group symbol (e.g. SM) and group name (e.g. silty sand) for identification.

Terminology describing cobbles, boulders, and non-matrix materials (organic matter or debris):

Terminology describing materials outside the USCS, (e.g. particles larger than 76 mm, visible organic matter, construction debris) is based upon the proportion of these materials present:

| Trace, or occasional | Less than 10% |
|----------------------|---------------|
| Some | 10-20% |
| Frequent | > 20% |

Terminology describing compactness of cohesionless soils:

The standard terminology to describe cohesionless soils includes compactness (formerly "relative density"), as determined by the Standard Penetration Test N-Value (also known as N-Index). A relationship between compactness condition and N-Value is shown in the following table.

| Compactness Condition | SPT N-Value |
|-----------------------|-------------|
| Very Loose | <4 |
| Loose | 4-10 |
| Compact | 10-30 |
| Dense | 30-50 |
| Very Dense | >50 |

Terminology describing consistency of cohesive soils:

The standard terminology to describe cohesive soils includes the consistency, which is based on undrained shear strength as measured by *in situ* vane tests, penetrometer tests, or unconfined compression tests.

| Osnalatanav | Undrained Shear Strength | | |
|-------------|--------------------------|-----------|--|
| Consistency | kips/sq.ft. | kPa | |
| Very Soft | <0.25 | <12.5 | |
| Soft | 0.25 - 0.5 | 12.5 - 25 | |
| Firm | 0.5 - 1.0 | 25 - 50 | |
| Stiff | 1.0 - 2.0 | 50 – 100 | |
| Very Stiff | 2.0 - 4.0 | 100 - 200 | |
| Hard | >4.0 | >200 | |



SEPTEMBER 2013

ROCK DESCRIPTION

Terminology describing rock quality:

| RQD | Rock Mass Quality | | | | | | |
|--------|-------------------|--|--|--|--|--|--|
| 0-25 | Very Poor | | | | | | |
| 25-50 | Poor | | | | | | |
| 50-75 | Fair | | | | | | |
| 75-90 | Good | | | | | | |
| 90-100 | Excellent | | | | | | |

Rock quality classification is based on a modified core recovery percentage (RQD) in which all pieces of sound core over 100 mm long are counted as recovery. The smaller pieces are considered to be due to close shearing, jointing, faulting, or weathering in the rock mass and are not counted. RQD was originally intended to be done on NW core; however, it can be used on different core sizes if the bulk of the fractures caused by drilling stresses are easily distinguishable from *in situ* fractures. The terminology describing rock mass quality based on RQD is subjective and is underlain by the presumption that sound strong rock is of higher engineering value than fractured weak rock.

Terminology describing rock mass:

| Spacing (mm) | Joint Classification | Bedding, Laminations, Bands | | | | |
|--------------|----------------------|-----------------------------|--|--|--|--|
| > 6000 | Extremely Wide | - | | | | |
| 2000-6000 | Very Wide | Very Thick | | | | |
| 600-2000 | Wide | Thick | | | | |
| 200-600 | Moderate | Medium | | | | |
| 60-200 | Close | Thin | | | | |
| 20-60 | Very Close | Very Thin | | | | |
| <20 | Extremely Close | Laminated | | | | |
| <6 | - | Thinly Laminated | | | | |

Terminology describing rock strength:

| Strength Classification | Unconfined Compressive Strength (MPa) |
|-------------------------|---------------------------------------|
| Extremely Weak | <1 |
| Very Weak | 1 – 5 |
| Weak | 5 – 25 |
| Medium Strong | 25 – 50 |
| Strong | 50 - 100 |
| Very Strong | 100 – 250 |
| Extremely Strong | > 250 |

Terminology describing rock weathering:

| Term | Description |
|----------------------|--------------------------------------------------------------------------------------------------------------------------|
| Fresh | No visible signs of rock weathering. Slight discolouration along major discontinuities |
| Slightly Weathered | Discolouration indicates weathering of rock on discontinuity surfaces. All the rock material may be discoloured. |
| Moderately Weathered | Less than half the rock is decomposed and/or disintegrated into soil. |
| Highly Weathered | More than half the rock is decomposed and/or disintegrated into soil. |
| Completely Weathered | All the rock material is decomposed and/or disintegrated into soil. The original mass structure is still largely intact. |







RECOVERY

WS

HQ, NQ, BQ, etc.

For soil samples, the recovery is recorded as the length of the soil sample recovered. For rock core, recovery is defined as the total cumulative length of all core recovered in the core barrel divided by the length drilled and is recorded as a percentage on a per run basis.

N-VALUE

Numbers in this column are the field results of the Standard Penetration Test: the number of blows of a 140 pound (64 kg) hammer falling 30 inches (760 mm), required to drive a 2 inch (50.8 mm) O.D. split spoon sampler one foot (305 mm) into the soil. For split spoon samples where insufficient penetration was achieved and N-values cannot be presented, the number of blows are reported over sampler penetration in millimetres (e.g. 50/75). Some design methods make use of N value corrected for various factors such as overburden pressure, energy ratio, borehole diameter, etc. No corrections have been applied to the N-values presented on the log.

DYNAMIC CONE PENETRATION TEST (DCPT)

Wash sample

Rock core samples obtained with the use of

standard size diamond coring bits.

Dynamic cone penetration tests are performed using a standard 60 degree apex cone connected to A size drill rods with the same standard fall height and weight as the Standard Penetration Test. The DCPT value is the number of blows of the hammer required to drive the cone one foot (305 mm) into the soil. The DCPT is used as a probe to assess soil variability.

OTHER TESTS

| S | Sieve analysis |
|---------|------------------------------------------------------------|
| Н | Hydrometer analysis |
| k | Laboratory permeability |
| Y | Unit weight |
| Gs | Specific gravity of soil particles |
| CD | Consolidated drained triaxial |
| CU | Consolidated undrained triaxial with pore pressure |
| 00 | measurements |
| UU | Unconsolidated undrained triaxial |
| DS | Direct Shear |
| С | Consolidation |
| Q_{u} | Unconfined compression |
| , | Point Load Index (I _p on Borehole Record equals |
| Ιp | diameter of 50 mm) |

Stantec

| Ţ | Single packer permeability test; test interval from depth shown to bottom of borehole |
|---|---------------------------------------------------------------------------------------------|
| | Double packer permeability test; test interval as indicated |
| Ŷ | Falling head permeability test using casing |
| Ĭ | Falling head permeability test using well point or piezometer |



| | sta | antec | RD BH 14-1 | | | | | | |
|-------|-------------------------------------------|-----------------------------------------------------------|-------------------|----------|--------|---------|-------|----------------|--------------------------------------------------|
| C | LIENT | Carpenters Local 93 Training Co | enter | Ass | ociati | ion | | | BOREHOLE No. BH 14-1 |
| LO | OCATION | Campeau Drive, Ottawa, ON | | | | | | | PROJECT No |
| D. | ATES: BO | RING <u>March 31, 2014</u> WAT | DATUM Geodetic | | | | | | |
| - | (E) | | 01 | ц | | SA I | MPLES | 1 | UNDRAINED SHEAR STRENGTH - kPa 50 100 150 200 |
| TH (m | TION | SOIL DESCRIPTION | LA PL | R LEV | ш | ШШ | ERY | ЩQ | |
| DEP | LEVA | | STRAT | VATEI | ТҮР | NUMB | ECOV | N-VAL OR R(| |
| | ш | | | > | | | R R | | STANDARD PENETRATION TEST, BLOWS/0.3m |
| - 0 - | 102.61 | | | | | | | | 10 20 30 40 50 60 70 80 90 |
| - | 102.3 | 300 mm TOPSOIL (dark brown → silty clay with rootlets) | Г. Т | | SS | 1 | 500 | 15 | |
| | | Firm greyish brown fat CLAY | | | | | | | |
| - 1 - | | (CH) | | | SS | 2 | 610 | 5 | ┠┼╺ <mark>┛┊╴╷╷╷╷╷╷╷╷╴╴</mark> ┥ |
| | 101.1 | frozen | | | | | | | |
| - | | Stiff grey fat CLAY (CH) | | | SS | 3 | 610 | 2 | φ |
| - 2 - | | | | | | | | | |
| | 99.9 | | | ∇ | | | | | |
| 3- | | Firm to stiff grey lean to fat | | <u> </u> | | | | | |
| | | CLAY (CL-CH) | | | SS | 4 | 610 | 0 | • |
| | | | | | | | | | |
| - 4 - | | | | | | | | | |
| | | | | | | | | | ₽,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,, |
| | | | | | 22 | 5 | 610 | 0 | ₽,, |
| - 5 - | | | | | 55 | | 010 | | F+++++++++++++++++++++++++++++++++++++ |
| | | | | | | | | | |
| 6-6- | | | | | | | | | |
| | | - sand observed below 6.1 m | | | 55 | 6 | 610 | 1 | |
| | 95.9 | | | | 55 | | 010 | 1 | |
| - 7 - | | End of Borehole | | | | | | | |
| | | | | | | | | | |
| - | | | | | | | | | |
| - 8 - | | | | | | | | | |
| | | | | | | | | | |
| 9 | | | | | | | | | |
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| -10- | | | | | | | | | |
| | | | | | | | | | |
| - | | | | | | | | | |
| -11- | | | | | | I | 1 | 1 | ■ Field Vane Test, kPa |
| | | \square Inferred Groundwater Level | | | | | | | Remoulded Vane Test, kPa App'd |
| | ⊈ Groundwater Level Measured in Standpipe | | | | | | | | △ Pocket Penetrometer Test, kPa Date |

| ک | sta | antec ¹ | RD | BH 14-10 | | | | | | | |
|----------|-------------------------------------------|----------------------------------|----------|------------------|--------|------|-----------|-------------|------------------|-----------------------------------------|-----------------------------------------|
| CI | JENT | Carpenters Local 93 Training Ce | nter | Ass | ociati | ion | | | | BOREHOLE No | BH 14-10 |
| LC | OCATION | Campeau Drive, Ottawa, ON | | | | | | | | PROJECT No. | 122411024 |
| D | ATES: BO | RING <u>August 22, 2014</u> WAT | ER L | EVE | L | | | | | DATUM | Geodetic |
| | (| | | | | SA | MPLES | | UNDRA | AINED SHEAR STREN | GTH - kPa |
| (m) | m) NC | | PLOT | EVEL | | | Σ | | 50 | 100 | 150 200 |
| ЕРТН | /ATIC | SOIL DESCRIPTION | ATA | TERL | ΓPE | ABER | DVER m | ALUE RQD | WATER CONTENT & | ATTERBERG LIMITS | ^W P W WL ► O I |
| DE | ELEY | | STF | WA | ŕ | Ŋ | LEC(| N-V NOR | DYNAMIC PENETRAT | ION TEST, BLOWS/0.3n | n * |
| | | | - | $\left \right $ | | | | | STANDARD PENETRA | ATION TEST, BLOWS/0.3 | 3m |
| - 0 - | 102.15 | 180 mm TOPSOIL with rootlets | <u>\</u> | | | | | | | $\frac{0}{1}$ 40 50 6 | 50 70 80 90 |
| - | 102.0 | and wood | | | SS | 1 | 430 | 8 | | 0 | |
| | | Firm to very stiff brown to grey | | | | | | | | | |
| - 1 - | | lean to fat CLAY (CL-CH) | | | SS | 2 | 400 | 7 | | · o · · · · · · · · · · · · · · · · · · | |
| | | | | 1 | | | | | | | |
| - | | | | | SS | 3 | 600 | 6 | | | |
| - 2 - | | | | | 55 | | | | | | |
| | | | | | 00 | | (00 | | | | |
| - | | | | | 88 | 4 | 600 | 6 | ¶ | φ | |
| - 3 - | | | | | | | | | | +++++++++++++++++++++++++++++++++++++++ | |
| | 98 5 | | | | | | | | | 9 | |
| | 70.0 | End of Borehole | | | | | | | | | |
| - 4 - | | Su > 102 kPa | | | | | | | | | |
| | | | | | | | | | | | |
| - | | | | | | | | | | | |
| - 3 - | | | | | | | | | | | |
| | | | | | | | | | | | |
| - 6 - | | | | | | | | | | | |
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| - 7 - | | | | | | | | | | · · · · · · · · · · · · · · · · · · · | |
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| - 8 - | | | | | | | | | | | |
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| - 9 - | | | | | | | | | | | |
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| -10- | | | | | | | | | | | |
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| -11 - | | | 1 | | 1 | | | | Field Vane Te | ⊥⊥⊥⊥⊥⊥⊥⊥⊥⊥⊥⊥⊥⊥ st kPa | |
| | | ☑ Inferred Groundwater Level | | | | | | | □ Remoulded V | ane Test, kPa | App'd |
| | ✓ Groundwater Level Measured in Standpipe | | | | | | | | △ Pocket Penetr | ometer Test, kPa | Date |

ſ

| ک | sta | antec | BH 14-11 | | | | | | | | |
|--------------------------------------------------|---------------------------------------------|--------------------------------|--------------|----------|------|------|-------|---------------|-----------------------------------|-------------------------------------------------------------------------------------------------------------------|--------------|
| CI | LIENT | Carpenters Local 93 Training C | BOREHOLE No. | BH 14-11 | | | | | | | |
| LO | DCATION | Campeau Drive, Ottawa, ON | | | | | | | | PROJECT No. | 122411024 |
| DATES: BORING <u>August 22, 2014</u> WATER LEVEL | | | | | | | | | <u>.</u> | DATUM | Geodetic |
| | _ ۲ | | | | | SA | MPLES | | UNDR. | AINED SHEAR STREN | GTH - kPa |
| (m) H |) NOI | | A PLC | LEVE | | к | Ϋ́ | ШО | | | + WW |
| рерт | EVAT | SUIL DESCRIPTION | [RAT/ | ATER | ТҮРЕ | UMBE | (mm) | -VALL R RQ | WATER CONTENT & | ATTERBERG LIMITS | |
| _ | Ē | | ی ا | Ň | | ž | RE | żΟ | | FION TEST, BLOWS/0.3m | 1 * |
| | 101.81 | | | | | | | | 10 20 3 | $0 \qquad 40 \qquad 50 \qquad 6$ | 50 70 80 90 |
| - 0 - | 101.7 | 150 mm TOPSOIL with rootlets | <u>اللا</u> | | 22 | 1 | 250 | 13 | | | |
| | | and wood | | | 66 | 1 | 230 | 15 | | | |
| - 1 - | | lean to fat CLAY (CL-CH) | | | 66 | 2 | 450 | 0 | | | |
| | | | | | 33 | 2 | 430 | 0 | | | |
| | | | | | | | (00 | | | | |
| - 2 - | | | | | SS | 3 | 600 | 6 | | 0 | |
| | | | | | | | | | | | |
| - | | | | | SS | 4 | 600 | 4 | | $\left \begin{array}{c} \cdot \\ \cdot $ | |
| - 3 - | | | | | | | | | | | |
| | 98.2 | | | | SS | 5 | 600 | 4 | i ● i i i i i i | ++++++ 0 1 | |
| | | End of Borehole | | | | | | | | | |
| - 4 - | | | | | | | | | | | |
| | | | | | | | | | | | |
| - 5 - | | | | | | | | | | | |
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| - 6 - | | | | | | | | | | | |
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| - 7 - | | | | | | | | | | | |
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| - 8 - | | | | | | | | | | | |
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| _ 9 _ | | | | | | | | | | | |
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| -10- | | | | | | | | | | | |
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| - | | | | | | | | | | | |
| -11 - | | | | | | | | <u> </u> | Field Vane To | est. kPa | |
| | | | | | | | | | □ Remoulded V | ane Test, kPa | App'd |
| | ✓ Groundwater Level Measured in Standpipe △ | | | | | | | | | rometer Test, kPa | Date |

| | Stantec BOREHOLE RECORD BH 14-12 | | | | | | | | | | |
|--------|-------------------------------------------|-----------------------------------------|-----------|---------------------------------|---------|------|-------|-------------|------------------------------------------|--------------------------------------------------------|--|
| CI | LIENT | Carpenters Local 93 Training Cer | nter | Ass | sociati | on | | | BOREHOLE | NoBH 14-12 | |
| | DCATION | <u>Campeau Drive, Ottawa, ON</u> | PROJECT N | D. <u>122411024</u> Coodetia | | | | | | | |
| D | ATES: BO | RING <u>August 22, 2014</u> WAT | ER L | EVE | .L | 64 | | | UNDRAINED SHEAR S | TRENGTH - kPa | |
| (m | (m) z | | LOT | NEL | | 34 | | | 50 100 | 150 200 | |
| ЕРТН (| VATIOI | SOIL DESCRIPTION | RATA P | TER LE | ΥΡΕ | MBER | DVER) | ALUE RQD | ں ہے۔ WATER CONTENT & ATTERBERG LIM | ' w _{P W} 'w _L ITS I ⊖ I | |
| ā | ELE | | STF | WA. | F | NN | L L L | 7-N N-N | DYNAMIC PENETRATION TEST, BLOW | /S/0.3m * | |
| • | 102.43 | | | | | | | | 10 20 30 40 50 | •ws/0.3m • 60 70 80 90 | |
| | 102.3 | 150 mm TOPSOIL with rootlets | | | SS | 1 | 190 | 10 | | | |
| | | Firm to very stiff brown to grey | | | | | | | | | |
| - 1 - | | lean to fat CLAY (CL-CH) | \bigvee | | SS | 2 | 430 | 10 | · · · · · • • · · · · · · · · • • • • • | | |
| | | | | | | | | | | | |
| - 2 - | | | | | SS | 3 | 560 | 10 | | | |
| | | | | | S.S. | 1 | | 4 | | | |
| 3 | | | | | 66 | 4 | | 4 | | | |
| | | | | | | | | | | | |
| | 98.8 | End of Borehole | .[| | | | | | | | |
| - 4 - | | Su > 102 kPa | | | | | | | | | |
| | | | | | | | | | | | |
| - 5 - | | | | | | | | | | | |
| | | | | | | | | | | | |
| - 6 - | | | | | | | | | | | |
| - | | | | | | | | | | | |
| | | | | | | | | | | | |
| - 7 - | | | | | | | | | | | |
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| - 8 - | | | | | | | | | | | |
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| - 9 - | | | | | | | | | | | |
| | | | | | | | | | | | |
| 10 | | | | | | | | | | | |
| -10- | | | | | | | | | | | |
| | | | | | | | | | | | |
| -11 | | | | | | | | | Field Vane Test. kPa | | |
| | | \checkmark Inferred Groundwater Level | (- 1 | | | | | | □ Remoulded Vane Test, kPa | App'd | |
| | ✓ Groundwater Level Measured in Standpipe | | | | | | | | Δ Pocket Penetrometer Test, | KPa Date | |

| کل | St | antec ^I | RD BH 14-2 | | | | | | |
|--------|-------------------------------------------|-----------------------------------------|-------------------|-----------|-----------------|-------------|--------------|----------------|-------------------------------------------------------------|
| | LIENT | Carpenters Local 93 Training Ce | nter | N: Ass | 5 01' ociati | 7 848 on | 3 E: 34 | 8 653 | BOREHOLE No. BH 14-2 |
| L | DCATION | Campeau Drive, Ottawa, ON | | | | | | | PROJECT No. 122411024 |
| D. | ATES: BO | RING <u>March 31, 2014</u> WAT | ER L | EVE | Ĺ | | | | DATUM Geodetic |
| | Ê | | | | | SA | MPLES | | UNDRAINED SHEAR STRENGTH - kPa |
| H (m) | i) NOI | | A PLO | LEVE | | Ř | RY | що | |
| DEPT | EVAT | SOIL DESCRIPTION | TRAT, | ATER | ТҮРЕ | UMBE | COVE (mm) | -VALL DR RQ | WATER CONTENT & ATTERBERG LIMITS |
| | Ш | | s, | 8 | | z | RE | żΟ | DYNAMIC PENETRATION TEST, BLOWS/0.3m |
| 0 | 102.27 | | | | | | | | 10 20 30 40 50 60 70 80 90 |
| - 0 - | 102.0 | 300 mm TOPSOIL (dark brown | | | SS | 1 | 500 | 13 | |
| | | Brown to brownish-grev fat | | | | <u> </u> | | _ | |
| - 1 - | | CLAY (CH) | | | SS | 2 | 610 | 4 | |
| - | 100.8 | - frozen | | | | <u> </u> | 010 | | |
| | | Firm to very stiff grey fat CLAY | | | SS | 3 | 610 | 4 | |
| - 2 - | | (CH) | | | 55 | | 010 | | |
| | | $s_u > 106 \text{ kPa} @ 2.7 \text{ m}$ | | | | | | | |
| 2 | 99.3 | s _u > 106 kPa @ 3.0 m | | ∇ | | | | | |
| - 3 - | | Firm grey lean to fat CLAY | | ¥ | 55 | 4 | 610 | 0 | |
| | | (CL-CH) | | | 55 | 4 | 010 | | • • • • • • • • • • • • • • • • • • • |
| - 4 - | | | | | | | | | |
| - | | | | | | | | | P P |
| | | | | | ~~ | | | | P • |
| - 5 - | | | | | SS | 5 | 610 | 0 | |
| | | | | | | | | | |
| - | | | | | | | | | |
| - 6 - | | - sand observed below 6.1 m | | | | | | | |
| | 95.6 | | | | SS | 6 | 610 | 0 | |
| - 7 - | | End of Borehole | | | | | | | |
| - | | | | | | | | | |
| | | | | | | | | | |
| - 8 - | | | | | | | | | |
| | | | | | | | | | |
| - | | | | | | | | | |
| -9- | | | | | | | | | |
| | | | | | | | | | |
| - 10 - | | | | | | | | | |
| | | | | | | | | | |
| | | | | | | | | | |
| -11 | | | | | | <u> </u> | | | Eigld Vang Test 100 |
| | | | | | | | | | Freid vane rest, KPa Remoulded Vane Test, kPa App'd |
| | ✓ Groundwater Level Measured in Standpipe | | | | | | | | △ Pocket Penetrometer Test, kPa Date |

| <u>کی</u> | sta | antec ¹ | BH 14-3 | | | | | | | | |
|-----------|-----------------------------------------|-------------------------------------------------------------------------------|---------|-------------|--------|------|--------|---------------|---------------------|------------------------|----------------------|
| C | LIENT | Carpenters Local 93 Training Ce | nter | Ass | ociati | on | | | | BOREHOLE No. | BH 14-3 |
| L | OCATION | Campeau Drive, Ottawa, ON | | | | | | | | PROJECT No. | 122411024 |
| D. | ATES: BO | RING April 1, 2014 WAT | ER L | EVE | L | | | | 1 | DATUM | Geodetic |
| ~ | (E) | | 1 | • | | SA | M PLES | | UNDF 50 | AINED SHEAR STREN | GTH - kPa 150 200 |
| TH (m | TION | SOIL DESCRIPTION | TA PL | R LEV | ш | ER | 'ERY | Щ Q | | | W _{PW} WL |
| DEP | ILEVA | | STRA | NATE | ТҮР | NUMB | ECO/ | N-VAL OR R | WATER CONTENT 8 | ATTERBERG LIMITS | |
| | ш | | | | | _ | Ē | _ | STANDARD PENETF | RATION TEST, BLOWS/0.3 | ' 3m ● |
| - 0 - | 102.41 | 200 TODGOU (1.1.1. | 1.57 | | | | | | 10 20 3 | <u>30 40 50 6</u> | 50 70 80 90 |
| - | 102.2 | _ 200 mm TOPSOIL (dark brown silty clay with rootlets) | | | SS | 1 | 230 | 9 | | Φ | |
| | | Firm brown to greyish brown fat | | | | | | | | | |
| - 1 - | | CLAY (CH) | | | SS | 2 | 405 | 6 | | 0 | |
| | 100.9 | | | | | | | | | | |
| | | Firm to very stiff grey fat CLAY (CH) | | | | | | | | | |
| - 2 - | | $s_u > 106 \text{ kPa} @ 2.0 \text{ m}$ | | ⊻ | | | | | | | |
| | | $s_u > 106 \text{ kPa} @ 2.3 \text{ m}$ | | | SS | 3 | 610 | 3 | | Φ | |
| - 3 - | 99.5 | Stiff grey lean to fat CLAY | | | | | | | | | |
| - | | (CL-CH) | | | | | | | | | |
| | | | | | | | | | Ф Ф . | | |
| - 4 - | | | | | SS | 4 | 610 | 0 | ↓ | | |
| | | | | | ~~ | - | | | | | |
| - | | | | | | | | | | | |
| - 5 - | | | | | | | | | | | |
| | | - sand observed below 5.3 m | | | SS | 5 | 610 | 0.0 | | | |
| - 6 - | | | | | 55 | | | | T | | |
| | | | | | | | | | | | |
| | 05.5 | | | | | | | | P | | |
| - 7 - | 95.5 | Inferred CLAY | | | | | | | | | |
| | | | | | | | | | | | |
| - | | | | | | | | | | | |
| - 8 - | | | | | | | | | | | |
| | 93.7 | | | | | | | | | | |
| 9 | | End of Borehole | | | | | | | | | |
| | | Refusal of Dynamic Penetration | | | | | | | | | |
| | | Test | | | | | | | | | |
| -10- | | | | | | | | | | | |
| | | | | | | | | | | | |
| | | | | | | | | | | | |
| -11- | I | | 1 | 1 1 | | 1 | 1 | 1 | Field Vane T | est, kPa | |
| | | ✓ Inferred Groundwater Level ✓ Groundwater Level | to:: 1 | | | | | | □ Remoulded V | Vane Test, kPa | App'd |
| | Groundwater Level Measured in Standpipe | | | | | | | | △ Pocket Penet | rometer Test, kPa | Date |

| کی | sta | antec | BO | ŖĮ | EHC | | ERI | ECO | RD BH 14-4 |
|----------|----------|-------------------------------------------------------------------------------------------|---------------|----------|--------|---------------|---------|--------|--------------------------------------------------|
| C | lient | Carpenters Local 93 Training C | <u>Center</u> | n Ass | s 5 01 | 7 89 1 | / E: 34 | 18 646 | BOREHOLE NoBH 14-4 |
| L | OCATION | Campeau Drive, Ottawa, ON | | | | | | | PROJECT No122411024 |
| D | ATES: BO | RING <u>March 31, 2014</u> WA | TER L | EVE | L | | | | DATUM Geodetic |
| | Ê | | | | | SA | MPLES | 1 | UNDRAINED SHEAR STRENGTH - kPa 50 100 150 200 |
| (m) H |) NOI | SOIL DESCRIPTION | A PLO | S LEVE | | L H | R X | 벽요 | |
| DEP1 | EVAL | | TRAT | ATEF | ТҮРЕ | UMBE | (mm) | -VALU | WATER CONTENT & ATTERBERG LIMITS |
| | Ē | | Ň | \$ | | Z | RE | 20 | DYNAMIC PENETRATION TEST, BLOWS/0.3m |
| _ 0 _ | 102.04 | | | | | | | | 10 20 30 40 50 60 70 80 90 |
| | 101.8 | 200 mm TOPSOIL (dark brown | | | SS | 1 | 460 | 11 | |
| | | Brown to grevish brown fat | | | ~~ | | | | |
| - 1 - | | CLAY (CH) | | | SS | 2 | 460 | 5 | |
| - | 100.5 | | | | 55 | | | | |
| | 100.0 | Very stiff grey fat CLAY (CH) | | | | | | | |
| - 2 - | | $s_{u} > 106 \text{ kPa}$ (a) 2.0 m | | | | | | | |
| | | $s_u > 106 \text{ kPa} @ 2.3 \text{ m}$ | | | 99 | 2 | (10 | 2 | |
| | 99.1 | | | | 22 | 3 | 610 | 3 | ┃ ┩ \ \ \ \ \ |
| - 3 - | | Firm to stiff grey lean to fat $CLAY$ (CL-CH) | | | | | | | |
| | | CLAT (CL-CII) | | ¥ | | | | | |
| _ 4 _ | | | | | | | | | |
| | | | | | SS | 4 | 610 | 0 | • • • • • • • • • • • • • • • • • • • |
| | | | | | | | | | |
| - 5 - | | | | | | | | | ▋ |
| - | - | | | | | | | | ↓ ↓ ↓ ↓ ↓ ↓ ↓ ↓ ↓ ↓ ↓ ↓ ↓ ↓ ↓ ↓ ↓ ↓ ↓ |
| | | | | | SS | 5 | 405 | 0 | • · · · · · · · · · · · · · · · · · · · |
| - 6 - | | | | | | | | | |
| | | | | | | | | | |
| | 95.1 | | | | | | | | ++ |
| - 7 - | | End of Borehole | | | | | | | |
| | | | | | | | | | |
| - 8 - | | | | | | | | | |
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| - 9 - | | | | | | | | | |
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| -10- | | | | | | | | | |
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| 11 | | | | | | | | | |
| -11- | | | | | | | | | Field Vane Test, kPa |
| | | ✓ Inferred Groundwater Level ✓ Groundwater Level Measured in | Stand | nine | | | | | Remoulded Vane Test, kPa App'd |
| | 1 | | Sund | - PC | | | | | - I OUNCET CHCHCHICHE I COL, NI & Dale |

| کی | sta | antec | BO | ŖĮ | EHC | | ERI | ECO | RD | В | ^{1 of 1} H 14-5 |
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| | IENT | Carpenters Local 93 Training Ce | enter | N Ass | : 501 sociati | 7 900 ion |) E: 34 | 8 /15 | | | BH 14-5 |
| | DCATION | Campeau Drive, Ottawa, ON | 11101 | 110 | Joeran | | | | | PROJECT No. | 122411024 |
| D. | ATES: BO | RING March 31, 2014 WAT | ER L | EVE | L | | | | | | Geodetic |
| | | | | | | SA | MPLES | | UNDR | AINED SHEAR STREN | GTH - kPa |
| (L | (m) | | LOT | VEL | | | | | 50 | 100 | 150 200 |
| TH (I | ATION | SOIL DESCRIPTION | TA PI | IR LE | щ | BER | /ERY | B G | | 1 | W _{PW} WL |
| DEF | ILEV/ | | STRA | NATE | TYF | | (mr | N-VA OR R | WATER CONTENT & | ATTERBERG LIMITS | |
| | ш | | | | | | <u>۳</u> | | STANDARD PENETR | ATION TEST, BLOWS/0. | 3m ● |
| _ 0 _ | 101.89 | | | | | | | | 10 20 3 | 0 40 50 | 50 70 80 90 |
| | | 600 mm TOPSOIL (dark brown | | | SS | 1 | 460 | 16 | | | |
| | 101.3 | silty clay), frozen | | | 55 | 1 | | 10 | | | |
| _ 1 _ | | Firm to very stiff grey fat CLAY | | | ~~~ | | | | | | |
| 1 - | | (CII) | | | SS | 2 | 610 | 6 | | | |
| | | | | | | | | | | | |
| _ 2 _ | | | | | | | | | | | |
| - | | $s_u > 106 \text{ kPa} @ 2.0 \text{ m}$ | | | | | | | | | |
| | | $s_u > 106 \text{ kPa} (a) 2.3 \text{ m}$ | | | SS | 3 | 610 | 2 | $[\bullet] \\ [\bullet] $ | | E |
| - 3 - | | | | | | | | | | | |
| - | | | | | | | | | | | |
| | 0.00 1 | | | ∇ | | | | | | · · · · · P · · · · · · · · · · · · · · · · · · · | |
| - 4 - | 98.1 | Firm to stiff grey lean to fat | | - | | | | | | | |
| - | | CLAY (CL-CH) | | | SS | 4 | 610 | 0 | ● | | |
| | | | | | | | | | | | <u> </u> |
| - 5 - | | | | | | | | | | | |
| | | | | | | | | | | | |
| | | | | | SS | 5 | 610 | 0 | | - | |
| - 6 - | | | | | | | | | | | |
| - | | | | | | | | | | | |
| | | | | | | | | | P '''' 'P ''' '''' | | |
| - 7 - | 95.0 | End of Borehole | - | | | | | | | <u> </u> | <u> </u> |
| - | | | | | | | | | | | |
| | | | | | | | | | | | |
| - 8 - | | | | | | | | | | | |
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| - 9 - | | | | | | | | | | | |
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| -10- | | | | | | | | | | | E |
| - | | | | | | | | | | | |
| | | | | | | | | | | | |
| -11 - | | | | | | | | | | | |
| | | ☑ Inferred Groundwater Level | | | | | | | Field Vane To | est, kPa Vane Test - kPa | App'd |
| | | ✓ Groundwater Level Measured in S | Standı | pipe | | | | | \triangle Pocket Penetr | cometer Test, kPa | Date |

| کی | sta | antec | BO | RF | |) [] | | | RD BH 14-6 |
|-------|----------|--------------------------------------------------------------------|------------|------|--------|-------------|---------|--------|-----------------------------------------------------------------------------|
| CI | LIENT | Carpenters Local 93 Training Ce | enter | Ass | ociati | on |) E. 34 | 10709 | BOREHOLE No BH 14-6 |
| LC | OCATION | Campeau Drive, Ottawa, ON | | | | | | | PROJECT No. <u>122411024</u> |
| D. | ATES: BO | RING <u>April 1, 2014</u> WAT | FER L | EVE | L | | | | DATUM Geodetic |
| | Ê | | | | | SA | MPLES | | UNDRAINED SHEAR STRENGTH - kPa 50 100 150 200 |
| (m) H |) NOI | | A PLO | LEVI | | н Ш | ШК | 4 Q | |
| DEPI | -EVA | | TRAT | ATEF | ТҮРЕ | IUMBE | (mm) | I-VALI | WATER CONTENT & ATTERBERG LIMITS |
| | Ē | | S | 5 | | 2 | R | 20 | DYNAMIC PENETRATION TEST, BLOWS/0.3m STANDARD PENETRATION TEST, BLOWS/0.3m |
| - 0 - | 101.97 | | | | | | | | 10 20 30 40 50 60 70 80 90 |
| | 101.7 | 300 mm TOPSOIL (dark brown | Γ <u>Γ</u> | | SS | 1 | 380 | 13 | |
| | | Firm brownish-grey to grey fat | | | | | | | |
| - 1 - | | CLAY (CH) | | | SS | 2 | 460 | 4 | |
| | 100.5 | - top 300 mm frozen | | | | | | | |
| - | | Firm to very stiff grey lean to fat | | | | | | | |
| - 2 - | | c_{LAY} (CL-CH) $s_{\mu} > 106 \text{ kPa} (a) 2.0 \text{ m}$ | | | | | | | |
| | | $s_u > 106 \text{ kPa} @ 2.3 \text{ m}$ | | × | SS | 3 | 610 | 3 | |
| 2 | | | | | 55 | | 010 | | |
| - 3 - | | | | | 55 | 1 | 160 | | |
| | | | | | 55 | 4 | 400 | - | |
| - 4 - | | | | | ст | _ | (10 | | |
| - | | | | | 51 | 3 | 610 | - | |
| | | | | | | | | | |
| - 5 - | | | | | | | | | ₽ →→→→ ₽ →→→→→→→→→→→→→→→→→→→→→→→→→→→→→ |
| | | | | | ~~ | | | | ₽ ; ; ; ; ; : ; ; ; ; ; ; ; ; ; ; ; ; ; ; ; ; ; ; ; |
| - | | | | | SS | 6 | 610 | 0 | • · · · · · · · · · · · · · · · · · · · |
| - 6 - | | 300 mm thick layer of sand | | | | | | | |
| | 95.3 | observed @ 6.1 m | | | SS | 7 | 610 | 1 | ● |
| - 7 - | | Very loose to loose grey silty | | | | | | | |
| - | | (SC-SM): TILL | | | SS | 8 | 300 | 1 | • • • • • • • • • • • • • • • • • • • |
| | | | | 1 | | | | | |
| - 8 - | | | | | SS | 9 | 460 | 1 | |
| | | | | | | | | | |
| - | | | | | SS | 10 | 150 | 1 | • · · · · · · · · · · · · · · · · · · · |
| - 9 - | | | | | | | | | |
| | | | P | | SS | 11 | 610 | 5 | ● • |
| -10- | 92.0 | | | | SS | 12 | 150 | 50/ | 0 |
| | | End of Borehole | | | | | | 150mm | |
| | | Auger Refusal on Inferred | | | | | | | |
| -11 - | | Bedrock | | | | | | | Field Vano Tast PRe |
| | | | | | | | | | Remoulded Vane Test, kPa App'd |
| | | ▼ Groundwater Level Measured in S | Standy | oipe | | | | | △ Pocket Penetrometer Test, kPa Date |

| | IENIT | Carpenters Local 93 Training Cer | nter | IN Ass | : 5 01 ociati | / 863 01 | 5 E: 34 | 8670 | | | | | | | | т | | DE | 110 | NI I | | Jo | | | | | RI | H 1 | 12 | 4 |
|--------|----------|-------------------------------------|--------------|-----------|------------------|--------------------|-------------|------------------|-----|-------------------------|------------|------|------------|-----|----------|------------------|-----|----------|--------|---------|------------|------|----------------|---------|----------------|----------|-----------|--------------|-------------|----------|
| LC | CATION | Campeau Drive, Ottawa, ON | | 1100 | ociuti | 011 | | | | | | | | | _ | I | PRO | ке ЭЛ | EC | ΓN | e r No. | 10. | | | | 12 | <u>24</u> | 11 | 0 | <u>'</u> |
| DA | TES: BOI | RING August 21, 2014 WAT | ER L | EVE | L | | | | | | | | | | _ | I | DA' | TU | М | _ | | | | | | | Ge | od | le | 21 |
| | <u> </u> | | | | | SA | MPLES | | | | | | | UN | DR | AIN | IEC |) Sł | HEA | ٩R | ST | REN | √GT | Ή- | kPa | a | | | _ | |
| | m) NC | | PLOT | EVEL | | ~ | * | | ┝ | | | | 50 | | | | | 10 | 0 | | | | 150 |) | | | 2 | 00 | | |
| | EVATIO | SOIL DESCRIPTION | RATA | TER L | ΥPE | IMBEF | OVEF mm) | /ALUE R R Q D | | WAT | ΓER | со | NT | EN | Т& | AT | TEF | RBE | RG | ; LI | МΙΤ | S | | , | ₩ _P | ۷ — | ∾ Э— | V | ∾∟ • | _ |
| | ELE | | ST | ٨M | Г | N | REC (| N-N P | | DYN | IAM | IC F | PEN | IET | RA | TIO | ΝT | ES | Т, В | LO | ws | /0.3 | m | | | | * | r | | |
| | 102.04 | | | | | | | | 1 | STA 1 | .ND/ .0 | ARD |) PE 20 | ENE | etr 3 | аті 0 | ON | те 40 | ST, | BL 5 | .00 50 | /S/0 | .3m 60 | | 70 |) | 8 |) 0 | | |
| + | 102.04 | _200 mm TOPSOIL | <u>\\/</u> , | | 00 | 1 | 250 | 10 | i | | Γ | | T | | | Ī | | Ī | | | Ī | | Ī | | Ţ | | | | | - |
| - | | Firm greyish brown to grey lean | | | 55 | 1 | 250 | 10 | | | | | | | | | | | | | | | | | | | | | | |
| - | | to fat CLAY (CL-CH) | | | | | | | l | | | | | | | | | | | | | | | | | | | | | |
| - | | | | | SS | 2 | 500 | 6 | | | | | | | | | | | | | | | | | | | | | | |
| - | 100.2 | | | | | | | | ļ | | | | | | | | | | | | | | | | | | | | | 1 |
| - | 100.2 | Firm to very stiff grey lean to fat | | | SS | 3 | 500 | 4 | Ļ | ● ' ' ' <u> </u> | | | | | | | | | 0 | | ļ | Щ | H | Ĥ | 4 | | Щ | | | L |
| - | | CLAY (CL-CH) | | | | | | | ļ | | li | | | | | | | | | | ļ | | , | | | | ij | | , İ | |
| - | | s _u > 102 kPa @ 2.6 m | | | | | | | ļ | | li | | | | | | | | | | ļį | | , i i i | ii | | | ij | | . i | |
| - | | s _u > 102 kPa @ 2.9 m | | | | | | | H | | H | | | | | H | | | | | H | +++ | ;++ | ++ | ++ | +++ | | -++ -++ | + | |
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| - | | | | | SS | 5 | 600 | 1 | | | | | H | | | | | | - | | k | ļ | | | | ++- | | | . - | |
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| - | | | | | SS | 6 | 600 | 1 | | | | | | | | | | ¦ | | | | | | | | | | | | l |
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| - | 94.4 | | | | | | | | - ! | | | | | | | | | | | | | | | | | | | | | |
| - | | Grey Limestone BEDROCK | ╞╧ | - | | | | | | | | | | | | | | | | | | | | | | | | | | |
| - | | -Poor to excellent quality | | | NQ | 7 | 51% | 46% | | | | | | | | | | | | | | | | | | | | | | |
| - | | -Very strong bedrock | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| - | | Refer to field bedrock core log | | | | | | | Ļ | | | | | | | | | | | | | | ⊢ | <u></u> | 4 | <u></u> | ĻĻļ | | - - | L |
| - | | for full description | | - | | | 1000 | 1000/ | | | | | | | | | | | | | | | | | | | | | | |
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| C | LIENT | Carpenters Local 93 Training | Center | Ass | ociat | ion | , D. 24 | 0070 | | | | | | | | в | OR | EH | OLI | E No |) | | | Bŀ | <u>+ 1</u> 2 | <u>I-7</u> |
| L | OCATION | Campeau Drive, Ottawa, ON | | | | | | | | | | | | | | P | RO | JEC | TN | No | | | 12 | <u>224</u> | 110 | <u>24</u> |
| D | ATES: BC | RING <u>August 21, 2014</u> w | ATER LI | EVE | L | | | | Γ | | | | | | | | | UM | [| etdi | | | | Ge | <u>ode</u> | <u>tic</u> |
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| TH (n | ATION | SOIL DESCRIPTION | TA PL | R LE | щ | BER | /ERY n) | J UE | | | | | + | | | | | 1 | | | | v | V _P | w | 1 W | - |
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| -11 - | | | | | | | | | ╞ | | 10 T i | | 20 |) | 3 | 0 | 4 | 10 | 5 | 0 | 60 |) · · · · · | 70 | 80 |) | 90 |
| | 90.5 | | | | | | | | İ | | | | | | | | | | | | | | | | | |
| | | End of Borehole | | | | | | | | | | | | | | | | | | | | | | | | |
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| | | V Informed Crossedworther I and | | | | | | | | | Fi | eld | Va | ane | Te T | est, | kP | a | 1-10 | 10 | | ۰. | J | | | |
| | | ✓ Interfed Groundwater Level ✓ Groundwater Level Measured i | in Standp | oipe | | | | | | | ке Рс | emo ocko | et l | ueo Per | ı v neti | and | e I nete | est, er To | кР est, | a kPa | a | App' Date | u | | | - - |

| <u></u> | sta | antec ^E | 30 | RI | E HC : 5.01 |)L] | E RI | E CO | RD BH 14-8 |
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| C | LIENT | Carpenters Local 93 Training Cer | nter | Ass | sociati | on | | 0 0 0 | BOREHOLE No BH 14-8 |
| LO | OCATION | Campeau Drive, Ottawa, ON | | | | | | | PROJECT No 122411024 |
| D | ATES: BO | RING <u>August 25, 2014</u> WAT | ER L | EVE | CL | | | | DATUM Geodetic |
| ~ | (E) | | 1 | EL | | SA | M PLES | | UNDRAINED SHEAR STRENGTH - kPa 50 100 150 200 |
| DEPTH (m | ELEVATION | SOIL DESCRIPTION | STRATA PLO | WATER LEV | ТҮРЕ | NUMBER | RECOVERY (mm) | N-VALUE OR RQD | WP W WL WATER CONTENT & ATTERBERG LIMITS HOLD DYNAMIC PENETRATION TEST, BLOWS/0.3m |
| | 102.08 | | | | | | | | STANDARD PENETRATION TEST, BLOWS/0.3m ● 10 20 30 40 50 60 70 80 90 |
| - 0 - | 102.00 | _200 mm TOPSOIL | <u>\.</u> | - | | | | | |
| | 10115 | Very stiff grey lean to fat CLAY (CL-CH) | | | SS | 1 | 200 | 12 | $\left \begin{array}{cccccccccccccccccccccccccccccccccccc$ |
| - 1 - | | | | | SS | 2 | 405 | 5 | |
| - 2 - | 100.0 | | | | SS | 3 | 600 | 4 | ··•·································· |
| | | Firm to stiff grey lean to fat CLAY (CL-CH) | | | | | | | |
| - 3 - | | | | | SS | 4 | 600 | 2 | + + + + + + + + + + + + + + + + + + |
| - 4 - | | | | | | | | | |
| | | | | | 55 | 5 | 600 | 1 | |
| - 5 - | | | | | | | | | |
| - 6 - | | | | | SS | 6 | 600 | 1 | $\begin{array}{c c c c c c c c c c c c c c c c c c c $ |
| - 7 - | | | | | SS | 7 | 250 | 4 | |
| - 8 - | 94.5 | Very loose to stiff clayey SILT (ML) TILL | | | SS | 8 | 100 | 22 | $\begin{array}{c} & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\$ |
| - 9 - | | Dynamic Cone Penetration Test from 8.2 m to the End of Borehole | | | | | | | Image: State of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state of the state |
| | 92.6 | End of Borehole | | | | | | | |
| -10- | | DCPT Refusal on Inferred | | | | | | | |
| | | Bedrock Vibrating Wire Piezometer | | | | | | | |
| -11- | | ✓ Inferred Groundwater Level ✓ Groundwater Level Measured in State | tandı | pipe | | | | | □ Field Vane Test, kPa □ Remoulded Vane Test, kPa App'd △ Pocket Penetrometer Test, kPa Date |

| | st 🕯 | antec | BO | | E H (| DL] | E RE | E CO 8 698 | RD | E | ^{2 c} BH 14-8 | of 2 |
|----------|----------|------------------------------------------------|----------|-------|--------------|-------------|-----------|----------------------|-----------------------------------------------------------|----------------------------|----------------------------------------|-------------|
| CI | LIENT | Carpenters Local 93 Training | Center | Ass | ociat | ion | | 0 070 | | BOREHOLE No. | BH 14 | <u>4-8</u> |
| LC | OCATION | Campeau Drive, Ottawa, ON | | | | | | | | PROJECT No. | 1224110 | 024 |
| D. | ATES: BC | PRING <u>August 25, 2014</u> W | ATER L | EVE | L | | | | | DATUM | Geode | <u>etic</u> |
| <u> </u> | (ш | | DT | Ē | | SA T | MPLES | | UNDR 50 | RAINED SHEAR STREN 100 | JGTH-kPa 150 200 | |
| TH (m | TION | SOIL DESCRIPTION | LA PLO | 2 LEV | ш | н | ERY (| E C | | | | 4 |
| DEP | LEVA | | STRAT | VATE | ТҮР | NUMB | mm (mm | N-VAL OR R(| WATER CONTENT & | | ا ـــة ∟ ★ | - |
| | Ш | | | > | | | R | _ | STANDARD PENETRA | RATION TEST, BLOWS/0.5 | .3m ● | |
| -11 - | | X | | | | | | | 10 20 3 | 30 40 50 | 60 70 80 | 90 |
| | | Installed to 3.7 m | | | | | | | | | | |
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| -12- | | | | | | | | | | | | |
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| -14- | | | | | | | | | | | ++++++++++++++++++++++++++++++++++++++ | |
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| -15- | | | | | | | | | | | | |
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| -16- | | | | | | | | | | | | |
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| -17- | | | | | | | | | | | | E E |
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| -18- | | | | | | | | | | | | |
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| -22 | | | | | | | | | | | | |
| | | $\overline{\nabla}$ Inferred Groundwater Level | | | | | | | □ Field Vane T □ Remoulded V | est, kPa Vane Test, kPa | App'd | |
| | | ▼ Groundwater Level Measured in | n Standp | oipe | | | | | \triangle Pocket Penet | rometer Test, kPa | Date | _ |

| ک | sta | antec ^I | 30 | | |)L] | E RI | ECO | PRD BH 14-9 |
|----------|-------------|-----------------------------------------|-----------|-------|--------|-------------|-------------|----------|--------------------------------------------------|
| CI | LIENT | Carpenters Local 93 Training Cer | nter | Ass | ociati | on | . 1. 34 | 10 / 5 / | BOREHOLE No BH 14-9 |
| LO | OCATION | Campeau Drive, Ottawa, ON | | | | | | | PROJECT No. 122411024 |
| D. | ATES: BO | RING August 22, 2014 WAT | ER L | EVE | L | | | | DATUM Geodetic |
| | Ê | | | | | SA | MPLES | 1 | UNDRAINED SHEAR STRENGTH - kPa 50 100 150 200 |
| TH (m | TION | SOIL DESCRIPTION | A PLO | S LEV | 111 | н |) ERY | Щą | |
| DEP' | LEVA | | TRAT | VATEF | ТҮР | IUMB | | N-VAL | |
| | Ξ | | 0 | > | | 2 | R. | 20 | STANDARD PENETRATION TEST, BLOWS/0.3m |
| - 0 - | 101.49 | | <u> </u> | | | | | | 10 20 30 40 50 60 70 80 90 |
| | 101.3 | -\ <u>150 mm TOPSOIL</u> | | | SS | 1 | 480 | 9 | |
| | | to grey lean to fat CLAY | | | | | | | |
| - 1 - | | (CL-CH) | | | SS | 2 | 600 | 8 | ····• |
| | | | | | | | | | |
| - | | | | | SS | 3 | 600 | 5 | •••••••••••••••••••••••••••••••••••••• |
| - 2 - | 99.4 | Firm to stiff grey lean to fat | | | | | | | |
| | | CLAY (CL-CH) | | | SS | 4 | 600 | 4 | ● |
| - 3 - | | | | 1 | | | | | |
| | | | | | | | | | |
| | | | | | | | | | |
| - 4 - | | | \bigvee | | SS | 5 | 600 | 1 | |
| | | | | | 00 | | | 1 | |
| - | | | | | | | | | |
| - 5 - | | | | | | | | | |
| | | | | ĬŦ | 22 | 6 | 600 | 1 | |
| 6-6- | | | | | 00 | | | 1 | |
| | | | | | | | | | |
| | 04.6 | | | | | | | | |
| - 7 - | 94.0 | Very loose grey SILT (ML) | -Kitt | | | _ | 120 | 1 | |
| | 02.0 | non plastic @ 7.2 m | | | 88 | 7 | 430 | I | • |
| | 93.8 | Compact to dense grev silty | | | 66 | 0 | 250 | 10 | |
| - 8 - | | SAND (SM) TILL | | | 22 | ° | 230 | 19 | |
| | | | | | 00 | | 450 | 26 | |
| 9 | | | | | 88 | 9 | 450 | 36 | 0 1 1 1 0 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 |
| | | | | | | | | | |
| | | | | ! | SS | 10 | 250 | 22 | /9 |
| -10- | | | | | | | | | |
| | <u>91.0</u> | | | | SS | 11 | 450 | 42 | |
| - | | Grey Limestone BEDROCK | þ | | | | | | |
| -11 - | | | | - | | | I | 1 | Field Vane Test, kPa |
| | | \checkmark Inferred Groundwater Level | , . | | | | | | Remoulded Vane Test, kPa App'd |
| | | | tandr | oipe | | | | | △ Pocket Penetrometer Test, kPa Date |

| | st 🕯 | antec | BO | RI | |)L] | | ECO | RD BH 14-9 |
|-------|----------|-------------------------------------------------------------------------------------------|----------|------|----------------|-------------|---------|---------------|-------------------------------------------------------------------------------------------|
| CI | LIENT | Carpenters Local 93 Training (| Center | Ass | <u>sociati</u> | <u>on</u> | , E. 34 | 0 137 | BOREHOLE No BH 14-9 |
| LC | DCATION | Campeau Drive, Ottawa, ON | | | | | | | PROJECT No. <u>122411024</u> |
| D. | ATES: BO | RING <u>August 22, 2014</u> W | ATER L | EVE | EL | | | | DATUM <u>Geodetic</u> |
| | (L | | | | | SA | MPLES | | UNDRAINED SHEAR STRENGTH - kPa |
| (m) H | I) NOI | | A PLO | LEVE | | R | RY | ШО | |
| рерт | EVAT | SOIL DESCRIPTION | LRAT/ | ATER | ТҮРЕ | UMBE | (mm) | -VALU R RQ | WP W WL WATER CONTENT & ATTERBERG LIMITS H O |
| | EL | | S | Ň | | ž | RE | żΟ | DYNAMIC PENETRATION TEST, BLOWS/0.3m |
| 11 | | | | | | | | | 10 20 30 40 50 60 70 80 90 |
| -11- | | -Fair to excellent quality | | | NQ | 12 | 100% | 96% | |
| | | -Strong to very strong bedrock | | | | | | | |
| -12- | | Refer to field bedrock core log | | | | | | | |
| - | | for full description | | | NQ | 13 | 98% | 70% | |
| | | | | | | | | | |
| -13- | 88.4 | | | | | | | | |
| | | End of Borehole | | | | | | | |
| - | | | | | | | | | |
| -14- | | | | | | | | | |
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| -15- | | | | | | | | | |
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| -16- | | | | | | | | | |
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| -17- | | | | | | | | | <u> </u> |
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| 10 | | | | | | | | | |
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| -19- | | | | | | | | | |
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| -20- | | | | | | | | | |
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| -21- | | | | | | | | | |
| | | | | | | | | | |
| -22 | | | | | | | | | |
| | | V Inferred Groundwatar Laval | | | | | | | Field Vane Test, kPa Remoulded Vane Test, kPa Appld |
| | | ✓ Interfed Oroundwater Level ✓ Groundwater Level Measured in | n Standı | oipe | | | | | ▲ Pocket Penetrometer Test, kPa Date |



Field Bedrock Core Log

| Client: | | | Carpe | enters L | .ocal 93 | | | | | | | Proje | ect No |).: | 122411024 | |
|----------------------------|--------------------|--------------|----------------------------------------------|----------------------------------------------|----------------------------------------------------------------|---------------------|-------------|-------------|----------|-------------|----------|--------------------|----------|-------------|--------------------------------------|--------------------------|
| Projec [†] | t: | | Block | 22, Car | mpeau and Palladium Drive | | | | | | - | Date | : | | September 12, 2 | 2014 |
| Contra | ctor: | | | Downir | ng | | | | | | - | Bore | hole I | No.: | BH 14-7 | |
| | | | | | | | | | | | - | Logg | er: | | Kasgin Khaheshi | ĺ |
| | | <u> </u> | | | T | | | | | | | | | | | T |
| (L) | | /ER' | | Ê | | | U | | Π | | | 111F2 | | | 4 | |
| DEPTH FROM | RUN NO. | % CORE RECOV | % RQD | DEPTH TO (r | GENERAL DESCRIPTION (Rock Type/s, %, Colour, Texture, etc.) | STRENGTH | WEATHERIN | NO. OF SETS | TYPE/S | ORIENTATION | SPACING | ROUGHNESS | APERTURE | FILLING | OCCASIONAL FEATURES | DRILLING OBSERVATIONS |
| | | | | | | T | T | Ī | В | F | C | SU | | Ē | $\overline{\Box}$ | |
| 7.5 | NQ7 | 51% | 46% | 8.7 | Grey Limestone BEDRUCK (Casing dropped from 8.7 to 9.04 m) | | | | | | | | | | 1 | |
| | | | | <u> </u> | | | | | | | | | | | 1 | |
| | | | | | | | | | В | F | VC-M | SU | | | | |
| 9.04 | NQ8 | 100% | 100% | 10 | Grey Limestone BEDROCK | | | | | | | | | |] | |
| IL | | <u> </u> | <u> </u> | <u> </u> | | | | | | | | | | | | |
| 10 | NQ9 | 100% | 98% | 11.5 | Grey Limestone BEDROCK | | | | В | F | C-M | SU | | | | |
| | | | | | | T | | | | | | | | | | |
| 1 | | | | 1 | | | | | | | | | | | 1 | |
| ll | | | $ _ $ | ' | | | | | | | | | | | 1 | |
| ╟──── | | | | | | | | | <u> </u> | <u> </u> | | | | <u> </u> | | |
| EH = E | .xtreme | ly Stro | ng = > 2 | 250 | VW = Very Weak = 1-5 B = Bec | Iding Jo | oint | | | F = Flat | t = 0-20 | 10 10 | 1 | | T = Tight, Hard | |
| VS = V | ery Stro | ong = 1 | 00-250 | | EW = Extremely Weak = < 1 J = Cros | s Joint | | | | D = Dip | ping = | 20-50 ⁰ |) | | O = Oxidized | |
| S = Str MS = | ong = 5 Mediun | 0-100 | g = 25-i | 50 | F = Faul S = She | it er Plan | ۵ | | | V = n-\ | /ertical | = >50 ^v | | | SA = Slightly Alto S = Sandy Clay | ered, Clay Free |
| W = V | /eak = 5 | 5 - 25 | 5-25-5 | | | | - | | | | ROL | JGHNE | SS | | Si = Sandy, Silty | , Minor Clay |
| | WE | ATHER | ING | | | SPAC | ING | | | RU = R | ough Ur | ndulati | ing | | NC = Non-softer | ning Clay |
| U = Ur | weath | ered = | No Sign | IS | VW = V | ery Wic | de = >31 | m | | RP = Rc | ough Pla | anar | | | SC = Swelling, So | oft Clay |
| S = Slif | ghtly = (| Oxidize | d | | W = Wi | de = 1- | 3 m | | | SU = Sr | mooth L | Jndula Vanar | ting | | | |
| M = M | oderat | ely = Di | scolour | red | M = Mc | oderate | = 0.3-1 | . m | | LU = SI | ickensic | ded Un | dulatin | g | | |
| $\Pi = \Pi $ | aniy = F mplete | lv = So | il-like | | C = Close VC = Vf | e = 5-3 erv Clos | e = <5 (| m | | LP = Sli | ickensid | led Pla | nar | 0 | | |

V:\01224\active\1224110XX\122411024\Detailed Investigation Report\Report\Appendix Support\field_core_logs_122411024 BH 14-7.xlsx



Field Bedrock Core Log

| Client: | | | Carpe | enters L | .ocal 93 | | | | | | | | Proje | ect No | .: | 122411024 | |
|-------------------|-----------|--------------------|---------------|---------------|----------------------------------------------------------------|----------------------|-------------------|-----------|-------------|--------|--------------------|---------------------|---------------------------|-----------|---------|--------------------------------------|--------------------------|
| Project | :: | | Block | 22, Car | npeau and Palladium Drive | | | | | | | - | Date | : | | September 12, 2 | 2014 |
| Contra | ctor: | | | Downir | ng | | | | | | | - | Bore | hole I | No.: | BH 14-9 | |
| | | | | | | | | | | | | - | Logg | er: | | Kasgin Khaheshi | |
| Ir | | | | | 1 | | | 1 | | | | | | | | | |
| (L) | | ER) | | ਿ | | | | U | | I | DISCO | | JITIES | 1 | | 4 | |
| DEPTH FROM | RUN NO. | % CORE RECOV | % RQD | DEPTH TO (n | GENERAL DESCRIPTION (Rock Type/s, %, Colour, Texture, etc.) |) | STRENGTH | WEATHERIN | NO. OF SETS | TYPE/S | ORIENTATION | SPACING | ROUGHNESS | APERTURE | FILLING | OCCASIONAL FEATURES | DRILLING OBSERVATIONS |
| | | | | | | | | | | В | F | С | SU | | | | |
| 10.5 | NQ12 | 100% | 96% | 11.6 | Grey Limestone BEDROCK | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | В | F | VC-M | SU | | | | |
| 11.6 | NQ13 | 98% | 70% | 13.1 | Grey Limestone BEDROCK | | | | | | | | | | |] | |
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| | | | | <u>STRENG</u> | <u>STH (MPa)</u> | DISCO | ONTIN | | 'PE | | | ORIENT | ATION | <u> </u> | | <u>FIL</u> | LING |
| EH = E | xtreme | ly Stroi | ng = > 2 | .50 | VW = Very Weak = 1-5 B | = Bedd | ling Joi | nt | | | F = Fla | t = 0-20 | 0 | | | T = Tight, Hard | |
| VS = V S = Str | ery Stro |)ng = 1 0-100 | 00-250 | | EW = Extremely Weak = < 1 J = | = Cross = Fault | Joint | | | | D = Dıµ V = n-\ | oping = /ertical | $20-50^{\circ}$ = >50° | | | 0 = Oxidized SA = Slightly Alt | ered Clay Free |
| MS = 1 | Vedium | i Stron | g = 25-5 | 50 | S | = Shear | r Plane | 1 | | | • | ver tieur | - 30 | | | S = Sandy, Clay | Free |
| W = W | /eak = 5 | - 25 | | | | | | | | | | ROL | JGHNE | <u>SS</u> | | Si = Sandy, Silty | , Minor Clay |
| | <u>WE</u> | <u>ATHER</u> | ING | | | | <u>SPAC</u> | ING | | | RU = R | ough U | ndulati | ng | | NC = Non-softer SC = Swelling, Sc | ning Clay oft Clay |
| U = Ur | weathe | ered = | No Sign | S | V | W = Ve | ry Wid | e = >3r | n | | κρ = κι SU = Si | ougn Pi mooth l | anar Jndula | ting | | oc owening, o | |
| S = SII M = M | ioderat | Jxiaize elv = D | u iscolour | red | | v = wide ∕I = Moc | e = 1-3 derate | = 0.3-1 | m | | SP = Sr | nooth F | lanar | | | | |
| H = Hi | ghly = F | riable | 2201001 | 24 | C | = Close | 2 = 5-30 |) cm | | | LU = SI | ickensio | ded Un | dulatin | g | | |
| C = Co | mplete | lv = Soi | l-like | | V | C = Ver | v Close | • = <5 c | m | | LP = Sli | ickensic | led Pla | nar | | | |



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GEOTECHNICAL DESIGN REPORT April 2025

APPENDIX D

D.1 LABORATORY TEST RESULTS









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APPENDIX E

E.1 MASW TESTING REPORT





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August 28th, 2014

Transmitted by email: Kasgin.KhaheshiBanab@stantec.com Our Ref.: M-14896

Mr. Kasgin Khaheshi Banab, Ph.D., P.Eng. Geotechnical Engineer Stantec inc. 2781, Landcaster Rd, Suite 200 Ottawa (ON) K1B 1A7

Subject: Shear-wave Velocity Sounding, Palladium Drive, Kanata, Ottawa

Dear Sir.

Geophysics GPR International Inc. has been requested by Stantec inc. to carry out seismic shear wave surveys on a vacant field located west of the intersection of Palladium Drive and Huntmar Drive, in Kanata, Ottawa. The geophysical investigations used the Multi-channel Analysis of Surface Waves (MASW) and the Extended SPatial AutoCorrelation (ESPAC) methods. From the subsequent results, the V_{S30} value was calculated to identify the Site Class.

The surveys were carried out on August 14th, by Mr. Charles Trottier, M.A.Sc., phys. and Mr. Nicolas Beaulieu, Jr. Eng. Figure 1 shows the regional location of the site, and Figure 2 illustrates the location of the seismic spread. Both figures are presented in the appendix.

The following paragraphs briefly describe the survey design, the principles of the test methods, and the results in graphic and table format.



Method Principle

The *Multi-channel Analysis of Surface Waves* (MASW) and the *Extended SPatial AutoCorrelation* (ESPAC or MAM for *Microtremors Array Method*) are seismic methods used to evaluate the shear wave velocities of subsurface materials through the analysis of the dispersion properties of the Rayleigh surface waves ("ground roll"). The MASW is considered an "active" method, as the seismic signal is induced at known location and time in the geophones spread axis. Conversely, the ESPAC is considered a "passive" method, using the low frequency "noises" produced far away. The dispersion properties are measured as a change in phase velocity with frequency. Surface wave energy will decay exponentially with depth. Lower frequency surface waves will travel deeper and thus be more influenced by deeper velocity layering than the shallow higher frequency waves. The inversion of the Rayleigh wave dispersion curve yields a shear wave (V_s) velocity depth profile (sounding). Figure 3 outlines the basic operating procedure for the MASW method.

Figure 4 illustrates an example of one of the MASW/ESPAC records, the corresponding spectrogram analysis and resulting 1D V_S model. The ESPAC method allows deeper Vs soundings, but generally with a lower resolution for the surface portion. Its dispersion curve can then be merged with the higher frequency one from the MASW to calculate a more complete inversion.

More detailed descriptions of the methods are presented in *Shear wave velocity measurement guidelines for Canadian seismic site characterization in soil and rock*, Hunter, J.A., Crow, H.L., et al., Geological Surveys of Canada, public file 7079, 2012. For the MASW method, one can also refer to *Multi-channel Analysis of Surface Waves*, Park, C.B., Miller, R.D. and Xia, J. Geophysics, Vol. 64, No. 3 (May-June 1999); p. 800–808. For the ESPAC method, one could refer to the paper *Shear Velocity Profiles Obtained from Microtremor Array Data with an Example from Direct Fitting of SPAC Curves*, Asten, M.W., 2007, Proceedings of the 20th SAGEEP Conference, Denver, Environmental and Engineering Geophysical Society, and for more details: *The Microtremor Survey Method*, Okada, H., S.E.G., Geophysical Monograph Series No. 12.

Interpretation Steps

The main processing sequence involved data inspection, editing (when required), picking the fundamental mode and the first higher ones, and 1D inversion of the MASW and ESPAC shot records using the SeisImagerSW[™] software. The data inversions were realized with a non-linear least square method and a genetic algorithm. In theory, all the shot records for a given seismic spread should produce a similar shear-wave velocity



Mr. Kasgin Khaheshi Banab, Ph.D., P.Eng. August 28th, 2014

profile. In practice, however, differences can arise due to energy dissipation, localized surface seismic velocities variations, and/or dipping of overburden layers or rock. In general the precision of the calculated seismic shear wave velocities (V_s) is of the order of 15% or better.

Basic seismic refraction processing were also realized for rock depth evaluation, as well as for its seismic shear wave velocity. These results were used to guide the initial geophysical model, prior to the mathematical inversions, for optimised and more accurate V_S results.

Survey Design

The main seismic spread was located on a vacant field, north-west of Palladium Drive (cf. Figure 2). Its geophone spacing was 3 meters, which means that the total length of a 24 geophones spread was 69 meters. It was used for the MASW as well as for the seismic refraction surveys. A second shorter seismic spread, with geophone spacing of 1 meter, was dedicated to the near surface details.

The seismic records counted 4096 data, sampled at 1000 μ s for the MASW, and 50 μ s for the seismic refraction method. They were triggered by electrical close-contact.

Unlike the refraction method, which allows to produce a data point beneath each geophone, the shear wave depth sounding can be considered as the average of the bulk area within the geophone spread, especially for its central half-length. The seismic records were realized with a seismograph Terraloc MK6 (from ABEM Instrument), and the geophones were 4.5 Hz. A 20 pounds sledgehammer was used as the primary energy source with impacts being recorded off both ends of the seismic spread.

RESULTS

The rock depth was calculated between 8 and 10 meters deep by seismic refraction (critical distances), and its shear wave velocity would be approximately 2445 m/s.

The V_{S30} value results from the harmonic mean of the shear wave velocities, from the surface to 30 metres deep. It is calculated by dividing the total depth of interest (e.g. 30 metres) by the sum of the time spent in each velocity layer from the surface up to 30 metres. This value reflects an equivalent homogeneous single layer response. The calculated V_{S30} value is 475.6 m/s (cf. Table 1), corresponding to the Site Class "C". Nevertheless, very low seismic velocities (V_S) were calculated from the surface and 5 meters deep.

3



CONCLUSION

Seismic surveys were realized with the MASW/ESPAC methods, to calculate the V_{S30} value for the Site Class determination. The vacant field is located west of the intersection of Palladium Drive and Huntmar Drive, in Kanata, Ottawa. The V_{S30} calculation is presented in Table 1.

The calculated V_{S30} value is 476 m/s. Based on this value (determined through the MASW/ESPAC methods), Table 4.1.8.4.A of the NBC, and the Building Code, O. Reg. 332/12, the investigated actual site presents a Class "C" ($360 < V_{S30} \le 760$ m/s).

Between the surface and 5 meters deep, low seismic velocities were calculated. Geotechnical evaluation of the corresponding materials should be realized (without being limited to) for the clay sensitivity and the potential of liquefaction.

It must be noted that other geotechnical information gleaned onsite; including the presence of liquefiable soils, soft clays, high moisture content etc. can supersede the site classification provided in this report based on the $V_{S_{30}}$ value.

The V_s values calculated are representative of the in situ materials, and were not corrected for the total and effective stress.

This report has been written by Jean-Luc Arsenault, M.A.Sc., P.Eng.

Jean-Luc Arsenault, M.A.Sc., P.Eng. Project Manager





Figure 1: Regional location of the Site (extracted from topographic map 31 G/5)



Figure 2: Location of the seismic spread (source : *Google Earth*™)





Figure 3: MASW Operating Principle



Figure 4: Example of a MASW/ESPAC shot record, phase velocity/frequency curve and resulting 1D shear wave velocity model









| Donth | | Vs | | Thickness | Cumulated | Delay for | Cumulated | Average Vs for |
|-------|--------|--------|--------|-----------|-----------|-----------|-----------|----------------|
| Depth | Min. | Median | Max. | Thickness | Thickness | med. Vs | Delay | given Depth |
| (m) | (m/s) | (m/s) | (m/s) | (m) | (m) | (s) | (s) | (m/s) |
| 0.00 | 145.1 | 154.2 | 159.4 | | | | | |
| 1.07 | 118.7 | 136.5 | 145.3 | 1.07 | 1.07 | 0.006946 | 0.006946 | 154.2 |
| 2.31 | 116.9 | 123.2 | 137.6 | 1.24 | 2.31 | 0.009058 | 0.016004 | 144.2 |
| 3.71 | 133.6 | 139.6 | 143.7 | 1.40 | 3.71 | 0.011374 | 0.027378 | 135.4 |
| 5.27 | 196.5 | 241.9 | 272.3 | 1.57 | 5.27 | 0.011221 | 0.038599 | 136.6 |
| 7.01 | 204.4 | 269.2 | 306.5 | 1.73 | 7.01 | 0.007156 | 0.045754 | 153.1 |
| 8.90 | 317.4 | 937.7 | 2307.7 | 1.90 | 8.90 | 0.007043 | 0.052797 | 168.6 |
| 10.96 | 1995.9 | 2273.7 | 2412.6 | 2.06 | 10.96 | 0.002197 | 0.054994 | 199.3 |
| 13.19 | 2119.1 | 2365.9 | 2414.9 | 2.23 | 13.19 | 0.000979 | 0.055973 | 235.6 |
| 15.58 | 2119.1 | 2365.9 | 2427.7 | 2.39 | 15.58 | 0.001010 | 0.056983 | 273.3 |
| 18.13 | 2119.1 | 2365.9 | 2435.9 | 2.56 | 18.13 | 0.001080 | 0.058063 | 312.3 |
| 20.85 | 2119.1 | 2365.9 | 2435.9 | 2.72 | 20.85 | 0.001150 | 0.059213 | 352.1 |
| 23.74 | 2119.1 | 2365.9 | 2435.9 | 2.89 | 23.74 | 0.001219 | 0.060432 | 392.8 |
| 26.79 | 2119.1 | 2365.9 | 2439.4 | 3.05 | 26.79 | 0.001289 | 0.061721 | 434.0 |
| 30.00 | 2119.1 | 2365.9 | 2442.9 | 3.21 | 30.00 | 0.001359 | 0.063080 | 475.6 |

| TABLE 1 | | | |
|------------------|-----------------------------|-----|--|
| V _{S30} | Calculation for the Site Cl | ass | |

| V _{s30} (m/s) = | 475.6 |
|--------------------------|-------|
| Site Class : | C * |

*: conditional to a geotechnical assessment of the soils between the surface and (at least) 5 meters deep.

