Geotechnical Investigation
Proposed Residential Development
2983, 3053 and 3079 Navan Road
Ottawa, Ontario

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Executive Summary

EXP Services Inc. (EXP) is pleased to present the results of the geotechnical investigation completed for the proposed residential development to be located on the parcel of land with the civic addresses of 2983, 3053 and 3079 Navan Road, Ottawa, Ontario (Figure 1). Terms and conditions of this assignment were outlined in EXP's proposal number: OTT-21004743-A0 (Rev) dated March 30, 2021 and was authorized by 12714001 Canada Inc. on April 1, 2021 via our signed work authorization form.

A Phase One Environmental Site Assessment (ESA) of 3053 and 3079 Navan Road was undertaken by EXP and the results are documented in a separate report titled, *Phase One Environmental Site Assessment, 3053 and 3079 Navan Road, Ottawa, Ontario* dated March 26, 2021 (EXP Project Number: OTT-21004743-A0).

It is our understanding that the residential development will consist of twelve (12) townhouse block units, six (6) four (4) story condominium buildings and a service station. It is assumed that the townhouse block units and the condominium buildings will each have one (1) basement level. The development will be serviced by underground services, access roads, parking lots and parkland areas. Information regarding the design finished floor elevations of the proposed buildings, final site grades and invert elevations of the underground services were not available at the time of preparing this report.

The fieldwork for the geotechnical investigation was completed from April 28 to 30, 2021 and consists of ten (10) boreholes (Borehole Nos. 1 to 10) drilled to termination depths ranging from 6.2 to 30.5 m below the existing ground surface. Standpipes were installed in all the boreholes for long-term monitoring of the groundwater table. A piezocone penetration test with seismic shear wave and pore pressure measurements (SCPTu) was completed next to Borehole No. 9 and extended to a termination depth of 32.5 m (Elevation 52.2 m). The fieldwork was supervised on a full-time basis by a representative from EXP.

The borehole information indicates the subsurface conditions on the site consist of surficial topsoil and fill underlain by native loose to compact silty sand to sandy silt that extends to varying depths (elevations) in the boreholes followed by a deep silty clay to clay deposit with an upper stiff to very stiff desiccated brown crust underlain by a firm to stiff grey silty clay to clay. The silty clay to clay lowers in strength with depth. The depth of the groundwater table ranges from 0.6 m to 1.7 m (Elevation 84.1 m to Elevation 79.5 m).

Based on the results from the piezocone penetration test with seismic shear wave and pore pressure measurements (SCPTu) conducted next to Borehole No. 9, the average shear wave velocity of the site (V_s) from ground surface to a 30.0 m depth below ground surface is 123 m/s. The Table 4.1.8.4.A in the 2012 Ontario Building Code (as amended May 2, 2019) indicates that for an average Vs value less than 180 m/s, the site classification for seismic site response is **Class E**. Therefore, for design purposes, the site classification for seismic response for the site is **Class E.** The subsurface soils are not susceptible to liquefaction during a seismic event.

The site is underlain by a sensitive marine clay deposit that is prone to consolidation settlement if overstressed by loads imposed on it by site grade raise, foundations and by the permanent lowering of the groundwater level following construction. Overstressing of the clay will result in its consolidation and subsequent settlement of foundations, which may exceed tolerable limits of the structure resulting in cracking of the structure.

Based on a review of the engineering properties of the clay in conjunction with the recommended bearing pressure at serviceability limit state (SLS) for foundations in Section 10 of this report, it is recommended that the maximum grade raise at the site is 0.8 m using approved soil fill. Grade raises that exceed the maximum permissible of 0.8 m will have to be achieved by using light-weight fill (LWF).

Based on a review of the borehole information, it is considered feasible to support the proposed buildings on strip and spread footings founded on the native loose to compact silty sand to sandy silt and stiff to very stiff desiccated brown crust of the silty clay to clay deposit. The footings should be kept as high as practical in the native silty sand to sandy silt and the brown desiccated crust of the silty clay to clay, since the silty clay to clay lowers in strength with depth and to minimize excavations below the groundwater level.

Strip footings having a maximum width of 1.5 m and founded on the native silty sand to sandy silt and brown stiff to very stiff silty clay to clay to a maximum 1.0 m depth below existing grade may be designed for a bearing pressure at serviceability limit state (SLS) of 90 kPa and factored geotechnical resistance at ultimate limit state (ULS) of 135 kPa. Square pad footings having a maximum width and length of 3.0 m and founded on the native silty sand to sandy silt and brown silty clay to clay to a maximum 1.0 m depth below existing grade may be designed for a bearing pressure at SLS of 110 kPa and factored geotechnical resistance at ULS of 165 kPa. The factored geotechnical resistance at ULS includes a resistance factor of 0.5. The SLS and factored ULS values are valid provided the 0.8 m grade raise is respected and the footings are founded no deeper than 1.0 m below existing grade on the native soils. The settlement of footings designed for the above SLS bearing pressures are expected to be within the tolerable limits of 25 mm total and 19 mm differential.

A minimum of 1.5 m of earth cover should be provided to the exterior foundations of heated structures to protect them from damage due to frost penetration. The frost cover should be increased to 2.1 m for unheated structures if snow will not be removed from their vicinity and to 2.4 m if snow will be removed from the vicinity of the structure. When earth cover is less than the required cover, an equivalent thermal combination of earth cover and rigid insulation or rigid insulation alone should be provided. EXP can provide additional comments in this regard, if required.

The lowest floor slabs of the proposed buildings may be designed as a slab-on-grade founded on a bed of 200 mm of 19 mm clear stone placed on top of a minimum 300 mm thick compacted Granular B Type II pad placed on the native soils and constructed in accordance with Section 9 of this report. The clear stone would prevent the capillary rise of moisture from the sub-soil to the floor slab. Adequate saw cuts should be provided in the floor slabs to control cracking.

Perimeter drains should be provided for the proposed buildings. The need for underfloor drains will depend on the design elevation of the lowest floor slab relative to the elevation of the groundwater level. Once the design elevation of the lowest floor of the proposed buildings are known, EXP should be contacted to determine if a drainage system is required beneath the lowest floor slab.

Excavations for the construction of the proposed building foundations are anticipated to extend into the silty sand to sandy silt and silty clay to clay to a 1.0 m depth and will likely be above or near the groundwater level. The excavation for underground services will likely extend deeper into the silty sand to sandy silt and the silty clay to clay and are anticipated to be below the groundwater level. Excavations above the groundwater level are anticipated to be relatively straightforward. Excavations that extend below the groundwater level particularly within the permeable silty sand to sandy silt will be more problematic.

All excavations must be undertaken in accordance with the Occupational Health and Safety Act (OHSA), Ontario Reg. 213/91. Based on the definitions provided in OHSA, the subsurface soils on site are considered to be Type 3 and as such must be cut back at 1H:1V from the bottom of the excavation. Below the groundwater level, the excavation side slopes are expected to slough and eventually stabilize at a slope of 3H:1V. It is recommended that for excavations below the groundwater level, the groundwater should be lowered to below the base of the excavation prior to start of excavation.

Seepage of the surface and subsurface water into the excavations above the groundwater level is anticipated and it should be possible to collect water entering the excavations at low points and to remove it by conventional pumping techniques. Excavations that extend below the groundwater level within the permeable silty sand to sandy silt are subject to basal instability in the form of piping or heave that will require lowering the groundwater table to below the final excavation base level before commencing the excavation work. This may be achieved for shallow excavations by pumping from deep sumps although the progress is anticipated to be slow. Excavations that extend deeper than approximately 1.0 m below the groundwater table would require the installation of well points or well points with a vacuum. It is recommended that an experienced de-watering specialist contractor should undertake the selection, design and installation of the de-watering system.

It is anticipated that the majority of the material required for engineered fill, backfilling purposes, or as subgrade fill for the project would have to be imported and should preferably conform to the specifications provided in the body of the report.

Pavement structure thicknesses required for the proposed roads and parking facilities were computed and are provided in the body of the report.

It is noted that the above recommendations have been made on the basis of information determined from ten (10) boreholes completed at locations on the site that could be accessed by the drill rig. Therefore, based on the limited number of boreholes completed to date, it is recommended that an additional geotechnical (borehole) investigation should be completed once the site has been cleared of vegetation (such as the removal of trees) and the finished grades have been established at the site. The purpose of the additional boreholes is to provide better coverage of the entire site and to confirm the geotechnical properties of the silty clay to clay deposit in areas currently not accessible by the drill rig.

The above and other related considerations are discussed in greater detail in the attached report.

1. Introduction

EXP Services Inc. (EXP) is pleased to present the results of the geotechnical investigation completed for the proposed residential development to be located on the parcel of land with the civic addresses of 2983, 3053 and 3079 Navan Road, Ottawa, Ontario (Figure 1). Terms and conditions of this assignment were outlined in EXP's proposal number: OTT-21004743-A0 (Rev) dated March 30, 2021 and was authorized by 12714001 Canada Inc. on April 1, 2021 via our signed work authorization form.

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It is our understanding that the residential development will consist of twelve (12) townhouse block units, six (6) four (4) story condominium buildings and a service station. It is assumed that the townhouse block units and the condominium buildings will each have one (1) basement level. The development will be serviced by underground services, access roads, parking lots and parkland areas. Information regarding the design finished floor elevations of the proposed buildings, final site grades and invert elevations of the underground services were not available at the time of preparing this report.

This geotechnical investigation was undertaken to:

a) Establish the subsurface soil and groundwater conditions at ten (10) boreholes located on the site;

b) Provide classification of the site for seismic design in accordance with requirements of the 2012 Ontario Building Code (OBC) as amended May 2, 2019 and assess the liquefication potential of the subsurface soils during a seismic event;

c) Discuss grade raise restrictions;

d) Provide the bearing pressure at Serviceability Limit State (SLS) and factored geotechnical resistance at Ultimate Limit State (ULS) of the most suitable type of foundation for the proposed buildings, as well as anticipated total and differential settlements;

e) Comment on slab-on-grade construction and permanent drainage requirements;

f) Discuss excavation conditions and dewatering requirements during construction of the foundations for the proposed buildings and the installation of the underground services;

g) Provide pipe bedding requirements for the new underground services;

h) Comment on backfilling requirements and suitability of the on-site soils for backfilling purposes;

i) Comment on subsurface concrete requirements and the corrosion potential of subsurface soils to buried metal structures/members; and

j) Recommend pavement structure thickness for the proposed roads and outdoor parking facilities.

The comments and recommendations given in this report assume that the above-described design concept will proceed into construction. If changes are made either in the design phase or during construction, this office must be retained to review these modifications. The result of this review may be a modification of our recommendations or it may require additional field or laboratory work to check whether the changes are acceptable from a geotechnical viewpoint.

2. Site Description

The site is a triangular-shaped property bounded along the north side by Brian Coburn Boulevard West, the east side by Page Road and the south side by Navan Road. Existing residential development flanks the east and south sides of the site with the residential development fronting onto Page Road and Navan Road. The site is densely covered with trees.

Based on the ground surface elevations of the boreholes, the topography across the site is relatively flat sloping towards Navan Road in a south/southeast direction with ground surface elevations ranging between 85.72 m and 81.13 m at the locations of the boreholes.

3. Site Geology

3.1 Surficial Geology

The surficial geology map (Map 1506A – Surficial Geology, Ontario-Quebec, Geological Survey of Canada, printed by the Surveys and Mapping Branch, 1982) indicates that beneath any fill material, the site is underlain by off-shore marine deposits consisting of silt, silty clay and clay.

3.2 Bedrock Geology

The bedrock geology map (Map 1508A – Generalized Bedrock Geology, Ottawa-Hull, Ontario and Quebec, Geological Survey of Canada, printed by the Surveys and Mapping Branch, 1979) indicates the site is underlain by shale bedrock of the Billings formation.

The drift thickness map (Figure 3 Drift Thickness Trend, Ottawa-Hull Ontario and Quebec Geological Survey of Canada, printed by the Surveys and Mapping Branch, 1979) indicates the trend in the overburden drift thickness or depth to bedrock in the vicinity of the site ranges from approximately 18.0 m to 55.0 m.

4. Available Information

The geotechnical report titled, *Geotechnical Investigation, Proposed Commercial Development, Brian Coburn Boulevard at Navan Road, Ottawa, Ontario (Report: PG4415-1 Revision 1)* dated November 13, 2018 and prepared by Paterson Group Inc. (Paterson) was made available to EXP for use as reference material in the preparation of this geotechnical report. The locations of the boreholes from the Paterson geotechnical investigation are shown on the Borehole Location Plan, Figure 2. The borehole logs from the Paterson geotechnical investigation are shown in Appendix A.

5. Procedure

The fieldwork for the geotechnical investigation was completed from April 28 to 30, 2021 and consists of ten (10) boreholes (Borehole Nos. 1 to 10) drilled to termination depths ranging from 6.2 m to 30.5 m below the existing ground surface. The fieldwork was supervised on a full-time basis by a representative from EXP.

The borehole locations and geodetic elevations were established by a survey crew from EXP and are shown on Figure 2.

Prior to the fieldwork, the locations of the boreholes were cleared of any public and private underground services. The boreholes were drilled using a track mounted drill rig equipped with hollow stem augers operated by a drilling specialist subcontracted to EXP. Auger samples of the soils from the ground surface to a 0.8 m depth were undertaken in Borehole Nos. 2 and 5. Standard penetration tests (SPTs) were performed in all the boreholes at 0.75 m to 1.5 m depth intervals and the soil samples were retrieved by the split-spoon sampler. Shelby tube samples of the silty clay soil were retrieved from selected depths in some of the boreholes. The undrained shear strength of the cohesive soils was measured by conducting penetrometer and in-situ vane tests. In Borehole No. 6, a dynamic cone penetration test (DCPT) was conducted from a 13.1 m depth to a termination depth of 30.5 m below ground surface.

A piezocone penetration test with seismic shear wave and pore pressure measurements (SCPTu) was located next to Borehole No. 9 and extended to a termination depth of 32.5 m (Elevation 52.2 m).

A 19 mm diameter standpipe (with slotted section) was installed in each borehole for long-term monitoring of the groundwater level. The standpipes were installed in accordance with EXP standard practice and the installation configuration is documented on the respective borehole logs. The boreholes were backfilled upon completion of drilling and the installation of the standpipes.

All soil samples were visually examined in the field for textural classification, logged, preserved in plastic bags and identified. Similarly, the Shelby tube samples were sealed and labelled. On completion of the fieldwork, all the soil samples were transported to the EXP laboratory in Ottawa where they were visually examined by a geotechnical engineer and the borehole logs were prepared and the Shelby tube samples stored. The engineer also assigned the laboratory testing which consisted of performing the following tests on the soil samples:

Natural Moisture Content Determination .....54 tests
Natural Unit Weight Determination.....10 tests
Grain Size Analysis.....6 tests
Atterberg Limits.....5 tests
One-Dimensional Consolidation Test.....3 tests
Chemical Analysis (pH, sulphate, chloride and resistivity) .....5 tests

6. Subsurface Soil and Groundwater Conditions

A detailed description of the geotechnical conditions encountered in the boreholes is given on the borehole logs, Figures 3 to 12. The results from the piezocone penetration test with seismic shear wave and pore pressure measurements (SCPTu) located next to Borehole No. 9 are shown in Appendix B.

The borehole logs and related information depict subsurface conditions only at the specific locations and times indicated. Subsurface conditions and water levels at other locations may differ from conditions at the locations where sampling was conducted. The passage of time may also result in changes in the conditions interpreted to exist at the locations where sampling was conducted.

The boreholes were drilled to provide representation of subsurface conditions as part of a geotechnical exploration program and are not intended to provide evidence of environmental conditions.

It should be noted that the soil boundaries indicated on the borehole logs are intended to reflect approximate transition zones for the purpose of geotechnical design and should not be interpreted as exact planes of geological change. The “Notes on Sample Descriptions” preceding the borehole logs forms an integral part of this report and should be read in conjunction with this report.

A review of the borehole logs indicates the following subsurface soil conditions with depth and groundwater level measurements.

6.1 Topsoil

A surficial 75 mm to 400 mm thick topsoil layer was contacted in all boreholes with the exception of Borehole Nos. 2 and 6.

6.2 Fill

A surficial fill layer was encountered in Borehole Nos. 2 and 6 and extends to a 300 mm and 500 mm depth (Elevation 80.9 m and Elevation 80.6 m). In Borehole No. 2, the fill consists of a 100 mm thick silty sand and crushed gravel layer underlain by a 360 mm thick gravelly sand fill. In Borehole No. 6, the fill consists of a 300 mm thick gravelly sand. The moisture content of the fill is 11 percent.

6.3 Silty Sand to Sandy Silt

The topsoil and fill in Borehole Nos. 1 to 4, 7 and 10 are underlain by silty sand to sandy silt that extends to depths ranging from 0.5 m to 2.8 m (Elevation 87.4 m to Elevation 78.3 m). The N values from the standard penetration test (SPT) of 7 to 10 indicate the silty sand to sandy silt is in a loose to compact state. The natural moisture content of the silty sand to sandy silt is 22 percent to 27 percent.

The results from the grain-size analysis conducted on one (1) sample of the silty and to sandy silt from Borehole No. 1 are summarized in Table I. The grain-size distribution curve is shown in Figure 13.

Table I: Summary of Results from Grain-Size Analysis – Silty Sand Sample					
Borehole (BH) No. – Sample (SS) No.	Depth (m)	Grain-Size Analysis (%)			Soil Classification (USCS)
		Gravel	Sand	Fines (Silt and Clay)	
BH 1 – SS1	0.8 – 1.4	0	84	16	Silty Sand (SM)

Based on a review of the results from the grain size analysis, the soil sample may be classified as a silty sand (SM) in accordance with the Unified Soil Classification System (USCS).

6.4 Silty Clay to Clay

The topsoil and native silty sand to sandy silt are underlain by a sensitive marine clay contacted in all ten (10) boreholes at a 0.3 m to 1.4 m depths (Elevation 87.4 m to Elevation 80.9 m). The marine clay consists of an upper desiccated brown silty clay to clay crust underlain by a lower strength un-desiccated grey silty clay to clay.

6.4.1 Upper Brown Desiccated Silty Clay to Clay Crust

The upper desiccated brown silty clay to clay crust extends to depths of 1.5 m to 3.1 m (Elevation 86.2 m to Elevation 77.7 m). The undrained shear strength of the crust ranges from 67 kPa to 180 kPa indicating a stiff to very stiff consistency. The sensitivity values of 6.0 to 9.3 indicates the clay is sensitive to extra-sensitive. The natural moisture content and unit weight of the silty clay to clay crust is 34 percent to 49 percent and 17.1 kN/m^3 to 19.1 kN/m^3 respectively.

6.4.2 Grey Silty Clay to Clay

The upper brown desiccated silty clay to clay crust in all boreholes is underlain by the un-desiccated grey silty clay to clay contacted at 1.5 m and 3.1 m depths (Elevation 86.2 m and Elevation 77.7 m). The grey silty clay to clay in Borehole No. 10 contains sand seams. All boreholes terminated within the grey clay to silty clay at 6.2 m to 13.1 m depths (Elevation 81.7 m to Elevation 68.1 m).

The undrained shear strength of the silty clay to clay ranges from 24 kPa to 62 kPa indicating a firm to stiff consistency with a localized soft zone in Borehole Nos. 5. The sensitivity values of 5.5 to 9.3 indicate that the clay is sensitive to extra-sensitive. The grey silty clay to clay has natural moisture contents of 52 percent to 86 percent. Locally in Borehole No. 10, the zone of the silty clay to clay that contains sand seams and has a natural moisture content of 28 percent. The natural unit weight of the silty clay to clay is 15.0 kN/m^3 to 15.3 kN/m^3.

The results from the grain-size analysis and Atterberg limit determination conducted on five (5) selected samples of the grey silty clay to clay is summarized in Table II. The grain-size distribution curves are shown in Figures 14 to 18.

Table II: Summary of Results from Grain-Size Analysis and Atterberg Limit Determination Grey Silty Clay to Clay Samples									
Borehole (BH) No. – Sample (SS) No.	Depth (m)	Grain-Size Analysis (%)			Atterberg Limits (%)				
		Gravel	Sand	Fines (Silt and Clay)	Moisture Content	Liquid Limit	Plastic Limit	Plasticity Index	Soil Classification (USCS)
BH 2 – SS7	6.1 – 6.7	0	0	100	76	50	25	25	Clay of High Plasticity (CH)
BH 3 – SS3	2.3 – 2.9	0	3	97	65	32	17	15	Silty Clay of Low Plasticity (CL)
BH 4 – SS6	4.7 – 5.3	0	0	100	62	58	27	31	Clay of High Plasticity (CH)
BH 6 – SS8	9.1 – 9.7	0	0	100	78	45	26	19	Silty Clay of Medium Plasticity (CL)
BH 10 – SS4	3.2 – 3.8	0	2	98	71	50	22	28	Clay of High Plasticity (CH)

Based on a review of the results of the grain-size analysis and Atterberg limits, the soil may be classified as a silty to clay of low to high plasticity (CL and CH) in accordance with the USCS.

One-dimensional consolidation tests were performed on three (3) Shelby tube samples of the silty clay to clay. The test results are summarized in Table III and shown in Appendix C.

Table III: One-Dimensional Oedometer Test Results – Grey Silty Clay to Clay Samples									
Borehole No.-Sample No.	Sample Depth (Elevation) (m)	σ'_{v0} (kPa)	W_c (%)	γ (kN/m^3)	σ'_p (kPa)	e_o	C_r	C_c	OCR
BH 6 –TW10	12.2 – 12.8 (69.0 – 68.4)	94	74	15.0	120	2.131	0.04	1.5	1.3
BH 7 – TW6	4.6 – 5.2 (79.5 – 78.9)	52	73	15.3	150	2.056	0.03	1.4	2.9
BH 8 – TW4	3.0 -3.6 (79.3 – 78.7)	39	75	15.1	70	2.127	0.03	1.4	1.8

σ'_{v0} = calculated effective overburden pressure (kPa); W_c: natural moisture content (%), γ: estimated natural unit weight σ'_p = pre-consolidation pressure (kPa), e_o = initial void ratio; C_r = re-compression index; C_c = compression index; OCR - Over-Consolidation Ratio

The pre-consolidation pressure of the silty clay to clay samples at similar elevations in Borehole Nos. 7 and 8 range from 70 kPa to 150 kPa and is 120 kPa at a deeper depth (elevation) in Borehole No. 6. Based on a review of the consolidation test results, the silty clay to clay samples are over-consolidated by a factor of 1.3 to 2.9.

6.5 Dynamic Cone Penetration Test (DCPT)

Dynamic cone penetration test (DCPT) was preformed from the below the sampled depth of Borehole No. 6 from a 13.1 m to 30.5 m depth (Elevation 68.1 m to Elevation 50.7 m). The DCPT indicates the bedrock is present below a 30.5 m depth (Elevation 50.7 m).

6.6 Piezocone Penetration Test (SCPTu)

One (1) piezocone penetration test with seismic shear wave and pore pressure measurements was carried out at the location of Borehole No. 9 (SCPTu-9) from ground surface to a termination depth of 32.5 m (Elevation 52.2 m). The SCPTu results are shown in Appendix B. The SCPTu results indicate the silty clay to clay is present to the termination depth of the SCPTu, with sand layers from 29.5 m depth to the 32.5 m termination depth.

6.7 Groundwater Levels

Groundwater level measurements were taken on June 19, 2021 in the standpipes installed in all boreholes. The groundwater level measurements are summarized in Table IV.

Table IV: Summary of Groundwater Level Measurements

Borehole No. (BH)	Ground Surface Elevation (m)	Date of Measurement (Elapsed Time in Days from Date of Installation)	Groundwater Depth Below Ground Surface (Elevation), m
BH 1	84.97	June 19, 2021 (51 days)	1.4 (83.6)
BH 2	81.13	June 19, 2021 (52 days)	0.9 (80.2)
BH 3	84.73	June 19, 2021 (51 days)	0.6 (84.1)
BH 4	85.72	June 19, 2021 (50 days)	1.7 (84.0)
BH 5	81.46	June 19, 2021 (52 days)	1.0 (80.5)
BH 6	81.19	June 19, 2021 (52 days)	1.7 (79.5)
BH 7	84.12	June 19, 2021 (50 days)	1.4 (82.7)
BH 8	82.28	June 19, 2021 (51 days)	1.4 (80.9)
BH 9	84.70	June 19, 2021 (50 days)	Damaged
BH 10	84.72	June 19, 2021 (51 days)	1.3 (83.4)

Based on a review of the groundwater level measurements, the groundwater level ranges from 0.6 m to 1.7 m (Elevation 84.1 m to Elevation 79.5 m).

Groundwater levels were determined in the boreholes at the times and under the conditions stated in the scope of services. Note that fluctuations in the level of groundwater may occur due to a seasonal variation such as precipitation, snowmelt, rainfall activities, and other factors not evident at the time of measurement and therefore may be at a higher level during wet weather periods.

7. Seismic Site Classification and Liquefaction Potential of Soils

7.1 Site Classification for Seismic Site Response

Based on the results from the piezocone penetration test with seismic shear wave and pore pressure measurements (SCPTu) conducted next to Borehole No. 9, the average shear wave velocity of the site (V_s) from ground surface to a 30.0 m depth below ground surface is 123 m/s. The Table 4.1.8.4.A in the 2012 Ontario Building Code (as amended May 2, 2019) indicates that for an average Vs value less than 180 m/s, the site classification for seismic site response is **Class E**. Therefore, for design purposes, the site classification for seismic response for the site is **Class E**.

Once the site has been cleared of vegetation (such as the removal of trees) and better access is made available to various areas of the site, consideration should be given to conducting an additional Multi-channel Analysis of Surface Waves (MASW) survey, specifically at the location of the proposed four (4) story condominium buildings to confirm the seismic site classification.

7.2 Liquefaction Potential of Soils

The subsurface soils are not susceptible to liquefaction during a seismic event.

8. Grade Raise Restrictions

The site is underlain by a sensitive marine clay deposit that is prone to consolidation settlement if overstressed by loads imposed on it by site grade raise, foundations and by the permanent lowering of the groundwater level following construction. Overstressing of the clay will result in its consolidation and subsequent settlement of foundations, which may exceed tolerable limits of the structure resulting in cracking of the structure.

Based on a review of the engineering properties of the clay in conjunction with the recommended bearing pressure at serviceability limit state (SLS) for foundations in Section 10 of this report, it is recommended that the maximum grade raise at the site is 0.8 m using approved soil fill. Grade raises that exceed the maximum permissible of 0.8 m will have to be achieved by using light-weight fill (LWF).

An allowance for permanent groundwater lowering was not required as part of the review, since the foundations for the proposed buildings will be at or slightly below the groundwater level and measures will be employed in new service trenches to minimize the permanent lowering of the groundwater level at the site (use of clay seals), as recommended in Section 14 of this report.

9. Site Grading

Site grading within the floor slab area of the proposed buildings should consist of the excavation and removal of all existing topsoil, fill and organic stained soils down to the native undisturbed native silty clay to clay and silty sand to sandy silt.

The exposed silty sand to sandy silt should be proofrolled in order to consolidate any loose pockets. The silty sand to sandy silt and silty clay to clay subgrades should be examined by a geotechnician. Any soft, wet or loose zones of the exposed subgrade soils should be removed and replaced with Ontario Provincial Standard Specification (OPSS) Granular B Type II compacted to 98 percent standard Proctor maximum dry density (SPMDD). The site grades within the floor slab area may then be raised to the design subgrade level of the floor slab using OPSS Granular B Type II compacted to 98 percent SPMDD.

For new pavement areas, all topsoil should be excavated and removed to the existing fill and native silty sand to sandy silt and silty clay to clay. The exposed existing fill and silty sand to sandy silt should be proofrolled. The proofrolled existing fill and silty sand to sandy silt subgrade and the exposed silty clay to clay subgrade should be examined by a geotechnican. Any loose, wet or soft zones identified in the subgrade should be excavated and removed and replaced with OPSS select subgrade material (SSM) compacted to 95 percent SPMDD. Once the subgrade has been approved, the site grades may be raised to the design subgrade level for the paved areas using OPSS select subgrade material compacted to 95 percent SPMDD. In wet areas, crusher-run granular type material may be required in the lower levels of the required fill to stabilize the subgrade.

In-place density tests should be performed on each lift of placed material to ensure that it has been compacted to the project specifications.

10. Foundation Considerations

It is our understanding that the residential development will consist of twelve (12) townhouse block units, six (6) four (4) story condominium buildings and a service station. It is assumed that the townhouse block units and the condominium buildings will each have one (1) basement level. The development will be serviced by underground services, access roads, parking lots and parkland areas. Information regarding the design finished floor elevations of the proposed buildings, final site grades and invert elevations of the underground services were not available at the time of preparing this report.

The borehole information indicates the subsurface conditions consist of surficial topsoil and fill underlain by silty sand to sandy silt that extends to varying depths (elevations) in the boreholes followed by a deep silty clay to clay deposit with a stiff to very stiff upper desiccated brown crust underlain by a firm to stiff grey silty clay to clay. The silty clay to clay lowers in strength with depth. The groundwater level ranges from 0.6 m to 1.7 m (Elevation 84.1 m to Elevation 79.5 m).

Based on a review of the borehole information, it is considered feasible to support the proposed buildings on strip and spread footings founded on the native loose to compact silty sand to sandy silt and stiff to very stiff desiccated brown crust of the silty clay to clay deposit. The footings should be kept as high as practical in the native silty sand to sandy silt and the brown desiccated crust of the silty clay to clay, since the silty clay to clay lowers in strength with depth and to minimize excavations below the groundwater level.

For the proposed condominium buildings, consideration may be given to supporting the proposed condominium buildings by a raft foundation. If the raft foundation option is to be seriously considered, its feasibility will need to be further investigated.

Strip footings having a maximum width of 1.5 m and founded on the native silty sand to sandy silt and brown silty clay to clay to a maximum 1.0 m depth below existing grade may be designed for a bearing pressure at serviceability limit state (SLS) of 90 kPa and factored geotechnical resistance at ultimate limit state (ULS) of 135 kPa. Square pad footings having a maximum width and length of 3.0 m and founded on the native silty sand to sandy silt and brown silty clay to clay to a maximum 1.0 m depth below existing grade may be designed for a bearing pressure at SLS of 110 kPa and factored geotechnical resistance at ULS of 165 kPa. The factored geotechnical resistance at ULS includes a resistance factor of 0.5. The SLS and factored ULS values are valid provided the 0.8 m grade raise is respected and the footings are founded no deeper than 1.0 m below existing grade on the native soils.

Settlements of footings designed for the above SLS bearing pressures are expected to be within the tolerable limits of 25 mm total and 19 mm differential.

All footing beds should be examined by a geotechnical engineer to ensure that the founding surfaces are capable of supporting the design bearing pressure at SLS and that the footing beds have been properly prepared. The surface of the exposed silty sand to sandy silt subgrade should be proofrolled and examined by a geotechnical engineer prior to concrete placement.

The exposed surface of the silty clay to clay is expected to be susceptible to disturbance due to movement of workers and construction equipment. It is therefore recommended that the approved subgrade in the footing beds must be covered with a 50 mm thick concrete mud slab to prevent disturbance to the clay subgrade.

A minimum of 1.5 m of earth cover should be provided to the exterior foundations of heated structures to protect them from damage due to frost penetration. The frost cover should be increased to 2.1 m for unheated structures if snow will not be removed from their vicinity and to 2.4 m if snow will be removed from the vicinity of the structure. When earth cover is less than the required cover, an equivalent thermal combination of earth cover and rigid insulation or rigid insulation alone should be provided. EXP can provide additional comments in this regard, if required.

The recommended bearing pressure at SLS and factored geotechnical resistances at ULS have been calculated by EXP from the borehole information for the design stage only. The investigation and comments are necessarily on-going as new information of underground conditions becomes available. For example, more specific information is available with respect to conditions between boreholes when foundation construction is underway. The interpretation between boreholes and the recommendations of this report must therefore be checked through field monitoring provided by an experienced geotechnical engineer to validate the information for use during the construction stage.

10.1 Additional Geotechnical Investigation

It is noted that the above recommendations have been made on the basis of information determined from ten (10) boreholes completed at locations on the site that could be accessed by the drill rig. Therefore, based on the limited number of boreholes completed to date, it is recommended that an additional geotechnical (borehole) investigation should be completed once the site has been cleared of vegetation (such as the removal of trees) and the finished grades have been established at the site. The purpose of the additional boreholes is to provide better coverage of the entire site and to confirm the geotechnical properties of the silty clay to clay deposit in areas currently not accessible by the drill rig.

11. Slab-on-Grade Construction and Permanent Drainage Systems

The lowest floor slabs of the proposed buildings may be designed as a slab-on-grade founded on a bed of 200 mm of 19 mm clear stone placed on top of a minimum 300 mm thick compacted Granular B Type II pad placed on the native soils and constructed in accordance with Section 9 of this report. The clear stone would prevent the capillary rise of moisture from the sub-soil to the floor slab. Adequate saw cuts should be provided in the floor slabs to control cracking.

Perimeter drains should be provided for the proposed buildings. The need for underfloor drains will depend on the design elevation of the lowest floor slab relative to the elevation of the groundwater level. Once the design elevation of the lowest floor is known, EXP should be contacted to determine if underfloor drains are required for the proposed buildings.

The ground floor slab should be set at least 150 mm above the surrounding exterior grades and the exterior grades should be sloped away from the proposed buildings to prevent ponding of surface water close to the exterior walls of the proposed buildings.

12. Lateral Earth Pressure on Subsurface Walls

The subsurface basement walls of the building should be backfilled with free draining material, such as OPSS 1010 Granular B Type II compacted to 95 percent SPMDD and equipped with a perimeter drainage system to prevent the buildup of hydrostatic pressure behind the walls. The walls will be subjected to lateral static and dynamic (seismic) earth forces. The expressions below assume free draining backfill material, a perimeter drainage system, level backfill surface behind the wall and vertical face on the back side of the wall.

For design purposes, the lateral static earth thrust against the subsurface walls may be computed from the following equation:

$$P = K_0 h (½ \gamma h + q)$$

where P = lateral earth thrust acting on the subsurface wall, kN/m

K_0 = lateral earth pressure at rest coefficient, assumed to be 0.5 for Granular B Type II backfill material

γ = unit weight of free draining granular backfill; Granular B Type II = 22 kN/m^3

h = depth of point of interest below top of backfill, m

q = surcharge load stress, kPa

The lateral dynamic thrust may be computed from the equation given below:

$$\Delta_{Pe} = \gamma H^2 \frac{a_h}{g} F_b$$

where Δ_{Pe} = dynamic thrust in kN/m of wall

H = height of wall, m

γ = unit weight of backfill material = 22 kN/m^3

$\frac{a_h}{g}$ = earth pressure coefficient = 0.32 for Ottawa area

F_b = thrust factor = 1.0

The dynamic thrust does not take into account the surcharge load. The resultant force of the lateral dynamic thrust acts approximately at 0.63H above the base of the wall.

All subsurface walls should be properly waterproofed.

13. Excavation and De-Watering Requirements

13.1 Excess Soil Management

Ontario Regulation 406/19 made under the Environmental Protection Act (November 28, 2019) has been enacted as of January 1, 2021. The new regulation dictates the testing protocol required for the management and disposal of excess soils. As set forth in the regulation, specific analytical testing protocols need to be implemented and followed based on the volume of soil to be managed. The testing protocols are specific as to whether the soils are stockpiled or in situ. In either scenario, the testing protocols are far more onerous than have been historically carried out as part of standard industry practices. These decisions should be factored in and accounted for prior to the initiation of the project-defined scope of work. EXP would be pleased to assist with the implementation of a soil management and testing program that would satisfy the requirements of Ontario Regulation 406/19.

13.2 Excavations

Excavation for the construction of the proposed building foundations are anticipated to extend into the silty sand to sandy silt and the silty clay to clay to a 1.0 m depth and will likely be above or near the groundwater level. The excavation for underground services will likely extend deeper into the silty sand to sandy silt and into the silty clay to clay and are anticipated to be below the groundwater level. Excavations above the groundwater level are anticipated to be relatively straightforward. Excavations that extend below the groundwater level particularly within the permeable silty sand to sandy silt will be more problematic.

The excavations may be undertaken by conventional heavy equipment.

All excavations must be undertaken in accordance with the Occupational Health and Safety Act (OHSA), Ontario Reg. 213/91. Based on the definitions provided in OHSA, the subsurface soils on site are considered to be Type 3 and as such must be cut back at 1H:1V from the bottom of the excavation. Below the groundwater level, the excavation side slopes are expected to slough and eventually stabilize at a slope of 3H:1V. It is recommended that for excavations below the groundwater level, the groundwater should be lowered to below the base of the excavation prior to start of excavation.

Base heave type failure is not anticipated for excavations that extend to a 3.0 m depth below existing grade with the excavation bases located in the silty clay to clay.

Many geologic materials deteriorate rapidly upon exposure to meteorological elements. Unless otherwise specifically indicated in this report, walls and floors of excavations must be protected from moisture, desiccation, and frost action throughout the course of construction.

13.3 De-Watering Requirements

Seepage of the surface and subsurface water into the excavations above the groundwater level is anticipated and it should be possible to collect water entering the excavations at low points and to remove it by conventional pumping techniques.

Excavations that extend below the groundwater level within the permeable silty sand to sandy silt are subject to basal instability in the form of piping or heave that will require lowering the groundwater table to below the final excavation base level before commencing the excavation work. This may be achieved for shallow excavations by

pumping from deep sumps although the progress is anticipated to be slow. Excavations that extend deeper than approximately 1.0 m below the groundwater table would require the installation of well points or well points with a vacuum. It is recommended that an experienced de-watering specialist contractor should undertake the selection, design and installation of the de-watering system.

It is anticipated that groundwater will need to be removed from the excavations. It is noteworthy to mention that new legislation came into force in Ontario on March 29, 2016 to regulate groundwater takings for construction dewatering purposes. Prior to March 29, 2016, a Category 2 Permit to Take Water (PTTW) was required from the Ontario Ministry of the Environment and Climate Change (MOECC) for groundwater takings related to construction dewatering, where taking volumes in excess of 50 m^3/day, but less than 400 m^3/day, and the taking duration was no more than 30 consecutive days. The new legislation replaces the Category 2 PTTW for construction dewatering with a new process under the Environmental Activity and Sector Registry (EASR). The EASR is an on-line registry, which allows persons engaged in prescribed activities, such as water takings, to register with the MOECC instead of applying for a PTTW.

To be eligible for the new EASR process, the construction dewatering taking must be less than 400 m^3/day under normal conditions. The water taking can be groundwater, storm water, or a combination of both. It should be noted that the 30-consecutive day limit on the water taking under the old Category 2 PTTW process has been removed in the new EASR process. Also, it should be noted that the EASR process requires two technical studies be prepared by a Qualified Person, prior to any water taking. These studies include a Water Taking Report, which provides assurance that the taking will not cause any unacceptable impacts, and a Discharge Plan, which provides assurance that the discharge will not result in any adverse impacts to the environment. EXP has qualified persons who can prepare these types of reports, if required. A significant advantage of the new EASR process over the former Category 2 PTTW process, is that the groundwater taking may begin immediately after completing the on-line registration of the taking and paying the applicable fee, assuming the accompanying technical studies have been completed. The former PTTW process typically took more than 90 days, which had the potential to impact construction schedules.

Although this investigation has estimated the groundwater levels at the time of the fieldwork, and commented on dewatering and general construction problems, conditions may be present which are difficult to establish from standard boring and excavating techniques and which may affect the type and nature of dewatering procedures used by the contractor in practice. These conditions include local and seasonal fluctuations in the groundwater table, erratic changes in the soil profile, thin layers of soil with large or small permeabilities compared with the soil mass, etc. Only carefully controlled tests using pumped wells and observation wells will yield the quantitative data on groundwater volumes and pressures that are necessary to adequately engineer construction dewatering systems.

14. Pipe Bedding Requirements

It is recommended that the bedding for the underground services including material specifications, thickness of cover material and compaction requirements conform to municipal requirements and/or Ontario Provincial Standard Specification and Drawings (OPSS and OPSD).

The pipe subgrade material is anticipated to consist of firm to very stiff silty clay to clay. In this case, it is recommended the pipe bedding consist of 300 mm thick of OPSS 1010 Granular A bedding material. The bedding material should be compacted to at least 98 percent SPMDD.

The bedding thickness may be further increased in areas where the silty clay to clay subgrade becomes disturbed or below the water table. Trench base stabilization techniques, such as removal of loose/soft material, placement of crushed stone sub-bedding (Granular B Type II) that is completely wrapped in a non-woven geotextile, may also be used if trench base disturbance becomes a problem in wet or soft areas.

If the backfill for the service trenches will consist of granular fill, clay seals should be installed in the service trenches at select intervals as required. The seals should be 1 m wide, extend over the entire trench width and from the bottom of the trench to the underside of the pavement structure. The clay should be compacted to 95 percent SPMDD. The purpose of the clay seals is to prevent the permanent lowering of the groundwater level.

The underground services should be installed in short open trench sections that are excavated and backfilled the same day.

15. Backfilling Requirements and Suitability of On-Site Soils for Backfilling Purposes

The material to be excavated from the site will mainly comprise of topsoil, silty sand to sandy silt and silty clay to clay. These soils are not considered suitable for use under structural elements and for backfilling purposes. Portions of the silty sand to sandy silt and silty clay to clay above the groundwater level may be used as backfill material for service trenches, subject to evaluation and testing at time of construction. Portions of these soils above the groundwater level may also be used for general grading purposes in landscaped areas.

It is anticipated that the majority of the material required for engineered fill, backfilling purposes, or as subgrade fill for the project would have to be imported and should preferably conform to the following specification:

- Engineered fill under slab-on-grade - OPSS 1010 Granular B Type II placed in 300 mm thick lifts and each lift compacted 98 percent SPMDD.

- Backfill in footing trenches and against foundation walls – OPSS 1010 Granular B Type II placed in 300 mm thick lifts and each lift compacted to 98 percent of the SPMDD inside the building and 95 percent SPMDD outside the building respectively.

- Backfill in services trenches inside building – OPSS 1010 Granular B Type II placed in 300 mm thick lifts and each lift compacted to 98 percent of the SPMDD.

- Backfill in exterior services trenches – OPSS 1010 Select Subgrade Material (SSM) placed in 300 mm thick lifts and each lift compacted to 95 percent of the SPMDD.

16. Subsurface Concrete and Steel Requirements

Chemical tests limited to pH, chloride, sulphate and resistivity were performed on five (5) selected soil samples. The certificate of the laboratory test results is attached in Appendix D and the results are summarized in Table V below.

Table V: Results of pH, Chloride, Sulphate and Resistivity Tests on Soil Samples

Borehole No. (Sample No.)	Soil Type	Depth (m)	pH	Sulphate (%)	Chloride (%)	Resistivity (ohm-cm)
BH 3 – SS2	Brown Silty Clay to Clay	1.5-2.1	7.70	0.0012	0.0010	17200
BH 6 – SS4	Grey Silty Clay to Clay	3.0-3.6	8.03	0.0120	0.0027	3050
BH 7 – SS5	Grey Silty Clay to Clay	3.8-4.4	8.17	0.0028	0.0005	7140
BH 8 – SS2	Brown Silty Clay to Clay	1.5-2.1	7.75	0.0020	0.0019	14700
BH 10 – SS2	Grey Silty Clay to Clay	1.5-2.1	8.35	0.0016	0.0003	9620

The results indicate the clay has a sulphate content of less than 0.1 percent. This concentrations of sulphate in the clay would have a negligible potential of sulphate attack on subsurface concrete. The concrete should be designed in accordance with Table Nos. 3 and 6 of CSA A.23.1-14. However, the concrete should be dense, well compacted and cured.

Based on a review of the resistivity test results, the brown silty clay to clay samples are considered to be non-corrosive to bare steel as per the National Association of Corrosion Engineers (NACE). The grey silty clay to clay samples are considered to be mildly corrosive to bare steel as per NACE. Appropriate measures should be undertaken to protect buried steel elements from corrosion.

17. Pavement Structure

Pavement structure thicknesses required for the proposed roads and parking facilities were computed and are shown on Table VI. The thicknesses are based upon an estimate of the subgrade soil properties determined from visual examination and textural classification of the soil samples and pavement functional design life of ten (10) to fifteen (15) years. The proposed functional design life represents the number of years to the first rehabilitation, assuming regular maintenance is carried out. The subgrade is anticipated to consist of fill, silty sand to sandy silt, silty clay to clay, OPSS Granular B Type II material or select subgrade material (SSM).

Table VI: Recommended Pavement Structure Thicknesses

Pavement Layer	Compaction Requirements	Pavement Design to be Used by Light Duty Vehicles	Heavy Duty Vehicles / Subdivsion Roads
Asphaltic Concrete (PG 58-34)	92-97 % MRD*	40 mm HL3/SP12.5 Cat B 50 mm HL8/SP12.5	50 mm HL3/SP12.5 Cat B 60 mm HL8 SP19.0 Cat B
OPSS 1010 Granular A Base	100% SPMDD**	150 mm	150 mm
OPSS 1010 Granular B Sub-Base Type II	100% SPMDD**	450 mm	600 mm

**Denotes maximum relative density.*

*** Denotes standard Proctor maximum dry density, ASTM-D698-12e2.*

The foregoing design assumes that construction is carried out during dry periods and that the subgrade is stable under the load of construction equipment. If construction is carried out during wet weather, and heaving or rolling of the subgrade is experienced, additional thickness of granular material and/or geotextile may be required.

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

1. As part of the subgrade preparation for the areas to be paved, the proposed new pavement areas should be stripped of topsoil, organic stained soil and other obviously unsuitable material. The subgrade should be properly shaped, crowned, then proofrolled with a non-vibratory roller in the full-time presence of a representative of this office. Any soft or spongy subgrade areas detected should be sub excavated and properly replaced with suitable OPSS 1010 Granular B Type II compacted to 95 percent SPMDD (ASTM D698). To prevent overstressing the clay subgrade, coarser material may be required in the lower 300 mm of the subgrade fill such as OPSS 1010 Granular B Type II or well graded blast-shattered bedrock.

2. The long-term performance of the pavement structure is highly dependent upon the subgrade support conditions. Stringent construction control procedures should be maintained to ensure that uniform subgrade moisture and density conditions are achieved. The need for adequate drainage cannot be over-emphasized. Subdrains should be installed on both sides of the access road(s). Subdrains must be installed in the proposed parking area and on both sides of the roadways at low points and should be continuous between catchbasins to intercept excess surface and subsurface moisture and to prevent subgrade softening. This will ensure no water collects in the granular course, which could result in pavement failure

during the spring thaw. The location and extent of sub drainage required within the paved areas should be reviewed by this office in conjunction with the proposed site grading.

3. To minimize the problems of differential movement between the pavement and catchbasins/ manhole due to frost action, the backfill around the structures should consist of free-draining granular preferably conforming to OPSS 1010 Granular B Type II material. Weep holes should be provided in the catchbasins/manholes to facilitate drainage of any water that may accumulate in the granular fill.

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

5. The finished pavement surface should be free of depressions and should be sloped (preferably at a minimum cross fall of 2 percent) to provide effective surface drainage towards catchbasins. Surface water should not be allowed to pond adjacent to the outside edges of paved areas.

6. Relatively weaker subgrade may develop over service trenches at subgrade level. These areas may require the use of thicker/coarser sub-base material and the use of a geotextile at the subgrade level. if this is the case, it is recommended that additional 150 mm of granular sub-base Granular B Type II should be provided in these areas in addition to the use of a geotextile at the subgrade level.

7. The granular materials used for pavement construction should conform to OPSS 1010 for Granular A and Granular B Type II and should be compacted to 100 percent of the SPMDD (ASTM D698). The asphaltic concrete and its placement should meet OPSS requirements. It should be compacted to 92 to 97 percent of the maximum relative density in accordance with ASTM D2041.

It is recommended that EXP be retained to review the final pavement structure design and drainage plans prior to construction to ensure that they are consistent with the recommendations of this report.

18. Additional Geotechnical Investigations

It is noted that the above recommendations have been made on the basis of information determined from ten (10) boreholes completed at locations on the site that could be accessed by the drill rig. Therefore, based on the limited number of boreholes completed to date, it is recommended that an additional geotechnical (borehole) investigation should be completed once the site has been cleared of vegetation (such as the removal of trees) and the finished grades have been established at the site. The purpose of the additional boreholes is to provide better coverage of the entire site and to confirm the geotechnical properties of the silty clay to clay deposit in areas currently not accessible by the drill rig.

19. General Comments

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

The information contained in this report is not intended to reflect on environmental aspects of the soils. Should specific information be required, including for example, the presence of pollutants, contaminants or other hazards in the soil, refer to the environmental reports prepared for the site.

We trust that the information contained in this report is satisfactory for your purposes. Should you have any questions, please contact this office.

Sincerely.

DRAFT

Susan M. Potyondy, P.Eng.
Senior Project Manager
Earth and Environment

DRAFT

Ismail M. Taki, M.Eng., P.Eng.
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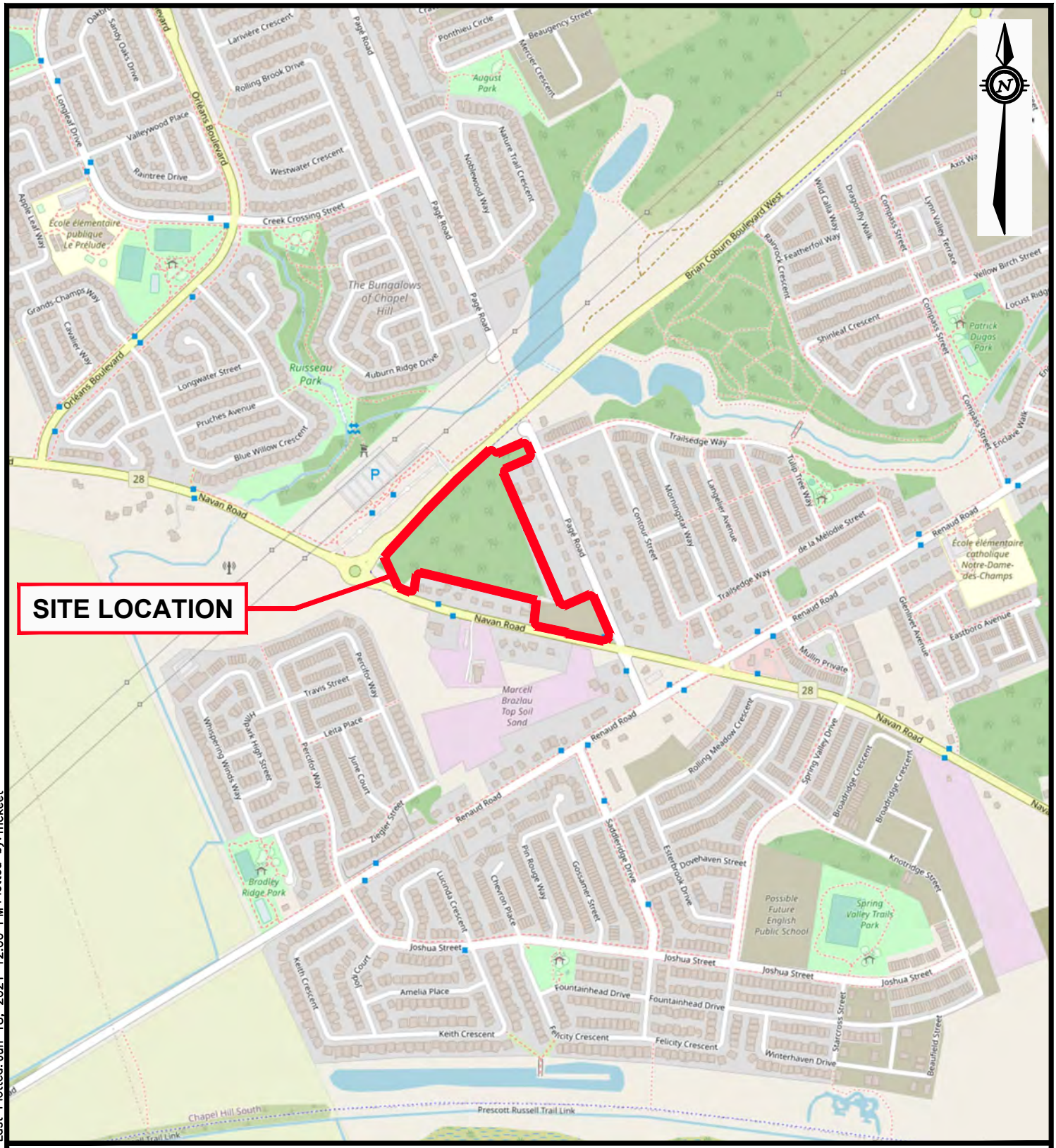
Earth and Environment

Figures



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DESIGN	IT
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DATE	JUNE, 2021
FILE NO	OTT-21004743-B0

GEOTECHNICAL INVESTIGATION
PROPOSED RESIDENTIAL DEVELOPMENT
2983, 3053 & 3079 NAVAN ROAD, OTTAWA, ON

SITE LOCATION PLAN

SCALE 1:10,000

SKETCH NO FIG 1

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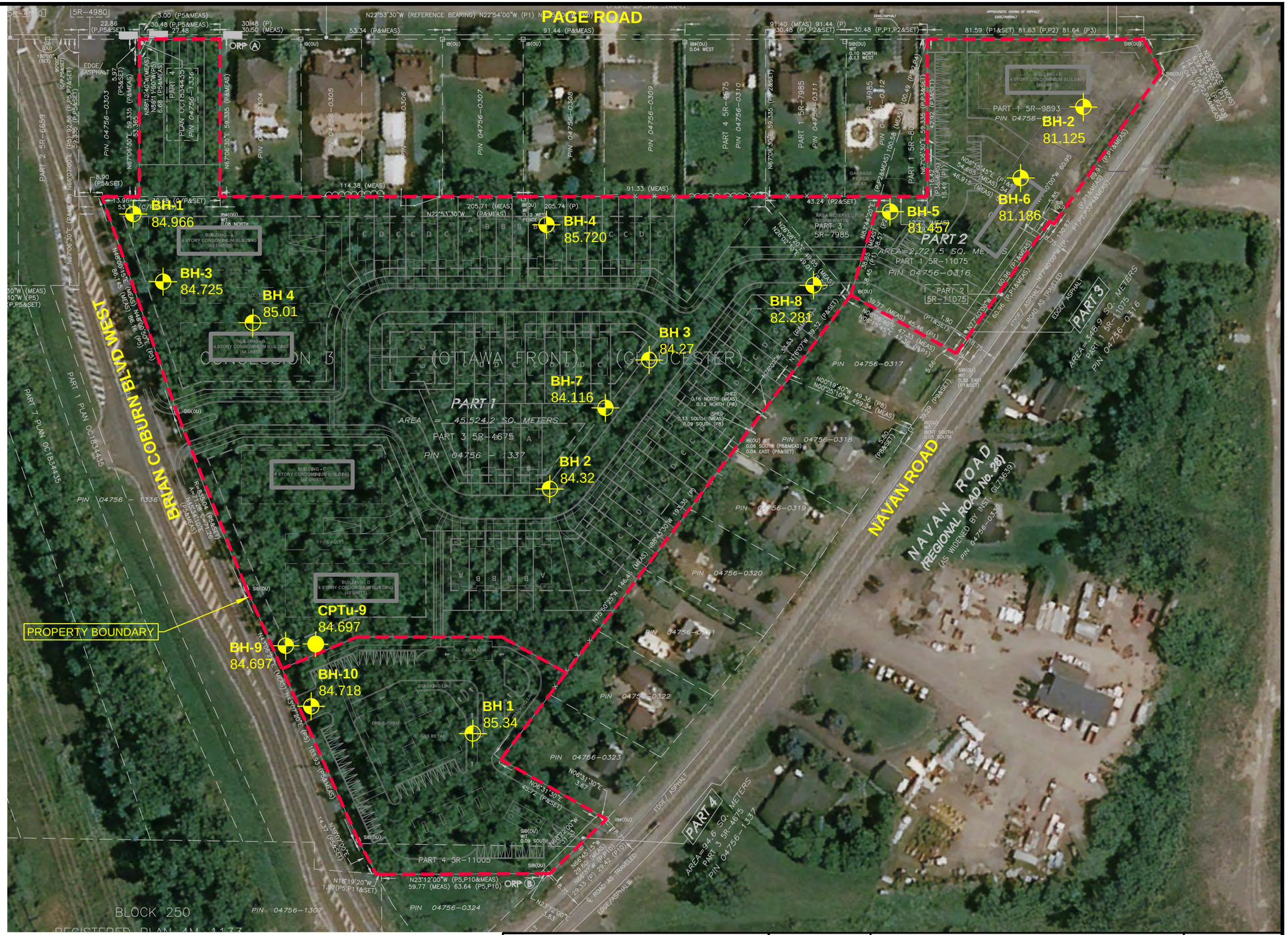

LEGEND

BH-1 81.115	BOREHOLE NO. & LOCATION SURFACE ELEVATION ABOVE SEA LEVEL (m)
CPTu-9 81.115	PIEZOCONE PENETROMETER BOREHOLE LOCATION AND GROUND SURFACE ELEVATION
BH-1 81.115	PATERSON BOREHOLE NO. & LOCATION,GROUND SURFACE ELEVATION (m) (REFERENCE: PATERSON REPORT DATED NOVEMBER 13, 2018, REPORT: PG4415-1 REVISION 1).

NOTES:

1. THE BOUNDARIES AND SOIL TYPES HAVE BEEN ESTABLISHED ONLY AT BOREHOLE LOCATIONS. BETWEEN BOREHOLES THEY ARE ASSUMED AND MAY BE SUBJECT TO CONSIDERABLE ERROR.
2. SOIL SAMPLES WILL BE RETAINED IN STORAGE FOR THREE MONTHS AND THEN DESTROYED UNLESS THE CLIENT ADVISES THAT AN EXTENDED TIME PERIOD IS REQUIRED.
3. TOPSOIL QUANTITIES SHOULD NOT BE ESTABLISHED FROM THE INFORMATION PROVIDED AT THE BOREHOLE LOCATIONS.
4. BOREHOLE ELEVATIONS SHOULD NOT BE USED TO DESIGN BUILDING(S) OR FLOOR SLABS OR PARKING LOT(S) GRADES.
5. THIS DRAWING FORMS PART OF THE REPORT PROJECT NUMBER AS REFERENCED AND SHOULD BE USED ONLY IN CONJUNCTION WITH THIS REPORT.
6. BASE PLAN INFORMATION OBTAINED FROM LAPALME RHEAULT ARCHITECTS, DATED MARCH 16, 2021.

0 15m 30m 60m
HORIZONTAL 1:1500

exp Services Inc.
100-2650 Queensview Drive
Ottawa, ON K2B 8H6
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DATE	JUNE, 2021
FILE NO	OTT-21004743-B0

GEOTECHNICAL INVESTIGATION
PROPOSED RESIDENTIAL DEVELOPMENT
2983, 3053 & 3079 NAVAN ROAD, OTTAWA, ON

BOREHOLE LOCATION PLAN

SCALE	1:1500
SKETCH NO	FIG 2

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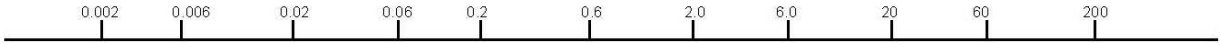
Notes On Sample Descriptions

1. All sample descriptions included in this report follow the Canadian Foundations Engineering Manual soil classification system. This system follows the standard proposed by the International Societv for Soil Mechanics and Foundation Engineering. Laboratory grain size analyses provided by **exp** Services Inc. also follow the same system. Different classification systems may be used by others; one such system is the Unified Soil Classification. Please note that, with the exception of those samples where a grain size analysis has been made, all samples are classified visually. Visual classification is not sufficiently accurate to provide exact grain sizing or precise differentiation between size classification systems.

ISSMFE SOIL CLASSIFICATION

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



EQUIVALENT GRAIN DIAMETER IN MILLIMETRES

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

UNIFIED SOIL CLASSIFICATION

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

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

Log of Borehole BH-01

Project No: OTT-21004743-B0

Project: Proposed Residential Development

Location: 2983, 3053 and 3079 Navan Road, Ottawa, Ontario

Figure No. 3

Page. 1 of 1

Date Drilled: 'April 29, 2021

Drill Type: CME-850 Track Mounted Drill Rig

Datum: Geodetic Elevation

Logged by: ML Checked by: SMP

Split Spoon Sample ⊠
Auger Sample ◧
SPT (N) Value ○
Dynamic Cone Test ——
Shelby Tube ■
Shear Strength by Vane Test +S

Combustible Vapour Reading □
Natural Moisture Content ×
Atterberg Limits —○—
Undrained Triaxial at % Strain at Failure ⊕
Shear Strength by Penetrometer Test ▲

GWL	SYMBOL	SOIL DESCRIPTION	Geodetic Elevation m	Depth	Standard Penetration Test N Value / Shear Strength kPa	Combustible Vapour Reading (ppm) / Natural Moisture Content % / Atterberg Limits (% Dry Weight)	SAMPLES	Natural Unit Wt. kN/m³
		TOPSOIL ~400 mm thick	84.97	0				
		SILTY SAND Brown, moist to wet. (compact)	84.6					
		SILTY CLAY TO CLAY Sensitive, brown, moist to wet, (very stiff)	83.6	1	10		SS1	
			83.57	2	4; 168; 150; s = 6.0		SS2	18.4
				2			SS3	17.7
		SILTY CLAY TO CLAY Sensitive, grey, wet, (firm to stiff)	81.9	3	100; s = 6.7			
				1			SS4	
				4	53; s = 7.3			
				Hammer Weight			SS5	
				5	48; s = 6.7			
				6				
				Hammer Weight			SS6	
				7	43; s = 6.0			
				Hammer Weight			SS7	
				8	48; s = 6.7			
		Borehole Terminated at 8.5 m Depth	76.5					

LOG OF BOREHOLE BH LOGS - JULY 5 UPDATED BOREHOLE LOGS.GPJ TROW OTTAWA.GDT 7/7/21

NOTES:

1. Borehole data requires interpretation by EXP before use by others
2. A 19 mm diameter standpipe installed as shown.
3. Field work supervised by an EXP representative.
4. See Notes on Sample Descriptions
5. Log to be read with EXP Report OTT-21004743-B0

WATER LEVEL RECORDS

Date	Water Level (m)	Hole Open To (m)
Completion	2.7	7.6
June 19, 2021	1.4	

CORE DRILLING RECORD

Run No.	Depth (m)	% Rec.	RQD %

Log of Borehole BH-02

Project No: OTT-21004743-B0

Project: Proposed Residential Development

Location: 2983, 3053 and 3079 Navan Road, Ottawa, Ontario

Figure No. 4

Page. 1 of 1

Date Drilled: 'April 28, 2021

Drill Type: CME-850 Track Mounted Drill Rig

Datum: Geodetic Elevation

Logged by: ML Checked by: SMP

Split Spoon Sample ⊠
Auger Sample ◧
SPT (N) Value ○
Dynamic Cone Test ——
Shelby Tube ■
Shear Strength by Vane Test +S

Combustible Vapour Reading □
Natural Moisture Content ×
Atterberg Limits |—○—|
Undrained Triaxial at % Strain at Failure ⊕
Shear Strength by Penetrometer Test ▲

GWL	SYMBOL	SOIL DESCRIPTION	Geodetic Elevation m	Depth	Standard Penetration Test N Value / Shear Strength kPa	Combustible Vapour Reading (ppm) / Natural Moisture Content % / Atterberg Limits (% Dry Weight)	SAMPLES	Natural Unit Wt. kN/m³
		GRANULAR FILL ~100 mm thick Silty sand and crushed gravel, grey, damp	81.13 81.0	0			AS1	
		FILL ~360 mm thick Gravelly sand, brown and black, moist	80.6					
▽		**SILTY SAND TO SANDY SILT** Brown, moist to wet, (loose to compact)	80.23	1	10		SS2	
				2	16		SS3	
				3	7		SS4	
		CLAY High plasticity, sensitive to extra-sensitive, grey, wet, (firm to stiff)	78.3		34 s = 9.3			
					Hammer Weight		SS5	
					29 s = 6.0			
				5	Hammer Weight		SS6	
					34 s = 7.0			
				6	Hammer Weight		SS7	
				7	48 s = 8.0			
					Hammer Weight		SS8	
		Borehole Terminated at 8.5 m Depth	72.6	8	53 s = 7.3			

LOG OF BOREHOLE BH LOGS - JULY 5 UPDATED BOREHOLE LOGS.GPJ TROW OTTAWA.GDT 7/7/21

NOTES:

1. Borehole data requires interpretation by EXP before use by others
2. A 19 mm diameter standpipe installed as shown.
3. Field work supervised by an EXP representative.
4. See Notes on Sample Descriptions
5. Log to be read with EXP Report OTT-21004743-B0

WATER LEVEL RECORDS

Date	Water Level (m)	Hole Open To (m)
Completion	1.5	7.6
June 19, 2021	0.9	

CORE DRILLING RECORD

Run No.	Depth (m)	% Rec.	RQD %

Log of Borehole BH-03

Project No: OTT-21004743-B0

Project: Proposed Residential Development

Location: 2983, 3053 and 3079 Navan Road, Ottawa, Ontario

Figure No. 5

Page. 1 of 1

Date Drilled: 'April 29, 2021

Drill Type: CME-850 Track Mounted Drill Rig

Datum: Geodetic Elevation

Logged by: ML Checked by: SMP

Split Spoon Sample ☒
Auger Sample ◧
SPT (N) Value ○
Dynamic Cone Test ——
Shelby Tube ■
Shear Strength by Vane Test +S

Combustible Vapour Reading □
Natural Moisture Content ×
Atterberg Limits |—○—|
Undrained Triaxial at % Strain at Failure ⊕
Shear Strength by Penetrometer Test ▲

GWL	SYMBOL	SOIL DESCRIPTION	Geodetic Elevation m	Depth	Standard Penetration Test N Value / Shear Strength kPa	Combustible Vapour Reading (ppm) / Natural Moisture Content % / Atterberg Limits (% Dry Weight)	SAMPLES	Natural Unit Wt. kN/m³
		TOPSOIL ~75 mm thick	84.73	0				
		SILTY SAND Brown, moist to wet. (loose)	84.6					
			84.13	1	8		SS1	
		SILTY CLAY TO CLAY Sensitive, brown, moist to wet, (very stiff)	83.4	2	5; 144; 130; s = 6.5		SS2	18.1
		SILTY CLAY Low plasticity, medium sensitive to sensitive, grey, wet, (firm to stiff)	82.2	3	1; 53; s = 7.3; Hammer Weight		SS3	
					48; s = 6.7; Hammer Weight		SS4	
				5	43; s = 6.0; Hammer Weight		SS5	
				6	41; s = 5.7		SS6	
				7	Hammer Weight		SS7	
		Borehole Terminated at 7.0 m Depth	77.7		43; s = 6.0			

LOG OF BOREHOLE BH LOGS - JULY 5 UPDATED BOREHOLE LOGS.GPJ TROW OTTAWA.GDT 7/7/21

NOTES:
1. Borehole data requires interpretation by EXP before use by others
2. A 19 mm diameter standpipe installed as shown.
3. Field work supervised by an EXP representative.
4. See Notes on Sample Descriptions
5. Log to be read with EXP Report OTT-21004743-B0

WATER LEVEL RECORDS		
Date	Water Level (m)	Hole Open To (m)
Completion	3.0	6.1
June 19, 2021	0.6	

CORE DRILLING RECORD			
Run No.	Depth (m)	% Rec.	RQD %

Log of Borehole BH-04

Project No: OTT-21004743-B0

Project: Proposed Residential Development

Location: 2983, 3053 and 3079 Navan Road, Ottawa, Ontario

Figure No. 6

Page. 1 of 1

Date Drilled: 'April 30, 2021

Drill Type: CME-850 Track Mounted Drill Rig

Datum: Geodetic Elevation

Logged by: ML Checked by: SMP

Split Spoon Sample ⊠
Auger Sample ◧
SPT (N) Value ○
Dynamic Cone Test ——
Shelby Tube ■
Shear Strength by Vane Test +S

Combustible Vapour Reading □
Natural Moisture Content ×
Atterberg Limits |—○—|
Undrained Triaxial at % Strain at Failure ⊕
Shear Strength by Penetrometer Test ▲

GWL	SYMBOL	SOIL DESCRIPTION	Geodetic Elevation m	Depth	Standard Penetration Test N Value / Shear Strength kPa	Combustible Vapour Reading (ppm) / Natural Moisture Content % / Atterberg Limits (% Dry Weight)	SAMPLES	Natural Unit Wt. kN/m³
		TOPSOIL ~125 mm thick	85.72	0				
		SILTY SAND Brown, moist to wet, (loose)	85.6					
		SILTY CLAY TO CLAY Sensitive, brown, moist to wet, (very stiff)	84.7	1	8 ○ 168 ▲	×	SS1	
			84.02	2	7 ○ 132 ▲ 125 +S s = 6.3	×	SS2	19.1
			83.0	3	2 ○ 48 +S s = 8.0 Hammer Weight	×	SS3	
		CLAY High plasticity, sensitive, grey, wet, (firm)					SS4	
					29 +S s = 6.0 Hammer Weight	×	SS5	
				5	29 +S s = 8.0 Hammer Weight	|—×—|	SS6	
				6	34 +S s = 7.0			
					Hammer Weight	×	SS7	
				7	34 +S s = 5.6			
				8	Hammer Weight		TW8	
			77.2		38 +S s = 6.4			
		Borehole Terminated at 8.5 m Depth						

LOG OF BOREHOLE BH LOGS - JULY 5 UPDATED BOREHOLE LOGS.GPJ TROW OTTAWA.GDT 7/7/21

NOTES:

1. Borehole data requires interpretation by EXP before use by others
2. A 19 mm diameter standpipe installed as shown.
3. Field work supervised by an EXP representative.
4. See Notes on Sample Descriptions
5. Log to be read with EXP Report OTT-21004743-B0

WATER LEVEL RECORDS

Date	Water Level (m)	Hole Open To (m)
Completion	2.4	7.6
June 19, 2021	1.7	

CORE DRILLING RECORD

Run No.	Depth (m)	% Rec.	RQD %

Log of Borehole BH-05

Project No: OTT-21004743-B0

Project: Proposed Residential Development

Location: 2983, 3053 and 3079 Navan Road, Ottawa, Ontario

Figure No. 7

Page. 1 of 1

Date Drilled: 'April 28, 2021

Drill Type: CME-850 Track Mounted Drill Rig

Datum: Geodetic Elevation

Logged by: ML Checked by: SMP

Split Spoon Sample ⊠ | Auger Sample ◧ | SPT (N) Value ○ | Dynamic Cone Test —— | Shelby Tube ■ | Shear Strength by Vane Test + S

Combustible Vapour Reading □ | Natural Moisture Content × | Atterberg Limits |—○—| | Undrained Triaxial at % Strain at Failure ⊕ | Shear Strength by Penetrometer Test ▲

GWL	SYMBOL	SOIL DESCRIPTION	Geodetic Elevation m	Depth	Standard Penetration Test N Value / Shear Strength kPa	Combustible Vapour Reading (ppm) / Natural Moisture Content % / Atterberg Limits (% Dry Weight)	SAMPLES	Natural Unit Wt. kN/m³
		TOPSOIL ~400 mm thick	81.46	0				
		SILTY CLAY TO CLAY Extra-sensitive, brown, moist to wet, (stiff to very stiff)	81.1				AS1	
			80.46	1	2; 120; 67; s = 9.3		SS2	
					1		SS3	
			79.6	2	48; s = 6.7			
		SILTY CLAY TO CLAY Sensitive, grey, wet, (soft ot firm)			Hammer Weight		SS4	
				3	29; s = 8.0			
					Hammer Weight		SS5	
					24; s = 6.7			
					Hammer Weight		SS6	
					24; s = 6.7			
				5				
					Hammer Weight		SS7	
				6	29; s = 6.0			
				7	Hammer Weight		SS8	
			73.7		34; s = 7.0			
		Borehole Terminated at 7.8 m Depth						

LOG OF BOREHOLE BH LOGS - JULY 5 UPDATED BOREHOLE LOGS.GPJ TROW OTTAWA.GDT 7/7/21

NOTES:

1. Borehole data requires interpretation by EXP before use by others
2. A 19 mm diameter standpipe installed as shown.
3. Field work supervised by an EXP representative.
4. See Notes on Sample Descriptions
5. Log to be read with EXP Report OTT-21004743-B0

WATER LEVEL RECORDS		
Date	Water Level (m)	Hole Open To (m)
Completion	0.0	6.7
June 19, 2021	1.0	

CORE DRILLING RECORD			
Run No.	Depth (m)	% Rec.	RQD %

Log of Borehole BH-06

Project No: OTT-21004743-B0

Project: Proposed Residential Development

Location: 2983, 3053 and 3079 Navan Road, Ottawa, Ontario

Figure No. 8

Page. 1 of 3

Date Drilled: 'April 28, 2021

Drill Type: CME-850 Track Mounted Drill Rig

Datum: Geodetic Elevation

Logged by: ML Checked by: SMP

Split Spoon Sample ☒
Auger Sample ◧
SPT (N) Value ○
Dynamic Cone Test ——
Shelby Tube ■
Shear Strength by Vane Test +S

Combustible Vapour Reading □
Natural Moisture Content ×
Atterberg Limits |—○—|
Undrained Triaxial at % Strain at Failure ⊕
Shear Strength by Penetrometer Test ▲

GWL	SYMBOL	SOIL DESCRIPTION	Geodetic Elevation m	Depth	Standard Penetration Test N Value / Shear Strength kPa	Combustible Vapour Reading (ppm) / Natural Moisture Content % / Atterberg Limits (% Dry Weight)	SAMPLES	Natural Unit Wt. kN/m³
		FILL ~300 mm thick Gravelly sand, brown and black, moist	81.19 80.9	0				
		SILTY CLAY TO CLAY Brown, moist to wet, (very stiff)		1	8 ○ 144 ▲	×	SS1	18.0
			79.49	2	7 ○ 132 ▲	×	SS2	17.1
		SILTY CLAY TO CLAY Sensitive, grey, wet, (firm to stiff)	79.0	3	1 ○	×	SS3	
					34 +S s = 7.0			
					Hammer Weight ○	86 ×	SS4	
				4	34 +S s = 7.0			
				5	Hammer Weight ○	×	SS5	
					34 +S s = 7.0			
				6	Hammer Weight ○	×	SS6	
				7	38 +S s = 8.0			
				8	Hammer Weight ○	81 ×	SS7	
					53 +S s = 7.3			
		Medium plasticity from 9.1 m to 9.7 m depths		9	Hammer Weight ○	|—○—| ×	SS8	
				10	48 +S s = 6.7			

Continued Next Page

NOTES:
1. Borehole data requires interpretation by EXP before use by others
2. A 19 mm diameter standpipe installed as shown.
3. Field work supervised by an EXP representative.
4. See Notes on Sample Descriptions
5. Log to be read with EXP Report OTT-21004743-B0

WATER LEVEL RECORDS

Date	Water Level (m)	Hole Open To (m)
Completion	1.8	7.6
June 19, 2021	1.7	

CORE DRILLING RECORD

Run No.	Depth (m)	% Rec.	RQD %

LOG OF BOREHOLE BH LOGS - JULY 5 UPDATED BOREHOLE LOGS.GPJ TROW OTTAWA.GDT 7/7/21

Log of Borehole BH-06

Project No: OTT-21004743-B0

Project: Proposed Residential Development

Figure No. 8

GWL	SYMBOL	SOIL DESCRIPTION	Geodetic Elevation m	Depth	Standard Penetration Test N Value / Shear Strength kPa	Combustible Vapour Reading (ppm) / Natural Moisture Content % / Atterberg Limits (% Dry Weight)	SAMPLES	Natural Unit Wt. kN/m³
		SILTY CLAY TO CLAY Sensitive, grey, wet, (firm to stiff) *(continued)*	71.19	10	Shear Strength 20 40 60 80 kPa; 50 100 150 200	250 500 750; 20 40 60		
				11	Hammer Weight		SS9	
					55 s = 7.7			
				12	Hammer Weight		TW10 15.0	
			68.1	13	62 s = 6.5			
		Dynamic cone penetration test (DCPT) conducted from 13.1 m to 30.5 m termination depth.		14				
				15				
				16				
				17				
				18				
				19				
				20				
				21				
				22				

Continued Next Page

NOTES:

1. Borehole data requires interpretation by EXP before use by others
2. A 19 mm diameter standpipe installed as shown.
3. Field work supervised by an EXP representative.
4. See Notes on Sample Descriptions
5. Log to be read with EXP Report OTT-21004743-B0

WATER LEVEL RECORDS

Date	Water Level (m)	Hole Open To (m)
Completion	1.8	7.6
June 19, 2021	1.7	

CORE DRILLING RECORD

Run No.	Depth (m)	% Rec.	RQD %

Log of Borehole BH-06

Project No: OTT-21004743-B0

Project: Proposed Residential Development

Figure No. 8

Page. 3 of 3

GWL	SYMBOL	SOIL DESCRIPTION	Geodetic Elevation m	Depth	Standard Penetration Test N Value / Shear Strength kPa	Combustible Vapour Reading (ppm) / Natural Moisture Content % / Atterberg Limits (% Dry Weight)	SAMPLES	Natural Unit Wt. kN/m³
		Dynamic cone penetration test (DCPT) conducted from 13.1 m to 30.5 m termination depth. *(continued)*	59.19	22	20 40 60 80 / 50 100 150 200	250 500 750 / 20 40 60		
				23				
				24				
				25				
				26				
				27				
				28				
				29				
				30				
		DCPT Terminated at 30.5 m Depth	50.7					

LOG OF BOREHOLE BH LOGS - JULY 5 UPDATED BOREHOLE LOGS.GPJ TROW OTTAWA.GDT 7/7/21

NOTES:

1. Borehole data requires interpretation by EXP before use by others
2. A 19 mm diameter standpipe installed as shown.
3. Field work supervised by an EXP representative.
4. See Notes on Sample Descriptions
5. Log to be read with EXP Report OTT-21004743-B0

WATER LEVEL RECORDS		
Date	Water Level (m)	Hole Open To (m)
Completion	1.8	7.6
June 19, 2021	1.7	

CORE DRILLING RECORD			
Run No.	Depth (m)	% Rec.	RQD %

Log of Borehole BH-07

Project No: OTT-21004743-B0

Project: Proposed Residential Development

Location: 2983, 3053 and 3079 Navan Road, Ottawa, Ontario

Figure No. 9

Page. 1 of 1

Date Drilled: 'April 30, 2021

Drill Type: CME-850 Track Mounted Drill Rig

Datum: Geodetic Elevation

Logged by: ML Checked by: SMP

Split Spoon Sample ⊠
Auger Sample ◧
SPT (N) Value ○
Dynamic Cone Test ——
Shelby Tube ■
Shear Strength by Vane Test +S

Combustible Vapour Reading □
Natural Moisture Content ×
Atterberg Limits |—○
Undrained Triaxial at % Strain at Failure ⊕
Shear Strength by Penetrometer Test ▲

GWL	SYMBOL	SOIL DESCRIPTION	Geodetic Elevation m	Depth	Standard Penetration Test N Value / Shear Strength kPa	Combustible Vapour Reading (ppm) / Natural Moisture Content % / Atterberg Limits (% Dry Weight)	SAMPLES	Natural Unit Wt. kN/m³
		TOPSOIL ~100 mm thick	84.12	0				
		SILTY SAND Brown, moist to wet, (loose)	84.0					
				1	7		SS1	
			82.7		82.72			
		SILTY CLAY TO CLAY Sensitive, brown, moist to wet, (very stiff)		2	6 156 115 s = 7.7		SS2 SS3	18.2
			81.3		2			
		SILTY CLAY TO CLAY Sensitive to extra-sensitive, grey, wet, (firm)		3	45 s = 6.0 Hammer Weight		SS4	
					34 s = 9.3 Hammer Weight		SS5	
					31 s = 8.7 Hammer Weight		TW6	15.3
				5	29 s = 6.0			
				6	Hammer Weight		SS7	
			77.1	7	34 s = 7.0			
		Borehole Terminated at 7.0 m Depth						

LOG OF BOREHOLE BH LOGS - JULY 5 UPDATED BOREHOLE LOGS.GPJ TROW OTTAWA.GDT 7/7/21

NOTES:

1. Borehole data requires interpretation by EXP before use by others
2. A 19 mm diameter standpipe installed as shown.
3. Field work supervised by an EXP representative.
4. See Notes on Sample Descriptions
5. Log to be read with EXP Report OTT-21004743-B0

WATER LEVEL RECORDS		
Date	Water Level (m)	Hole Open To (m)
Completion	2.1	6.1
June 19, 2021	1.4	

CORE DRILLING RECORD			
Run No.	Depth (m)	% Rec.	RQD %

Log of Borehole BH-08

Project No: OTT-21004743-B0

Project: Proposed Residential Development

Location: 2983, 3053 and 3079 Navan Road, Ottawa, Ontario

Figure No. 10

Page. 1 of 1

Date Drilled: 'April 29, 2021

Drill Type: CME-850 Track Mounted Drill Rig

Datum: Geodetic Elevation

Logged by: ML Checked by: SMP

Split Spoon Sample ⊠
Auger Sample ◧
SPT (N) Value ○
Dynamic Cone Test ——
Shelby Tube ■
Shear Strength by Vane Test +S

Combustible Vapour Reading □
Natural Moisture Content ×
Atterberg Limits |—○
Undrained Triaxial at % Strain at Failure ⊕
Shear Strength by Penetrometer Test ▲

GWL	SYMBOL	SOIL DESCRIPTION	Geodetic Elevation m	Depth	Standard Penetration Test N Value / Shear Strength kPa	Combustible Vapour Reading (ppm) / Natural Moisture Content % / Atterberg Limits (% Dry Weight)	SAMPLES	Natural Unit Wt. kN/m³
		TOPSOIL ~250 mm thick	82.28	0				
		SILTY CLAY TO CLAY Sensitive, brown, moist to wet, (very stiff)	82.0					
				1	7 ○ ; 180 ▲		SS1	
			80.88					
				2	4 ○ ; 132 ▲ ; 120 + s = 8.0	×	SS2	
		SILTY CLAY TO CLAY Sensitive to extra-sensitive, grey, wet, (firm)	80.0					
				3	1 ○ ; 34 + s = 9.3 ; Hammer Weight ○	×	SS3	
							TW4	15.1
				4	31 + s = 8.7			
				5	Hammer Weight ○	×	SS5	
					29 + s = 8.0			
				6	Hammer Weight ○	×	SS6	
			75.3	7	31 + s = 6.5			
		Borehole Terminated at 7.0 m Depth						

LOG OF BOREHOLE BH LOGS - JULY 5 UPDATED BOREHOLE LOGS.GPJ TROW OTTAWA.GDT 7/7/21

NOTES:

1. Borehole data requires interpretation by EXP before use by others
2. A 19 mm diameter standpipe installed as shown.
3. Field work supervised by an EXP representative.
4. See Notes on Sample Descriptions
5. Log to be read with EXP Report OTT-21004743-B0

WATER LEVEL RECORDS

Date	Water Level (m)	Hole Open To (m)
Completion	1.8	6.1
June 19, 2021	1.4	

CORE DRILLING RECORD

Run No.	Depth (m)	% Rec.	RQD %

Log of Borehole BH-09

Project No: OTT-21004743-B0

Project: Proposed Residential Development

Location: 2983, 3053 and 3079 Navan Road, Ottawa, Ontario

Figure No. 11

Page. 1 of 1

Date Drilled: 'April 30, 2021

Drill Type: CME-850 Track Mounted Drill Rig

Datum: Geodetic Elevation

Logged by: ML Checked by: SMP

Split Spoon Sample ☒
Auger Sample ◧
SPT (N) Value ○
Dynamic Cone Test ——
Shelby Tube ■
Shear Strength by Vane Test +S

Combustible Vapour Reading □
Natural Moisture Content ×
Atterberg Limits |—○
Undrained Triaxial at % Strain at Failure ⊕
Shear Strength by Penetrometer Test ▲

GWL	SYMBOL	SOIL DESCRIPTION	Geodetic Elevation m	Depth	Standard Penetration Test N Value / Shear Strength kPa	Combustible Vapour Reading (ppm) / Natural Moisture Content % / Atterberg Limits (% Dry Weight)	SAMPLES	Natural Unit Wt. kN/m³
		TOPSOIL ~300mm thick	84.7	0	20 40 60 80 / 50 100 150 200	250 500 750 / 20 40 60		
			84.4					
		SILTY CLAY TO CLAY Brown, moist, (very stiff)		1				
				2	120 s = 8.0			
			82.1					
		SILTY CLAY TO CLAY Grey, wet, (firm)		3	29 s = 6.0			
				4	29 s = 6.0			
				5	31 s = 6.5			
					34 s = 7.0			
			78.5	6	34 s = 7.0			
		Borehole Terminated at 6.2 m Depth						

LOG OF BOREHOLE BH LOGS - JULY 5 UPDATED BOREHOLE LOGS.GPJ TROW OTTAWA.GDT 7/7/21

NOTES:

1. Borehole data requires interpretation by EXP before use by others
2. A 19 mm diameter standpipe installed as shown.
3. Field work supervised by an EXP representative.
4. See Notes on Sample Descriptions
5. Log to be read with EXP Report OTT-21004743-B0

WATER LEVEL RECORDS		
Date	Water Level (m)	Hole Open To (m)
Completion	1.8	6.1
June 19, 2021	Damaged	

CORE DRILLING RECORD			
Run No.	Depth (m)	% Rec.	RQD %

Log of Borehole BH-10

Project No: OTT-21004743-B0

Project: Proposed Residential Development

Location: 2983, 3053 and 3079 Navan Road, Ottawa, Ontario

Figure No. 12

Page. 1 of 1

Date Drilled: 'April 29, 2021

Drill Type: CME-850 Track Mounted Drill Rig

Datum: Geodetic Elevation

Logged by: ML Checked by: SMP

Split Spoon Sample ⊠
Auger Sample ◧
SPT (N) Value ○
Dynamic Cone Test ——
Shelby Tube ■
Shear Strength by Vane Test +S

Combustible Vapour Reading □
Natural Moisture Content ×
Atterberg Limits I—○
Undrained Triaxial at % Strain at Failure ⊕
Shear Strength by Penetrometer Test ▲

GWL	SYMBOL	SOIL DESCRIPTION	Geodetic Elevation m	Depth	Standard Penetration Test N Value / Shear Strength kPa	Combustible Vapour Reading (ppm) / Natural Moisture Content % / Atterberg Limits (% Dry Weight)	SAMPLES	Natural Unit Wt. kN/m³
		TOPSOIL ~200 mm thick	84.72	0				
		SILTY SAND ~ 300 mm thick Brown, moist to wet	84.5					
		SILTY CLAY TO CLAY Brown, moist to wet, (very stiff)	84.2	1	2 ○; 120 ▲	×	SS1	
			83.42					
		SILTY CLAY TO CLAY Sensitive, grey, moist to wet, (firm to stiff) with sand seams from 1.5 m to 2.9 m depths	83.2	2	5 ○; 53 +S s = 5.5	×	SS2	
				3	1 ○; 34 +S s = 7.0	×	SS3	
		High plasticity from 3.2 m to 3.8 m depths		4	Hammer Weight ○; 29 +S s = 6.0	I—○ ×	SS4	
				5	Hammer Weight ○; 34 +S s = 5.6	×	SS5	
				6	Hammer Weight ○		TW6	
				7	41 +S s = 6.8			
		Borehole Terminated at 7.0 m Depth	77.7					

LOG OF BOREHOLE BH LOGS - JULY 5 UPDATED BOREHOLE LOGS.GPJ TROW OTTAWA.GDT 7/7/21

NOTES:

1. Borehole data requires interpretation by EXP before use by others
2. A 19 mm diameter standpipe installed as shown.
3. Field work supervised by an EXP representative.
4. See Notes on Sample Descriptions
5. Log to be read with EXP Report OTT-21004743-B0

WATER LEVEL RECORDS

Date	Water Level (m)	Hole Open To (m)
Completion	1.8	6.1
June 19, 2021	1.3	

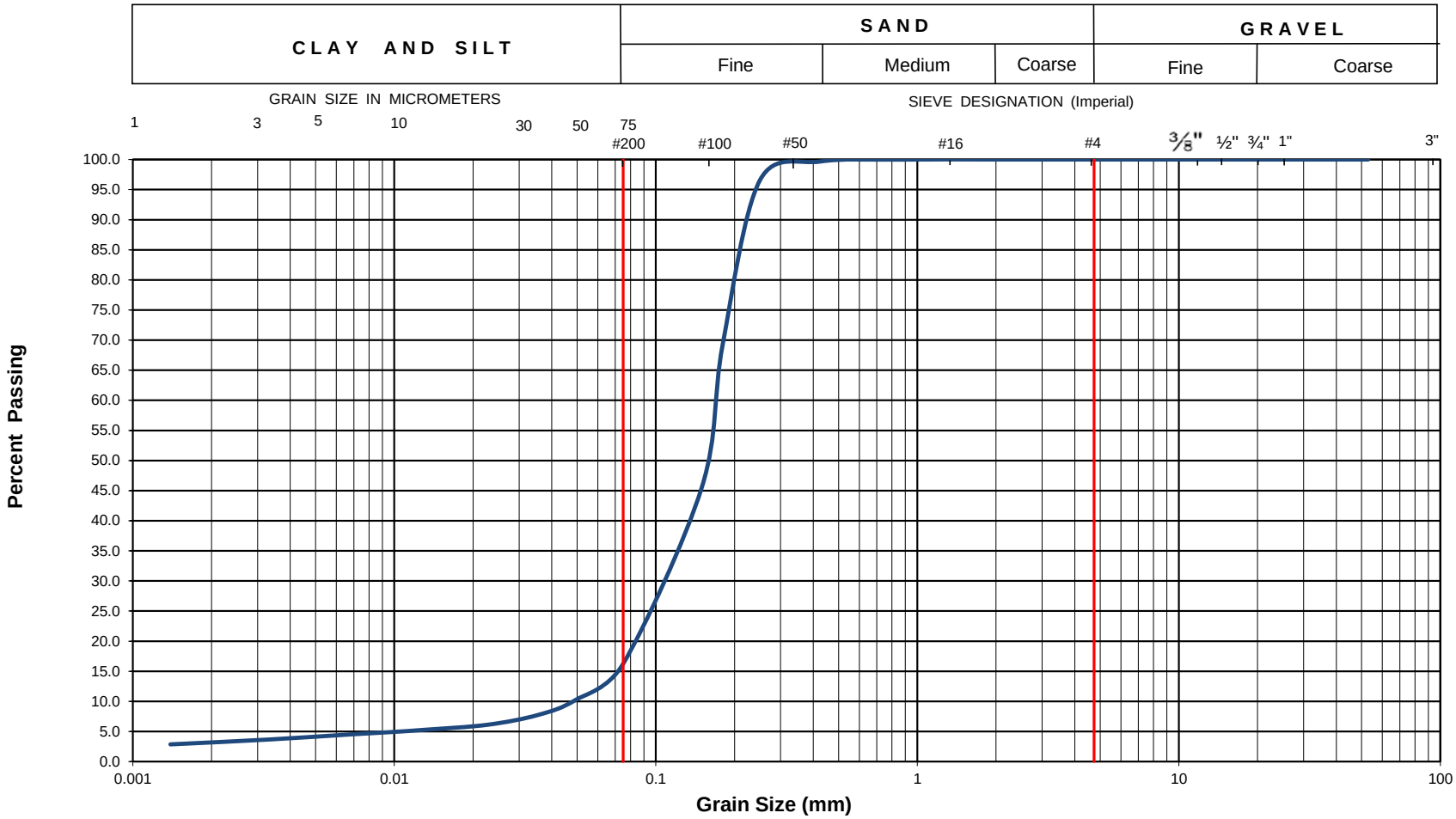
CORE DRILLING RECORD

Run No.	Depth (m)	% Rec.	RQD %

EXP Services Inc.
100-2650 Queensview Drive
Ottawa, ON K2B 8H6

Grain-Size Distribution Curve
Method of Test For Particle Size Analysis of Soil
ASTM C-136/ASTM D422

Unified Soil Classification System

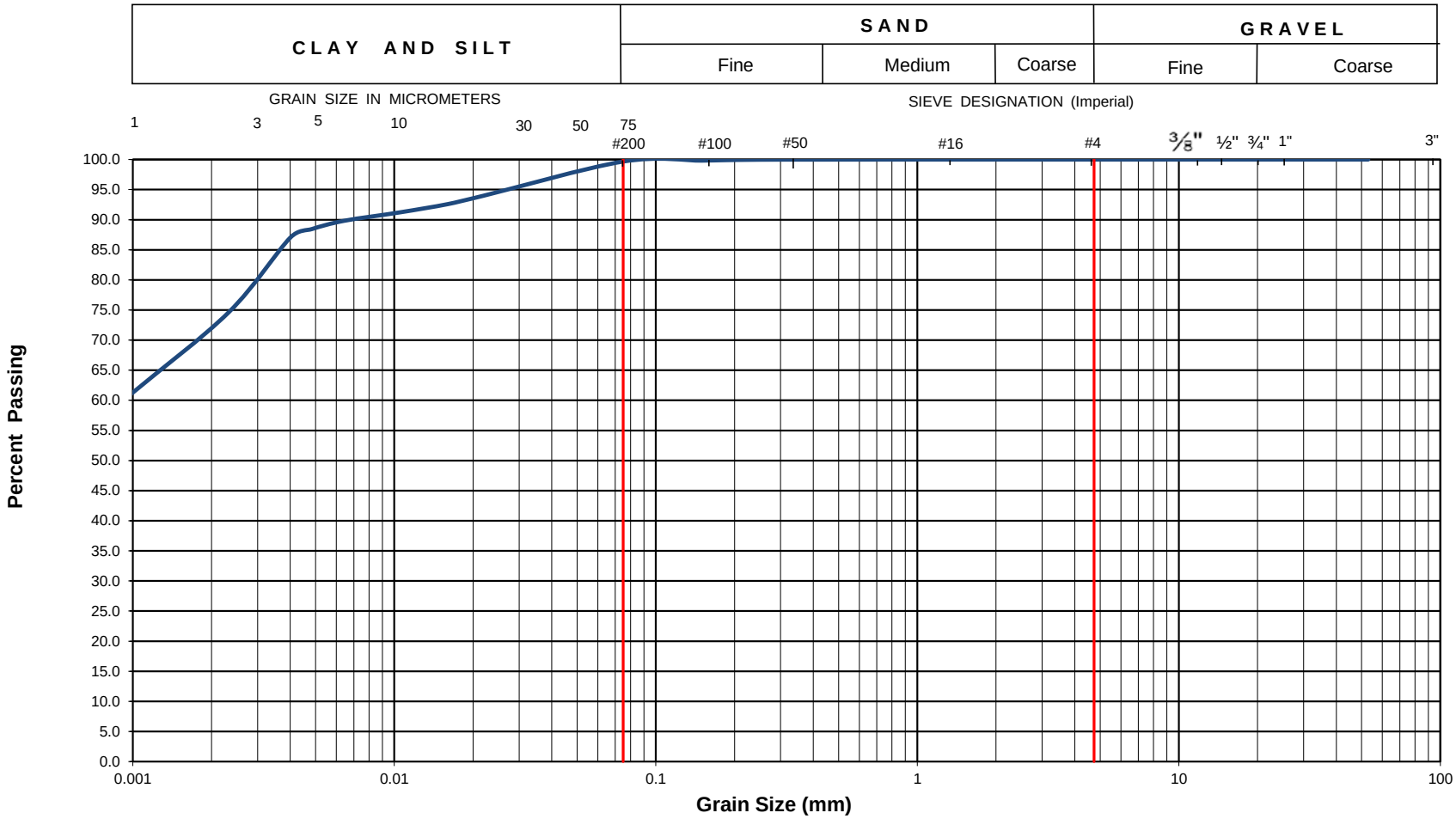


EXP Project No.:	**OTT-21004743-B0**	**Project Name :**	**Proposed Residential Development**						
Client :	**12714001 Canada Inc.**	**Project Location :**	**2983, 3053 & 3079 Navan Road, Ottawa, ON**						
Date Sampled :	**April 29, 2021**	**Borehole No:**	**BH 1**	**Sample No.:**	**SS1**	**Depth (m) :**	**0.8-1.4**		
Sample Description :		**% Silt and Clay**	**16**	**% Sand**	**84**	**% Gravel**	**0**	**Figure :**	**13**
Sample Description :		**Silty Sand (SM)**							

EXP Services Inc.
100-2650 Queensview Drive
Ottawa, ON K2B 8H6

Grain-Size Distribution Curve
Method of Test For Particle Size Analysis of Soil
ASTM C-136/ASTM D422

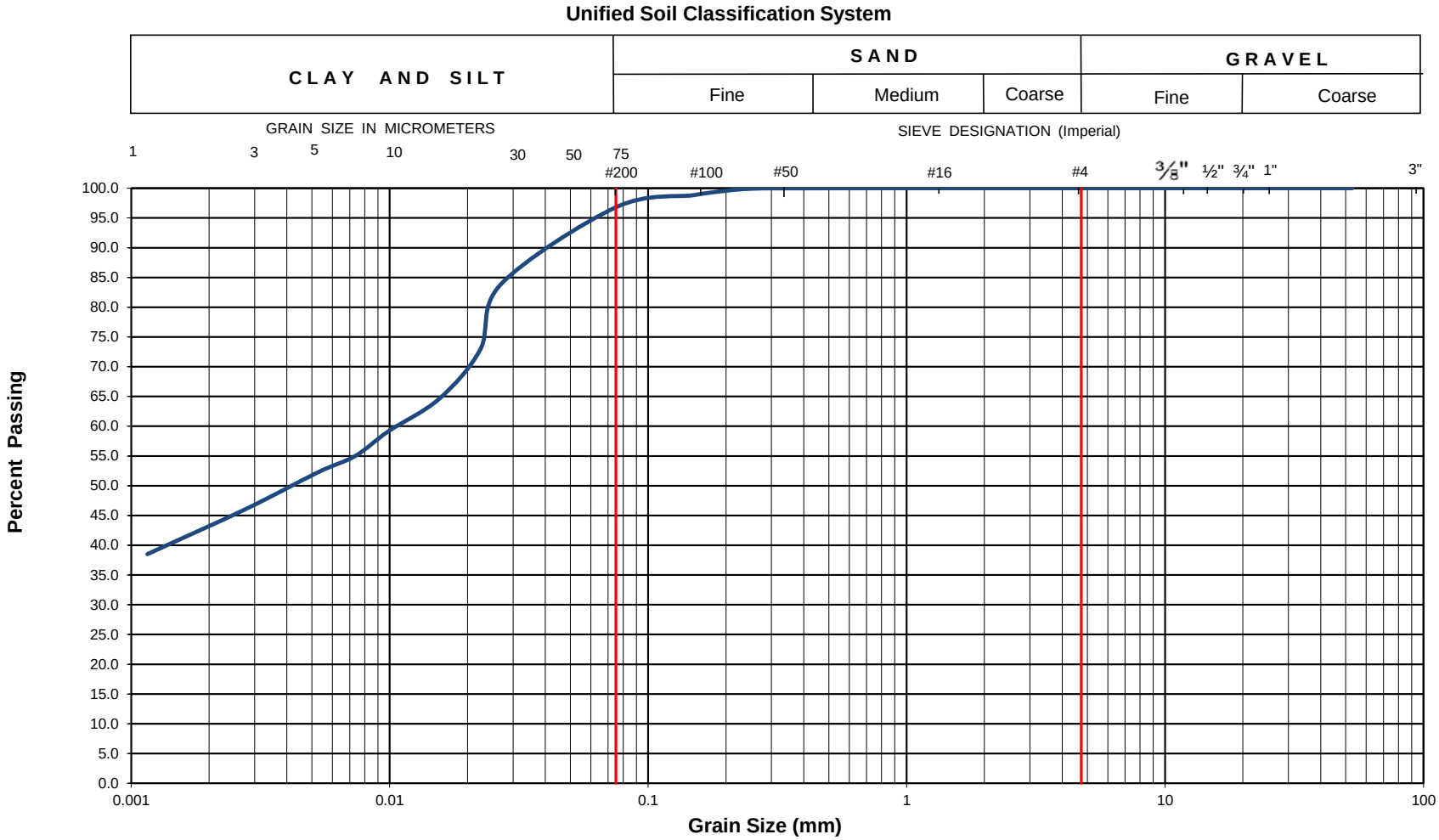
Unified Soil Classification System



EXP Project No.:	**OTT-21004743-B0**	**Project Name :**	**Proposed Residential Development**						
Client :	**12714001 Canada Inc.**	**Project Location :**	**2983, 3053 & 3079 Navan Road, Ottawa, ON**						
Date Sampled :	**April 28, 2021**	**Borehole No:**	**BH 2**	**Sample No.:**	**SS7**	**Depth (m) :**	**6.1-6.7**		
Sample Description :		**% Silt and Clay**	**100**	**% Sand**	**0**	**% Gravel**	**0**	**Figure :**	**14**
Sample Description :		**Grey Clay of High Plasticity (CH)**							

EXP Services Inc.
100-2650 Queensview Drive
Ottawa, ON K2B 8H6

Grain-Size Distribution Curve
Method of Test For Particle Size Analysis of Soil
ASTM C-136/ASTM D422

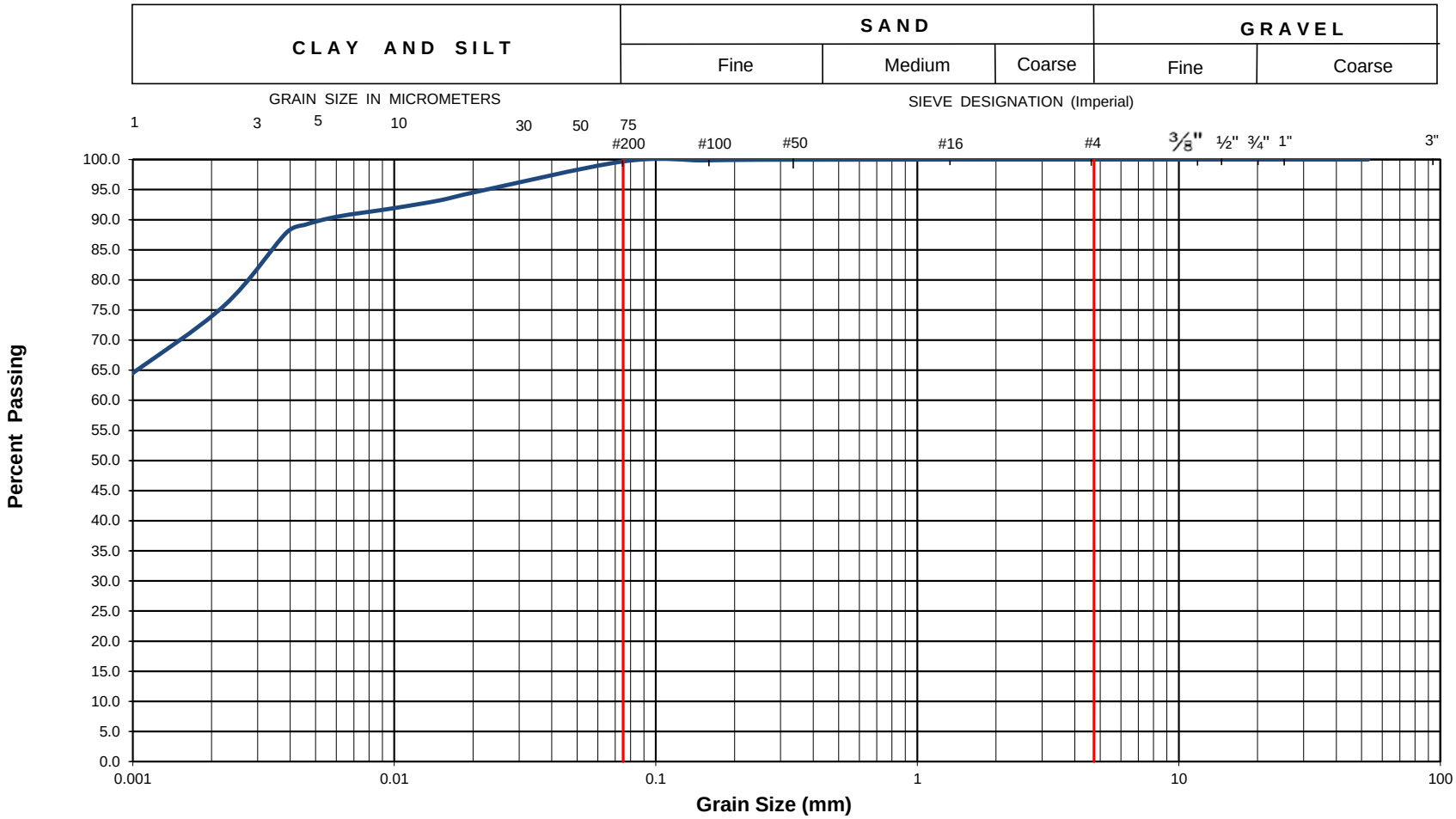


EXP Project No.:	**OTT-21004743-B0**	**Project Name :**	**Proposed Residential Development**						
Client :	**12714001 Canada Inc.**	**Project Location :**	**2983, 3053 & 3079 Navan Road, Ottawa, ON**						
Date Sampled :	**April 29, 2021**	**Borehole No:**	**BH 3**	**Sample No.:**	**SS3**	**Depth (m) :**	**2.3-2.9**		
Sample Description :		**% Silt and Clay**	**97**	**% Sand**	**3**	**% Gravel**	**0**	**Figure :**	**15**
Sample Description :		**Grey Silty Clay of Low Plasticity (CL)**							

EXP Services Inc.
100-2650 Queensview Drive
Ottawa, ON K2B 8H6

Grain-Size Distribution Curve
Method of Test For Particle Size Analysis of Soil
ASTM C-136/ASTM D422

Unified Soil Classification System



EXP Project No.:	**OTT-21004743-B0**	**Project Name :**	**Proposed Residential Development**						
Client :	**12714001 Canada Inc.**	**Project Location :**	**2983, 3053 & 3079 Navan Road, Ottawa, ON**						
Date Sampled :	**April 28, 2021**	**Borehole No:**	**BH 4**	**Sample No.:**	**SS6**	**Depth (m) :**	**4.7-5.3**		
Sample Description :		**% Silt and Clay**	**100**	**% Sand**	**0**	**% Gravel**	**0**	**Figure :**	**16**
Sample Description :		**Grey Clay of High Plasticity (CH)**							

EXP Services Inc.
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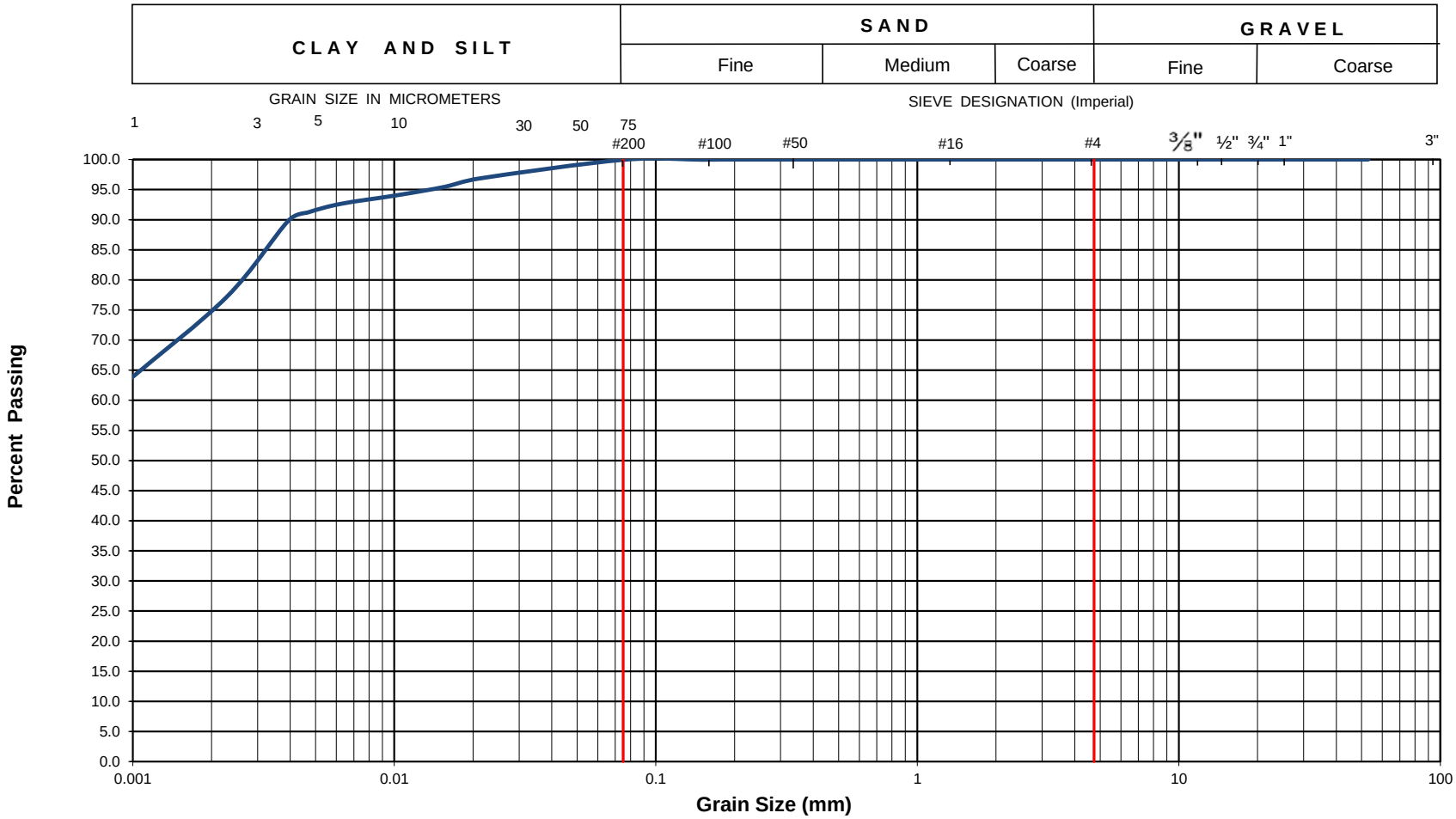
Ottawa, ON K2B 8H6

Grain-Size Distribution Curve
Method of Test For Particle Size Analysis of Soil
ASTM C-136/ASTM D422

Unified Soil Classification System



EXP Project No.:	**OTT-21004743-B0**	**Project Name :**	**Proposed Residential Development**						
Client :	**12714001 Canada Inc.**	**Project Location :**	**2983, 3053 & 3079 Navan Road, Ottawa, ON**						
Date Sampled :	**April 28, 2021**	**Borehole No:**	**BH 6**	**Sample No.:**	**SS8**	**Depth (m) :**	**9.1-9.7**		
Sample Description :		**% Silt and Clay**	**100**	**% Sand**	**0**	**% Gravel**	**0**	**Figure :**	**17**
Sample Description :		**Grey Silty Clay of Medium Plasticity (CL)**							

EXP Services Inc.
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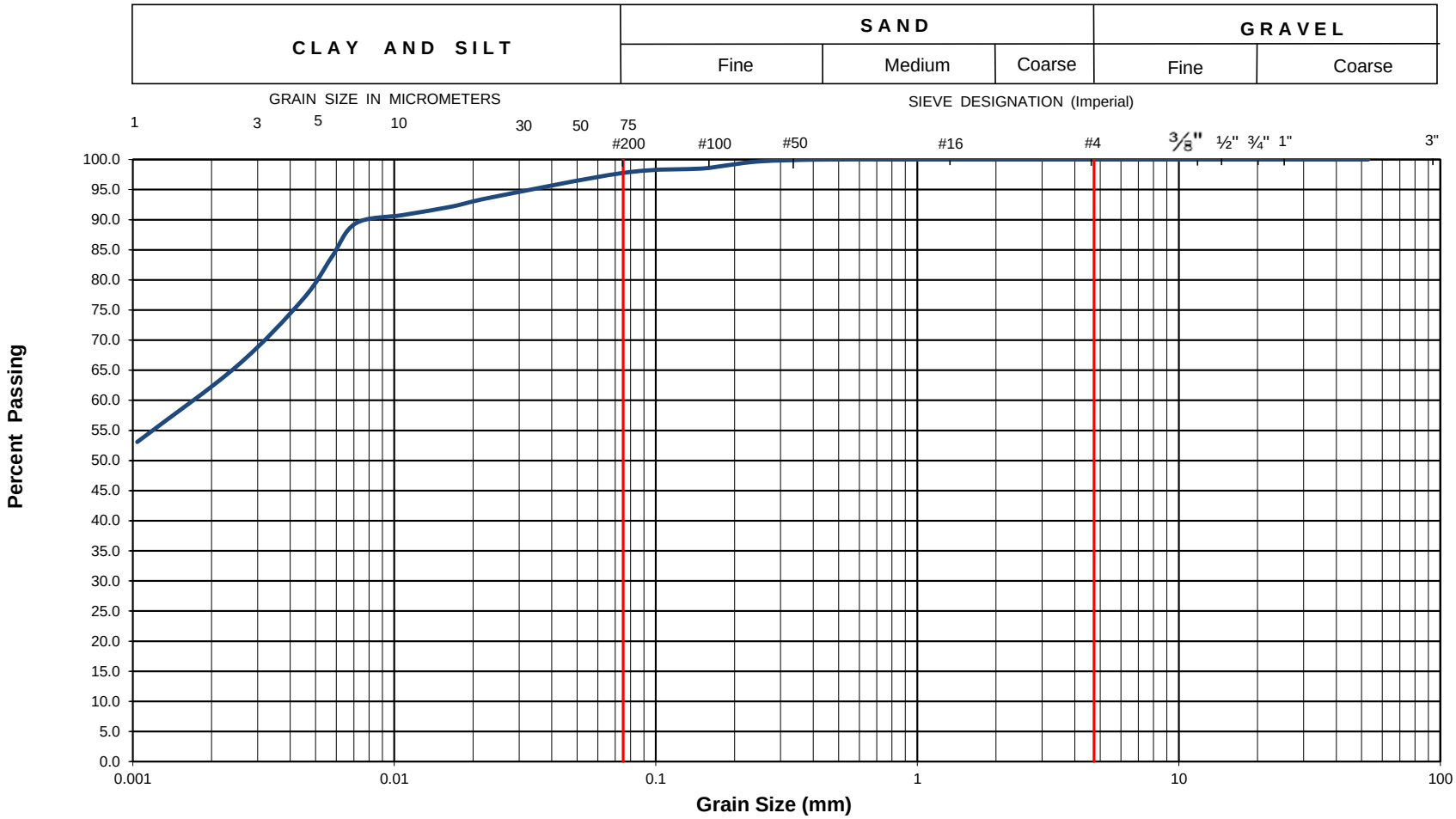
Ottawa, ON K2B 8H6

Grain-Size Distribution Curve
Method of Test For Particle Size Analysis of Soil
ASTM C-136/ASTM D422

Unified Soil Classification System



EXP Project No.:	**OTT-21004743-B0**	**Project Name :**	**Proposed Residential Development**						
Client :	**12714001 Canada Inc.**	**Project Location :**	**2983, 3053 & 3079 Navan Road, Ottawa, ON**						
Date Sampled :	**April 29, 2021**	**Borehole No:**	**BH 10**	**Sample No.:**	**SS4**	**Depth (m) :**	**3.2-3.8**		
Sample Description :		**% Silt and Clay**	**98**	**% Sand**	**2**	**% Gravel**	**0**	**Figure :**	**18**
Sample Description :		**Grey Clay of High Plasticity (CH)**							

Appendix A:
2018 Borehole Logs - Paterson Group Inc.

patersongroup

Consulting Engineers

154 Colonnade Road South, Ottawa, Ontario K2E 7J5

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Prop. Commercial Development - Navan Road
Ottawa, Ontario

DATUM Ground surface elevations provided by Stantec Geomatics Limited.

FILE NO. PG4415

REMARKS

HOLE NO. BH 1

BORINGS BY CME 18 Power Auger **DATE** 22 May 2018

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	85.34
TOPSOIL 0.20		AU	1				
Compact, brown **SILTY SAND,** trace gravel, organics 1.45		SS	2	83	15	1	84.34
		SS	3	96	5	2	83.34
Very stiff to stiff, brown **SILTY CLAY**						3	82.34
- stiff to firm and grey by 3.7m depth		SS	4	100	W	4	81.34
						5	80.34
						6	79.34
6.40 End of Borehole							

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

20 40 60 80

120

Piezometer Construction

20 40 60 80 100

Shear Strength (kPa)

▲ Undisturbed △ Remoulded

patersongroup

Consulting Engineers

154 Colonnade Road South, Ottawa, Ontario K2E 7J5

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Prop. Commercial Development - Navan Road
Ottawa, Ontario

DATUM Ground surface elevations provided by Stantec Geomatics Limited.

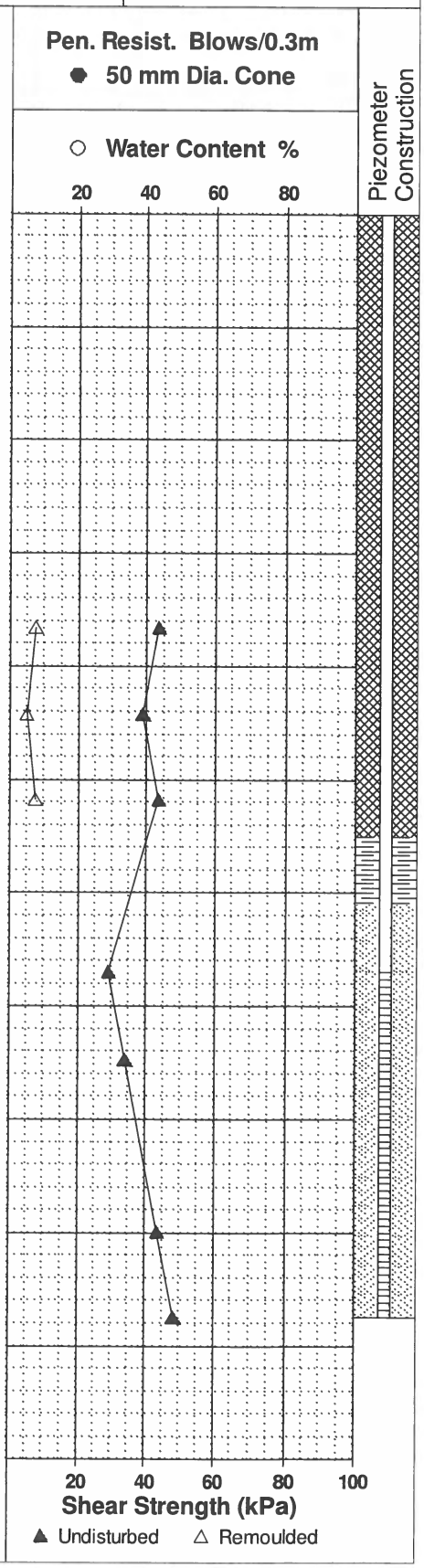
FILE NO. PG4415

REMARKS

HOLE NO. BH 2

BORINGS BY CME 18 Power Auger **DATE** 22 May 2018

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	84.32
TOPSOIL 0.30		AU	1				
		SS	2	96	4	1	83.32
		SS	3	100	4	2	82.32
		SS	4		W	3	81.32
						4	80.32
Firm, grey **SILTY CLAY**						5	79.32
		SS	5	100	W	6	78.32
						7	77.32
		SS	6	83	W	8	76.32
						9	75.32
9.75						10	74.32
Dynamic Cone Penetration Test commenced at 9.75m depth. Cone pushed to 24.7m depth.						11	73.32



patersongroup Consulting Engineers

154 Colonnade Road South, Ottawa, Ontario K2E 7J5

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Prop. Commercial Development - Navan Road
Ottawa, Ontario

DATUM Ground surface elevations provided by Stantec Geomatics Limited.

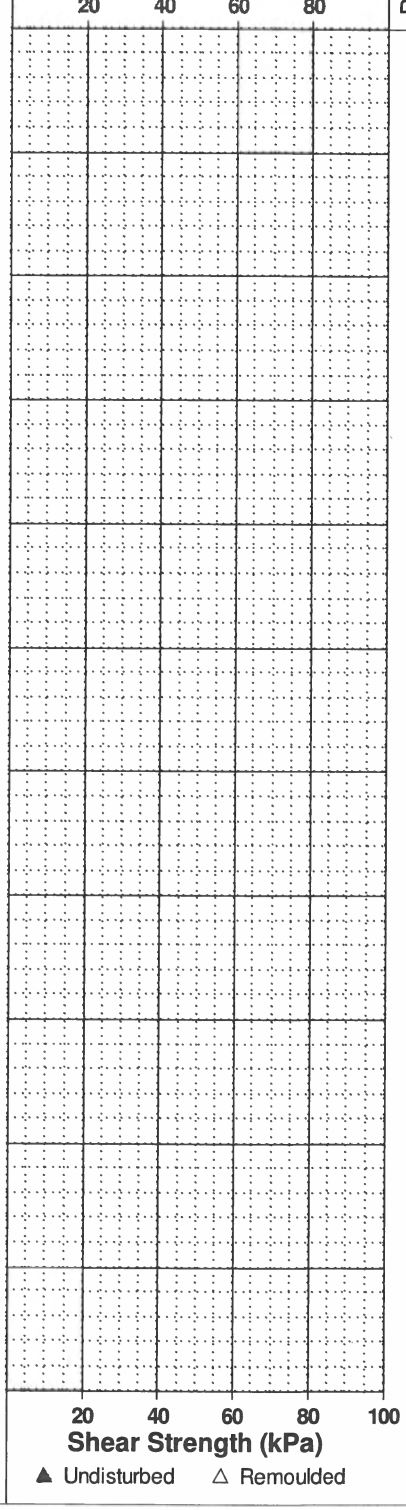
FILE NO. PG4415

REMARKS

HOLE NO. BH 2

BORINGS BY CME 18 Power Auger DATE 22 May 2018

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)	Pen. Resist. Blows/0.3m ● 50 mm Dia. Cone ○ Water Content %	Piezometer Construction
GROUND SURFACE						0			
						11	73.32		
						12	72.32		
						13	71.32		
						14	70.32		
Inferred **SILTY CLAY**						15	69.32		
						16	68.32		
						17	67.32		
						18	66.32		
						19	65.32		
						20	64.32		
						21	63.32		
						22	62.32		



patersongroup

Consulting Engineers

154 Colonnade Road South, Ottawa, Ontario K2E 7J5

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Prop. Commercial Development - Navan Road
Ottawa, Ontario

DATUM Ground surface elevations provided by Stantec Geomatics Limited.

FILE NO. PG4415

REMARKS

HOLE NO. BH 2

BORINGS BY CME 18 Power Auger **DATE** 22 May 2018

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)	Pen. Resist. Blows/0.3m ● 50 mm Dia. Cone ○ Water Content %	Piezometer Construction
GROUND SURFACE									
Inferred **SILTY CLAY**						22	62.32		
						23	61.32		
						24	60.32		
						25	59.32		
						26	58.32		
						27	57.32		
						28	56.32		
						29	55.32		
						30	54.32		
30.48									
End of Borehole									

20 40 60 80

20 40 60 80 100

Shear Strength (kPa)

▲ Undisturbed △ Remoulded

patersongroup

Consulting Engineers

154 Colonnade Road South, Ottawa, Ontario K2E 7J5

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Prop. Commercial Development - Navan Road
Ottawa, Ontario

DATUM Ground surface elevations provided by Stantec Geomatics Limited.

FILE NO. PG4415

REMARKS

HOLE NO. BH 3

BORINGS BY CME 18 Power Auger **DATE** 22 May 2018

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	84.27
TOPSOIL 0.30		AU	1				
Loose, brown **SILTY SAND,** some clay		SS	2	83	8	1	83.27
1.45		SS	3	100	4	2	82.27
Stiff to firm, brown **SILTY CLAY**		SS	4	96	4	3	81.27
		SS	5	100	2	4	80.27
- grey by 3.7m depth							
		SS	6	25	W	5	79.27
						6	78.27
6.70							
End of Borehole							

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

○ Water Content %

20 40 60 80

Piezometer Construction

20 40 60 80 100

Shear Strength (kPa)

▲ Undisturbed △ Remoulded

patersongroup

Consulting Engineers

154 Colonnade Road South, Ottawa, Ontario K2E 7J5

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Prop. Commercial Development - Navan Road
Ottawa, Ontario

DATUM Ground surface elevations provided by Stantec Geomatics Limited.

FILE NO. PG4415

REMARKS

HOLE NO. BH 4

BORINGS BY CME 18 Power Auger **DATE** 23 May 2018

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	85.01
TOPSOIL 0.20		AU	1				
Compact, brown **SILTY SAND**		SS	2	54	23	1	84.01
1.45		SS	3	92	4	2	83.01
Stiff to firm, brown **SILTY CLAY**, trace sand						3	82.01
- grey by 3.0m depth						4	81.01
		SS	4	46	W	5	80.01
6.70						6	79.01
End of Borehole							

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

20 40 60 80

Piezometer Construction

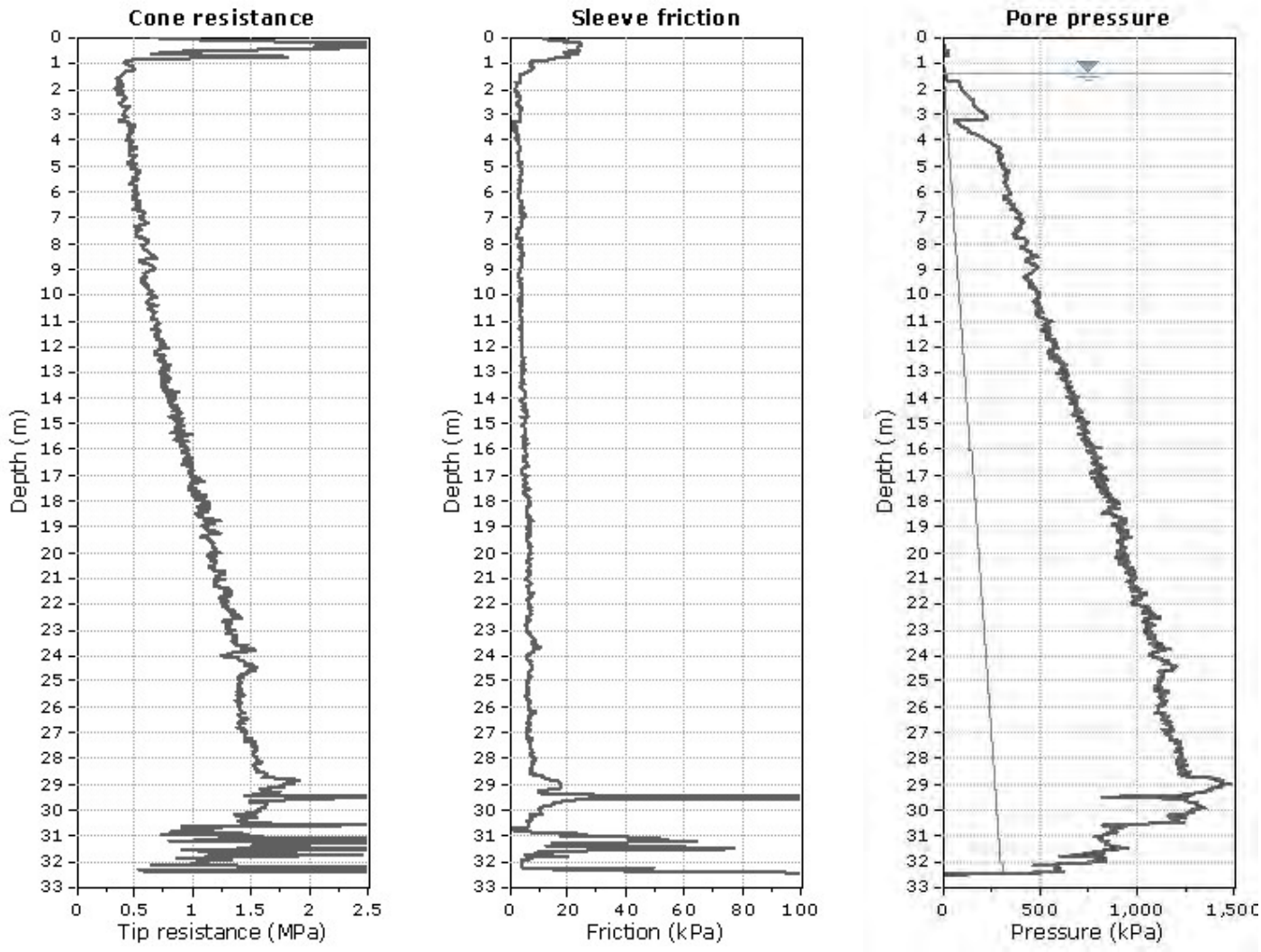
20 40 60 80 100
Shear Strength (kPa)
▲ Undisturbed △ Remoulded

Appendix B:
Seismic Piezocone Penetration Test Results

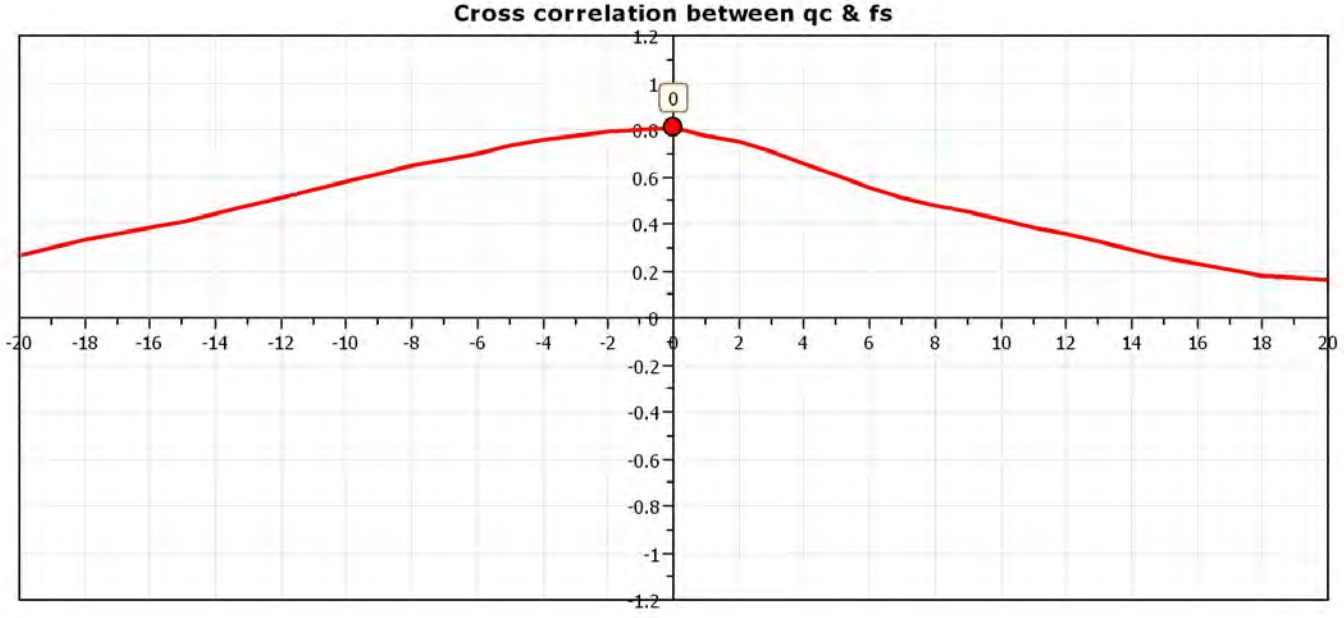
EXP
2650 Queensview Dr Suite 100
Ottawa, Ontario, K2B 8H6
https://ww.exp.com

CPT: SCPTu-9
Total depth: 32.51 m
Surface Elevation: 84.70 m
Cone Type: Vertek 4544 - 5t
Cone Operator: Kevin Simoneau, P.Eng, M.Sc.

Project: **3053 & 3079 Navan Road**
Location: **Navan / Pagé Roads, Ottawa**



The plot below presents the cross correlation coeficient between the raw qc and fs values (as measured on the field). X axes presents the lag distance (one lag is the distance between two sucessive CPT measurements).

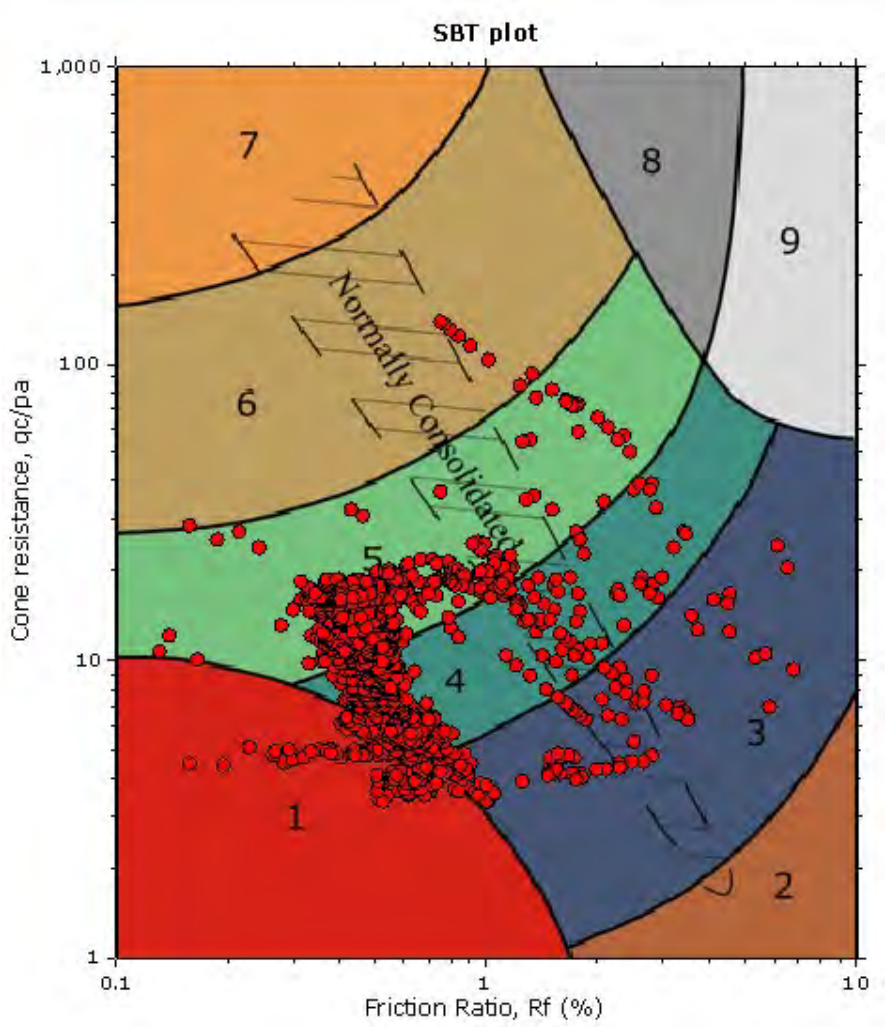


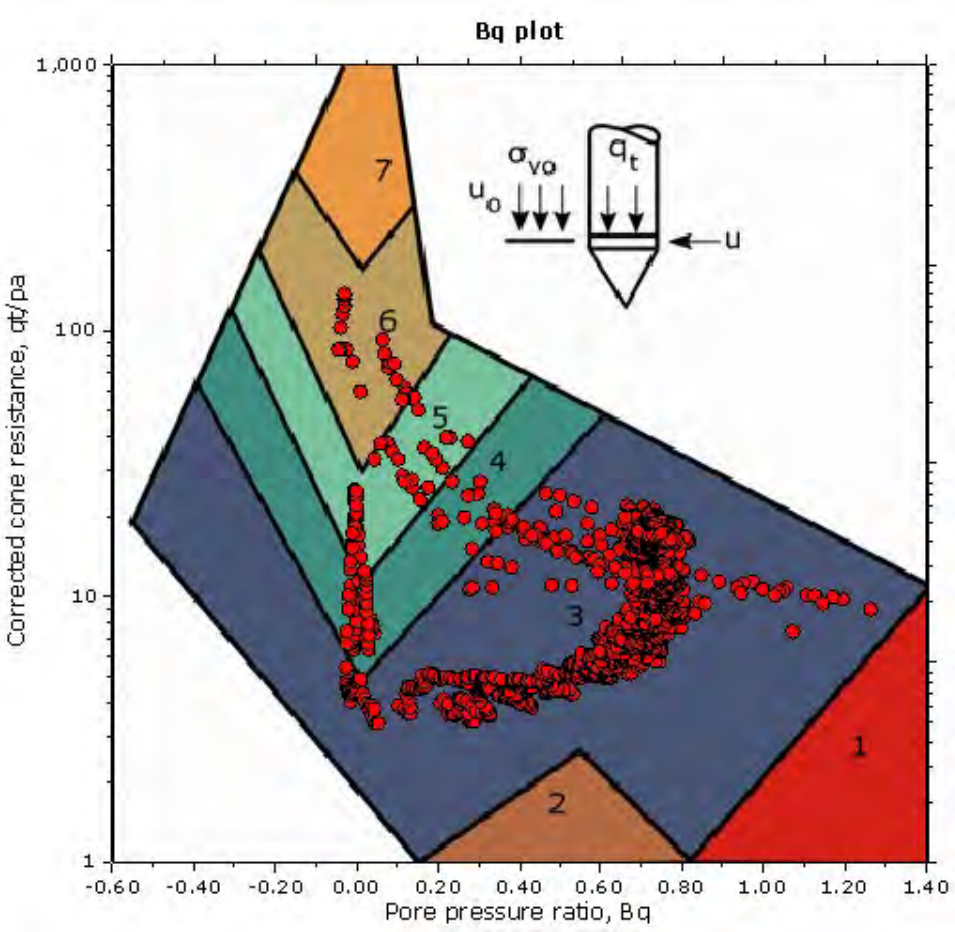
EXP
2650 Queensview Dr Suite 100
Ottawa, Ontario, K2B 8H6
https://ww.exp.com

Project: **3053 & 3079 Navan Road**
Location: **Navan / Pagé Roads, Ottawa**

CPT: SCPTu-9
Total depth: 32.51 m
Surface Elevation: 84.70 m
Cone Type: Vertek 4544 - 5t
Cone Operator: Kevin Simoneau, P.Eng, M.Sc.

SBT - Bq plots





SBT legend

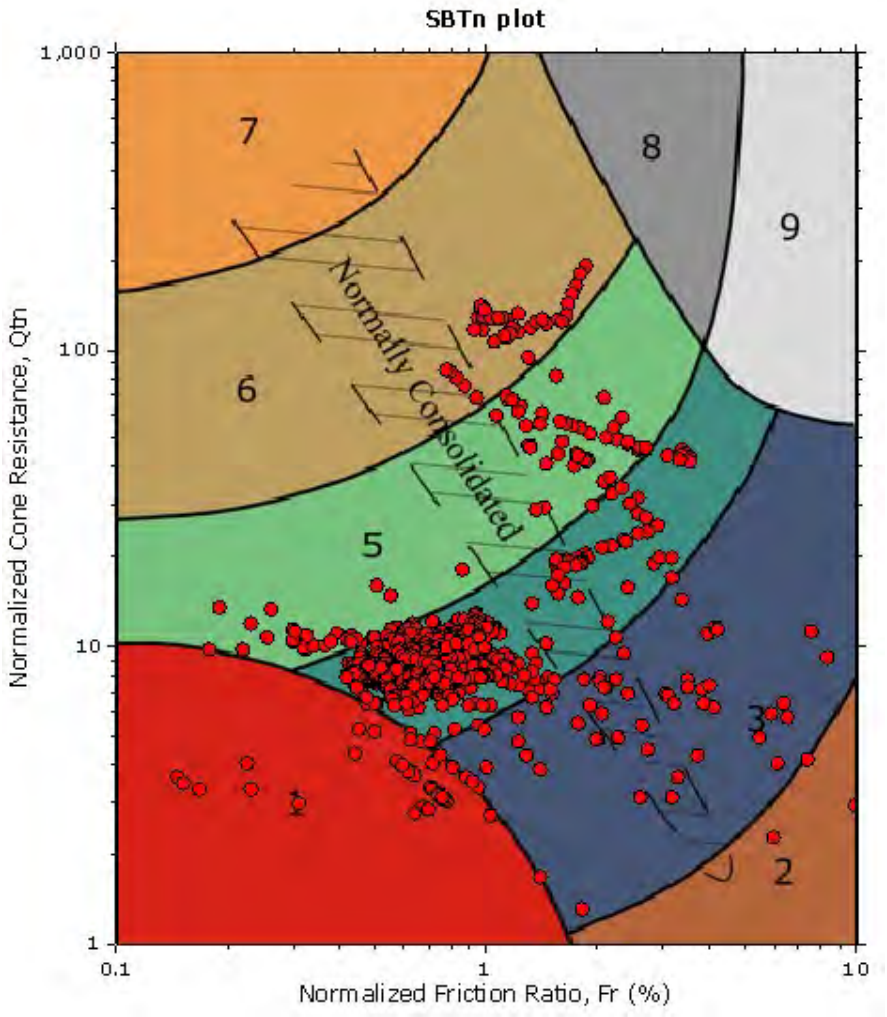
1. Sensitive fine grained	4. Clayey silt to silty clay	7. Gravelly sand to sand
2. Organic material	5. Silty sand to sandy silt	8. Very stiff sand to clayey sand
3. Clay to silty clay	6. Clean sand to silty sand	9. Very stiff fine grained

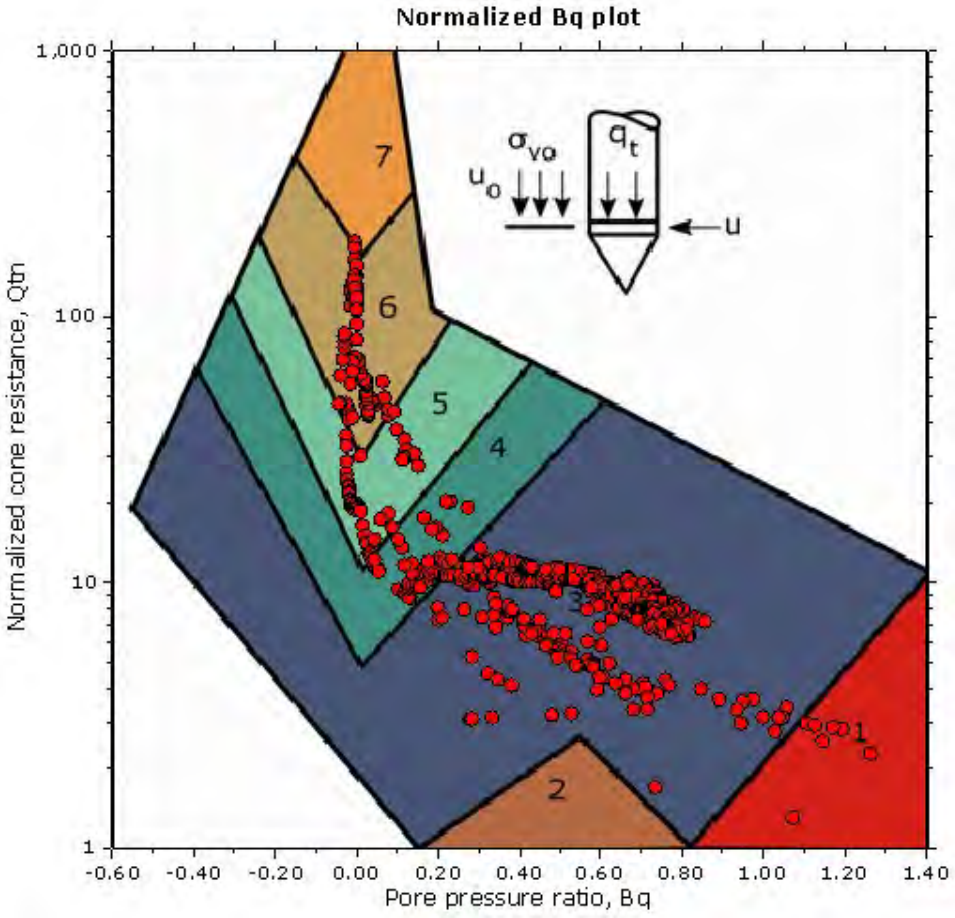
EXP
2650 Queensview Dr Suite 100
Ottawa, Ontario, K2B 8H6
https://ww.exp.com

Project: **3053 & 3079 Navan Road**
Location: **Navan / Pagé Roads, Ottawa**

CPT: SCPTu-9
Total depth: 32.51 m
Surface Elevation: 84.70 m
Cone Type: Vertek 4544 - 5t
Cone Operator: Kevin Simoneau, P.Eng, M.Sc.

SBT - Bq plots (normalized)





SBTn legend

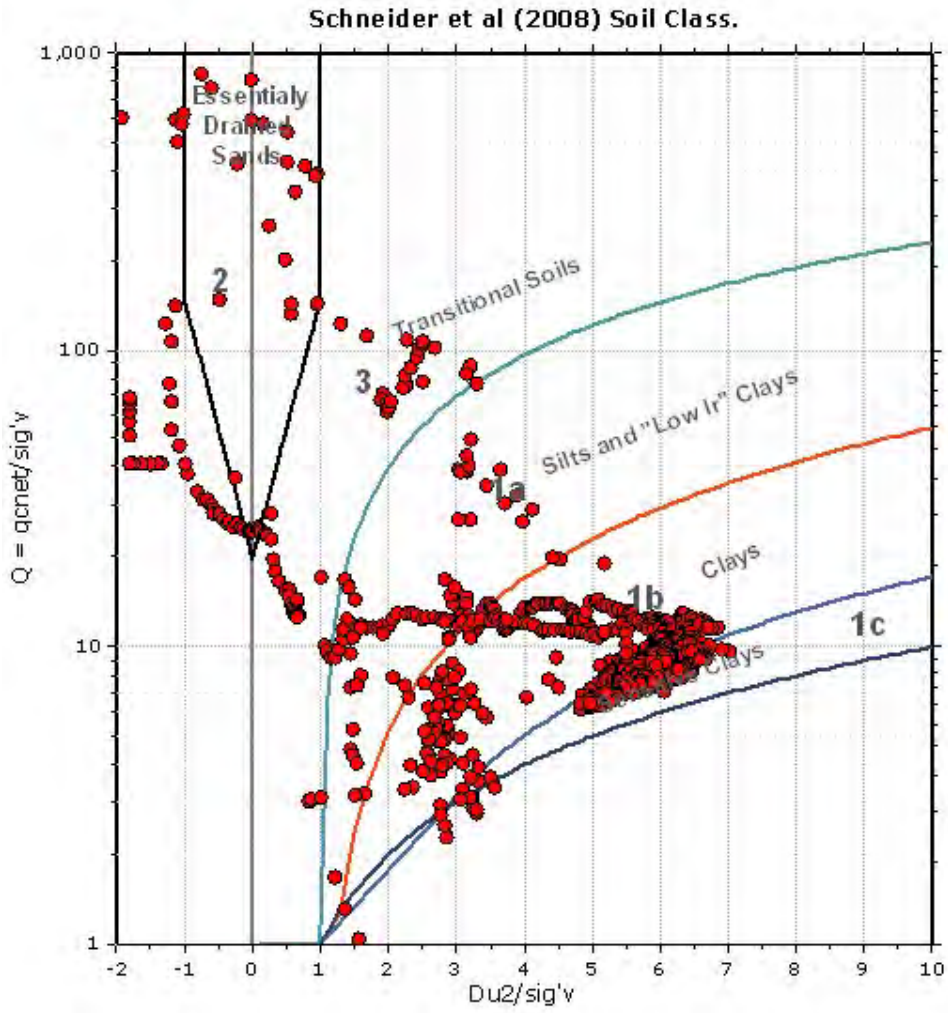
1. Sensitive fine grained	4. Clayey silt to silty clay	7. Gravelly sand to sand
2. Organic material	5. Silty sand to sandy silt	8. Very stiff sand to clayey sand
3. Clay to silty clay	6. Clean sand to silty sand	9. Very stiff fine grained

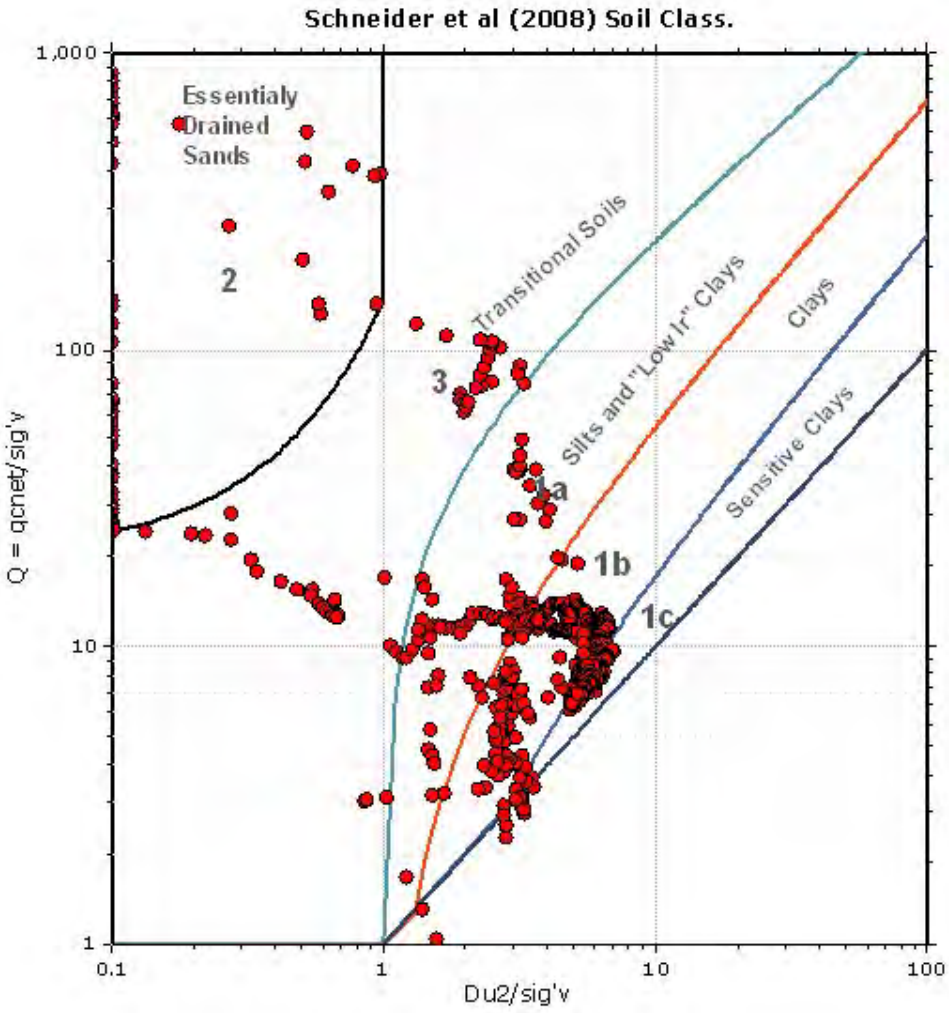
EXP
2650 Queensview Dr Suite 100
Ottawa, Ontario, K2B 8H6
https://ww.exp.com

Project: **3053 & 3079 Navan Road**
Location: **Navan / Pagé Roads, Ottawa**

CPT: SCPTu-9
Total depth: 32.51 m
Surface Elevation: 84.70 m
Cone Type: Vertek 4544 - 5t
Cone Operator: Kevin Simoneau, P.Eng, M.Sc.

Bq plots (Schneider)





EXP
2650 Queensview Dr Suite 100
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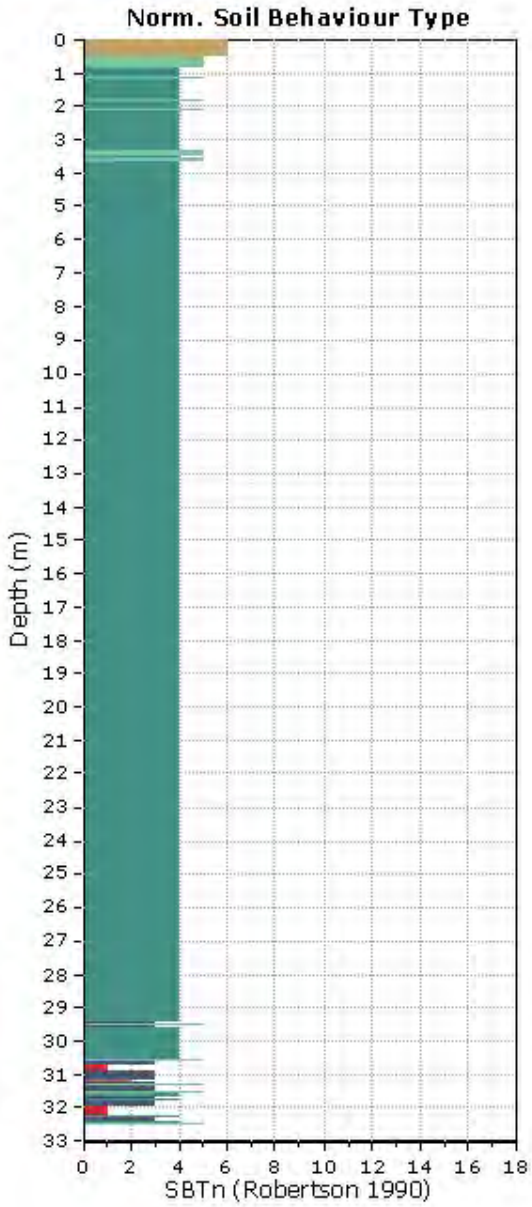
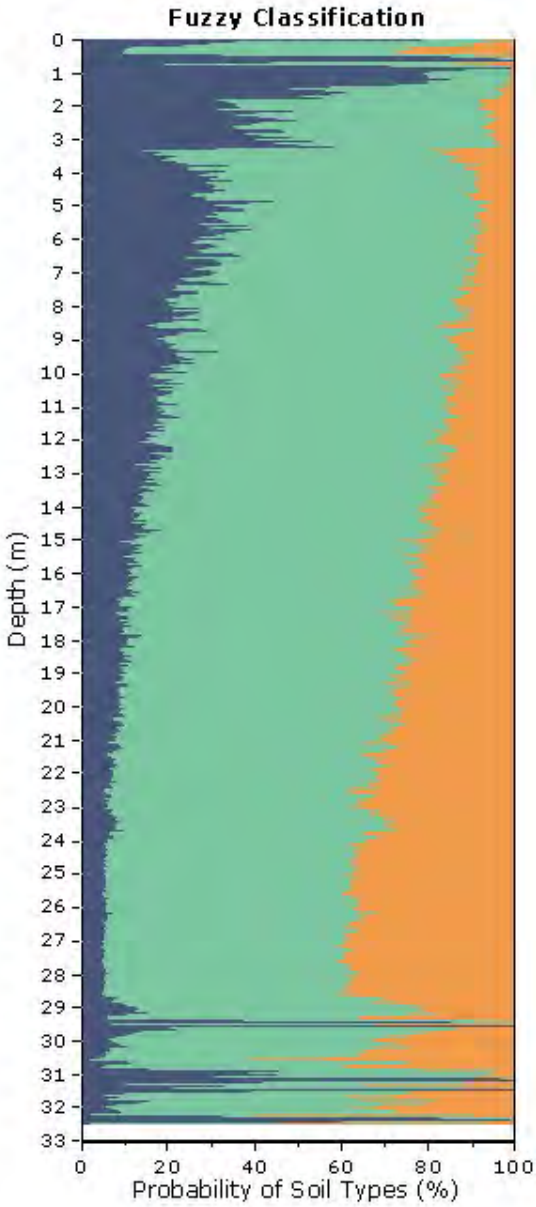
https://ww.exp.com

Project: **3053 & 3079 Navan Road**
Location: **Navan / Pagé Roads, Ottawa**

CPT: SCPTu-9
Total depth: 32.51 m
Surface Elevation: 84.70 m
Cone Type: Vertek 4544 - 5t
Cone Operator: Kevin Simoneau, P.Eng, M.Sc.





EXP
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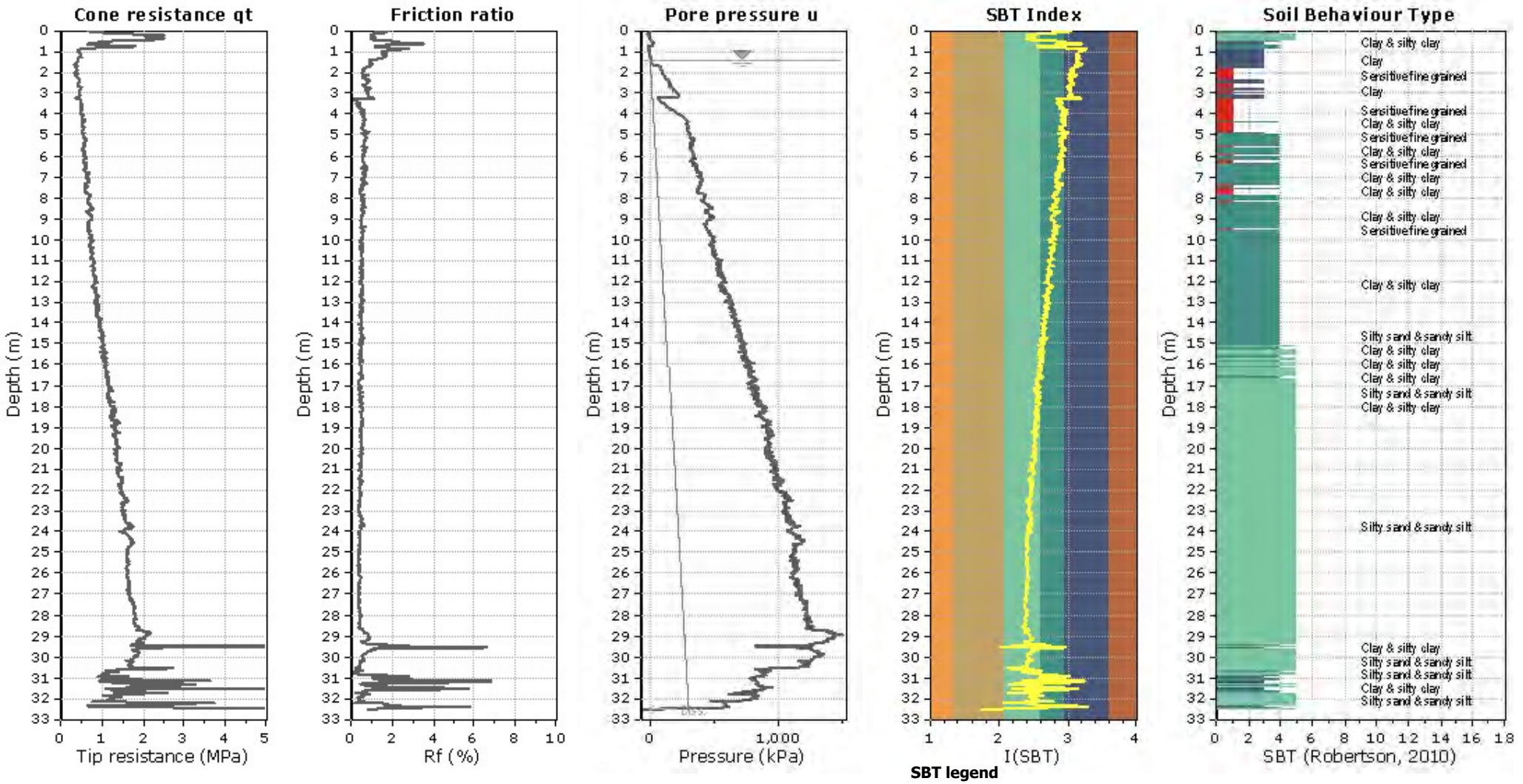
Project: **3053 & 3079 Navan Road**
Location: **Navan / Pagé Roads, Ottawa**

CPT: SCPTu-9
Total depth: 32.51 m
Surface Elevation: 84.70 m
Cone Type: Vertek 4544 - 5t
Cone Operator: Kevin Simoneau, P.Eng, M.Sc.



EXP
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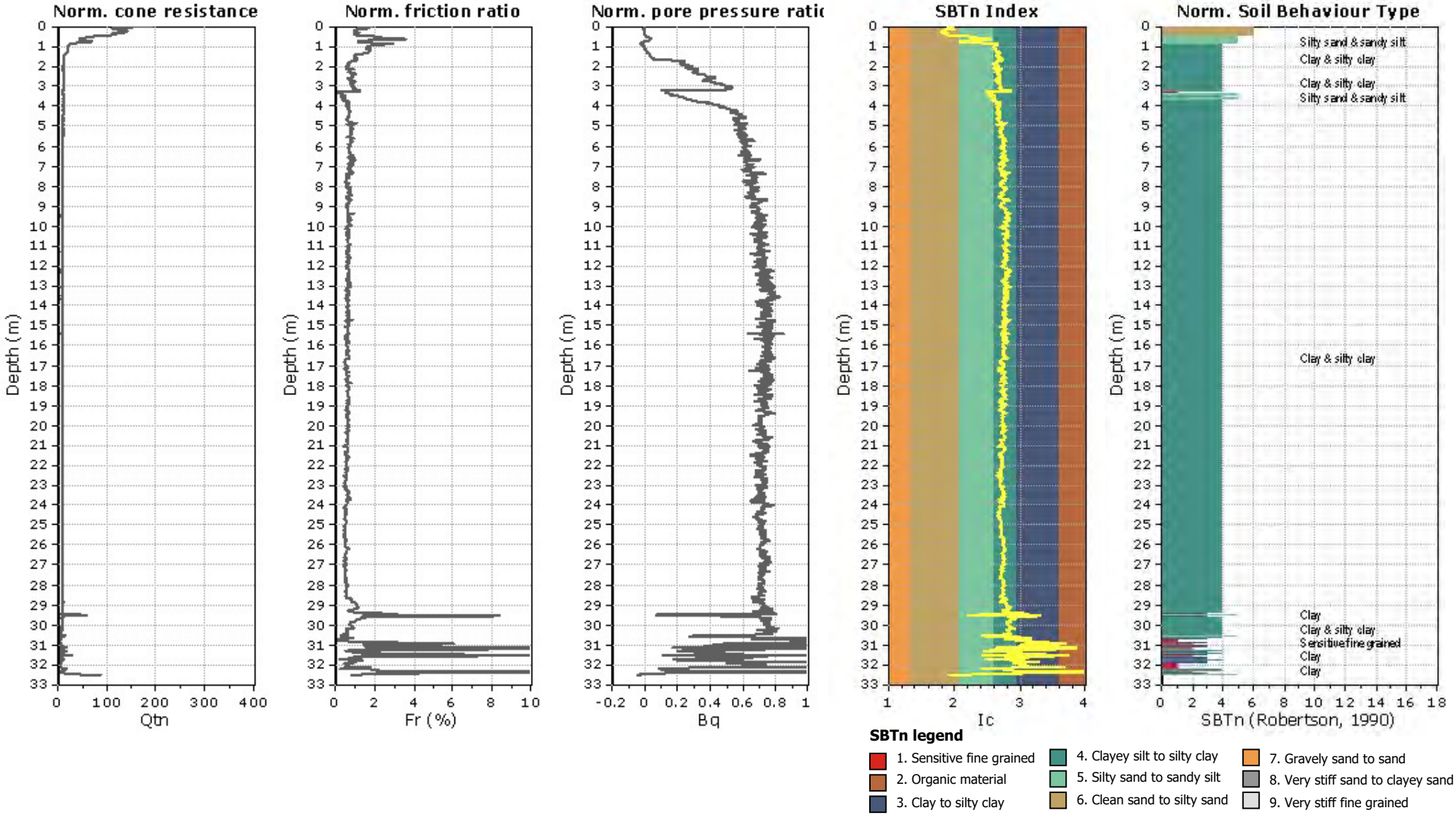
Ottawa, Ontario, K2B 8H6
https://ww.exp.com

Project: **3053 & 3079 Navan Road**
Location: **Navan / Pagé Roads, Ottawa**

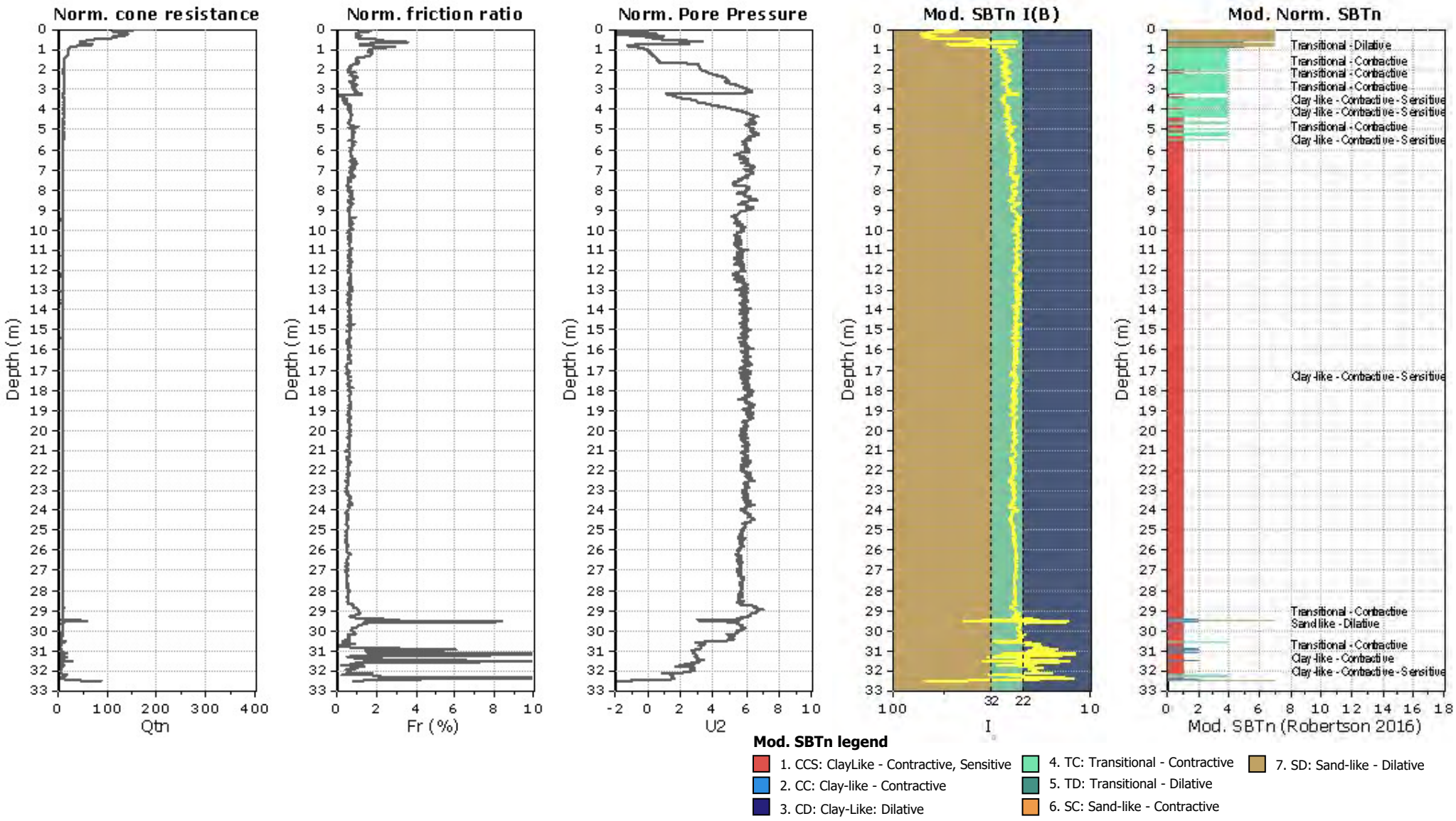
CPT: SCPTu-9
Total depth: 32.51 m
Surface Elevation: 84.70 m
Cone Type: Vertek 4544 - 5t
Cone Operator: Kevin Simoneau, P.Eng, M.Sc.



EXP
2650 Queensview Dr Suite 100
Ottawa, Ontario, K2B 8H6
https://ww.exp.com

Project: **3053 & 3079 Navan Road**
Location: **Navan / Pagé Roads, Ottawa**

CPT: SCPTu-9
Total depth: 32.51 m
Surface Elevation: 84.70 m
Cone Type: Vertek 4544 - 5t
Cone Operator: Kevin Simoneau, P.Eng, M.Sc.



EXP
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Location: **Navan / Pagé Roads, Ottawa**

CPT: SCPTu-9
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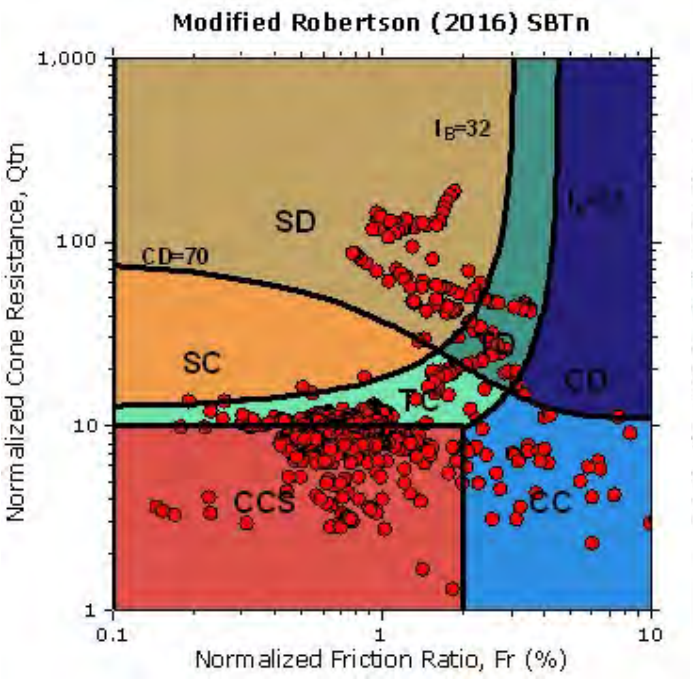
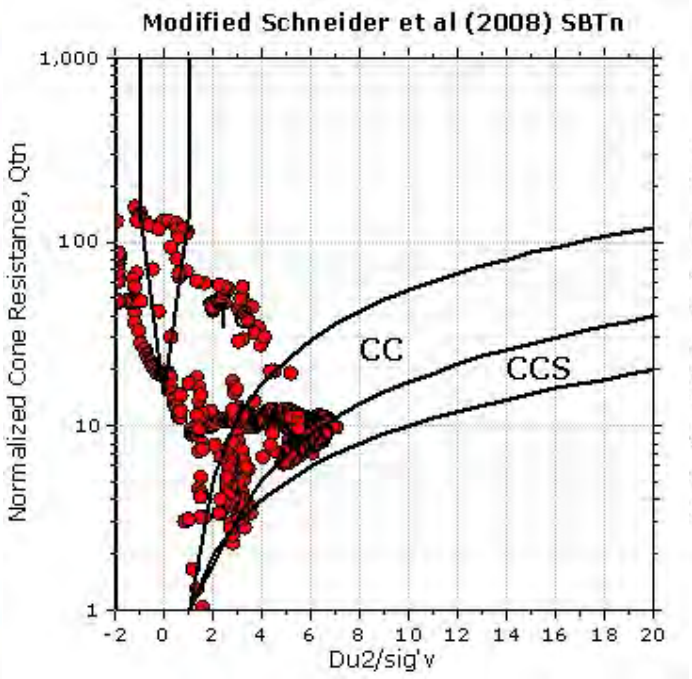
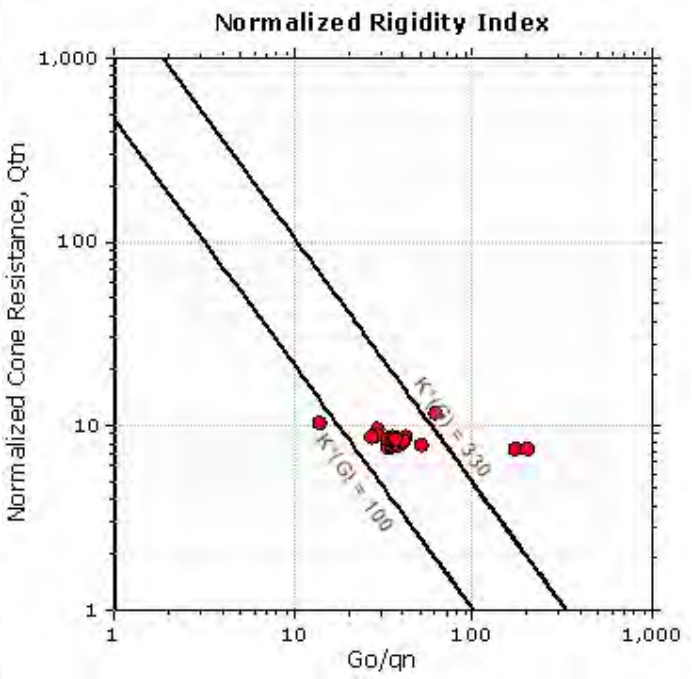
Surface Elevation: 84.70 m
Cone Type: Vertek 4544 - 5t
Cone Operator: Kevin Simoneau, P.Eng, M.Sc.

Updated SBTn plots







CCS: Clay-like - Contractive - Sensitive
CC: Clay-like - Contractive
CD: Clay-like - Dilative
TC: Transitional - Contractive
TD: Transitional - Dilative
SC: Sand-like - Contractive
SD: Sand-like - Dilative

K(G) > 330: Soils with significant microstructure (e.g. age/cementation)

EXP
2650 Queensview Dr Suite 100
Ottawa, Ontario, K2B 8H6
https://ww.exp.com

Project: **3053 & 3079 Navan Road**
Location: **Navan / Pagé Roads, Ottawa**

CPT: SCPTu-9
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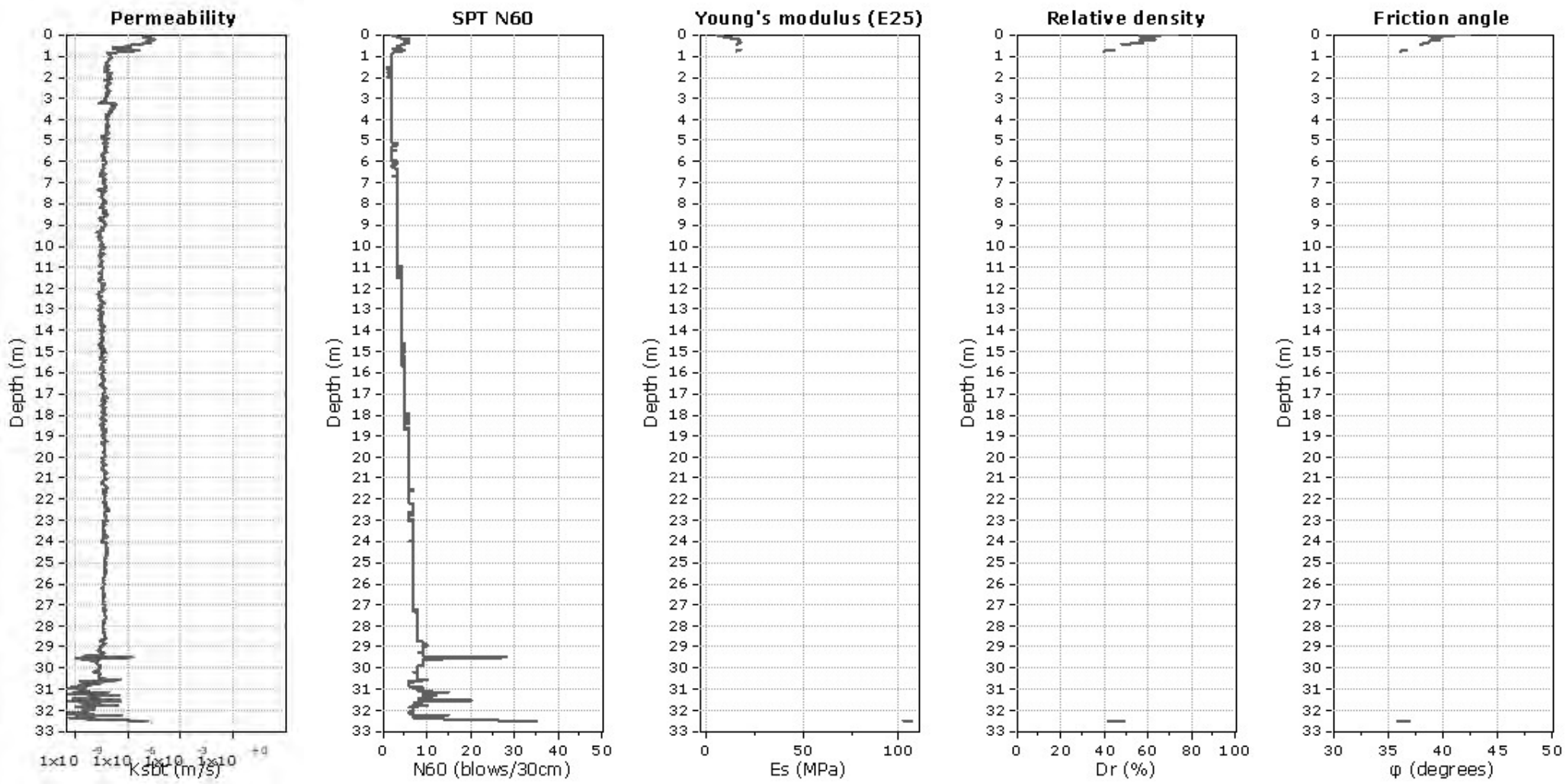

Calculation parameters

Permeability: Based on SBT_n
SPT N_{60}: Based on I_c and q_t
Young's modulus: Based on variable alpha using I_c (Robertson, 2009)
Relative density constant, C_{Dr}: 350.0
Phi: Based on Kulhawy & Mayne (1990)
User defined estimation data

EXP
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Ottawa, Ontario, K2B 8H6
https://ww.exp.com

Project: **3053 & 3079 Navan Road**
Location: **Navan / Pagé Roads, Ottawa**

CPT: SCPTu-9
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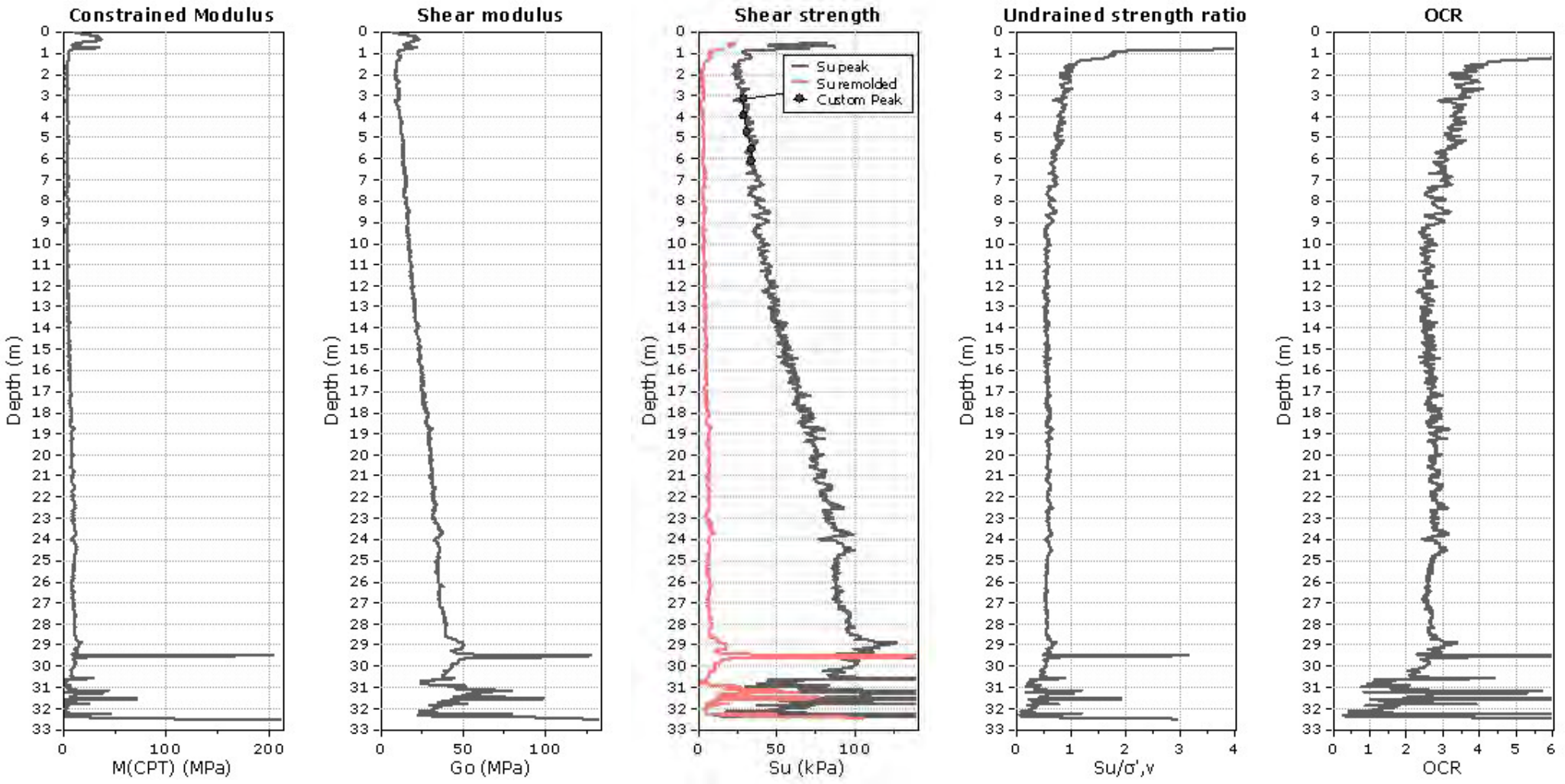


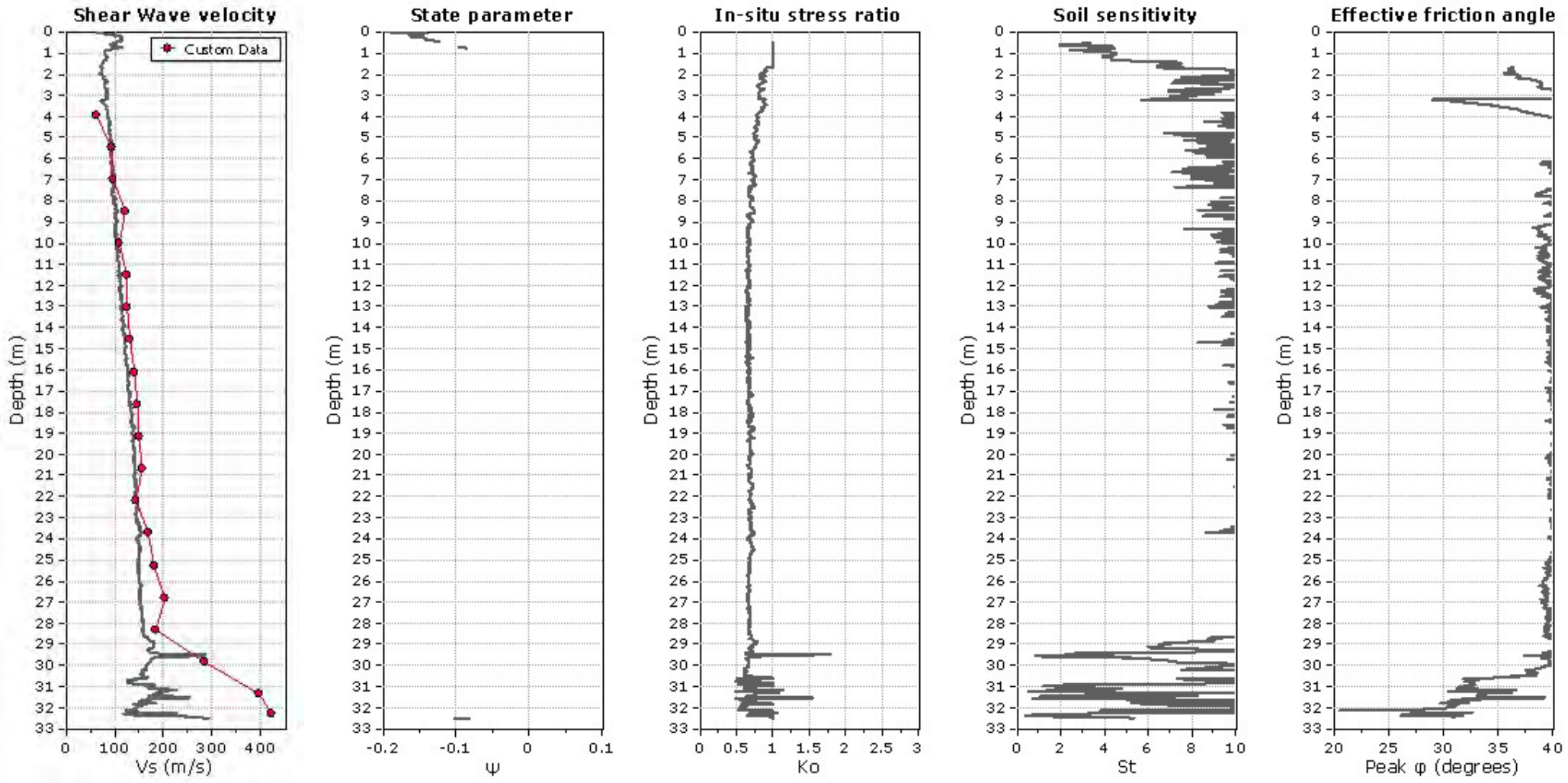
Calculation parameters

Constrained modulus: Based on variable alpha using I_c and Q_{tn} (Robertson, 2009)
Go: Based on variable alpha using I_c (Robertson, 2009)
Undrained shear strength cone factor for clays, N_{kt}: 14
OCR factor for clays, N_{kt}: 0.33
User defined estimation data
Flat Dilatometer Test data

EXP
2650 Queensview Dr Suite 100
Ottawa, Ontario, K2B 8H6
https://ww.exp.com

Project: **3053 & 3079 Navan Road**
Location: **Navan / Pagé Roads, Ottawa**

CPT: SCPTu-9
Total depth: 32.51 m
Surface Elevation: 84.70 m
Cone Type: Vertek 4544 - 5t
Cone Operator: Kevin Simoneau, P.Eng, M.Sc.



Calculation parameters

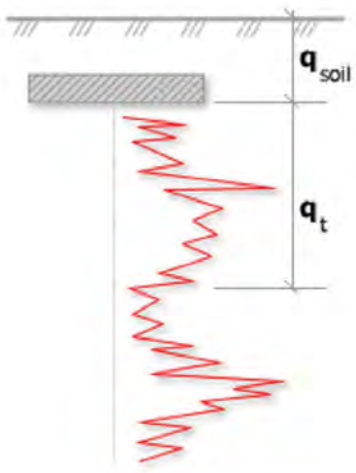
Soil Sensitivity factor, N_S: 7.00

User defined estimation data

EXP
2650 Queensview Dr Suite 100
Ottawa, Ontario, K2B 8H6
https://ww.exp.com

CPT: SCPTu-9
Total depth: 32.51 m
Surface Elevation: 84.70 m
Cone Type: Vertek 4544 - 5t
Cone Operator: Kevin Simoneau, P.Eng, M.Sc.

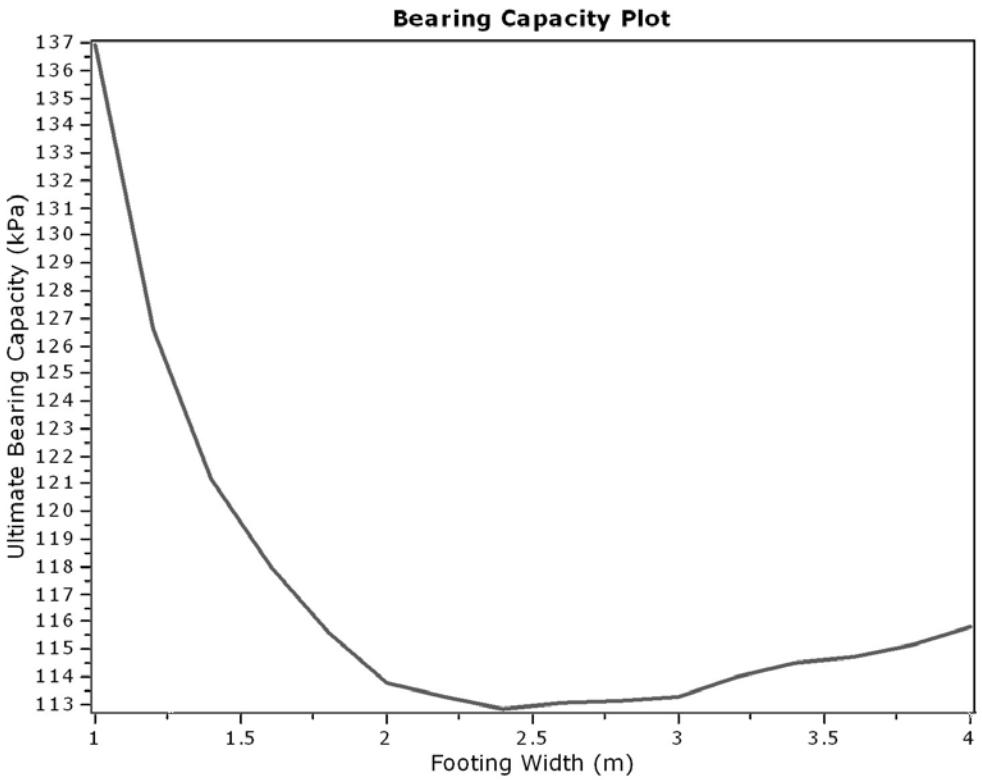
Project: **3053 & 3079 Navan Road**
Location: **Navan / Pagé Roads, Ottawa**



Bearing Capacity calculation is perfromed based on the formula:

$$Q_{ult} = R_k \times q_t + q_{soil}$$

where:
R_k: Bearing capacity factor
q_t: Average corrected cone resistance over calculation depth
q_{soil}: Pressure applied by soil above footing



:: Tabular results ::

No	B (m)	Start Depth (m)	End Depth (m)	Ave. q_t (MPa)	R_k	Soil Press. (kPa)	Ult. bearing cap. (kPa)
1	1.00	0.50	2.00	0.64	0.20	9.50	136.93
2	1.20	0.50	2.30	0.59	0.20	9.50	126.65
3	1.40	0.50	2.60	0.56	0.20	9.50	121.16
4	1.60	0.50	2.90	0.54	0.20	9.50	117.98
5	1.80	0.50	3.20	0.53	0.20	9.50	115.57
6	2.00	0.50	3.50	0.52	0.20	9.50	113.75
7	2.20	0.50	3.80	0.52	0.20	9.50	113.28
8	2.40	0.50	4.10	0.52	0.20	9.50	112.83
9	2.60	0.50	4.40	0.52	0.20	9.50	113.01
10	2.80	0.50	4.70	0.52	0.20	9.50	113.10
11	3.00	0.50	5.00	0.52	0.20	9.50	113.28
12	3.20	0.50	5.30	0.52	0.20	9.50	113.97
13	3.40	0.50	5.60	0.52	0.20	9.50	114.47
14	3.60	0.50	5.90	0.53	0.20	9.50	114.73
15	3.80	0.50	6.20	0.53	0.20	9.50	115.17
16	4.00	0.50	6.50	0.53	0.20	9.50	115.79

Dissipation Tests Results

Dissipation tests

Dissipation tests consists of stopping the piezocone penetration and observing porepressures (u) with elapsed time (t). The data are automatic recorded by the field computer and should take place until a minimum of 50% dissipation.

The porepressures are plotted as a function of square root of (t). The graphical technique suggested by Robertson and Campanella (1989), yields a value for t_{50}, which corresponds to the time for 50% consolidation.

The value of the coefficient of consolidation in the radial or horizontal direction c_h was then calculated by Houlsby and Teh's (1988) theory using the following equation:

$$c_h = \frac{T \times r^2 \times I_r^{0.5}}{t_{50}}$$

where:

T: time factor given by Houlsby and Teh's (1988) theory corresponding to the porepressure position
r: piezocone radius
I_r: stiffness index, equal to shear modulus G divided by the undrained strength of clay (S_u).
t_{50}: time corresponding to 50% consolidation

Permeability estimates based on dissipation test

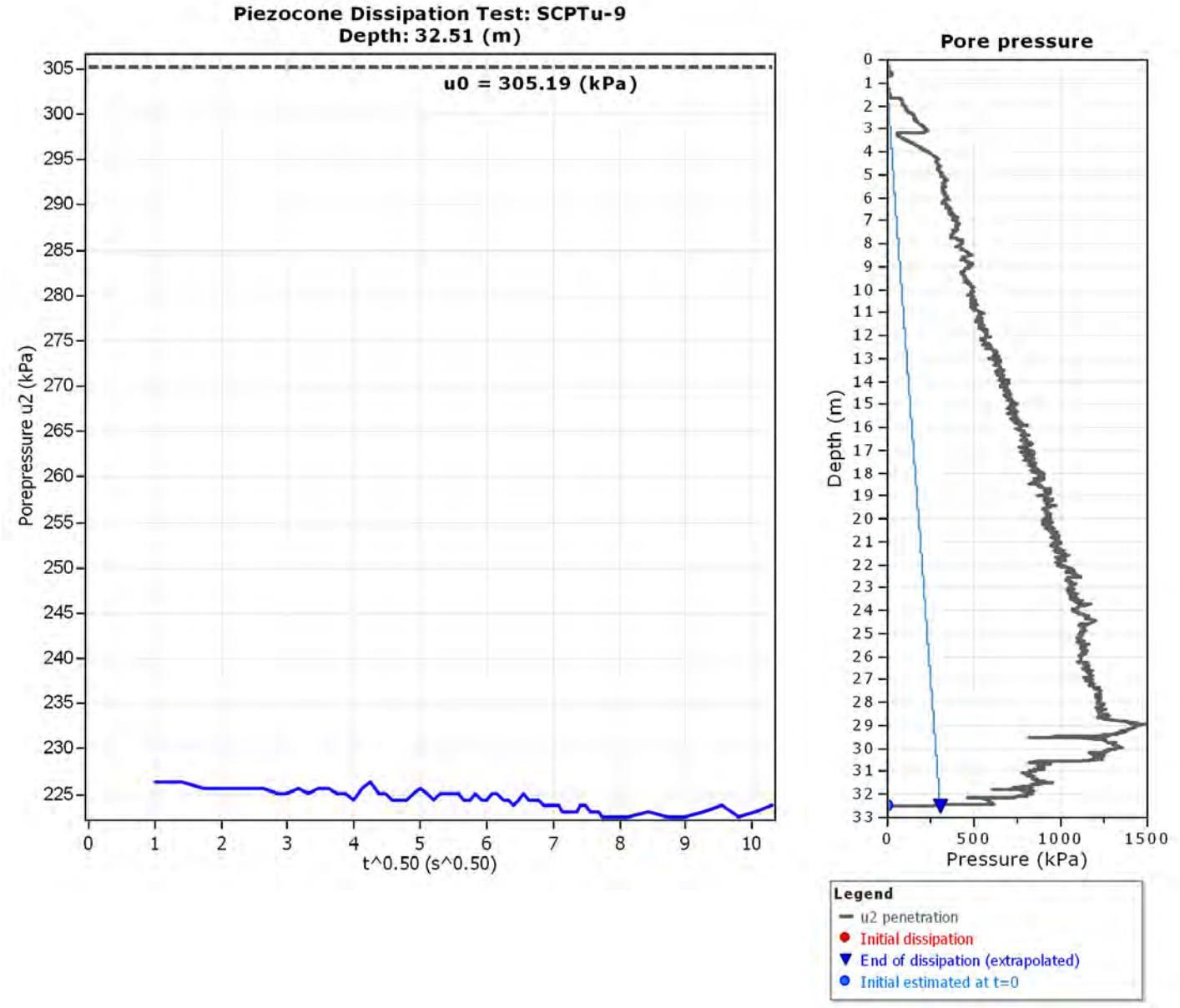
The dissipation of pore pressures during a CPTu dissipation test is controlled by the coefficient of consolidation in the horizontal direction (c_h) which is influenced by a combination of the soil permeability (k_h) and compressibility (M), as defined by the following:

$$k_h = c_h \times \gamma_w / M$$

where: M is the 1-D constrained modulus and γ_w is the unit weight of water, in compatible units.

Tabular results

CPTU Borehole	Depth (m)	$(t_{50})^{0.50}$	t_{50} (s)	t_{50} (years)	G/S_u	c_h (m^2/s)	c_h (m^2/year)	M (MPa)	k_h (m/s)
SCPTu-9	32.51	0.0	0	0.00E+000	100.00	0.00E+000	0	187.13	-1.00E+004


Piezocone Dissipation Test: SCPTu-9
Depth: 32.51 (m)
u0 = 305.19 (kPa)
Porepressure u2 (kPa)
t^0.50 (s^0.50)
Pore pressure
Depth (m)
Pressure (kPa)
Legend
u2 penetration
Initial dissipation
End of dissipation (extrapolated)
Initial estimated at t=0

Presented below is a list of formulas used for the estimation of various soil properties. The formulas are presented in SI unit system and assume that all components are expressed in the same units.

:: Unit Weight, g (kN/m³) ::

$$g = g_w \cdot \left(0.27 \cdot \log(R_f) + 0.36 \cdot \log(\frac{q_t}{p_a}) + 1.236 \right)$$

where g_w = water unit weight

:: Permeability, k (m/s) ::

$I_c < 3.27$ and $I_c > 1.00$ then $k = 10^{0.952-3.04 \cdot I_c}$

$I_c \leq 4.00$ and $I_c > 3.27$ then $k = 10^{-4.52-1.37 \cdot I_c}$

:: N_{SPT} (blows per 30 cm) ::

$$N_{60} = \left(\frac{q_c}{P_a} \right) \cdot \frac{1}{10^{1.1268-0.2817 \cdot I_c}}$$

$$N_{1(60)} = Q_{tn} \cdot \frac{1}{10^{1.1268-0.2817 \cdot I_c}}$$

:: Young's Modulus, Es (MPa) ::

$$(q_t - \sigma_v) \cdot 0.015 \cdot 10^{0.55 \cdot I_c + 1.68}$$

(applicable only to $I_c < I_{c\_cutoff}$)

:: Relative Density, Dr (%) ::

$$100 \cdot \sqrt{\frac{Q_{tn}}{k_{DR}}}$$ (applicable only to SBT_n: 5, 6, 7 and 8 or $I_c < I_{c\_cutoff}$)

:: State Parameter, ψ ::

$$\psi = 0.56 - 0.33 \cdot \log(Q_{tn,cs})$$

:: Drained Friction Angle, φ (°) ::

(applicable only to SBT_n: 5, 6, 7 and 8 or $I_c < I_{c\_cutoff}$)

:: 1-D constrained modulus, M (MPa) ::

If $I_c > 2.20$
$\alpha = 14$ for $Q_{tn} > 14$
$\alpha = Q_{tn}$ for $Q_{tn} \leq 14$
$M_{CPT} = \alpha \cdot (q_t - \sigma_v)$

If $I_c \geq 2.20$

:: Small strain shear Modulus, Go (MPa) ::

$$G_0 = (q_t - \sigma_v) \cdot 0.0188 \cdot 10^{0.55 \cdot I_c + 1.68}$$

:: Shear Wave Velocity, Vs (m/s) ::

$$V_s = \left(\frac{G_0}{\rho} \right)^{0.50}$$

:: Undrained peak shear strength, Su (kPa) ::

$N_{kt} = 10.50 + 7 \cdot \log(F_r)$ or user defined

$$S_u = \frac{(q_t - \sigma_v)}{N_{kt}}$$

(applicable only to SBT_n: 1, 2, 3, 4 and 9 or $I_c > I_{c\_cutoff}$)

:: Remolded undrained shear strength, Su(rem) (kPa) ::

$S_{u(rem)} = f_s$ (applicable only to SBT_n: 1, 2, 3, 4 and 9 or $I_c > I_{c\_cutoff}$)

:: Overconsolidation Ratio, OCR ::

$$k_{OCR} = \left[\frac{Q_{tn}^{0.20}}{0.25 \cdot (10.50 \cdot +7 \cdot \log(F_r))} \right]^{1.25}$$ or user defined

$OCR = k_{OCR} \cdot Q_{tn}$

(applicable only to SBT_n: 1, 2, 3, 4 and 9 or $I_c > I_{c\_cutoff}$)

:: In situ Stress Ratio, Ko ::

$$K_O = (1 - \sin\varphi') \cdot OCR^{\sin\varphi'}$$

(applicable only to SBT_n: 1, 2, 3, 4 and 9 or $I_c > I_{c\_cutoff}$)

:: Soil Sensitivity, S_t ::

$$S_t = \frac{N_S}{F_r}$$

(applicable only to SBT_n: 1, 2, 3, 4 and 9 or $I_c > I_{c\_cutoff}$)

:: Peak Friction Angle, φ' (°) ::

$$\varphi' = 29.5° \cdot B_q^{0.121} \cdot (0.256 + 0.336 \cdot B_q + \log Q_t)$$

(applicable for $0.10 < B_q < 1.00$)

References

• Robertson, P.K., Cabal K.L., Guide to Cone Penetration Testing for Geotechnical Engineering, Gregg Drilling & Testing, Inc., 5th Edition, November 2012

• Robertson, P.K., Interpretation of Cone Penetration Tests - a unified approach., Can. Geotech. J. 46(11): 1337–1355 (2009)

Appendix C:
One-Dimensional Consolidation Test Results

Stantec Consulting Ltd.
400 - 1331 Clyde Avenue, Ottawa ON K2C 3G4

June 2, 2021
File: 121623683

Attention: Ismail Taki, M.Eng., P.Eng.
Exp Services Inc
2650 Queensview Drive
Suite 100
Ottawa, Ontario, Canada, K2B 8H6
Tel: 1-613-853-1350
E-mail: ismail.taki@exp.com

Dear Mr. Taki,

Reference: Consolidation Test Results, Exp Services Inc., File #21004743-B0: BH 6 TW10, 40-42 ft BH 8 TW4, 10-12 ft & BH7 TW6, 15-17 ft. sampled on April 28, 29 & 30

This letter presents the results of one-dimensional consolidation test carried out on the above referenced samples in accordance with ASTM D2435/D2435M – 11(2020). The test results are provided in the attached tables and figures.

This letter provides test results only and does not constitute any interpretation or engineering recommendations with respect to material suitability or specification compliance.

We trust the information presented herein meets your present requirements. Should you have any questions or require additional information, please do not hesitate to contact us.

Regards,

Stantec Consulting Ltd.

Rajib Dey Ph.D., P.Eng.
Geotechnical Engineer
Direct: 905 944-6190
Mobile: 709 693-0418
Rajib.Dey@stantec.com

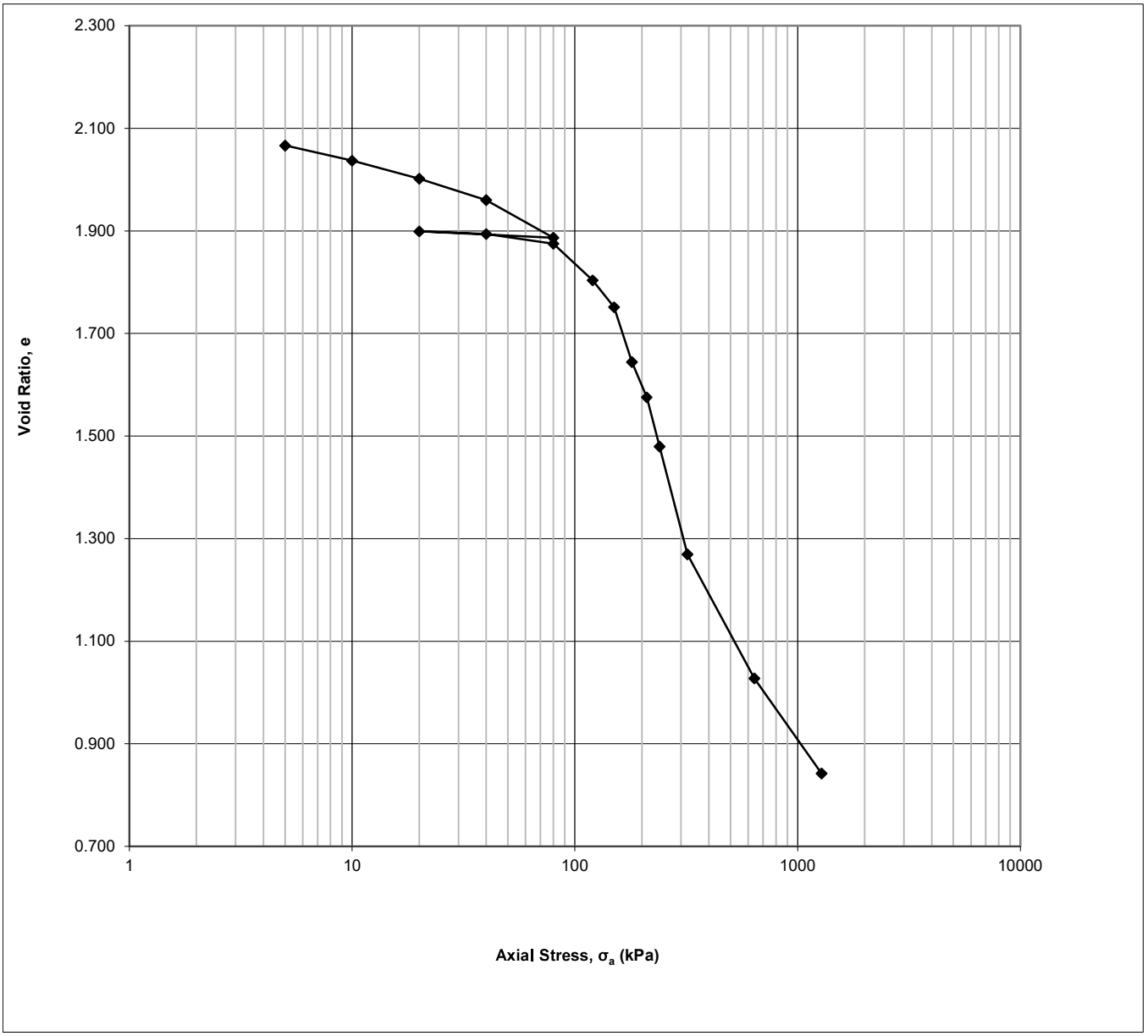
v:\01216\active\laboratory_standing_offers\2021 laboratory standing offers\121623683 exp services inc\may 3, three consolidation, file# ott-21004743-b0\121623683_let_consolidation_bh 6 tw10, bh8 tw4, & bh7 tw6.docx

Stantec

One-Dimensional Consolidation Properties of Soils Using Incremental Loading

ASTM D2435/D2435M - 11(2020)

Project	**Exp, File# OTT21004743-B0**
Project No.	**121623683**
Borehole No.	**BH 6**
Sample No.	**TW10**
Sample Depth	**40-42 ft.**



Stantec

Stantec Consulting Ltd.

Checked by: D. Boateng Date: June 7, 2021
Approved by: R. Dey Date: June 7, 2021

One-Dimensional Consolidation Test using Incremental Loading
ASTM D2435/D2435M - 11(2020)

Specimen Details

Project Name	Exp, File# OTT21004743-B0
Project Location	Navan, ON
Borehole	BH 6
Sample No.	TW10
Depth	40-42 ft.
Sample Date	April 28, 2021
Test Number	One
Technician Name	Daniel Boateng

Soil Description & Classification

Silty clay, grey, wet	
Specific Gravity of Solids	2.750
Average water content of trimmings %	74.23
Additional Notes (information source, occurence and size of large isolated particles etc.)	
1. Specific Gravity of Solids Assumed, 2. Loading schedule provided by client	

Initial Specimen Conditions

Height	mm	20.00
Diameter	mm	50.00
Area	mm^2	1963
Volume	mm^3	39270
Mass	g	60.10
Dry Mass	g	34.49
Density	Mg/m^3	1.530
Dry Density	Mg/m^3	0.878
Water Content	%	74.25
Degree of Saturation	%	95.8
Height of Solids	mm	6.39
Initial Void Ratio		2.131

Final Specimen Conditions

Water Content	%	36.91
Final Void Ratio		0.842
Final Height	mm	11.77

Stantec

Stantec Consulting Ltd.

Filename: V:\01216\active\laboratory_standing_offers\2021 Laboratory Standing Offers\121623685 Date: June 7, 2021
Checked by: D. Boateng Date: June 7, 2021
Approved by: R. Dey Date:

One-Dimensional Consolidation Test using Incremental Loading
ASTM D2435/D2435M - 11(2020)

Specimen Details

Project Name	Exp, File# OTT21004743-B0
Project Location	Navan, ON
Borehole	BH 6
Sample No.	TW10
Depth	40-42 ft.
Sample Date	April 28, 2021
Test Number	One
Technician Name	Daniel Boateng

Test Procedure

Date Started		May 4, 2021
Date Finished		May 21, 2021
Machine Number		Frame D
Cell Number		D
Ring Number		D
Trimming Procedure		Trimming Turntable/ Cutting Ring
Moisture Condition		Inundated
Axial Stress at Inundation	kPa	5
Water Used		De-aired Tap Water
Test Method		A
Interpretation Procedure for c_v		2

All Departures from Outlined ASTM D2435/D2435M-11(2020) Procedure

Calculations

Load Increment	Increment Duration min	Axial Stress σ_a kPa	Corrected Deformation ΔH mm	Specimen Height H mm	Axial Strain ε_a %	Void Ratio e
Seating	0.0	0	0.0000	20.0000	0.00	2.131
1	1440.0	5	0.4105	19.5895	2.05	2.067
2	1440.0	10	0.6004	19.3996	3.00	2.037
3	1440.0	20	0.8262	19.1738	4.13	2.002
4	1440.0	40	1.0908	18.9092	5.45	1.960
5	1440.0	80	1.5602	18.4398	7.80	1.887
6	1440.0	20	1.4798	18.5202	7.40	1.899
7	1440.0	40	1.5150	18.4850	7.58	1.894
8	1440.0	80	1.6343	18.3657	8.17	1.875
9	1440.0	120	2.0899	17.9101	10.45	1.804
10	1440.0	150	2.4263	17.5737	12.13	1.751
11	1440.0	180	3.1072	16.8928	15.54	1.645
12	1440.0	210	3.5481	16.4519	17.74	1.576
13	1440.0	240	4.1631	15.8369	20.82	1.479
14	1440.0	320	5.5038	14.4962	27.52	1.269
15	1440.0	640	7.0496	12.9504	35.25	1.027
16	1440.0	1280	8.2338	11.7662	41.17	0.842

Stantec

Stantec Consulting Ltd.

Filename: V:\01216\activellaboratory_standing_offers\2021 Laboratory Standing
Date: June 7, 2021
Checked by: D. Boateng
Date: June 7, 2021
Approved by: R. Dey
Date: June 7, 2021

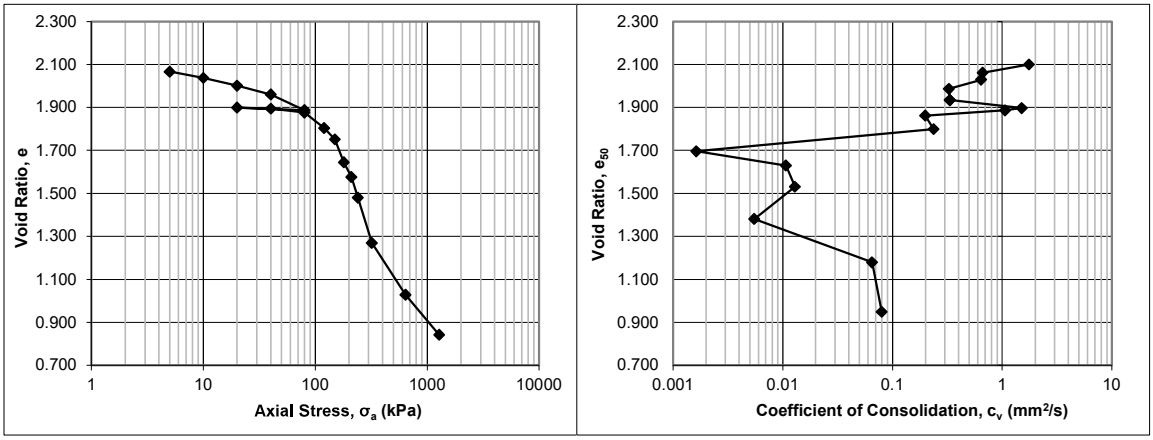
One-Dimensional Consolidation Test using Incremental Loading
ASTM D2435/D2435M - 11(2020)

Specimen Details

Job Ref.	Exp, File# OTT21004743-B0
Job Location	Navan, ON
Borehole	BH 6
Sample No.	TW10
Depth	40-42 ft.
Sample Date	April 28, 2021
Test Number	One
Technician Name	Daniel Boateng

Calculations

		Calculated using Interpretation Procedure 2				Interpretation Procedure 1		Interpretation Procedure 2	
Load Increment	Axial Stress $\sigma_{a,\ average}$ kPa	Corrected Deformation ΔH_{50} mm	Specimen Height H_{50} mm	Axial Strain $\varepsilon_{a,50}$ %	Void Ratio e_{50}	Time t_{50} sec	Coeff. Consol. c_v mm^2/s	Time t_{90} sec	Coeff. Consol. c_v mm^2/s
Seating	0								
1	3	0.2006	19.7994	1.00	2.100			47	1.76E+00
2	8	0.4419	19.5581	2.21	2.062			122	6.62E-01
3	15	0.6548	19.3452	3.27	2.029			123	6.44E-01
4	30	0.9259	19.0741	4.63	1.986			236	3.27E-01
5	60	1.2623	18.7377	6.31	1.933			223	3.34E-01
6	50	1.5338	18.4662	7.67	1.891				
7	30	1.4963	18.5037	7.48	1.897			48	1.51E+00
8	60	1.5652	18.4348	7.83	1.886			68	1.06E+00
9	100	1.7231	18.2769	8.62	1.861			355	1.99E-01
10	135	2.1233	17.8767	10.62	1.799			285	2.38E-01
11	165	2.7821	17.2179	13.91	1.696			38440	1.63E-03
12	195	3.2072	16.7928	16.04	1.629			5592	1.07E-02
13	225	3.8330	16.1670	19.16	1.531			4280	1.29E-02
14	280	4.7896	15.2104	23.95	1.381			8918	5.50E-03
15	480	6.0838	13.9162	30.42	1.179			631	6.51E-02
16	960	7.5521	12.4479	37.76	0.949			412	7.98E-02



Stantec	Project No.: 121623683 Project Name: Exp, File# OTT-21004743-B0	Photo Log

Photo No.: 1	Borehole: BH 6 TW-10	Depth: 40 – 42 ft

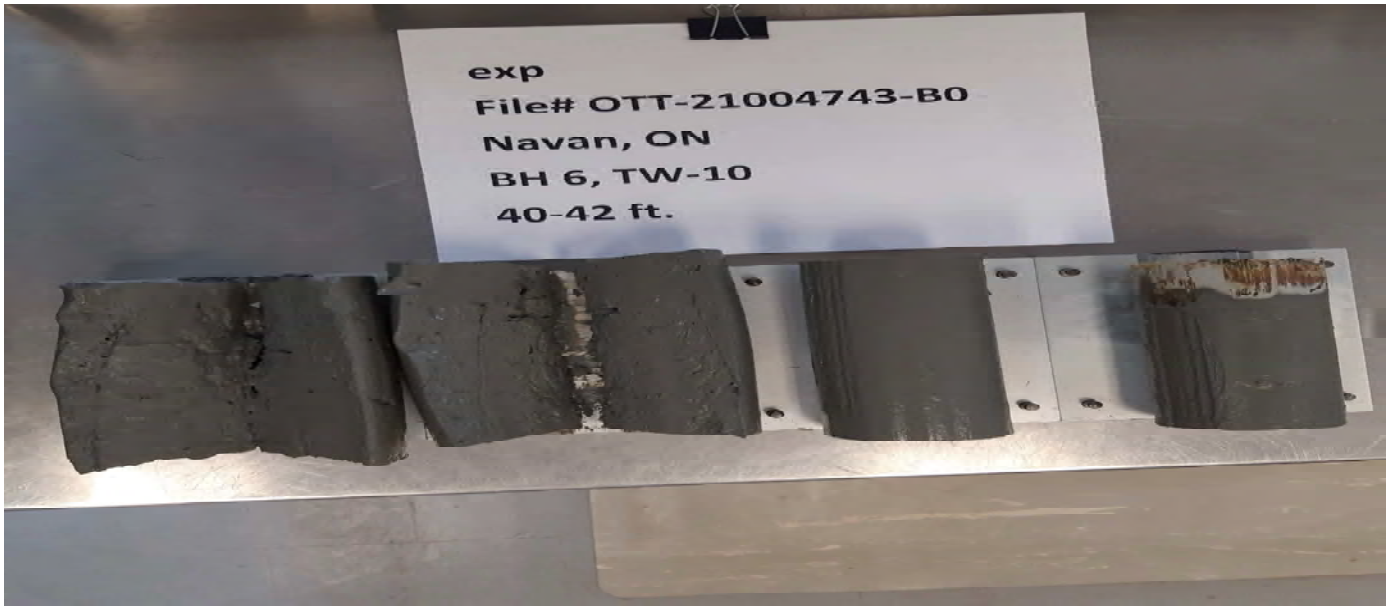


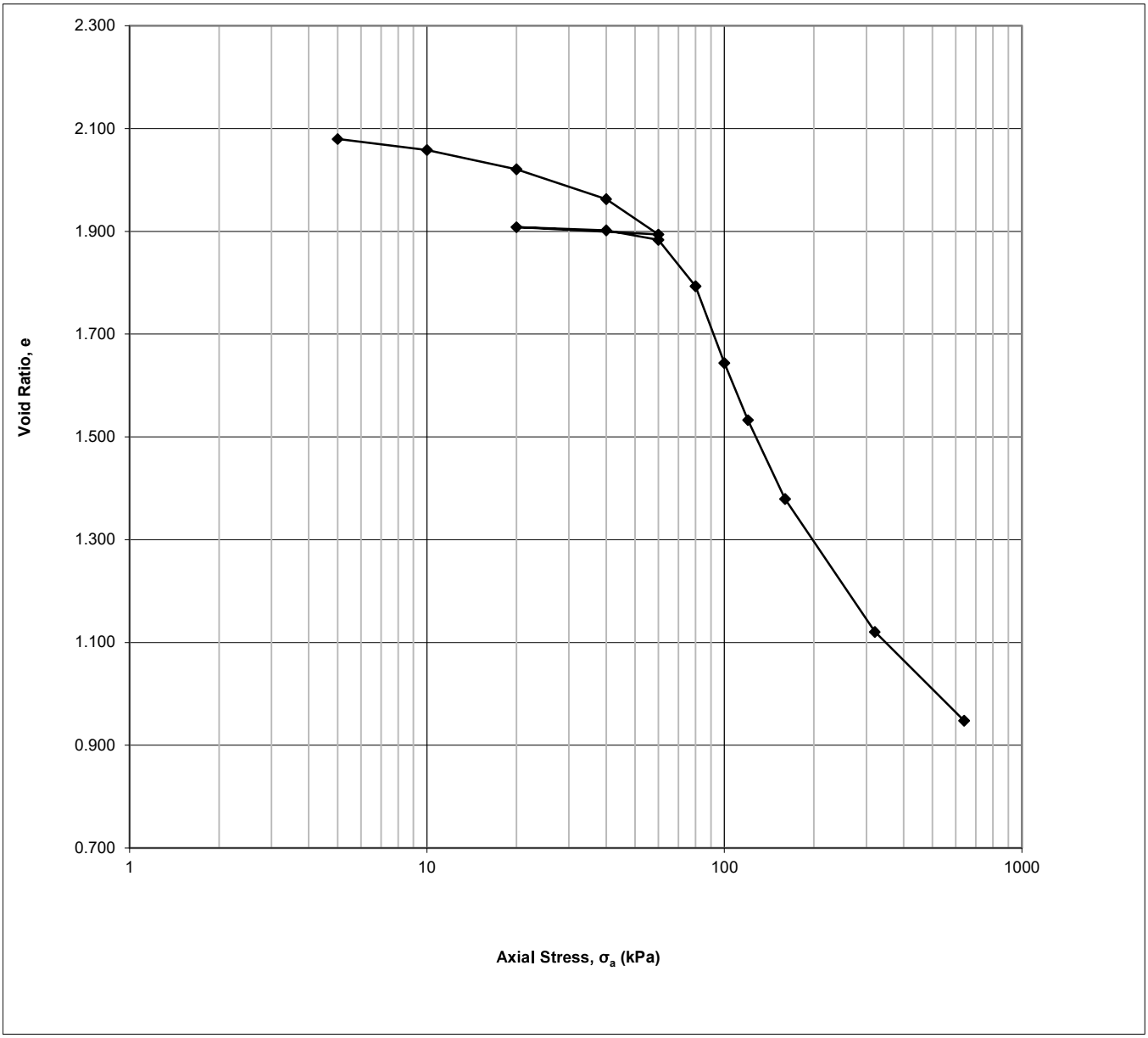
Photo No.: 2	Borehole: BH 6 TW-10	Depth: 40 – 42 ft

Stantec

One-Dimensional Consolidation Properties of Soils Using Incremental Loading

ASTM D2435/D2435M - 11(2020)

Project	**Exp, File# OTT21004743-B0**
Project No.	**121623683**
Borehole No.	**BH 8**
Sample No.	**TW4**
Sample Depth	**10-12 ft.**



Stantec

Stantec Consulting Ltd.

Checked by: D. Boateng Date: June 7, 2021
Approved by: R. Dey Date: June 7, 2021

One-Dimensional Consolidation Test using Incremental Loading
ASTM D2435/D2435M - 11(2020)

Specimen Details

Project Name	Exp, File# OTT21004743-B0
Project Location	Navan, ON
Borehole	BH 8
Sample No.	TW4
Depth	10-12 ft.
Sample Date	April 29, 2021
Test Number	Two
Technician Name	Daniel Boateng

Soil Description & Classification

Silty clay, grey, wet	
Specific Gravity of Solids	2.750
Average water content of trimmings %	74.78
Additional Notes (information source, occurence and size of large isolated particles etc.)	
1. Specific Gravity of Solids Assumed, 2. Loading schedule provided by client	

Initial Specimen Conditions

Height	mm	20.00
Diameter	mm	50.00
Area	mm^2	1963
Volume	mm^3	39270
Mass	g	60.35
Dry Mass	g	34.53
Density	Mg/m^3	1.537
Dry Density	Mg/m^3	0.879
Water Content	%	74.78
Degree of Saturation	%	96.7
Height of Solids	mm	6.39
Initial Void Ratio		2.127

Final Specimen Conditions

Water Content	%	37.42
Final Void Ratio		0.948
Final Height	mm	12.46

Stantec

Stantec Consulting Ltd.

Filename: V:\01216\active\laboratory_standing_offers\2021 Laboratory Standing Offers\121623685 Date: June 7, 2021
Checked by: D. Boateng Date: June 7, 2021
Approved by: R. Dey Date:

One-Dimensional Consolidation Test using Incremental Loading
ASTM D2435/D2435M - 11(2020)

Specimen Details

Project Name	Exp, File# OTT21004743-B0
Project Location	Navan, ON
Borehole	BH 8
Sample No.	TW4
Depth	10-12 ft.
Sample Date	April 29, 2021
Test Number	Two
Technician Name	Daniel Boateng

Test Procedure

Date Started		May 4, 2021
Date Finished		May 19, 2021
Machine Number		Frame E
Cell Number		E
Ring Number		E
Trimming Procedure		Trimming turntable/Cutting ring
Moisture Condition		Inundated
Axial Stress at Inundation	kPa	5
Water Used		De-aired tap water
Test Method		A
Interpretation Procedure for c_v		2

All Departures from Outlined ASTM D2435/D2435M-11 Procedure

Calculations

Load Increment	Increment Duration min	Axial Stress σ_a kPa	Corrected Deformation ΔH mm	Specimen Height H mm	Axial Strain ε_a %	Void Ratio e
Seating	0.0	0	0.0000	20.0000	0.00	2.127
1	1440.0	5	0.3052	19.6948	1.53	2.080
2	1440.0	10	0.4408	19.5592	2.20	2.059
3	1440.0	20	0.6806	19.3194	3.40	2.021
4	1440.0	40	1.0524	18.9476	5.26	1.963
5	1440.0	60	1.4918	18.5082	7.46	1.894
6	1440.0	20	1.4011	18.5989	7.01	1.908
7	1440.0	40	1.4422	18.5578	7.21	1.902
8	1440.0	60	1.5605	18.4395	7.80	1.883
9	1440.0	80	2.1372	17.8628	10.69	1.793
10	1440.0	100	3.0925	16.9075	15.46	1.644
11	1440.0	120	3.8023	16.1977	19.01	1.533
12	1440.0	160	4.7844	15.2156	23.92	1.379
13	1440.0	320	6.4396	13.5604	32.20	1.121
14	1440.0	640	7.5443	12.4557	37.72	0.948

Stantec

Stantec Consulting Ltd.

Filename: V:\01216\active\laboratory_standing_offers\2021 Laboratory SI
Date: June 7, 2021
Checked by: D. Boateng Date: June 7, 2021
Approved by: R. Dey Date: June 7, 2021

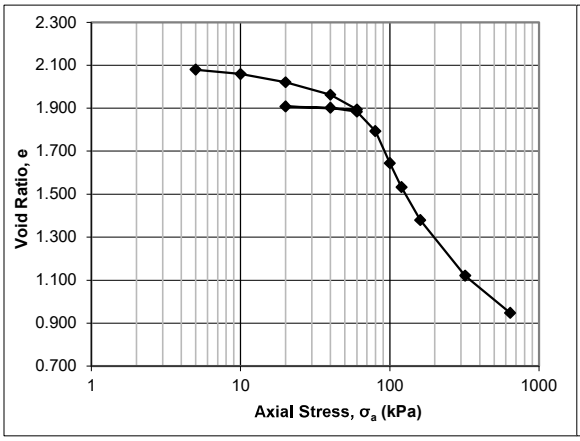
One-Dimensional Consolidation Test using Incremental Loading
ASTM D2435/D2435M - 11(2020)

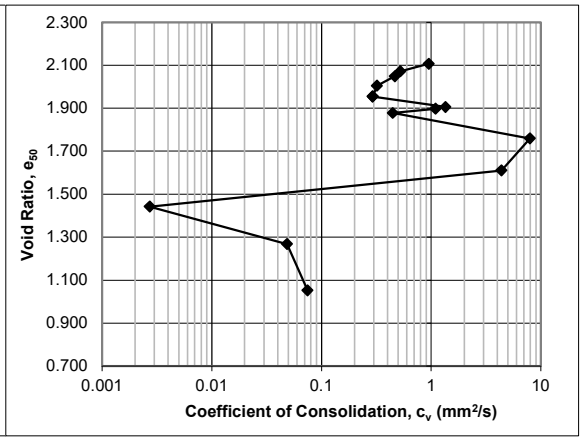
Specimen Details

Job Ref.	Exp, File# OTT21004743-B0
Job Location	Navan, ON
Borehole	BH 8
Sample No.	TW4
Depth	10-12 ft.
Sample Date	April 29, 2021
Test Number	Two
Technician Name	Daniel Boateng

Calculations

		Calculated using Interpretation Procedure 2				Interpretation Procedure 1		Interpretation Procedure 2	
Load Increment	Axial Stress $\sigma_{a,\ average}$ kPa	Corrected Deformation ΔH_{50} mm	Specimen Height H_{50} mm	Axial Strain $\varepsilon_{a,50}$ %	Void Ratio e_{50}	Time t_{50} sec	Coeff. Consol. c_v mm^2/s	Time t_{90} sec	Coeff. Consol. c_v mm^2/s
Seating	0								
1	3	0.1328	19.8672	0.66	2.107			88	9.52E-01
2	8	0.3573	19.6427	1.79	2.072			156	5.24E-01
3	15	0.5028	19.4972	2.51	2.049			173	4.67E-01
4	30	0.7888	19.2112	3.94	2.004			245	3.20E-01
5	50	1.1091	18.8909	5.55	1.954			258	2.93E-01
6	40	1.4503	18.5497	7.25	1.901				
7	30	1.4189	18.5811	7.09	1.906			54	1.35E+00
8	50	1.4684	18.5316	7.34	1.898			66	1.10E+00
9	70	1.5934	18.4066	7.97	1.878			160	4.48E-01
10	90	2.3556	17.6444	11.78	1.759			8	7.94E+00
11	110	3.3032	16.6968	16.52	1.611			13	4.38E+00
12	140	4.3856	15.6144	21.93	1.442			18992	2.72E-03
13	240	5.4934	14.5066	27.47	1.268			917	4.87E-02
14	480	6.8742	13.1258	34.37	1.053			490	7.45E-02





Stantec	Project No.: 121623683 Project Name: Exp, File# OTT-21004743-B0	Photo Log

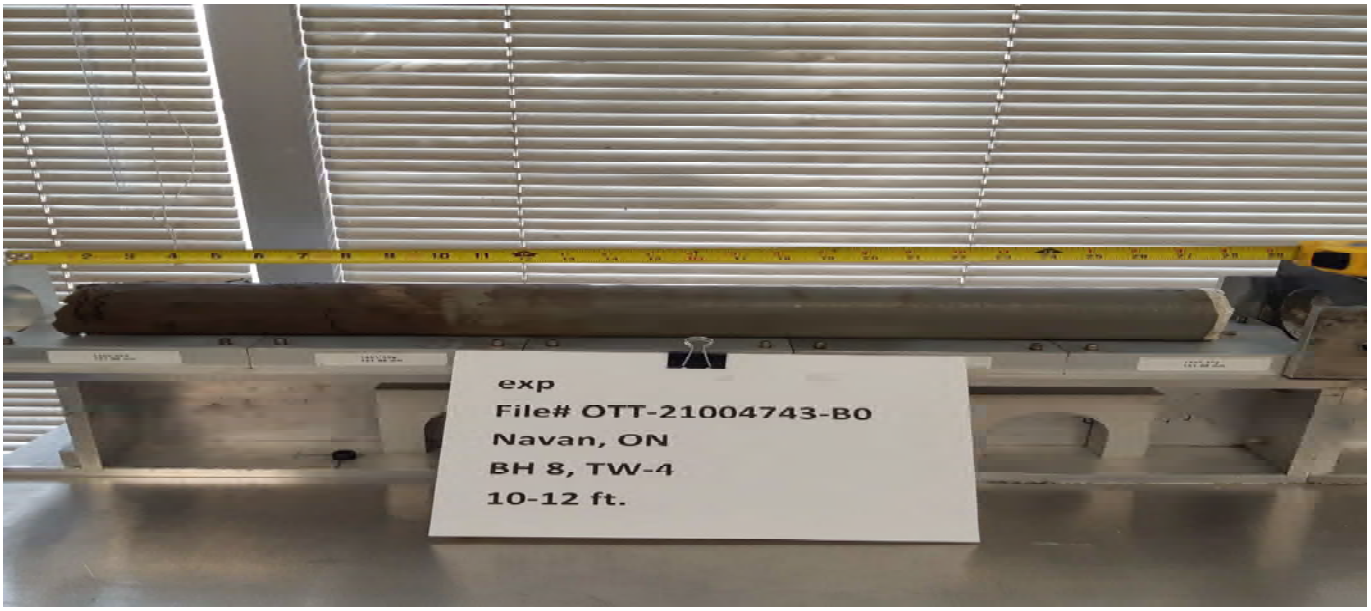


Photo No.: 1	Borehole: BH 8 TW-4	Depth: 10 – 12 ft

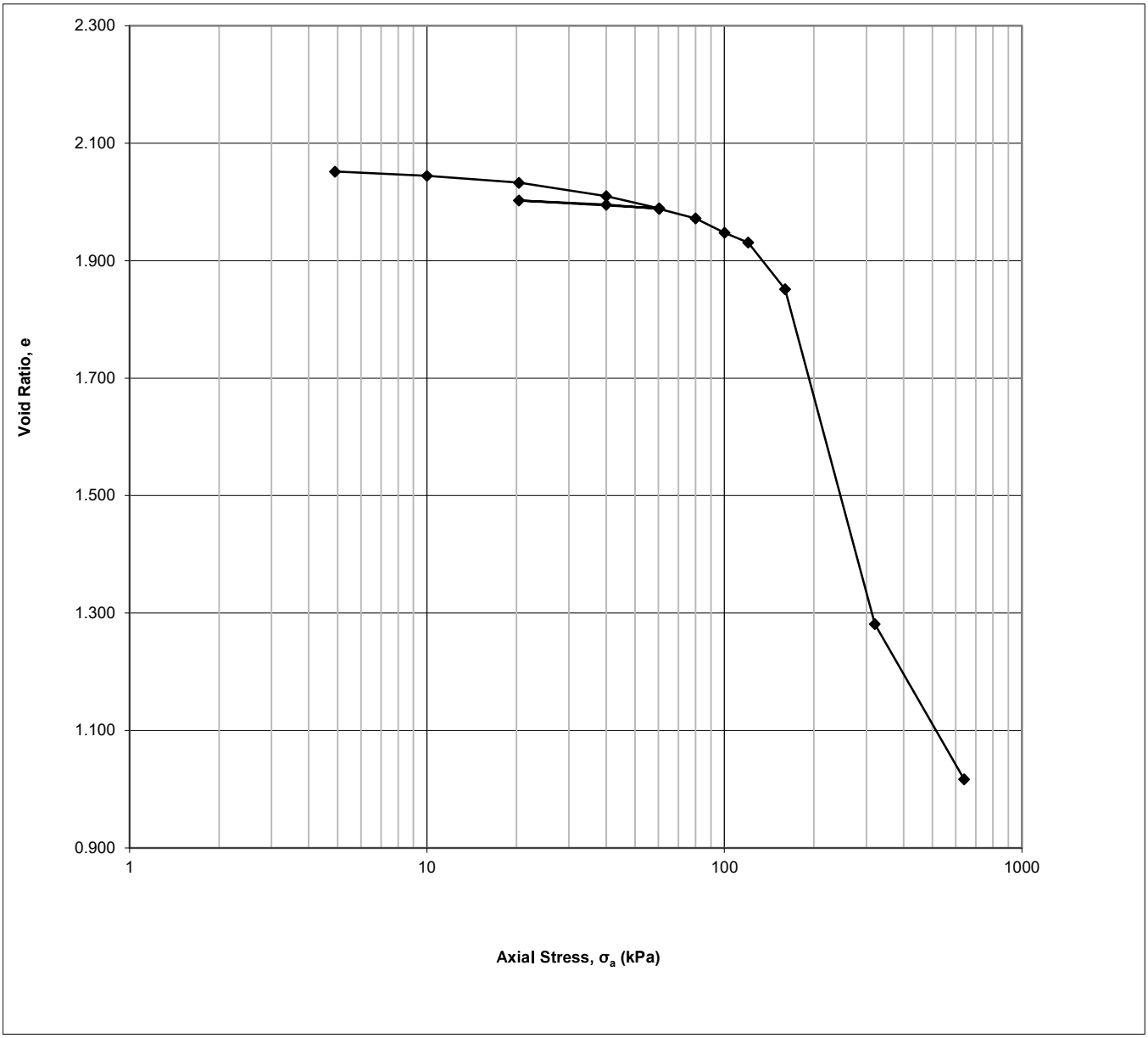
Photo No.: 2	Borehole: BH 8 TW-4	Depth: 10 – 12 ft

Stantec

One-Dimensional Consolidation Properties of Soils Using Incremental Loading

ASTM D2435/D2435M - 11(2020)

Project	**Exp, File# OTT21004743-B0**
Project No.	**121623683**
Borehole No.	**BH 7**
Sample No.	**TW6**
Sample Depth	**15-17 ft**



Stantec

Stantec Consulting Ltd.

Checked by: D. Boateng Date: June 7, 2021
Approved by: R. Dey Date: June 7, 2021

One-Dimensional Consolidation Test using Incremental Loading

ASTM D2435/D2435M - 11(2020)

Specimen Details

Project Name	Exp, File# OTT21004743-B0
Project Location	Navan, ON
Borehole	BH 7
Sample No.	TW6
Depth	15-17 ft
Sample Date	April 30, 2021
Test Number	Three
Technician Name	Daniel Boateng

Soil Description & Classification

Silty clay, brown/grey, friable, moist	
Specific Gravity of Solids	2.750
Average water content of trimmings %	73.07
Additional Notes (information source, occurence and size of large isolated particles etc.)	
1. Specific Gravity of Solids Assumed, 2. Loading schedule provided by client	

Initial Specimen Conditions

Height	mm	19.03
Diameter	mm	50.86
Area	mm^2	2032
Volume	mm^3	38662
Mass	g	60.21
Dry Mass	g	34.79
Density	Mg/m^3	1.557
Dry Density	Mg/m^3	0.900
Water Content	%	73.07
Degree of Saturation	%	97.7
Height of Solids	mm	6.23
Initial Void Ratio		2.056

Final Specimen Conditions

Water Content	%	40.67
Final Void Ratio		1.017
Final Height	mm	12.56

Stantec

Stantec Consulting Ltd.

Filename: V:\01216\active\laboratory_standing_offers\2021 Laboratory Standing Offers\121623685 Date: June 7, 2021
Checked by: D. Boateng Date: June 7, 2021
Approved by: R. Dey Date:

One-Dimensional Consolidation Test using Incremental Loading
ASTM D2435/D2435M - 11(2020)

Specimen Details

Project Name	Exp, File# OTT21004743-B0
Project Location	Navan, ON
Borehole	BH 7
Sample No.	TW6
Depth	15-17 ft
Sample Date	April 30, 2021
Test Number	Three
Technician Name	Daniel Boateng

Test Procedure

Date Started		May 7, 2021
Date Finished		May 22, 2021
Machine Number		Frame B
Cell Number		B
Ring Number		B
Trimming Procedure		Trimming turntable/Cutting ring
Moisture Condition		Inundated
Axial Stress at Inundation	kPa	5
Water Used		De-aired tap water
Test Method		A
Interpretation Procedure for c_v		2

All Departures from Outlined ASTM D2435/D2435M-11 Procedure

Calculations

Load Increment	Increment Duration min	Axial Stress σ_a kPa	Corrected Deformation ΔH mm	Specimen Height H mm	Axial Strain ε_a %	Void Ratio e
Seating	0.0	0	0.0000	19.0300	0.00	2.056
1	1440.0	5	0.0260	19.0040	0.14	2.052
2	1440.0	10	0.0710	18.9590	0.37	2.045
3	1440.0	20	0.1430	18.8870	0.75	2.033
4	1440.0	40	0.2850	18.7450	1.50	2.010
5	1440.0	60	0.4160	18.6140	2.19	1.989
6	1440.0	20	0.3320	18.6980	1.74	2.003
7	1440.0	40	0.3780	18.6520	1.99	1.995
8	1440.0	60	0.4220	18.6080	2.22	1.988
9	1440.0	80	0.5210	18.5090	2.74	1.972
10	1440.0	100	0.6740	18.3560	3.54	1.948
11	1440.0	120	0.7790	18.2510	4.09	1.931
12	1440.0	160	1.2740	17.7560	6.69	1.851
13	1440.0	320	4.8230	14.2070	25.34	1.282
14	1440.0	640	6.4700	12.5600	34.00	1.017

Stantec

Stantec Consulting Ltd.

Filename: V:\01216\active\laboratory_standing_offers\2021 Laboratory SI
Date: June 7, 2021
Checked by: D. Boateng
Date: June 7, 2021
Approved by: R. Dey
Date: June 7, 2021

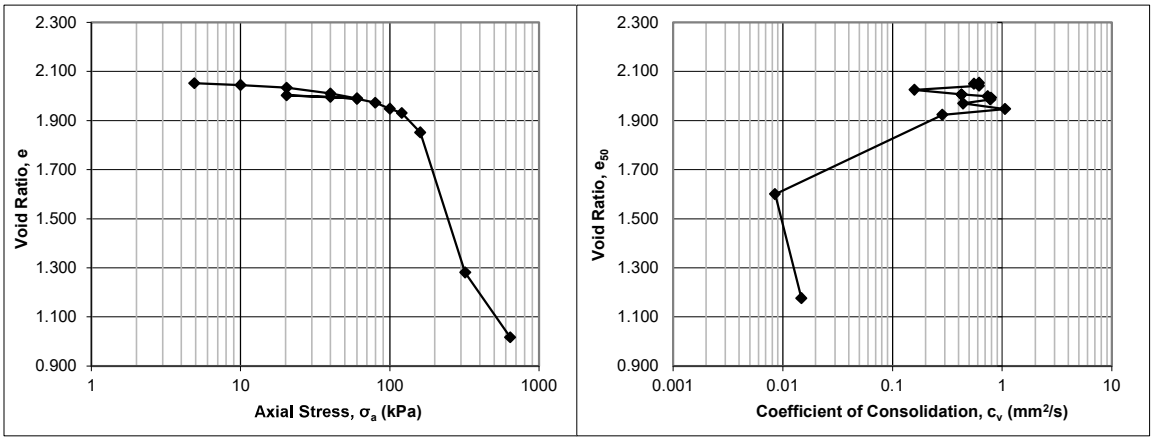
One-Dimensional Consolidation Test using Incremental Loading
ASTM D2435/D2435M - 11(2020)

Specimen Details

Job Ref.	Exp, File# OTT21004743-B0
Job Location	Navan, ON
Borehole	BH 7
Sample No.	TW6
Depth	15-17 ft
Sample Date	April 30, 2021
Test Number	Three
Technician Name	Daniel Boateng

Calculations

		Calculated using Interpretation Procedure 2				Interpretation Procedure 1		Interpretation Procedure 2	
Load Increment	Axial Stress $\sigma_{a,\ average}$ kPa	Corrected Deformation ΔH_{50} mm	Specimen Height H_{50} mm	Axial Strain $\varepsilon_{a,50}$ %	Void Ratio e_{50}	Time t_{50} sec	Coeff. Consol. c_v mm^2/s	Time t_{90} sec	Coeff. Consol. c_v mm^2/s
Seating	0								
1	2	0.0137	19.0163	0.07	2.054			124	6.17E-01
2	8	0.0436	18.9864	0.23	2.049			137	5.56E-01
3	15	0.0924	18.9376	0.49	2.041			123	6.17E-01
4	30	0.1928	18.8372	1.01	2.025			472	1.59E-01
5	50	0.3127	18.7173	1.64	2.006			173	4.28E-01
6	40	0.3797	18.6503	2.00	1.995				
7	30	0.3549	18.6751	1.87	1.999			100	7.37E-01
8	50	0.3945	18.6355	2.07	1.993			93	7.93E-01
9	70	0.4412	18.5888	2.32	1.985			94	7.81E-01
10	90	0.5405	18.4895	2.84	1.969			165	4.40E-01
11	110	0.6825	18.3475	3.59	1.946			67	1.06E+00
12	140	0.8241	18.2059	4.33	1.924			247	2.85E-01
13	240	2.8350	16.1950	14.90	1.601			6536	8.51E-03
14	480	5.4755	13.5545	28.77	1.177			2631	1.48E-02



Appendix D:
Laboratory Certificate of Analysis

AGAT Laboratories

5835 COOPERS AVENUE
MISSISSAUGA, ONTARIO
CANADA L4Z 1Y2
TEL (905)712-5100
FAX (905)712-5122
http://www.agatlabs.com

CLIENT NAME: EXP SERVICES INC
2650 QUEENSVIEW DRIVE, UNIT 100
OTTAWA, ON K2B8H6
(613) 688-1899
ATTENTION TO: Ismail M. Taki
PROJECT: OTT-21004743
AGAT WORK ORDER: 21Z744061
SOIL ANALYSIS REVIEWED BY: Nivine Basily, Inorganics Report Writer
DATE REPORTED: May 14, 2021
PAGES (INCLUDING COVER): 6
VERSION*: 1

Should you require any information regarding this analysis please contact your client services representative at (905) 712-5100

*Notes

Disclaimer:

- *All work conducted herein has been done using accepted standard protocols, and generally accepted practices and methods. AGAT test methods may incorporate modifications from the specified reference methods to improve performance.*
- *All samples will be disposed of within 30 days after receipt unless a Long Term Storage Agreement is signed and returned. Some specialty analysis may be exempt, please contact your Client Project Manager for details.*
- *AGAT's liability in connection with any delay, performance or non-performance of these services is only to the Client and does not extend to any other third party. Unless expressly agreed otherwise in writing, AGAT's liability is limited to the actual cost of the specific analysis or analyses included in the services.*
- *This Certificate shall not be reproduced except in full, without the written approval of the laboratory.*
- *The test results reported herewith relate only to the samples as received by the laboratory.*
- *Application of guidelines is provided "as is" without warranty of any kind, either expressed or implied, including, but not limited to, warranties of merchantability, fitness for a particular purpose, or non-infringement. AGAT assumes no responsibility for any errors or omissions in the guidelines contained in this document.*
- *All reportable information as specified by ISO/IEC 17025:2017 is available from AGAT Laboratories upon request.*

AGAT Laboratories

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http://www.agatlabs.com

Certificate of Analysis

AGAT WORK ORDER: 21Z744061

PROJECT: OTT-21004743

CLIENT NAME: EXP SERVICES INC

ATTENTION TO: Ismail M. Taki

SAMPLING SITE:

SAMPLED BY:

Inorganic Chemistry (Soil)

DATE RECEIVED: 2021-05-07

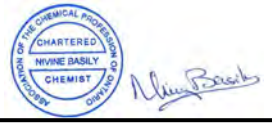
DATE REPORTED: 2021-05-14

		SAMPLE DESCRIPTION:		BH3 SS2 5'-7'	BH6 SS4 10'-12'	BH7 SS5 12'6"-14'6"	BH8 SS2 5'-7'	BH10 SS2 5'-7'
		SAMPLE TYPE:		Soil	Soil	Soil	Soil	Soil
		DATE SAMPLED:		2021-04-29	2021-04-28	2021-04-30	2021-04-29	2021-04-29
Parameter	Unit	G / S	RDL	2443617	2443618	2443619	2443620	2443621
Chloride (2:1)	µg/g		2	10	27	5	19	3
Sulphate (2:1)	µg/g		2	12	120	28	20	16
pH (2:1)	pH Units		NA	7.70	8.03	8.17	7.75	8.35
Resistivity (2:1) (Calculated)	ohm.cm		1	17200	3050	7140	14700	9620

Comments: RDL - Reported Detection Limit; G / S - Guideline / Standard

2443617-2443621 EC, pH, Chloride and Sulphate were determined on the extract obtained from the 2:1 leaching procedure (2 parts DI water: 1 part soil). Resistivity is a calculated parameter.
Analysis perfomed at AGAT Toronto (unless marked by *)

Certified By:



AGAT Laboratories

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Certificate of Analysis

AGAT WORK ORDER: 21Z744061

PROJECT: OTT-21004743

CLIENT NAME: EXP SERVICES INC

ATTENTION TO: Ismail M. Taki

SAMPLING SITE:

SAMPLED BY:

Inorganic Chemistry (Soil) %

DATE RECEIVED: 2021-05-07

DATE REPORTED: 2021-05-14

SAMPLE DESCRIPTION:				BH3 SS2 5'-7'	BH6 SS4 10'-12'	BH7 SS5 12'6"-14'6"	BH8 SS2 5'-7'	BH10 SS2 5'-7'
SAMPLE TYPE:				Soil	Soil	Soil	Soil	Soil
DATE SAMPLED:				2021-04-29	2021-04-28	2021-04-30	2021-04-29	2021-04-29
Parameter	Unit	G / S	RDL	2443617	2443618	2443619	2443620	2443621
Chloride (2:1)	%		0.0002	0.001	0.0027	0.0005	0.0019	0.0003
Sulphate (2:1)	%		0.0002	0.0012	0.012	0.0028	0.002	0.0016

Comments: RDL - Reported Detection Limit; G / S - Guideline / Standard

2443617-2443621 Chloride and Sulphate were determined on the extract obtained from the 2:1 leaching procedure (2 parts DI water: 1 part soil).

Analysis perfomed at AGAT Toronto (unless marked by *)

Certified By:

AGAT Laboratories

5835 COOPERS AVENUE
MISSISSAUGA, ONTARIO
CANADA L4Z 1Y2
TEL (905)712-5100
FAX (905)712-5122
http://www.agatlabs.com

Quality Assurance

CLIENT NAME: EXP SERVICES INC

AGAT WORK ORDER: 21Z744061

PROJECT: OTT-21004743

ATTENTION TO: Ismail M. Taki

SAMPLING SITE:

SAMPLED BY:

Soil Analysis

RPT Date: May 14, 2021			DUPLICATE				REFERENCE MATERIAL			METHOD BLANK SPIKE			MATRIX SPIKE		
PARAMETER	Batch	Sample Id	Dup #1	Dup #2	RPD	Method Blank	Measured Value	Acceptable Limits		Recovery	Acceptable Limits		Recovery	Acceptable Limits	
								Lower	Upper		Lower	Upper		Lower	Upper
Inorganic Chemistry (Soil)															
Chloride (2:1)	2454700		4	4	NA	< 2	98%	70%	130%	103%	80%	120%	103%	70%	130%
Sulphate (2:1)	2454700		82	82	0.0%	< 2	92%	70%	130%	99%	80%	120%	102%	70%	130%
pH (2:1)	2454700		8.07	8.09	0.2%	NA	100%	80%	120%						

Comments: NA signifies Not Applicable.
pH duplicates QA acceptance criteria was met relative as stated in Table 5-15 of Analytical Protocol document.

Duplicate NA: results are under 5X the RDL and will not be calculated.

Inorganic Chemistry (Soil) %															
Chloride (2:1)	2454700		0.0004	0.0004	NA	< 2	98%	70%	130%	103%	80%	120%	103%	70%	130%
Sulphate (2:1)	2454700		0.082	0.082	NA	< 2	92%	70%	130%	99%	80%	120%	102%	70%	130%

Comments: NA signifies Not Applicable.
Duplicate NA: results are under 5X the RDL and will not be calculated.

Certified By:

5835 COOPERS AVENUE
MISSISSAUGA, ONTARIO
CANADA L4Z 1Y2
TEL (905)712-5100
FAX (905)712-5122
http://www.agatlabs.com

Method Summary

CLIENT NAME: EXP SERVICES INC

AGAT WORK ORDER: 21Z744061

PROJECT: OTT-21004743

ATTENTION TO: Ismail M. Taki

SAMPLING SITE:

SAMPLED BY:

PARAMETER	AGAT S.O.P	LITERATURE REFERENCE	ANALYTICAL TECHNIQUE
Soil Analysis			
Chloride (2:1)	INOR-93-6004	modified from SM 4110 B	ION CHROMATOGRAPH
Sulphate (2:1)	INOR-93-6004	modified from SM 4110 B	ION CHROMATOGRAPH
pH (2:1)	INOR 93-6031	modified from EPA 9045D and MCKEAGUE 3.11	PH METER
Resistivity (2:1) (Calculated)	INOR-93-6036	McKeague 4.12, SM 2510 B,SSA #5 Part 3	CALCULATION

AGAT Laboratories

5835 Coopers Avenue
Mississauga, Ontario L4Z 1Y2
Ph: 905.712.5100 Fax: 905.712.5122
webearth.agatlabs.com

Chain of Custody Record

If this is a Drinking Water sample, please use Drinking Water Chain of Custody Form (potable water consumed by humans)

Laboratory Use Only

Work Order #: 21744061

Cooler Quantity: One - no ice

Arrival Temperatures: 19.1 | 19.1 | 19.3
2.4 | 2.8 | 15.3

Custody Seal Intact: ☐ Yes ☐ No ☒ N/A

Notes: on ice packs

Report Information:

Company: EXP
Contact: Ismail Tak:
Address: 2650 Queensview Dr Suite 100
Ottawa ON K2B 8H6
Phone: 613-688-1899 Fax:
Reports to be sent to:
1. Email: Ismail.Tak@exp.com
2. Email:

Regulatory Requirements:

(Please check all applicable boxes)

☐ Regulation 153/04
Table ___ *Indicate One*
☐ Ind/Com
☐ Res/Park
☐ Agriculture
Soil Texture *(Check One)*
☐ Coarse
☐ Fine

☐ Excess Soils R406
Table ___ *Indicate One*
☐ Regulation 558
☐ CCME

☐ Sewer Use ☐ Sanitary ☐ Storm
___ *Region*
☐ Prov. Water Quality Objectives (PWQO)
☐ Other
___ *Indicate One*

Is this submission for a **Record of Site Condition?** ☐ Yes ☐ No

Report Guideline on *Certificate of Analysis* ☐ Yes ☐ No

Turnaround Time (TAT) Required:

Regular TAT ☒ 5 to 7 Business Days

Rush TAT (Rush Surcharges Apply)

☐ 3 Business Days ☐ 2 Business Days ☐ Next Business Day

OR Date Required (Rush Surcharges May Apply):

Please provide prior notification for rush TAT
**TAT is exclusive of weekends and statutory holidays*

For 'Same Day' analysis, please contact your AGAT CPM

Project Information:

Project: OTT-21004743
Site Location: Navan Rd
Sampled By: EXP
AGAT Quote #: PO:
Please note: If quotation number is not provided, client will be billed full price for analysis.

Invoice Information:

Bill To Same: Yes ☒ No ☐

Company:
Contact:
Address:
Email:

Sample Matrix Legend

B	Biota
GW	Ground Water
O	Oil
P	Paint
S	Soil
SD	Sediment
SW	Surface Water

Sample Identification	Date Sampled	Time Sampled	# of Containers	Sample Matrix	Comments/ Special Instructions	Field Filtered - Metals, Hg, CrVI, DOC Y/N	O. Reg 153: Metals & Inorganics	Metals - ☐ CrVI, ☐ Hg, ☐ HWSB	BTEX, F1-F4 PHCs Analyze F4G if required ☐ Yes ☐ No	PAHs	PCBs	VOC	O. Reg 558: Landfill Disposal Characterization TCLP: ☐ M&I ☐ VOCs ☐ ABNs ☐ B(a)P ☐ PCBs	O. Reg 406: Excess Soils SPLP Rainwater Leach ☐ Metals ☐ VOCs ☐ SVOCs	Excess Soils Characterization Package pH, ICPMS Metals, BTEX, F1-F4	Salt - EC/SAR	pH	Sulphate	Chloride	Electrical Conductivity				Potential for Hazardous or High Concentration (Y/N)
BH 3 SS 2 5'-7'	Apr 29/21	AM PM	1														✓	✓	✓	✓				
BH 6 SS 4 10'-12'	Apr 28	AM PM	1														✓	✓	✓	✓				
BH 7 SS 5 12'6"-14'6"	Apr 30	AM PM	1														✓	✓	✓	✓				
BH 8 SS 2 5'-7'	Apr 29	AM PM	1														✓	✓	✓	✓				
BH 10 SS 2 5'-7'	Apr 29	AM PM	1														✓	✓	✓	✓				
		AM PM																						
		AM PM																						
		AM PM																						
		AM PM																						
		AM PM																						
		AM PM																						

Samples Relinquished By (Print Name and Sign)	Date	Time	Samples Received By (Print Name and Sign)	Date	Time
Ryan DiGiuseppe	May 6/21	5:00pm	UBerthiaume	2021/05/07	10h31
Samples Relinquished By (Print Name and Sign): UPS to Pkns	21/5/7	16h00	Samples Received By (Print Name and Sign): Adriana Bellavia ABellavia	May 8/21	9:48
Samples Relinquished By (Print Name and Sign)	Date	Time	Samples Received By (Print Name and Sign)	Date	Time

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N°: 111858

Document ID: DN-TS-1511-010

Pink Copy - Client | Yellow Copy - AGAT | White Copy- AGAT

Date Issued: August 04, 2020

Appendix E:
Legal Notification

Legal Notification

This report was prepared by EXP Services Inc. (EXP) for the account of 12714001 Canada Inc.

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

Report Distribution

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