Updated 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 updated 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). Authorization to proceed with this geotechnical investigation was provided by 12714001 Canada Inc.

Geotechnical investigations for the proposed gas bar (Block 16) to be located west of the residential development site and for the off-site municipal servicing along Brian Coburn Road and Navan Road were undertaken by EXP and are provided in separate geotechnical reports. A Phase One Environmental Site Assessment (ESA) of 3053 and 3079 Navan Road was undertaken by EXP and is also documented in a separate report.

The proposed development will include townhouse block and apartment buildings.

The apartment buildings will be located at Blocks 14,15 and 17 with two (2) apartment buildings in each block. Each building will consist of 4 storeys with a one-level underground parking garage. Outdoor parking, access roads and loading areas will be located on top of the parking garage podium slab. Based on the grading drawings (Drawing No. C02) for Blocks 14,15 and 17 dated July 26,2024 (Revision No. 2) and September 6,2024 (Revision No. 1) and prepared by J.L. Richards (JLR), the floor slab of the underground parking garage will range from Elevation 82.25 m to Elevation 78.86 m for the six (6) buildings. Proposed maximum site grade raise for Blocks 14, 15 and 17 are 1.3 m, 1.0 m and 2.0 m respectively.

The **townhouse blocks** will be located at Blocks 1 to 6 and 8 to 11. The grading plan, Drawing No. G1, dated August 27,2024 (Revision No. 5) and prepared by J.L. Richards (JLR) indicates the townhouse blocks will have basements. The grading plan also shows the spot elevations for the existing grades and for the proposed final grades at the townhouse block properties and along the access roads within the development and the proposed design elevation of the underside of the footings for the townhouse blocks.

The development will be serviced by municipal services. A spill over pond will be located in the southeast portion of the site at Block 13 and will be designed as a dry pond. The grading for the spill over pond is provided in the grading plan, Drawing No. POND, dated August 27,2024 (Revision No. 5) and prepared by JLR. The overall residential development will include paved access roads with access to the development made available by Paleo Heights from Brian Coburn Boulevard West and from Navan Road.

An outdoor park will be located at Block 7 and Block 12 will be an easement.

The fieldwork for the geotechnical investigation was completed in three (3) phases with the first phase undertaken from April 28 to 30, 2021, the second phase undertaken from September 11 to 14, 2023 and the third phase on January 31,2024. The fieldwork consists of a total of nineteen (19) boreholes (Borehole Nos. 1 to 9, 11 to 18,20 and 21). Borehole Nos. 1 to 9 were conducted in 2021 and Borehole Nos. 11 to 18 and 20 were undertaken in 2023 and Borehole No. 21 was conducted in 2024. Borehole No. 10 is part of the proposed gas bar site located west of the site of the proposed residential development and is included in the EXP geotechnical report for the proposed gas bar. Also, the log for Borehole No. 10 is included in this report. Borehole No. 19 was not drilled. The boreholes were advanced to termination depths ranging from 6.2 m to 30.5 m below the existing ground surface. Monitoring wells were installed in selected boreholes for long-term monitoring of the groundwater levels.

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. Highest and lowest groundwater level measurements undertaken from June 2012 to September 2024 are provided in the attached geotechnical report.

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. 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 results of the boreholes revealed that the site is underlain by a sensitive marine clay deposit and the groundwater level is high. The clay deposit is prone to consolidation settlement that will exceed normally tolerable limits if overstressed by a combination of the following loads imposed on the clay:

- Placement of fill on the site to raise the site grades,
- Footing loads applied to the clay by the proposed structures; and,
- Post construction permanent lowering of the groundwater table due to the installation of subsurface drainage systems.

For the proposed development, the load stress imposed on the clay at the apartment and townhouse block properties will include a combination of all three (3) types of loads listed above. The total combined load stress applied to the clay should be below the preconsolidation pressure of the clay in order to keep consolidation settlement of the proposed structures within normally tolerable limits.

Based on a review of the borehole information, JLR grading plans and that the proposed **apartment buildings (Blocks 14,15 and 17)** will be supported by pile foundations as recommended in Section 10.1 of the attached report, the proposed maximum site grade raise of 1.3 m and 1.0 m for the apartment buildings located in Blocks 14 and 15 respectively may be achieved by using soil fill. For the apartment buildings located at Block 17, the maximum permissible site grade raise using soil fill is 1.5 m. To achieve the proposed 2.0 m maximum site grade raise at Block 17, light-weight fill (LWF) will need to be used for the remaining 0.5 m site grade raise. The acceptability of the proposed maximum site grade raise has taken into consideration the permanent lowering of the groundwater level (using highest groundwater level) from the permanent drainage systems of the buildings.

Based on a review of the borehole information and JLR grading plans, it is considered that the proposed **townhouses (Blocks 1 to 6 and 8 to 11)** may supported by footings founded at the proposed design elevation of the underside of footing in conjunction with achieving the proposed maximum site grade raise by using soil fill. The exception to this is Block 8 where the proposed 2.0 m site grade raise will have to be achieved by a combination of 1.0 m of soil fill and 1.0 m of light-weight fill (LWF). A summary of design site grade raise with recommended SLS and factored ULS values for footings is shown in the attached report. The acceptability of the proposed maximum site grade raise includes the permanent lowering of the groundwater level (using highest groundwater level) from the permanent drainage systems of the buildings.

Based on a review of the JLR grading plan, the proposed site grade raise within the access roads, Rosalie Ridge and Paleo Heights, is in the order of 1.7 m. The maximum proposed site grade raise of 1.7 m using approved soil fill within the proposed access roads is considered acceptable.

The lowest floor slab of the proposed buildings may be designed as a slab-on-grade. The slab-on-grade may be founded on a bed of 200 mm of 19 mm size clear stone placed on top of a minimum 300 mm thick compacted OPSS Granular B Type II pad placed on the native silty clay to clay and constructed in accordance with Section 9 of the attached report. Alternatively, the clear stone layer may be replaced with a 300 mm thick OPSS Granular A layer compacted to 98 percent SPMDD and overlain with a vapour barrier. 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.

The proposed apartment buildings with an underground parking garage and townhouse buildings with basements should have a permanent perimeter drainage system around the buildings. Since the design elevation of the floor slab of the underground parking garages will be close to and below the highest groundwater level, the proposed apartment buildings will need to have an underfloor drainage system. For the townhouses, the design elevation of the basement floors is not known but is assumed to be 600 mm above the design underside footing elevation (USF). In this case and based on a review of the USF with the highest groundwater level, the basement slab will be located close to or below the highest groundwater level and therefore will require an underfloor drainage system. Both systems should be connected to separate sumps so that at least one system would be operational should the other system fail and the design should include back up pumps and generators, in case of mechanical failure and/or power outage.

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.

Seepage of the surface and subsurface water into the excavations is anticipated and it should be possible to collect water entering the excavations at low points and to remove it by conventional pumping techniques. In areas of high infiltration or where more permeable soils exist, such as within the sandy silt to silty sand, a higher seepage rate should be anticipated and may require high-capacity pumps to keep the excavation dry.

Excavations that terminate within the silty sand to sandy silt and below the groundwater level will be prone to base heave failure in the form of piping. To minimize base heave failure, the groundwater level within the silty sand to sandy silt will need to be lowered to at least 1.0 m below the base of the excavation prior to start of excavation. The groundwater may be lowered by installing deep sumps equipped with pumps.

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 attached report.

For the design of the piles to support the proposed apartment buildings, additional boreholes should be undertaken to determine the bedrock depth (elevation). Based on the findings from the additional boreholes, the pile recommendations in this report will need to be updated.

A hydrogeological investigation should be undertaken to estimate short term construction and long-term permanent water taking volumes and to determine the impact, if any, short and long-term groundwater lowering at the site may have on existing buildings, structures and infrastructure near the site.

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

This executive summary is a brief synopsis of the report and should not be read in lieu of reading the attached geotechnical report in its entirety.

1. Introduction

EXP Services Inc. (EXP) is pleased to present the results of the updated 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). Authorization to proceed with this geotechnical investigation was provided by 12714001 Canada Inc.

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The development will be serviced by municipal services. A spill over pond will be located in the southeast portion of the site at Block 13 and will be designed as a dry pond. The grading for the spill over pond is provided in the grading plan, Drawing No. POND, dated August 27,2024 (Revision No. 5) and prepared by JLR. The overall residential development will include paved access roads with access to the development made available by Paleo Heights from Brian Coburn Boulevard West and from Navan Road.

An outdoor park will be located at Block 7 and Block 12 will be an easement.

This geotechnical investigation was undertaken to:

a) Establish the subsurface soil and groundwater conditions at nineteen (19) 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 January 1,2022 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) Comment on the design and construction of the spill over pond,

h) Provide pipe bedding requirements for the new underground services,

i) Comment on backfilling requirements and suitability of the on-site soils for backfilling purposes,

j) Provide pavement structures for driveways and access roads,

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

l) Provide comments regarding tree planting restrictions.

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 Elevation 85.92 m and Elevation 80.89 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 m to 55 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

5.1 Borehole Fieldwork

The fieldwork for the geotechnical investigation was completed in three (3) phases with the first phase undertaken from April 28 to 30, 2021, the second phase undertaken from September 11 to 14, 2023 and the third phase on January 31,2024. The fieldwork consists of a total of nineteen (19) boreholes (Borehole Nos. 1 to 9, 11 to 18,20 and 21). Borehole Nos. 1 to 9 were conducted in 2021 and Borehole Nos. 11 to 18 and 20 were undertaken in 2023 and Borehole No. 21 was conducted in 2024. Borehole No. 10 is part of the proposed gas bar site located west of the site of the proposed residential development and is included in the EXP geotechnical report for the proposed gas bar. Also, the log for Borehole No. 10 is included in this report. Borehole No. 19 was not drilled. The boreholes were advanced 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 for the three (3) phases of the fieldwork were identified on site. The 2021 borehole locations and geodetic elevations were established by a survey crew from EXP and are shown in Figure 2. The 2023 borehole locations and elevations were determined by Stantec. The ground surface elevation at Borehole No.4 was estimated from the spot elevations provided on the September 22,2023 grading plan prepared by JLR. Therefore, the ground surface elevation for Borehole No. 4 should be considered approximate.

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. Relatively undisturbed tube samples (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).

Nineteen (19) mm diameter standpipes and fifty (50) mm diameter monitoring wells were installed in the boreholes for long-term monitoring of the groundwater level. The standpipes and monitoring wells 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 and monitoring wells.

On completion of the fieldwork, the soil samples were transported to the EXP laboratory in Ottawa. Soil classification consisted of classifying the main constituents of the soils in accordance with the Unified Soil Classification System (USCS) using the soil group name and symbol and by the modified Burmister Soil classification System for the classification of the minor constituents of the soil using modifiers and adjectives (such as trace and some).

5.2 Laboratory Testing Program

The laboratory testing program for this project is summarized in Table I.

Table I: Summary of Laboratory Testing Program

Type of Test	Number of Tests Completed
Moisture Content Determination	135
Unit Weight Determination	8
Grain Size Analysis	13
Atterberg Limit Determination	10
Consolidation Tests	5
Corrosion Analysis Package (pH, sulphate, chloride and resistivity)	5

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 22. 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 C.

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 50 mm to 450 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 to 18, 20 and 21 are underlain by silty sand to sandy silt that extends to depths ranging from 0.3 m to 2.2 m (Elevation 87.4 m to Elevation 78.3 m). The N values from the standard penetration test (SPT) of 2 to 14 indicate the silty sand to sandy silt is in a very loose to compact state. The natural moisture content of the silty sand to sandy silt ranges from 8 percent to 32 percent.

The results from the grain-size analysis conducted on two (2) samples of the silty sand to sandy silt are summarized in Table II. The grain-size distribution curves are shown in Figures 23 and 24.

Table II: Summary of Results from Grain-Size Analysis – Silty Sand to Sandy Silt Samples						
Borehole No. (BH) – Sample No. (SS)	Depth (m)	Grain-Size Analysis (%)				Soil Classification
		Gravel	Sand	Silt	Clay	
BH1 – SS1	0.8-1.4	0	84	13	3	Silty Sand (SM) – Trace Clay
BH12 – SS1 and SS2	0.0-0.6 0.8-1.4	0	79	12	9	Silty Sand (SM) – Trace Clay

Based on a review of the results from the grain size analysis, the soil may be classified as a silty sand (SM) with trace clay.

6.4 Silty Clay to Clay

The topsoil and native silty sand to sandy silt are underlain by a sensitive marine silty clay to clay contacted in all nineteen (19) boreholes at a 0.3 m to 2.2 m depths (Elevation 87.4 m to Elevation 80.6 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 was contacted in all boreholes except Borehole Nos. 15, 17, 18 and 21 and extends to depths of 1.3 m to 3.6 m (Elevation 86.2 m to Elevation 77.7 m). The undrained shear strength of the crust ranges from 58 kPa to 180 kPa indicating a stiff to very stiff consistency. The natural moisture content and unit weight of the silty clay to clay crust is 25 percent to 49 percent and 17.1 kN/m^3 to 19.3 kN/m^3 respectively.

The results from the grain-size analysis conducted on two (2) samples of the silty clay to clay are summarized in Table III. The grain-size distribution curves are shown in Figures 25 and 26.

Table III: Summary of Results from Grain-Size Analysis and Atterberg Limit Determination Brown Silty Clay to Clay Samples										
Borehole No. (BH) -Sample No. (SS)	Depth (m)	Grain-Size Analysis (%)				Atterberg Limits (%)				
		GR	SA	Silt	Clay	MC	LL	PL	PI	Soil Classification
BH11-SS4	2.3-2.9	0	15	35	50	41	40	15	25	Silty Clay of Low Plasticity (CL) – Some Sand
BH14-SS2	0.8-1.4	0	2	41	57	28	52	20	32	Silty Clay of High Plasticity (CH) -Trace Sand
GR= Gravel, SA= Sand, MC = Moisture Content, LL = Liquid Limit, PL Plastic Limit, PI= Plasticity Index										

Based on a review of the results from the grain size analysis, the soil may be classified as a silty clay of low to high plasticity (CL and CH) with trace to some sand.

6.4.2 Lower 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 0.8 m to 3.6 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 (undrained shear strength of 14 kPa) in Borehole No.17 at a 1.7 m depth (Elevation 82.9 m). The grey silty clay to clay has natural moisture contents of 44 percent to 87 percent. Locally in Borehole No. 21, the silty clay has a soft consistency to approximately a 3.0 m depth (Elevation 79.2 m) based on the undrained shear strength value of 19 kPa. The natural unit weight of the silty clay to clay is 14.7 kN/m^3 to 15.3 kN/m^3.

The results from the grain-size analysis and Atterberg limit determination conducted on eight (8) selected samples of the grey silty clay to clay are summarized in Table IV. The grain-size distribution curves are shown in Figures 27 to 34.

Table IV: Summary of Results from Grain-Size Analysis and Atterberg Limit Determination Grey Silty Clay to Clay Samples

Borehole No. (BH) -Sample No. (SS)	Depth (m)	Grain-Size Analysis (%)				Atterberg Limits (%)				
		GR	SA	Silt	Clay	MC	LL	PL	PI	Soil Classification
BH2-SS7	6.1-6.7	0	0	28	72	76	50	25	25	Silty Clay of Medium to High Plasticity (CI and CH)
BH3-SS3	2.3-2.9	0	3	54	43	65	32	17	15	Silty Clay of Medium Plasticity (CI) – Trace Sand
BH4-SS6	4.7-5.3	0	0	26	74	62	58	27	31	Clay of High Plasticity (CH) – Some Silt
BH6-SS8	9.1-9.7	0	0	25	75	78	45	26	19	Silty Clay of Medium Plasticity (CI)
BH10-SS4	3,2-3.8	0	2	36	62	71	50	22	28	Silty Clay of Medium to High Plasticity (CI and CH) – Trace Sand
BH11-SS5	3.8-4.4	0	0	25	75	77	59	26	33	Silty Clay of High Plasticity (CH)
BH12-SS3	2.3-2.9	0	0	23	77	66	64	26	38	Silty Clay of High Plasticity (CH)
BH17-SS3	2.3-2.9	0	0	32	68	61	54	23	31	Silty Clay of High Plasticity (CH)

GR= Gravel, SA= Sand, MC = Moisture Content, LL = Liquid Limit, PL Plastic Limit, PI= Plasticity Index

Based on a review of the results from the grain size analysis, the soil may be classified as silty clay to clay of medium to high plasticity (CI and CH) with trace sand and some silt.

Consolidation tests were performed on five (5) Shelby tube samples of the silty clay to clay. The test results and estimated soil parameters are summarized in Table V and shown in Appendix B.

Table V: Consolidation 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)	87	74	15.0	120	2.131	0.04	1.3	1.4
BH 7 – TW6	4.6 – 5.2 (79.5 – 78.9)	53	73	15.3	150	2.056	0.03	1.9	2.8
BH 8 – TW4	3.0 -3.6 (79.3 – 78.7)	37	75	15.1	70	2.127	0.03	1.2	1.9
BH12-ST1	3.0-3.6 (79.9-79.3)	39	88	14.7	80	2.443	0.048	1.6	2.1
BH15-ST2	9.1-9.7 (75.4-75.1)	71	74	15.3	110	2.054	0.022	1.6	1.5
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									

Based on a review of the consolidation test results, the pre-consolidation pressure of the silty clay to clay samples ranges from 70 kPa to 150 kPa at shallow depths (3.0 m to 4.6 m and 4.6m to 5.2 m) and is 110 kPa and 120 kPa at lower depths (9.1 m to 9.7 m and 12.2 m to 12.8 m) within the grey silty clay to clay. The silty clay to clay samples are over-consolidated by a factor of 1.9 to 2.8 at shallow depths and 1.4 and 1.5 at lower depths.

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 C. 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

A summary of the groundwater level measurements taken in the standpipes and monitoring wells installed in some of the boreholes during the period from June 19,2021 to September 10,2024 is shown in Appendix D. It is noted that the lowest groundwater level measurement taken on September 21,2023 for Borehole Nos. 12 and 20 are not considered representative, since the groundwater level had likely not stabilized since the measurements were taken a short time after the installation date of the monitoring wells of September 12, 2023 (Borehole No. 12) and on September 20,2023 (Borehole No. 20).

A summary of the stabilized highest and lowest groundwater level measurements is shown in Table VI.

Table VI: Summary of Highest and Lowest Groundwater Level Measurements – June 19,2021 to September 10.2024

Borehole No. (BH)	Ground Surface Elevation (m)	Highest Groundwater Level		Lowest Groundwater Level	
		Depth (m)	Elevation (m)	Depth (m)	Elevation (m)
BH 1	84.97	0.50	84.51	1.60	83.38
BH 3	84.73	0.20	84.53	0.60	84.09
BH 4	84.86	1.40	83.49	2.00	82.90
BH 5	81.46	0.20	81.28	1.00	80.43
BH 7	84.12	0.07	84.05	1.70	82.43
BH 10	84.72	0.30	84.52	1.30	83.40
BH 11	85.92	1.40	84.55	2.30	83.66
BH 12	82.95	0.40	82.55	1.40	81.55
BH 13	84.45	0.80	83.65	1.80	82.70
BH 14	83.87	0.70	83.20	1.80	82.12
BH 15	84.52	0.11	84.41	0.90	83.62
BH 16	84.84	3.40	81.46	3.60	81.28
BH 17	84.57	1.00	83.61	1.60	82.95
BH 18	84.41	0.80	83.57	1.80	82.61
BH 20	80.89	0.60	80.25	1.50	79.35
BH 21	82.22	0.20	82.05	0.60	81.64

Groundwater levels were determined in the boreholes at the times and under the conditions stated in this report. 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. Table 4.1.8.4.A in the 2012 Ontario Building Code (as amended January 1,2022) 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**.

7.2 Liquefaction Potential of Soils

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

8. Grade Raise

The results of the boreholes revealed that the site is underlain by a sensitive marine clay deposit and the groundwater level is high. This clay deposit is prone to consolidation settlement that will exceed normally tolerable limits if overstressed by a combination of the following loads imposed on the clay:

- Placement of fill on the site to raise the site grades,
- Footing loads applied to the clay by the proposed structures; and
- Post construction permanent lowering of the groundwater table due to the installation of subsurface drainage systems.

For the proposed development, the load stress imposed on the clay at the apartment and townhouse block properties will include a combination of all three (3) types of loads listed above. The total combined load stress applied to the clay should be below the preconsolidation pressure of the clay in order to keep consolidation settlement of the proposed structures within normally tolerable limits.

Based on the JLR grading plans, a summary of the proposed site grade raise at each **apartment block (Blocks 14,15 and 17)** is shown in Table VII.

Table VII: Summary of Proposed Site Grade Raise - Apartment Buildings – Blocks 14,15 and 17

Block No.	Closest Borehole (BH) (Ground Surface Elevation), m	Proposed Final Grade Elevation (m)	Existing Grade (m)	Proposed Maximum Site Grade Raise (m)
14	BH 3 (84.73)	86.20-85.62	85.33-84.64	1.3
15	BH 16 (84.84)	85.90-85.30	84.98-84.70	1.0
17	BH 2 (81.13) BH 6 (81.19) BH 20 (80.89)	82.90-82.55	81.30-80.79	2.0

Based on a review of the borehole information, JLR grading plans and that the proposed apartment buildings will be supported by recommended pile foundations as discussed in Section 10.1 of this report, the proposed maximum site grade raise of 1.3 m and 1.0 m for the apartment buildings located in Blocks 14 and 15 respectively may be achieved by using soil fill. For the apartment buildings located at Block 17, the maximum permissible site grade raise using soil fill is 1.5 m. To achieve the proposed 2.0 m maximum site grade raise at Block 17, light-weight fill (LWF) will need to be used for the remaining 0.5 m site grade raise. The acceptability of the proposed maximum site grade raise has taken into consideration the permanent lowering of the groundwater level (using the highest groundwater level) from the permanent drainage systems of the buildings.

Based on a review of the borehole information and JLR grading plans, it is considered that the proposed **townhouses (Blocks 1 to 6 and 8 to 11)** may supported by footings founded at the proposed design elevation of the underside of footing in conjunction with achieving the proposed maximum site grade raise by using soil fill. The exception to this is Block 8 where the proposed 2.0 m site grade raise will have to be achieved by a combination of 1.0 m of soil fill and 1.0 m of light-weight fill (LWF). A summary of the proposed site grade raise with recommended SLS and factored ULS values for footings are shown in Table IX, Section 10.2 of this report. The acceptability of the proposed maximum

site grade raise includes the permanent lowering of the groundwater level (using highest groundwater level) from the permanent drainage systems of the buildings.

Based on a review of the August 27,2024 (Revision No. 4) JLR grading plan, the proposed site grade raise within the access roads, Rosalie Ridge and Paleo Heights, is in the order of 1.7 m. The maximum proposed site grade raise of 1.7 m using approved soil fill within the proposed access roads is considered acceptable. Clay seals are recommended to be installed in the service trenches as discussed in Section 15 of this report to prevent the permanent lowering of the groundwater level.

8.1 Light-Weight Fill

The light-weight fill should extend a horizontal distance of 2.4 m beyond the exterior sides of the proposed buildings.

For guidance, the LWF may consist of expanded polystyrene (EPS) blocks conforming to ASTM C578 specification with a normal density of 21.6 kg/m^3, a compressive strength of 103 – 145 kPa at 10 percent strain, water absorption of 1.0 percent to 3.5 percent and tolerances within 0.5 percent for thickness, flatness and squareness. The LWF blocks should be tightly fitted to the walls of the excavation without voids. The LWF blocks should be fixed on all sides to the adjacent blocks with Building Grip PL300 construction adhesive. If another layer of light weight blocks is required, it should be installed at right angles to the previous layer with blocks fitting tightly leaving no voids. The LWF should be covered with geotextile (such as Terrafix 270R or equivalent) prior to placement of granular fill.

The type of LWF selected for a building will depend on the stress imposed on the LWF. The LWF should be placed above the groundwater level to avoid buoyancy effect.

9. Site Grading

Site grading within the **floor slab area** of the proposed buildings designed as slabs-on-grade 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 or silty sand to sandy silt, whichever occurs first. 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 a minimum 300 mm thick OPSS Granular B Type II pad 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 or silty clay to clay, whichever occurs first. The exposed existing fill and silty sand to sandy silt should be proofrolled. The proofrolled existing fill and silty sand to sandy silt subgrades and the exposed silty clay to clay subgrade should be examined by a geotechnician. 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 or in cut 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

The proposed **apartment buildings** with underground parking garages at Blocks 14,15 and 17 may be supported by piles driven to bedrock and designed in end bearing. Footings and mat foundations are not considered feasible to support the proposed apartment buildings in conjunction with the proposed maximum site grade raise and permanent lowering of the groundwater level from the permanent drainage systems of the proposed buildings.

The proposed **townhouse blocks** with basements supported by footings at the design elevation of the underside of footing in conjunction with the proposed site grade raise indicated on the JLR grading plan and the permanent lowering of the groundwater level (using the highest groundwater level) from the permanent drainage systems of the proposed buildings, is considered feasible.

Foundation considerations for the apartment and townhouse blocks are discussed in the following section of this report.

10.1 Apartment Buildings (Blocks 14,15 and 17)

The proposed apartment buildings may be supported by steel H or concrete filled pipe piles driven to practical refusal into the underlying bedrock and designed in end-bearing. It is recommended that additional boreholes should be undertaken to determine the bedrock depth which is anticipated to be below a 30 m depth.

Since the piles are expected to meet refusal in the bedrock, the factored geotechnical resistance at ultimate limit state (ULS) will govern the design. The factored geotechnical resistance values at ULS for various pile sections are shown in Table VIII. The factored geotechnical resistance values at ULS are based on steel piles with a yield strength of 350 MPa and concrete compressive strength of 35 MPa and a geotechnical resistance factor of 0.4.

It is noted that the piles will be subjected to down-drag forces (negative skin friction) due to consolidation of the silty clay as a result of the grade raise at the site and permanent lowering of the groundwater level. The down-drag forces would need to be deducted from the factored geotechnical resistance values at ULS of the piles shown in Table VIII to determine the estimated load carrying capacity of the piles. Once the depth to bedrock is known, EXP can provide the estimated load carrying capacity of the piles.

Table VIII: Factored Geotechnical Resistance at Ultimate Limit State (ULS) of Steel Pipe and H-Piles

Pile Section	Description	Factored Geotechnical Resistance at ULS (kN) (1)
Steel Pipe	245 mm O.D. by 10 mm wall thickness	1275
	245 mm O.D. by 12 mm wall thickness	1445
	324 mm O.D. by 12 mm wall thickness	2120
Steel H	HP 310 x 79	1260
	HP 310 x 110	1775
	HP 310 x 125	2000

Note:

(1) Once the depth to bedrock is known, the factored geotechnical resistance at ULS of piles shown in Table VIII will need to be reduced as a result of down-drag forces that will develop along the pile from site grade raise and the permanent lowering of the highest groundwater level due to the permanent drainage systems of the proposed buildings.

Total and differential settlement of the piles founded in the bedrock designed in end bearing and installed as indicated below are expected to be less than 10 mm.

To achieve the pile capacity given previously, the pile-driving hammer must seat the pile in the overburden without overstressing the pile material. For guidance purposes, it is estimated that a hammer with rated energy of 54 kJ to 70 kJ (40,000 to 52,000 ft. lbs.) per blow would be required to drive the piles to practical refusal. Practical refusal is considered to have been achieved at a set of 5 blows for 6 mm or less of pile penetration. However, the driving criteria for a particular hammer-pile system must be established at the beginning of the project using the Pile Driving Analyzer.

The piles should be equipped with a driving shoe to protect them from damage during driving as per Ontario Provincial Standard Drawing (OPSD) 3001.100, Type II, Revision No. 2 dated November 2017.

A number of test piles (5 percent of total number of piles) should be monitored with the Pile Driving Analyzer during the initial driving and re-striking at the beginning of the project. This monitoring will allow for the evaluation of transferred energy into the pile from the hammer, determination of driving criteria and an evaluation of the ultimate bearing capacity of the piles. Depending on the results of the pile driving analysis, the pile capacity may have to be proven by at least one pile load test for each pile type before production piling begins. If necessary, the pile load test should be performed in accordance with the American Society for Testing and Materials (ASTM) D 1143.

Closed end pipe piles tend to displace a relatively large volume of soil. When driven in a cluster or group, they may tend to jack up the adjacent piles in the group. Consequently, the elevation and the location of the top of each pile in a group should be monitored immediately after driving and after all the piles in the group have been driven. This is to ensure that the piles are not heaving or being displaced. Any piles found to heave more than 3 mm should be re-tapped.

Piles driven at the site may be subject to relaxation (loss of set with time). It is therefore recommended that all the piles should be re-tapped at least 24 hours after initially driving and at 24-hour intervals thereafter until it can be proven that relaxation is no longer a problem.

The installation of the piles at the site should be monitored on a full-time basis by a geotechnician working under the direction and supervision of a qualified geotechnical engineer to verify that the piles are driven in accordance with the project specifications.

The concrete grade beams and pile caps for heated structures should be protected from frost action by providing the beams and caps with 1.5 m of earth cover. For non-heated structures, the pile caps and beams should be provided with 2.4 m of earth cover in areas where the snow will be removed and 2.1 m of earth cover where the snow will not be removed. Alternatively, frost protection may be provided by rigid insulation or a combination of rigid insulation and earth cover.

A 50 mm thick concrete mud slab is recommended to installed under the grade beams and pile caps immediately upon excavation and approval of the subgrade to protect the surface of the silty clay from disturbance from water, the effects from the weather and foot traffic from construction workers.

Temporary granular roads and mats (at least 900 mm thick) will be required to provide access for the pile driving rig. The actual thickness required for the granular roads and mats will have to be established by the piling contractor, based on the type of piling rig that will be used on site and subsurface condition.

The recommended 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.

10.2 Townhouse Blocks (Blocks 1 to 6 and 8 to 11)

For each townhouse block, a summary of the bearing pressure at serviceability limit state (SLS) and factored geotechnical resistance at ultimate limit state (ULS) recommended for footings set at the proposed design underside of footing elevation (USF) along with the proposed maximum site grade raise indicated in the JLR grading plan is provided in Table IX. Based on the borehole information, footings set at the design USF elevation will be founded on the brown and grey firm to very stiff silty clay. The footings should be founded below any soft zones of the silty clay.

Table IX: Summary of Proposed Site Grade Raise and Underside Founding Elevation indicated on August 27,2024 JLR Grading Plan and Recommended SLS/Factored ULS Values for Footings

Block No.	Closest BH (Elevation, m)	Proposed Final Grade Elevation (m)	Existing Grade Elevation (m)	Proposed Maximum Site Grade Raise (m)	Proposed USF Elevation (m)	Highest Groundwater Level Measurement Depth (Elevation), m	Lowest Groundwater Level Measurement Depth (Elevation), m	SLS Value for Footing (kPa)	Factored ULS Value for Footing (kPa)
1	BH 1 (84.97)	86.14-85.90	86.41-84.92	1.0	83.73	0.50 (84.51)	1.60 (83.38)	100	150
2	BH 11 (85.92)	86.18-85.42	86.49-85.45	None (Cut Area) to 0.7 m	83.77	1.40 (84.55)	2.30 (83.66)	80	120
3	BH 4 (84.86)	85.61-84.75	86.01-84.45	0.5	83.02/82.70	1.40(83.49)	2.00 (82.90)	35	50
4	BH 12 (82.95)	84.58-83.54	84.66-82.81	1.6	82.03	0.40 (82.55)	1.4 (81.55)	40	60
5	BH 7 (84.12)	85.30-84.58	84.74-84.07	0.8	82.89	0.07 (84.05)	1.70 (82.43)	40	60
6	BH 13 (84.45) BH 15 (84.52)	85.82-85.28	87.24-85.00	1.3	83.23	0.80 (83.65) 0.11 (84.41)	1.80 (82.70) 0.90 (83.63)	45	70
8	BH 8 (82.28)	84.42-83.02	82.67-82.19	2.0 (1.0 m soil fill + 1.0 m Light-Weight Fill (LWF) Required)	81.87/81.69/81.33	0.30 (82.0) (estimated)	1.40 ((80.88) (estimated)	60	90
9	BH 14 (83.87)	85.61-84.08	84.76-82.98	1.2	82.66/82.57	0.70 (83.20)	1.80 (82.12)	60	90
10	BH 18 (84.41)	86.02-85.08	84.95-84.01	1.9	82.89	0.8 (83.57)	1.80 (82.61)	30	45
11	BH 17 (84.57)	86.29-85.33	85.20-84.51	1.7	83.14	1.00(83.61)	1.60 (82.95)	30	45

Notes to be read in conjunction with Table IX:

1. Proposed final and existing grade elevations obtained from spot elevations shown on the August 27,2024 (Revision No. 5) JLR grading plan.
2. Proposed underside of footing elevation (USF) obtained from the USF elevations shown on the August 27,2024 (Revision No. 5 JLR grading plan.
3. The bearing pressure at serviceability limit state (SLS) and factored geotechnical resistance at ultimate limit state (ULS) are for strip footings having a maximum width of 1.5 m and square pad footings having a maximum width and length of 3.0 m.
4. The factored bearing resistance at ULS includes a geotechnical resistance factor of 0.5.
5. Acceptability of proposed maximum site grade raise and determination of SLS and factored ULS values for footings have taken into consideration the permanent lowering of the highest groundwater level from the permanent drainage systems of the buildings.

If the footings cannot be designed for the lower SLS values recommended for some of the blocks in Table IX, the site grade raise may be achieved by using light-weight fill (LWF) and the SLS may be increased. EXP can provide additional comments in this regard, if required.

The total and differential settlement of the footings is expected to be within the normally tolerable limits of 25 mm total and 19 mm differential movements.

If the site grade raise at the blocks will be greater than indicated in Table IX for items such as garage floors, porches or grading of the townhouse block, the site grade raise would have to be achieved by using light-weight fill (LWF). Reference is made to Section 8.1 of this report for details regarding LWF.

10.3 Additional Comments for Foundations

Should the magnitude of the site grade raise and/or the USF elevation for footings change from those indicated in Table X, EXP should be contacted to review and comment on the site grade raise and provide updated SLS and factored ULS values for the footings, for the purpose of confirming that the clay deposit is not overstressed by site grade raise, footing loads and required permanent groundwater lowering.

All footing bed subgrades 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 exposed surface of the footing subgrade 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 and for the mat foundation must be covered with a 50 mm thick concrete mud slab within the same day of approval, to prevent disturbance to the 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.

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

For the proposed townhouse and apartment buildings, the lowest floor slabs of the proposed buildings may be designed as slabs-on-grade.

The slab-on-grade may be founded on a bed of 200 mm of 19 mm size clear stone placed on top of a minimum 300 mm thick compacted OPSS Granular B Type II pad placed on the native silty clay to clay 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. Alternatively, the clear stone layer may be replaced with a 300 mm thick OPSS Granular A layer compacted to 98 percent SPMDD and overlain with a vapour barrier. Adequate saw cuts should be provided in the floor slabs to control cracking.

A summary of the design elevation of the underground parking garage floor slabs of the **apartment buildings** and measured groundwater levels is shown in Table X.

Table X: Summary of Highest and Lowest Groundwater Level Measurements – Apartment Blocks 14, 15 and 17

Block No.	Borehole No. (BH)	Ground Surface Elevation (m)	Highest Groundwater Level			Lowest Groundwater Level	
			Design Elevation of Underground Parking Garage Floor (m)	Depth (m)	Elevation (m)	Depth (m)	Elevation (m)
Block 14	BH 3	84.73	82.25	0.20	84.53	0.60	84.09
Block 15	BH 16	84.84	81.90	3.40	81.46	3.60	81.28
Block 17	BH 20	80.89	78.86	0.60	80.25	1.50	79.35

The proposed apartment buildings with an underground parking garage should have a permanent perimeter drainage system around the buildings. Since the design elevation of the floor slab of the underground parking garage will be close to and below the highest groundwater level, the proposed apartment buildings will need to have an underfloor drainage system. Both systems should be connected to separate sumps so that at least one system would be operational should the other system fail and the design should include back up pumps and generators, in case of mechanical failure and/or power outage.

The proposed **townhouse buildings** with basement should have a permanent perimeter drainage system around the buildings. The design elevation of the basement floors is not known but is assumed to be 600 mm above the design underside footing elevation (USF). In this case and based on a review of the USF and highest groundwater level in Table IX, the basement slab will be located close to or below the highest groundwater level and therefore will require an underfloor drainage system. Both systems should be connected to separate sumps so that at least one system would be operational should the other system fail and the design should include back up pumps and generators, in case of mechanical failure and/or power outage.

The perimeter drainage system may consist of 100 mm diameter perforated pipe set on the footings and surrounded with 150 mm thick 19 mm sized clear stone that is fully wrapped or covered with an approved porous geotextile membrane, such as Terrafix 270R or equivalent. The underfloor drainage system may consist of 100 mm diameter perforated pipe or equivalent placed in parallel rows at 5 m to 6 m centres and at least 300 mm below the underside of the floor slab. The drains should be set on a 100 mm thick bed of 19 mm sized clear stone and covered on top and sides with 100 mm thick clear stone that is fully wrapped or covered with an approved porous geotextile membrane, such as Terrafix 270R or equivalent.

As previously indicated, the perimeter and underfloor drainage systems for the proposed buildings should be connected to separate sumps equipped with backup (redundant) pumps and generators in case of mechanical failure and/or power outage, so that at least one system would be operational should the other fail.

The finished ground floor slab for all proposed buildings should be set at least 150 mm above the surrounding exterior grade.

The finished exterior grades should be sloped away from all proposed buildings to prevent ponding of surface water close to the exterior walls of the proposed buildings.

11.1 Apartment Garage Floor Slab

The parking garage floor for proposed apartment buildings may be a concrete or asphalt surface. Recommendations for asphalt and concrete pavement surfaces are discussed below.

11.1.1 Lowest Floor Level as a Concrete Surface

Following approval of the silty clay to clay subgrade, the concrete slab for the parking garage floor for light duty traffic (cars only) may be constructed as follows:

- 150 mm thick concrete with 32 MPa compressive strength and air content of 5 percent to 8 percent; over
- 150 mm thick layer of Ontario Provincial Standard Specification (OPSS) 1010 Granular A compacted to 100 percent standard Proctor maximum dry density (SPMDD); over
- 600 mm minimum thick layer of OPSS 1010 Granular B Type II compacted to 100 percent SMPDD for silty clay to clay subgrade.

The concrete slab should be reinforced and adequate saw cuts should be provided in the floor slab to control cracking. The need to cover the approved clay subgrade with a separation membrane can be assessed during construction.

11.1.2 Lowest Floor Level as a Paved Surface

Following approval of the silty clay to clay subgrade, the asphalt pavement structure for light duty traffic (cars only) may be constructed on the silty clay to clay subgrade as follows:

- 65 mm thick layer of asphaltic concrete consisting of HL3/SP12.5 – The asphaltic concrete should be placed and compacted as per OPSS 310 and 313 and should be designed in accordance with OPSS 1150/1151; over
- 150 mm thick layer of OPSS Granular A compacted to 100 percent SPMDD; over

- 600 mm thick layer of OPSS Granular B Type II compacted to 100 percent SPMDD for approved silty clay to clay subgrade.

The need to cover the approved clay subgrade with a separation membrane can be assessed during construction.

12. Lateral Earth Pressure Against Subsurface Walls

The subsurface basement walls of the proposed apartment and townhouse buildings 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 dampproofed.

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 and installation of the municipal services are anticipated to extend into the silty sand to sandy silt and the silty clay to clay and will likely be below the groundwater level.

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.

Excavations that terminate within the silty sand to sandy silt and below the groundwater level will be prone to base heave failure in the form of piping. To minimize base heave failure, the groundwater level within the silty sand to sandy silt will need to be lowered to at least 1.0 m below the base of the excavation prior to start of excavation. The groundwater may be lowered by installing deep sumps equipped with pumps.

If side slopes noted above for the construction of the proposed buildings cannot be achieved due to space restrictions on site, such as the proximity of open cut excavations to the property limits or existing infrastructure, the excavations would have to be undertaken within the confines of an engineered support system (shoring system) that is designed and installed in accordance with the above-noted regulations and the 2023 Fifth Edition of the Canadian Foundation Engineering Manual. For excavations above the groundwater level or properly dewatered, the installation of municipal underground services may be undertaken within the confines of a prefabricated support system (trench box) designed and installed in accordance with OHSA.

Base heave type failure is not anticipated for excavations that extend to a 4.0 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 is anticipated and it should be possible to collect water entering the excavations at low points and to remove it by conventional pumping techniques. In areas of high

infiltration or where more permeable soils exist, such as within the sandy silt to silty sand, a higher seepage rate should be anticipated and may require high-capacity pumps to keep the excavation dry.

As previously mentioned, excavations that terminate within the silty sand to sandy silt and below the groundwater level will be prone to base heave failure in the form of piping. To minimize base heave failure, the groundwater level within the silty sand to sandy silt will need to be lowered to at least 1.0 m below the base of the excavation prior to start of excavation. The groundwater may be lowered by installing deep sumps equipped with pumps.

For construction dewatering, an Environmental Activity and Sector Registry (EASR) approval may be obtained for water takings greater than 50 m^3 and less than 400 m^3. If more than 400 m^3 per day of groundwater are generated per day for dewatering purposes, then a Permit to Take Water (PTTW) must be obtained from the MECP. A hydrogeological investigation of the proposed excavations would be required to support a PTTW application.

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.

13.4 Hydrogeological Investigation

A hydrogeological investigation should be undertaken to estimate short term construction and long-term permanent water taking volumes and to determine the impact, if any, short and long-term groundwater lowering at the site may have on existing buildings, structures and infrastructure near the site.

14. Spill Over Pond

A spill over pond will be located in the southeast portion of the site. It is our understanding that the pond will be designed as a dry pond. The grading for the spill over pond is provided in the grading plan, Drawing No. POND, dated August 27,2024 (Revision No. 5) and prepared by JLR. The grading plan indicates the bottom of the pond will be set at Elevation 81.38 m to Elevation 81.32 m. The final grade of the top of the walls or berms of the proposed spill over pond will range from Elevation 83.20 m to Elevation 82.43 m resulting in a site grade raise or height of the berms above existing grade ranging from approximately 0.2 m to 1.0 m. The interior side slopes of the pond will be set at a maximum gradient of 3H:1V. The maximum (100 year) water level is at Elevation 82.12 m.

Borehole Nos. 5 and 21 are located within the footprint of the proposed dry pond and indicate that the side walls of the berms below existing grade and the design elevation of the bottom of the pond will consist of compact silty sand and stiff to very stiff silty clay. A summary of the groundwater level in the two (2) boreholes is shown in Table XI.

Table XI: Summary of Highest and Lowest Groundwater Level Measurements – Spill Over Pond

Borehole No. (BH)	Ground Surface Elevation (m)	Highest Groundwater Level		Lowest Groundwater Level	
		Depth (m)	Elevation (m)	Depth (m)	Elevation (m)
BH 5	81.46	0.20	81.28	1.00	80.43
BH 21	82.22	0.20	82.05	0.60	81.64

Based on a review of the drawing for the spill over pond and the groundwater level measurements, the bottom of the pond will be at the highest groundwater level to approximately 0.7 m below the highest groundwater level and the maximum (100 year) water level will be approximately 0.1 m above the highest groundwater level.

The estimated coefficient of permeability of the silty sand is 10^{-3} cm/s to 10^{-5} cm/s and the estimated coefficient of permeability of the silty clay is 10E-7 cm/s and less.

Construction of the pond to the design elevation of the bottom of the pond will require excavations to terminate within the silty sand and silty clay below the groundwater level. As previously mentioned, since a portion of the excavation will terminate within the silty sand and will be below the groundwater level, the silty sand will be prone to base heave failure in the form of piping. To minimize base heave failure, the groundwater level within the silty sand will need to be lowered to at least 1.0 m below the base of the excavation prior to start of excavation. The groundwater level within the pond area may be lowered by installing deep sumps equipped with pumps.

For berm construction, the proposed site grade raise of up to 1.0 m is considered acceptable from a settlement perspective and should consist of OPSS Granular B Type II material compacted to 95 percent SPMDD. All topsoil should be removed down to the native silty sand and silty clay prior to the placement of the Granular B Type II material.

The walls of the pond will consist of compact silty sand and stiff to very stiff silty clay and compacted Granular B Type II material. Side slopes of the walls of the pond with gradients no steeper than 3H:1V within these soils are considered to be stable, provided the base of the pond and faces of the side slopes are protected from erosion by using erosion control blankets or other vegetation systems. Rip rap underlain by a non-woven geotextile should be used in areas of flowing water.

15. Pipe Bedding Requirements

15.1 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 stiff silty clay to clay. In this case, it is recommended the pipe bedding consist of 300 mm thick of OPSS 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 all service trenches of the proposed development at a maximum spacing of 60 m. The clay seals should be situated at strategic locations such as at property boundaries to prevent permanent lowering of the groundwater level at the site of the proposed development and on adjacent properties. 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 silty clay should be compacted to 95 percent SPMDD.

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

15.2 Buoyancy of Manholes

During the installation of the concrete manholes, uplift of the manholes is not anticipated during installation provided the excavations are properly dewatered and the installation of the manholes are undertaken in dry conditions. Once the manhole is installed and properly backfilled all around, the side friction that develops between the exterior wall of the concrete manhole and the granular backfill will provide sufficient resistance to uplift forces.

16. 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 and are not considered suitable for use under structural elements and for backfilling purposes. From a geotechnical perspective, portions of the sandy silt to silty sand and silty clay to clay above the groundwater level may be re-used as fill material to raise the grades at the site to the design subgrade level in landscaped and access road areas, subject to additional examination and testing during construction. These soils are susceptible to moisture absorption due to precipitation and therefore should be protected from the elements if stockpiled on site. The silty sand to sandy silt and silty clay to clay below the groundwater table is expected to be too wet for re-use and for adequate compaction and should be discarded. However, these materials may be used for general grading purposes in the landscape areas if left in the sun to dry or mixed with drier material. The topsoil is not considered suitable for use as backfill material.

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.
- 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) or OPSS Granular B Type II material placed in 300 mm thick lifts and each lift compacted to 95 percent of the SPMDD.

17. Subsurface Concrete and Steel Requirements

Chemical tests limited to pH, chloride, sulphate and resistivity were performed on seven (7) selected soil samples. The certificate of the laboratory test results is attached in Appendix E and the results are summarized in Table XII.

Table XII: 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	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	1.5-2.1	8.35	0.0016	0.0003	9620
BH15-SS6	Grey Clay	7.6-8.2	9.38	0.0064	0.0005	3830
BH20-SS5	Grey Silty Clay	9.1-9.7	9.68	0.0049	0.0029	2080

The results indicate the silty clay to clay has a sulphate content of less than 0.1 percent. This concentration 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.23.1-19.

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.

18. Pavement Structures

18.1 Pavement Structures Over Earth for Access Roads and Parking Facilities

Pavement structure thicknesses required for the proposed roads and parking facilities were computed and are shown on Table XIII. 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 XIII: Recommended Pavement Structure Thicknesses

Pavement Layer	Compaction Requirements	Pavement Design to be Used by Light Duty Vehicles	Heavy Duty Vehicles / Subdivision 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

Notes for Table XIII:

1) SPMDD denotes standard Proctor maximum dry density (SPMDD).
2) MRD denotes Maximum Relative Density (MRD)
3) The upper 300 mm of the subgrade fill should be compacted to 98 percent SPMDD.
4) The approved subgrade should be covered with a geotextile prior to the placement of the sub-base material.

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 may be required in addition to the geotextile indicated in Table XIII.

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 roads 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.

18.2 Pavement Structure Constructed Over Parking Garage Structure (Podium Slab) – Apartment Buildings

The recommended pavement structures constructed on top of the parking garage structure (podium slab) are shown in Table XIV.

Table XIV: Recommended Pavement Structure Thicknesses – Pavement Constructed Over Parking Garage Structure

Pavement Layer	Compaction Requirements	Light Duty Parking Areas	Heavy Duty Parking Areas and Access Roads
Asphaltic Concrete (PG 58-34)	Minimum 92% MRD	50 mm – SP12.5 Cat B or HL3	40 mm – 12.5 Cat B/HL3 50 mm – 19.0 Cat B/HL8
Granular A Base (OPSS 1010) (crushed limestone)	100% SPMDD	300 mm	300 mm

SPMDD denotes Standard Proctor Maximum Dry Density, ASTM-D698-12e2
MRD denotes Maximum Relative Density, ASTM D2041

The granular materials used for pavement construction should conform to Ontario Provincial Standard Specifications (OPSS) for Granular A and Granular B Type II and should be compacted to 100 percent SPMDD. The asphaltic concrete and its placement should meet OPSS 1151 requirements. It should be placed and compacted to OPSS 311 and 313.

A 10 horizontal: 1 vertical longitudinal transition zone should be used at the bottom of the pavement structures for abutting pavement structures with different pavement structure thicknesses. The joint between a rigid pavement structure (concrete pavement structure) and flexible pavement structure (asphalt pavement structure) should be sealed with a polymer modified bitumen strip to prevent ingress of water, dirt, vegetation and other particles that would compromise the performance of the pavements and to withstand different rates of expansion between the 2 different types of pavement structures.

The Granular A base layer thickness should be increased to a minimum thickness of 600 mm below the top of the parking garage podium slab for a minimum horizontal distance of 1.5 m from the face of the foundation wall prior to providing the above recommended transition zone.

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

19. Tree Planting Restrictions

The site is underlain by marine clay. The test results of the native upper brown and lower grey clay of the marine clay deposit were compared with the document titled, *Tree Planting in Sensitive Marine Clay Soils – 2017 City of Ottawa Guidelines (2017 Guidelines)* and indicate the upper brown clay and the lower grey clay have a low/medium potential for soil volume change. For soils that have a low/medium potential for soil volume change, the 2017 Guidelines indicate that the tree to foundation setback distance and tree planting restrictions should be in accordance with the 2017 guidelines.

In accordance with the City of Ottawa Tree Planting in Sensitive Marine Clay Soils (2017 Guidelines**), for soils of a low/medium potential for soil volume change**, as is the case for this project, large trees (mature height over 14.0 m) can be planted provided a tree to foundation setback equal to the full mature height of the tree can be provided (e.g. in a park or other green space).

In accordance with the City of Ottawa Tree Planting in Sensitive Marine Clay Soils (2017 Guidelines**), for soils of a low/medium potential for soil volume change**, as is the case for this project, for street trees in the road right-of-way, the tree to foundation setbacks may be reduced to **4.5 m** for small (mature tree height up to 7.5 m) and medium sized trees (mature tree height 7.5 m to 14.0 m) provided all of the following conditions are met:

- The underside of footing (USF) is 2.1 m or greater below the lowest finished grade. Note: This footing level must be satisfied for footings within 10 m of the tree, as measured from centre of tree trunk, and verified by means of the grading plan as indicated in the Procedural Changes in the 2017 Guidelines. Based on a review of the JLR grading plan (Revision No. 4), the USF relative to the final site grades provided by JLR meet this criterion and are 2.1 m or greater below the lowest finished grade.
- A small sized tree must be provided with a minimum of 25 cubic metres of available soil volume, as determined by a Landscape Architect. A medium sized tree must be provided with a minimum 30 cubic metres of available soil volume, as determined by the Landscape Architect. The developer will ensure the soil is generally uncompacted when backfilling in street tree planting locations.
- The tree species must be small to medium sized, as confirmed by the Landscape Architect in the Landscape Plan.
- The foundation walls are to be reinforced at least nominally (minimum of two (2) upper and two (2) lower 15 M sized bars in the foundation walls).
- Grading surrounding the tree must promote draining to the tree root zone (in such a manner as not to be detrimental to the tree), as to be noted on the subdivision Grading Plan.

A landscape architect should be consulted to ensure the setbacks and tree planting restrictions are in accordance with the 2017 Guidelines.

20. Additional Investigations

The following additional investigations are recommended:

- For the design of the piles to support the proposed apartment buildings, additional boreholes should be undertaken to determine the bedrock depth (elevation). Based on the findings from the additional boreholes, the pile recommendations in this report will need to be updated.
- A hydrogeological investigation should be undertaken to estimate short term construction and long-term permanent water taking volumes and to determine the impact, if any, short and long-term groundwater lowering at the site may have on existing buildings, structures and infrastructure near the site.

21. 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.

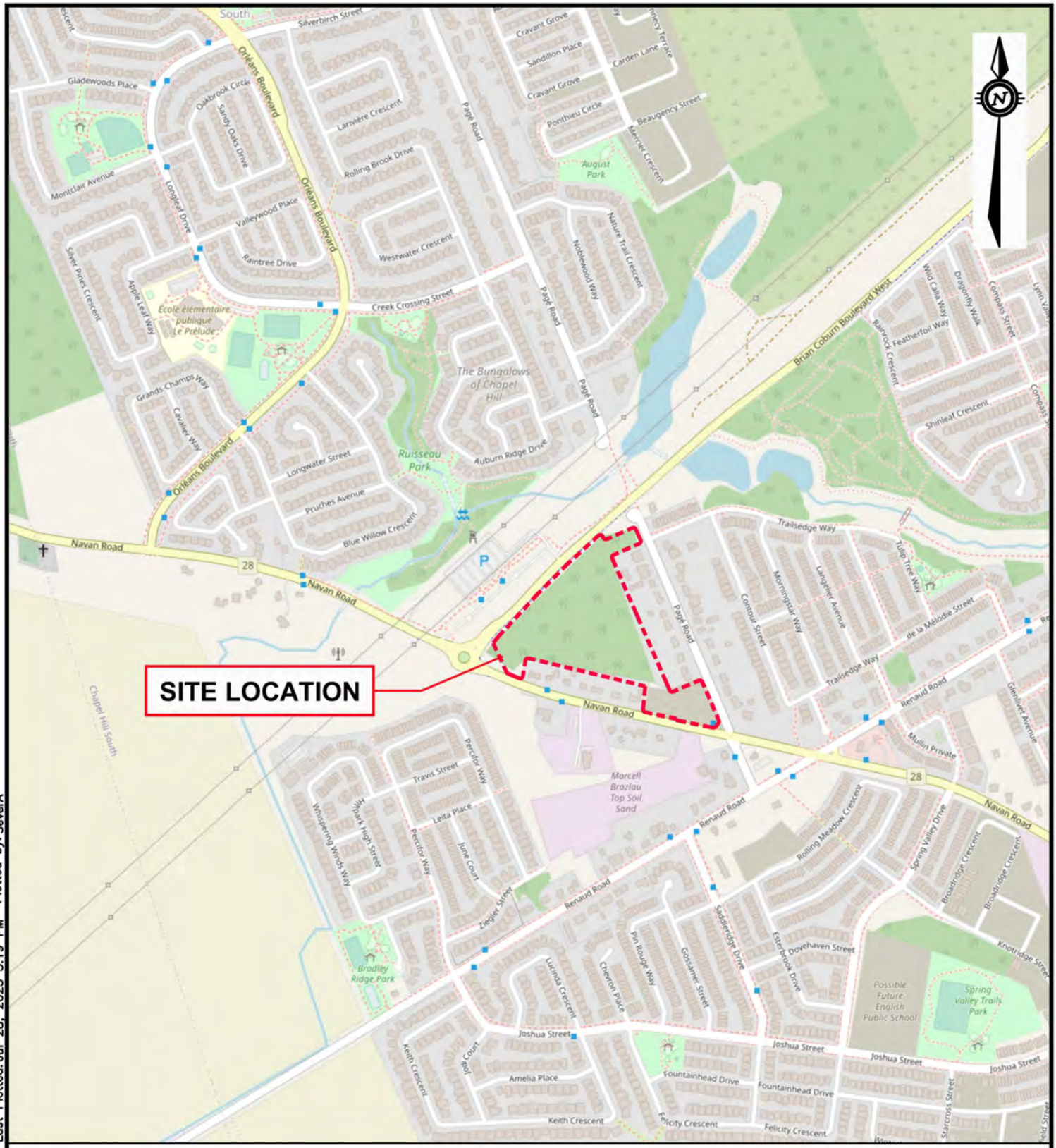
We trust that the information contained in this report is satisfactory for your purposes. Should you have any questions, please contact this office.

Sincerely,

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

Ismail M. Taki, M.Eng., P.Eng.
Senior Manager, Eastern Region
Earth and Environment

Figures



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HORIZONTAL 1:10,000

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DESIGN	IT/SP
DRAWN	TM/AS
DATE	JULY 2023
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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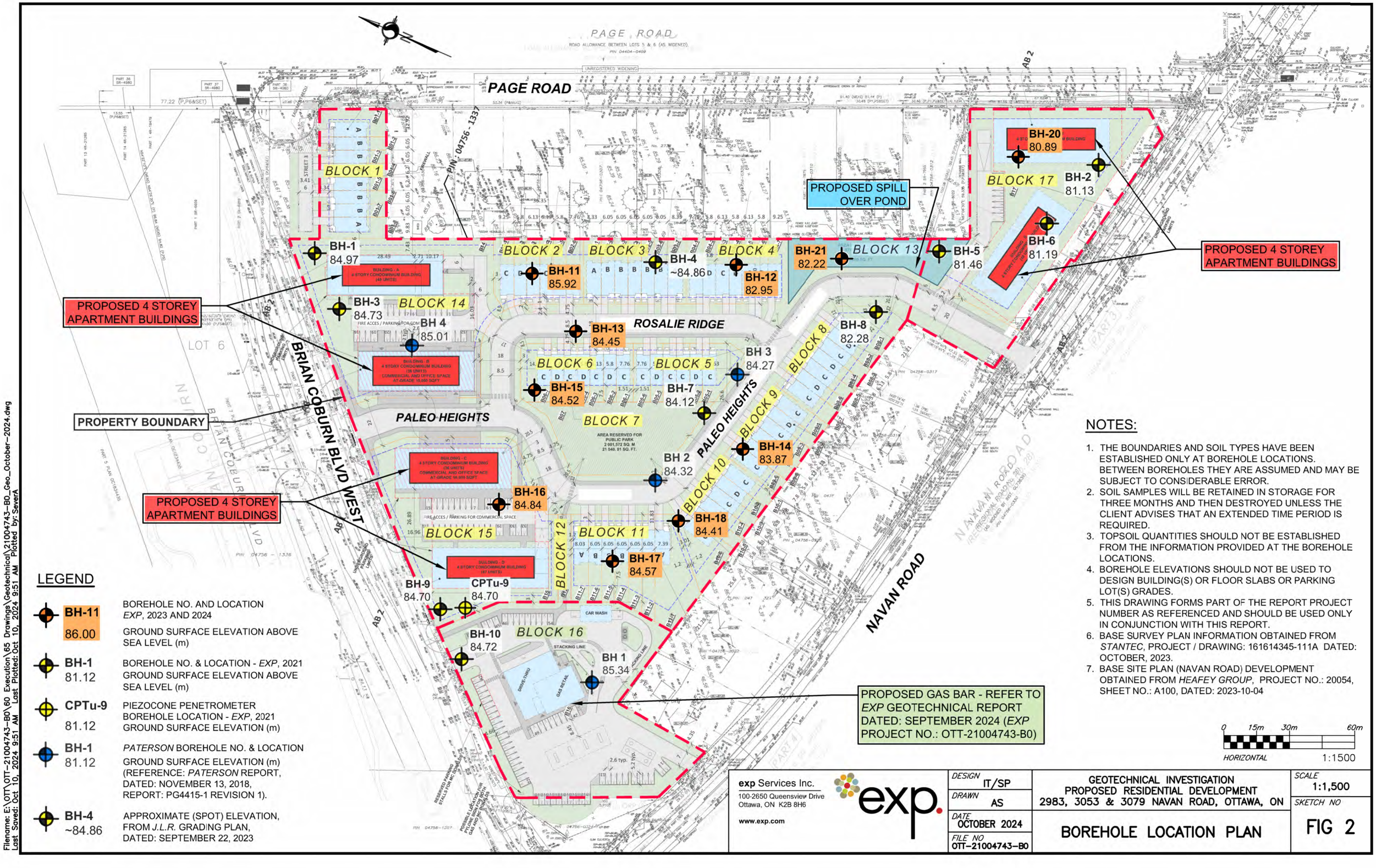

LEGEND

- **BH-11** 86.00 — BOREHOLE NO. AND LOCATION *EXP*, 2023 AND 2024; GROUND SURFACE ELEVATION ABOVE SEA LEVEL (m)
- **BH-1** 81.12 — BOREHOLE NO. & LOCATION - *EXP*, 2021; GROUND SURFACE ELEVATION ABOVE SEA LEVEL (m)
- **CPTu-9** 81.12 — PIEZOCONE PENETROMETER BOREHOLE LOCATION - *EXP*, 2021; GROUND SURFACE ELEVATION (m)
- **BH-1** 81.12 — *PATERSON* BOREHOLE NO. & LOCATION; GROUND SURFACE ELEVATION (m) (REFERENCE: *PATERSON* REPORT, DATED: NOVEMBER 13, 2018, REPORT: PG4415-1 REVISION 1).
- **BH-4** ~84.86 — APPROXIMATE (SPOT) ELEVATION, FROM *J.L.R.* GRADING PLAN, DATED: SEPTEMBER 22, 2023

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 SURVEY PLAN INFORMATION OBTAINED FROM *STANTEC*, PROJECT / DRAWING: 161614345-111A DATED: OCTOBER, 2023.
7. BASE SITE PLAN (NAVAN ROAD) DEVELOPMENT OBTAINED FROM *HEAFEY GROUP*, PROJECT NO.: 20054, SHEET NO.: A100, DATED: 2023-10-04

0 15m 30m 60m
HORIZONTAL 1:1500

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DESIGN	IT/SP
DRAWN	AS
DATE	OCTOBER 2024
FILE NO	OTT-21004743-B0

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

BOREHOLE LOCATION PLAN

SCALE 1:1,500
SKETCH NO FIG 2

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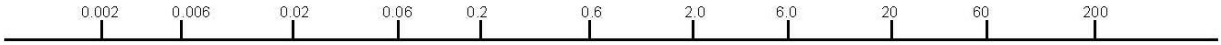
Notes On Sample Descriptions

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 Trace clay, brown, moist to wet. (compact)	84.6					
			83.6	1	10		SS1	
		SILTY CLAY High plasticity, trace sand, brown, moist to wet, (very stiff)	83.37	2	4; 168; 150 kPa; s = 6.0		SS2	18.4
					2; 100 kPa; s = 6.7		SS3	17.7
		SILTY CLAY TO CLAY Grey, wet, (firm to stiff)	81.9	3	1; 53 kPa; s = 7.3		SS4	
				4				
				5	Hammer Weight; 48 kPa; s = 6.7		SS5	
				6	Hammer Weight; 43 kPa; s = 6.0		SS6	
				7				
				8	Hammer Weight; 48 kPa; s = 6.7		SS7	
		Borehole Terminated at 8.5 m Depth	76.5					

LOG OF BOREHOLE BH LOGS - JULY 5 UPDATED BOREHOLE LOGS.GPJ TROW OTTAWA.GDT 9/6/24

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)
June 19, 2021	1.4	7.6
August 2, 2023	1.3	
September 21, 2023	1.4	
October 6, 2023	1.6	
October 19, 2023	1.6	

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	
					7		SS4	
		SILTY CLAY Medium to high plasticity, grey, wet, (firm to stiff)	78.3	3	34 kPa s = 9.3			
					Hammer Weight		SS5	
					29 kPa s = 6.0			
				5	Hammer Weight		SS6	
					34 kPa s = 7.0			
				6	Hammer Weight		SS7	
				7	48 kPa s = 8.0			
					Hammer Weight		SS8	
		Borehole Terminated at 8.5 m Depth	72.6	8	53 kPa s = 7.3			

LOG OF BOREHOLE BH LOGS - JULY 5 UPDATED BOREHOLE LOGS.GPJ TROW OTTAWA.GDT 9/6/24

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)
June 19, 2021	0.9	7.6
August 2, 2023	Damaged	
September 21, 2023	Not Found	

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 Brown, moist to wet, (very stiff)	83.4					
				2	5; 144; 130 kPa; s = 6.5		SS2	18.1
		SILTY CLAY Medium plasticity, trace sand, grey, wet, (firm to stiff)	82.2					
				3	1; 53 kPa; s = 7.3; Hammer Weight		SS3	
					48 kPa; s = 6.7; Hammer Weight		SS4	
					43 kPa; s = 6.0; Hammer Weight		SS5	
				5	41 kPa; s = 5.7		SS6	
				6	Hammer Weight		SS7	
				7	43 kPa; s = 6.0			
			77.7					
		Borehole Terminated at 7.0 m Depth						

LOG OF BOREHOLE BH LOGS - JULY 5 UPDATED BOREHOLE LOGS.GPJ TROW OTTAWA.GDT 9/6/24

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)
June 19, 2021	0.6	6.1
August 2, 2023	Not Found	
September 21, 2023	Not Found	

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	84.86	0				
		SILTY SAND Brown, moist to wet, (loose)	84.8					
		SILTY CLAY TO CLAY Brown, moist to wet, (very stiff)	83.9	1	8 ○ 168 ▲	×	SS1	
				2	7 ○ 132 ▲ 125 kPa + s = 6.3	×	SS2	19.1
			82.86					
		CLAY High plasticity, some silt, grey, wet, (firm)	82.2	3	2 ○ 48 kPa + s = 8.0 Hammer Weight	×	SS3	
					29 kPa + s = 6.0 Hammer Weight	×	SS4	
				5	29 kPa + s = 8.0 Hammer Weight	×	SS5	
					34 kPa + s = 7.0	×	SS6	
				6	Hammer Weight	×	SS7	
				7	34 kPa + s = 5.6			
				8	Hammer Weight		TW8	
			76.4		38 kPa + s = 6.4			
		Borehole Terminated at 8.5 m Depth						

LOG OF BOREHOLE BH LOGS - JULY 5 UPDATED BOREHOLE LOGS.GPJ TROW OTTAWA.GDT 9/6/24

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)
June 19, 2021	1.7	7.6
August 2, 2023	1.4	
September 21, 2023	1.7	
October 6, 2023	1.8	
October 19, 2023	2.0	

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 Brown, moist to wet, (stiff to very stiff)	81.1				AS1	
			80.46	1	2 ○ 120 ▲ 67 kPa + s = 9.3		SS2	
			79.6	1	1 ○		SS3	
		SILTY CLAY TO CLAY Grey, wet, (soft to firm)		2	48 kPa + s = 6.7			
					Hammer Weight ○		SS4	
				3	29 kPa + s = 8.0			
					Hammer Weight ○		SS5	
					24 kPa + s = 6.7			
					Hammer Weight ○		SS6	
					24 kPa + s = 6.7			
				5				
					Hammer Weight ○		SS7	
				6	29 kPa + s = 6.0			
				7				
					Hammer Weight ○		SS8	
			73.7		34 kPa + s = 7.0			
		Borehole Terminated at 7.8 m Depth						

LOG OF BOREHOLE BH LOGS - JULY 5 UPDATED BOREHOLE LOGS.GPJ TROW OTTAWA.GDT 9/6/24

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)
June 19, 2021	1.0	6.7
August 2, 2023	0.9	
September 21, 2023	1.0	
October 6, 2023	1.0	
October 19, 2023	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

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)	80.69	1	8, 144		SS1	18.0
				2	7, 132		SS2	17.1
		SILTY CLAY Medium plasticity, grey, wet, (firm to stiff)	79.0	3	1 34 kPa s = 7.0 Hammer Weight		SS3 SS4	
				4	34 kPa s = 7.0			
				5	Hammer Weight		SS5	
				6	34 kPa s = 7.0			
				7	Hammer Weight 38 kPa s = 8.0		SS6	
				8	Hammer Weight 53 kPa s = 7.3		SS7	
				9	Hammer Weight		SS8	
				10	48 kPa 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)
June 19, 2021	1.7	7.6
August 2, 2023	0.5	
September 21, 2023	Not Found	

CORE DRILLING RECORD

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

LOG OF BOREHOLE BH LOGS - JULY 5 UPDATED BOREHOLE LOGS.GPJ TROW OTTAWA.GDT 9/6/24

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 Medium plasticity, grey, wet, (firm to stiff) *(continued)*	71.19	10	20 40 60 80 50 100 150 200 kPa	250 500 750 20 40 60		
				11	Hammer Weight 55 kPa s = 7.7		SS9	
				12				
				13	Hammer Weight 62 kPa s = 6.5		TW10 15.0	
			68.1					
		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)
June 19, 2021	1.7	7.6
August 2, 2023	0.5	
September 21, 2023	Not Found	

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

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 9/6/24

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)
June 19, 2021	1.7	7.6
August 2, 2023	0.5	
September 21, 2023	Not Found	

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					
		SILTY CLAY High plasticity, trace sand, brown, moist to wet, (very stiff)	82.52		6; 156; 115 kPa; s = 7.7		SS2	18.2
				2	2		SS3	
			81.3					
		SILTY CLAY TO CLAY Grey, wet, (firm)		3	45 kPa; s = 6.0; Hammer Weight		SS4	
					34 kPa; s = 9.3; Hammer Weight		SS5	
					31 kPa; s = 8.7; Hammer Weight		TW6	15.3
				5	29 kPa; s = 6.0			
				6	Hammer Weight		SS7	
			77.1	7	34 kPa; s = 7.0			
		Borehole Terminated at 7.0 m Depth						

LOG OF BOREHOLE BH LOGS - JULY 5 UPDATED BOREHOLE LOGS.GPJ TROW OTTAWA.GDT 9/6/24

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)
June 19, 2021	1.4	6.1
August 2, 2023	1.1	
September 21, 2023	1.4	
October 6, 2023	1.7	
October 19, 2023	1.6	

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 Brown, moist to wet, (very stiff)	82.0					
			81.18	1	7 ○ 180 ▲		SS1	
				2	4 ○ 132 ▲ 120 kPa + s = 8.0	×	SS2	
		SILTY CLAY TO CLAY Grey, wet, (firm)	80.0		1 ○	×	SS3	
				3	34 kPa + s = 9.3	×	TW4	15.1
				4	31 kPa + s = 8.7			
				5	Hammer Weight ○ 29 kPa + s = 8.0	×	SS5	
				6	Hammer Weight ○	×	SS6	
			75.3	7	31 kPa + s = 6.5			
		Borehole Terminated at 7.0 m Depth						

LOG OF BOREHOLE BH LOGS - JULY 5 UPDATED BOREHOLE LOGS.GPJ TROW OTTAWA.GDT 9/6/24

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)
June 19, 2021	1.4	6.1
August 2, 2023	1.1	
September 21, 2023	Not Found	

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
		TOPSOIL ~300mm thick	84.7	0
		SILTY CLAY TO CLAY Brown, moist, (very stiff)	84.4	
		SILTY CLAY TO CLAY Grey, wet, (firm)	82.1	
		Borehole Terminated at 6.2 m Depth	78.5	6

Standard Penetration Test N Value: 20 40 60 80
Shear Strength: 50 100 150 200 kPa

Combustible Vapour Reading (ppm): 250 500 750
Natural Moisture Content % Atterberg Limits (% Dry Weight): 20 40 60

SAMPLES

Natural Unit Wt. kN/m³

Depth 0 1 2 3 4 5 6

120 kPa
s = 8.0
29 kPa
s = 6.0
29 kPa
s = 6.0
31 kPa
s = 6.5
34 kPa
s = 7.0
34 kPa
s = 7.0

LOG OF BOREHOLE BH LOGS - JULY 5 UPDATED BOREHOLE LOGS.GPJ TROW OTTAWA.GDT 9/6/24

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)
June 19, 2021	Damaged	6.1
August 2, 2023	Not Found	

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 ⊢○ | Undrained Triaxial at % Strain at Failure ⊕ | Shear Strength by Penetrometer Test ▲

GWL	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					
		83.72	1	2 120		SS1	
	SILTY CLAY Medium to high plasticity, trace sand, grey, moist to wet, (firm to stiff) with sand seams from 1.5 m to 2.9 m depths.	83.2		5 53 kPa s = 5.5		SS2	
			2	1 34 kPa s = 7.0		SS3	
			3	Hammer Weight 29 kPa s = 6.0		SS4	
			4	Hammer Weight 34 kPa s = 5.6		SS5	
			5				
			6	41 kPa s = 6.8		TW6	
	Borehole Terminated at 7.0 m Depth	77.7	7				

LOG OF BOREHOLE BH LOGS - JULY 5 UPDATED BOREHOLE LOGS.GPJ TROW OTTAWA.GDT 9/6/24

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)
June 19, 2021	1.3	6.1
August 2, 2023	1.0	
September 21, 2023	0.9	
October 6, 2023	1.0	
October 19, 2023	1.0	

CORE DRILLING RECORD

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

Log of Borehole BH-11

Project No: OTT-21004743-B0

Project: Proposed Residential Development

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

Figure No. 13

Page. 1 of 1

Date Drilled: 'September 12, 2023

Drill Type: CME-55 Track Mounted Drill Rig

Datum: Geodetic Elevation

Logged by: M.Z Checked by: IT

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 ~300 mm thick	85.92	0	4		SS1	
		SILTY SAND Light brown to brown, moist, (loose to compact)	85.6	1	10		SS2	
					16		SS3	
▽			83.7	2				
		SILTY CLAY Low plasticity, some sand seams, brown, wet, (stiff)	83.72		2		SS4	18.5
				3	58 kPa s=8			
			82.3					
		SILTY CLAY High plasticity, grey, wet, (firm)			Hammer Weight		SS5	
				5	48 kPa s=20			
					Hammer Weight		SS6	
				6	43 kPa s=18			
			79.5					
		Borehole Terminated at 6.4 m Depth						

LOG OF BOREHOLE BH LOGS - JULY 5 UPDATED BOREHOLE LOGS.GPJ TROW OTTAWA.GDT 9/6/24

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)
September 21, 2023	2.3	
October 6, 2023	2.2	
October 19, 2023	2.2	

CORE DRILLING RECORD

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

Log of Borehole BH-12

Project No: OTT-21004743-B0

Project: Proposed Residential Development

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

Figure No. 14

Page. 1 of 1

Date Drilled: 'September 12, 2023

Drill Type: CME-55 Track Mounted Drill Rig

Datum: Geodetic Elevation

Logged by: M.Z Checked by: IT

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	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 ~450 mm thick	82.95	0	2		SS1	
	SILTY SAND Trace clay, brown, moist	82.5					
	CLAY Brown, moist, (very stiff)	82.1	1	4		SS2	17.8
		81.65		130 kPa s=6.5			
	SILTY CLAY High plasticity, grey, wet, (firm)	80.9	2	Hammer Weight		SS3	14.7
			3	29 kPa s=12			
				Hammer Weight	86	SS4	
			5	38 kPa			
				Hammer Weight	87	SS5	
			6	43 kPa s=18			
		76.6					
	Borehole Terminated at 6.4 m Depth						

NOTE :
Relatively undisturbed tube sample (Shelby tube) retrieved from 3.0 m to 3.6 m depths in borehole located adjacent to BH 12.

LOG OF BOREHOLE BH LOGS - JULY 5 UPDATED BOREHOLE LOGS.GPJ TROW OTTAWA.GDT 9/6/24

NOTES:
1. Borehole data requires interpretation by EXP before use by others
2. A 50 mm diameter monitoring well 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)
September 21, 2023	3.3	
October 6, 2023	1.4	
October 19, 2023	1.3	

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

Log of Borehole BH-13

Project No: OTT-21004743-B0

Project: Proposed Residential Development

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

Figure No. 15

Page. 1 of 1

Date Drilled: 'September 12, 2023

Drill Type: CME-55 Track Mounted Drill Rig

Datum: Geodetic Elevation

Logged by: M.Z Checked by: IT

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	84.45	0				
		SILTY SAND Brown, moist, (very loose)	84.4		2		SS1	
			83.8		180 kPa s=12			
		SILTY CLAY With sand seams, brown, moist to wet, (very stiff)		1	2		SS2	19.3
			83.15		101 kPa s=6			
			82.4	2				
		SILTY CLAY Grey, moist to wet, (firm)			Hammer Weight		SS3	
				3	38 kPa s=8			
					Hammer Weight		SS4	
					38 kPa s=16			
				5	Hammer Weight		SS5	
				6	38 kPa s=16			
			78.1					
		Borehole Terminated at 6.4 m Depth						

LOG OF BOREHOLE BH LOGS - JULY 5 UPDATED BOREHOLE LOGS.GPJ TROW OTTAWA.GDT 9/6/24

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)
September 21, 2023	1.8	
October 13, 2023	1.4	
October 19, 2023	1.3	

CORE DRILLING RECORD

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

Log of Borehole BH-14

Project No: OTT-21004743-B0

Project: Proposed Residential Development

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

Figure No. 16

Page. 1 of 1

Date Drilled: 'September 12, 2023

Drill Type: CME-55 Track Mounted Drill Rig

Datum: Geodetic Elevation

Logged by: M.Z Checked by: IT

Split Spoon Sample
Auger Sample
SPT (N) Value
Dynamic Cone Test
Shelby Tube
Shear Strength by Vane Test

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	83.87	0				
		SILTY SAND Clay seams, brown, moist, (very loose)	83.8		3		SS1	
		SILTY CLAY High plasticity, brown, moist, (very stiff)	83.2	1	4		SS2	19.0
					> 120 kPa			
			82.07	2				
		CLAY Light brown to grey, moist to wet, (firm to stiff)	81.8		2		SS3	
				3	53 kPa s=11			
					Hammer Weight		SS4	
				5	48 kPa s=10			
					Hammer Weight		SS5	
				6	48 kPa s=10			
			77.5					
		Borehole Terminated at 6.4 m Depth						

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)
September 21, 2023	1.7	
October 6, 2023	1.7	
October 19, 2023	1.8	

CORE DRILLING RECORD

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

LOG OF BOREHOLE BH LOGS - JULY 5 UPDATED BOREHOLE LOGS.GPJ TROW OTTAWA.GDT 9/6/24

Log of Borehole BH-15

Project No: OTT-21004743-B0

Project: Proposed Residential Development

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

Figure No. 17

Page. 1 of 1

Date Drilled: 'September 13, 2023

Drill Type: CME-55 Track Mounted Drill Rig

Datum: Geodetic Elevation

Logged by: M.Z Checked by: IT

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 ~50 mm thick	84.52	0	4		SS1	
		SILTY SAND	84.5					
		With native,clayey seams, brown, moist, (loose)	83.72	1	1		SS2	
			83.6		29 kPa s=12			
		CLAY Grey, wet, (firm to stiff)		2	Hammer Weight		SS3	
				3			ST1	
					48 kPa s=20			
				4				
					Hammer Weight		SS4	
				5	46 kPa s=19			
				6	Hammer Weight		SS5	
					43 kPa s=18			
				7	Hammer Weight		SS6	
				8	53 kPa s=11			
				9			ST2	15.3
			74.3	10	48 kPa s=20			
		Borehole Terminated at 10.2 m Depth						

LOG OF BOREHOLE BH LOGS - JULY 5 UPDATED BOREHOLE LOGS.GPJ TROW OTTAWA.GDT 9/6/24

NOTES:

1. Borehole data requires interpretation by EXP before use by others
2. A 50 mm diameter monitoring well 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)
September 21, 2023	0.8	
October 6, 2023	0.9	
October 19, 2023	0.8	

CORE DRILLING RECORD

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

Log of Borehole BH-16

Project No: OTT-21004743-B0

Project: Proposed Residential Development

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

Figure No. 18

Page. 1 of 1

Date Drilled: 'September 13, 2023

Drill Type: CME-55 Track Mounted Drill Rig

Datum: Geodetic Elevation

Logged by: M.Z Checked by: IT

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 ~50 mm thick	84.84	0	5	×	SS1	
		SILTY SAND ~ 300 mm thick Brown, moist, (loose)	84.8					
		SILTY CLAY Brown, moist, (very stiff)	84.5	1	100 kPa s=10			
		SILTY CLAY Grey, wet, (firm)	83.5	2	1 38 kPa s=16		SS2	
				3	Hammer Weight	×	SS3	
			81.34	4	36 kPa s=15			
				5	43 kPa s=18		ST1	
				6	Hammer Weight	×	SS4	
				7	43 kPa s=18			
				8	Hammer Weight	×	SS5	
					48 kPa s=20			
				9	Hammer Weight	×	SS6	
				10	43 kPa s=18			
		Borehole Terminated at 10.2 m Depth	74.6					

LOG OF BOREHOLE BH LOGS - JULY 5 UPDATED BOREHOLE LOGS.GPJ TROW OTTAWA.GDT 9/6/24

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)
September 21, 2023	3.4	
October 6, 2023	3.5	
October 19, 2023	3.5	

CORE DRILLING RECORD

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

Log of Borehole BH-17

Project No: OTT-21004743-B0

Project: Proposed Residential Development

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

Figure No. 19

Page. 1 of 1

Date Drilled: 'September 11, 2023

Drill Type: CME-55 Track Mounted Drill Rig

Datum: Geodetic Elevation

Logged by: M.Z Checked by: IT

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	84.57	0	6		SS1	
		SILTY SAND With topsoil inclusions, brown, moist, (loose)	84.5 / 83.8					
▽		**SILTY CLAY** High plasticity, grey, wet, (soft to firm) With silty sand seams in upper 150 mm.	83.07	1	4		SS2	
					14 kPa s=5.8			
				2	Hammer Weight		SS3	
				3	41 kPa s=17			
					Hammer Weight	84	SS4	
				5	43 kPa s=18			
					Hammer Weight	81	SS5	
				6	36 kPa s=15			
		Borehole Terminated at 6.4 m Depth	78.2					

LOG OF BOREHOLE BH LOGS - JULY 5 UPDATED BOREHOLE LOGS.GPJ TROW OTTAWA.GDT 9/6/24

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)
September 21, 2023	1.6	
October 6, 2023	1.5	
October 19, 2023	1.5	

CORE DRILLING RECORD

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

Log of Borehole BH-18

Project No: OTT-21004743-B0

Project: Proposed Residential Development

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

Figure No. 20

Page. 1 of 1

Date Drilled: 'September 11, 2023

Drill Type: CME-55 Track Mounted Drill Rig

Datum: Geodetic Elevation

Logged by: M.Z Checked by: IT

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	84.41	0	6		SS1	
		SILTY SAND Clay seams and with topsoil inclusion, brown to grey, moist, (loose to compact)	84.3					
				1	14 48 kPa		SS2	
			83.0					
		SILTY CLAY Grey, wet, (firm)	82.81		Hammer Weig s=10		SS3	
		With reddish brown bands in upper 300 mm.		2	38 kPa s=16			
				3	Hammer Weight	85	SS4	
				4	43 kPa s=18			
					Hammer Weight		SS5	
				5	38 kPa s=16			
				6	Hammer Weight		SS6	
			77.7					
		Borehole Terminated at 6.7 m Depth						

LOG OF BOREHOLE BH LOGS - JULY 5 UPDATED BOREHOLE LOGS.GPJ TROW OTTAWA.GDT 9/6/24

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)
September 21, 2023	1.8	
October 6, 2023	1.5	
October 19, 2023	1.6	

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

Log of Borehole BH-20

Project No: OTT-21004743-B0

Project: Proposed Residential Development

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

Figure No. 21

Page. 1 of 1

Date Drilled: 'September 14, 2023

Drill Type: CME-55 Track Mounted Drill Rig

Datum: Geodetic Elevation

Logged by: M.Z Checked by: IT

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 ~200 mm thick	80.89	0	5		SS1	
		SILTY SAND ~ 100mm thick	80.7					
		Brown, moist, (loose)	80.6		80 kPa, s=2			
		SILTY CLAY		1				
		Brown, moist , (stiff)	79.59		1		SS2	
				2	36 kPa, s=7.5			
		SILTY CLAY	78.7					
		Grey, wet, (soft to stiff)		3			ST1	
				4	24 kPa, s=20			
					Hammer Weight		87 SS3	
				5	34 kPa, s=14			
				6			ST2	
				7	48 kPa, s=20			
					Hammer Weight		SS4	
				8	50 kPa, s=21			
				9	Hammer Weight		SS5	
				10	53 kPa, s=22			
			70.7					
		Borehole Terminated at 10.2 m Depth						

LOG OF BOREHOLE BH LOGS - JULY 5 UPDATED BOREHOLE LOGS.GPJ TROW OTTAWA.GDT 9/6/24

NOTES:

1. Borehole data requires interpretation by EXP before use by others
2. A 50 mm diameter monitoring well 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)
September 21, 2023	5.7	
October 6, 2023	1.5	
October 19, 2023	1.3	

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

Log of Borehole BH-21

Project No: OTT-21004743-B0

Project: Proposed Residential Development

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

Figure No. 22

Page. 1 of 1

Date Drilled: 'January 31, 2024

Drill Type: CME-55 Track Mounted Drill Rig

Datum: Geodetic Elevation

Logged by: M.Z. Checked by: S.P.

Split Spoon Sample
Auger Sample
SPT (N) Value
Dynamic Cone Test
Shelby Tube
Shear Strength by Vane Test

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 ~300 mm thick	82.22	0	2		SS1	
		SILTY SAND Silty sand, some organics, brown to grey, moist to wet, (very loose to compact)	81.9	1	11		SS2	
				2	11		SS3	
		SILTY CLAY Grey, wet, (soft)	80.0	3	Hammer Weight 19 kPa	85	SS4	
				5	Hammer Weight 24 kPa	90	SS5	
				6	Hammer Weight	86	SS6	
				7	19 kPa			
		Borehole Terminated at 7.9 m Depth	74.3					

NOTES:

1. Borehole data requires interpretation by EXP before use by others
2. A 50 mm diameter monitoring well 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)

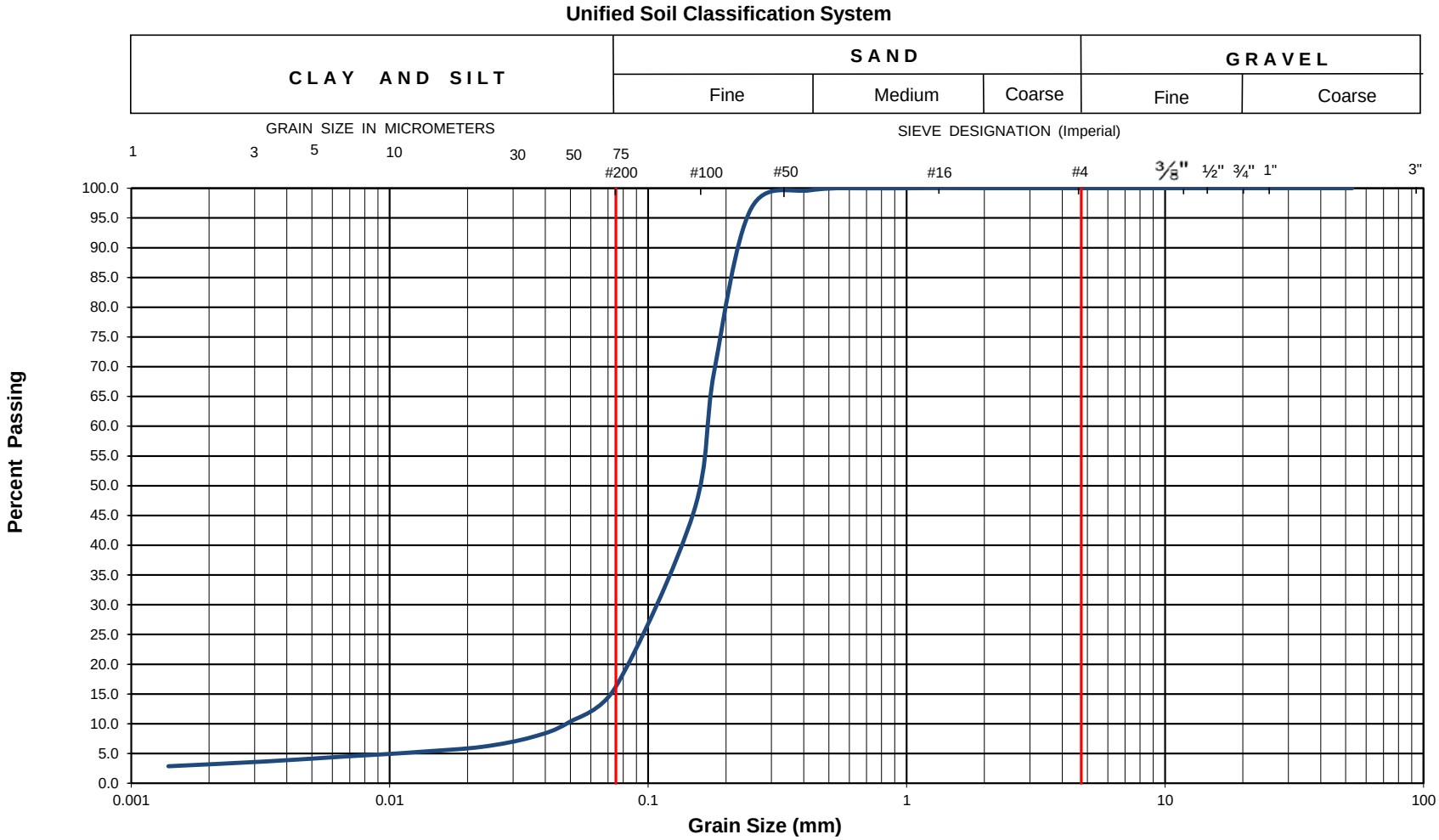
CORE DRILLING RECORD

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

LOG OF BOREHOLE BH LOGS - JULY 5 UPDATED BOREHOLE LOGS.GPJ TROW OTTAWA.GDT 9/6/24

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 1**	**Sample No.:**	**SS1**	**Depth (m) :**	**0.8-1.4**		
Sample Description :		**% Silt and Clay**	**16**	**% Sand**	**84**	**% Gravel**	**0**	**Figure :**	**23**
Sample Description :		**Silty Sand (SM) - Trace Clay**							

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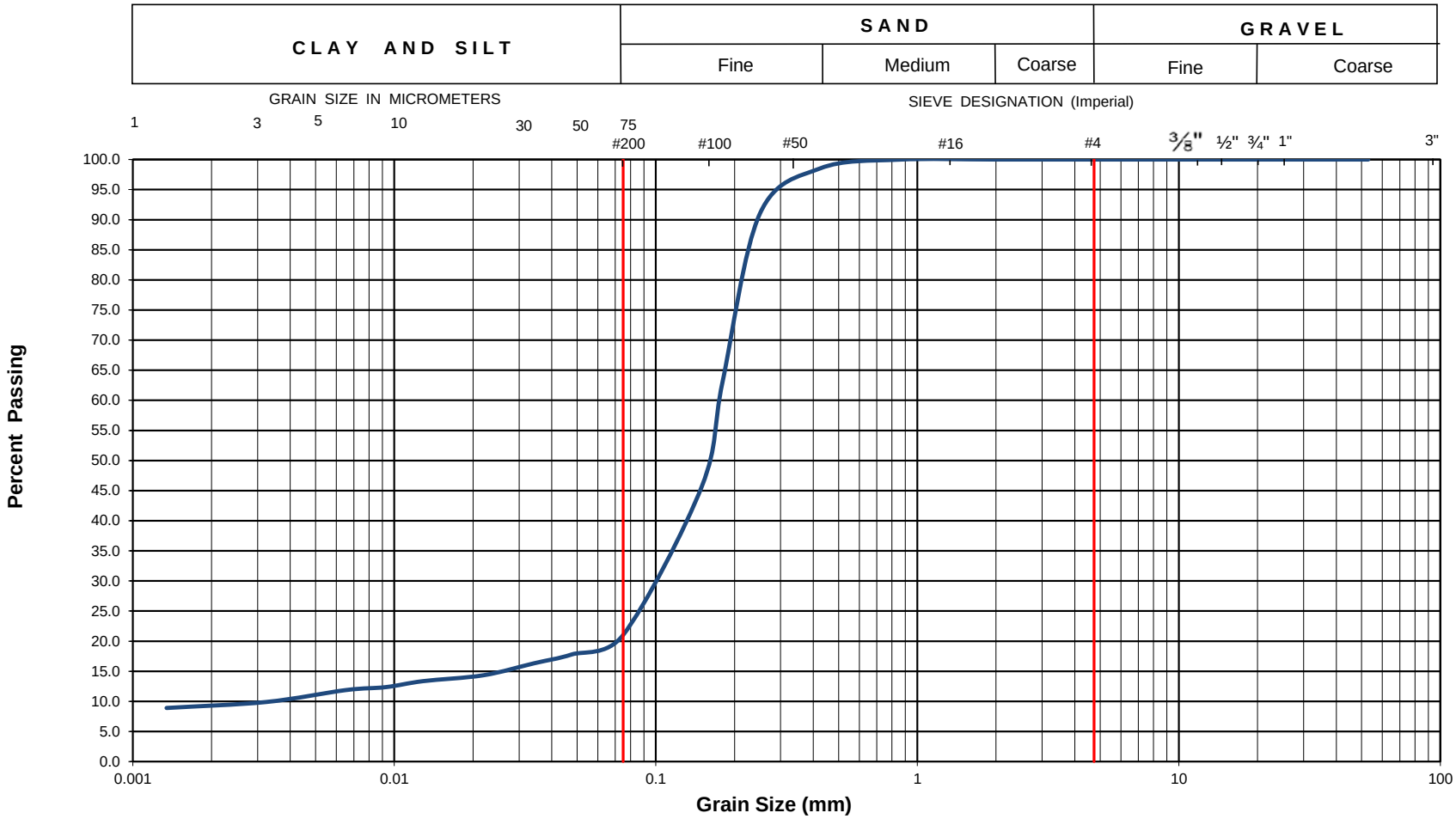
Grain-Size Distribution Curve
Method of Test For Particle Size Analysis of Soil
ASTM C-136/ASTM D422

Unified Soil Classification System



EXP Project No.:	**OTT-21004743-A0**	**Project Name :**	**Proposed Residential Development**						
Client :	**12714001 Canada Inc.**	**Project Location :**	**2983, 3053 & 3079 Navan Road, Ottawa, ON**						
Date Sampled :	**September 12, 2023**	**Borehole No:**	**BH 12**	**Sample No.:**	**SS1 & SS2**	**Depth (m) :**	**0-1.4**		
Sample Description :		**% Silt and Clay**	**21**	**% Sand**	**79**	**% Gravel**	**0**	**Figure :**	**24**
Sample Description :		**Silty Sand (SM) -Trace Clay**							

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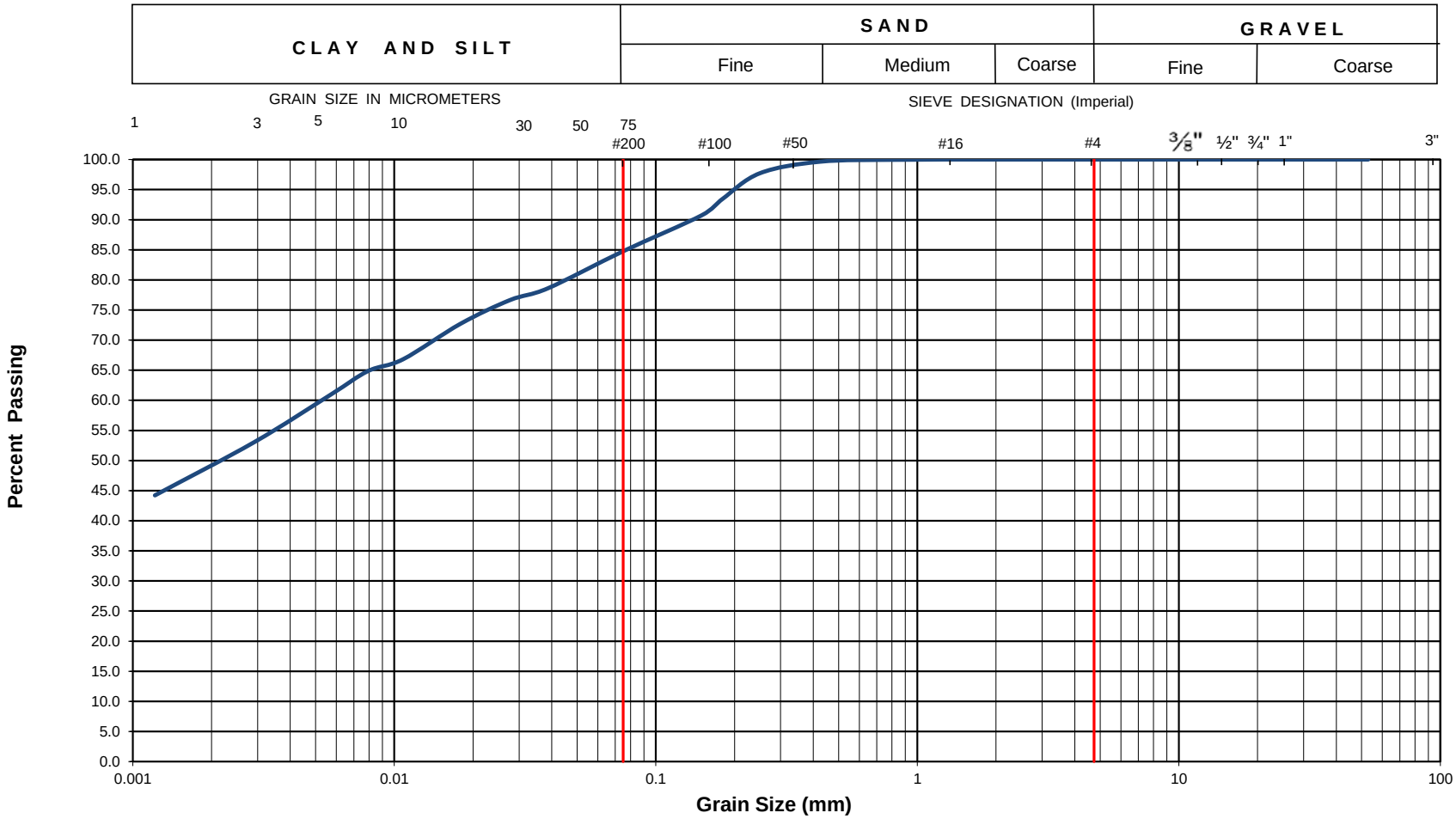
Grain-Size Distribution Curve
Method of Test For Particle Size Analysis of Soil
ASTM C-136/ASTM D422

Unified Soil Classification System



EXP Project No.:	**OTT-21004743-A0**	**Project Name :**	**Proposed Residential Development**						
Client :	**12714001 Canada Inc.**	**Project Location :**	**2983, 3053 & 3079 Navan Road, Ottawa, ON**						
Date Sampled :	**September 12, 2023**	**Borehole No:**	**BH 11**	**Sample No.:**	**SS4**	**Depth (m) :**	**2.3-2.9**		
Sample Description :		**% Silt and Clay**	**85**	**% Sand**	**15**	**% Gravel**	**0**	**Figure :**	**25**
Sample Description :		**Silty Clay of Low Plasticity (CL) - Some Sand**							

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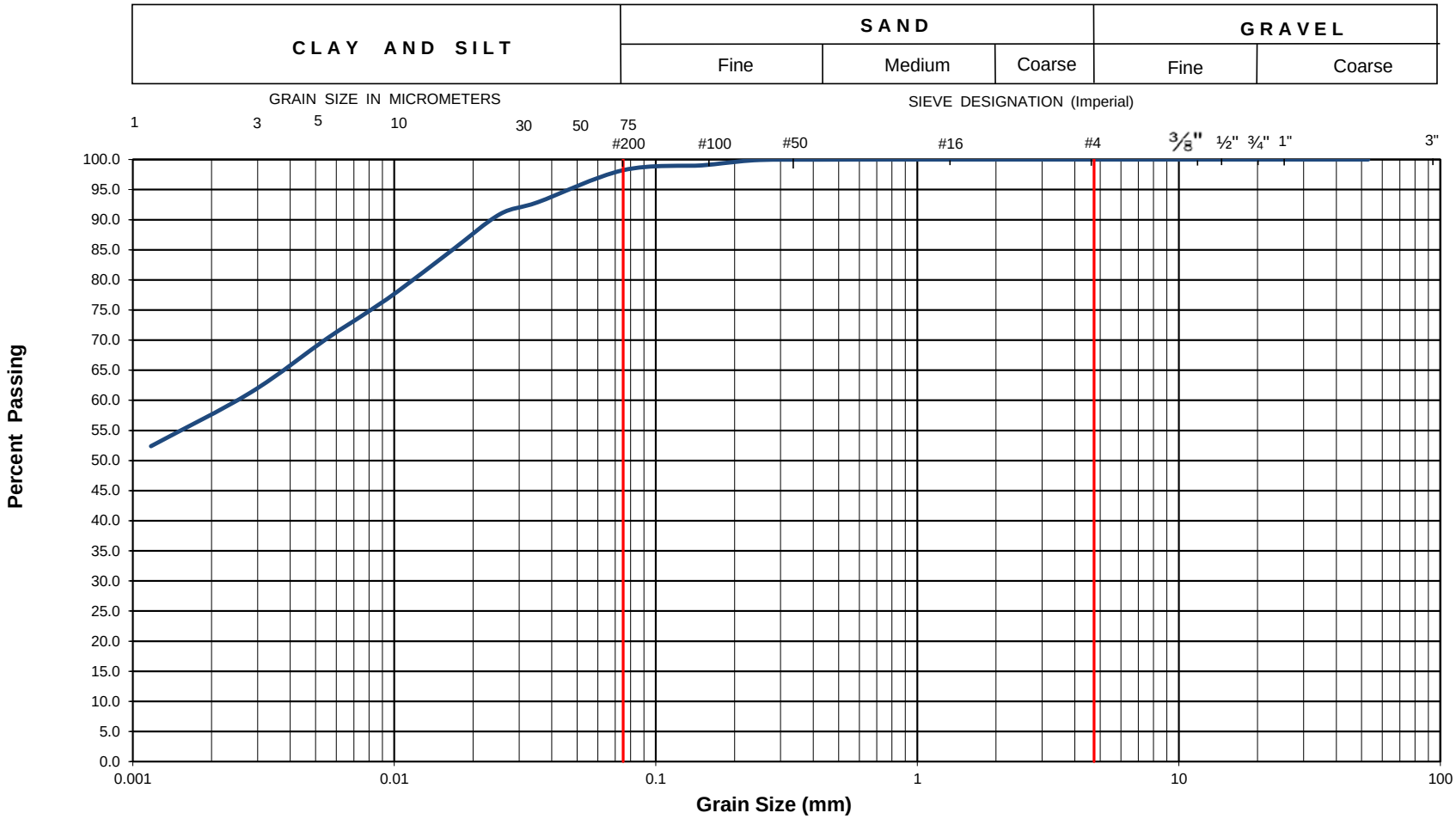
Grain-Size Distribution Curve
Method of Test For Particle Size Analysis of Soil
ASTM C-136/ASTM D422

Unified Soil Classification System



EXP Project No.:	**OTT-21004743-A0**	**Project Name :**	**Proposed Residential Development**						
Client :	**12714001 Canada Inc.**	**Project Location :**	**2983, 3053 & 3079 Navan Road, Ottawa, ON**						
Date Sampled :	**September 12, 2023**	**Borehole No:**	**BH 14**	**Sample No.:**	**SS2**	**Depth (m) :**	**0.8-1.4**		
Sample Description :		**% Silt and Clay**	**98**	**% Sand**	**2**	**% Gravel**	**0**	**Figure :**	**26**
Sample Description :	**Silty Clay of High Plasticity (CH) - Trace Sand**								

EXP Services Inc.
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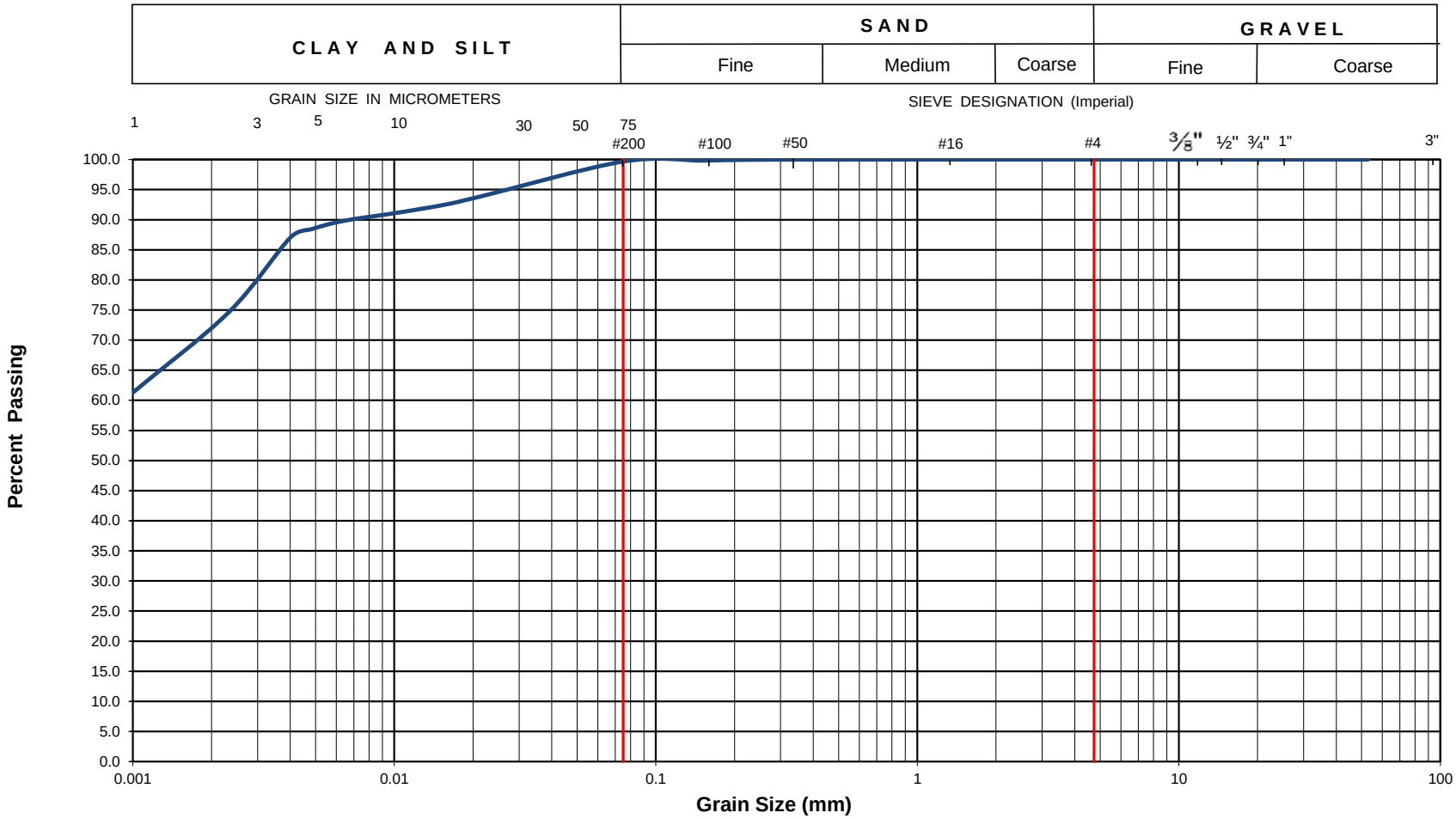
Ottawa, ON K2B 8H6

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 2**		**Sample No.:**	**SS7**		**Depth (m) :**	**6.1-6.7**
Sample Description :		**% Silt and Clay**	**100**	**% Sand**	**0**	**% Gravel**	**0**	**Figure :**	**27**
Sample Description :	**Grey Clay of Medium to High Plasticity (CI and CH)**								

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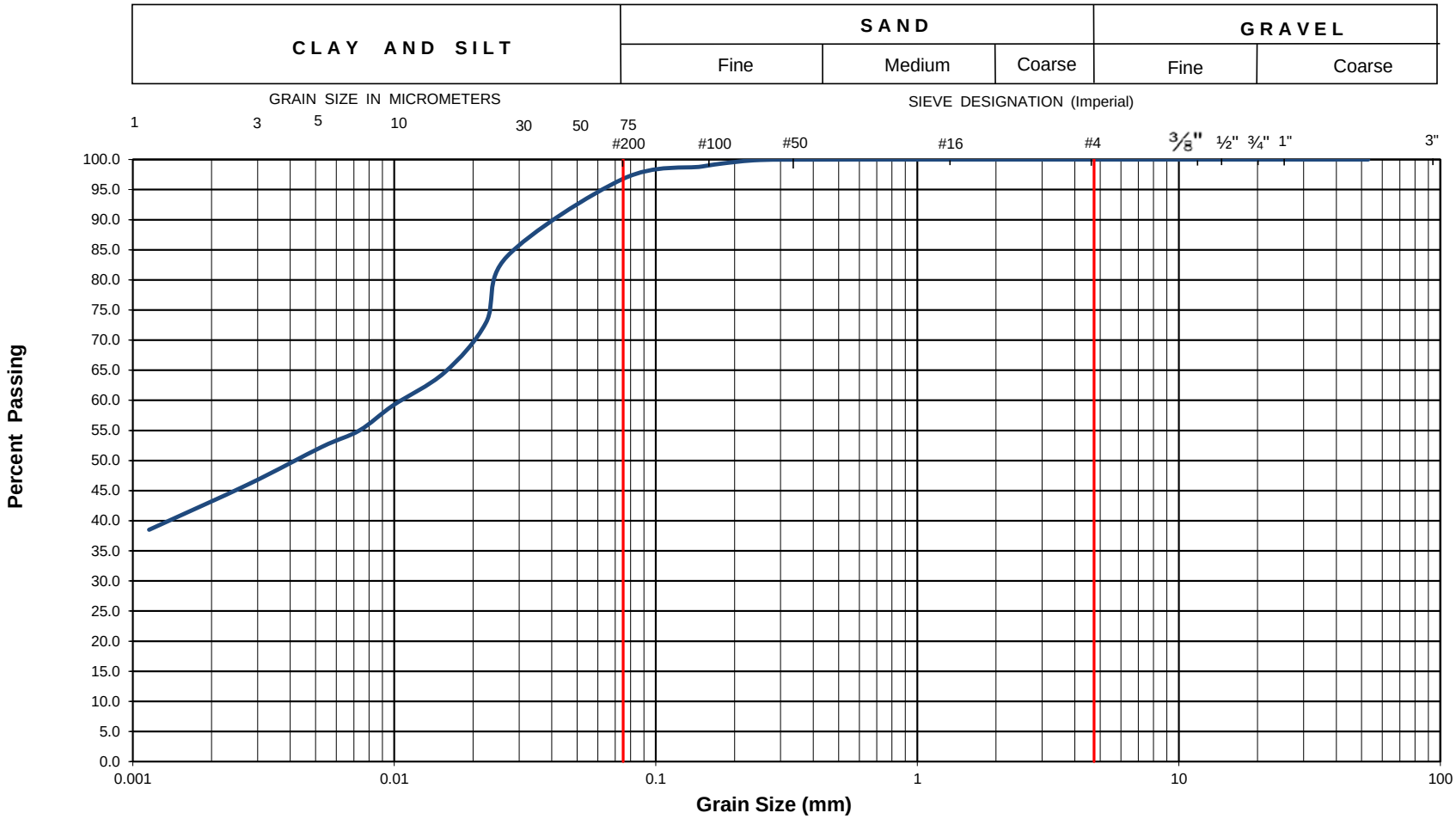
Grain-Size Distribution Curve
Method of Test For Particle Size Analysis of Soil
ASTM C-136/ASTM D422

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 3**	**Sample No.:**	**SS3**	**Depth (m) :**	**2.3-2.9**		
Sample Description :		**% Silt and Clay**	**97**	**% Sand**	**3**	**% Gravel**	**0**	**Figure :**	**28**
Sample Description :		**Silty Clay of Medium Plasticity (CI) -Trace Sand**							

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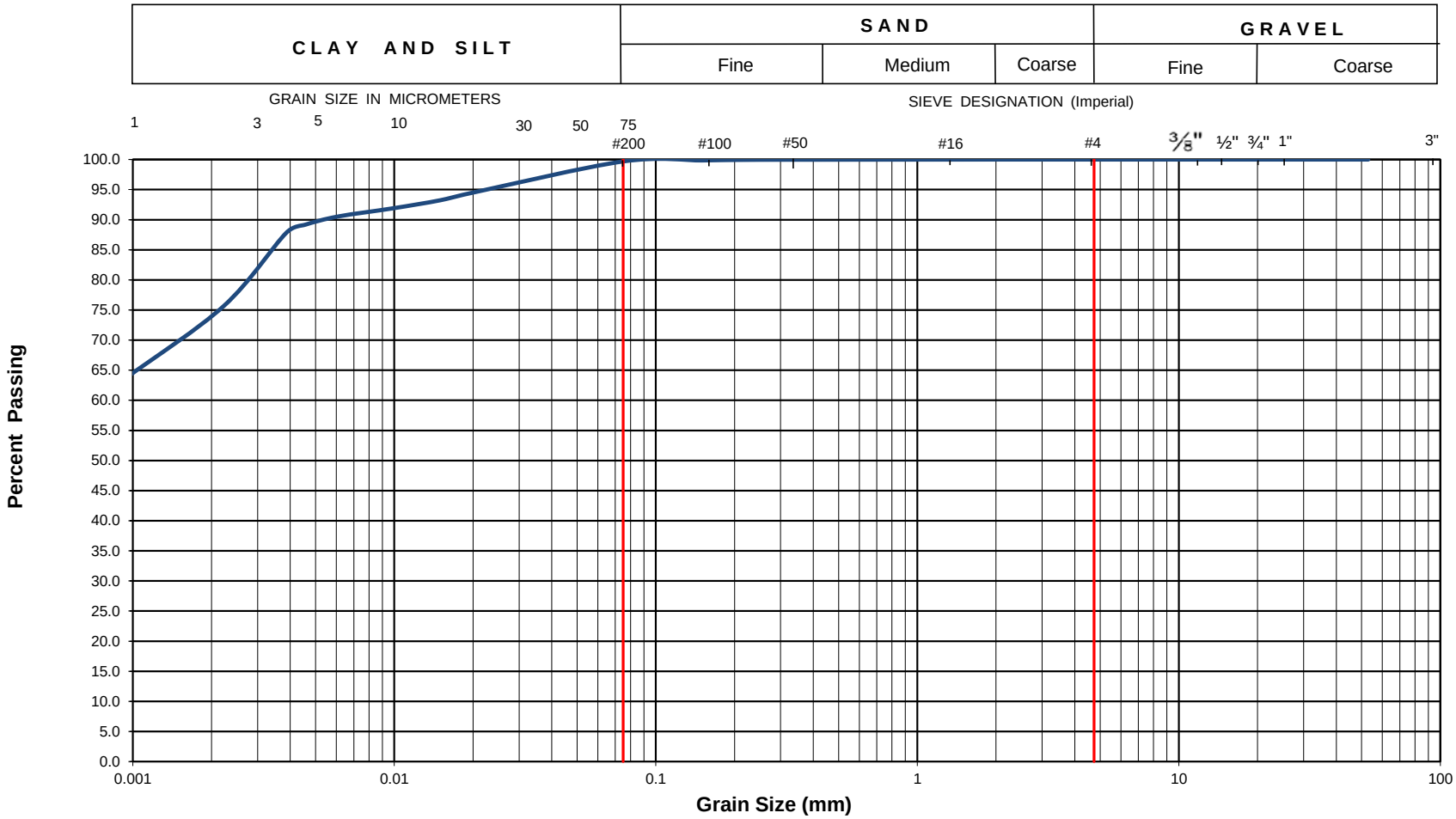
Grain-Size Distribution Curve
Method of Test For Particle Size Analysis of Soil
ASTM C-136/ASTM D422

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 :**	**29**
Sample Description :		**Clay of High Plasticity (CH) -Some Silt**							

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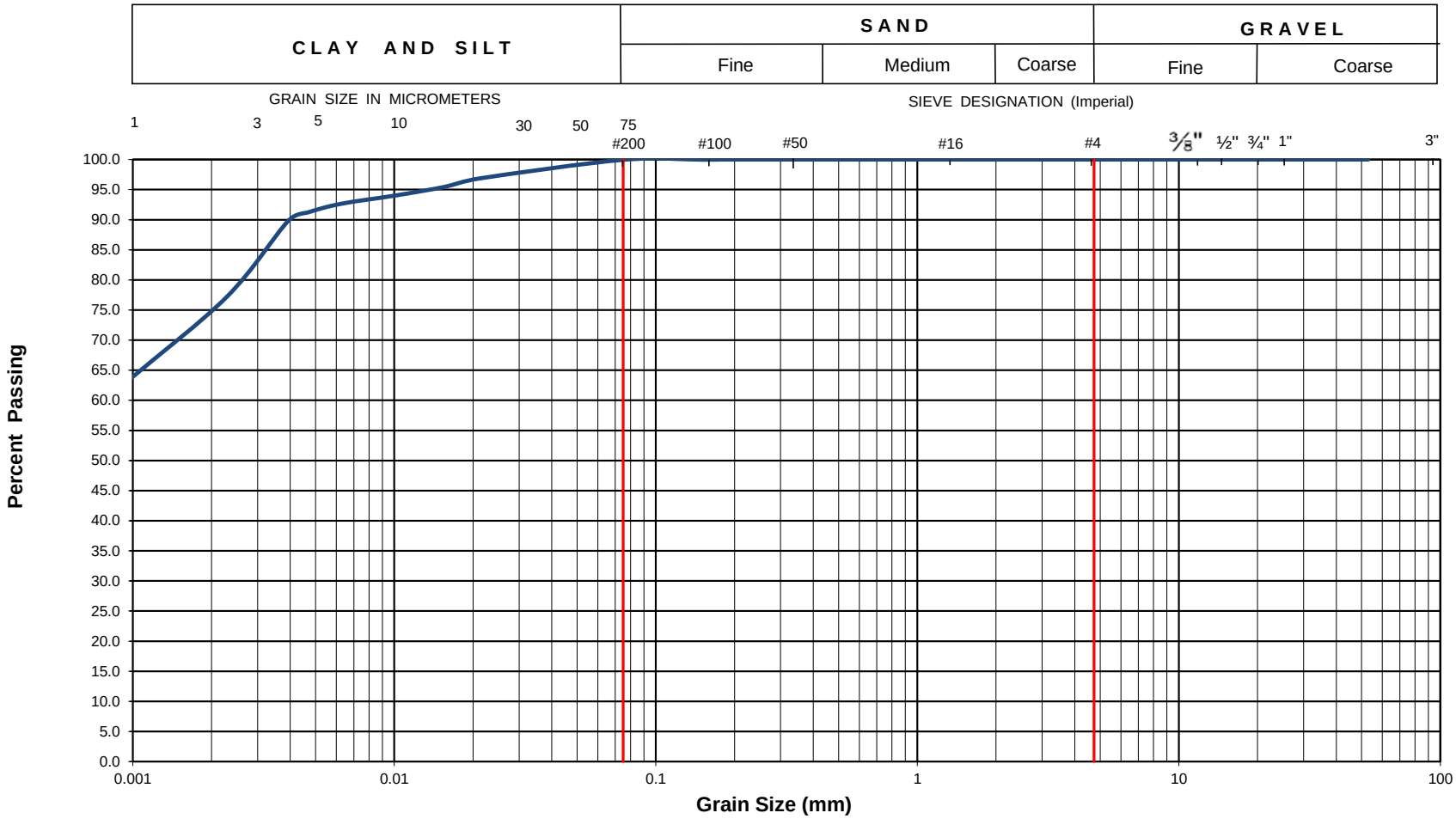
Grain-Size Distribution Curve
Method of Test For Particle Size Analysis of Soil
ASTM C-136/ASTM D422

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 :**	**30**
Sample Description :		**Silty Clay of Medium Plasticity (CI)**							

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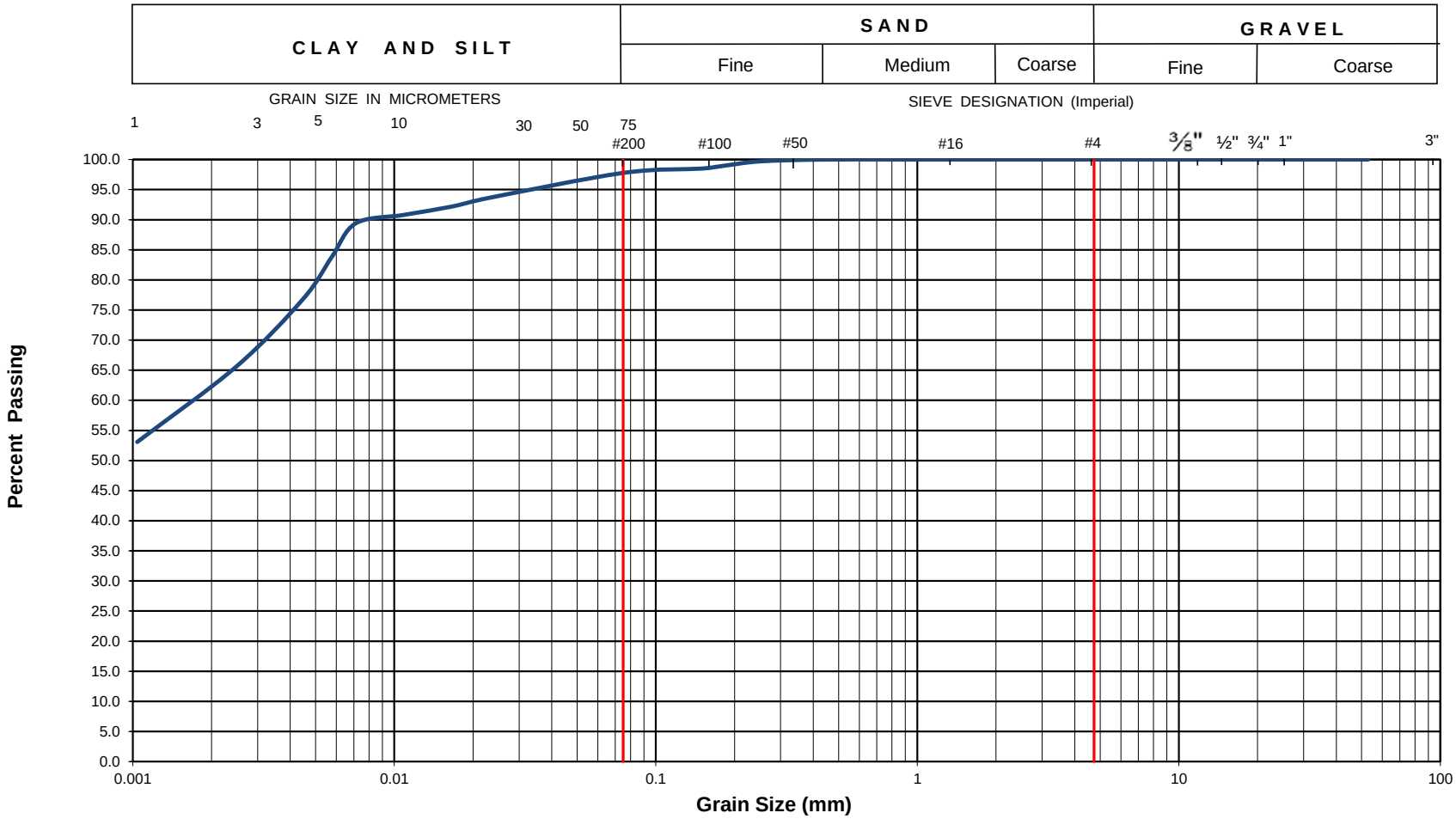
Grain-Size Distribution Curve
Method of Test For Particle Size Analysis of Soil
ASTM C-136/ASTM D422

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 :**	**31**
Sample Description :	**Silty Clay of Medium to High Plasticity (CI and CH) -Trace Sand**								

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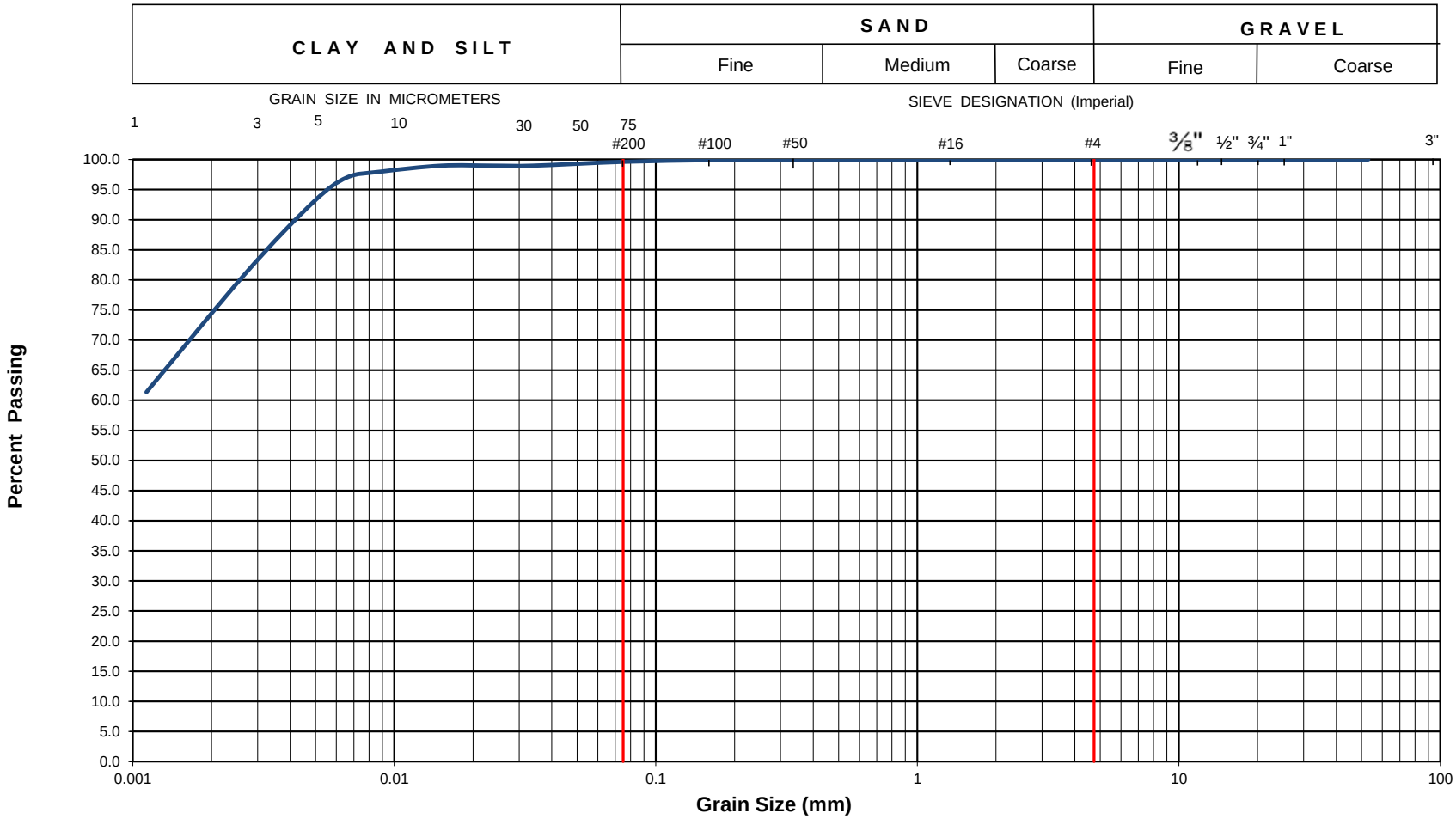
Grain-Size Distribution Curve
Method of Test For Particle Size Analysis of Soil
ASTM C-136/ASTM D422

Unified Soil Classification System



EXP Project No.:	**OTT-21004743-A0**	**Project Name :**	**Proposed Residential Development**						
Client :	**12714001 Canada Inc.**	**Project Location :**	**2983, 3053 & 3079 Navan Road, Ottawa, ON**						
Date Sampled :	**September 12, 2023**	**Borehole No:**	**BH 11**		**Sample No.:**	**SS5**		**Depth (m) :**	**3.8-4.4**
Sample Description :		**% Silt and Clay**	**100**	**% Sand**	**0**	**% Gravel**	**0**	**Figure :**	**32**
Sample Description :		**Silty Clay of High Plasticity (CH)**							

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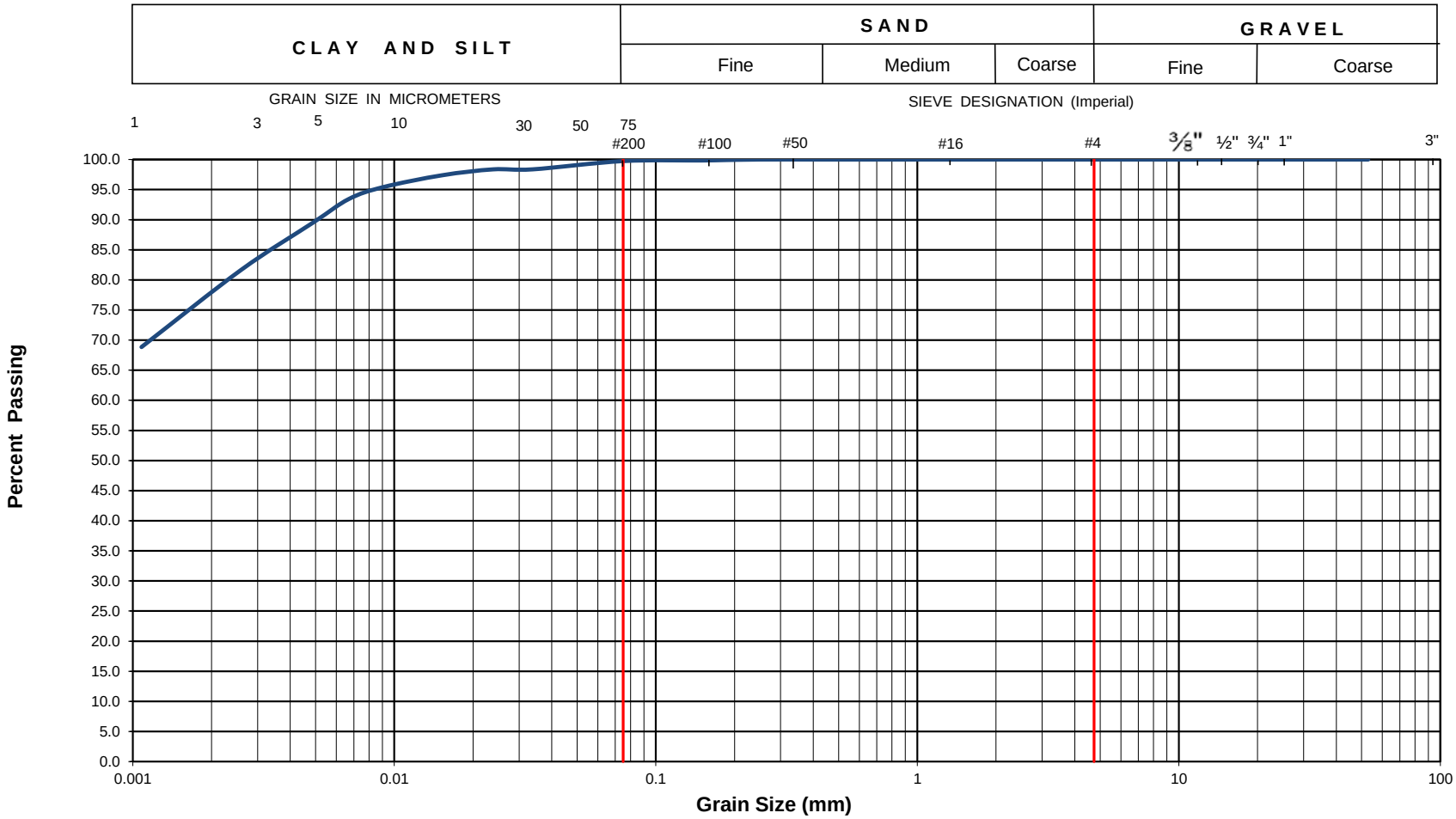
Grain-Size Distribution Curve
Method of Test For Particle Size Analysis of Soil
ASTM C-136/ASTM D422

Unified Soil Classification System



EXP Project No.:	**OTT-21004743-A0**	**Project Name :**	**Proposed Residential Development**						
Client :	**12714001 Canada Inc.**	**Project Location :**	**2983, 3053 & 3079 Navan Road, Ottawa, ON**						
Date Sampled :	**September 12, 2023**	**Borehole No:**	**BH 12**		**Sample No.:**	**SS3**		**Depth (m) :**	**2.3-2.9**
Sample Description :		**% Silt and Clay**	**100**	**% Sand**	**0**	**% Gravel**	**0**	**Figure :**	**33**
Sample Description :		**Silty Clay of High Plasticity (CH)**							

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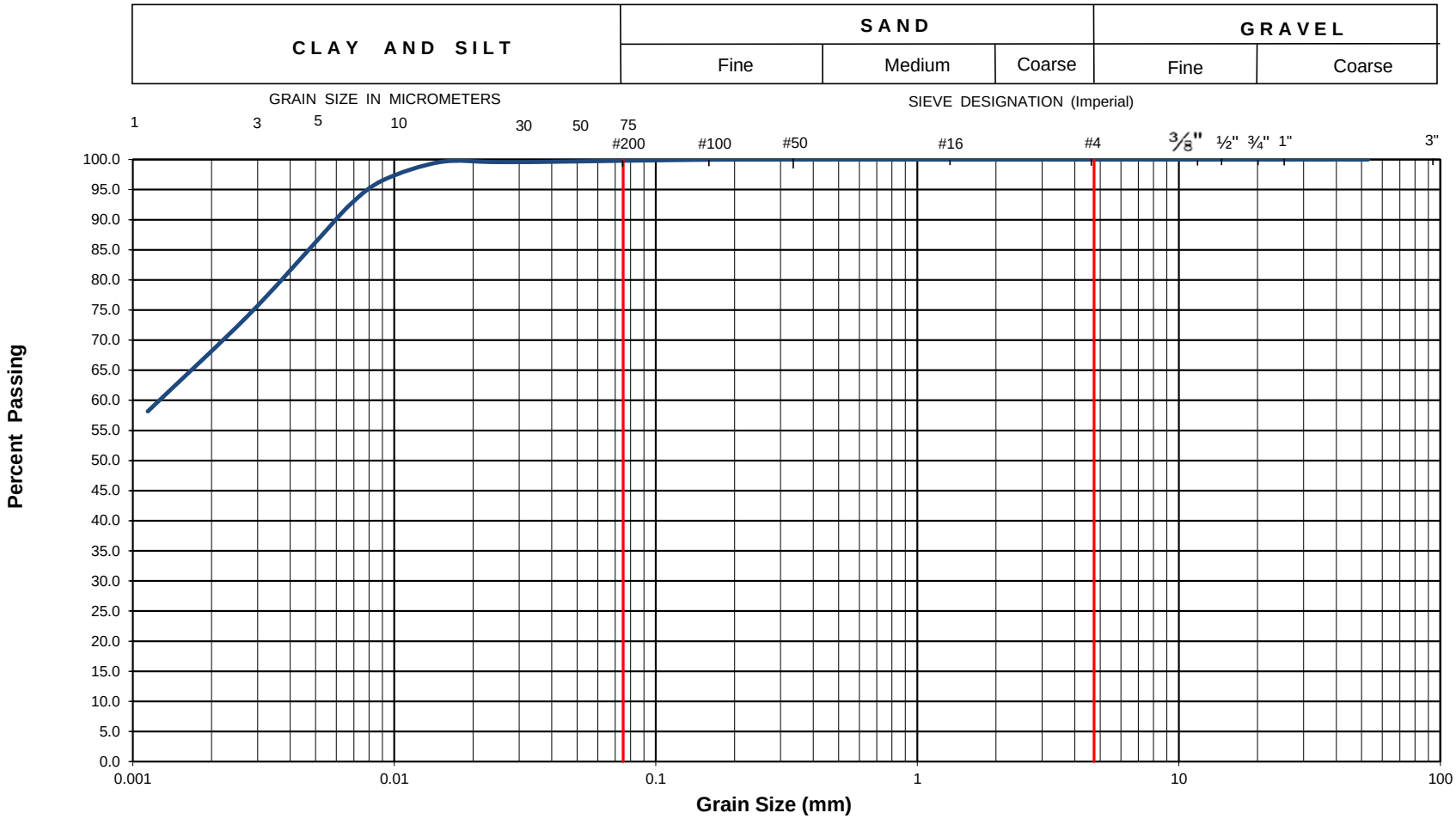
Grain-Size Distribution Curve
Method of Test For Particle Size Analysis of Soil
ASTM C-136/ASTM D422

Unified Soil Classification System



EXP Project No.:	**OTT-21004743-A0**	**Project Name :**	**Proposed Residential Development**						
Client :	**12714001 Canada Inc.**	**Project Location :**	**2983, 3053 & 3079 Navan Road, Ottawa, ON**						
Date Sampled :	**September 11, 2023**	**Borehole No:**	**BH 17**		**Sample No.:**	**SS3**		**Depth (m) :**	**2.3-2.9**
Sample Description :		**% Silt and Clay**	**100**	**% Sand**	**0**	**% Gravel**	**0**	**Figure :**	**34**
Sample Description :		**Silty 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.

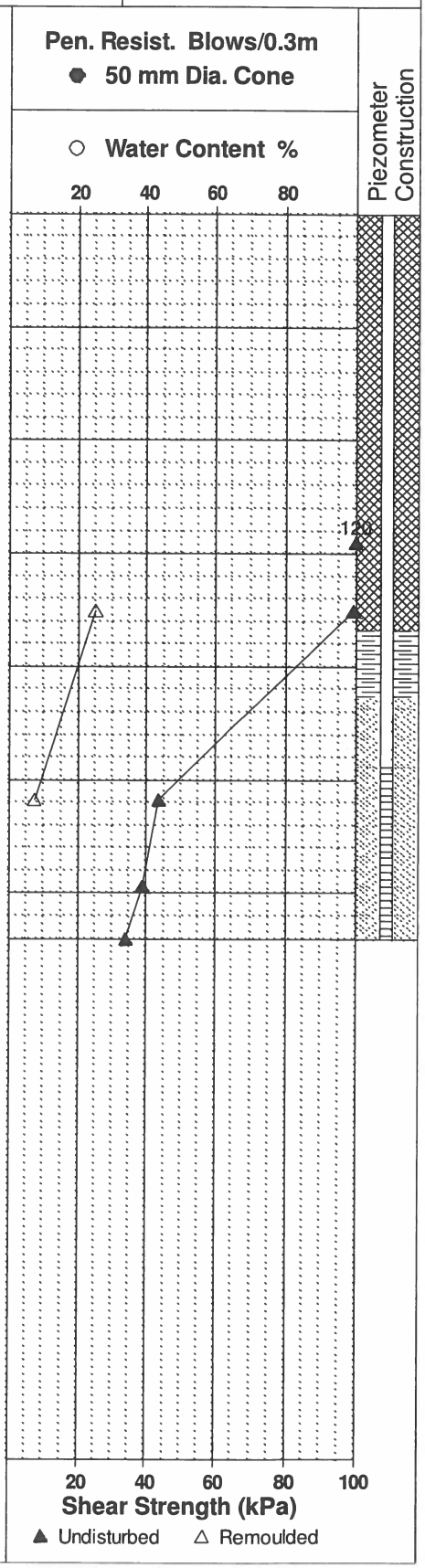
FILE NO. PG4415

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							



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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.

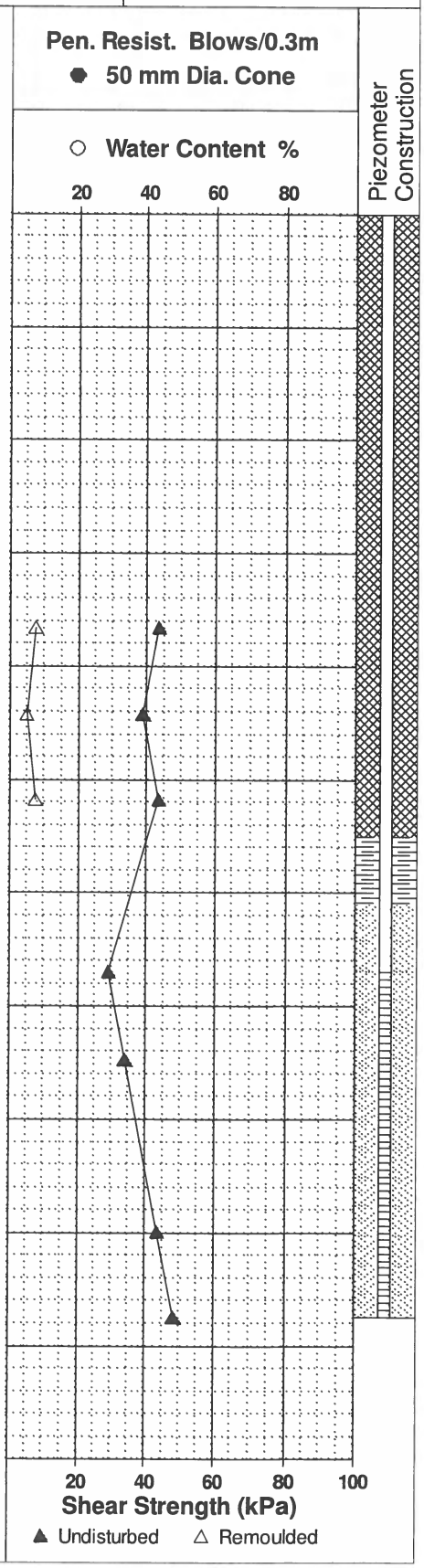
FILE NO. PG4415

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



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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						11	73.32	20 40 60 80	
						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	20 40 60 80 100 **Shear Strength (kPa)** ▲ Undisturbed △ Remoulded	

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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.

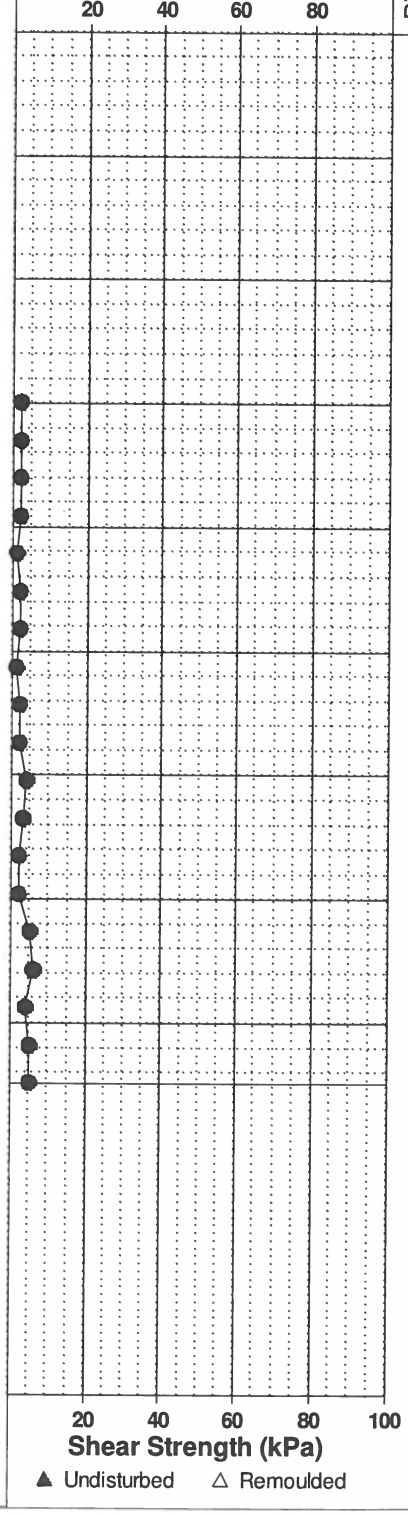
FILE NO. PG4415

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									



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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

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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	79.01
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

Appendix B:
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

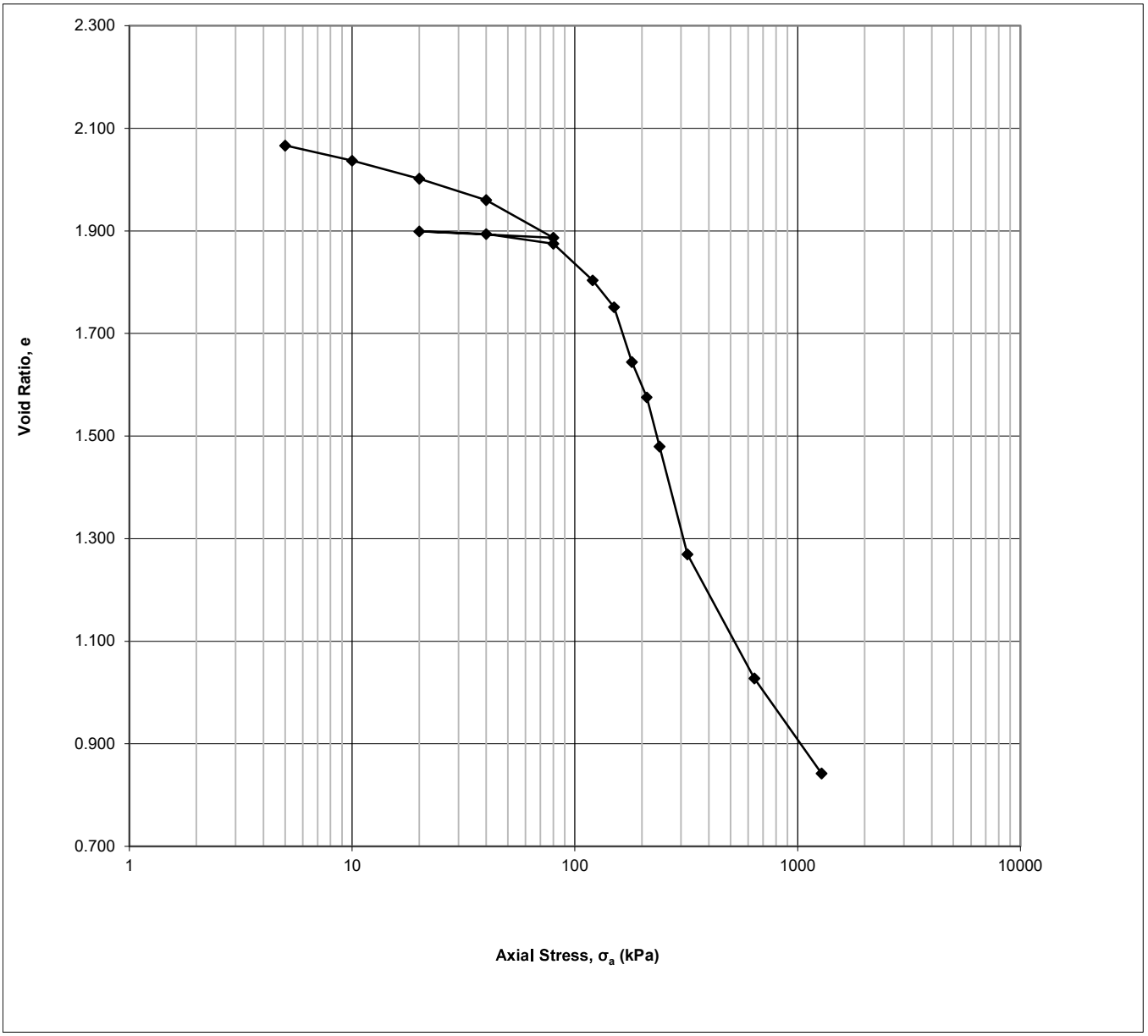
v:\01216\active\laboratory_standing_offers\2021 laboratory standing offers\121623683 exp services inc\may 3, three consolidation, file# ott-21004743-b0\121623683_let_consolidation_bh 6 tw10, bh8 tw4, & bh7 tw6.docx

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.

Date: June 7, 2021
Date: June 7, 2021

D. Boateng
R. Dey

Checked by:
Approved by:

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

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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

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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

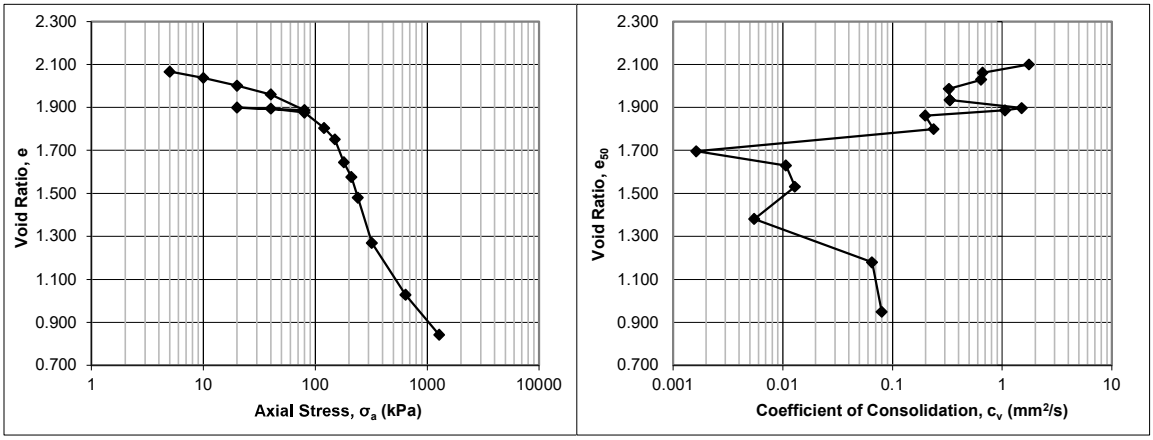
One-Dimensional Consolidation Test using Incremental Loading
ASTM D2435/D2435M - 11(2020)

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

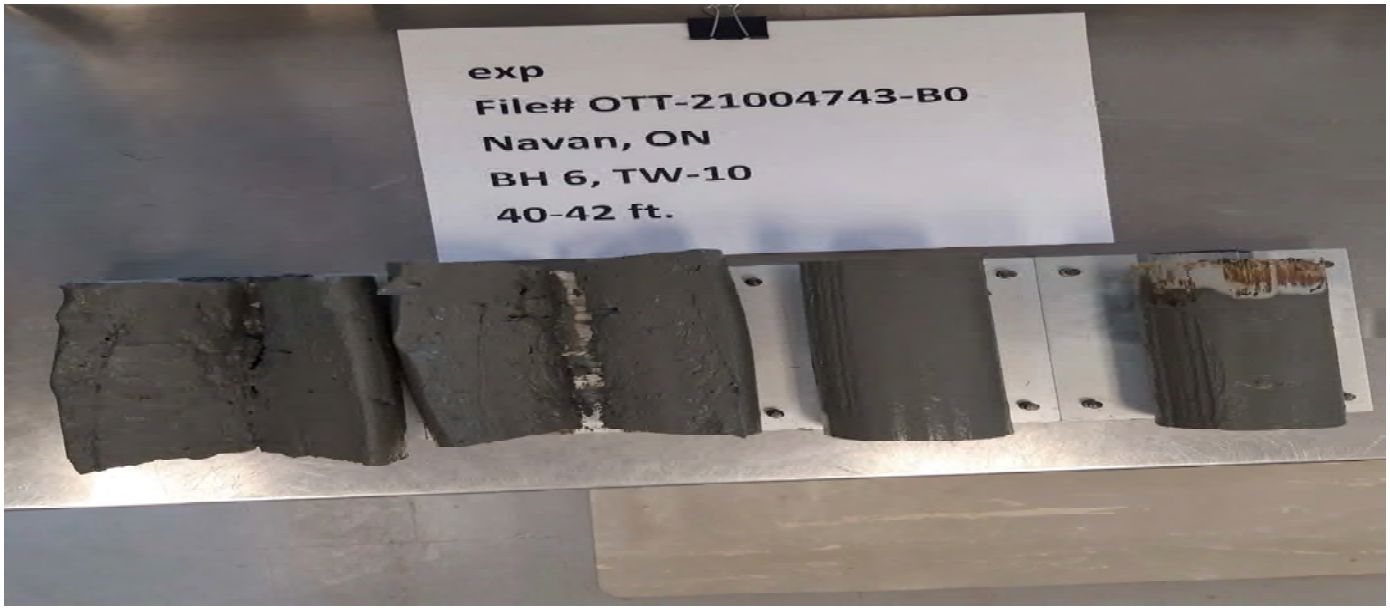


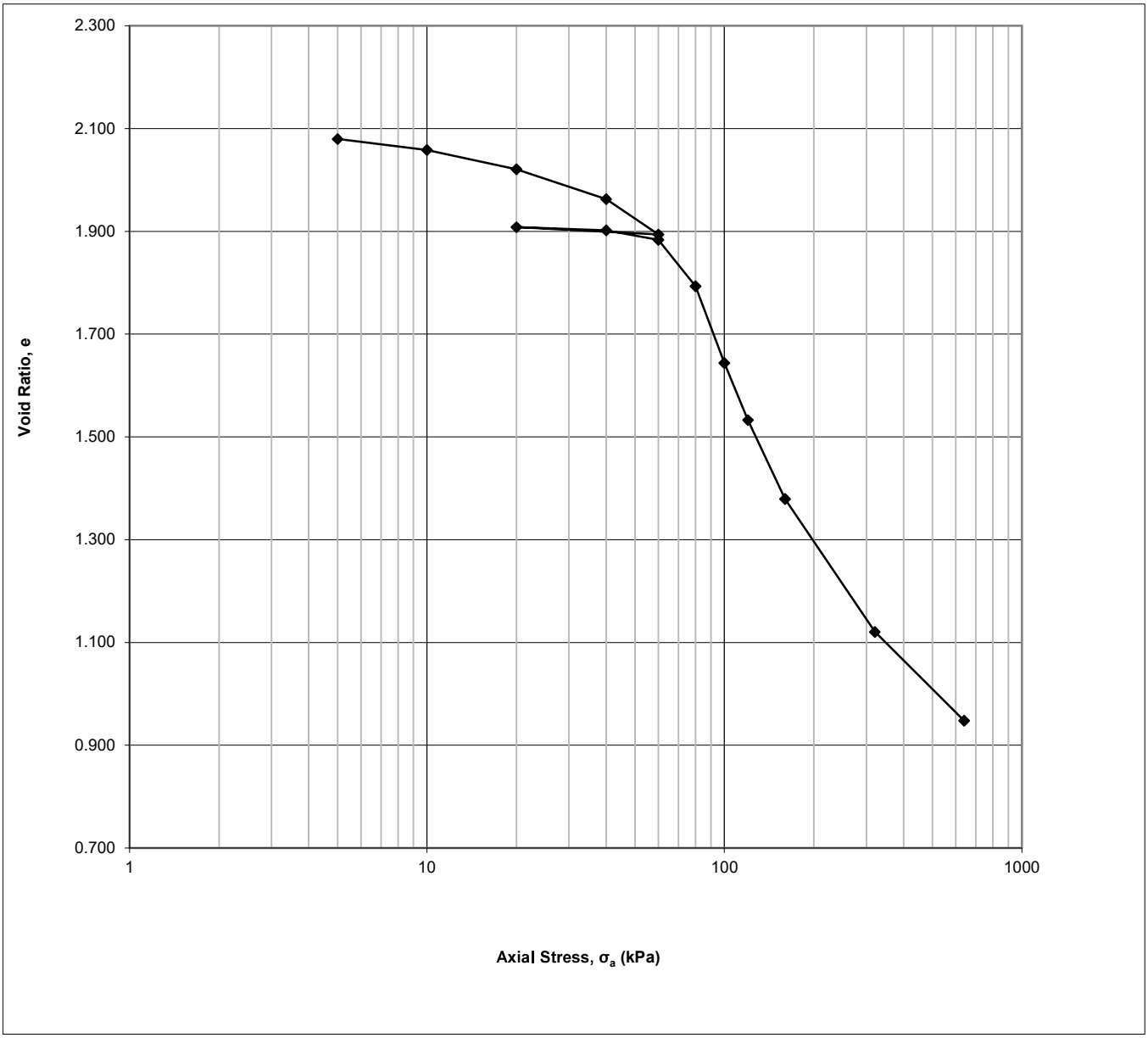
Photo No.: 2	Borehole: BH 6 TW-10	Depth: 40 – 42 ft

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

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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

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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

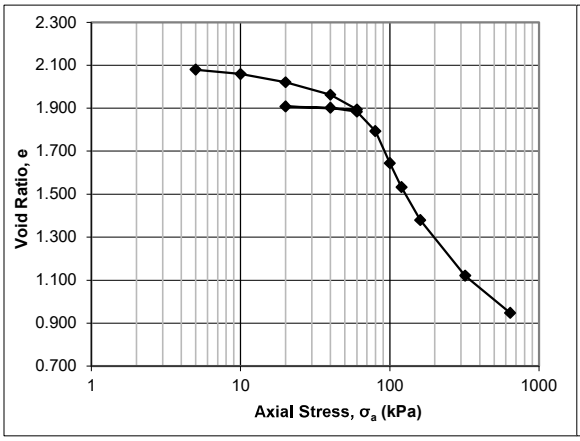
One-Dimensional Consolidation Test using Incremental Loading
ASTM D2435/D2435M - 11(2020)

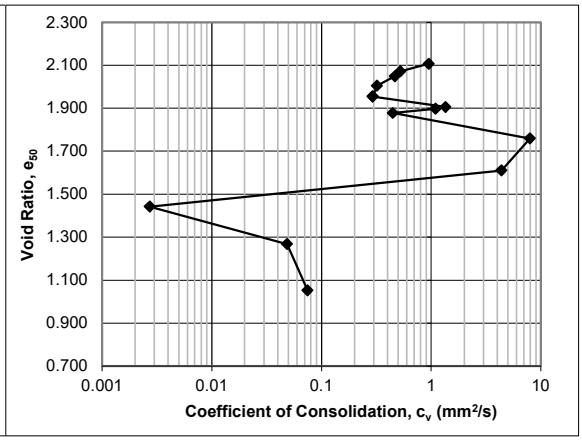
Specimen Details

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

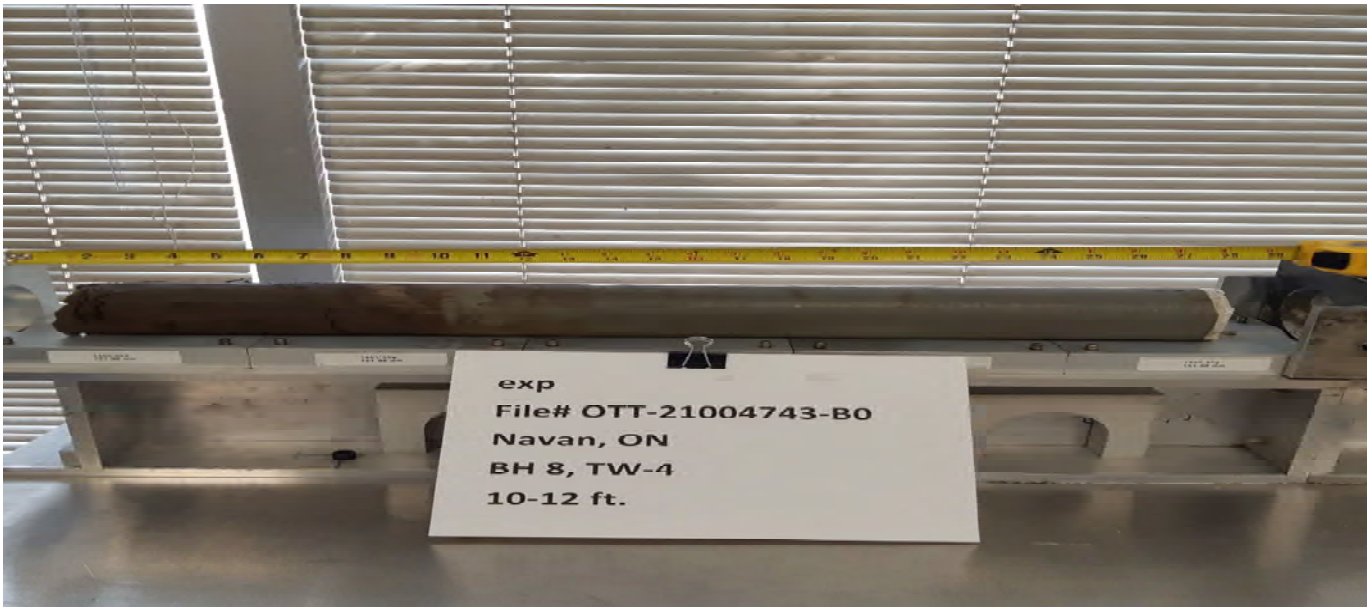


Photo No.: 1	Borehole: BH 8 TW-4	Depth: 10 – 12 ft

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

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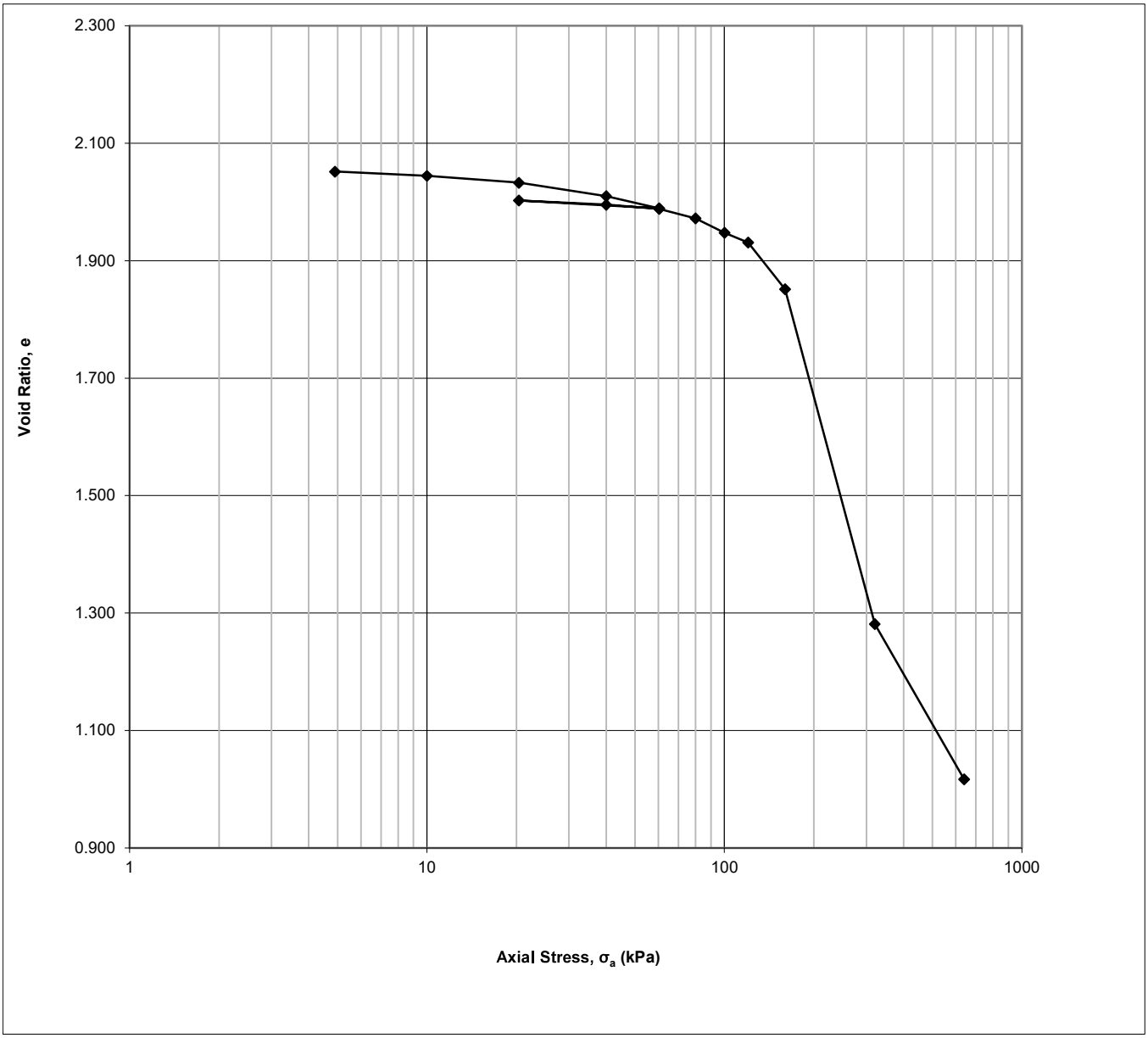
One-Dimensional Consolidation Properties of Soils Using Incremental Loading

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.

Date: June 7, 2021
Date: June 7, 2021

D. Boateng
R. Dey

Checked by:
Approved by:

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

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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

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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

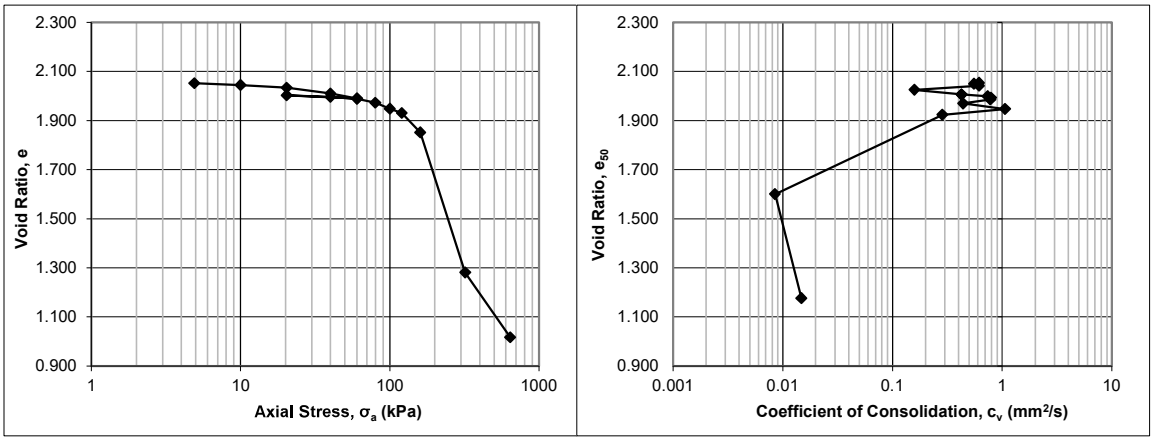
One-Dimensional Consolidation Test using Incremental Loading
ASTM D2435/D2435M - 11(2020)

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



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

October 12, 2023
File: 121624678

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: Navan Road @ Pagé Road, Orleans, ON.
Exp Services Inc., File # OTT-21004743-B0

This letter presents the results of one-dimensional consolidation tests carried out on two shelby tube samples in accordance with ASTM D2435/D2435M – 11(2020). The tests result is provided in the attached tables and figures.

Summary of sample tested

Sample ID	Depth (ft)	Date sampled
BH12 ST1	10-12	September 13, 2023
BH15 ST2	30-32	September 13, 2023

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.

Ramin Ghassemi

Ramin Ghassemi Ph.D., P.Eng.
Geotechnical Engineer
Direct: 613 722-4420
Mobile: 437 775-7625
Ramin.ghassemi@stantec.com

v:\01216\active\laboratory_standing_offers\2023-laboratory standing offers\121624678 exp services inc\two consolidations, exp file# ott-21004743-b0\121624678_let_consolidation_bh12 st1& bh15 st2.docx

CONSOLIDATION TEST SUMMARY

SAMPLE IDENTIFICATION

Borehole No. :	BH12	Sample No. :	ST1
		Sample Depth :	10-12 ft

TEST CONDITIONS

Test Type :	ASTM D2435/D2435M	Date Started :	20-Sep-23
Load Duration (hr) :	24	Date Completed :	6-Oct-23

SAMPLE DIMENSIONS AND PROPERTIES _ INITIAL

Sample Height (mm) :	20.00	Unit Weight (kN/m^3) :	14.73
Sample Diameter (mm) :	50.00	Dry Unit Weight (kN/m^3) :	7.83
Area (cm^2) :	19.63	Specific Gravity : (Assumed)	2.750
Volume (cm^3) :	39.27	Solid Height (mm) :	5.81
Water Content (%) :	88.05	Volume of Solids (cm^3) :	11.41
Wet Mass (g) :	58.99	Volume of Voids (cm^3) :	27.86
Dry Mass (g) :	31.37	Degree of Saturation (%) :	99.13

TEST COMPUTATIONS

Stress (kPa)	Initial Height (mm)	Final Height (mm)	Void Ratio	t_{90} (min)	C_v (cm^2/s)	m_v (m^2/kN)	k (cm/s)
	20.0000		2.443				
5	19.8742	19.9364	2.421	1.71	8.22E-01	1.26E-03	1.01E-08
10	19.7384	19.8183	2.398	2.39	5.80E-01	1.36E-03	7.72E-09
20	19.4530	19.6436	2.348	2.72	5.00E-01	1.43E-03	7.01E-09
40	18.9929	19.2955	2.269	10.16	1.29E-01	1.15E-03	1.46E-09
80	17.8996	18.6762	2.081	13.20	9.34E-02	1.37E-03	1.25E-09
20	17.9480	17.8535	2.089				
40	17.9034	17.9324	2.082	1.58	7.19E-01	1.12E-04	7.86E-10
80	17.7311	17.8418	2.052	2.75	4.09E-01	2.15E-04	8.63E-10
100	17.1706	17.6440	1.956	15.16	7.26E-02	1.40E-03	9.97E-10
120	16.3444	16.8756	1.813	26.48	3.80E-02	2.07E-03	7.70E-10
140	15.7402	16.0801	1.709	61.61	1.48E-02	1.51E-03	2.20E-10
160	15.2928	15.4813	1.632	160.69	5.27E-03	1.12E-03	5.78E-11
240	13.9085	14.5816	1.394	117.55	6.39E-03	8.65E-04	5.42E-11
320	13.2973	13.5672	1.289	243.21	2.67E-03	3.82E-04	1.00E-11
640	11.8809	12.6877	1.045	19.74	2.88E-02	2.21E-04	6.26E-11

SAMPLE DIMENSIONS AND PROPERTIES _ FINAL

Sample Height (mm) :	11.88	Unit Weight (kN/m^3) :	18.84
Sample Diameter (mm)	50.00	Dry Unit Weight (kN/m^3) :	13.19
Area (cm^2) :	19.63	Specific Gravity (Assumed) :	2.750
Volume (cm^3) :	23.33	Solid Height (mm) :	5.81
Water Content (%) :	42.88	Volume of Solids (cm^3) :	11.41
Wet Mass (g) :	44.82	Volume of Voids (cm^3) :	11.92
Dry Mass (g) :	31.37		

Project No. :	121624678	Prepared By :	DB
Date :	12-Oct-23	Checked By :	RG

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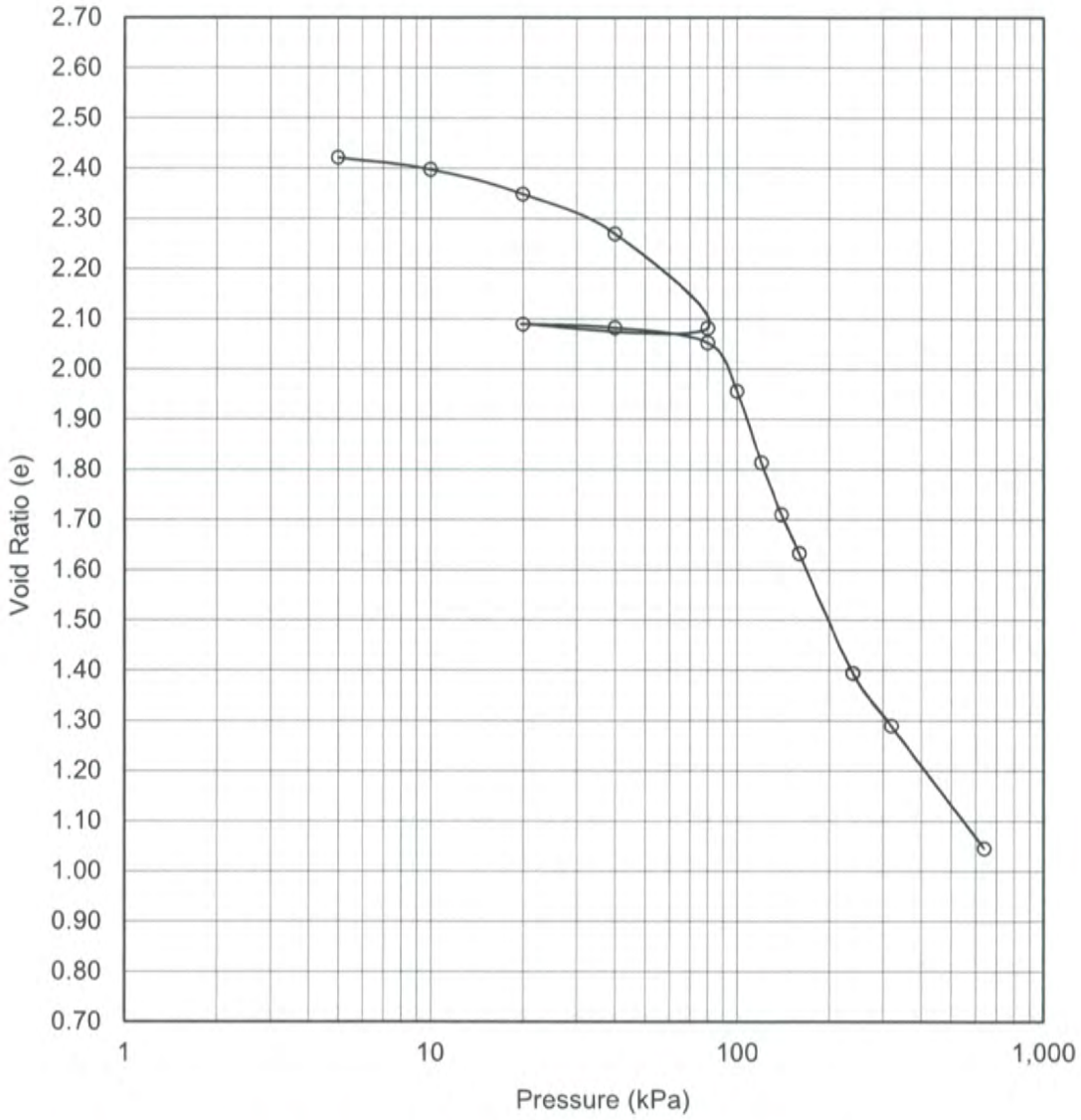
CONSOLIDATION TEST	FIGURE 1

Exp, File# OTT-21004743-B0

BH 12, ST1

Void Ratio vs Pressure



Soil Type :	Silty clay, grey, fraible, very wet				
e_o =	2.443	ω_L =	N/A	σ_{v0}' =	XX kPa
ω =	88.05 %	ω_P =	N/A	σ_P' =	XX kPa
γ =	14.7 kN/m^3	PI =	N/A		
Gs =	2.75				

Project No. : 121624678
Date : 12-Oct-23

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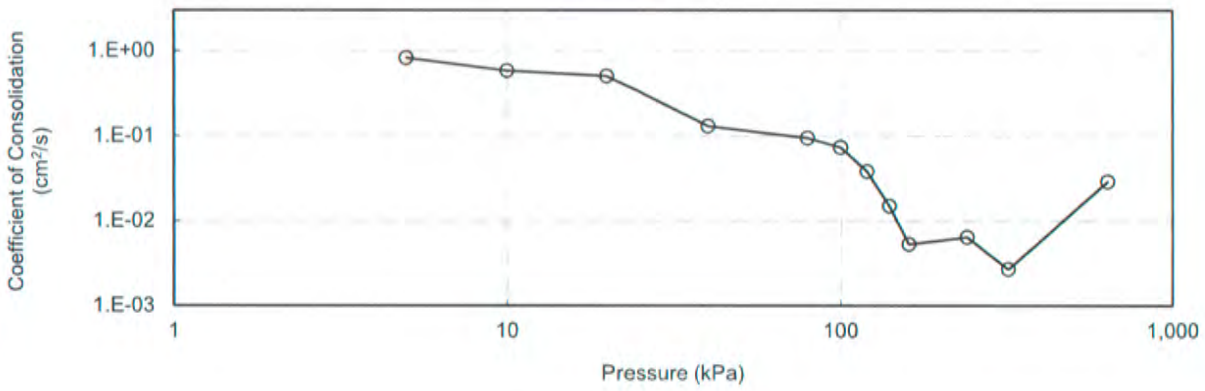
Prepared By : DB
Checked By : RG

CONSOLIDATION TEST	FIGURES 2, 3 & 4

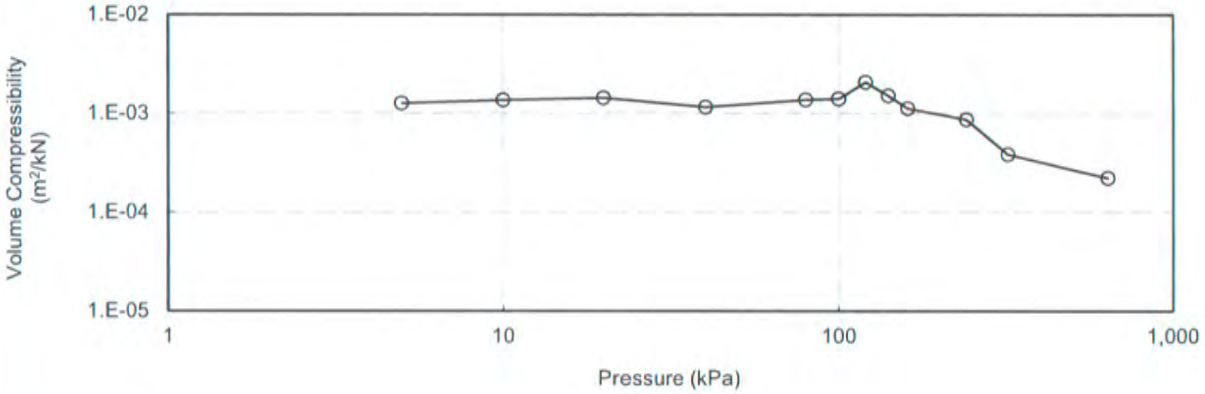
Exp, File# OTT-21004743-B0

BH 12, ST1

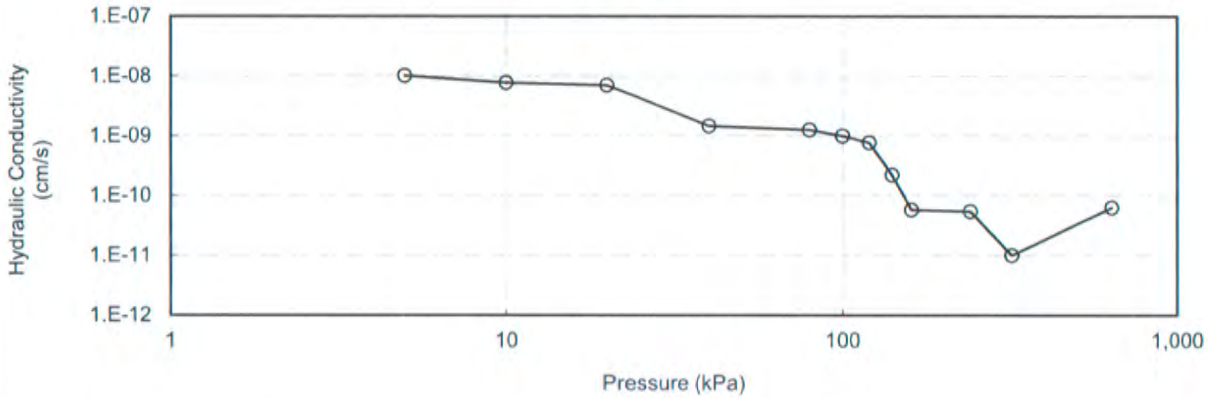
Cv vs Pressure



mv vs Pressure



k vs Pressure



Project No. :	121624678	Prepared By :	DB
Date :	12-Oct-23	Checked By :	RG

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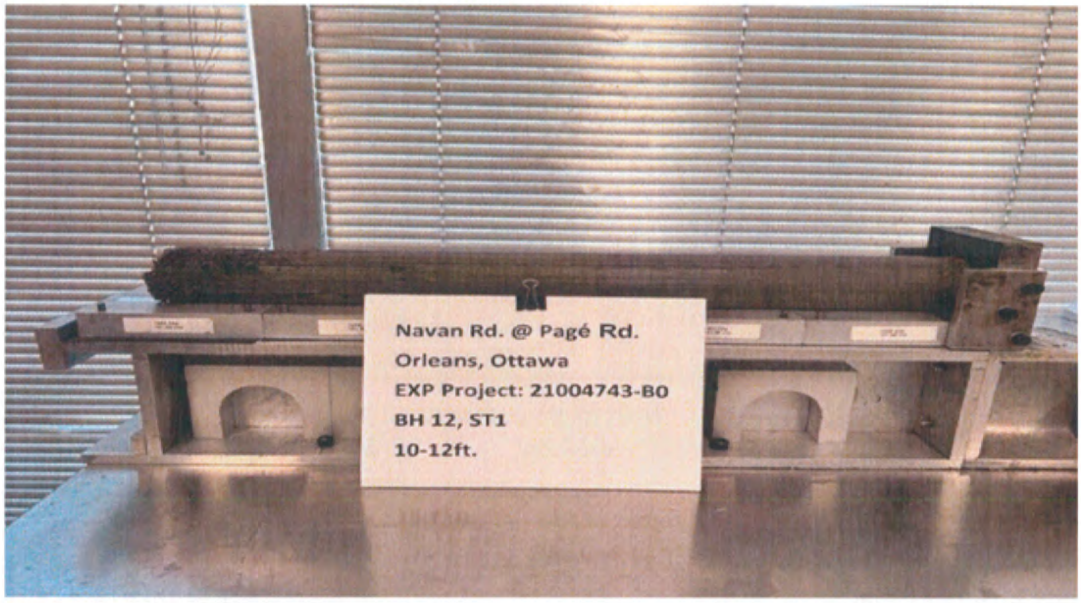
Exp, File# OTT-21004743-B0	PHOTOS 1 & 2

Navan Rd @ Pagé Rd, Orleans, ON

Silty clay, grey, fraible, very wet



BH12 ST1

BH12 ST1

Project No. : 121624678

Date : 12-Oct-2023

Prepared by : DB

Checked by : RG

CONSOLIDATION TEST SUMMARY

SAMPLE IDENTIFICATION

Borehole No. :	BH15	Sample No. :	ST2
		Sample Depth (m) :	30-32 ft

TEST CONDITIONS

Test Type :	ASTM D2435/D2435M	Date Started :	20-Sep-23
Load Duration (hr) :	24	Date Completed :	7-Oct-23

SAMPLE DIMENSIONS AND PROPERTIES _ INITIAL

Sample Height (mm) :	20.00	Unit Weight (kN/m^3) :	15.34
Sample Diameter (mm) :	50.00	Dry Unit Weight (kN/m^3) :	8.83
Area (cm^2) :	19.63	Specific Gravity : (Assumed)	2.750
Volume (cm^3) :	39.27	Solid Height (mm) :	6.55
Water Content (%) :	73.70	Volume of Solids (cm^3) :	12.86
Wet Mass (g) :	61.42	Volume of Voids (cm^3) :	26.41
Dry Mass (g) :	35.36	Degree of Saturation (%) :	98.67

TEST COMPUTATIONS

Stress (kPa)	Initial Height (mm)	Final Height (mm)	Void Ratio	t_{90} (min)	C_v (cm^2/s)	m_v (m^2/kN)	k (cm/s)
	20.0000		2.054				
5	19.9233	19.9580	2.042	0.42	3.35E+00	7.67E-04	2.52E-08
10	19.8643	19.8919	2.033	1.10	1.27E+00	5.90E-04	7.32E-09
20	19.7672	19.8162	2.019	0.91	1.53E+00	4.86E-04	7.28E-09
40	19.6571	19.7143	2.002	0.93	1.48E+00	2.75E-04	3.99E-09
80	19.4009	19.5658	1.963	1.10	1.23E+00	3.20E-04	3.87E-09
20	19.4718	19.4202	1.973				
40	19.4323	19.4514	1.967	0.68	1.96E+00	9.87E-05	1.90E-09
80	19.3149	19.3834	1.949	0.68	1.95E+00	1.47E-04	2.81E-09
100	19.1234	19.2722	1.920	3.38	3.88E-01	4.79E-04	1.82E-09
120	18.7618	18.9710	1.865	108.62	1.17E-02	9.04E-04	1.04E-10
140	18.1832	18.5587	1.777	36.63	3.32E-02	1.45E-03	4.71E-10
160	17.4935	17.9060	1.671	16.80	6.75E-02	1.72E-03	1.14E-09
240	15.5833	16.6810	1.380	55.75	1.76E-02	1.19E-03	2.07E-10
320	14.9721	15.3504	1.286	84.65	9.84E-03	3.82E-04	3.69E-11
640	13.5950	14.3943	1.076	9.79	7.48E-02	2.15E-04	1.58E-10
1280	12.6266	13.3617	0.928	2.47	2.56E-01	7.57E-05	1.90E-10

SAMPLE DIMENSIONS AND PROPERTIES _ FINAL

Sample Height (mm) :	12.63	Unit Weight (kN/m^3) :	19.50
Sample Diameter (mm)	50.00	Dry Unit Weight (kN/m^3) :	13.99
Area (cm^2) :	19.63	Specific Gravity (Assumed) :	2.750
Volume (cm^3) :	24.79	Solid Height (mm) :	6.55
Water Content (%) :	39.42	Volume of Solids (cm^3) :	12.86
Wet Mass (g) :	49.30	Volume of Voids (cm^3) :	11.93
Dry Mass (g) :	35.36		

Project No. : 121624678
Date : 12-Oct-23

Stantec

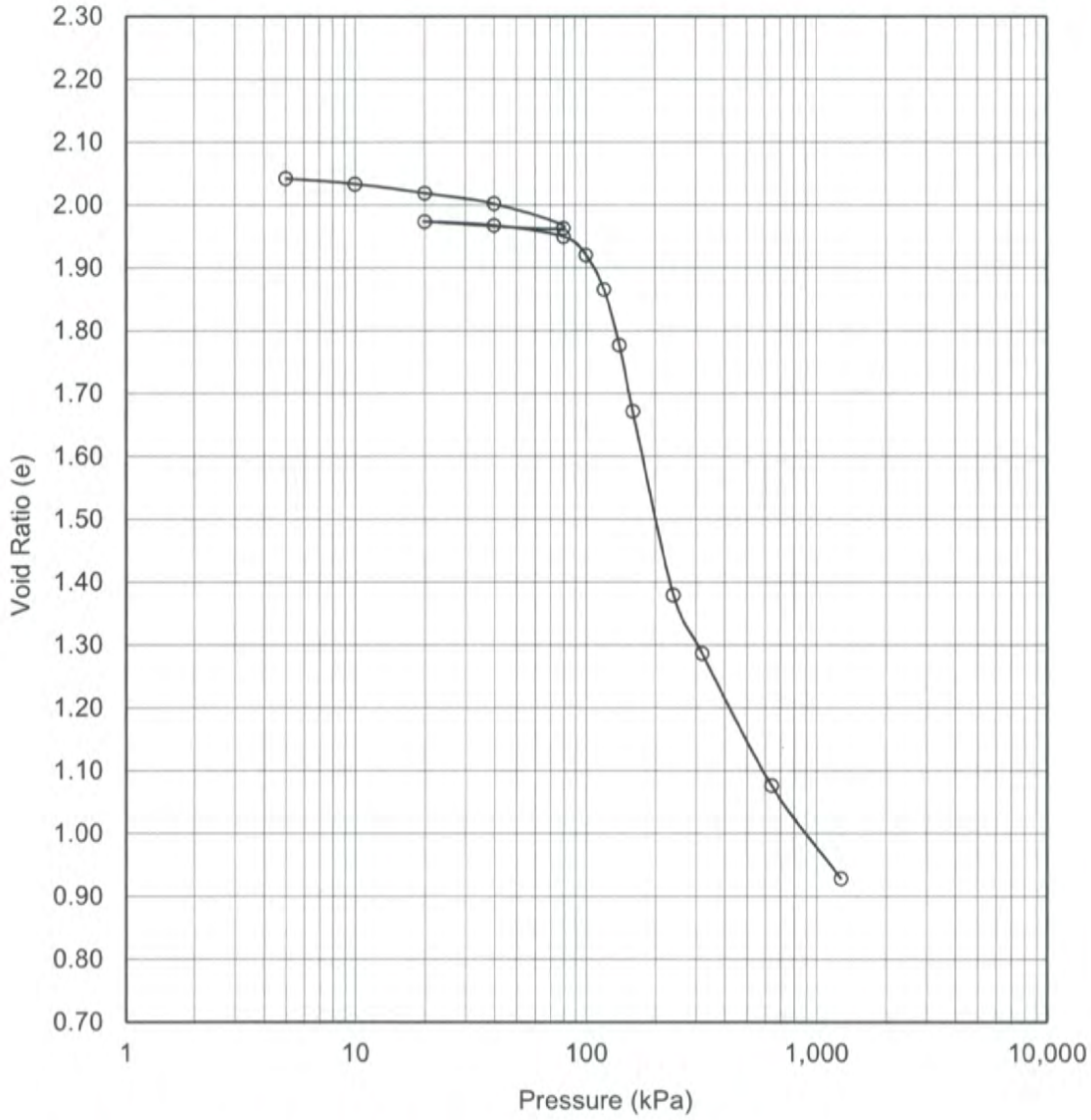
Prepared By : DB
Checked By : RG

CONSOLIDATION TEST	FIGURE 1

Exp, File# OTT-21004743-B0

BH 15, ST2

Void Ratio vs Pressure



Soil Type :	Silty clay, grey, fraible, very wet				
e_o =	2.054	ω_L =	N/A	σ_{v0}' =	XX kPa
ω =	73.70 %	ω_P =	N/A	σ_P' =	XX kPa
γ =	15.3 kN/m^3	PI =	N/A		
Gs =	2.75				

Project No. : 121624678
Date : 12-Oct-23

Stantec

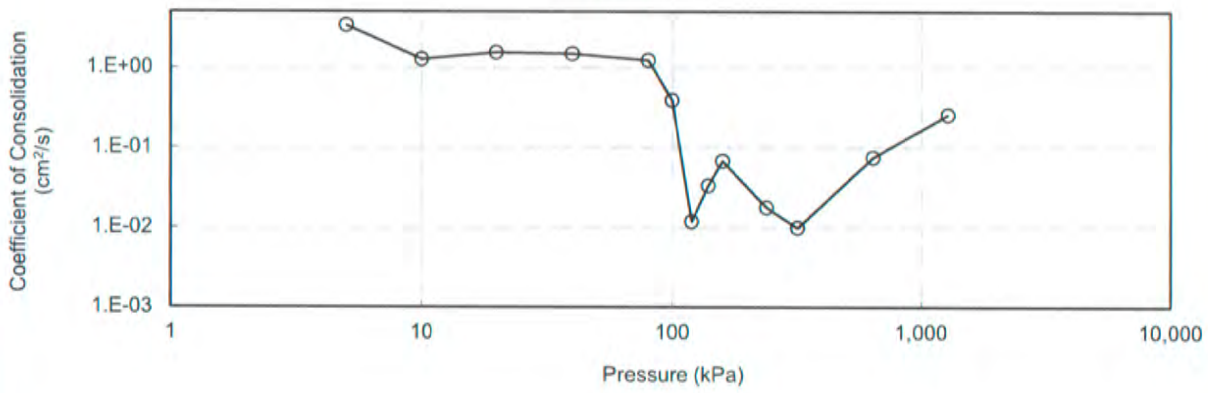
Prepared By : DB
Checked By : RG

CONSOLIDATION TEST	FIGURES 2, 3 & 4

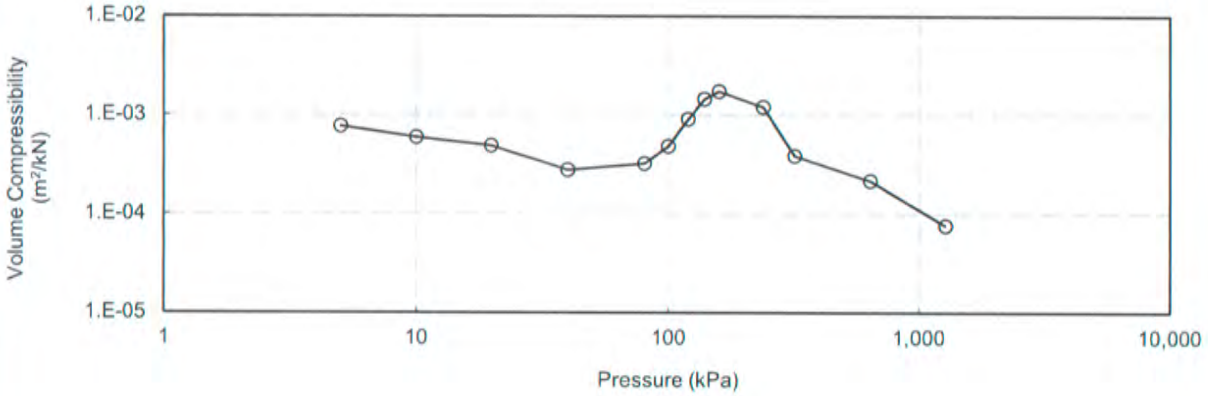
Exp, File# OTT-21004743-B0

BH 15, ST2

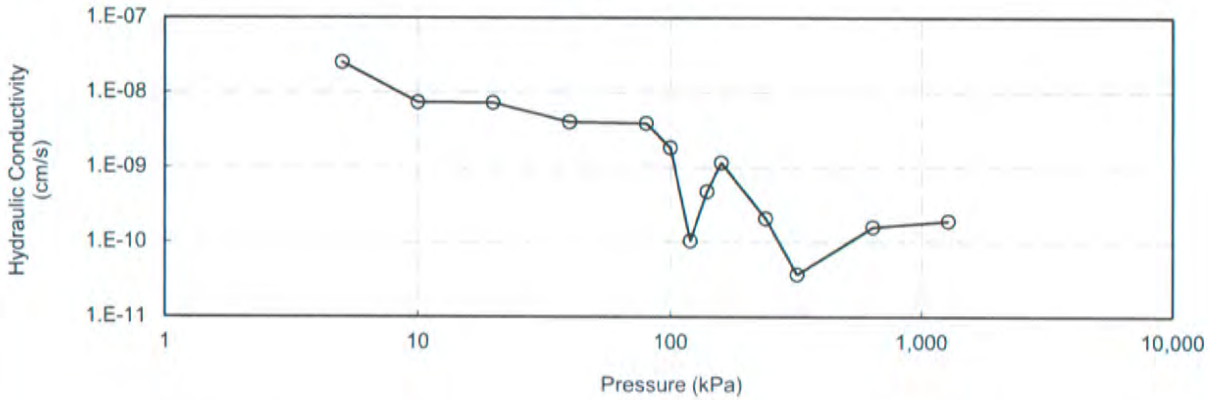
Cv vs Pressure



mv vs Pressure



k vs Pressure



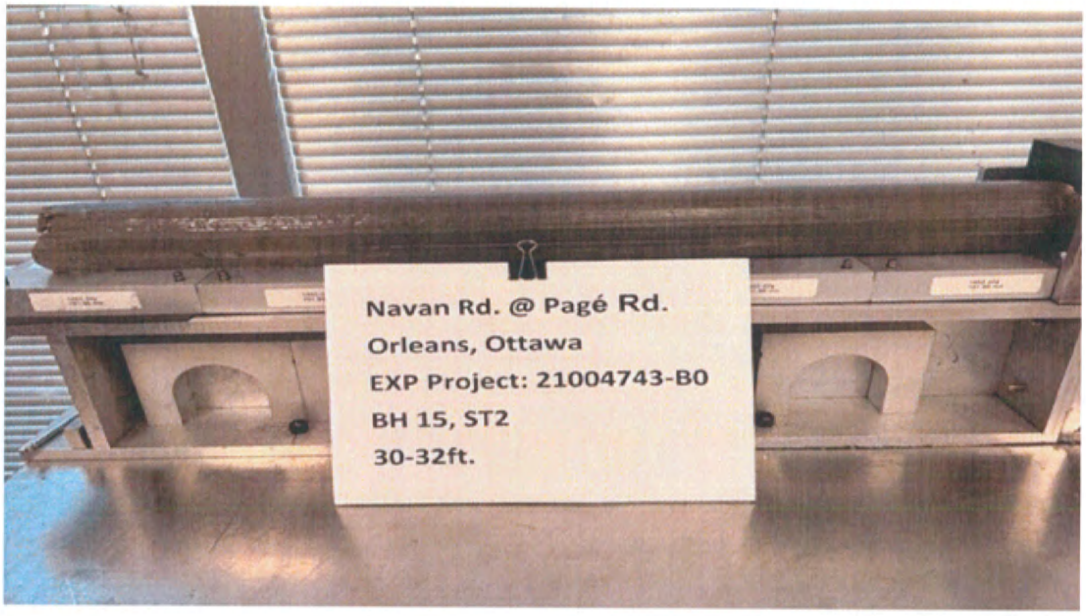
Project No. :	121624678	Prepared By :	DB
Date :	12-Oct-23	Checked By :	RG

Stantec

Exp, File# OTT-21004743-B0	FIGURE xx

Navan Rd @ Pagé Rd, Orleans, ON

Silty clay, grey, fraible, very wet



BH15, ST2

BH15, ST2

Project No. : 121624678

Date : 12-Oct-23

Prepared by : DB

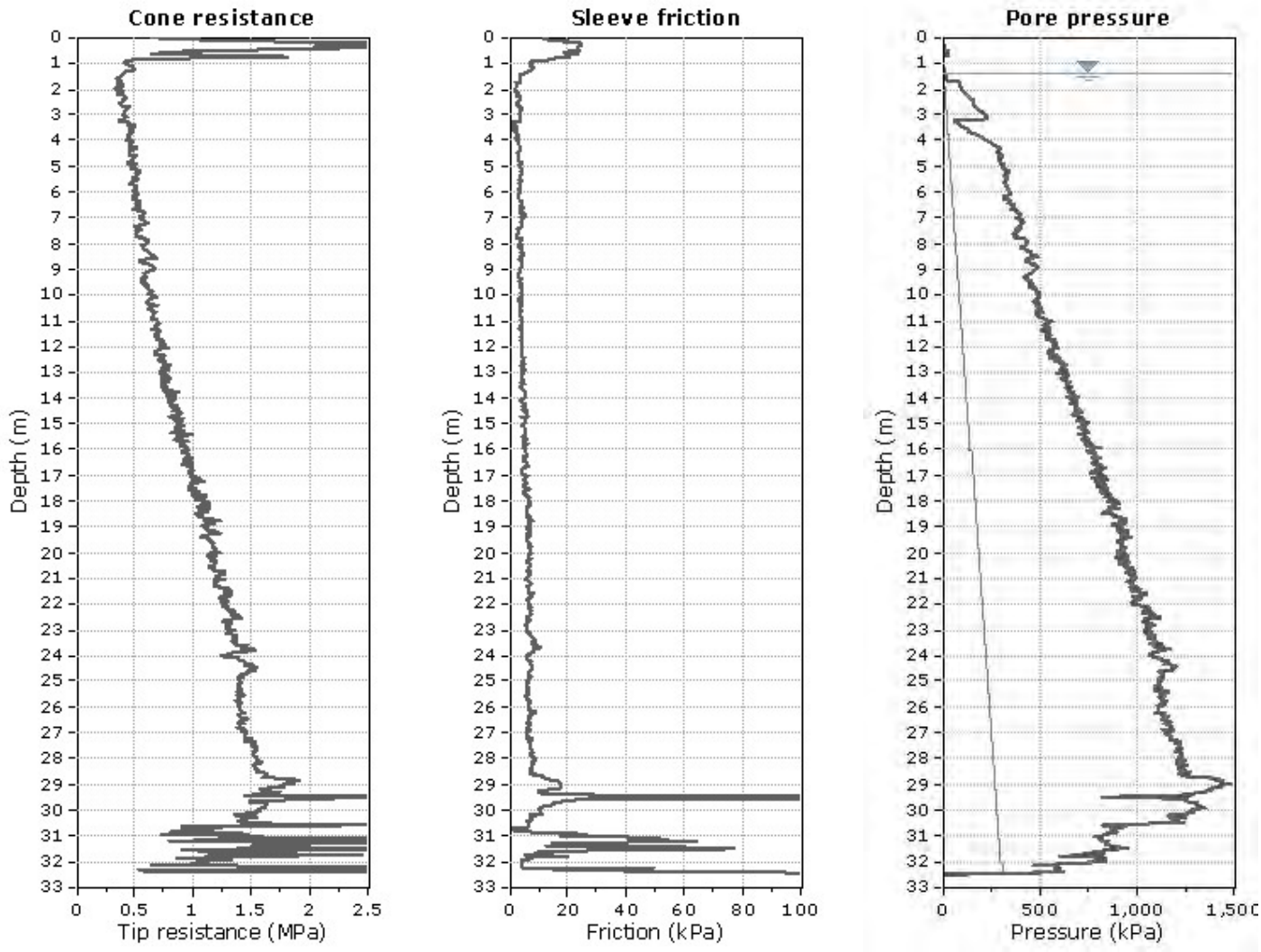
Checked by : RG

Appendix C:
Seismic Piezocone Penetration Test Results

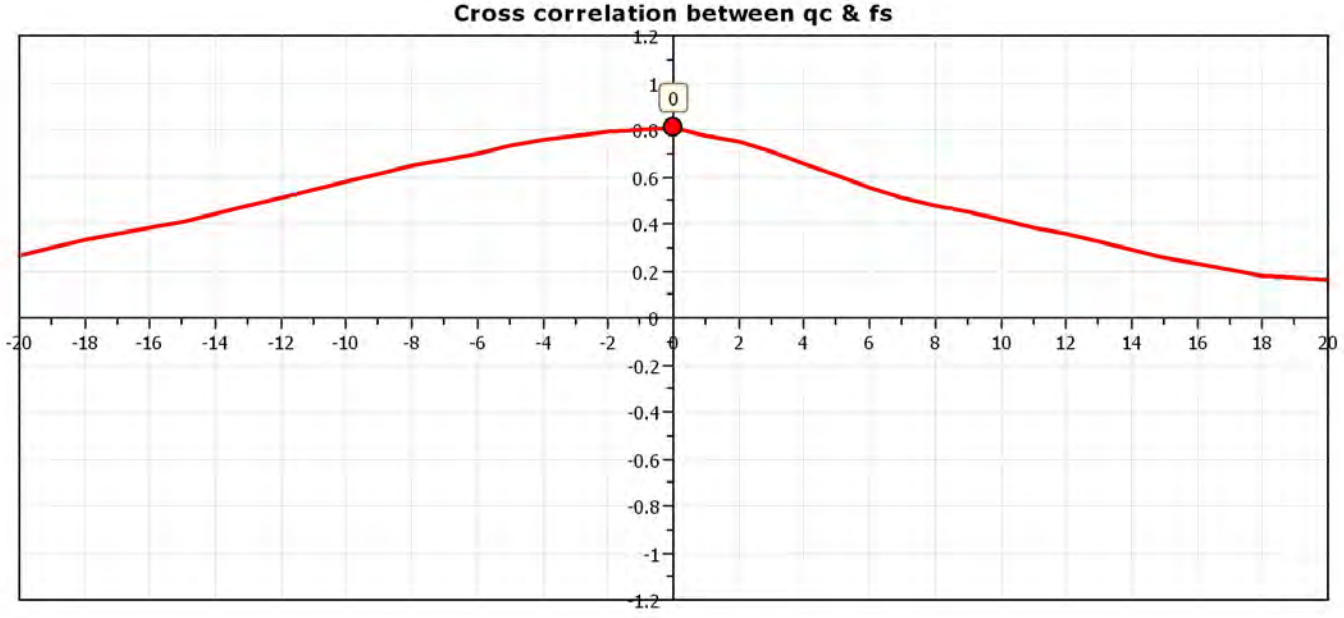
EXP
2650 Queensview Dr Suite 100
Ottawa, Ontario, K2B 8H6
https://ww.exp.com

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).

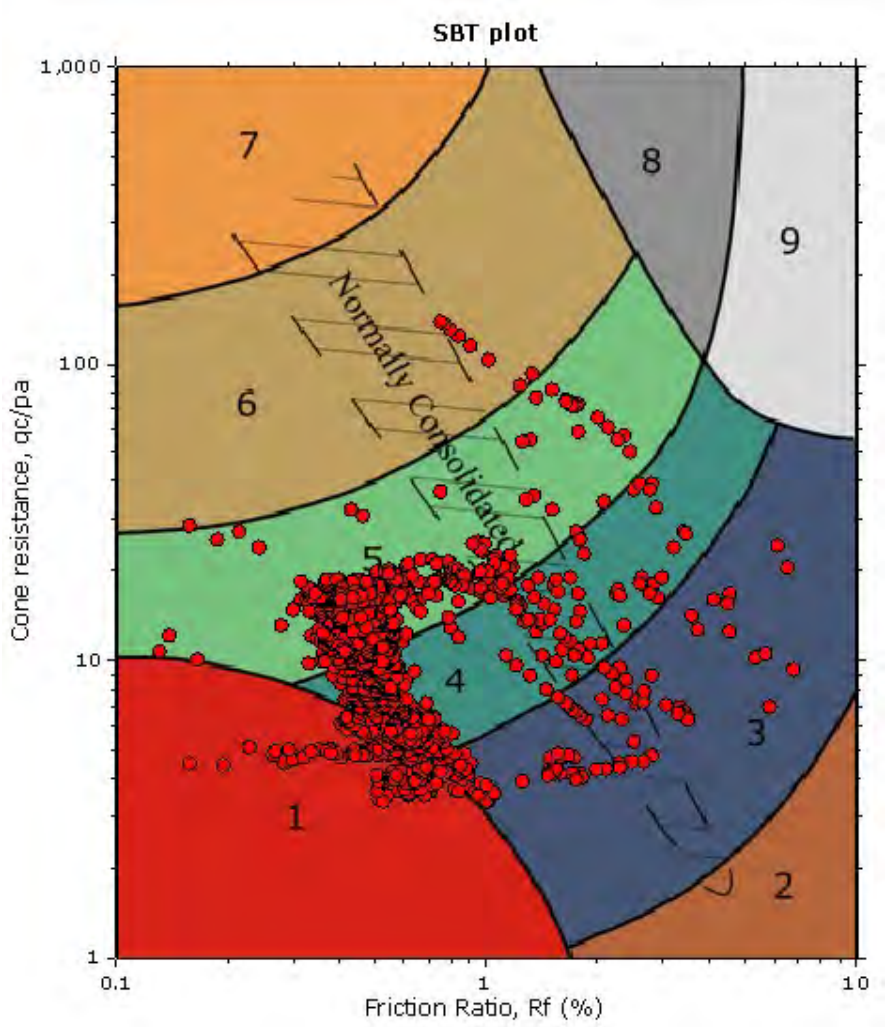


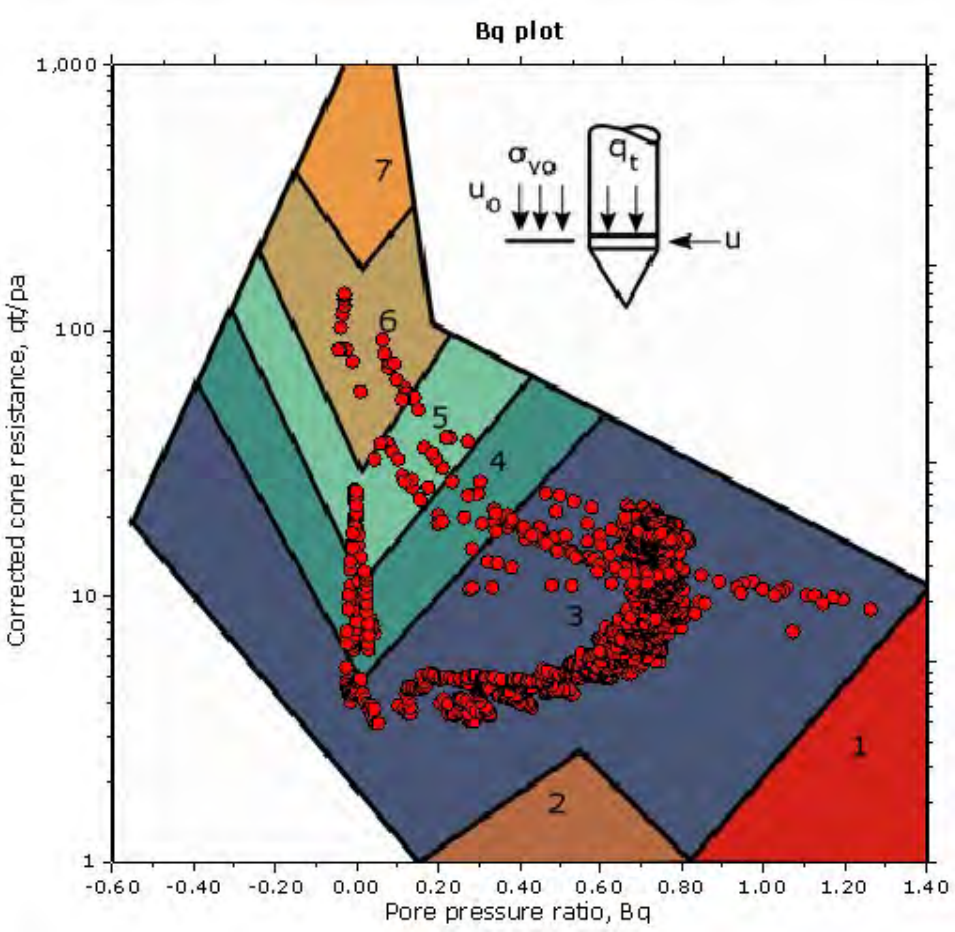
EXP
2650 Queensview Dr Suite 100
Ottawa, Ontario, K2B 8H6
https://ww.exp.com

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

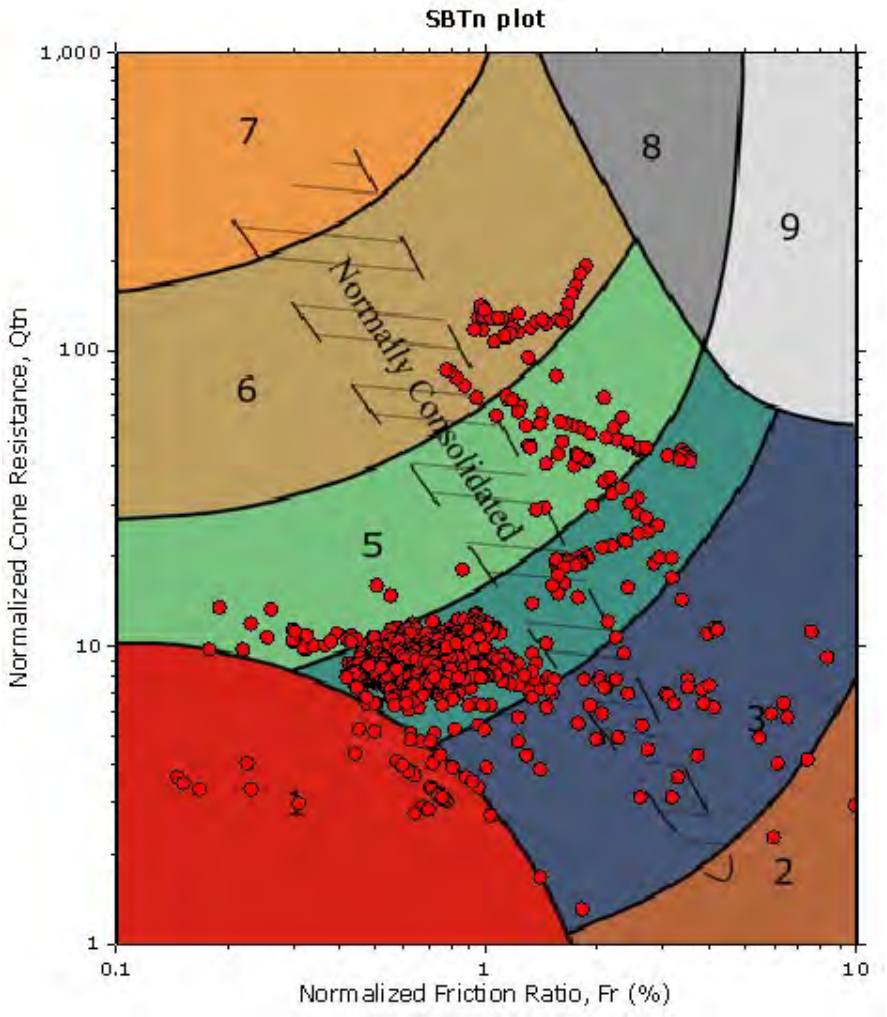
1. Sensitive fine grained	4. Clayey silt to silty clay	7. Gravelly sand to sand
2. Organic material	5. Silty sand to sandy silt	8. Very stiff sand to clayey sand
3. Clay to silty clay	6. Clean sand to silty sand	9. Very stiff fine grained

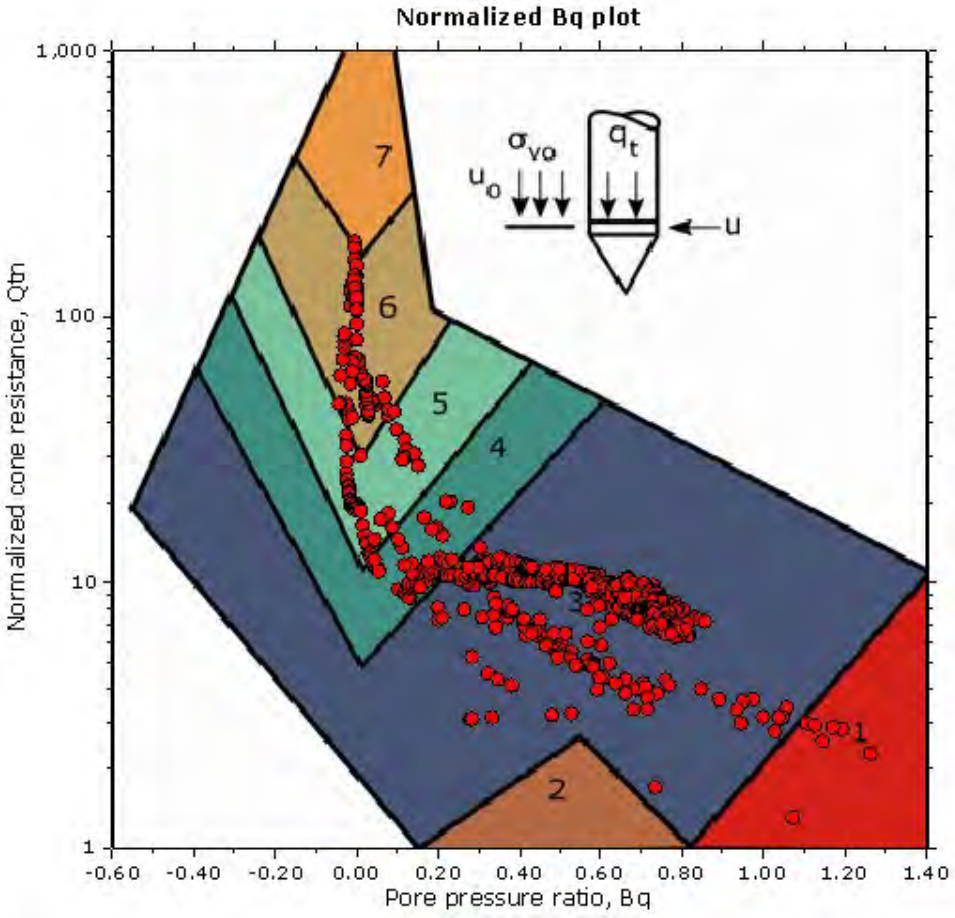
EXP
2650 Queensview Dr Suite 100
Ottawa, Ontario, K2B 8H6
https://ww.exp.com

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

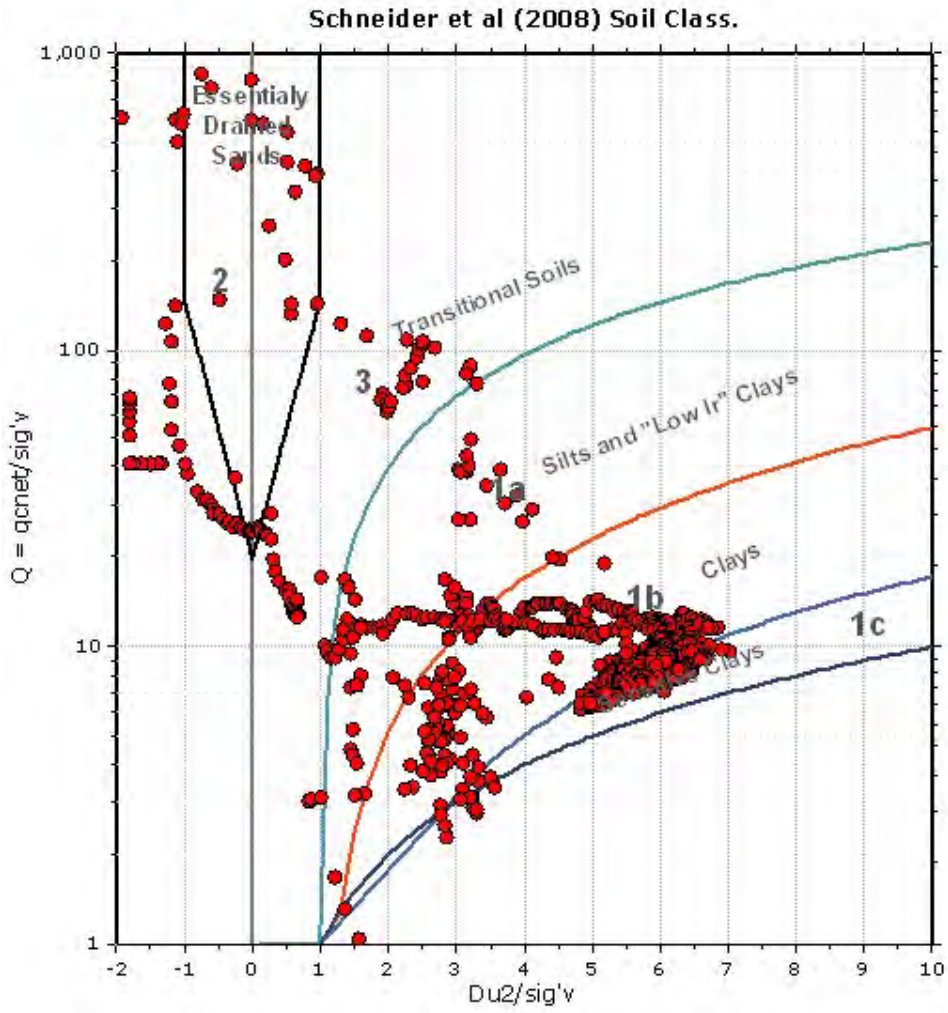
1. Sensitive fine grained	4. Clayey silt to silty clay	7. Gravelly sand to sand
2. Organic material	5. Silty sand to sandy silt	8. Very stiff sand to clayey sand
3. Clay to silty clay	6. Clean sand to silty sand	9. Very stiff fine grained

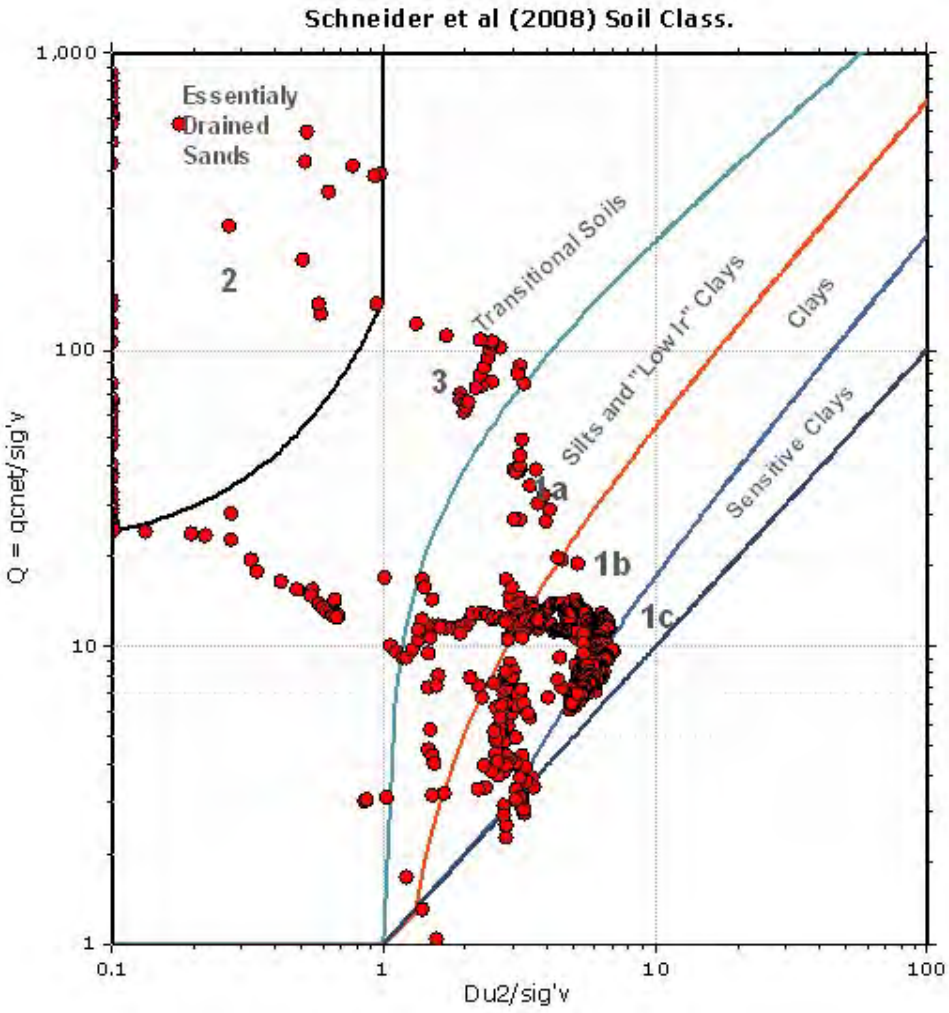
EXP
2650 Queensview Dr Suite 100
Ottawa, Ontario, K2B 8H6
https://ww.exp.com

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)

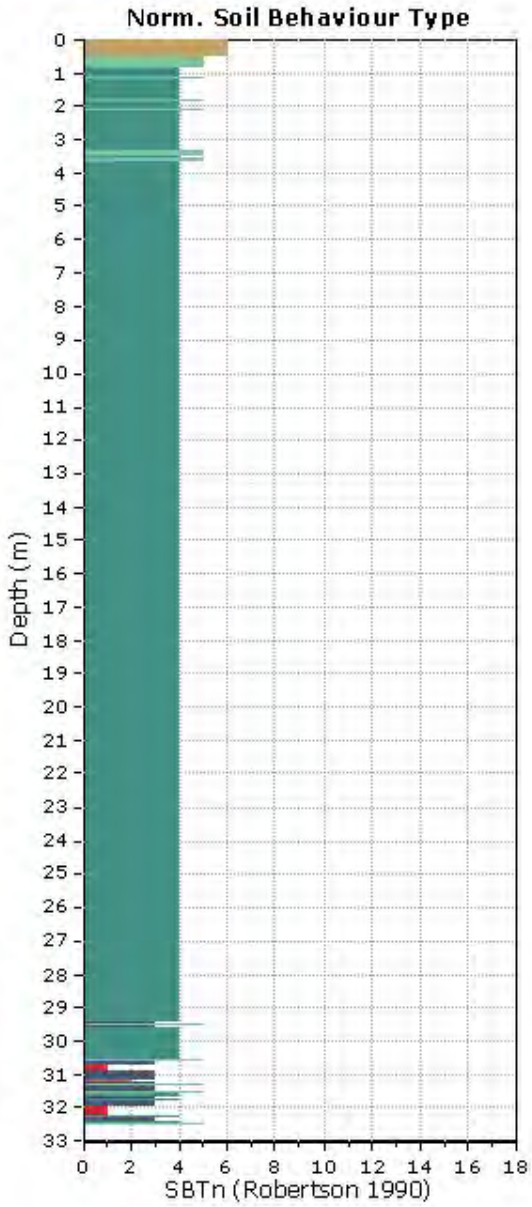


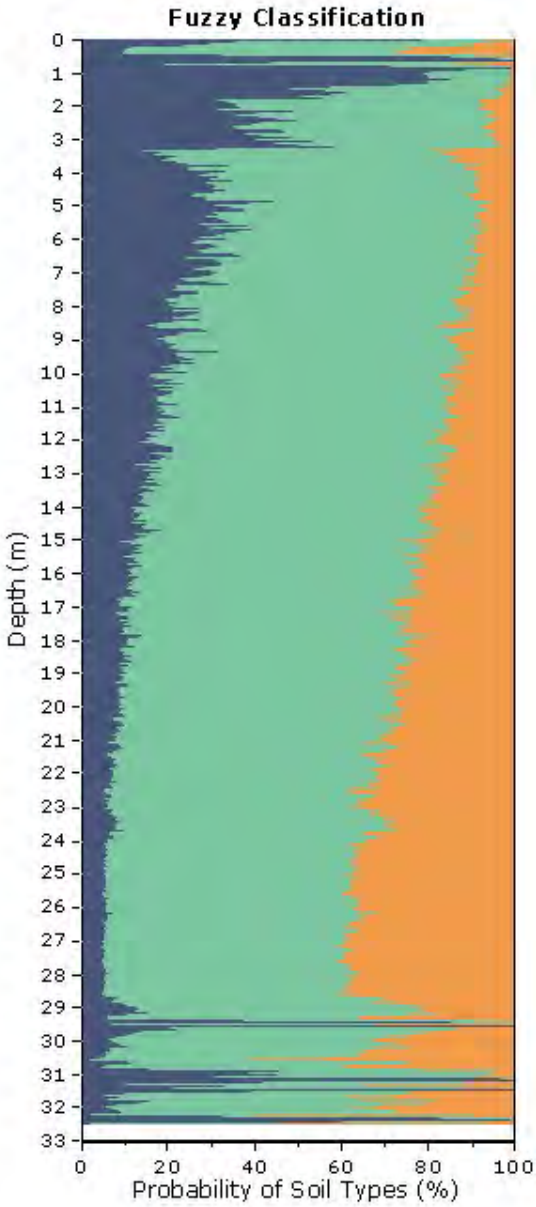


EXP
2650 Queensview Dr Suite 100
Ottawa, Ontario, K2B 8H6
https://ww.exp.com

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.

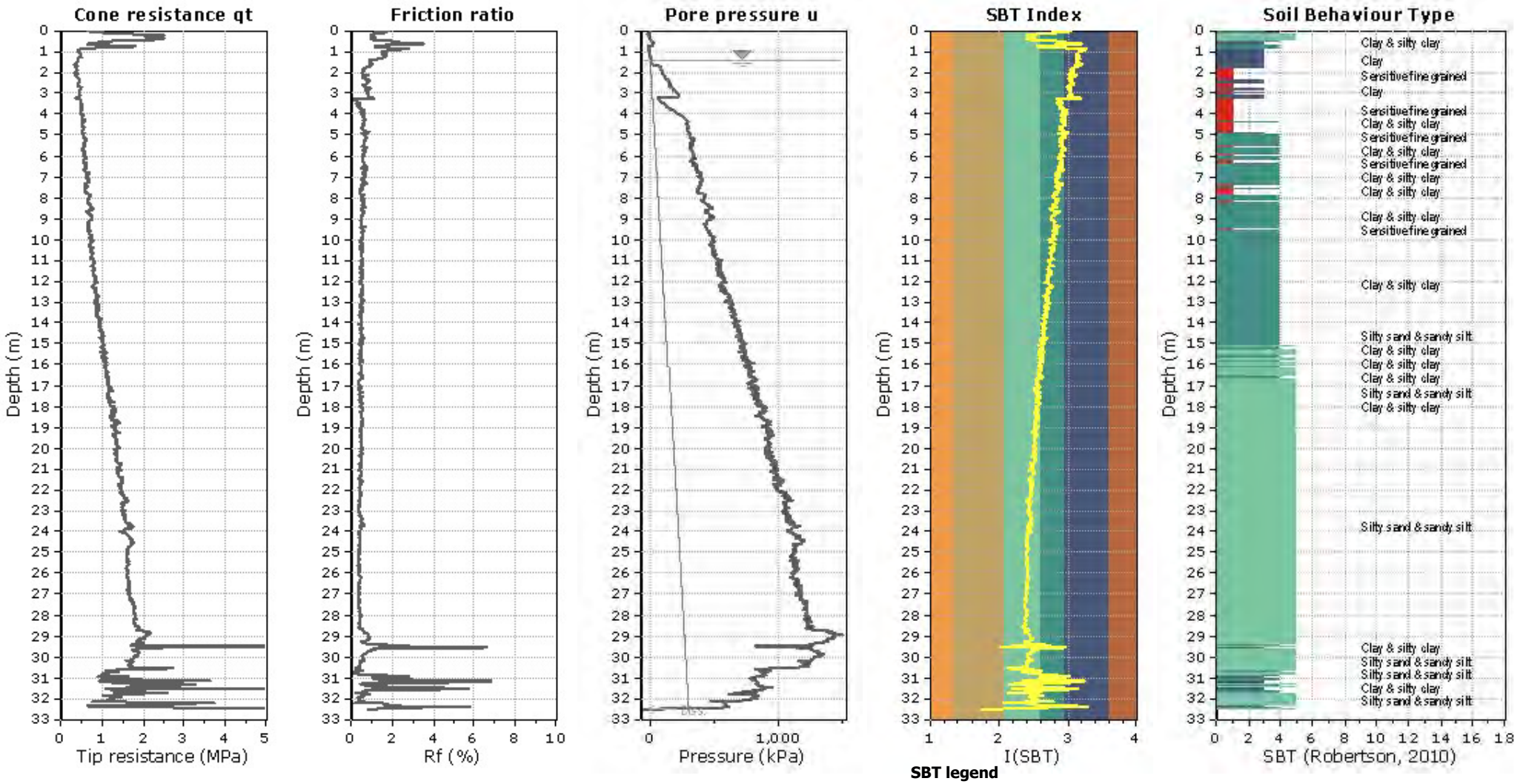




EXP
2650 Queensview Dr Suite 100
Ottawa, Ontario, K2B 8H6
https://ww.exp.com

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

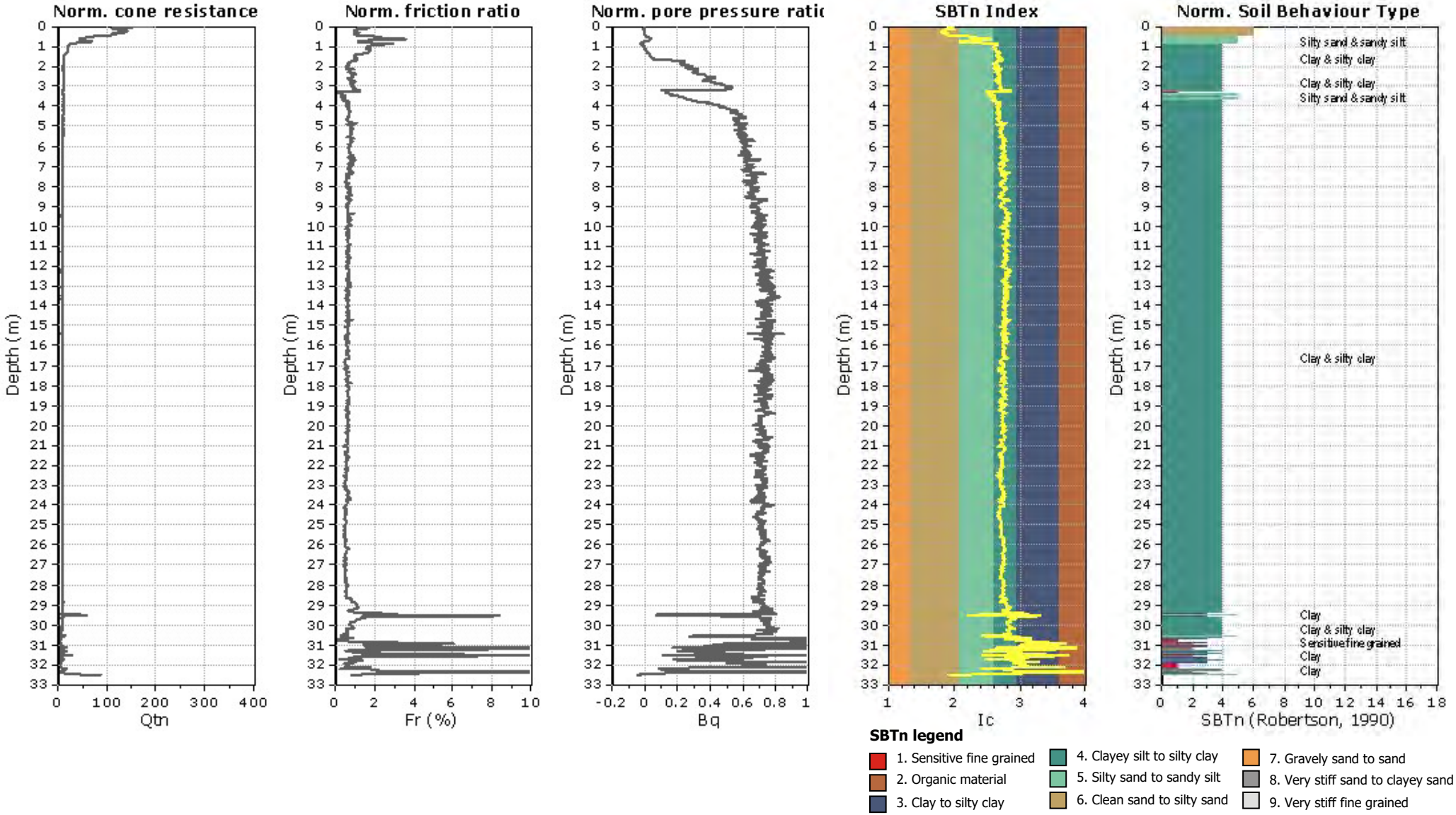
CPT: SCPTu-9
Total depth: 32.51 m
Surface Elevation: 84.70 m
Cone Type: Vertek 4544 - 5t
Cone Operator: Kevin Simoneau, P.Eng, M.Sc.



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

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

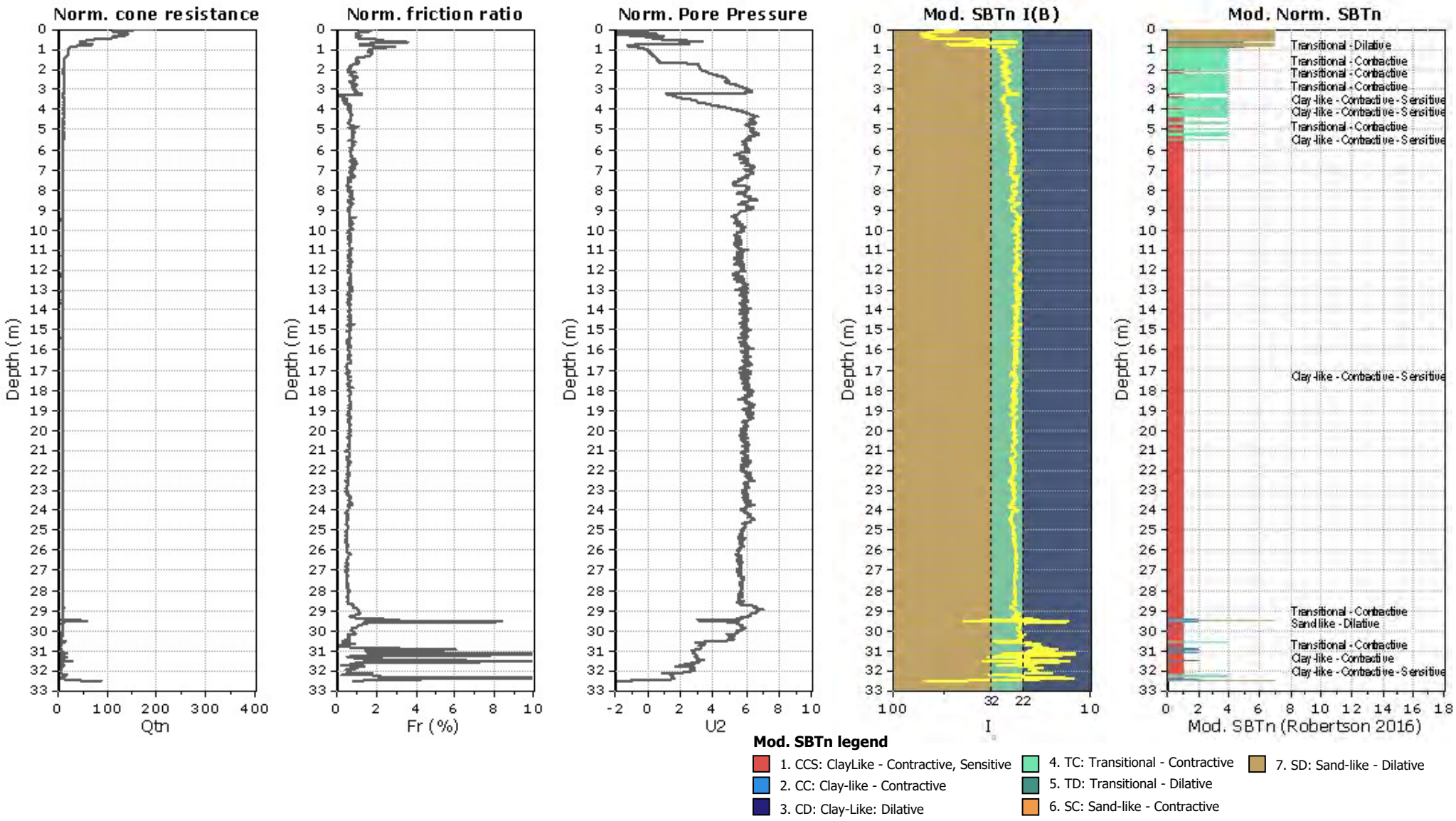
CPT: SCPTu-9
Total depth: 32.51 m
Surface Elevation: 84.70 m
Cone Type: Vertek 4544 - 5t
Cone Operator: Kevin Simoneau, P.Eng, M.Sc.



EXP
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.

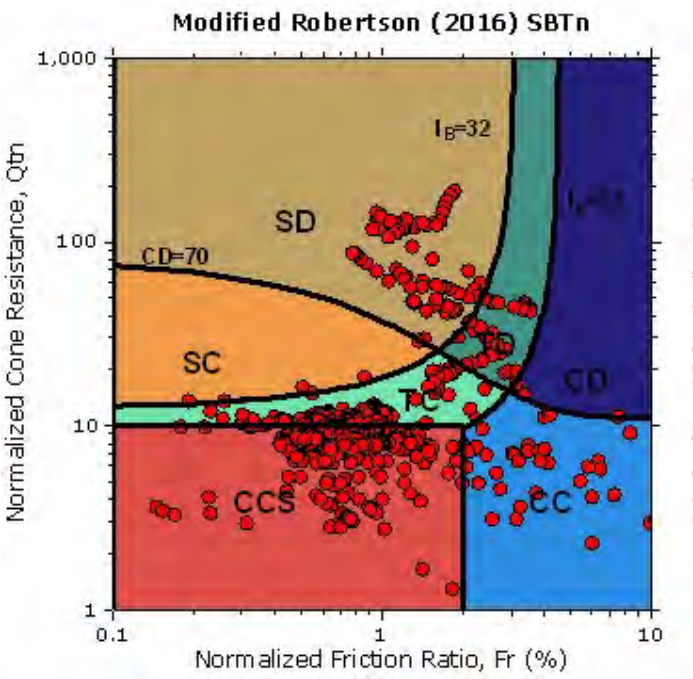


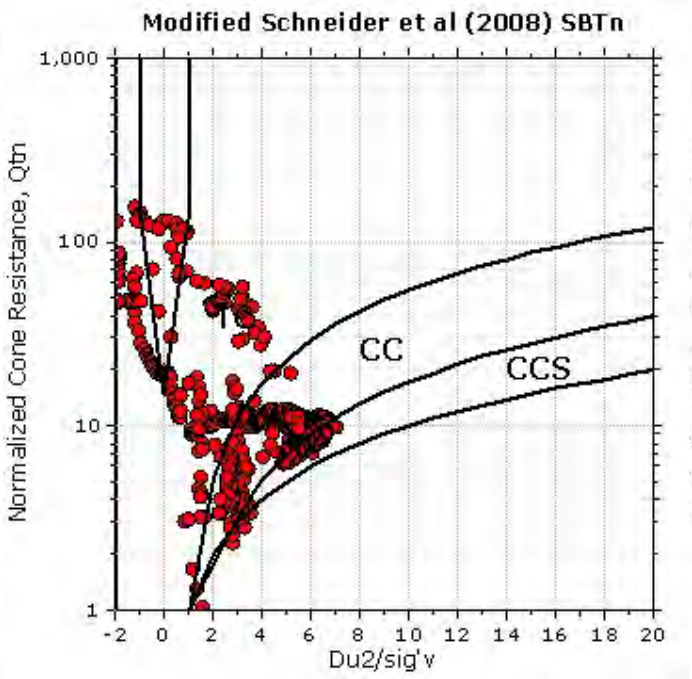
EXP
2650 Queensview Dr Suite 100
Ottawa, Ontario, K2B 8H6
https://ww.exp.com

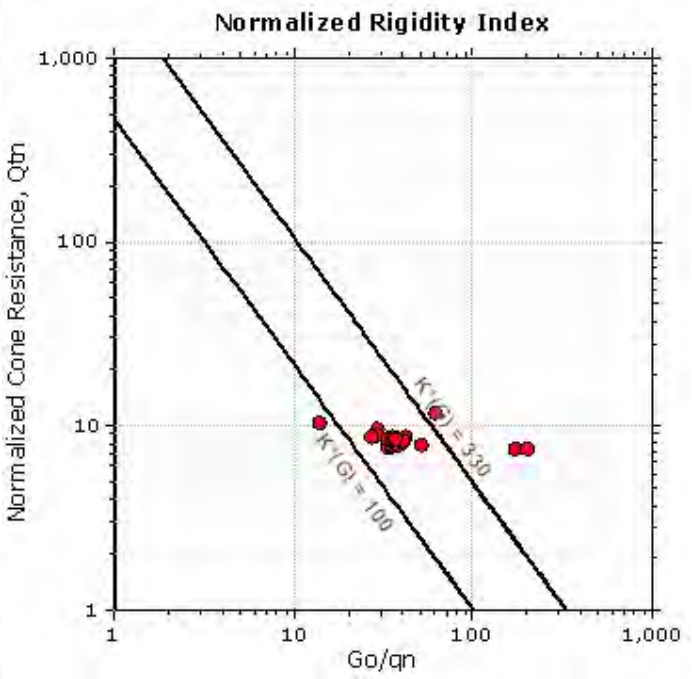
Project: **3053 & 3079 Navan Road**
Location: **Navan / Pagé Roads, Ottawa**

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.

Updated SBTn plots







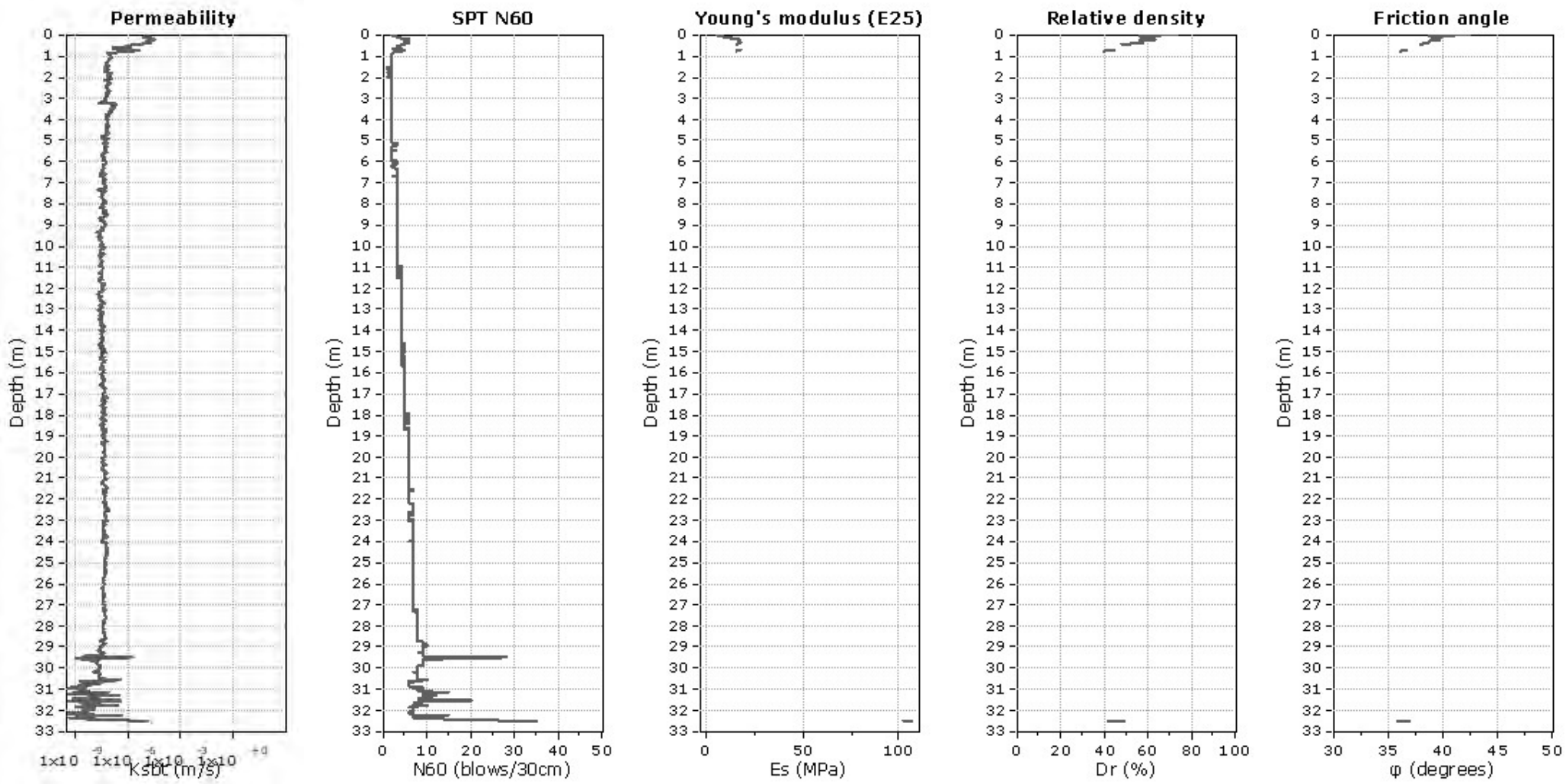
CCS: Clay-like - Contractive - Sensitive
CC: Clay-like - Contractive
CD: Clay-like - Dilative
TC: Transitional - Contractive
TD: Transitional - Dilative
SC: Sand-like - Contractive
SD: Sand-like - Dilative

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
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

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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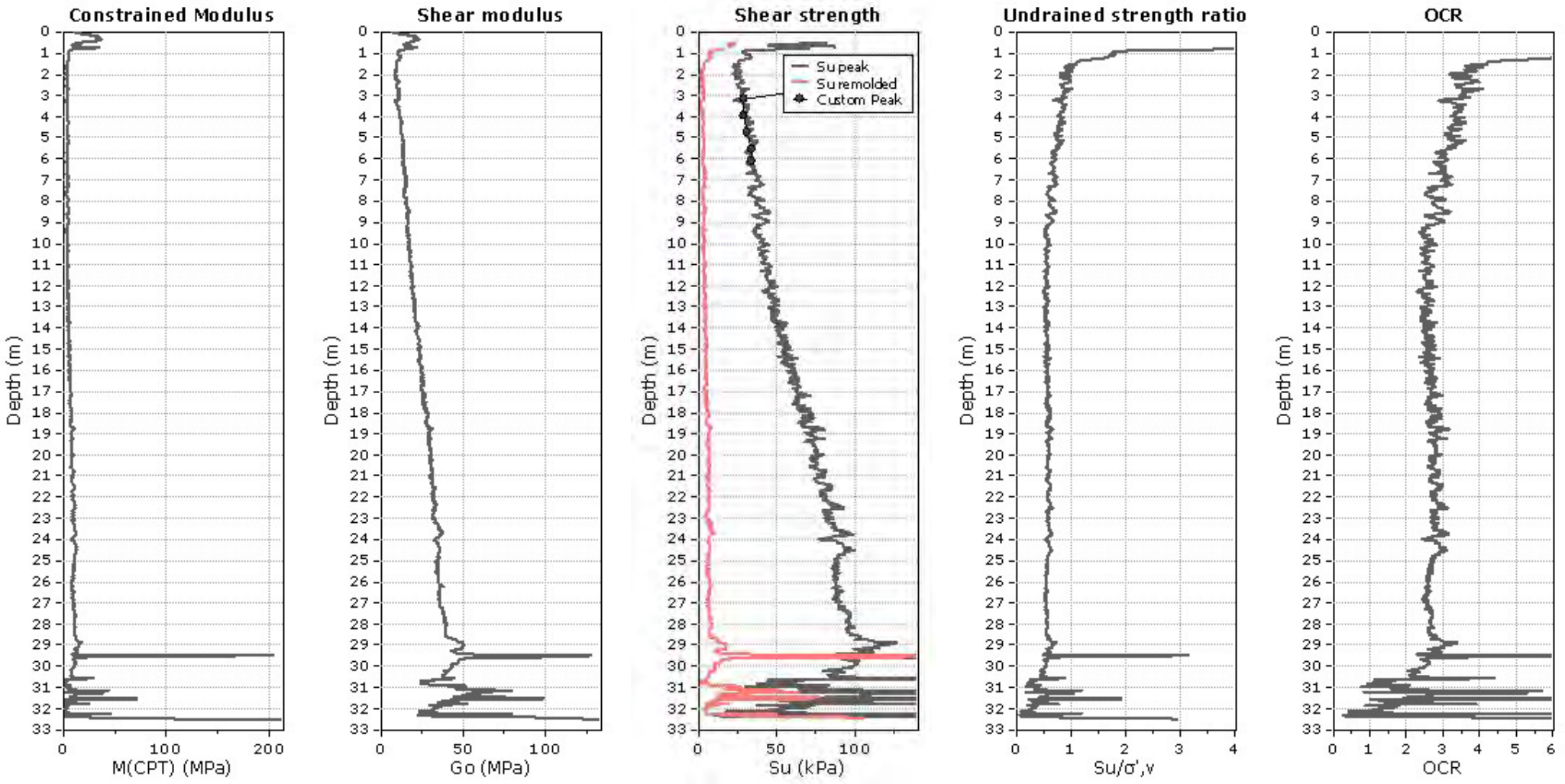

Calculation parameters

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
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Cone Type: Vertek 4544 - 5t
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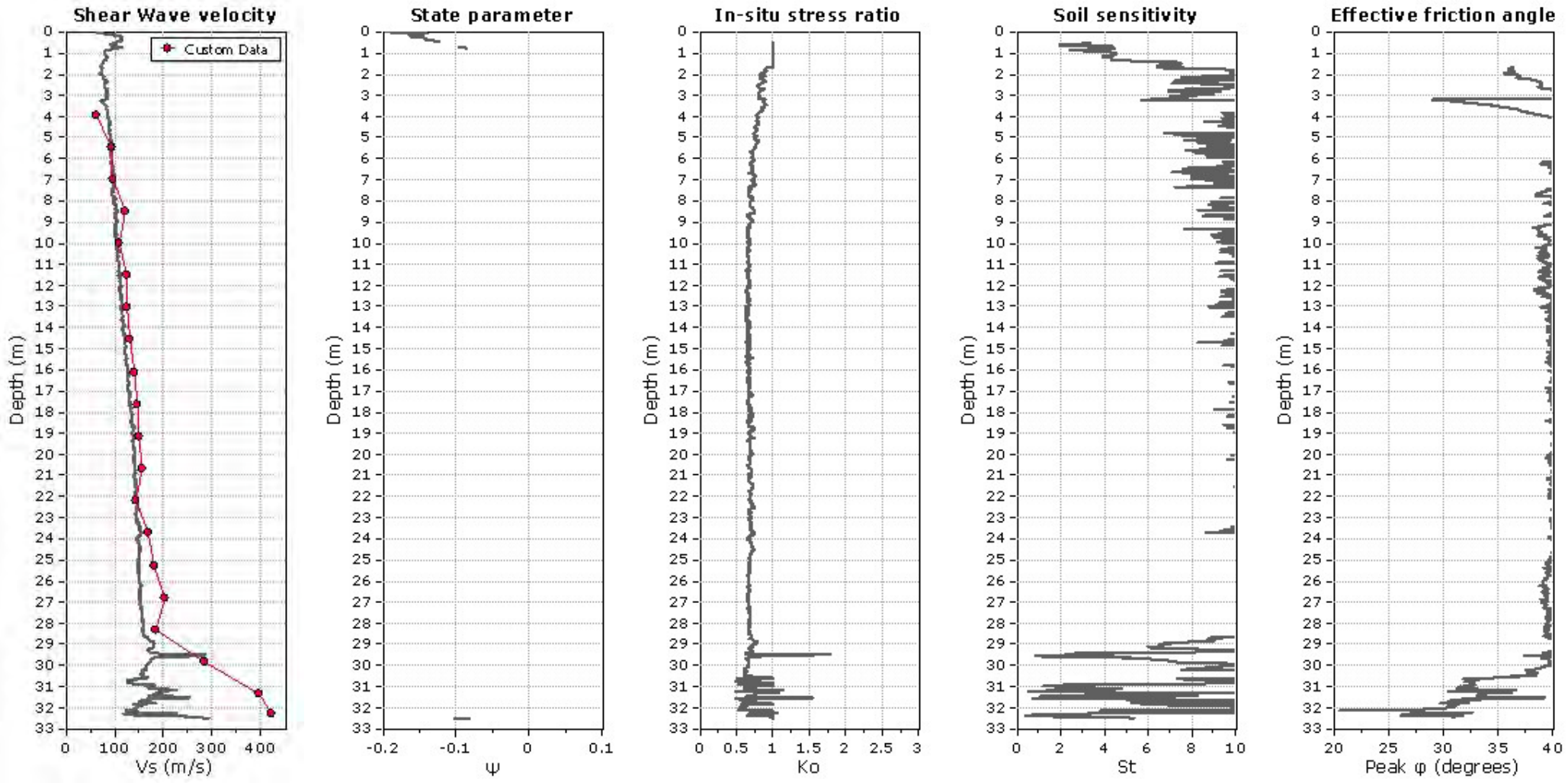


Calculation parameters

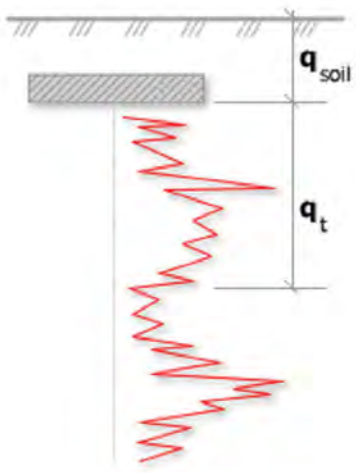
Soil Sensitivity factor, N_S: 7.00

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.

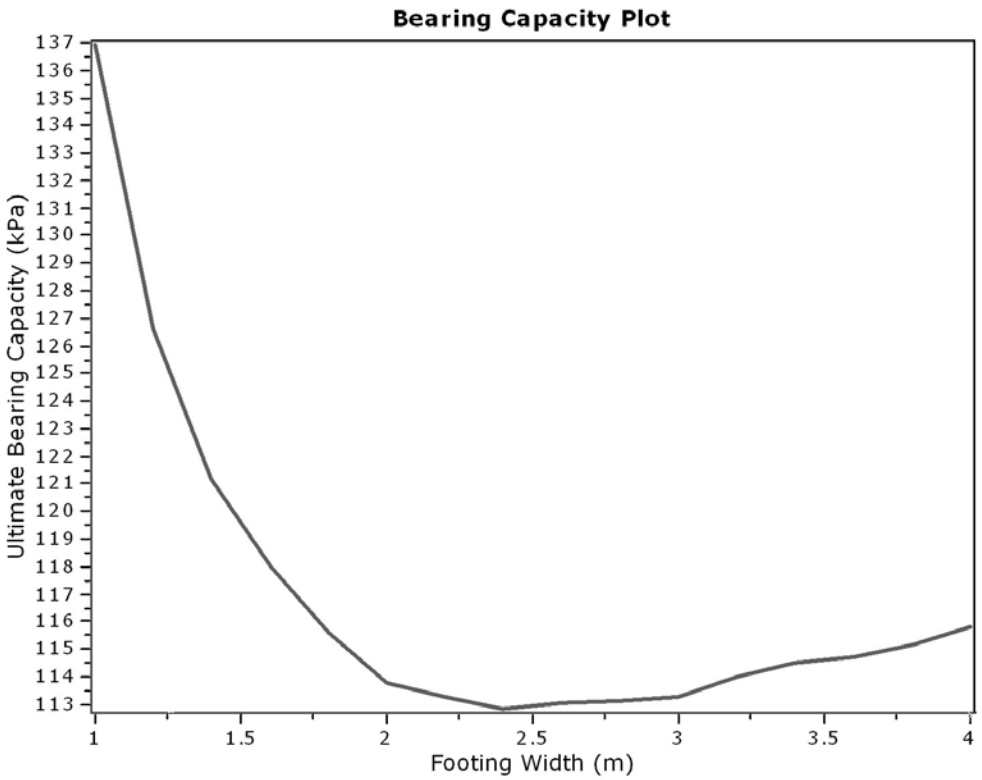
Project: **3053 & 3079 Navan Road**
Location: **Navan / Pagé Roads, Ottawa**



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

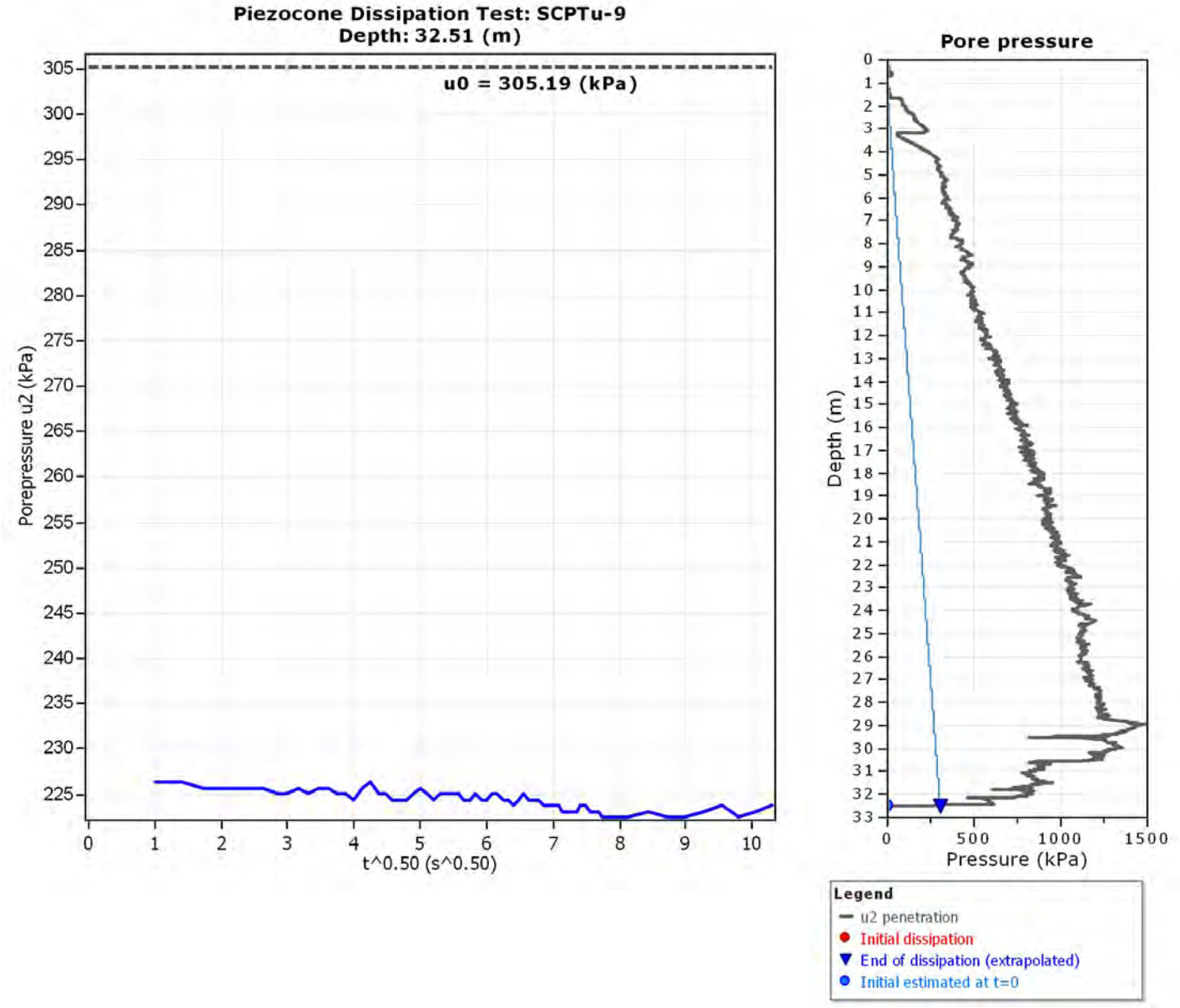
The dissipation of pore pressures during a CPTu dissipation test is controlled by the coefficient of consolidation in the horizontal direction (c_h) which is influenced by a combination of the soil permeability (k_h) and compressibility (M), as defined by the following:

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

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 $0.10 < B_q < 1.00$)

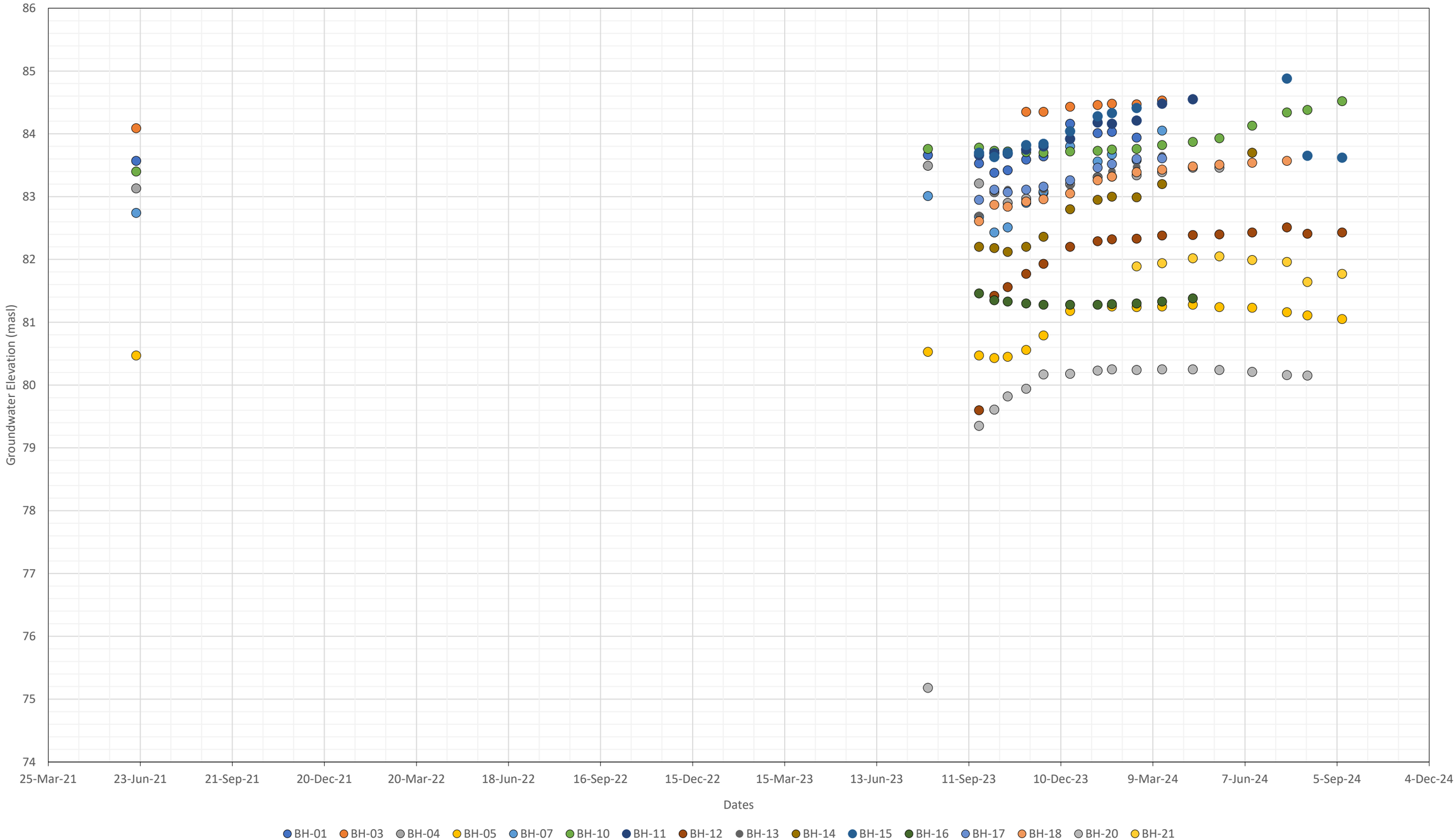
References

• 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 D:
Groundwater Level Measurements

2983 Navan Road Site - Monitored Manual Groundwater Elevation Plot from June, 2021 to September,2024



Summary of Monitored Manual Groundwater Elevation Measurements (June, 2021 to September, 2024) - Propsoed Residential Subdivision - 2983, 3053 and 3079 Navan Road, Ottawa, Ontario - EXP Project Number: OTT-21004743-B0

Monitoring Well ID	19-Jun-21	2-Aug-23	21-Sep-23	6-Oct-23	19-Oct-23	6-Nov-23	23-Nov-23	19-Dec-23	15-Jan-24	29-Jan-24	22-Feb-24	18-Mar-24	17-Apr-24	13-May-24	14-Jun-24	18-Jul-24	7-Aug-24	10-Sep-24
BH-01	83.57	83.66	83.53	83.38	83.42	83.59	83.64	84.16	84.01	84.03	83.94	84.51	damaged	damaged	damaged	damaged	damaged	damaged
BH-03	84.09					84.35	84.35	84.43	84.46	84.48	84.47	84.53	damaged	damaged	damaged	damaged	damaged	damaged
BH-04	83.13	83.49	83.21	83.07	82.9	82.97	83.06	83.2	83.31	83.32	83.34	83.39	83.46	83.46	missing	missing	missing	missing
BH-05	80.47	80.53	80.47	80.43	80.45	80.56	80.79	81.18		81.25	81.24	81.25	81.28	81.24	81.23	81.16	81.11	81.05
BH-07	82.74	83.01	82.68	82.43	82.51	82.9	83.08	83.8	83.56	83.67	83.58	84.05	damaged	damaged	damaged	damaged	damaged	damaged
BH-10	83.4	83.76	83.78	83.73	83.72	83.71	83.7	83.72	83.73	83.75	83.76	83.82	83.87	83.93	84.13	84.34	84.38	84.52
BH-11			83.66	83.69	83.68	83.75	83.8	83.92	84.18	84.16	84.21	84.48	84.55	missing	missing	missing	missing	missing
BH-12			79.6	81.42	81.56	81.77	81.93	82.2	82.29	82.32	82.33	82.38	82.39	82.40	82.43	82.51	82.41	82.43
BH-13			82.7	83.07	83.11	83.11	83.11	83.17	83.33	83.4	83.47	83.65	damaged	damaged	damaged	damaged	damaged	damaged
BH-14			82.2	82.18	82.12	82.2	82.36	82.8	82.95	83	82.99	83.2	damaged	damaged	83.70	damaged	damaged	damaged
BH-15			83.7	83.63	83.7	83.82	83.84	84.04	84.28	84.33	84.41		water floating	water floating	water floating	84.88	83.65	83.62
BH-16			81.46	81.35	81.33	81.3	81.28	81.28	81.28	81.29	81.3	81.33	81.38	missing	missing	missing	missing	missing
BH-17			82.95	83.11	83.07	83.11	83.16	83.26	83.46	83.52	83.6	83.61	damaged	damaged	damaged	damaged	damaged	damaged
BH-18			82.61	82.87	82.84	82.92	82.96	83.05	83.26	83.32	83.39	83.43	83.48	83.51	83.54	83.57	missing	missing
BH-20			75.18	79.35	79.61	79.82	79.94	80.17	80.18	80.23	80.25	80.24	80.25	80.25	80.24	80.21	80.16	80.15
BH-21											81.89	81.94	82.02	82.05	81.99	81.96	81.64	81.77

	Lowest GWE	**Lowest recorded groundwater elevation**
	Highest GWE	**Highest Recorded groundwater elevation**
		Data used in creating Groundwater Contour Map

Appendix E:
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.*
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AGAT Laboratories

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MISSISSAUGA, ONTARIO
CANADA L4Z 1Y2
TEL (905)712-5100
FAX (905)712-5122
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

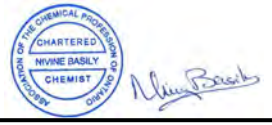
DATE REPORTED: 2021-05-14

		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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CANADA L4Z 1Y2
TEL (905)712-5100
FAX (905)712-5122
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)	%		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:

AGAT Laboratories

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
UP to Phas	21/5/17	16h00	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

Appendix F:
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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