Ottawa-Carleton District School Board (OCDSB)

Geotechnical Investigation

Type of Document
Updated Final

Project Name
Proposed Fernbank Public School
Cope Drive and Rouncey Road, Ottawa, ON

Project Number
OTT-00245378-K0

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Date Submitted
May 20, 2020

Ottawa-Carleton District School Board

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Legal Notification

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Executive Summary

EXP Services Inc. (EXP) is pleased to present the results of the geotechnical investigation completed for the proposed Fernbank Public School to be located in the Blackstone residential subdivision in the southwest corner of the Cope Drive and Rouncey Road intersection in Ottawa, Ontario. This work was completed under EXP Standing Offer Agreement with the Ottawa-Carleton District School Board (OCDSB) No. 18-0-7.

It is our understanding that the proposed school building will be a two-story building with no basement. The proposed building will have an elevator that will be set at approximately 2.0 m depth below the ground floor slab. The elevation of the ground floor slab will be at Elevation 101.25 m.

EXP completed a preliminary geotechnical investigation for this site and the results are reported in our geotechnical engineering report dated March 22, 2019 (Project No. OTT-00245378-K0). The preliminary geotechnical investigation includes seven (7) boreholes. For completeness, the information from these seven (7) boreholes has been incorporated into this final geotechnical engineering report.

The fieldwork for the preliminary and final geotechnical investigations were undertaken from February 21 to 25 and from October 22 to 28, 2019, respectively and consists of the drilling of twenty (20) boreholes (BH Nos. 1 to 20) extending to depths ranging from 3.2 m to 19.8 m below existing grade.

The investigation revealed the subsurface conditions at the site comprise of topsoil, fill, silt, silty clay and glacial till underlain by limestone bedrock. The glacial till in the west portion of the site was contacted at shallow depths whereas the east portion of the site is underlain by a deep silty clay deposit over a glacial till. The groundwater level at the site was measured at depths of 2.6 m to 3.5 m (Elevation 98.1 m to 97.2 m).

The site has been classified as Class D for seismic site classification based on shear wave velocity measurements at the site. The subsurface soils are not considered to be susceptible to liquefaction during a seismic event.

Based on a review of the borehole information, the site grade raise should be restricted to 1.2 m in conjunction with the recommended bearing pressure at serviceability limit state (SLS) and factored geotechnical resistance at ultimate limit state (ULS) values for the footings discussed in the attached report.

The geotechnical investigation revealed that the subsurface conditions at the site are well suited to supporting the proposed school building by strip and spread footings founded on the native brown silty clay at a maximum depth of 1.0 m below existing grade. Strip footings having a maximum width of 1.8 m may be designed for a bearing pressure at serviceability limit state (SLS) of 125 kPa and factored geotechnical resistance at ultimate limit state (ULS) of 190 kPa. Square pad footings having a maximum width and length of 2.2 m by 2.2 m may be designed for a bearing pressure at SLS of 150 kPa and factored geotechnical resistance at ULS of 225 kPa.

It is understood the proposed building will have an elevator located at Borehole No. 12. The elevator may be supported by a pad footing having a width and length of 2.8 m by 5.3 m and founded at a maximum 2.0 m depth below the finished floor on the brown silty clay. This 2.8 m by 5.3 m pad footing may be designed for a bearing pressure at SLS of 75 kPa and factored geotechnical resistance at ULS of 115 kPa.

The factored geotechnical resistance at ULS includes a resistance factor of 0.5. The recommended SLS and ULS values are considered valid, provided the 1.0 m site grade raise is respected.

Settlements of the footings designed for the SLS value above and properly constructed are expected to be within the normally tolerated limits of 25 mm total and 19 mm differential movements.

The exposed surface of the clay is susceptible to disturbance due to movement of workers and construction equipment especially if the excavations are undertaken during wet weather periods. It is therefore recommended that the approved subgrade in the footing beds be covered with a 50 mm concrete mud slab to prevent disturbance to the clay subgrade and should be allowed for in the contract.

The ground floor slab of the proposed building may be constructed as a slab-on-grade provided it is cast on a bed of well-compacted 19 mm clear stone at least 300 mm thick placed on engineered fill set on the natural undisturbed silty clay. The design elevation of the ground floor will be Elevation 101.15 m. A perimeter drainage system around the proposed building is recommended. An underfloor drainage system is not required, based on the elevation of the groundwater level and the design elevation of the ground floor of the proposed building. The finished floor slab should be set at least 150 mm higher than the finished exterior grade. The finished exterior grade of the building should be sloped away from the building to prevent ponding of surface water close to the exterior walls.

It is anticipated that excavations may be undertaken using conventional equipment and should be completed in accordance with the Occupational Health and Safety Act, Ontario, Reg. 213/91. Seepage of the surface and subsurface water into these excavations is anticipated. However, it should be possible to collect water entering the excavations at low points and to remove it by conventional pumping techniques.

It is anticipated that the majority of material required for backfilling purposes and subgrade preparation will need to be imported and should preferably conform to Ontario Provincial Standard Specification (OPSS) 1010 requirements for Granular A and Granular B Type II materials.

The above and other related considerations are discussed in greater detail in the main body of this report.

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1 Introduction

EXP Services Inc. (EXP) is pleased to present the results of the detailed geotechnical investigation completed for the proposed Fernbank Public School to be located in the Blackstone residential subdivision in the southwest corner of the Cope Drive and Rouncey Road intersection in Ottawa, Ontario. This work was completed under EXP Standing Offer Agreement with the Ottawa-Carleton District School Board (OCDSB) No. 18-0-7.

The proposed school building will be a two-story building with no basement and will have an elevator that will be set at approximately 2.0 m depth below the ground floor slab. The elevation of the ground floor slab will be at Elevation 101.25 m.

EXP completed a preliminary geotechnical investigation and the results are reported in our geotechnical engineering report dated March 22, 2019 (Project No. OTT-00245378-K0). The preliminary geotechnical investigation includes seven (7) boreholes. For completeness, the information from these seven (7) boreholes has been incorporated into this final geotechnical engineering report.

This geotechnical investigation was undertaken to:

a) Establish the subsurface soil, bedrock and groundwater conditions at the twenty (20) borehole locations;

b) Comment on the grade-raise restrictions;

c) Make recommendations regarding the most suitable type of foundations, founding depth and Serviceability Limit States (SLS) bearing pressures and Ultimate Limit States (ULS) factored geotechnical resistances and comment on anticipated settlements;

d) Discuss slab-on-grade construction and permanent drainage requirements;

e) Classify the site for seismic response in accordance with requirements of the 2012 Ontario Building Code (OBC) and comment on the liquefaction potential of subsurface soils during a seismic event;

f) Discuss excavation conditions and dewatering requirements;

g) Comment on pipe bedding requirements;

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

i) Recommend pavement structures for the proposed parking lots and access roads; and

j) Comment on subsurface concrete requirements and corrosion potential of the subsurface soils to buried metal structures/elements.

The comments and recommendations given in this report are based on the assumption 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 modifications 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 proposed school site is a 2.8 hectare (7 acre) parcel of vacant parcel of land in the southwest corner of the Cope Drive and Rouncey Road intersection in the Blackstone residential subdivision in Ottawa, Ontario (Figure 1). In October 2019, the site was occupied by three (3) soil stockpiles, however, the content and composition of the soils within these stockpiles are not known. The ground surface of the site is relatively flat with ground surface elevations at the borehole locations ranging from Elevation 100.16 m to 100.90 m.

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 the western portion of the site is underlain by shallow glacial till above an approximate 5.0 m depth. The eastern portion of the site is underlain by Champlain Sea offshore marine deposits consisting of silty 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 limestone bedrock of the Ottawa formation.

4 Procedure

4.1 Borehole Fieldwork

The fieldwork for the preliminary and detailed geotechnical investigations was undertaken from February 21 to 25 and from October 22 to 28, 2019, respectively. The borehole program consists of twenty (20) boreholes (BHs 1 to 20) drilled to termination depths ranging between 3.2 m and 19.8 m, as summarized in Table I. The locations of the boreholes are shown on the Borehole Location Plan, Figure 2.

Table I: Summary of Borehole Locations and Termination Depths

Proposed Installation	Borehole Number	Termination Depth (Elevation) m
Proposed School Building	BH 5	8.1 (92.2)
	BH 8	12.1 (88.4)
	BH 9	9.1 (91.1)
	BH 10	7.5 (93.1)
	BH 11	12.3 (88.2) – Cone Refusal
	BH 12	19.8 (80.5)
Portables	BH 4	13.1 (87.2) – Auger Refusal
	BH 17	4.9 (95.9)
Parking Lot and Access Road	BH 2	3.7 (97.2)
	BH 13	4.4 (95.9)
	BH 14	3.6 (97.0)
Sports Field	BH 1	7.0/7.1 (93.2/93.3) Borehole Terminated/Cone Refusal
	BH 15	3.6 (97.1)
Bus Route	BH 19	3.2 (97.2)
	BH 20	3.2 (97.3)
General Access Area	BH 3	9.2 (91.0)
	BH 6	8.1 (92.2)
	BH 7	18.8 (81.8) -Cone Refusal
	BH 16	4.7 (95.6)
	BH 18	3.2 (97.2)

The borehole locations and elevations were established in the field by a survey crew from EXP and their locations cleared from any underground services by USL-1 cable locators.

The boreholes were drilled with a CME-55 and CME-850 track-mounted drill rigs equipped with continuous flight hollow-stem auger equipment and rock coring capabilities. Standard penetration tests (SPTs) was performed in all the boreholes at 0.75 m to 2.3 m depth intervals. The soil samples were retrieved by the split-barrel sampler, in accordance with the American Society for Testing and Materials (ASTM). Auger samples were obtained from 0.0 m to 0.7 m depths in Borehole Nos. 1 to 7. Relatively undisturbed tube samples (Shelby tube) of the silty clay were retrieved at selected depths. In-situ vane tests were conducted in the silty clay at selected depth intervals to measure the undrained shear strength. In addition, penetrometer tests were undertaken on recovered split spoon samples to measure the undrained shear strength. A dynamic cone penetration test (DCPT) was conducted in the Borehole Nos. 1, 7 and 11. The presence of the bedrock was proven in Borehole Nos. 8 and 12 by conventional coring techniques using NQ-size core barrel. A record of wash water return, colour of wash and any sudden drop of the drill rods were kept during rock coring operations.

Borehole Nos. 1, 2, 4, 6, 7, 8, 10, 12, 15 and 16 are equipped with a 19 mm diameter PVC standpipe with screened section, for long-term monitoring of the groundwater levels. The installation configuration of each standpipe is documented on the respective borehole log. All boreholes were backfilled upon completion of drilling and sampling operations.

4.2 Laboratory Testing Program

All soil samples were visually examined in the field for textural classification, logged, preserved in plastic bags and identified accordingly. Similarly, all rock cores were placed in core boxes, identified and visually examined and logged. On completion of the fieldwork, all the soil samples and rock cores were transported to the EXP laboratory located in the City of Ottawa.

The soil samples and rock cores were visually examined in the laboratory by a senior geotechnical engineer. The soil samples were classified in accordance with the Unified Soil Classification System (USCS). The rock cores were visually examined and logged in accordance with Section 3.2 of the 2006 Canadian Foundation Engineering Manual (Fourth Edition, CFEM) and photographs taken of the rock cores.

A summary of the soil sample and rock core laboratory testing program is shown in Table II. The laboratory testing program for selected soil samples were undertaken in accordance with ASTM.

Table II: Summary of Laboratory Testing Program	
Type of Test	**Number of Tests Completed**
Soil Samples:	
Moisture Content Determination	137
Unit Weight Determination	36
Grain Size Analysis	8
Atterberg Limit Determination	5
Corrosion Analysis (pH, sulphate, chloride and electrical resistivity)	6
One Dimensional Oedometer Test (Consolidation Test)	2
Bedrock Cores:	
Unit Weight Determination	2
Unconfined Compressive Strength Test	2

4.3 Multi-channel Analysis of Surface Waves (MASW) Survey

A multi-channel analysis of surface waves (MASW) survey was conduced on site on February 11, 2019 by Geophysics (GPR) International Inc. The MASW survey consists of one (1) survey line across the site. The purpose of the MASW survey is to measure the shear wave velocity at the site and determine the site classification for seismic site response based on the shear wave velocity measurements.

5 Subsurface Conditions

A detailed description of the subsurface soil, bedrock and groundwater conditions determined from the boreholes (BH Nos. 1 to 20) is given on the attached borehole logs, Figure Nos. 3 to 22.

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

It should be noted that the soil boundaries indicated on the borehole logs are inferred from non-continuous sampling and observations during drilling. These boundaries 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 soil stratigraphy and bedrock with depth and groundwater level measurements.

5.1 Topsoil

A 300 mm thick surficial topsoil layer was contacted in Borehole Nos. 1, 3 and 6.

5.2 Fill

Surficial fill was encountered in Borehole Nos. 2, 5, 7 to 16 and 18 to 20. The fill extends to depths ranging from 0.1 m to 0.9 m (Elevation 100.5 m to 99.4 m). The composition of the fill varies from silty sand and gravel to silty clay with sand and gravel. Rootlets are present within the fill in Borehole Nos. 10 to 12 and 16. Wood debris is present within the fill from Borehole No. 12. Based on the standard penetration test (SPT) N-values of 2 to 21 indicating the clayey fill has a soft to stiff consistency and the sandy fill is in a loose to compact state. The moisture content of the fill is 10 percent to 38 percent. The unit weight of the fill ranges from 18.5 kN/m^3 to 21.5 kN/m^3.

It is not known whether the original topsoil was stripped from the entire site prior to placement of the fill throughout the site.

5.3 Buried Topsoil

A 100 mm thick buried topsoil layer was contacted in Borehole No. 14 beneath the fill at a 0.1 m depth (Elevation 100.5 m).

5.4 Silt

The fill in Borehole Nos. 19 and 20 is underlain by sandy silt with clay (BH 19) and clayey silt (BH 20). The silt extends to 1.4 m and 1.5 m depths (Elevation 99.0 m). The SPT N-values of the silt are 6 and 10 indicating the sandy silt is in a compact state (N value of 10) and the clayey silt has a firm consistency (N value of 6). The natural moisture content of the sandy silt is 18 percent and 26 percent for the clayey silt.

5.5 Silty Clay

The majority of the site is underlain by silty clay. The easterly portion of the site is underlain by a deep silty clay deposit that can be divided into two (2) sections; an upper brown desiccated silty clay crust underlain by a grey silty clay.

5.5.1 Brown Silty Clay Crust

The brown silty clay crust was contacted at ground surface in Borehole Nos. 4 and 17 and beneath the topsoil, fill and silt in the remaining boreholes. The silty clay was not present in Borehole No. 15. The brown silty clay extends to depths ranging from 2.5 m to 3.7 m (Elevation 97.8 m to 96.6 m). The brown silty clay contains silt partings. Penetrometer and vane test results indicate the shear strength of the brown silty clay ranges from 80 kPa to 150 kPa. Higher shear strength measurements of 192 kPa and greater than 250 kPa were measured in Borehole Nos. 8 and 13. Based on the shear strength measurements, the consistency of the silty clay is stiff to very stiff; locally hard in Borehole No. 8. The sensitivity values of the silty clay are 3.7 to 8.5 indicating the brown silty clay is medium sensitive to extra-sensitive. The natural moisture content of the brown silty clay is 23 percent to 52 percent. The natural unit weight of the brown silty clay is 16.5 kN/m^3 to 20.0 kN/m^3.

Grain-size analysis and Atterberg limit determination were conducted on two (2) samples of the brown silty clay and the results are summarized in Tables III and IV. The grain-size distribution curves are shown in Figures 23 and 24.

Table III: Summary of Results from Grain-size Analysis – Brown Silty Clay Samples

Borehole No. - Sample No.	Depth (m)	Grain-size Analysis (%)		
		Gravel	Sand	Fines
BH 4 – SS3	1.5 – 2.0	0	4	96
BH 11 – SS3	1.5 – 2.1	0	6	94

Table IV: Summary of Atterberg Limit Results – Brown Silty Clay Samples					
Borehole No. - Sample No.	**Depth (m)**	**Atterberg Limit Results (%)**			
		w_n	**LL**	**PL**	**PI**
BH 4 – SS3	1.5 – 2.0	30	34	18	16
BH 11 – SS3	1.5 – 2.1	30	33	19	14
W_n: Natural Moisture Content; **LL**: Liquid Limit; **PL:** Plastic Limit; **PI**: Plasticity Index					

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

5.5.2 Grey Silty Clay

The grey silty clay was contacted in Borehole Nos. 3 to 12, 16 and 17 at 2.5 m to 3.7 m depths (Elevation 97.8 m to 96.6 m). The grey silty clay extends to depths ranging from 3.3 m to 14.9 m (Elevation 97.3 m to 85.4 m). Borehole Nos. 3, 5 to 7, 9, 11, 16 and 17 terminated within the grey silty clay at 4.7 m to 10.1 m depths (Elevation 95.9 m to 90.4 m). The grey silty clay contains silt partings. The shear strength of the grey silty clay ranges from 24 kPa to 77 kPa indicating the silty clay has a soft to stiff consistency. Locally in Borehole No. 8, the shear strength of the grey silty clay is 120 kPa and 165 kPa indicating a very stiff consistency. Sensitivity values are from 4 to 10 indicating the grey silty clay is sensitive to extra-sensitive. Locally in Borehole No. 8, the sensitivity value is 3.3 and 3.4 indicating medium sensitive zone of the grey silty clay. The natural moisture content of the grey silty clay is 28 percent to 73 percent. The natural unit weight of the grey silty clay is 16.9 kN/m^3 to 18.5 kN/m^3.

Grain-size analysis and Atterberg limit determination were conducted on three (3) sample of the grey silty clay and the results are summarized in Tables V and VI. The grain-size distribution curves are shown in Figures 25 to 27.

Table V: Summary of Results from Grain-size Analysis – Grey Silty Clay Samples				
Borehole No. - Sample No.	**Depth (m)**	**Grain-size Analysis (%)**		
		Gravel	**Sand**	**Fines**
BH 4 – SS6	3.8 – 4.3	0	2	98
BH 4 – SS9	7.6 – 8.2	0	2	98
BH 12 – SS11	13.7 – 14.3	0	4	96

Table VI: Summary of Atterberg Limit Results – Grey Silty Clay Samples					
Borehole No. - Sample No.	**Depth (m)**	**Atterberg Limit Results (%)**			
		w_n	**LL**	**PL**	**PI**
BH 4 – SS6	3.8 – 4.3	40	29	17	12
BH 4 – SS9	7.6 – 8.2	42	32	17	15
BH 12 – SS11	13.7 – 14.3	28	27	17	10
W_n: Natural Moisture Content; **LL**: Liquid Limit; **PL:** Plastic Limit; **PI**: Plasticity Index					

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

One-dimensional oedometer(consolidation) test was performed on two (2) relatively undisturbed samples of the grey clay and the test results are summarized in Table VII. The test results are shown in Appendix A.

Table VII: Summary of Results from One-Dimensional Oedometer (Consolidation) Tests on Grey Silty Clay Samples										
Borehole No.-Sample No.	**Depth (Elevation) (m)**	**σ'_{v0} (kPa)**	**w_c (%)**	**γ (kN/m^3)**	**σ'_p (kPa)**	**e_o**	**c_r**	**c_c**	**OC (kPa)**	**OCR**
BH 12 – ST8	9.5 – 9.6	105	43	17.5	160	1.213	0.025	0.72	55	1.5
BH 16 -ST6	4.2 – 4.3	72	47	16.9	150	1.336	0.021	0.90	78	2.1
σ'_{v0} = calculated effective overburden pressure (kPa); Wc: 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; OC= available over-consolidation pressure (kPa); OCR -Over-Consolidation Ratio										
Note: σ'_{v0} calculated using May 7, 2018 groundwater level measurement and assuming an average groundwater level measurement of 1.3 m (Elevation 91.0 m) for Borehole No. 6.										

The test results indicate the grey silty clay is overconsolidated by 55 kPa to 78 kPa.

5.6 Glacial Till

The fill in Borehole No. 15, the brown silty clay crust in Borehole Nos. 1, 2, 13 and 14 and the grey silty clay in Borehole Nos. 8, 10 and 12 are underlain by glacial till. The glacial till contains cobbles and boulders. The glacial till was contacted at shallow depths of 0.6 m to 3.7 m below existing grade (Elevation 100.1 m to 96.8 m) in Borehole Nos. 1, 2, 8, 10 and 13 to 15 located in the west portion of the site. In the easterly portion of the site at Borehole No. 12 the glacial till was contacted at 14.9 m depth (Elevation 85.4 m) and inferred glacial till was contacted in Borehole No. 7 at 18.2 m depth (Elevation 82.4 m). Based on the SPT N values of 3 to 64, the glacial till is in a very loose to very dense state. The natural moisture content of the glacial till is 6 percent to 30 percent. The natural unit weight of the glacial till is 23.3 kN/m^3.

Grain-size analysis were conducted on three (3) sample of the glacial till and the results are summarized in Tables VIII. The grain-size distribution curves are shown in Figures 28 to 30.

Table VIII: Summary of Results from Grain-size Analysis – Glacial Till Samples

Borehole No. - Sample No.	Depth (m)	Grain-size Analysis (%)		
		Gravel	Sand	Fines
BH 1 – SS6	3.8 – 4.3	9	52	39
BH 13 – SS3	1.5 – 2.1	16	42	42
BH 15 – SS4	3.0 – 3.6	11	55	34

Based on a review of the results from the grain-size analysis, the glacial till may be classified as a silty sand with gravel to silty sand (SM) in accordance with the Unified Soil Classification System (USCS). The glacial till contains cobbles and boulders.

5.7 Inferred Cobbles, Boulders or Bedrock

Auger refusal was met in Borehole Nos. 2, 4 and 10 at 3.7 m to 13.1 m depths (Elevation 97.2 m 87.2 m). Cone refusal from the dynamic cone penetration test (DCPT) was met in Borehole Nos. 7 and 11 at 12.3 m and 18.8 m depths (Elevation 88.2 m and 81.8 m). Auger and cone refusal depths are considered to have occurred on inferred cobbles, boulders or bedrock.

5.8 Limestone Bedrock

The presence of limestone bedrock was confirmed by coring the bedrock in Borehole Nos. 8 and 12. Bedrock was contacted at 9.2 m and 17.8 m depths (Elevation 91.3 m and 82.5 m) in Borehole Nos. 8 and 12, respectively. Photographs of the bedrock cores are shown in Figures 31 and 32.

The Total Core Recovery (TCR) is 15 percent and 100 percent. The Rock Quality Designation (RQD) ranges from 29 percent to 75 percent indicating the bedrock is of a poor to good quality. The results of the unit weight determination and unconfined compressive strength test conducted on two (2) rock core sections are summarized in Table IX.

Table IX: Summary of Unconfined Compressive Strength Test Results – Bedrock Cores			
Borehole No.- Sample No.	**Depth (m)**	**Unit Weight (kN/m^3)**	**Unconfined Compressive Strength (MPa)**
BH 8 – Run 3	10.3 – 10.5	26.6	116.9
BH12 – Run 2	18.9 – 19.1	26.3	122.2

The unconfined compressive strength test results indicate the strength of the rock may be classified as very strong in accordance with the Canadian Foundation Engineering Manual (CFEM), Fourth Edition, 2006.

5.9 Groundwater Level Measurements

A summary of groundwater level measurements taken on November 12, 2019 in the standpipes installed in Borehole Nos. 8, 10, 12, 15 and 17 is shown in Table X. The standpipes installed in Borehole Nos. 1, 2, 4, 6 and 7 from the preliminary geotechnical investigation undertaken in March 2019 could not be found during our November 12, 2019 site visit.

Table X: Summary of Groundwater Level Measurements				
Borehole No.	**Ground Surface Elevation (m)**	**Date of Groundwater Level Measurement (Number of Days After Drilling)**	**Groundwater Depth (m)**	**Groundwater Elevation (m)**
8	100.45	November 12, 2019 (18 days)	3.1	97.4
10	100.57	November 12, 2019 (18 days)	3.4	97.2
12	100.33	November 12, 2019 (20 days)	2.9	97.4
15	100.66	November 12, 2019 (15 days)	2.6	98.1
16	100.34	November 12, 2019 (21 days)	3.5	96.8

A review of Table X indicates the groundwater level at the site was measured at depths of 2.6 m to 3.5 m (Elevation 98.1 m to 97.2 m).

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

6 Seismic Site Classification and Liquefaction Potential of On-Site Soils

Geophysics GPR International Inc. was commissioned to carry out a seismic shear-wave survey of the site. The results of the survey are presented in the report in Appendix B. Based on the results of the survey, the average shear-wave velocity to 30 m depth (V_{s30}) was established by GPR as 268.8 m/s. On this basis, the site has been classified as Class D in accordance with Table 4.1.8.4 A of the 2012 Ontario Building Code (OBC).

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

7 Site Grade Raise Restrictions

It is our understanding that the design elevation of the ground floor of the proposed school building will be at Elevation 101.25 m. Based on the ground surface elevation at each borehole location, the anticipated site grade raise will range from 0.3 m to 1.0 m. Within the proposed school building footprint, the site grade raise will range from 0.6 m to 1.2 m.

Based on a review of the borehole information, the site grade raise should be restricted to 1.2 m in conjunction with the recommended bearing pressure at serviceability limit state (SLS) and factored geotechnical resistance at ultimate limit state (ULS) values for the footings discussed in Section 9 of this report. The restricted site grade raise assumes no permanent lowering of the groundwater level, since the groundwater level is anticipated to be at or slightly below the excavations for the school development and measures are employed in new service trenches to minimize the permanent lowering of the groundwater level at the site (use of clay seals), as recommended in Section 13 of this report.

8 Site Grading

Site grading in building area, paved and sports field areas inclusive of areas of future portables should consist of the excavation and removal of all topsoil and organic stained soils, any buried topsoil layer that may be present and fill from the site. Removal of the existing fill soil stockpiles should also be undertaken as part of site grading operations. If the intent is to use this material as fill at the site, an additional test pit investigation should be completed in order to establish the quality and type of the material to determine if they are suitable for re-use as intended.

Following removal of the topsoil and fill as indicated above, the exposed subgrade should be proofrolled in the presence of a geotechnical engineer prior to placement of engineered fill. Any soft areas identified should be excavated and replaced with Ontario Provincial Standard Specification (OPSS) 1010 Granular B Type II compacted to 95 percent standard Proctor maximum dry density (SPMDD) to subgrade level.

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

9 Foundation Considerations

The geotechnical investigation revealed that the subsurface conditions at the site are well suited to supporting the proposed school building by strip and spread footings founded on the native brown silty clay at a maximum depth of 1.0 m below existing grade. Strip footings having a maximum width of 1.8 m may be designed for a bearing pressure at serviceability limit state (SLS) of 125 kPa and factored geotechnical resistance at ultimate limit state (ULS) of 190 kPa. Square pad footings having a maximum width and length of 2.2 m by 2.2 m may be designed for a bearing pressure at SLS of 150 kPa and factored geotechnical resistance at ULS of 225 kPa.

It is understood the proposed building will have an elevator located at Borehole No. 12. The elevator may be supported by a pad footing having a width and length of 2.8 m by 5.3 m and founded at a maximum 2.0 m depth below finished floor on the brown silty clay. This 2.8 m by 5.3 m pad footing may be designed for a bearing pressure at SLS of 75 kPa and factored geotechnical resistance at ULS of 115 kPa.

The factored geotechnical resistance at ULS includes a resistance factor of 0.5. The recommended SLS and ULS values are considered valid, provided the 1.0 m site grade raise is respected.

Settlements of the footings designed for the SLS value above and properly constructed are expected to be within the normally tolerated limits of 25 mm total and 19 mm differential movements.

All the footing beds should be examined by a geotechnical engineer to ensure that the founding surfaces are capable of supporting the design bearing pressure at SLS and that the footing beds have been properly prepared.

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 minimum required, an equivalent combination of earth cover and rigid insulation or rigid insulation alone should be provided. EXP can provide additional comments in this regard, if required.

It should be noted that the exposed surface of the clay is susceptible to disturbance due to movement of workers and construction equipment especially if the excavations are undertaken during wet weather periods. It is therefore recommended that the approved subgrade in the footing beds be covered with a 50 mm concrete mud slab to prevent disturbance to the clay subgrade. Hence, it is recommended that supply and placement of the concrete mud slab be allowed for by the contractor as part of the footing base preparation.

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

10 Floor Slab and Drainage Requirements

The ground floor slab of the proposed building may be constructed as a slab-on-grade provided it is cast on a bed of well-compacted 19 mm clear stone at least 300 mm thick placed on engineered fill set on the natural undisturbed silty clay. The engineered fill under the floor slab should comprise of OPSS 1010 Granular B Type II placed in 300 mm thick lifts and each lift compacted to 98 percent of the SPMDD.

The design elevation of the ground floor will be Elevation 101.25 m. A perimeter drainage system around the proposed building is recommended. An underfloor drainage system is not required, based on the elevation of the groundwater level and the design elevation of the ground floor of the proposed building.

The finished floor slab should be set at least 150 mm higher than the finished exterior grade. The finished exterior grade of the building should be sloped away from the building to prevent ponding of surface water close to the exterior walls.

11 Resistance to Buoyancy Forces

The proposed elevator should be designed as a watertight structure assuming for design that the highest groundwater table at the site will coincide with the existing ground surface. Therefore, the elevator structure may be subjected to flotation if the upward hydrostatic pressure is more than the weight of the proposed elevator. The uplift forces on the proposed elevator may be resisted by the weight of the elevator structure or by extending the base of the elevator beyond the perimeter of the elevator structure and utilizing the submerged weight of the soil on the extended portion of the slab and shearing resistance of the backfill material.

The resistance to uplift of the elevator due to extension of the base of the elevator beyond the perimeter of the elevator structure may be computed from the following equations. The subsurface walls of the elevator structure should be backfilled with OPSS Granular B Type II compacted to 98 percent SPMDD.

The resistance to uplift due to weight of the soil (kN) on the extended portion of the base of the elevator is given by:

$$R_1 = 2\,\gamma'\,h\,L_1\,[B + L + 2L_1]$$

where γ' = submerged weight of granular backfill = 12 kN/m^3

h = depth of the base of the elevator below slab, m

L_1 = extension of base of elevator beyond perimeter of the elevator structure, m

B = width of elevator structure, m

L = length of elevator structure, m

The shearing resistance of the soil (kN) may be computed from the expression:

$$R_2 = (B + L + 4L_1) \times \gamma'\,h^2\,K_a \tan \varphi$$

where K_a = coefficient of active earth pressure = 0.33

φ = angle of internal friction of granular backfill = 30º

All other terms have been described previously.

The elevator structure should be waterproofed.

12 Excavations and De-Watering Requirements

12.1 Excavations

Excavations for the foundations of the proposed building and underground services are expected to extend to an approximate depth of 3.0 m below the existing grade. These excavations will extend through the topsoil, fill, silt and into the brown silty clay crust, grey silty clay and glacial till. The excavations are anticipated to be approximately above or slightly below the groundwater level.

It is anticipated that excavations may be undertaken using conventional equipment capable of removing possible debris within the existing fill and cobbles/boulders within the glacial till. All excavation work should be completed in accordance with the Occupational Health and Safety Act, Ontario, Reg. 213/91. Based on the definitions provided in OHSA, the subsurface soils at the site are considered to be Type 3 soil. Excavations may be undertaken as open cut in Type 3 soil, provided the excavation walls are sloped back at 1H:1V from the bottom of the excavation as per OHSA. For excavations that extend below the groundwater level, the side slopes are expected to slough and eventually stabilize at 2H:1V to 3H:1V from the bottom of the excavation. If space restrictions prevent open-cut excavations (such as for underground service trenches), the excavations may be undertaken within the confines of a prefabricated support system (trench box) or shoring system designed and installed in accordance with the above noted regulation.

The contractor should review the site plan and surrounding properties and existing structures to determine if a shoring system is required in order to execute the proposed work in accordance with the above regulation and to protect existing features and underground service installations. The shoring system should be designed and installed in accordance with OHSA and the 2006 Canadian Foundation Engineering Manual (Fourth Edition).

It is assumed the excavations will extend to a depth of 3.0 m below existing grade and will be above or slightly below the groundwater table. A base heave type of failure of the excavation to a 3.0 m depth below existing grade is not anticipated in the glacial till and silty clay.

The silty clay stratum at the site is susceptible to disturbance due to the movement of construction equipment, and personnel on its surface. It is therefore recommended that the excavation at the site should be undertaken by equipment that does not travel on the excavated surface, such as a gradall or mechanical shovel. It is anticipated that temporary granular roads may be required to gain access to the site by construction equipment.

A pre-construction survey of all adjacent surrounding structures and infrastructure should be conducted prior to start of construction.

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.

12.2 De-Watering Requirements

Seepage of the surface and subsurface water into these excavations is anticipated. However, 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 in areas where more permeable soil layers may exist, a higher seepage rate should be anticipated. Therefore, the need of high capacity pumps to keep the excavation dry should not be ignored.

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

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

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 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 City of Ottawa requirements and/or Ontario Provincial Standard Specification and Drawings (OPSS and OPSD).

Due to the presence of the grey clay, it is recommended the pipe bedding consist of 300 mm thick OPSS 1010 Granular B Type II sub-bedding material overlain by 150 mm thick OPSS 1010 Granular A bedding material. The bedding materials should be compacted to at least 95 percent SPMDD.

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

If the backfill for the service trenches will consist of granular fill, clay seals should be installed in the service trenches at select intervals as per City of Ottawa Drawing No. S8. The seals should be 1 m wide, extend over the entire trench width and from the bottom of the trench to the underside of the pavement structure. The clay should be compacted to 95 percent SPMDD. The purpose of the clay seals is to prevent the permanent lowering of the groundwater level.

14 Backfilling Requirements and Suitability of On-Site Soils for Backfilling Purposes

The soils to be excavated from the site will comprise topsoil, fill, silt, brown silty clay crust, grey silty clay and glacial till. Portions of the fill that are free of cobbles, boulders and debris may be used for landscaping purposes. Portions of the brown silty clay crust and glacial till from above the groundwater table may be compactable subject to testing during construction. The approved portions of the brown silty clay and glacial till may be used to backfill service trenches and as subgrade fill in paved areas provided their moisture content is maintained between 2 percent and 3 percent of their optimum value. If they are determined to be not compactible, they may be used for landscaping purposes. The glacial till below the groundwater table and the grey silty clay is considered to be too wet for reuse as backfill material and should be discarded. It may be used in landscaped areas if left on the sun to dry prior to its use.

It is anticipated that the majority of material required for backfilling purposes and subgrade preparation will need to be imported and should preferably conform to the following requirements:

- Underfloor fill and backfill of footing trenches (building interior and exterior) – OPSS 1010 Granular B Type II placed in 300 mm thick lifts and each lift compacted to 98 percent of the SPMDD in the interior of the building and to 95 percent of the SPMDD in the exterior of the building;
- Trench backfill and subgrade fill exterior of buildings– OPSS 1010 Select Subgrade Material (SSM) placed in 300 mm thick lifts and each lift compacted to 95 percent of the SPMDD; and
- Landscaped area, clean fill free of organic and deleterious material placed in 300 mm thick lifts and each lift to compacted to 92 percent of the SPMDD.

15 Access Roads and Parking Areas

Subgrade for the proposed parking areas, access roadways, bus routes and other hard surfaces at the site will comprise of native silty clay, glacial till and/or select subgrade material used to raise the grades to the proposed subgrade levels following the removal of all the existing fill placed at the site.

Pavement structure thicknesses required for the light duty and heavy-duty roadways (fire and bus routes) were computed and are shown on Table XI. The thicknesses are based upon an estimate of the subgrade soil properties determined from visual examination, textural classification of the soil samples and functional design life of 15 to 18 years. The proposed functional design life represents the number of years to the first rehabilitation, assuming regular maintenance is carried out.

Table XI: Recommended Pavement Structure Thicknesses

Pavement Layer	Compaction Requirements	Light Duty (Cars and Parking)	Heavy Duty (Fire and Bus Routes)
Asphaltic Concrete (PG 58-34)	92 - 97% MRD	65 mm HL3 or SP12.5 Cat B	40 mm HL3 or SP12.5 Cat B 50 mm HL8 or SP19 Cat B
OPSS 1010 Granular A Base (crushed limestone)	100% SPMDD*	150 mm	150 mm
OPSS 1010 Granular B Type II Sub-base	100% SPMDD*	450 mm	600 mm

Notes:
MRD denotes Maximum Relative Density – ASTM D-2041, SPMDD denotes Standard Proctor Maximum Dry Density, ASTM-D698-12e2, Asphaltic Concrete in accordance with OPSS 1150 (Marshall Mixes) or OPSS 1151 (Superpave Mixes).

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

Additional comments on the construction of paved areas are as follows:

1. As part of the subgrade preparation, the proposed parking area and access roadways should be stripped of topsoil, existing fill down to native silty clay or glacial till. The subgrade should be proof rolled in the presence of a geotechnician and approved before placement of the granular materials for the pavement structure (or granular materials for the grade raise)
2. Fill required to raise the grades to design elevations should conform to requirement as per Section 14 which should be placed and compacted to 95 percent of the SPMDD. The subgrade should be properly shaped, crowned, then proofrolled with a roller in the full-time presence of a representative of this office. Any soft or spongy subgrade areas detected should be subexcavated and properly replaced with suitable approved backfill compacted to 95 percent SPMDD.

3. 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. Sub-drains must be installed on both sides of the access roads, in the proposed parking areas. The sub-drains should be installed at low points and should be continuous between catch basins 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 requirement and location and extent of subdrainage required within the paved areas will have to be established once the grades at the site are finalized.
4. To minimize the problems of differential movement between the pavement and catchbasins/ manholes 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 the granular fill.
5. 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, etc., may be required, especially if construction is carried out during unfavorable weather.
6. 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 catch basins. Surface water should not be allowed to pond adjacent to the outside edges of paved areas.
7. Relatively weaker subgrade may develop over service trenches at subgrade level if wet soils is used to backfill of the service trenches. Therefore, only dry and compactible material should be used to backfill service trenches as recommended in Section 15 of the report.
8. The granular materials used for pavement structure should conform to OPSS 1010 for Granular A and Granular B Type II and should be compacted to 100 percent of the SPMDD.
9. The asphaltic concrete used, and its placement should meet OPSS 1150 or 1151 requirements. It should be compacted from 92 percent to 97 percent of the Maximum Relative Density (ASTM D2041). Asphalt placement should be in accordance with OPSS 310 and OPSS 313.

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

16 Subsurface Concrete Requirements and Corrosion Potential of Subsurface Soil to Buried Steel

Chemical tests limited to pH, sulphate, chloride and electrical resistivity were undertaken on five (5) selected soil samples and the results are shown in Table XII. The laboratory certificates of analysis for the chemical tests are shown in Appendix C.

Table XII: Corrosion Analyses on Selected Soil Samples

Borehole No. - Sample No.	Soil	Depth (m)	pH	Sulphate (%)	Chloride (%)	Resistivity (ohm.cm)
BH1 – SS2	Brown Silty Clay Crust	0.76 – 1.4	7.8	0.00040	0.0013	3690
BH5 – SS3	Brown Silty Clay Crust	1.5 – 2.1	7.94	0.0039	0.0012	4740
BH6 – SS4	Brown Silty Clay Crust	2.3 – 2.9	8.09	0.0014	0.0009	5880
BH12 – SS6	Grey Silty Clay	5.3 – 5.9	8.20	0.0460	< 0.0002	1620
BH12 – SS10	Grey Silty Clay	12.2 – 12.8	8.99	0.0137	0.0002	2650
BH13 – SS4	Glacial Till	2.3 – 2.9	8.48	0.0019	0.0004	7300

The results indicate the soils have a sulphate and chloride content of less than 0.1 percent and 0.04 percent respectively. These concentrations of sulphate and chloride would have a negligible potential of sulphate and chloride attack on subsurface concrete. The concrete should be in accordance with Table Nos. 3 and 6 of CSA A.23.1-14. However, the concrete should be dense, well compacted and cured.

The results of the resistivity tests indicate that the silty clay is moderately to severely corrosive to underground bare steel structures. The glacial till is mildly corrosive to underground bare steel structures. A corrosion expert should be contacted to provide corrosion protection recommendations if steel is to be buried on the site.

17 Tree Planting Restrictions

The modified plasticity index of the samples of the brown and grey silty clay tested for Atterberg limits at 1.5 m to 2.1 m and 3.8 m to 4.3 m depths below existing grade was estimated to be 12 percent to 16 percent.

Based on the City of Ottawa document titled, “Tree Planting in Sensitive Marine Clay Soils – 2017 Guidelines,” soils with a modified plasticity index less than 40 percent are considered to have a low/medium potential for soil volume change. Reference is made to the 2017 City of Ottawa guidelines for comments and recommendations regarding tree planting at the site. A landscape architect should be consulted to ensure the applicable tree planting restrictions and setbacks for the development of this site are in accordance with the applicable City of Ottawa guideline and policy.

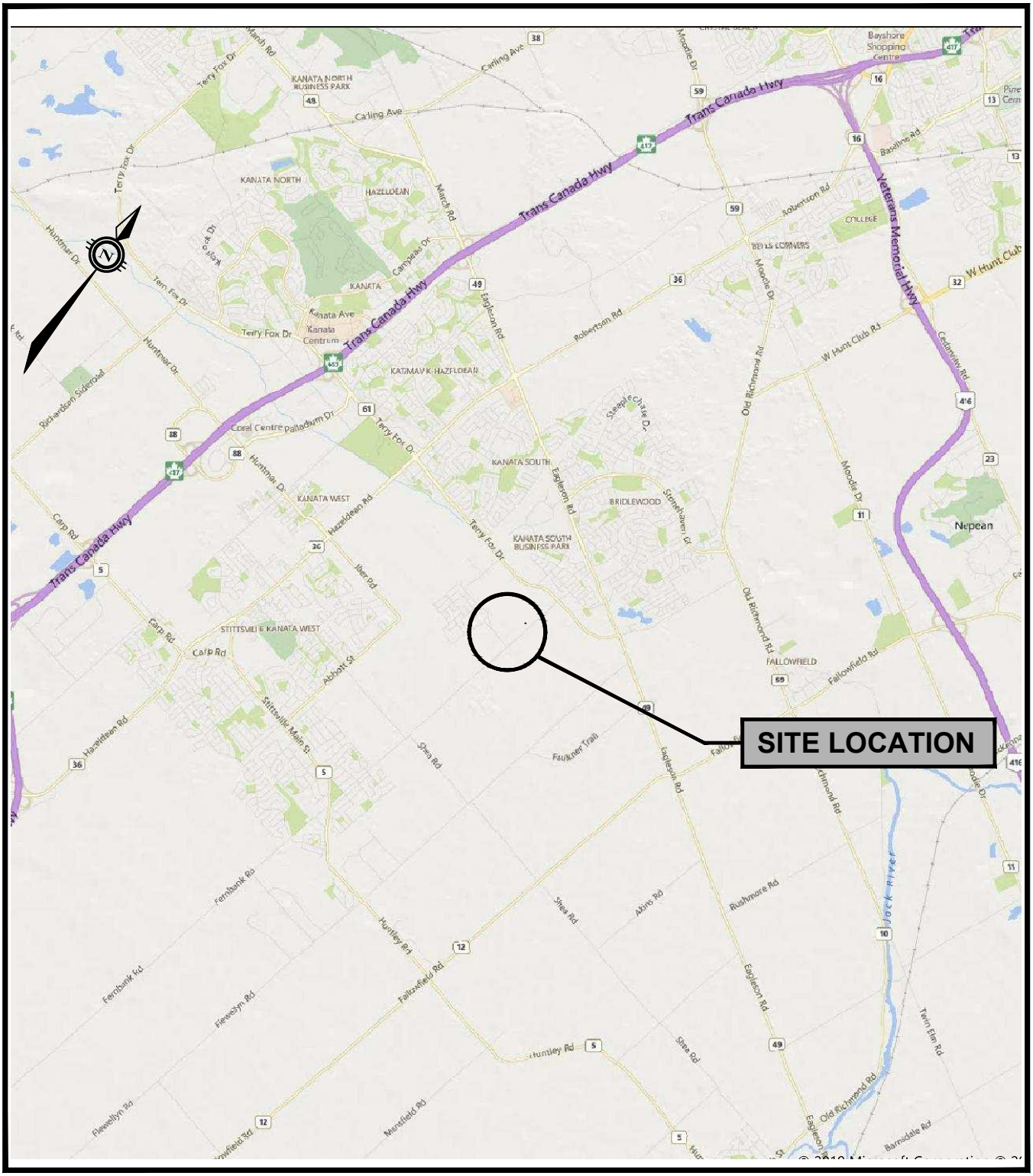
18 General Closure

The comments given in this report are intended only for the guidance of the 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 interpretation of the factual borehole results to draw their own conclusions as to how the subsurface conditions may affect them.

The information contained in this report in no way reflects on the environmental aspects of the soils. Should specific information be required, additional testing may be necessary.

We trust this report is satisfactory for your purposes. If you have any questions regarding our submission, please do not hesitate to contact this office.

FIGURES



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scale: N.T.S	CLIENT: OTTAWA CARLETON DISTRICT SCHOOL BOARD	project no.: OTT-00245378-K0
date: FEB, 2019	TITLE: SITE LOCATION PLAN PROPOSED FERNBANK PUBLIC SCHOOL, OTTAWA, ON	FIG 1
drawn by: A.O.		

Filename: p:\projects\geotechnical\24000\245000\245378 k0- geo inv scvhool blackstone ocdsblk - drawings\245378-k0 fig 1 site loc plan.dwg
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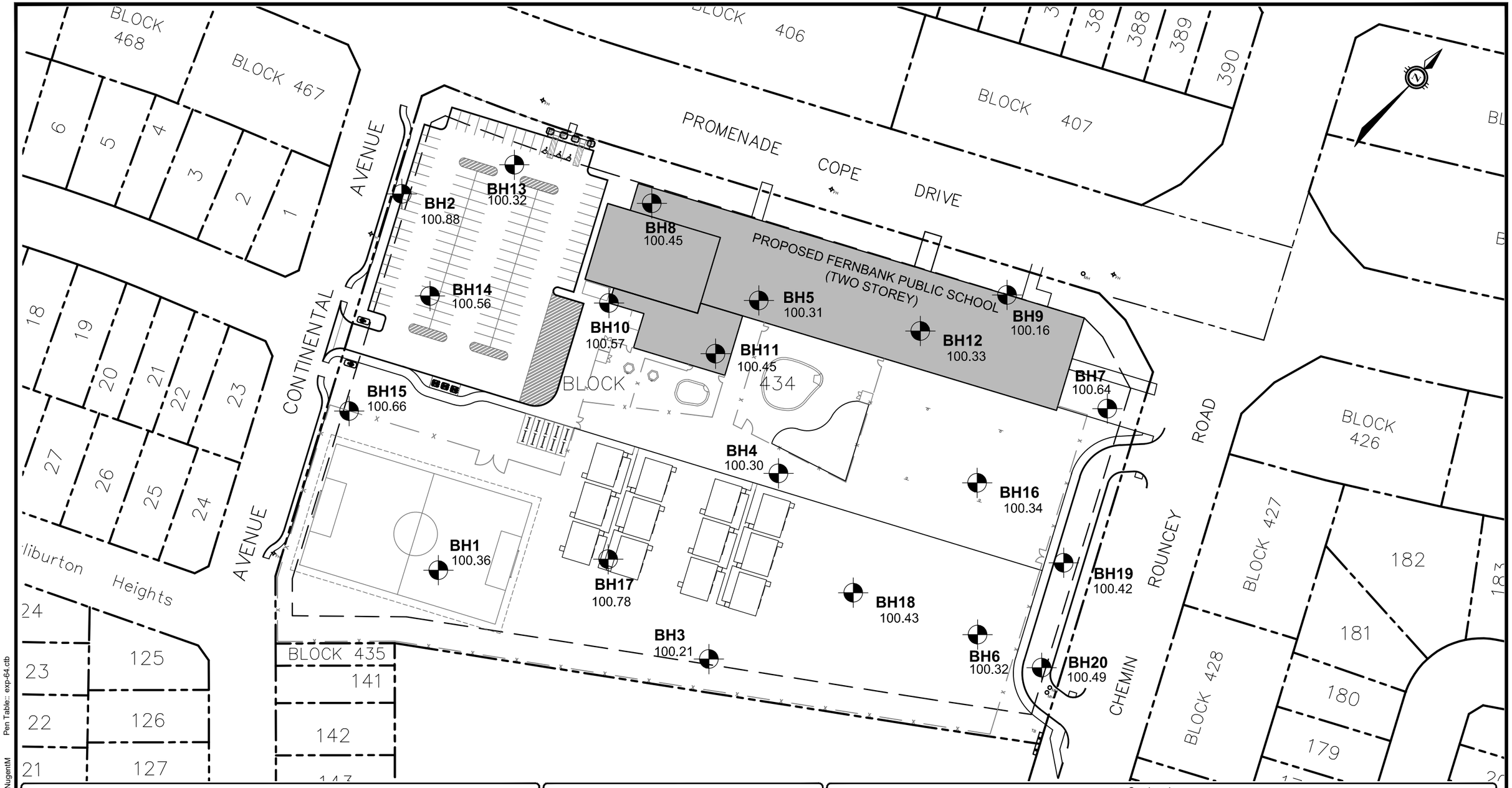

NOTES:

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 AND ROCK CORES WILL BE RETAINED IN STORAGE FOR THREE MONTHS AND THEN DESTROYED UNLESS THE CLIENT ADVISES THAT AN EXTENDED TIME PERIOD IS REQUIRED.*
3. *TOPSOIL QUANTITIES SHOULD NOT BE ESTABLISHED FROM THE INFORMATION PROVIDED AT THE BOREHOLE LOCATIONS.*
4. *BOREHOLE ELEVATIONS SHOULD NOT BE USED TO DESIGN BUILDING(S) OR FLOOR SLABS OR PARKING LOT(S) GRADES.*
5. *THIS DRAWING FORMS PART OF THE REPORT PROJECT NUMBER AS REFERENCED AND SHOULD BE USED ONLY IN CONJUNCTION WITH THIS REPORT.*
6. *BASE PLAN OBTAINED FROM AOV, PROJECT 19098, DATED SEPTEMBER 20, 2018. PROPOSED SCHOOL SITE PLAN OBTAINED FROM N45 ARCHITECTURE INC., OCTOBER 3, 2019.*

LEGEND

BH1
100.36

BOREHOLE NUMBER, LOCATION AND ELEVATION

0 10m 20m 40m

HORIZONTAL 1:1000

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scale: 1:1000	CLIENT: OTTAWA-CARLETON DISTRICT SCHOOL BOARD	project no.: OTT-00245378-K0
date: NOV., 2019	TITLE: BOREHOLE LOCATION PLAN PROPOSED FERNBANK PUBLIC SCHOOL COPE DRIVE & ROUNCEY ROAD, OTTAWA, ON	FIG 2
drawn by: A.O / M.N.		

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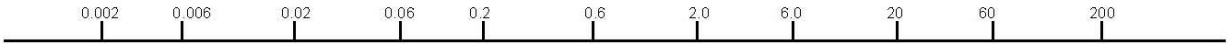
Notes On Sample Descriptions

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-00245378-K0

Project: Proposed Fernbank Public School

Location: Cope Drive and Rouncey Road, Ottawa, Ontario

Figure No. 3

Page. 1 of 1

Date Drilled: 'February 22, 2019

Drill Type: CME-55 Track Mounted Drill Rig

Datum: Geodetic Elevation

Logged by: AN Checked by: SKA

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	100.4	0	20 40 60 80 / 50 100 150 200 kPa	250 500 750 / 20 40 60	AS1	
		SILTY CLAY With oxidized stains, silt pockets, brown to grey, moist, (soft)	100.1		4		SS2	17.1
				1	3		SS3	
			98.1	2	28		SS4	
		GLACIAL TILL Silty sand with gravel, cobbles and boulders, grey, moist to wet, (very loose to compact)	97.75	3	17		SS5	
				4	3		SS6	
				5	8		SS7	
				6	20		SS8	23.3
			93.3	7	50/50mm		SS9	

Borehole Terminated at 7.1 m Depth

NOTES:

1.0) Dynamic Cone Penetration Test (DCPT) conducted adjacent to Borehole No.1 from ground surface to cone refusal at 7.1 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-00245378-K0

WATER LEVEL RECORDS		
Date	Water Level (m)	Hole Open To (m)
Completion	3.0	
11 days	2.7	

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

LOG OF BOREHOLE BH LOGS - 245378-K0.GPJ TROW OTTAWA.GDT 12/5/19

Log of Borehole BH-02

Project No: OTT-00245378-K0

Project: Proposed Fernbank Public School

Location: Cope Drive and Rouncey Road, Ottawa, Ontario

Figure No. 4

Page. 1 of 1

Date Drilled: 'February 25, 2019

Drill Type: CME-55 Track Mounted Drill Rig

Datum: Geodetic Elevation

Logged by: AN Checked by: SKA

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

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

GWL	SYMBOL	SOIL DESCRIPTION	Geodetic Elevation m	Depth	Standard Penetration Test N Value / Shear Strength kPa	Combustible Vapour Reading (ppm) / Natural Moisture Content % / Atterberg Limits (% Dry Weight)	SAMPLES	Natural Unit Wt. kN/m³
		FILL Silty sand with silty clay, some roots, brownish grey, moist	100.9	0			AS1	
			100.1					
		SILTY CLAY Brown, moist, (firm to stiff)		1	13		SS2	17.4
				2	6		SS3	16.9
			98.3		16		SS4	
		GLACIAL TILL Silty sand with gravel, cobbles and boulders, grey, moist, (compact)		3	25		SS5	
			97.2					
		Auger Refusal at 3.7 m Depth						

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

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-00245378-K0

WATER LEVEL RECORDS

Date	Water Level (m)	Hole Open To (m)
Completion	dry	
8 days	dry	

CORE DRILLING RECORD

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

LOG OF BOREHOLE BH LOGS - 245378-K0.GPJ TROW OTTAWA.GDT 12/5/19

Log of Borehole BH-03

Project No: OTT-00245378-K0

Project: Proposed Fernbank Public School

Location: Cope Drive and Rouncey Road, Ottawa, Ontario

Figure No. 5

Page. 1 of 1

Date Drilled: 'February 22, 2019

Drill Type: CME-55 Track Mounted Drill Rig

Datum: Geodetic Elevation

Logged by: AN Checked by: SKA

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	100.2	0			AS1	
		99.9						
		SILTY CLAY WIth dessicated silt pockets, sensitive, brown to grey, moist to wet, (very stiff)		1	4		SS2	18.9
				2	2		SS3	19.2
					110 s=6.6			
					2		SS4	
		97.4			48			
		SILTY CLAY Sensitive to extra-sensitive, grey to dark grey, wet, (firm)			Hammer Weis=6.7		SS5	
					Hammer Weight		SS6	
					43			
				5	Hammer Weis=5.1		SS7	
					43 s=6.0			
				6	Hammer Weight		SS8	
					48			
				7	s=48 7			
					Hammer Weig... s=10.0		SS9	
				8				
		91.0		9				
		Borehole Terminated at 9.2 m Depth						

LOG OF BOREHOLE BH LOGS - 245378-K0.GPJ TROW OTTAWA.GDT 12/5/19

NOTES:

1. Borehole data requires interpretation by EXP before use by others
2. Borehole backfilled upon completion of drilling.
3. Field work supervised by an EXP representative.
4. See Notes on Sample Descriptions
5. Log to be read with EXP Report OTT-00245378-K0

WATER LEVEL RECORDS		
Date	Water Level (m)	Hole Open To (m)
Completion	3.6	

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

Log of Borehole BH-04

Project No: OTT-00245378-K0

Project: Proposed Fernbank Public School

Location: Cope Drive and Rouncey Road, Ottawa, Ontario

Figure No. 6

Page. 1 of 1

Date Drilled: 'February 25, 2019

Drill Type: CME-55 Track Mounted Drill Rig

Datum: Geodetic Elevation

Logged by: AN Checked by: SKA

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
		SILTY CLAY With oxidized silt pockets, low plasticity, sensitive, brown, moist, (very stiff)	100.3	0	20 40 60 80 / 50 100 150 200 kPa	250 500 750 / 20 40 60	AS1	
				1	3		SS2	19.0
				2	2		SS3	18.7
			97.8		115 s=5.3			
		SILTY CLAY Low plasticity, sensitive to quick, grey to dark grey, moist to wet, (firm to stiff)		2	2 43 Hammer Weight		SS4	
			96.95		36 Hammer Ws=10.0		SS5	
					38 Hammer Ws=8.0		SS6	
				5	62 s=8.7		SS7	
				6	Hammer Weight		SS8	
				7	38 s=8.0			
				8	Hammer Weight		SS9	
					36 s=7.5			
				9				
				10				
				11	Hammer Weight 86 s=18.0		ST10	
				12				
			87.2	13				
		Auger Refusal at 13.1 m Depth						

LOG OF BOREHOLE BH LOGS - 245378-K0.GPJ TROW OTTAWA.GDT 12/5/19

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-00245378-K0

WATER LEVEL RECORDS		
Date	Water Level (m)	Hole Open To (m)
Completion	6.0	
8 days	3.4	

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

Log of Borehole BH-05

Project No: OTT-00245378-K0

Project: Proposed Fernbank Public School

Location: Cope Drive and Rouncey Road, Ottawa, Ontario

Figure No. 7

Page. 1 of 1

Date Drilled: 'February 21, 2019

Drill Type: CME-55 Track Mounted Drill Rig

Datum: Geodetic Elevation

Logged by: AN Checked by: SKA

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

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

GWL	SYMBOL	SOIL DESCRIPTION	Geodetic Elevation m	Depth	Standard Penetration Test N Value / Shear Strength kPa	Combustible Vapour Reading (ppm) / Natural Moisture Content % / Atterberg Limits (% Dry Weight)	SAMPLES	Natural Unit Wt. kN/m³
		FILL Silty sand with gravel and silty clay, brown, moist	100.3	0			AS1	
			99.6					
		SILTY CLAY With oxidized silt pockets, extra-sensitive, brown, moist, (stiff to very stiff)		1	3		SS2	
			98.4	2	2		SS3	19.4
					106 s=8.8			
				3	2		SS4	
					96 s=10.0			
			97.1		Hammer Weight		SS5	
		SILTY CLAY Extra-sensitive, grey to dark grey, moist to wet, (firm to stiff)			58 s=8.0			
					Hammer Weigh		SS6	
					46 s=9.8			
				5	Hammer Weig		SS7	
					48 s=10.0			
				6	Hammer Weight		SS8	
					48 s=10.0			
				7	43 s=9.0			
					Hammer Weight			
			92.2	8			SS9	
		Borehole Terminated at 8.1 m Depth						

LOG OF BOREHOLE BH LOGS - 245378-K0.GPJ TROW OTTAWA.GDT 12/5/19

NOTES:

1. Borehole data requires interpretation by EXP before use by others
2. Borehole backfilled upon completion of drilling.
3. Field work supervised by an EXP representative.
4. See Notes on Sample Descriptions
5. Log to be read with EXP Report OTT-00245378-K0

WATER LEVEL RECORDS		
Date	Water Level (m)	Hole Open To (m)
Completion	4.6	
11 days	1.9	

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

Log of Borehole BH-06

Project No: OTT-00245378-K0

Project: Proposed Fernbank Public School

Location: Cope Drive and Rouncey Road, Ottawa, Ontario

Figure No. 8

Page. 1 of 1

Date Drilled: 'February 22, 2019

Drill Type: CME-55 Track Mounted Drill Rig

Datum: Geodetic Elevation

Logged by: AN Checked by: SKA

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	100.3	0				
		SILTY CLAY With oxidized silt pockets, sensitive, brown, moist, (very stiff)	100.0				AS1	
				1	4		SS2	18.9
				2	2		SS3	19.1
					110 s=5.0			
			97.6		3		SS4	
		SILTY CLAY Sensitive, grey to dark grey, moist to wet, (firm to stiff)			62 Hammer Weight s=8.7		SS5	
					43 Hammer Weis=4.5		SS6	
					38 Hammer Ws=4.0		SS7	
			95.2	5	53 s=6.3			
				6	Hammer Weight		SS8	
				7	58 s=8.0			
					29 Hammer Weight s=6.0		SS9	
			92.2	8				
		Borehole Terminated at 8.1 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-00245378-K0

WATER LEVEL RECORDS		
Date	Water Level (m)	Hole Open To (m)
Completion	3.9	
12 days	5.1	

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

LOG OF BOREHOLE BH LOGS - 245378-K0.GPJ TROW OTTAWA.GDT 12/5/19

Log of Borehole BH-07

Project No: OTT-00245378-K0

Project: Proposed Fernbank Public School

Location: Cope Drive and Rouncey Road, Ottawa, Ontario

Figure No. 9

Page. 1 of 2

Date Drilled: 'February 21, 2019

Drill Type: CME-55 Track Mounted Drill Rig

Datum: Geodetic Elevation

Logged by: AN Checked by: SKA

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

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

GWL	SYMBOL	SOIL DESCRIPTION	Geodetic Elevation m	Depth	Standard Penetration Test N Value / Shear Strength kPa	Combustible Vapour Reading (ppm) / Natural Moisture Content % / Atterberg Limits (% Dry Weight)	SAMPLES	Natural Unit Wt. kN/m³
		FILL Silty sand with gravel dark brown, moist (frozen)	100.6	0			AS1	
			99.4	1	21		SS2	
		SILTY CLAY With oxidized silt pockets, sensitive to extra-sensitive, brown, moist, (stiff to very stiff)		2	2		SS3	
					106 s=6.3			
					1 96		SS4	19.2
			97.75	3	s=10			
			97.4		1		SS5	18.5
		SILTY CLAY Sensitive, grey to dark grey, moist to wet, (firm to stiff)			53 s=5.5			
				4	1 48		SS6	
					Hammer Weis s=6.7			
				5	43 s=6		SS7	
				6	Hammer Weight			
					46 s=4.8		SS8	
				7	36 s=7.5			
			92.6	8				
		INFERRED SILTY CLAY Dynamic Cone Penertation Test (DCPT) conducted from 7.9 m to cone refusal at 18.8 m depth		9				
				10				
				11				
				12				
				13				
				14				
				15				

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-00245378-K0

WATER LEVEL RECORDS

Date	Water Level (m)	Hole Open To (m)
Completion	4.8	
12 days	2.9	

CORE DRILLING RECORD

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

LOG OF BOREHOLE BH LOGS - 245378-K0.GPJ TROW OTTAWA.GDT 12/5/19

Log of Borehole BH-07

Project No: OTT-00245378-K0

Project: Proposed Fernbank Public School

Figure No. 9

Page. 2 of 2

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
		INFERRED SILTY CLAY Dynamic Cone Penertation Test (DCPT) conducted from 7.9 m to cone refusal at 18.8 m depth *(continued)*	85.6	15 16 17 18	20 40 60 80 Shear Strength kPa 50 100 150 200	250 500 750 Natural Moisture Content % Atterberg Limits (% Dry Weight) 20 40 60		
		INFERRED GLACIAL TILL	82.4					
		Cone Refusal at 18.8 m Depth	81.8					

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-00245378-K0

WATER LEVEL RECORDS

Date	Water Level (m)	Hole Open To (m)
Completion	4.8	
12 days	2.9	

CORE DRILLING RECORD

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

LOG OF BOREHOLE BH LOGS - 245378-K0.GPJ TROW OTTAWA.GDT 12/5/19

Log of Borehole BH-08

Project No: OTT-00245378-K0

Project: Proposed Fernbank Public School

Location: Cope Drive and Rouncey Road, Ottawa,Ontario

Figure No. 10

Page. 1 of 1

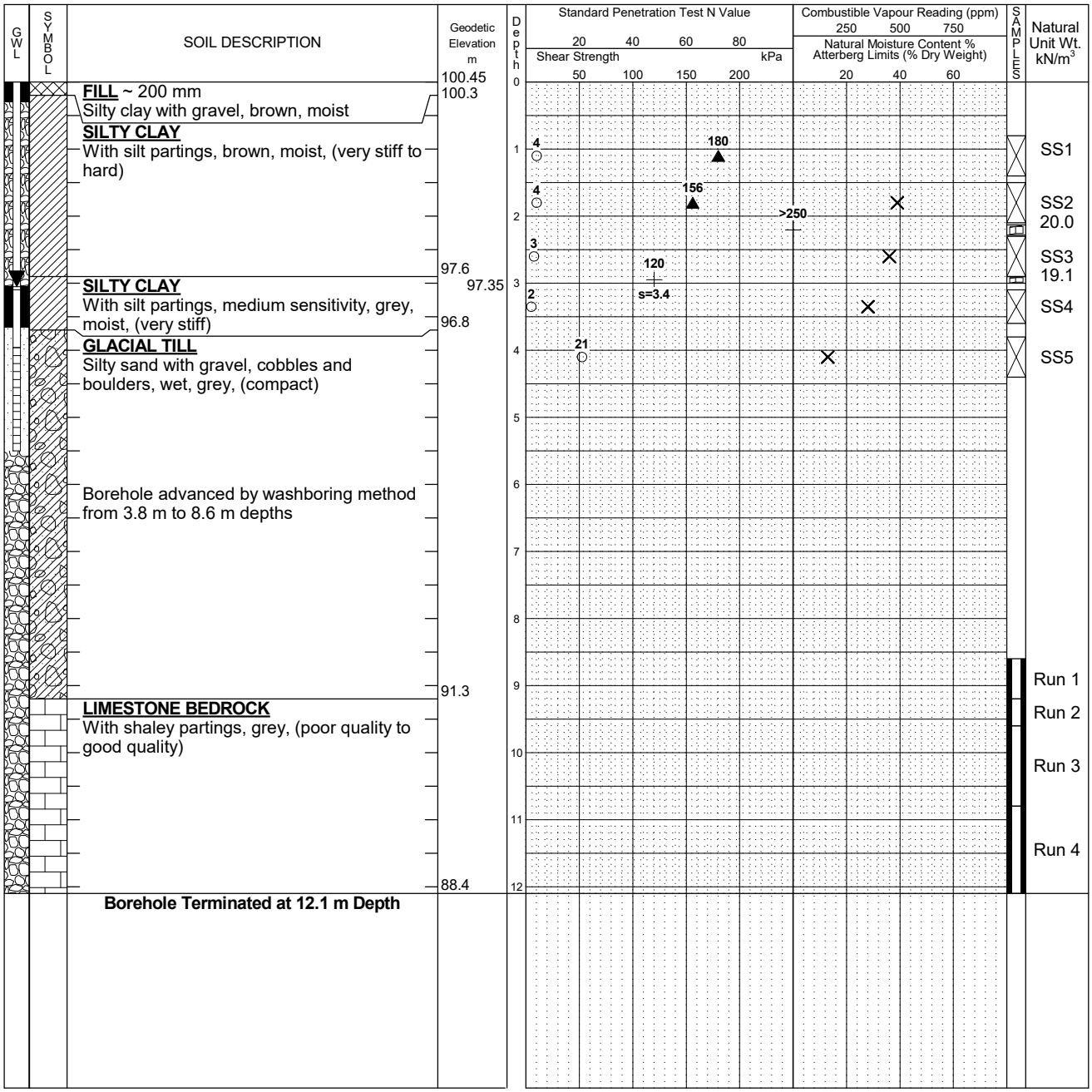
Date Drilled: `October 25, 2019

Drill Type: CME-850 Track Mounted Drill Rig

Datum: Geodetic Elevation

Logged by: ML Checked by: SP

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



LOG OF BOREHOLE 245378-K0 - BH8 - BH20.GPJ TROW OTTAWA.GDT 12/5/19

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-00245378-K0

WATER LEVEL RECORDS		
Date	Water Level (m)	Hole Open To (m)
18 days	3.1	
18 days	3.1	

CORE DRILLING RECORD			
Run No.	Depth (m)	% Rec.	RQD %
1	8.6 - 9.2	15	0
2	9.2 - 9.6	94	29
3	9.6 - 10.8	96	48
4	10.8 - 12.1	100	75

Log of Borehole BH-09

Project No: OTT-00245378-K0

Project: Proposed Fernbank Public School

Location: Cope Drive and Rouncey Road, Ottawa,Ontario

Figure No. 11

Page. 1 of 1

Date Drilled: `October 23, 2019

Drill Type: CME-850 Track Mounted Drill Rig

Datum: Geodetic Elevation

Logged by: ML Checked by: SP

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

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

GWL	SYMBOL	SOIL DESCRIPTION	Geodetic Elevation m	Depth	Standard Penetration Test N Value / Shear Strength kPa	Combustible Vapour Reading (ppm) / Natural Moisture Content % / Atterberg Limits (% Dry Weight)	SAMPLES	Natural Unit Wt. kN/m³
		FILL ~ 100 mm Silty clay with gravel, brown, wet	100.16 100.1	0				
		SILTY CLAY With silt partings, medium sensitivity to sensitive, brown, moist, (very stiff)		1 2	2 120 s=4.8 2 130 s=3.7		SS1 SS2	18.2 16.5
			97.4	3	1 43 Hammer Wei s=3.6		SS3	
		SILTY CLAY With silt partings, medium sensitivity, grey, wet, (firm)		4	30 Hammer V s=3.0		SS4	
				5	34 Hammer W s=2.3		SS5	
				6	38 s=3.2 Hammer Weight		SS6	
				7	38 s=4.0		SS7	
				8			ST8	
				9	Hammer Weight 34 s=4.0		SS9	
			91.1					
		Borehole Terminated at 9.1 m Depth						

LOG OF BOREHOLE 245378-K0 - BH8 - BH20.GPJ TROW OTTAWA.GDT 12/5/19

NOTES:

1. Borehole data requires interpretation by EXP before use by others
2. Borehole backfilled upon completion of drilling.
3. Field work supervised by an EXP representative.
4. See Notes on Sample Descriptions
5. Log to be read with EXP Report OTT-00245378-K0

WATER LEVEL RECORDS		
Date	Water Level (m)	Hole Open To (m)

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

Log of Borehole BH-10

Project No: OTT-00245378-K0

Project: Proposed Fernbank Public School

Location: Cope Drive and Rouncey Road, Ottawa,Ontario

Figure No. 12

Page. 1 of 1

Date Drilled: `October 25, 2019

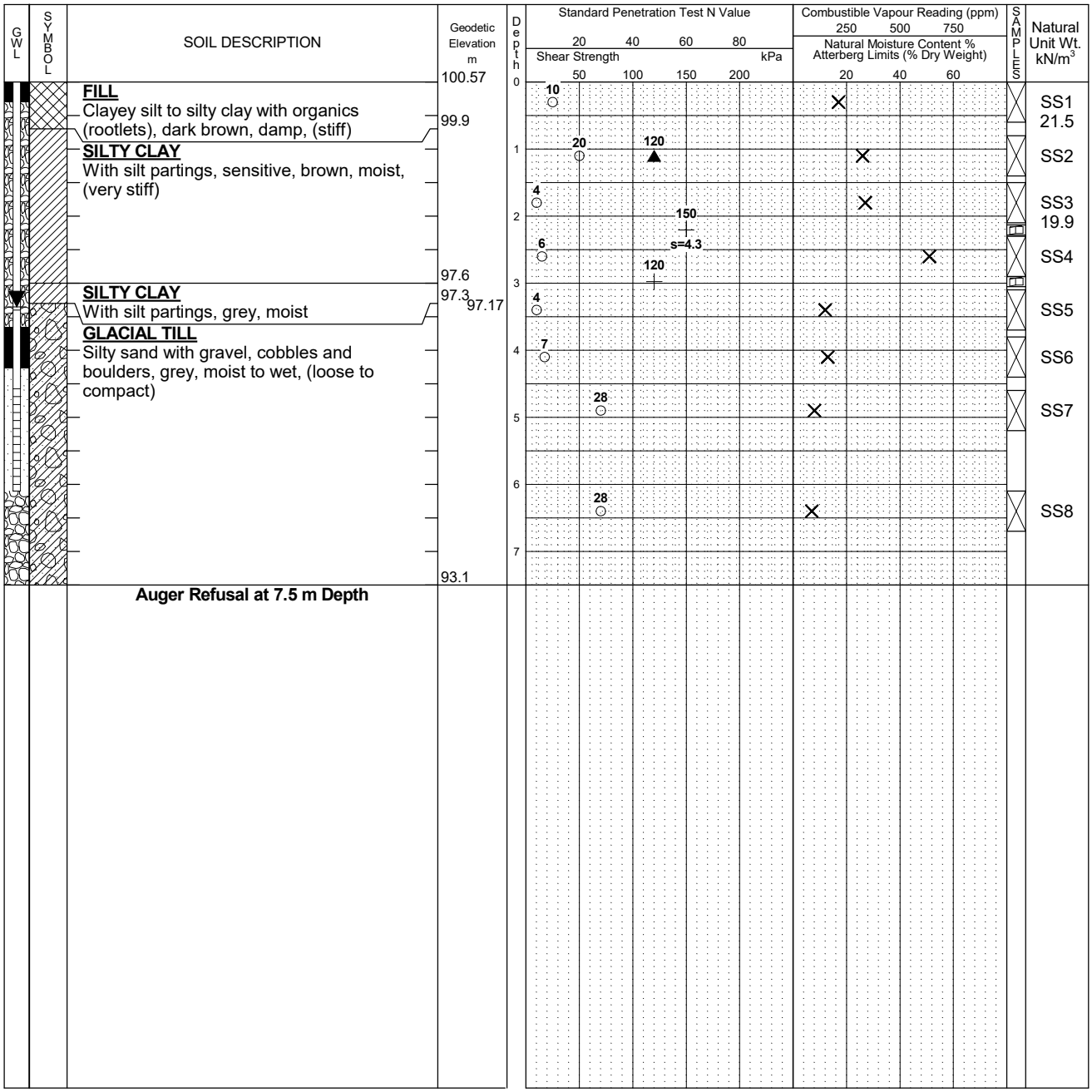
Drill Type: CME-850 Track Mounted Drill Rig

Datum: Geodetic Elevation

Logged by: ML Checked by: SP

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 ▲



LOG OF BOREHOLE 245378-K0 - BH8 - BH20.GPJ TROW OTTAWA.GDT 12/5/19

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-00245378-K0

WATER LEVEL RECORDS		
Date	Water Level (m)	Hole Open To (m)
On Completion	5.5	7.3
18 days	3.4	

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

Log of Borehole BH-11

Project No: OTT-00245378-K0

Project: Proposed Fernbank Public School

Location: Cope Drive and Rouncey Road, Ottawa,Ontario

Figure No. 13

Page. 1 of 1

Date Drilled: `October 22, 2019

Drill Type: CME-850 Track Mounted Drill Rig

Datum: Geodetic Elevation

Logged by: ML Checked by: SP

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
	FILL Silty clay with sand and organics (rootlets), brown, damp. (stiff)	100.45	0
	SILTY CLAY With silt partings, low plasticity, sensitive, brown, moist, (very stiff)	99.8	1
			2
		97.5	3
	SILTY CLAY With silt partings, sensitive, grey, moist to wet, (firm to stiff)		
▼		91.35	9
	Dynamic cone penetration test (DCPT) conducted from 10.4 m to cone refusal at 12.3 m depth	90.4	10
		88.2	12
	Cone Refusal at 12.3 m Depth		

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

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

Depth	SPT N	Shear Strength	Sample	Natural Unit Wt. kN/m³
0	11		SS1	20.8
1	9		SS2	
2	2		SS3	16.6
2	2	160 s=6.4	SS4	
3	1	125 s=5.6	SS5	
	Hammer Weight	77 s=8.0	SS6	
5	29	Hammer Vs=8.0	SS7	
6	26	s=7.3	ST8	
7	34	s=7.0		
8	Hammer Weight		SS9	
9	48	s=4.0		
10	Hammer Weight		SS10	
11	67	s=4.0		

NOTES:

1. Borehole data requires interpretation by EXP before use by others
2. Borehole backfilled upon completion of drilling.
3. Field work supervised by an EXP representative.
4. See Notes on Sample Descriptions
5. Log to be read with EXP Report OTT-00245378-K0

WATER LEVEL RECORDS

Date	Water Level (m)	Hole Open To (m)
On Completion	6.1	9.1

CORE DRILLING RECORD

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

LOG OF BOREHOLE 245378-K0 - BH8 - BH20.GPJ TROW OTTAWA.GDT 12/5/19

Log of Borehole BH-12

Project No: OTT-00245378-K0

Project: Proposed Fernbank Public School

Location: Cope Drive and Rouncey Road, Ottawa,Ontario

Figure No. 14

Page. 1 of 2

Date Drilled: `October 23, 2019

Drill Type: CME-850 Track Mounted Drill Rig

Datum: Geodetic Elevation

Logged by: ML Checked by: SP

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

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

GWL	SYMBOL	SOIL DESCRIPTION	Geodetic Elevation m	Depth	Standard Penetration Test N Value / Shear Strength kPa	Combustible Vapour Reading (ppm) / Natural Moisture Content % / Atterberg Limits (% Dry Weight)	SAMPLES	Natural Unit Wt. kN/m³
		FILL Silty clay with wood debris and organics (rootlets), bown to dark brown, moist, (firm)	100.33	0	6		SS1	18.5
			99.6	1	3		SS2	
		SILTY CLAY With silt partings, sensitive, brown, moist to wet, (firm to stiff)			96 s=5.0			
				2	1		SS3	18.0
					1		SS4	
			97.43	3	82 s=8.5			
		SILTY CLAY With silt partings, low plasticity, sensitive, grey, wet, (soft to stiff)	97.0					
				4			ST5	
					48 s=5.0			
				5	Hammer Weight			
				6	58 s=6.0		SS6	
				7				
				8	Hammer Weight		SS7	
					24 s=4.0			
				9			ST8	
				10	43 s=6.0			
				11	Hammer Weight		SS9	
					72 s=6.0			
				12	Hammer Weight		SS10	
				13	26			
				14	Hammer Weight		SS11	
					62 s=4.3			
			85.4	15				

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-00245378-K0

WATER LEVEL RECORDS

Date	Water Level (m)	Hole Open To (m)
On Completion	N/A	14.6
20 days	2.9	

CORE DRILLING RECORD

Run No.	Depth (m)	% Rec.	RQD %
1	17.7 - 18.5	96	46
2	18.5 - 19.8	88	23

LOG OF BOREHOLE 245378-K0 - BH8 - BH20.GPJ TROW OTTAWA.GDT 12/5/19

Log of Borehole BH-12

Project No: OTT-00245378-K0

Project: Proposed Fernbank Public School

Figure No. 14

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
		GLACIAL TILL Silty sand with gravel, cobbles and boulders, grey, wet, (compact to very dense) *(continued)*	85.33	15	13		SS12	
				16				
				17	95		SS13	
			82.5	18			Run 1	
		LIMESTONE BEDROCK With shaley partings, grey, (very poor quality to poor quality)		19			Run 2	
			80.5					
		Borehole Terminated at 19.8 m Depth						

Standard Penetration Test N Value: 20 40 60 80

Shear Strength kPa: 50 100 150 200

Combustible Vapour Reading (ppm): 250 500 750

Natural Moisture Content % / Atterberg Limits (% Dry Weight): 20 40 60

SAMPLES

Natural Unit Wt. kN/m³

LOG OF BOREHOLE 245378-K0 - BH8 - BH20.GPJ TROW OTTAWA.GDT 12/5/19

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-00245378-K0

WATER LEVEL RECORDS

Date	Water Level (m)	Hole Open To (m)
On Completion	N/A	14.6
20 days	2.9	

CORE DRILLING RECORD

Run No.	Depth (m)	% Rec.	RQD %
1	17.7 - 18.5	96	46
2	18.5 - 19.8	88	23

Log of Borehole BH-13

Project No: OTT-00245378-K0

Project: Proposed Fernbank Public School

Location: Cope Drive and Rouncey Road, Ottawa,Ontario

Figure No. 15

Page. 1 of 1

Date Drilled: `October 22, 2019

Drill Type: CME-850 Track Mounted Drill Rig

Datum: Geodetic Elevation

Logged by: ML Checked by: SP

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
			100.32		20 40 60 80 / 50 100 150 200	250 500 750 / 20 40 60		
		FILL ~ 100 mm Silty clay with sand and gravel, brown, moist	100.2	0	8 ○ ; 192 ▲	×	SS1	19.2
		SILTY CLAY With silt partings, brown, moist, (very stiff)	98.9	1	7 ○ ; 144 ▲	×	SS2	17.7
		GLACIAL TILL Silty sand with gravel, cobbles and boulders, brown, moist, (compact to dense)		2	10 ○	×	SS3	
			97.3	3	33 ○	×	SS4	
▼		**GLACIAL TILL** Silty sand with gravel, cobbles and boulders, grey, moist, (compact to dense)	96.32	4	20 ⊕	×	SS5	
			95.9		34 ○	×	SS6	
		Borehole Terminated at 4.4 m Depth						

LOG OF BOREHOLE 245378-K0 - BH8 - BH20.GPJ TROW OTTAWA.GDT 12/5/19

NOTES:

1. Borehole data requires interpretation by EXP before use by others
2. Borehole backfilled upon completion of drilling.
3. Field work supervised by an EXP representative.
4. See Notes on Sample Descriptions
5. Log to be read with EXP Report OTT-00245378-K0

WATER LEVEL RECORDS

Date	Water Level (m)	Hole Open To (m)
On Completion	4.0	4.3

CORE DRILLING RECORD

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

Log of Borehole BH-14

Project No: OTT-00245378-K0

Project: Proposed Fernbank Public School

Location: Cope Drive and Rouncey Road, Ottawa,Ontario

Figure No. 16

Page. 1 of 1

Date Drilled: `October 22, 2019

Drill Type: CME-850 Track Mounted Drill Rig

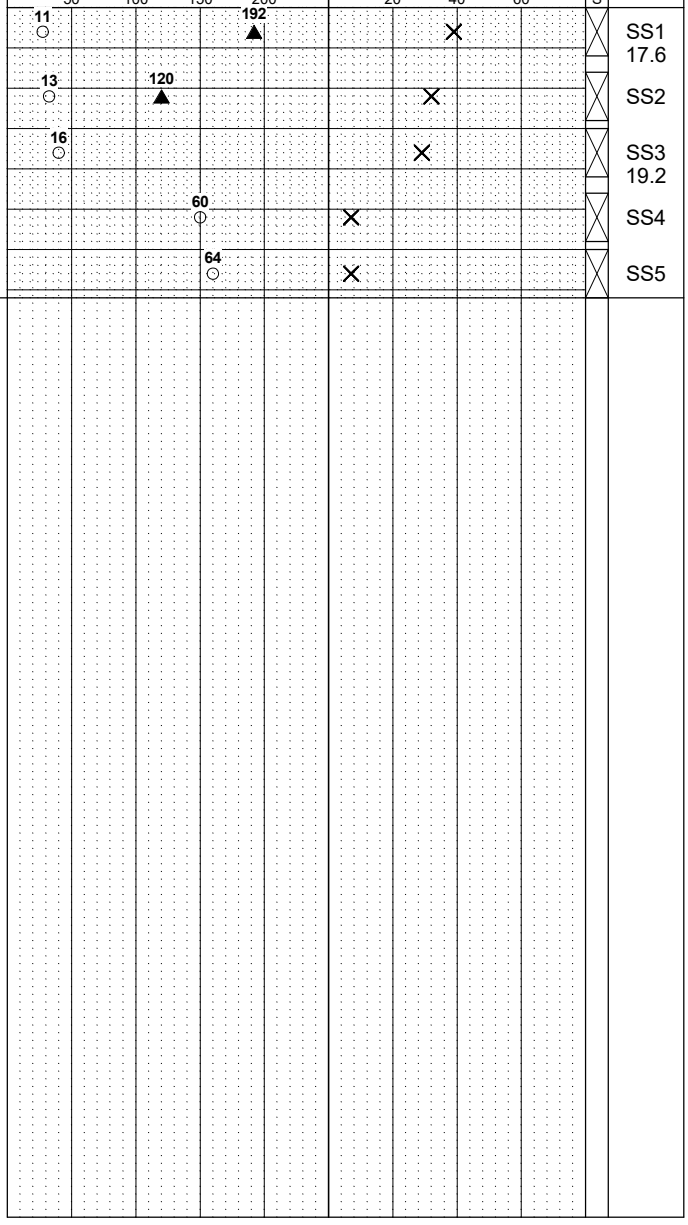
Datum: Geodetic Elevation

Logged by: ML Checked by: SP

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

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

GWL	SYMBOL	SOIL DESCRIPTION	Geodetic Elevation m	Depth	Standard Penetration Test N Value / Shear Strength kPa	Combustible Vapour Reading (ppm) / Natural Moisture Content % / Atterberg Limits (% Dry Weight)	SAMPLES	Natural Unit Wt. kN/m³
		FILL ~ 100 mm	100.56	0				
		Sllty clay with sand and gravel, brown to black, moist	100.5					
		TOPSOIL ~ 100 mm	100.4					
		SILTY CLAY With silt partings, brown, moist, (very stiff)		1				
			98.4	2				
		GLACIAL TILL Silty sand with gravel, cobbles and boulders, brown, moist, (very dense)		3				
			97.0					
		Borehole Terminated at 3.6 m Depth						



NOTES:

1. Borehole data requires interpretation by EXP before use by others
2. Borehole backfilled upon completion of drilling.
3. Field work supervised by an EXP representative.
4. See Notes on Sample Descriptions
5. Log to be read with EXP Report OTT-00245378-K0

WATER LEVEL RECORDS

Date	Water Level (m)	Hole Open To (m)
On Completion	Dry	2.7

CORE DRILLING RECORD

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

LOG OF BOREHOLE 245378-K0 - BH8 - BH20.GPJ TROW OTTAWA.GDT 12/5/19

Log of Borehole BH-15

Project No: OTT-00245378-K0

Project: Proposed Fernbank Public School

Location: Cope Drive and Rouncey Road, Ottawa,Ontario

Figure No. 17

Page. 1 of 1

Date Drilled: `October 28, 2019

Drill Type: CME-850 Track Mounted Drill Rig

Datum: Geodetic Elevation

Logged by: ML Checked by: SP

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

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

GWL	SYMBOL	SOIL DESCRIPTION	Geodetic Elevation m	Depth	Standard Penetration Test N Value / Shear Strength kPa	Combustible Vapour Reading (ppm) / Natural Moisture Content % / Atterberg Limits (% Dry Weight)	SAMPLES	Natural Unit Wt. kN/m³
		FILL Silty clay with sand and gravel, brown, moist	100.66	0				
		GLACIAL TILL Silty sand with gravel, cobbles and boulders, brown, moist, (compact to very dense)	100.1	1	14	×	SS1	22.9
				2	52	×	SS2	23.3
		GLACIAL TILL Silty sand with gravel, cobbles and boulders, grey, moist, (compact to dense)	98.5	2	23	×	SS3	
			98.06	3	31	×	SS4	
		Borehole Terminated at 3.6 m Depth	97.1					

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

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-00245378-K0

WATER LEVEL RECORDS

Date	Water Level (m)	Hole Open To (m)
On Completion	Dry	3.6
15 days	2.6	

CORE DRILLING RECORD

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

LOG OF BOREHOLE 245378-K0 - BH8 - BH20.GPJ TROW OTTAWA.GDT 12/5/19

Log of Borehole BH-16

Project No: OTT-00245378-K0

Project: Proposed Fernbank Public School

Location: Cope Drive and Rouncey Road, Ottawa,Ontario

Figure No. 18

Page. 1 of 1

Date Drilled: `October 22, 2019

Drill Type: CME-850 Track Mounted Drill Rig

Datum: Geodetic Elevation

Logged by: ML Checked by: SP

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

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

GWL	SYMBOL	SOIL DESCRIPTION	Geodetic Elevation m	Depth	Standard Penetration Test N Value / Shear Strength kPa	Combustible Vapour Reading (ppm) / Natural Moisture Content % / Atterberg Limits (% Dry Weight)	SAMPLES	Natural Unit Wt. kN/m³
		FILL Silty clay with gravel and organics (rootlets), dark brown to black, moist, (stiff)	100.34	0	9		SS1	19.9
			99.6					
		SILTY CLAY With silt partings, sensitive, brown, moist, (stiff to very stiff)		1	6		SS2	
				2	2		SS3	
					110 s=5.5			
					1		SS4	
				3	80 s=5.3			
			96.6 96.84		1		SS5	
		SILTY CLAY WIth silt partings, sensitive, grey, wet, (firm)		4	34 s=7.0		ST6	
			95.6		38 s=5.3			
		Borehole Terminated at 4.7 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-00245378-K0

WATER LEVEL RECORDS

Date	Water Level (m)	Hole Open To (m)
On Completion	3.4	4.3
21 days	3.5	

CORE DRILLING RECORD

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

LOG OF BOREHOLE 245378-K0 - BH8 - BH20.GPJ TROW OTTAWA.GDT 12/5/19

Log of Borehole BH-17

Project No: OTT-00245378-K0

Project: Proposed Fernbank Public School

Location: Cope Drive and Rouncey Road, Ottawa,Ontario

Figure No. 19

Page. 1 of 1

Date Drilled: `October 22, 2019

Drill Type: CME-850 Track Mounted Drill Rig

Datum: Geodetic Elevation

Logged by: ML Checked by: SP

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
		SILTY CLAY WIth silt partings, sensitive, brown, moist to wet, (firm to very stiff)	100.78	0	20 40 60 80 / 50 100 150 200	250 500 750 / 20 40 60		
				1	4 ○ 144 ▲ 135 + s=5.4	×	SS1	19.5
				2	4 ○ 115 + s=6.6	×	SS2	
				3	1 ○ 110 + s=6.6	×	SS3	18.7
		SILTY CLAY With silt partings, sensitive, grey, wet, (firm)	97.5		Hammer Weight			
				4	48 + s=6.7	×	SS4	
					Hammer Weig...		SS5	
			95.9		38 + s=6.4			
		Borehole Terminated at 4.9 m Depth						

NOTES:
1. Borehole data requires interpretation by EXP before use by others
2. Borehole backfilled upon completion of drilling.
3. Field work supervised by an EXP representative.
4. See Notes on Sample Descriptions
5. Log to be read with EXP Report OTT-00245378-K0

WATER LEVEL RECORDS		
Date	Water Level (m)	Hole Open To (m)
On Completion	3.6	4.6

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

LOG OF BOREHOLE 245378-K0 - BH8 - BH20.GPJ TROW OTTAWA.GDT 12/5/19

Log of Borehole BH-18

Project No: OTT-00245378-K0

Project: Proposed Fernbank Public School

Location: Cope Drive and Rouncey Road, Ottawa,Ontario

Figure No. 20

Page. 1 of 1

Date Drilled: `October 28, 2019

Drill Type: CME-850 Track Mounted Drill Rig

Datum: Geodetic Elevation

Logged by: ML Checked by: SP

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

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

GWL	SYMBOL	SOIL DESCRIPTION	Geodetic Elevation m	Depth	Standard Penetration Test N Value / Shear Strength kPa	Combustible Vapour Reading (ppm) / Natural Moisture Content % / Atterberg Limits (% Dry Weight)	SAMPLES	Natural Unit Wt. kN/m³
		FILL Silty clay with shale pieces, dark brown, moist, (soft)	100.43	0	2		SS1	20.0
			99.7	1	6		SS2	
		SILTY CLAY With silt partings, medium sensitivity to sensitive, brown, moist to wet, (very stiff)		2	5; 110; s=3.1; 4		SS3	19.4
							SS4	
			97.2	3	130; s=4.3			
		Borehole Terminated at 3.2 m Depth						

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

NOTES:
1. Borehole data requires interpretation by EXP before use by others
2. Borehole backfilled upon completion of drilling.
3. Field work supervised by an EXP representative.
4. See Notes on Sample Descriptions
5. Log to be read with EXP Report OTT-00245378-K0

WATER LEVEL RECORDS

Date	Water Level (m)	Hole Open To (m)
On Completion	Dry	1.8

CORE DRILLING RECORD

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

LOG OF BOREHOLE 245378-K0 - BH8 - BH20.GPJ TROW OTTAWA.GDT 12/5/19

Log of Borehole BH-19

Project No: OTT-00245378-K0

Project: Proposed Fernbank Public School

Location: Cope Drive and Rouncey Road, Ottawa,Ontario

Figure No. 21

Page. 1 of 1

Date Drilled: `October 28, 2019

Drill Type: CME-850 Track Mounted Drill Rig

Datum: Geodetic Elevation

Logged by: ML Checked by: SP

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

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

GWL	SYMBOL	SOIL DESCRIPTION	Geodetic Elevation m	Depth	Standard Penetration Test N Value / Shear Strength kPa	Combustible Vapour Reading (ppm) / Natural Moisture Content % / Atterberg Limits (% Dry Weight)	SAMPLES	Natural Unit Wt. kN/m³
		FILL Sandy silt to silty clay with gravel and organcis (rootlets), dark brown, moist, (loose/firm)	100.42	0	4		SS1	19.9
		SANDY SILT With clay, brown, moist, (compact)	99.8	1	10		SS2	
		SILTY CLAY With silt partings, sensitive, brown, moist to wet, (very stiff)	99.0	2	2; 150 s=4.3		SS3	
					2; 100 s=4.0		SS4	
		Borehole Terminated at 3.2 m Depth	97.2	3				

Standard Penetration Test N Value: 20 40 60 80
Shear Strength kPa: 50 100 150 200
Combustible Vapour Reading (ppm): 250 500 750
Natural Moisture Content % / Atterberg Limits (% Dry Weight): 20 40 60

NOTES:

1. Borehole data requires interpretation by EXP before use by others
2. Borehole backfilled upon completion of drilling.
3. Field work supervised by an EXP representative.
4. See Notes on Sample Descriptions
5. Log to be read with EXP Report OTT-00245378-K0

WATER LEVEL RECORDS

Date	Water Level (m)	Hole Open To (m)
On Completion	Dry	2.1

CORE DRILLING RECORD

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

LOG OF BOREHOLE 245378-K0 - BH8 - BH20.GPJ TROW OTTAWA.GDT 12/5/19

Log of Borehole BH-20

Project No: OTT-00245378-K0

Project: Proposed Fernbank Public School

Location: Cope Drive and Rouncey Road, Ottawa,Ontario

Figure No. 22

Page. 1 of 1

Date Drilled: `October 28, 2019

Drill Type: CME-850 Track Mounted Drill Rig

Datum: Geodetic Elevation

Logged by: ML Checked by: SP

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

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

GWL	SYMBOL	SOIL DESCRIPTION	Geodetic Elevation m	Depth	Standard Penetration Test N Value / Shear Strength kPa	Combustible Vapour Reading (ppm) / Natural Moisture Content % / Atterberg Limits (% Dry Weight)	SAMPLES	Natural Unit Wt. kN/m³
		FILL Silty clay with gravel, brown, moist, (stiff)	100.49	0	8		SS1	
			99.6					
		CLAYEY SILT Brown, moist, (firm)	99.0	1	6		SS2	
		SILTY CLAY With silt partings, sensitive, brown, moist to wet, (very stiff)		2	2; 120 s=4.8		SS3	18.8
					2; 100 s=5.0		SS4	
			97.3	3				
		Borehole Terminated at 3.2 m Depth						

Standard Penetration Test N Value: 20 40 60 80

Shear Strength kPa: 50 100 150 200

Combustible Vapour Reading (ppm): 250 500 750

Natural Moisture Content % Atterberg Limits (% Dry Weight): 20 40 60

NOTES:

1. Borehole data requires interpretation by EXP before use by others
2. Borehole backfilled upon completion of drilling.
3. Field work supervised by an EXP representative.
4. See Notes on Sample Descriptions
5. Log to be read with EXP Report OTT-00245378-K0

WATER LEVEL RECORDS

Date	Water Level (m)	Hole Open To (m)
On Completion	Dry	2.4

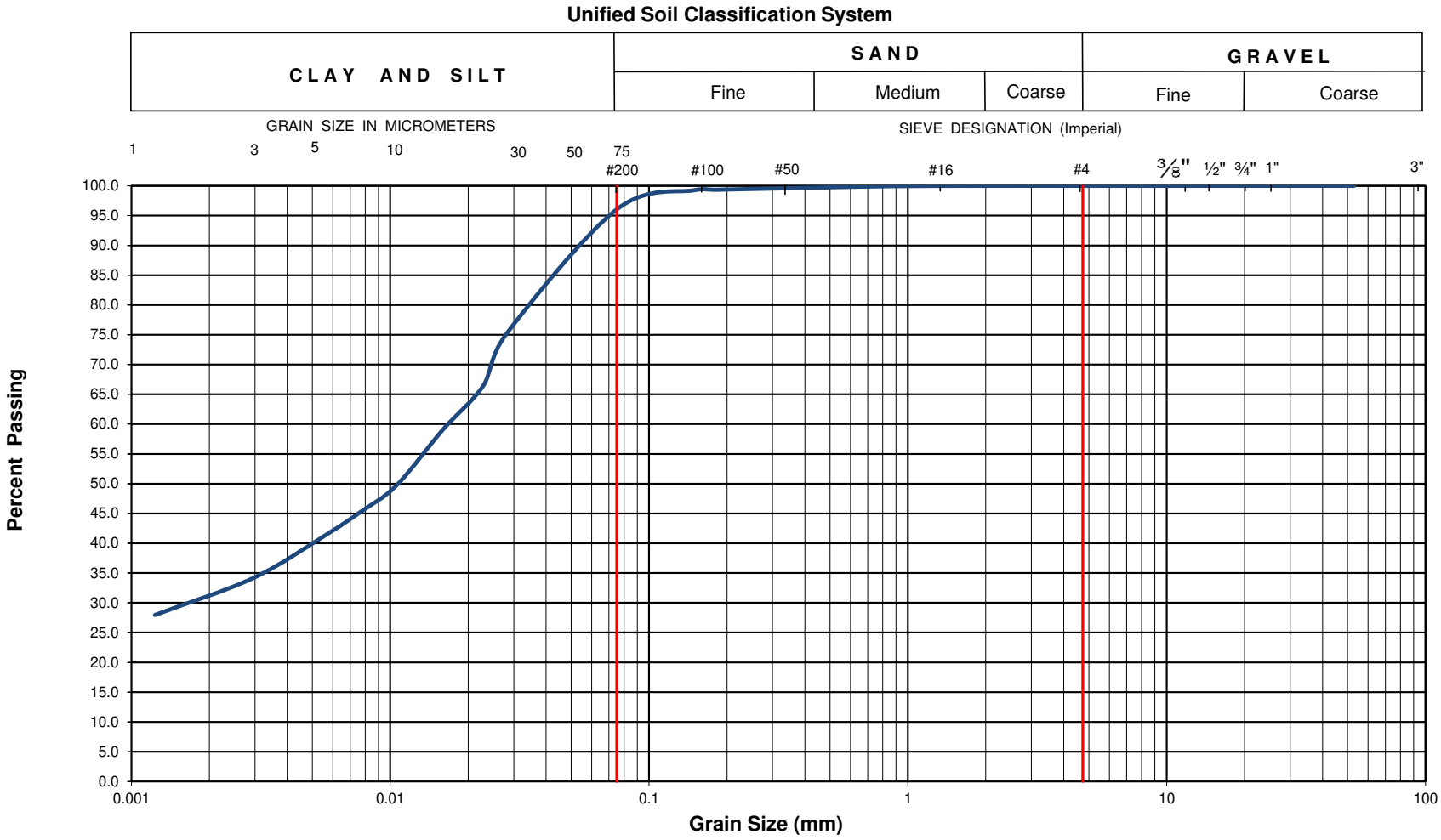
CORE DRILLING RECORD

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

LOG OF BOREHOLE 245378-K0 - BH8 - BH20.GPJ TROW OTTAWA.GDT 12/5/19

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

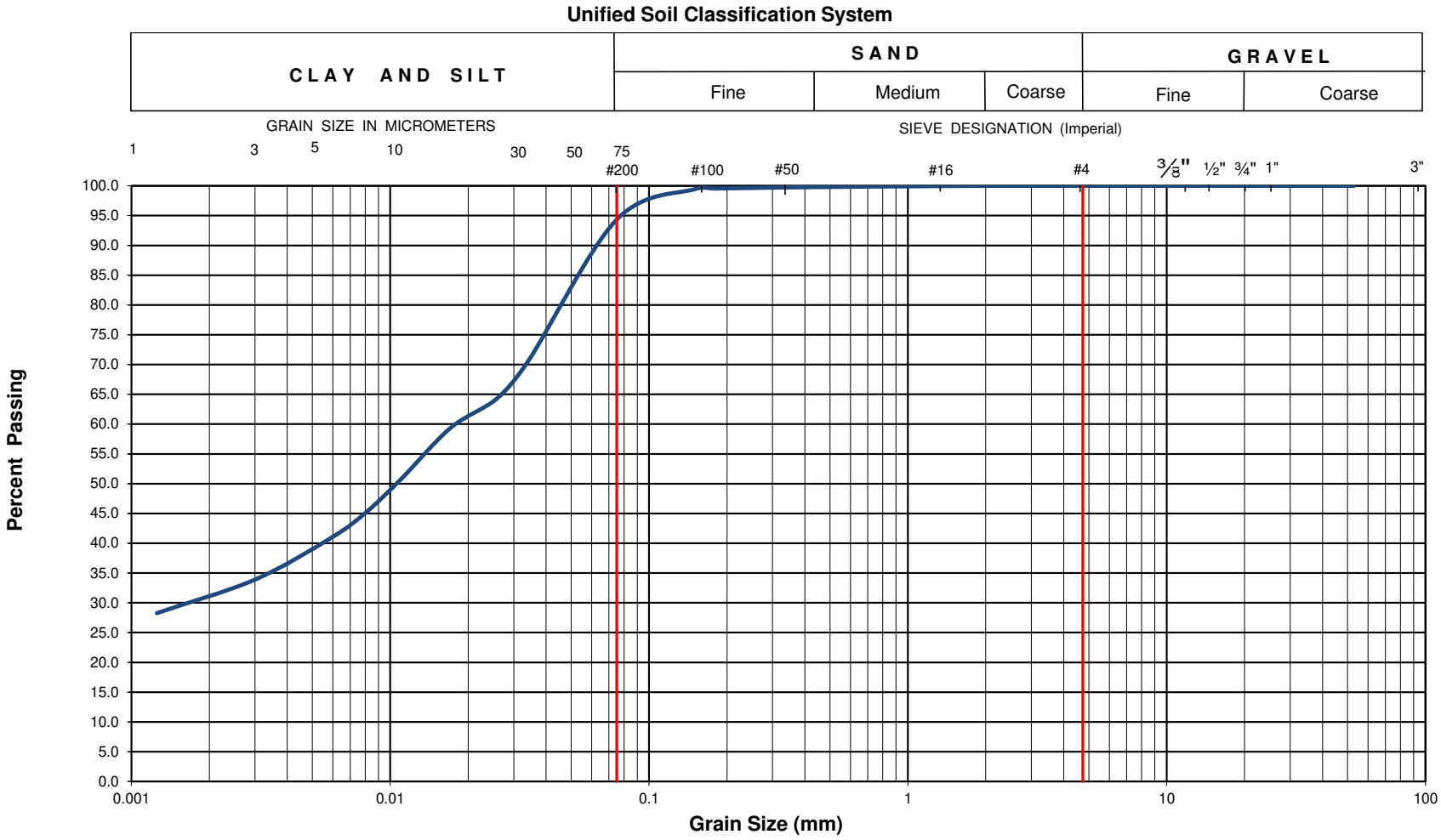
Grain-Size Distribution Curve
Method of Test For Particle Size Analysis of Soil
ASTM C-136/ASTM D422



EXP Project No.:	**OTT-00245378-K0**	**Project Name :**	**Proposed Fernbank Public School**						
Client :	**OCDSB**	**Project Location :**	**Cope Drive and Rouncey Road, Ottawa, ON.**						
Date Sampled :	**February 25, 2019**	**Borehole No:**	**4**		**Sample No.:**	**SS3**		**Depth (m) :**	**1.5-2.0**
Sample Description :		**% Silt and Clay**	**96**	**% Sand**	**4**	**% Gravel**	**0**	**Figure :**	**23**
Sample Description :		**Brown Silty Clay of Low Plasticity (CL)**							

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

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



EXP Project No.:	**OTT-00245378-K0**	**Project Name :**	**Proposed Fernbank Public School**						
Client :	**OCDSB**	**Project Location :**	**Cope Drive and Rouncey Road, Ottawa, ON.**						
Date Sampled :	**October 22, 2019**	**Borehole No:**	**11**	**Sample No.:**	**SS3**	**Depth (m) :**	**1.5-2.1**		
Sample Description :		**% Silt and Clay**	**94**	**% Sand**	**6**	**% Gravel**	**0**	**Figure :**	**24**
Sample Description :		**Brown Silty Clay of Low Plasticity (CL)**							

EXP Services Inc.
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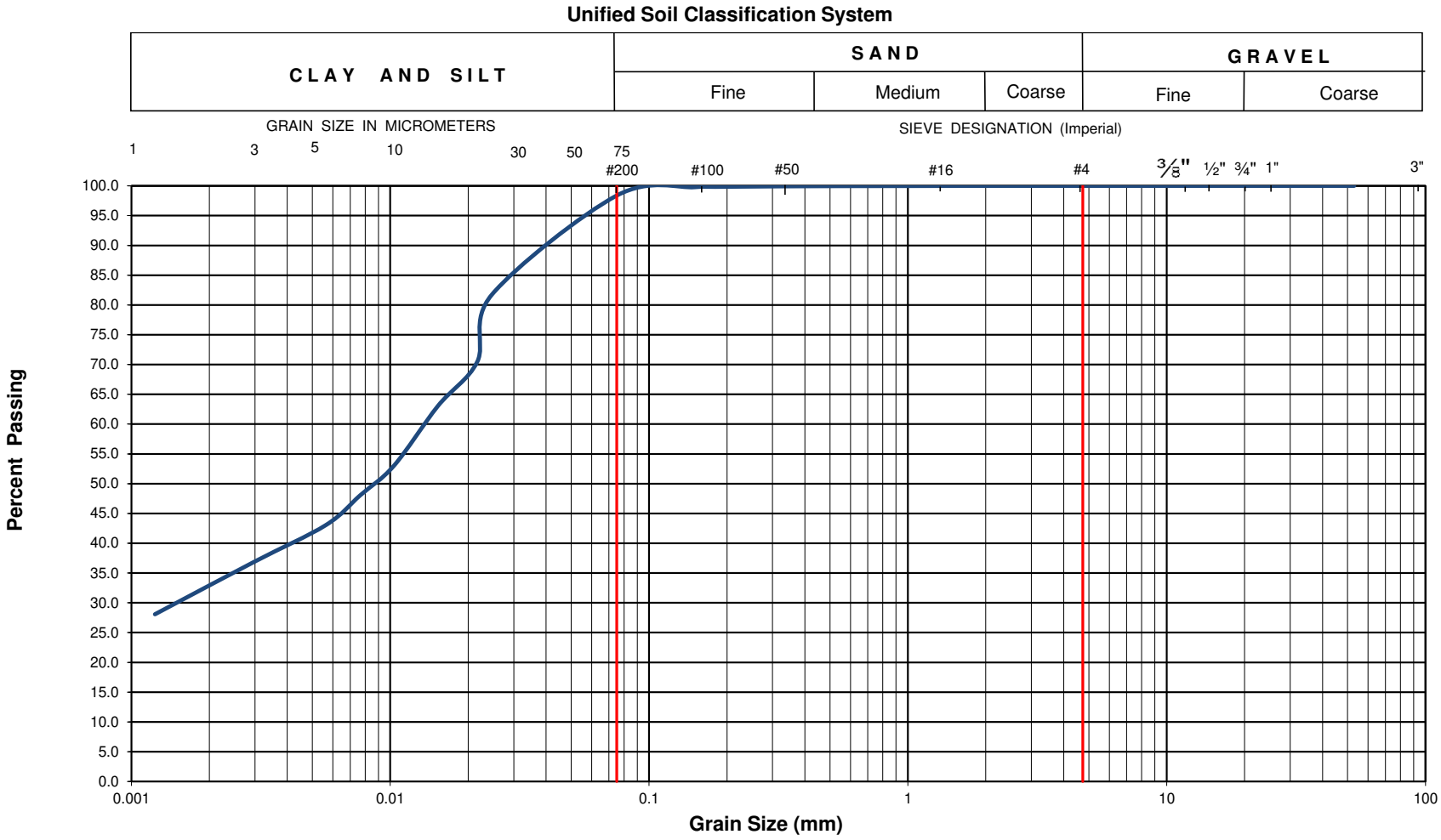
Ottawa, ON K2B 8H6

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



EXP Project No.:	**OTT-00245378-K0**	**Project Name :**	**Proposed Fernbank Public School**						
Client :	**OCDSB**	**Project Location :**	**Cope Drive & Rouncey Road, Ottawa, ON.**						
Date Sampled :	**February 25, 2019**	**Borehole No:**	**4**		**Sample No.:**	**SS6**		**Depth (m) :**	**3.8-4.3**
Sample Description :		**% Silt and Clay**	**98**	**% Sand**	**2**	**% Gravel**	**0**	**Figure :**	**25**
Sample Description :		**Grey Silty Clay of Low Plasticity (CL)**							

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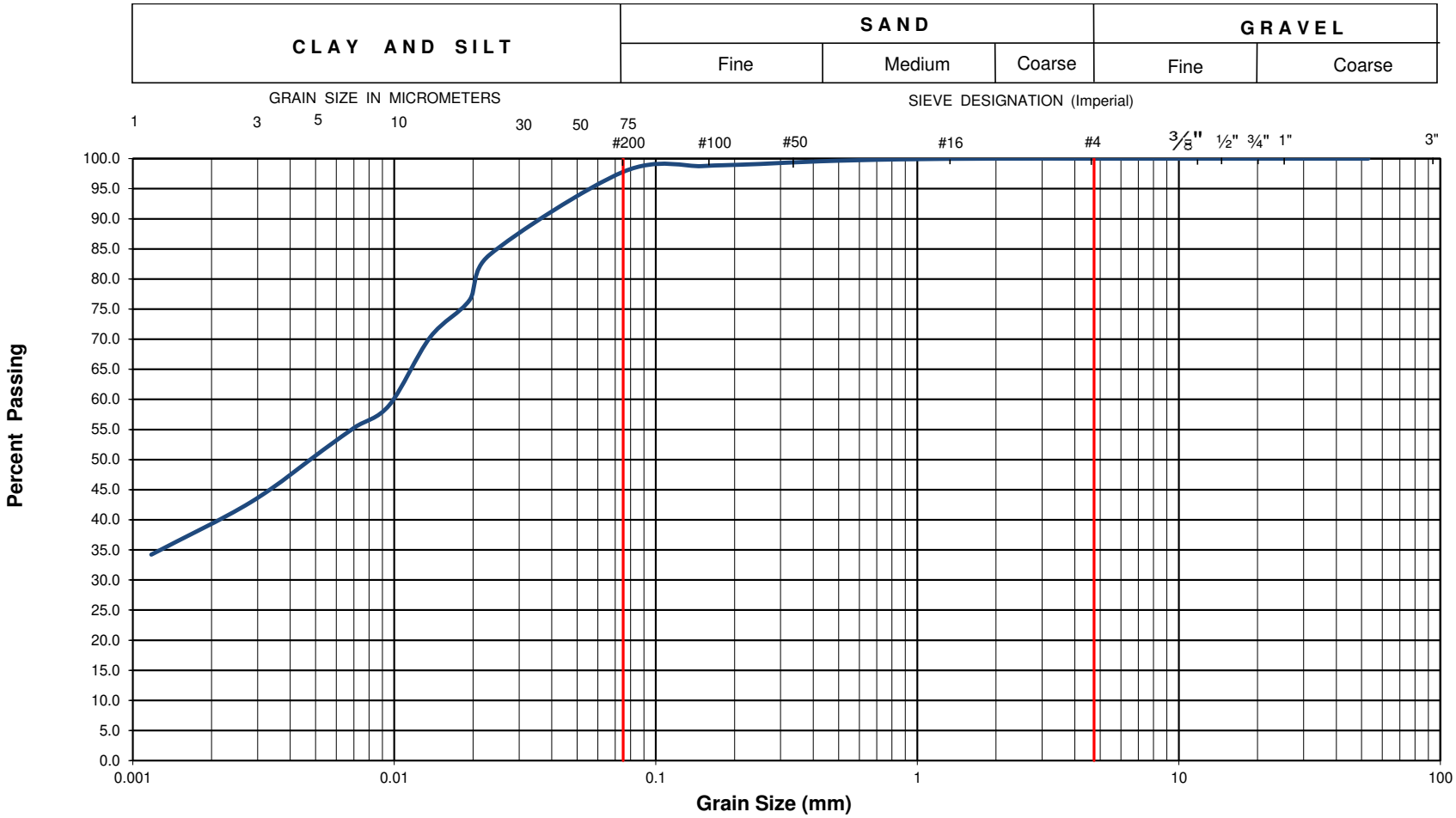
Grain-Size Distribution Curve
Method of Test For Particle Size Analysis of Soil
ASTM C-136/ASTM D422

Unified Soil Classification System



EXP Project No.:	**OTT-00245378-K0**	**Project Name :**	**Proposed Fernbank Public School**						
Client :	**OCDSB**	**Project Location :**	**Cope Drive & Rouncey Road, Ottawa, ON.**						
Date Sampled :	**February 25, 2019**	**Borehole No:**	**4**		**Sample No.:**	**SS9**		**Depth (m) :**	**7.6-8.2**
Sample Description :		**% Silt and Clay**	**98**	**% Sand**	**2**	**% Gravel**	**0**	**Figure :**	**26**
Sample Description :		**Grey Silty Clay of Low Plasticity (CL)**							

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Grain-Size Distribution Curve
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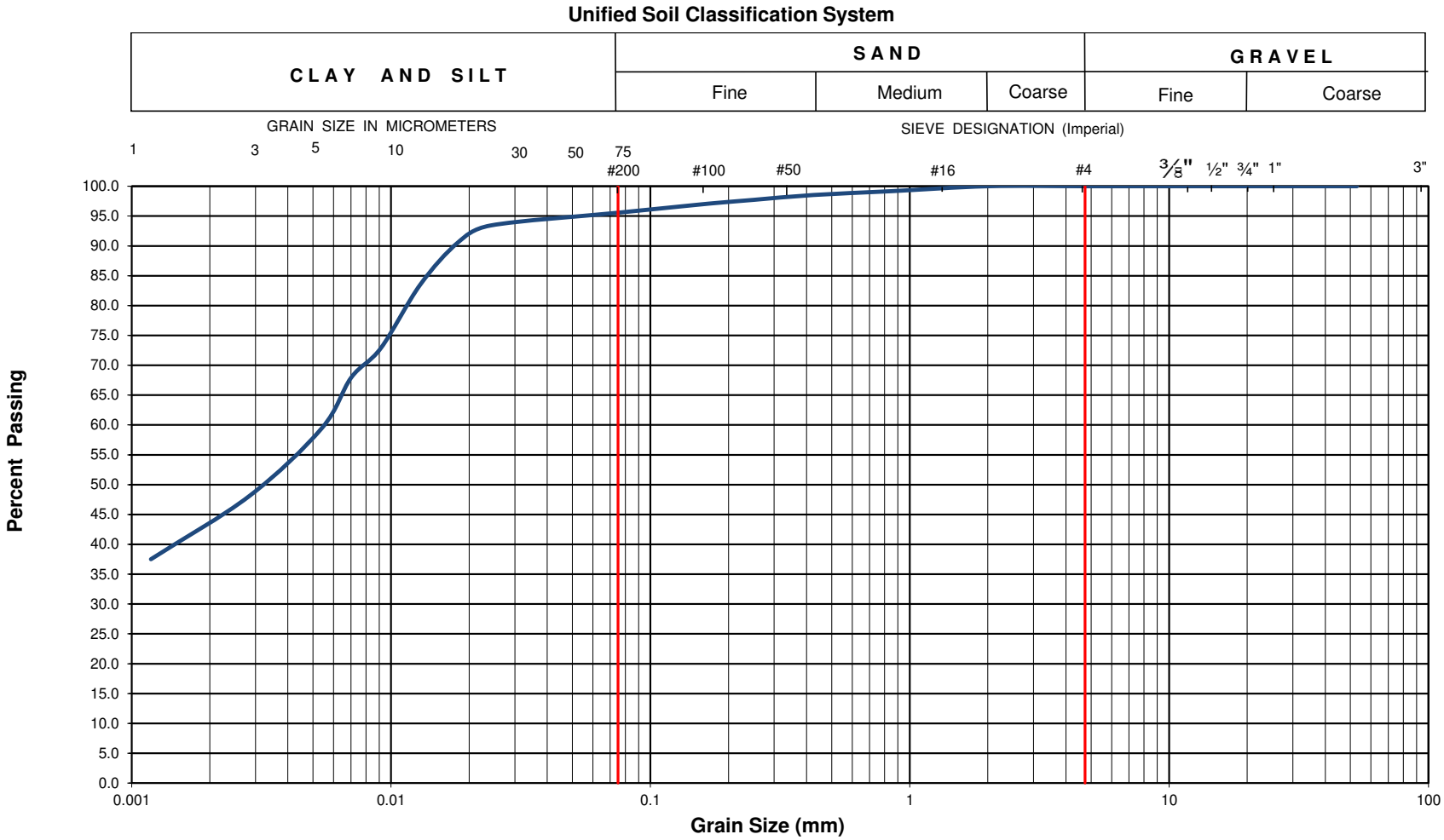

EXP Project No.:	**OTT-00245378-K0**	**Project Name :**	**Proposed Fernbank Public School**						
Client :	**OCDSB**	**Project Location :**	**Cope Drive and Rouncey Road, Ottawa, ON.**						
Date Sampled :	**October 22, 2019**	**Borehole No:**	**12**		**Sample No.:**	**SS11**		**Depth (m) :**	**13.7-14.3**
Sample Description :		**% Silt and Clay**	**96**	**% Sand**	**4**	**% Gravel**	**0**	**Figure :**	**27**
Sample Description :		**Grey Silty Clay of Low Plasticity (CL)**							

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Grain-Size Distribution Curve
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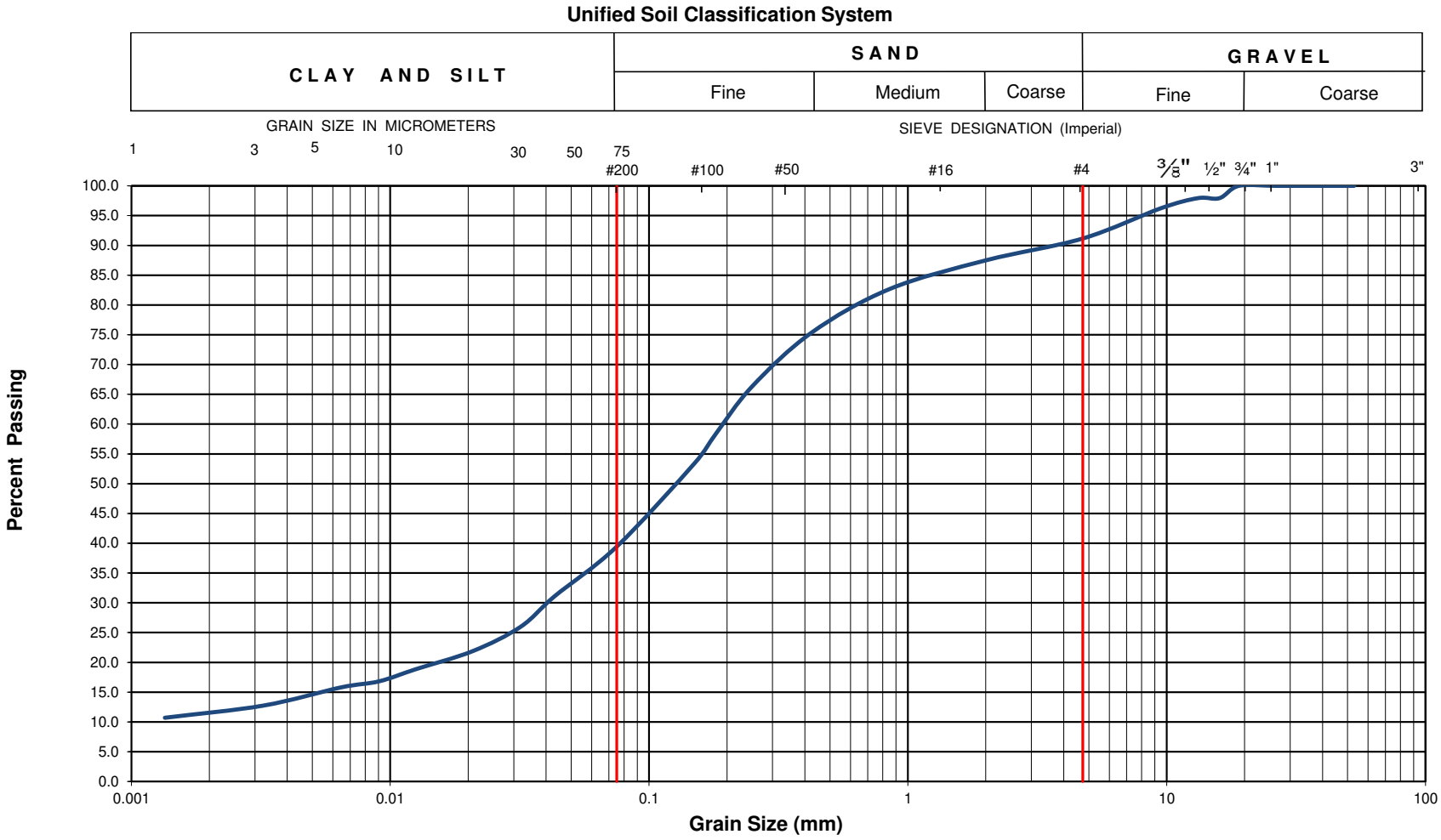
ASTM C-136/ASTM D422



EXP Project No.:	**OTT-00245378-K0**	**Project Name :**	**Proposed Fernbank Public School**						
Client :	**OCDSB**	**Project Location :**	**Cope Drive & Rouncey Road, Ottawa, ON.**						
Date Sampled :	**February 22, 2019**	**Borehole No:**	**1**		**Sample No.:**	**SS6**		**Depth (m) :**	**3.8-4.3**
Sample Description :		**% Silt and Clay**	**52**	**% Sand**	**39**	**% Gravel**	**9**	**Figure :**	**28**
Sample Description :		**Glacial Till: Silty Sand (SM)**							

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Grain-Size Distribution Curve
Method of Test For Particle Size Analysis of Soil
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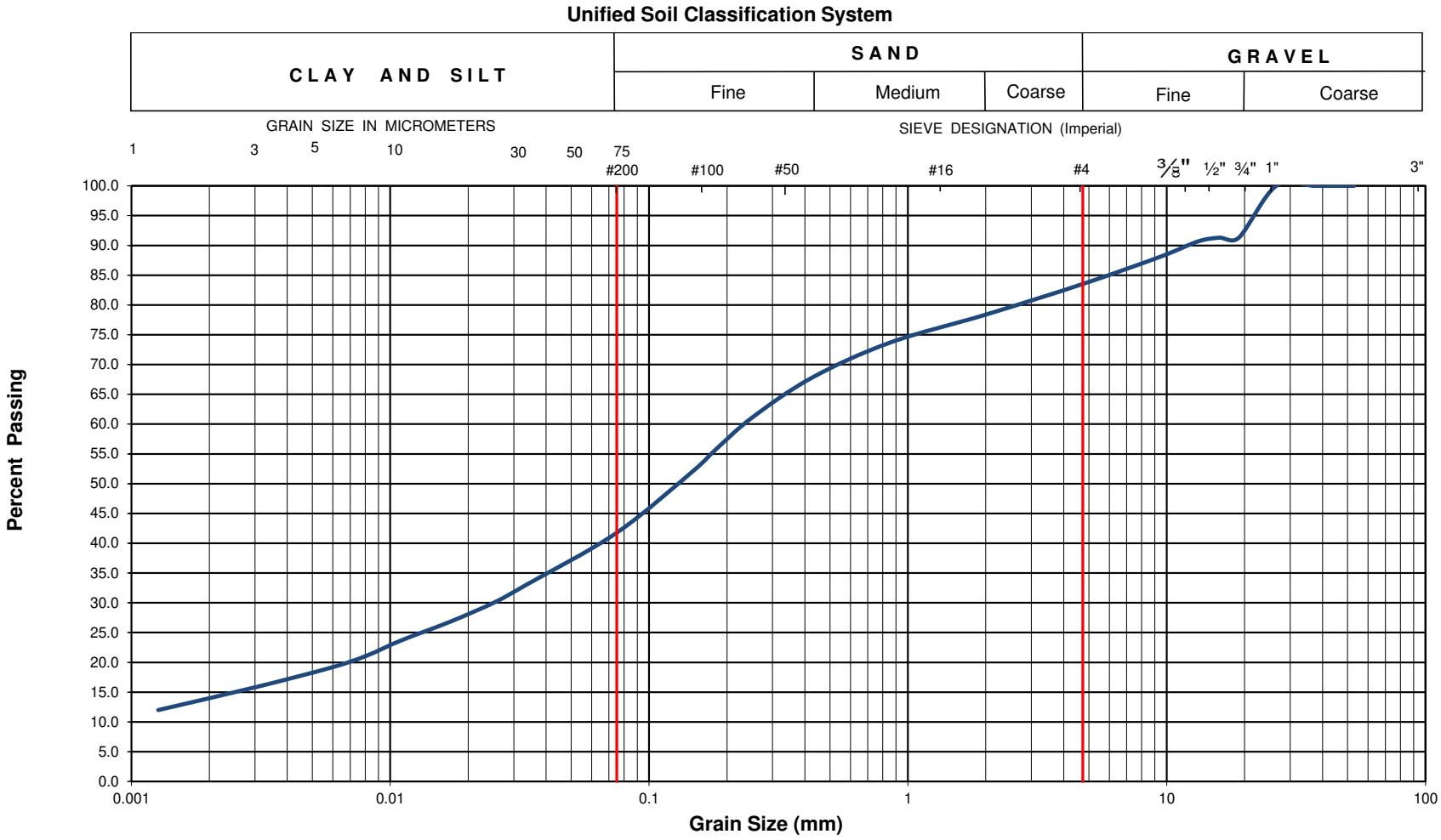

EXP Project No.:	**OTT-00245378-K0**	**Project Name :**	**Proposed Fernbank Public School**						
Client :	**OCDSB**	**Project Location :**	**Cope Drive and Rouncey Road, Ottawa, ON.**						
Date Sampled :	**October 22, 2019**	**Borehole No:**	**13**	**Sample No.:**	**SS3**	**Depth (m) :**	**1.5-2.1**		
Sample Description :		**% Silt and Clay**	**42**	**% Sand**	**42**	**% Gravel**	**16**	**Figure :**	**29**
Sample Description :		**Glacial Till: Silty Sand with Gravel (SM)**							

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Grain-Size Distribution Curve
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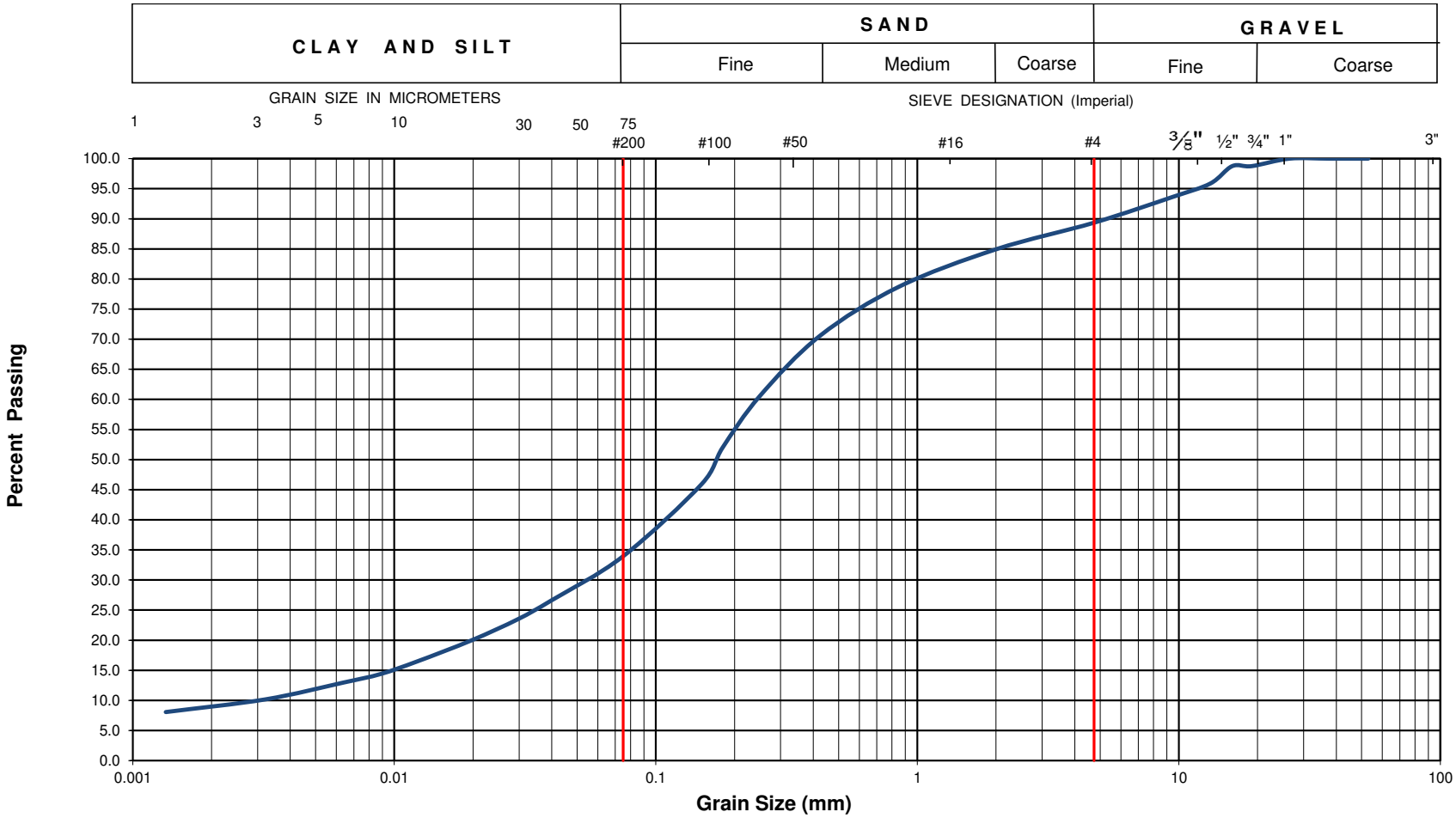
Unified Soil Classification System



EXP Project No.:	**OTT-00245378-K0**	**Project Name :**	**Proposed Fernbank Public School**						
Client :	**OCDSB**	**Project Location :**	**Cope Drive and Rouncey Road, Ottawa, ON.**						
Date Sampled :	**October 22, 2019**	**Borehole No:**	**15**		**Sample No.:**	**SS4**		**Depth (m) :**	**3.0 - 3.6**
Sample Description :		**% Silt and Clay**	**34**	**% Sand**	**55**	**% Gravel**	**11**	**Figure :**	**30**
Sample Description :		**Glacial Till: Silty Sand (SM)**							

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WET BEDROCK CORES

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2650 Queensview Drive, Suite 100
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Canada
www.exp.com

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borehole no.	core runs	PROJECT	project no.
BH-08	Run 1: 8.6m - 9.2m Run 2: 9.2m - 9.6m Run 3: 9.6m - 10.8m Run 4: 10.8m - 12.1m	PROPOSED FERNBANK PUBLIC SCHOOL	OTT-00245378-K0
date cored Oct 25, 2019		ROCK CORE PHOTOGRAPHS	FIG. 31

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borehole no.	core runs	PROJECT	project no.
BH-12	Run 1: 17.7m - 18.5m Run 2: 18.5m - 19.8m	PROPOSED FERNBANK PUBLIC SCHOOL	OTT-00245378-K0
date cored Oct 23, 2019		ROCK CORE PHOTOGRAPHS	FIG. 32

APPENDIX A: Consolidation Test Results

Englobe

One-Dimensional Consolidation Properties of Soils Using Incremental Loading

In reference of ASTM D 2435

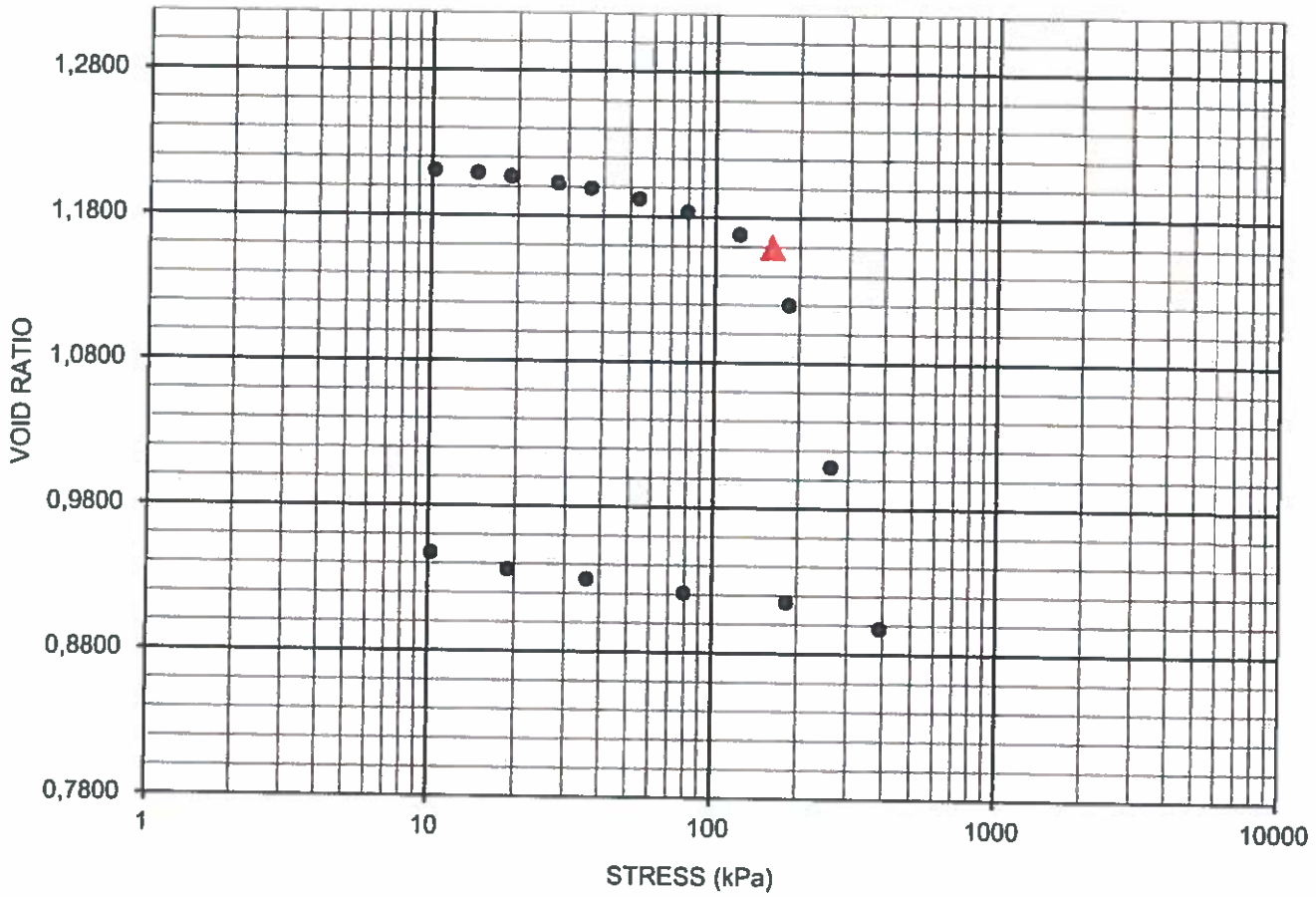
Client: EXP Services inc. **Date :** 2019-11-28

Project : Y/Project : OTT-00245378-K0 **Our file No. :** P-0011703-6-01

Boring No. : BH-12, ST-8 **Sample No. :** 19 **Depth (m) :** 9,50 - 9,60 m

Hydrostatic stress at the test (date) : Provided by ☒ the client ☐ Englobe

STRESS vs VOID RATIO CURVE



Geotechnical Characteristics of Soils :

Initial void ratio (e_o) :	1,213	Recompression index (C_r) :	0,025
Initial water content (w) :	43,3%	Virgin compression index (C_c) :	0,72
Initial humid unit weight (γ_h) :	17,5 kN/m³	Initial effective stress (σ'_v) :	
Initial saturation degree (S_r) :	98,2%	Preconsolidation pressure (σ'_p):	160 kPa
		Overconsolidation deviation ($\Delta\sigma$) :	-

Remarks : The sampling and transportation of the sample were carried out by a client's representative.
The initial effective stress has been provided by the client.

Prepared by :

Valérie Trempe, Géo. Stag.

Verified by :

Famakhan Fainke, ing.

Englobe

One-Dimensional Consolidation Properties of Soils Using Incremental Loading

In reference of ASTM D 2435

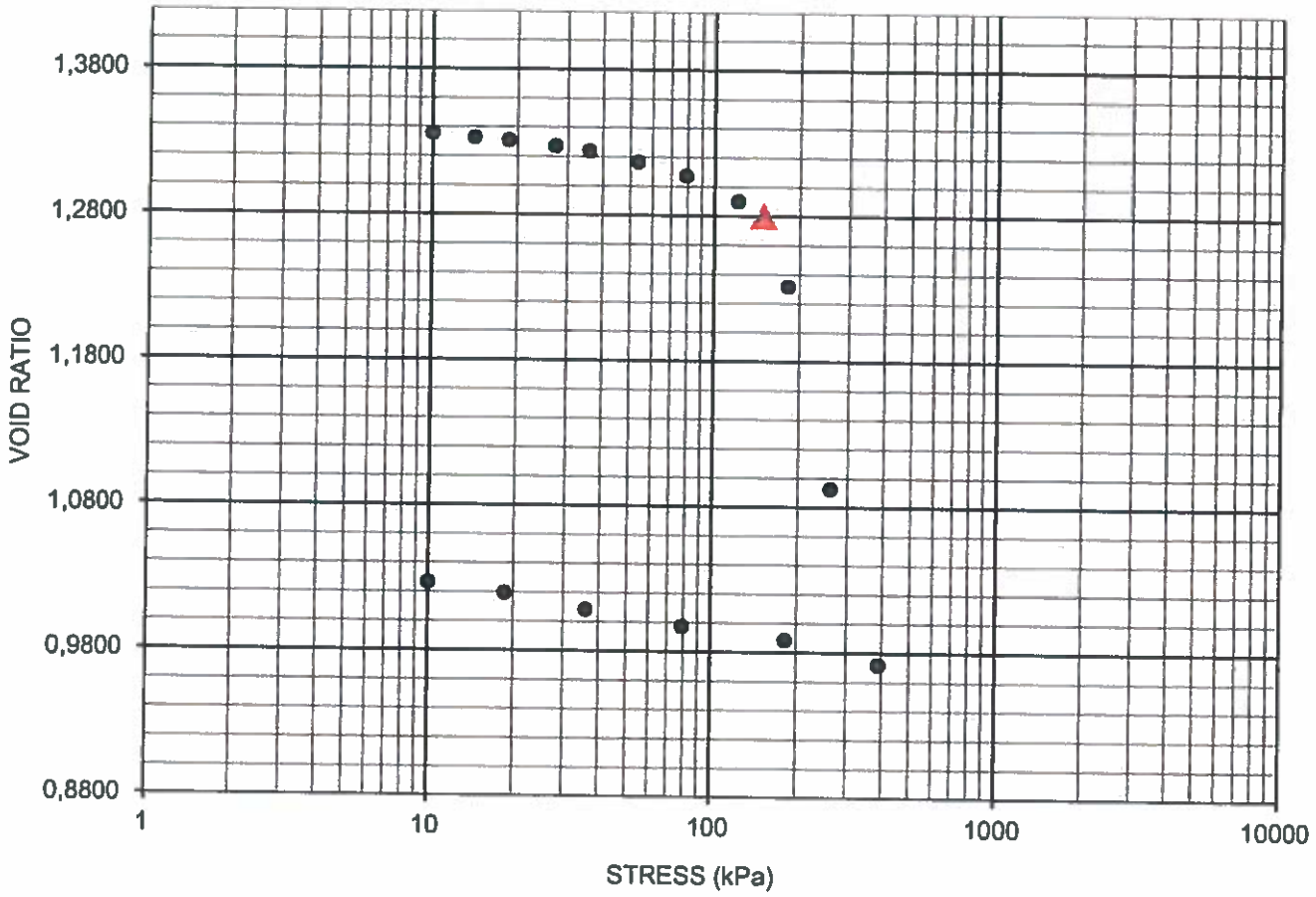
Client: EXP Services inc. **Date :** 2019-11-26

Project : Y/Project : OTT-00245378-K0 **Our file No. :** P-0011703-6-01

Boring No. : BH-16, ST6 **Sample No. :** 18 **Depth (m) :** 4,20 - 4,30 m

Hydrostatic stress at the test (date) : Provided by ☒ the client ☐ Englobe

STRESS vs VOID RATIO CURVE



Geotechnical Characteristics of Soils :

Initial void ratio (e_o) :	1,336	Recompression index (C_r) :	0,021
Initial water content (w) :	46,8%	Virgin compression index (C_c) :	0,90
Initial humid unit weight (γ_h) :	16,9 kN/m³	Initial effective stress (σ'_v) :	
Initial saturation degree (S_r) :	96,3%	Preconsolidation pressure (σ'_p):	150 kPa
		Overconsolidation deviation ($\Delta\sigma$) :	

Remarks : The sampling and transportation of the sample were carried out by a client's representative.
The initial effective stress has been provided by the client.

Prepared by :

Valérie Trempe, géo. Stag.

Verified by :

Famakhan Faike, ing.

APPENDIX B: Shear-wave Velocity Survey

GEOPHYSICS GPR INTERNATIONAL INC.

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Longueuil (Québec)
Canada J4K 3P7

Tel. : (450) 679-2400
Fax : (514) 521-4128
info@geophysicsgpr.com
www.geophysicsgpr.com

March 4th, 2019

Transmitted by email: ismail.taki@exp.com
Our Ref.: GPR-19-01194

Mr. Ismail M. Taki, M.Eng., P.Eng.
Manager, Geotechnical Services
exp Services inc.
100 - 2650 Queensview Drive
Ottawa (ON) K2B 8H6

Subject: **Shear Wave Velocity Sounding for Site Class Determination**
Cope Drive and Rouncey Road, Ottawa (ON)
[Project: OTT-00245378-K0]

Dear Sir,

Geophysics GPR International Inc. has been requested by **exp** Services Inc. to carry out seismic shear wave surveys over a field under development located in Stittsville, off Cope Drive, cornered by Terry Fox Drive and Fernbank Road, Ottawa (ON). The geophysical investigations used the Multi-channel Analysis of Surface Waves (MASW), the Extended SPatial AutoCorrelation (ESPAC), and the seismic refraction methods. From the subsequent results, the seismic shear wave velocities values were calculated for the soil and the rock.

The surveys were carried out, on February 11th, by Mr. Marc Rousseau, phys. and Mr. Kenny Gardner. Figure 1 shows the regional location of the site and Figure 2 illustrates the location of the seismic spreads. Both figures are presented in the Appendix.

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

METHODS PRINCIPLES

MASW Survey

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

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

Seismic Refraction Survey

The method consists in measuring the propagation delays of the direct and refracted seismic waves (P and/or S) produced by an artificial source in the axis of a seismic linear spread. The seismic velocities of the materials can be directly calculated, then the refractors depths.

INTERPRETATION METHODS

MASW Surveys

The main processing sequence involved data inspection and edition when required; spectral analysis ("phase shift" for MASW, and "cross-correlation" for ESPAC); picking the fundamental mode; and 1D inversion of the MASW and ESPAC shot records using the SeisImagerSW™ software. The data inversions used a nonlinear least squares algorithm.

In theory, all the shot records for a given seismic spread should produce a similar shear-wave velocity profile. In practice, however, differences can arise due to energy dissipation, local surface seismic velocities variations, and/or dipping of overburden layers or rock. In general, the precision of the calculated seismic shear wave velocities (V_S) is of the order of 15% or better.

Seismic Refraction surveys

The considered seismic wave's arrival times were identified for each geophone. The General Reciprocal Method was used, with signal sources at both ends of the seismic spreads, to consider seismic wave propagation for two opposite directions. The measurements were realised to calculate the rock depth, and its seismic velocity (using P waves). The rock seismic velocities (V_S) were calculated using two methods: the reduced travel-times (the Hobson and Overton method) and the opposite apparent velocities. The first one allows independence from the surface and rock topography effect, as well as the overburden lateral variation of its seismic velocity, but remains limited to common geophones. Its application remains however limited to shallow to intermediate depths refractors. The second one can use longer segments of opposite directions signals, improving the linear regressions accuracy, but remains affected by the surface and rock topography effect, as well as the overburden lateral variation of the seismic velocity. Conversely to the MASW method, the seismic rock velocity calculated by seismic refraction is only representative of its superior part, due to the evanescent nature of the refracted wave.

More detailed descriptions of these methods are presented in *Shear Wave Velocity Measurement Guidelines for Canadian Seismic Site Characterization in Soil and Rock*, Hunter, J.A., Crow, H.L., et al., Geological Surveys of Canada, General Information Product 110, 2015

SURVEY DESIGN

The seismic acquisition spreads were located in a field under development, south of the intersection of Cope Drive and Rouncey Road. The geophone spacing for the main spread was of 3 metres, using 24 geophones. A shorter seismic spread, with geophone spacing of 1 metre, was dedicated to the near surface materials.

The seismic records counted 4096 data, sampled at 1000 µs for the MASW surveys, and 50 µs for the seismic refraction. The records included a pre-trig portion of 10 ms. A stacking procedure was also used to improve the Signal / Noise ratio for the seismic records.

Unlike the refraction method, which allows producing a result point beneath each geophone, the shear wave depth sounding can be considered as the average of the bulk area within the geophone spread, especially for its central half-length. The seismic records were made with a seismograph Terraloc MK6 (from ABEM Instrument), and the geophones were 4.5 Hz. A 9 kg sledgehammer was used as the energy source with impacts being recorded off both ends of the seismic spreads.

RESULTS

From seismic refraction survey, the rock was calculated approximately 17.5 metres deep (± 10%). Its seismic velocity was calculated by seismic refraction between 2030 and 2130 m/s for its upper portion (cf. Figure 5). These results were used as initial parameters for the basic geophysical model, prior to the MASW dispersion curves inversions.

The MASW calculated V_S results are illustrated at Figure 6 and they are also presented at Table 1. Some high seismic velocities were calculated from the surface to approximately 1 metre deep. As it could be associated to frozen ground, they were replaced by the next lower layer velocities for a more realistic $\overline{V}_{S30}$ calculation.

The $\overline{V}_{S30}$ value results from the harmonic mean of the shear wave velocities, from the surface to 30 metres deep. It is calculated by dividing the total depth of interest (30 metres) by the sum of the time spent in each velocity layer from the surface up to 30 metres. This value represents an equivalent homogeneous single layer response.

The calculated $\overline{V}_{S30}$ value is 268.8 m/s (cf. Table 1), corresponding to the Site Class "D". However, some low seismic velocities were calculated from 1 to approximately 13 metres deep.

CONCLUSION

Geophysical surveys were carried out in a field under development, south of Cope Drive and Rouncey Road, in Ottawa (ON). The seismic surveys used the MASW, ESPAC analysis methods, seismic refraction, as well as the complementary borehole log information, to calculate the $\overline{V}_{S30}$ value for the Site Class determination. The $\overline{V}_{S30}$ calculation is presented in Table 1.

The calculated $\overline{V}_{S30}$ value of the actual site is 269 m/s corresponding to the Site Class "D" ($180 < \overline{V}_{S30} \leq 360$ m/s), as determined through the MASW, ESPAC and seismic refraction methods, Table 4.1.8.4.A of the NBC, and the Building Code, O. Reg. 332/12. It must be noted that some low seismic velocities were calculated for the unconsolidated materials between 1 metre and approximately 13 metres deep. A geotechnical assessment related to these materials should be realized.

It must be noted that other geotechnical information gleaned on site; including the presence of liquefiable soils, soft clays, high moisture content etc. can supersede the Site Classification provided in this report based on the $\overline{V}_{S30}$ value.

The V_S values calculated are representative of the in-situ materials and are not corrected for the total and effective stresses.

P.Eng.

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

LICENSED PROFESSIONAL ENGINEER
J.-L. ARSENAULT
100148122
PROVINCE OF ONTARIO
2019-03-04

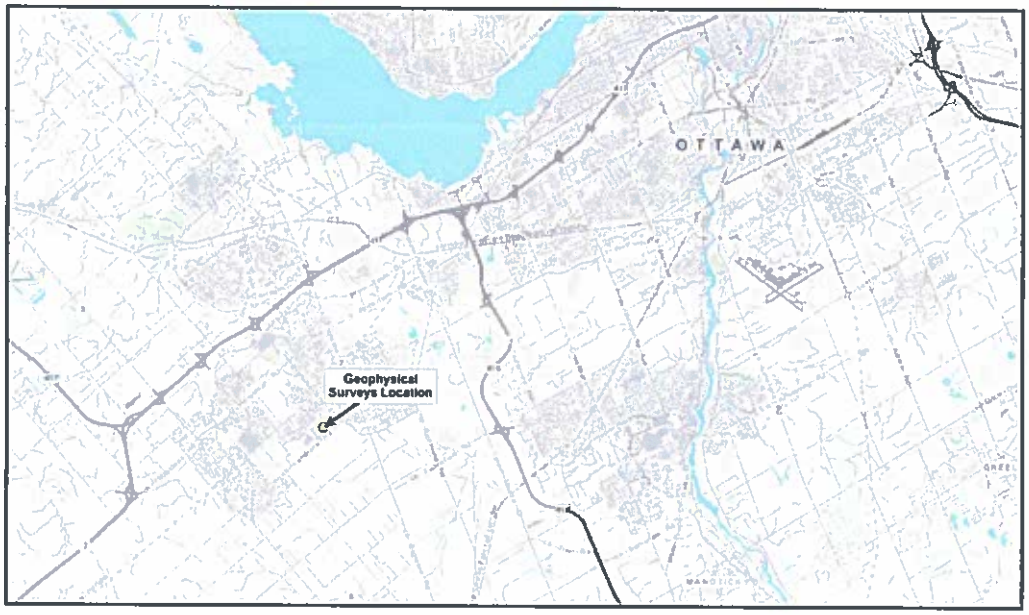

Figure 1: Regional location of the Site

(source: *GeoOttawa*)

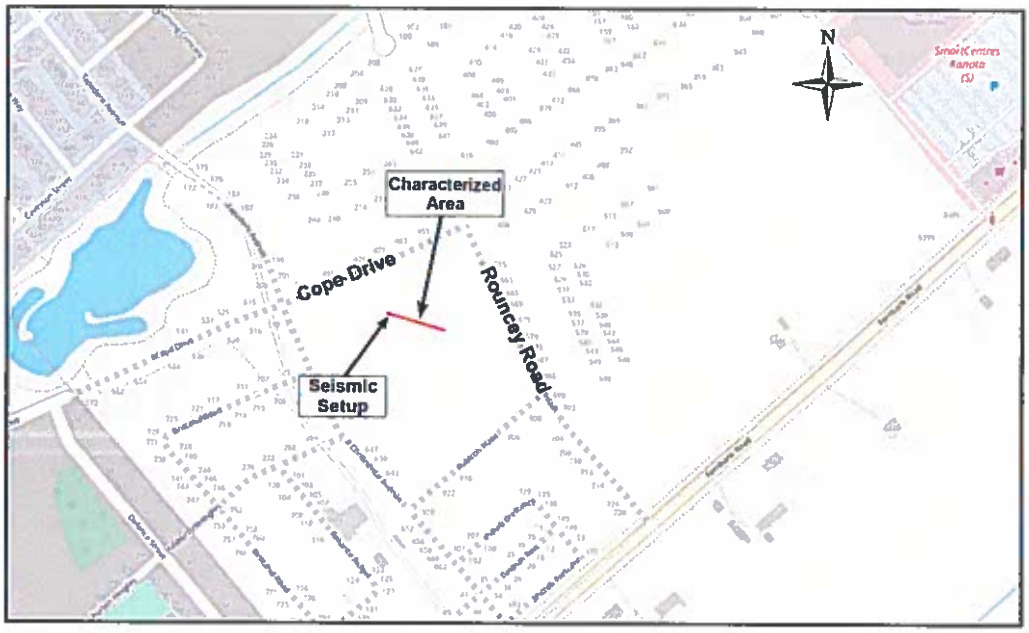

Figure 2: Location of the seismic spreads

(source: *OpenStreetMap©*)

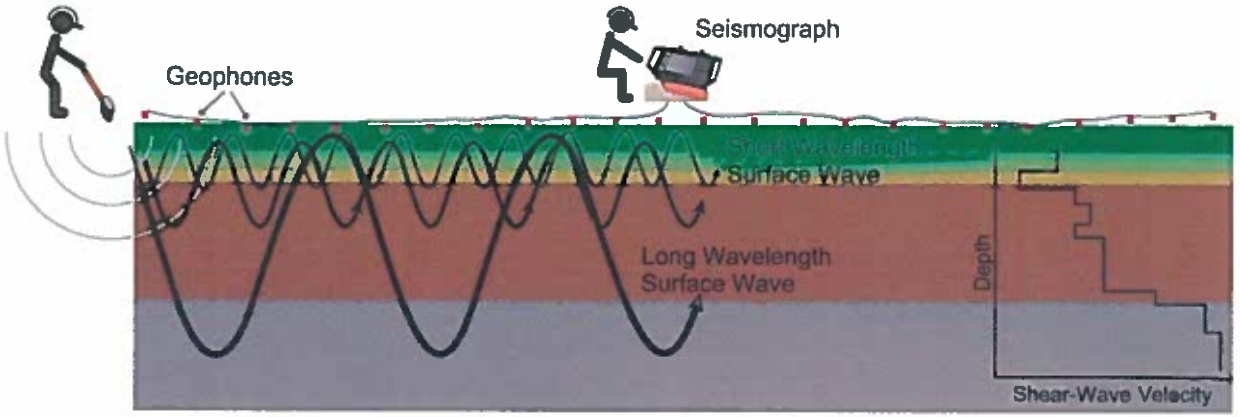

Figure 3: MASW Operating Principle

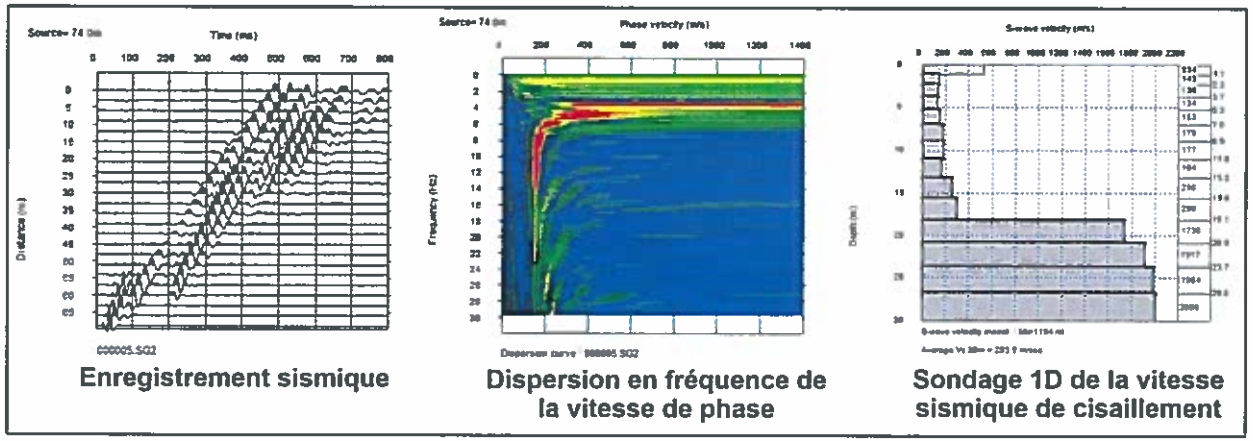

Figure 4: Example of a MASW/ESPAC record, Phase Velocity - Frequency curve and resulting 1D Shear Wave Velocity Model

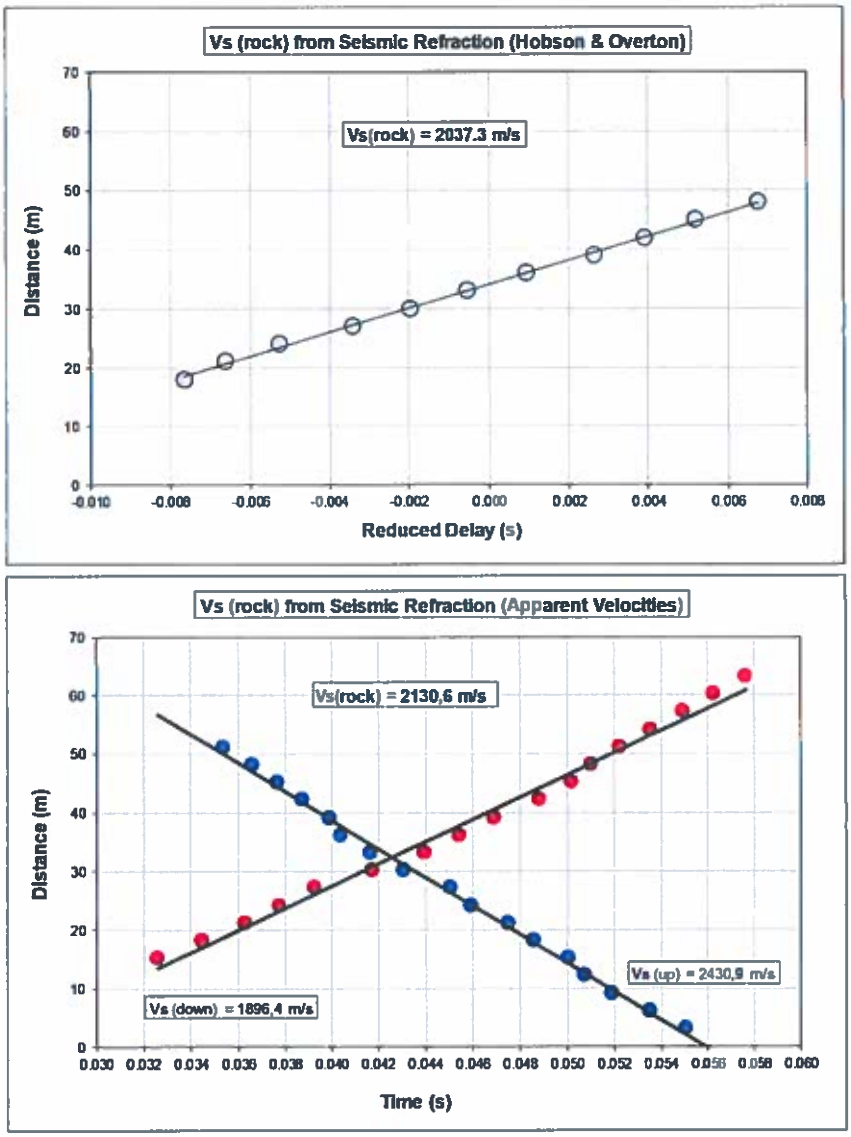

Figure 5: Rock V_S from Seismic Refraction

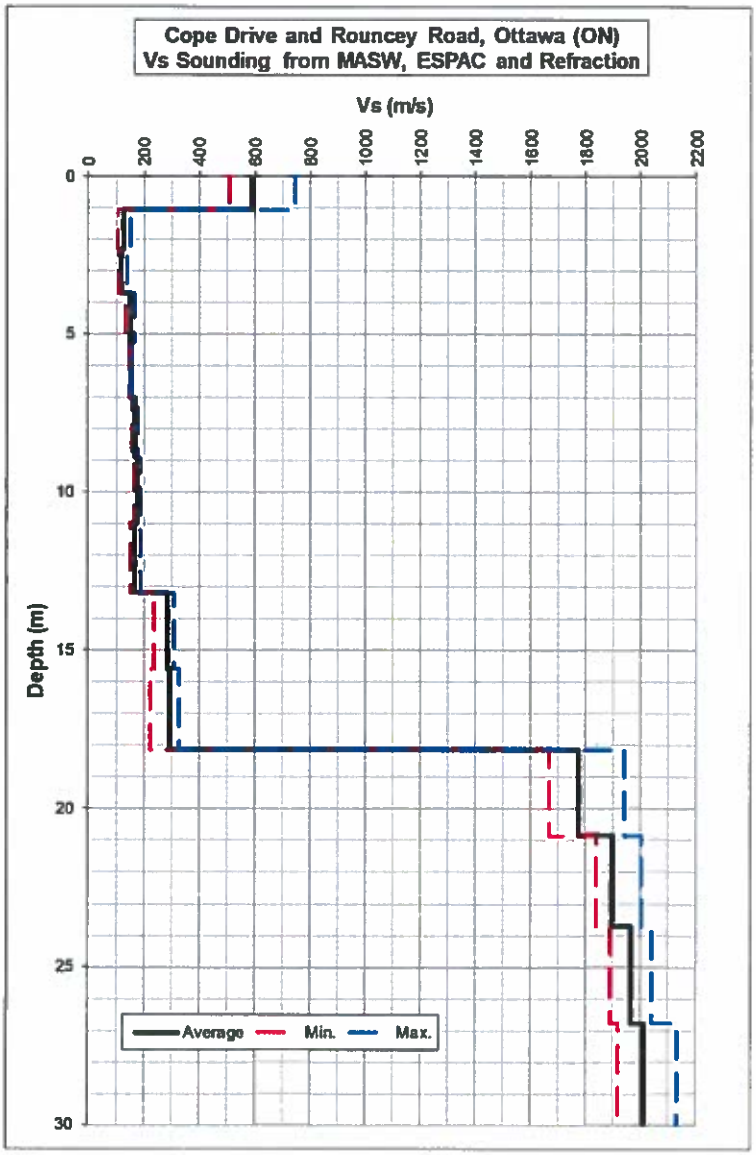

Figure 6: MASW Shear-Wave Velocities Sounding

TABLE 1
V_{S30} Calculation for the Site Class (actual site)

Depth	Vs			Thickness	Cumulative Thickness	Delay for Avg. Vs	Cumulative Delay	Vs at given Depth
	Min.	Average	Max.					
(m)	(m/s)	(m/s)	(m/s)	(m)	(m)	(s)	(s)	(m/s)
0	***106.4***	***125.7***	***151.1***					
1.07	**106.4**	**125.7**	**151.1**	1.07	1.07	0.008523	0.008523	125.7
2.31	**111.5**	**118.6**	**136.3**	1.24	2.31	0.009834	0.018357	125.7
3.71	**134.4**	**148.7**	**163.6**	1.40	3.71	0.011813	0.030169	122.9
5.27	**146.3**	**152.3**	**155.9**	1.57	5.27	0.010532	0.040702	129.6
7.01	**155.6**	**166.4**	**178.8**	1.73	7.01	0.011364	0.052065	134.6
8.90	**166.2**	**175.9**	187.2	1.90	8.90	0.011393	0.063458	140.3
10.96	**151.6**	**170.0**	190.3	2.06	10.96	0.011714	0.075171	145.8
13.19	239.2	284.2	311.8	2.23	13.19	0.013090	0.088261	149.4
15.58	**225.7**	293.0	328.6	2.39	15.58	0.008410	0.096671	161.1
18.13	1668.2	1775.3	1941.2	2.55	18.13	0.008720	0.105392	172.0
20.85	**1840.2**	1894.2	2000.7	2.72	20.85	0.001532	0.106924	195.0
23.74	1891.5	1963.9	2037.3	2.88	23.74	0.001523	0.108447	218.9
26.79	1915.7	2008.7	2130.6	3.05	26.79	0.001553	0.110000	243.5
30				3.21	30.00	0.001600	0.111600	268.8

V_{S30} (m/s)	**268.8**
Site Class	**D** [1]

[1]: conditional to geotechnical assessment of the low seismic velocities materials, from the surface to approximately 13 metres deep (potential of liquefaction and degree of clay sensitivity).

APPENDIX C: Laboratory Certificates of Analysis

AGAT Laboratories

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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: **SURINDER AGGARWAL**

PROJECT: **OTT-245378-KO**

AGAT WORK ORDER: **19Z442152**

SOIL ANALYSIS REVIEWED BY: **Yris Verastegui, Report Reviewer**

DATE REPORTED: **Mar 07, 2019**

PAGES (INCLUDING COVER): **5**

VERSION*: **1**

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

NOTES

All samples will be disposed of within 30 days following analysis. Please contact the lab if you require additional sample storage time.

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: 19Z442152

PROJECT: OTT-245378-KO

CLIENT NAME: EXP SERVICES INC

ATTENTION TO: SURINDER AGGARWAL

SAMPLING SITE:Cope Drive

SAMPLED BY:exp

Inorganic Chemistry (Soil)

DATE RECEIVED: 2019-02-28

DATE REPORTED: 2019-03-07

Parameter	Unit	G / S	RDL	SAMPLE DESCRIPTION: BH1 SS2 2. 5'-4.5'	BH5 SS3 5'-6.5'	BH6 SS4 7.5'-9'
			SAMPLE TYPE:	Soil	Soil	Soil
			DATE SAMPLED:	2019-02-22	2019-02-22	2019-02-22
				9933770	9933771	9933772
pH (2:1)	pH Units		N/A	7.80	7.94	8.09
Electrical Conductivity (2:1)	mS/cm		0.005	0.271	0.211	0.170
Chloride (2:1)	µg/g		2	13	12	9
Sulphate (2:1)	µg/g		2	40	39	14

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

Certified By: Iris Verástegui

AGAT Laboratories

5835 COOPERS AVENUE
MISSISSAUGA, ONTARIO
CANADA L4Z 1Y2
TEL (905)712-5100
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Quality Assurance

CLIENT NAME: EXP SERVICES INC

AGAT WORK ORDER: 19Z442152

PROJECT: OTT-245378-KO

ATTENTION TO: SURINDER AGGARWAL

SAMPLING SITE:Cope Drive

SAMPLED BY:exp

Soil Analysis

RPT Date: Mar 07, 2019			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)															
pH (2:1)	9933659		7.50	7.53	0.4%	NA	101%	90%	110%						
Electrical Conductivity (2:1)	9940089		1.50	1.52	1.3%	< 0.005	100%	90%	110%						
Chloride (2:1)	9934976		13	14	8.0%	< 2	102%	70%	130%	103%	70%	130%	102%	70%	130%
Sulphate (2:1)	9934976		13	12	9.5%	< 2	106%	70%	130%	93%	70%	130%	99%	70%	130%

Comments: NA signifies Not Applicable.

Certified By: Iris Verástegui

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Method Summary

CLIENT NAME: EXP SERVICES INC

AGAT WORK ORDER: 19Z442152

PROJECT: OTT-245378-KO

ATTENTION TO: SURINDER AGGARWAL

SAMPLING SITE:Cope Drive

SAMPLED BY:exp

PARAMETER	AGAT S.O.P	LITERATURE REFERENCE	ANALYTICAL TECHNIQUE
Soil Analysis			
pH (2:1)	INOR 93-6031	MSA part 3 & SM 4500-H+ B	PH METER
Electrical Conductivity (2:1)	INOR-93-6036	McKeague 4.12, SM 2510 B	EC METER
Chloride (2:1)	INOR-93-6004	McKeague 4.12 & SM 4110 B	ION CHROMATOGRAPH
Sulphate (2:1)	INOR-93-6004	McKeague 4.12 & SM 4110 B	ION CHROMATOGRAPH

AGAT Laboratories

5835 Coopers Avenue
Mississauga, Ontario L4Z 1Y2
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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)

Report Information:

Company: Exp Services
Contact: Surinder Aggarwal
Address: 2650 Queensview Drive Suite 100
Ottawa ON K2B 8H6
Phone: 613-688-1899 Fax:
Reports to be sent to:
1. Email: Surinder.Aggarwal@exp.com
2. Email:

Project Information:

Project: OTT-245378-K0
Site Location: Cope drive
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:

Regulatory Requirements:

☐ No Regulatory Requirement
(Please check all applicable boxes)

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

☐ Sewer Use
☐ Sanitary ☐ Storm
Region (Indicate One)
☐ MISA

☐ Regulation 558
☐ CCME
☐ 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

Laboratory Use Only

Work Order #: 19744215?

Cooler Quantity: one
Arrival Temperatures: 12.1 | 12.0 | 12.5
4.6 | 4.2 | 3.9
Custody Seal Intact: ☐ Yes ☐ No ☐ N/A
Notes: no ice

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

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 (Y/N)	O. Reg 153: Metals and Inorganics (☐ All Metals ☐ 153 Metals (excl. Hydrides) ☐ Hydride Metals ☐ 153 Metals (Incl. Hydrides))	O. Reg 153: ORPs: ☐ B-HWS ☐ Cr ☐ CN ☐ Cr^{6+} ☐ EC ☐ FOC ☐ Hg ☐ pH ☐ SAR	Full Metals Scan	Regulation/Custom Metals	Nutrients: ☐ TP ☐ NH_3 ☐ TKN ☐ NO_3 ☐ NO_2 ☐ NO_3+NO_2	Volatiles: ☐ VOC ☐ BTEX ☐ THM	PHCs F1 - F4	ABNs	PAHs	PCBs: ☐ Total ☐ Aroclors	Organochlorine Pesticides	TCLP: ☐ M&I ☐ VOCs ☐ ABNs ☐ B(a)P ☐ PCBs	Sewer Use	pH	Sulphides	Chlorides	Electro Conductivity
BH 1 SS2 2.5'-4.5'	Feb 22/19																		✓	✓	✓	✓
BH 5 SS3 5'-6.5'	Feb 24/19																		✓	✓	✓	✓
BH 6 SS4 7.5'-9'	Feb 22/19																		✓	✓	✓	✓

Samples Relinquished By (Print Name and Sign)	Date	Time	Samples Received By (Print Name and Sign)	Date	Time
Ryan DiGiuseppe	Feb 26/19	4:45		19-02-28	16h22
UPS to Ottawa	19-03-01	16h00	Simon	19/3/1	11:24

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Nº: T 078134 ✓

Document ID: DIV 78 1511 015

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Date Issued: July 16, 2015

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