

Geotechnical Investigation Proposed OC Transpo Hydro Substation 1500 St. Laurent Boulevard Ottawa, Ontario

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Executive Summary

Introduction

EXP Services Inc. (EXP) is pleased to present the results of the geotechnical investigation completed for the proposed hydro substation to be located at the OC Transpo facility at 1500 St. Laurent Boulevard, Ottawa, Ontario (Figure 1). The geotechnical investigation was undertaken in two (2) phases with the original investigation conducted in 2022 and the additional investigation conducted in 2024. Terms and conditions of the two (2) phases of this assignment were outlined in EXP's two (2) proposals dated June 21,2022 and March 11,2024 and are under EXP's standing offer agreements (SOAs) with the City of Ottawa SOA 30820-02500-S01 Category 5A and 5B (2022) and SOA 24423 24423-92500-S01 Category 5A and 5B (2024). Authorization to proceed with this work was provided by City of Ottawa Purchase Order Numbers: 0045102541 dated October 4,2022 and 0045108222 dated April 25,2024.

The geotechnical investigation for the proposed hydro substation was undertaken in conjunction with the geotechnical investigation for the proposed electrical bus garage to be located at the OC Transpo facility. The proposed garage will be located in the northwest portion of the facility and the proposed hydro substation will be located north of the proposed garage in the northwest corner of the facility. The boreholes completed for the geotechnical investigation for the proposed OC Transpo electrical bus garage include Borehole Nos. 22-01 to 22-09, 22-16, 22-17, 24-01 to 24-07, 24-09 and 24-12. The boreholes completed for the hydro substation include Borehole Nos. 22-10 to 22-15, 24-10 and 24-11. This geotechnical report discusses the results for the proposed hydro substation. The results of the geotechnical investigation for the proposed electrical bus garage are provided in a separate geotechnical report.

EXP completed a Phase One Environmental Site Assessment (ESA) of the site for the proposed development and the results of the ESA are provided in a separate report dated May 15,2023 (EXP Project Number: OTT-22007382-A0). EXP also completed a Phase Two of the site for the proposed development and the results are presented in a separate report dated December 8, 2022 (EXP Project No. OTT-22007382-A0). As part of the current assignment, EXP updated the Phase Two ESA of the site for the proposed development and the results are provided in a separate report.

Proposed Development

The proposed hydro substation will be located in the northwest corner of the OC Transpo facility at 1500 St. Laurent Boulevard in Ottawa. Currently, the site is occupied by an outdoor paved parking lot for buses. Based on available design information provided in the document titled, Technical Specifications for Geotechnical Investigation for the Proposed Substation located at OC Transpo St. Laurent (Rev.0) dated May 6,2022 (prepared by envari and CIMA) and the email dated July 4,2024 with the shop drawing for the proposed generator foundation, Drawing No. S3.1 dated December 7,2023, it is our understanding that the hydro substation will consist of the following:

- Three (3) switchgear buildings Two (2) of the three switchgear buildings will measure 5.84 m by 9.75 m, will be supported by eight (8) isolated footings with a building load of 13 000 kg/footing (128 kN/footing). The third switchgear building will measure 4.83 m by 5.41 m and will be supported by six (6) isolated footings with a building load of 13 000 kg/footing. The switchgear buildings will have a partial basement with the basement set at an approximate 2.0 m depth below final grade. The basement is assumed to be a drained structure. The switchgear buildings are considered to be heated buildings.
- XFO transformer foundations The two (2) XFO transformer foundations will each measure 3.0 m by 5.0 m and each XFO will have an approximate weight of 43 000 kg (422 kN), excluding the weight of the foundation. A below grade oil containment pit will surround the transformers. The depth below final grade of the oil containment pit (tank) at the time of this geotechnical investigation was not available. It is assumed the oil containment pit (tank) will be designed as a water-tight structure. The XFO transformers will be outdoor structures and are considered to be unheated structures.
- Generator foundations The generator foundations will be outdoor structures supported on a thickened reinforced
 concrete pad with the underside of the pad set at 1.050 m below final grade and supported by micro-piles. The
 generators are considered to be unheated structures.

The design elevation of the final site grades at the time of this geotechnical investigation was not available.



Fieldwork Program

The fieldwork for this geotechnical investigation was undertaken in two (2) phases and consists of a total of eight (8) boreholes. The first phase was undertaken on September 20 to 22 and November 15,2022 and consists of six (6) boreholes (Borehole Nos. 22-10to 22-15) advanced to auger refusal and termination depths ranging from 5.1 m to 8.7 m below existing grade. The second phase was undertaken on May 9,2024 and consists of two (2) boreholes (Borehole Nos. 24-10 and 24-11) advanced to termination depths of 7.1 m and 7.7 m below existing grade.

A seismic shear wave velocity soundings survey consisting of one (1) survey line was conducted at the site on May 15,2024 by Geophysics GPR International Inc. (GPR).

Subsurface Conditions

The borehole information indicates that below the pavement structure, the subsurface conditions at the site for the proposed hydro substation consist of very loose to very dense fill underlain by loose to very dense shaley glacial till followed by shale bedrock at 4.1 m to 5.0 m depths (Elevation 65.8 m to Elevation 64.6 m). The groundwater level ranges from 1.9 m to 2.8 m depths (Elevation 68.0 m to Elevation 66.6 m).

Geotechnical Engineering Comments and Recommendations

The seismic shear wave velocity soundings survey report dated May 31,2024 and prepared by GPR is shown in Appendix A. The GPR report indicates the seismic shear wave velocities (Vs) of the subsurface soils are greater than 200 m/s. Therefore, based on the results of the seismic shear wave velocity soundings survey and the results of the additional boreholes drilled as part of the additional geotechnical investigation, the subsurface soils are considered not to be liquefiable during a seismic event.

For the underside of footings, thickened reinforced concrete pads and grade beams founded 1.7 m or less from the bedrock surface, the site class for seismic response may be taken as **Class A**. For the underside of footings, thickened reinforced concrete pads and grade beams founded greater than 1.7 m but less than 3.0 from the bedrock surface, the site class for seismic response may be taken as **Class B**. If the underside of footings, thickened reinforced pads and grade beams are greater than 3.0 m from the bedrock surface, the site class for seismic response is **Class C**.

A review of the available design information and borehole data indicates that the proposed **switchgear buildings** with a basement approximately 2.0 m below final grade may be supported by strip and spread footings designed to bear on an engineered fill pad constructed on top of the native shaley glacial till or directly on the shaley glacial till and designed for a bearing pressure at serviceability limit state (SLS) of 200 kPa and factored geotechnical resistance at ultimate limit state (ULS) of 300 kPa. The factored geotechnical resistance at ULS value includes a geotechnical resistance factor of 0.50. It is recommended that the very loose to loose zone of the shaley glacial till, such as identified in Borehole Nos. 22-13 and 22-14 should be excavated and removed as directed by geotechnical engineer for the case where the footings will be directly founded on the shaley glacial till. The total and differential settlements of the footings designed in accordance with the recommendations of this report and with careful attention to construction detail are expected to be less than 25 mm and 19 mm respectively. Alternatively, the proposed switchgear buildings may be supported by caissons socketed into the sound shale bedrock. Piles designed in end bearing and driven to practical refusal into the shale bedrock are not considered practical due to the shallow depth of the bedrock. For the two (2) foundation options, the basement floor of the proposed switchgear buildings may be designed as a slab-on-grade founded on an engineered fill pad constructed on the shaley glacial till. The existing fill and buried topsoil/organic soil are not suitable to support foundations and the basement floor slab-on-grade of the proposed switchgear buildings.

The proposed **transformers** with oil containment pits (tanks) may be supported by a reinforced thickened concrete pad founded on an engineered fill pad constructed on the shaley glacial till or directly on the shaley glacial till and designed for a bearing pressure at serviceability limit state (SLS) of 200 kPa and factored geotechnical resistance at ultimate limit state (ULS) of 300 kPa. The factored geotechnical resistance at ULS value includes a geotechnical resistance factor of 0.50. It is recommended that the very loose to loose zone of the shaley glacial till, such as identified in Borehole Nos. 22-13 and 22-14 should be excavated and removed as directed by the geotechnical engineer for the case where the thickened reinforced concrete pad will be directly founded on the shaley glacial till. The total and differential settlements of the thickened reinforced concrete pad designed in accordance with the recommendations of this report and with careful attention to construction detail are expected to be less than 25 mm and 19 mm respectively.



The proposed **generators** may be set on a thickened reinforced concrete pad supported by micro-piles socketed into the sound shale bedrock. Micro-piles are a proprietary product that should be designed and installed by a contractor specializing in the design and installation of micro-piles in the province of Ontario.

The excavations are anticipated to extend below the groundwater level into the shaley glacial till that contains very loose to loose zones. The very loose to loose zones of the shaley glacial till below the groundwater level are susceptible to instability of the base of the excavation in the form of piping or heave. To minimize 'base-heave' type failure of the excavation base, maintain stability of the side slopes of the excavation and conduct the excavation and construction in relatively dry conditions, it is necessary to lower the groundwater table at the site to below the final excavation level prior to the start of the excavation. This may be achieved by installing deep sumps, pumping with high-capacity pumps and pumping on a continuous basis (such as twenty-four (24) hours a day, seven (7) days a week). The groundwater level should be lowered and maintained to at least 1.0 m below the bottom of the excavation until the placement and compaction of the engineered fill pad and other construction activities have been completed to the design subgrade level. Standpipes should also be installed to monitor the groundwater level during initial groundwater lowering and during construction. A specialized dewatering contractor should be consulted to determine the most appropriate dewatering method for the site conditions to allow for the construction of the engineered fill pad and other construction activities to be undertaken in relatively dry conditions.

The basement floor of the proposed switchgear building may be designed and constructed as a slab-on-grade placed on a 200 mm thick 19 mm sized clear stone bed placed on a minimum 300 mm thick engineered fill pad set on the approved shaley glacial till. The clear stone will minimize the capillary rise of moisture from the sub-soil to the floor slab. Alternatively, the clear stone layer may be replaced with a 200 mm thick bed of OPSS Granular A overlain by a vapour barrier. Adequate saw cuts should be provided in the floor slabs to control cracking. The proposed switchgear building will require perimeter and underfloor drainage systems.

The proposed generator thickened reinforced concrete pad supported by micro-piles should have a perimeter drainage system around the concrete pad.

All excavations must be undertaken in accordance with the Occupational Health and Safety Act (OHSA), Ontario Reg. 213/91. Based on the definitions provided in OHSA, the subsurface soils on site are considered to be Type 3 and as such must be cut back at 1H:1V from the bottom of the excavation. Within zones of seepage, the excavation side slopes are expected to slough and eventually stabilize at 2H:1V to 3H:1V from the bottom of the excavation. For excavations above the groundwater level or properly dewatered (refer to paragraph below), the installation of the municipal underground services may be undertaken within the confines of a prefabricated support system (trench box) designed and installed in accordance with OHSA.

If side slopes cannot be achieved due to space restrictions on site such as the proximity of open cut excavations to the property limits, existing infrastructure or to foundations of adjacent existing building(s), the new building construction would have to be undertaken within the confines of an engineered support system (shoring system).

It is anticipated that the majority of the material required for backfilling purposes in the interior and exterior of the proposed structures and in the underground service trenches will need to be imported and should preferably conform to the material specifications indicated in the attached geotechnical report.

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



1. Introduction

EXP Services Inc. (EXP) is pleased to present the results of the geotechnical investigation completed for the proposed hydro substation to be located at the OC Transpo facility at 1500 St. Laurent Boulevard, Ottawa, Ontario (Figure 1). The geotechnical investigation was undertaken in two (2) phases with the original investigation conducted in 2022 and the additional investigation conducted in 2024. Terms and conditions of the two (2) phases of this assignment were outlined in EXP's two (2) proposals dated June 21,2022 and March 11,2024 and are under EXP's standing offer agreements (SOAs) with the City of Ottawa SOA 30820-02500-S01 Category 5A and 5B (2022) and SOA 24423 24423-92500-S01 Category 5A and 5B (2024). Authorization to proceed with this work was provided by City of Ottawa Purchase Order Numbers: 0045102541 dated October 4,2022 and 0045108222 dated April 25,2024.

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The design elevation of the final site grades at the time of this geotechnical investigation was not available.



The geotechnical investigation was undertaken to:

- 1. Establish the subsurface soil and groundwater conditions at eight (8) boreholes located on the site,
- 2. Classify the site for seismic site response in accordance with the requirements of the 2012 Ontario Building Code (as amended January 1,2022) and assess the potential for liquefaction of the subsurface soils during a seismic event,
- 3. Comment on grade-raise restrictions and provide site grading requirements,
- 4. Make recommendations regarding the most suitable type of foundations, founding depth and bearing pressure at serviceability limit state (SLS) and factored geotechnical resistance at ultimate limit state (ULS) of the founding strata and comment on the anticipated total and differential settlements of the recommended foundation type,
- 5. Provide comment regarding slab-on-grade construction and the requirement for perimeter and underfloor drainage systems,
- 6. Make recommendations regarding soil parameters for lateral earth pressure (static and dynamic conditions) for drained foundations and for water-tight foundations,
- Comment on excavation conditions and de-watering requirements during construction,
- 8. Provide pipe bedding requirements for underground services,
- 9. Discuss backfilling requirements and suitability of on-site soils for backfilling purposes,
- 10. Recommend pavement structure thicknesses for paved access roads and parking lots,
- 11. Comment on the corrosion potential of subsurface soils buried concrete and steel structures/members; and
- 12. Provide comment on tree planting restrictions.

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



2. Site Description

The site of the proposed hydro substation will be located at the OC Transpo facility at 1500 St. Laurent Boulevard in the northwest corner of the facility, northwest of the existing north garage building. The site is currently occupied by an outdoor paved parking lot for buses. The overall site is relatively flat with borehole ground surface elevations ranging from Elevation 70.03 m to Elevation 69.23 m.



3. Site Geology

3.1 Surficial Geology Map

The surficial geology map (Map 1506A – Surficial Geology, Ontario-Quebec, Geological Survey of Canada, printed by the Surveys and Mapping Branch, 1982) indicates that beneath any fill, the site is underlain by glacial till.

3.2 Bedrock Geology Map

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



4. Procedure

4.1 Boreholes

4.1.1 Fieldwork

The fieldwork for this geotechnical investigation was undertaken in two (2) phases and consists of a total of eight (8) boreholes. The first phase was undertaken on September 20 to 22 and November 15,2022 and consists of six (6) boreholes (Borehole Nos. 22-10 to 22-15) advanced to auger refusal and termination depths ranging from 5.1 m to 8.7 m below existing grade. The second phase was undertaken on May 9,2024 and consists of two (2) boreholes (Borehole Nos. 24-10 and 24-11) advanced to termination depths of 7.1 m and 7.7 m below existing grade. The borehole fieldwork was supervised on a full-time basis by EXP.

It is noted that Borehole Nos. 22-01 to 22-09, 22-16, 22-17, 24-01 to 24-07, 24-09 and 24-12 were undertaken for the proposed electrical bus garage to be located south of the proposed hydro substation and are included in a separate geotechnical engineering report. The locations of the proposed garage building and hydro substation are shown in Figure 2.

The locations and geodetic elevations of the boreholes for the proposed hydro substation were established on site by EXP and are shown on the borehole location plan, Figure 3.

The boreholes were drilled using CME-55 and CME-75 truck-mounted drill rigs equipped with continuous flight hollow-stem auger equipment and rock coring capabilities. Below the augered depth of 1.5 m, the 2024 boreholes (Borehole Nos. 24-10 and 24-11) were advanced to casing refusal depths using casing and wash-boring technique and maintaining a head (column) of water in the casing. Grab (GS) and auger (AS) samples were taken in the upper level of the boreholes. Standard penetration tests (SPTs) were performed in all the boreholes on a continuous basis to 0.75 m depth interval and the soil samples (SS) retrieved by the split-spoon sampler. The bedrock was cored in selected boreholes using the N-size core barrel and conventional rock coring techniques. A field record of wash water return, colour of wash water and any sudden drops of the core barrel were kept during rock coring operations.

The subsurface soil conditions in each borehole were logged and each soil sample placed in labelled plastic bags. Similarly, the rock cores were visually examined, placed in core boxes, identified, and logged.

Monitoring wells having diameters of thirty-two (32 mm) and fifty (50 mm) were installed in selected boreholes for long-term monitoring of the groundwater level and for groundwater sampling as part of the Phase Two ESA. The monitoring wells were installed in accordance with EXP standard practice, and the installation configuration is documented on the respective borehole log. The boreholes were backfilled upon completion of drilling and installation of the monitoring wells.

4.1.2 Laboratory Testing Program

On completion of the borehole fieldwork, the soil samples and rock cores were transported to the EXP laboratory in Ottawa where they were examined by a geotechnical engineer and borehole logs prepared. The main constituents of the soils are classified in accordance with the Unified Soil Classification System (USCS) using the soil group name and symbol and by the modified Burmister soil classification method for the classification of the minor constituents of the soil using adjectives and modifiers such as trace and some (2006 Fourth Edition of the Canadian Foundation Engineering Manual (CFEM)).

The rock cores were visually examined by the geotechnical engineer and logged in accordance with Section 3.2 of the 2006 Canadian Foundation Engineering Manual (CFEM) Fourth Edition. Photographs were taken of the bedrock cores.



The laboratory testing program for the soil samples and rock core sections is summarized in Table I.

Table I: Summary of Laboratory Testing Program							
Type of Test	Number of Tests Completed						
Soil Samples							
Moisture Content Determination	60						
Grain Size Analysis	10						
Atterberg Limit Determination	6						
Corrosion Analysis (pH, sulphate, chloride and resistivity)	4						
Bedrock C	ore Sections						
Unit Weight Determination	9						
Unconfined Compressive Strength Test	9						
Corrosion Analysis (pH, sulphate, chloride and resistivity)	2						

4.2 Seismic Shear Wave Velocity Soundings Survey

A seismic shear wave velocity soundings survey consisting of one (1) survey line was conducted at the site on May 15,2024 by Geophysics GPR International Inc. (GPR). The purpose of the seismic shear wave survey was to determine the seismic shear wave velocity of the site and based on the shear wave velocity provide the site classification for seismic response and to assist in determining if the subsurface soils are liquefiable during a seismic event. The survey line is located within the footprint of the proposed hydro substation. The location of the survey line is shown on the Borehole Location Plan, Figure 3. The seismic shear wave survey was undertaken using the multi-channel analysis of surface waves (MASW), spatial auto correlation (SPAC) and seismic refraction methods. The seismic shear wave velocity soundings survey report dated May 31,2024 and prepared by GPR is shown in Appendix A.



5. Subsurface Conditions and Groundwater Levels

A detailed description of the subsurface conditions encountered in the boreholes is given on the attached Borehole Logs, Figures 4 to 11.

The borehole logs and related information depict subsurface conditions only at the specific locations and at the 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 also may 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. Reference should be made to the EXP Phase One ESA and updated Phase Two ESA for potential environmental concerns with respect to the subsurface conditions at the site.

It should be noted that the soil and bedrock boundaries indicated on the borehole logs are inferred from observations during drilling operations. 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 form an integral part of this report and should be read in conjunction with this report.

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

5.1 Pavement Structure

All of the boreholes are located in a paved area. Based on the borehole information, the pavement structure consists of 125 mm to 175 mm thick asphaltic concrete underlain by 400 mm to 800 mm thick granular fill (base). The granular fill (base) consists of gravel, sand and silt of varying percentages. Based on the standard penetration test (SPT) N-values of 39 to 64 the granular fill (base) is in a dense to very dense state. Moisture contents of the granular fill (base) are 1 percent to 3 percent.

Results from the grain-size analysis conducted on one (1) sample of the granular fill (base) are summarized in Table II. The grain-size distribution curve is shown in Figure 12.

Table II: Summary of Results from Grain-Size Analysis – Granular Fill (Base)								
Borehole No.			Grain-Siz					
(BH): Sample No. (SS)	Depth (m)	Gravel	Sand	Silt	Clay	Soil Classification		
BH 24-10 – AS1	0.2-0.6	38	42	20	0	Silty Sand (SM) and Gravel		

Based on a review of the results of the grain-size analysis, the granular fill (base) may be classified as a silty sand (SM) and gravel.

5.2 Fill

Fill was contacted beneath the pavement structure in all the boreholes. The fill extends to depths of 1.4 m to 3.8 m below existing grade (Elevation 67.7 m to Elevation 66.2 m). The fill consists of gravel, sand silt and clay of varying percentages. In some boreholes, the fill also contains asphalt and wood fragments, organics (rootlets), shale fragments and possible cobbles and boulders. Based on the SPT N-values of 3 to 79, the fill is in a very loose to very dense state. The moisture content of the fill is 5 percent to 24 percent.

In Borehole 24-10, the fill contains an approximate 800 mm thick buried organic soil layer contacted within the fill at a 1.4 m depth (Elevation 68.3 m) and extends to a 2.2 m depth (Elevation 67.5 m) within the fill. The organic soil consists of a mixture of silty sand and organic soil with rootlets and exhibits an organic-type odour. The SPT N-value of the organic soil is 7 indicating the organic soil is in a loose state. The moisture content of the organic soil is 10 percent.

Results from the grain-size analysis conducted on four (4) samples of the fill are summarized in Table III. The grain-size distribution curves are shown in Figures 13 to 16.



Table II	Table III: Summary of Results from Grain-Size Analysis and Atterberg Limit Determination — Fill Samples									
Borehole No.						Grain-Size Ana	ılysis (%) and	d Atterbei	g Limits (%)	
(RHI) Sample '	Depth (m)	Gravel	Sand	Silt	Clay	Moisture Content	Liquid Limit	Plastic Limit	Plasticity Index	Soil Classification
BH/MW 22-10: SS2	0.8-1.4	24	45	21	10	7	-	-	N.P.	Silty Sand (SM) - Gravelly, Trace Clay
BH 22-11: SS2	0.8-1.4	20	41	26	13	10	-	-	N.P.	Silty Sand (SM) - Some Gravel and Clay
BH 22-12: SS3	1.5-2.1	17	48	24	11	10		-	N.P.	Silty Sand (SM) – Some Gravel and Clay
BH 22-14: SS3	1.5-2.1	24	45	23	8	9	-	-	N.P.	Silty Sand (SM) _ Gravelly, Trace Clay

Note:

N.P. = Not Plastic

Based on a review of the results of the grain size analysis and Atterberg limit determination, the fill may be classified as a silty sand (SM) that is gravely to some gravel with trace to some clay.

5.3 Shaley Glacial Till

The fill in all of the boreholes is underlain by shaley glacial till contacted at 2.3 m to 3.8 m depths (Elevation 67.7 m to Elevation 65.9 m). The shaley glacial till extends to depths of 4.1 m to 5.0 m (Elevation 65.8 m to Elevation 64.6 m). The shaley glacial till contains varying percentages of gravel, sand, silt and clay. The shaley glacial till also contains shale fragments and possible cobbles and boulders. Based on the SPT N-values of 7 to 90. The shaley glacial till is in a loose to very dense state. In some boreholes, the SPT N-value is high for low sampler penetration, such as 50 for 125 mm of sampler penetration. This may be a result of the sampler making contact with a possible cobble, boulder or concentrated zone or seams of shale fragments within the shaley glacial till. The natural moisture content of the shaley glacial till ranges from 7 percent to 12 percent.

The results from the grain-size analysis and Atterberg limit determination conducted on five (5) samples of the shaley glacial till are summarized in Table IV. The grain-size distribution curve is shown in Figures 17 to 21.

Table IV: S	Table IV: Summary of Results from Grain-Size Analysis and Atterberg Limit Determination – Glacial Till Samples									
Borehole No. (BH): Sample No. (SS)	Double					Grain-Size Ana	lysis (%) and	d Atterbei	g Limits (%)	
		Gravel	Sand	Silt	Clay	Moisture Content	Liquid Limit	Plastic Limit	Plasticity Index	Soil Classification
BH/MW22-10: SS4	2.3-2.9	17	47	25	11	10	20	13	7	Clayey Sand (SC) – Low Plasticity, Some Gravel, Silty
BH 22-11: SS7	4.6-5.0	31	42	21	6	10				Silty Sand (SM) – Gravelly, Trace Clay
BH 22-12: SS6	3.8-4.4	19	45	27	9	7				Silty Sand (SM) – Some Gravel, Trace Clay
BH 24-10: SS6	3.8-4.1	38	54	8	0	11				Poorly-Graded Sand (SP-SM) and Gravel, Trace Silt
BH/MW 24-11: SS5	3.0-3.6	13	47	27	13	9	22	12	10	Clayey Sand (SC) – Low Plasticity, Some Gravel, Silty



Based on a review of the test results of the grain-size analysis and Atterberg limits, the glacial till may be classified as a clayey sand (SC) of low plasticity that is silty with some gravel to a silty sand (SM) to poorly-graded silty sand (SP-SM) that contains gravel to some gravel and trace of clay. The shaley glacial till contains shale fragments and may contain possible cobbles and boulders.

5.4 Inferred and Actual Bedrock

Auger refusal was met on inferred cobbles, boulders or bedrock in Borehole Nos. 22-14 and 22-15 at 5.1 m and 5.3 m depths (Elevation 64.6 m and Elevation 63.9 m). Bedrock was contacted in the remaining boreholes at 4.1 m to 5.0 m (Elevation 65.8 m to Elevation 64.6 mA summary of the auger refusal and bedrock depths (elevations) are shown in Table V.

Table V: Summary of Inferred and Actual Bedrock Depths (Elevations)							
Borehole (BH)/Monitoring Well (MW) No.	Ground Surface Elevation (m)	Auger Depth (Elevation) on Inferred Bedrock (m)	Bedrock Depth (Elevation) (m)				
BH/MW 22-10	69.95	-	4.2 (65.8)				
BH 22-11	69.61	-	5.0 (64.6)				
BH 22-12	70.03	-	4.7 (65.3)				
BH/MW 22-13	69.99	-	4.7 (65.3) – 300 mm thick weathered zone 5.0 (65.0) – Unweatheed zone				
BH 22-14	69.71	5.1 (64.6)	-				
BH/MW 22-15	69.23	5.3 (63.9)	-				
BH 24-10	69.73	-	4.1 (65.6)				
BH/MW 24-11	69.88	-	4.5 (65.4)				

The bedrock is black shale of the Billings formation. A review of the borehole logs indicates that in Borehole No. 22-13, a 300 mm thick weathered zone of the bedrock was contacted from the surface of the bedrock at a 4.7 m depth (Elevation 65.3 m).

The total core recovery of the bedrock ranges from 86 percent to 100 percent and the rock quality designation (RQD) ranges from 50 percent to 100 percent indicating the quality of the bedrock is fair to excellent. The RQD value of the weathered zone in Borehole No. 22-13 is 24 percent indicating the weathered zone of the bedrock is of a very poor quality. Photographs of the bedrock cores are shown in Appendix B.

A summary of the unit weight and unconfined compressive strength of the bedrock are shown in Table VI.

Table VI: Summary of Unit Weight and Unconfined Compressive Strength – Bedrock Cores							
Borehole (BH)/Monitoring Well (MW)No.: Run No.	Depth (m)	Unit Weight (kN/m³)	Unconfined Compressive Strength (MPa)				
BH/MW 22-10: Run 2	6.3-6.5	26.0	41.2				
BH22-11: Run 3	7.7-7.8	24.4	44.2				
BH 22-12: Run 2	5.9-6.0	26.0	46.6				
BH/MW 22-13: Run 1	5.6-5.7	25.8	37.9				
BH/MW 22-13: Run 3	8.3-8.5	25.8	44.0				
BH 24-10: Run 1	4.7-4.9	26.4	39.3				
BH 24-10: Run 2	6.26.3	26.5	45.2				
BH/MW 24-11: Run 1	5.4-5.5	26.4	39.5				
BH/ MW 24-11: Run 3	7.5-7.7	26.4	43.5				



A review of the test results in Table VI indicates the strength of the rock may be classified as medium strong (R3) in accordance with the Canadian Foundation Engineering Manual (CFEM), Fourth Edition, 2006.

5.5 Groundwater Level Measurements

A summary of the groundwater level measurements taken in the boreholes equipped with monitoring wells on May 30,2024 and November 14 and 24,2022 is shown in Table VII.

Table VII: Summary of Groundwater Level Measurements							
Borehole (BH)/Monitoring Well (MW) No.	Ground Surface Elevation (m)	Date of Measurement (Elapsed Time in Years/Days from Date of Installation)	Groundwater Depth Below Ground Surface (Elevation), (m				
DU/MW 22 40	50.05	May 30,2024 (~1.5 years))	2.7 (67.3)				
BH/MW 22-10	69.95	November 14,2022 (53 days)	2.0 (68.0)				
DU/NW 22 42	50.00	May 30,2024 (~1.5 years)	2.7 (67.3)				
BH/MW 22-13	69.99	November 14,2022 (53 days)	2.8 (67.2)				
DII/MM 22 45	co 22	May 30,2024 (~1.5 years)	2.6 (66.6)				
BH/MW 22-15	69.23	November 24,2022 (9 days)	2.1 (67.1)				
BH/MW 24-11	69.88	May 30, 2024 (21years)	1.9 (68.0)				

Based on a review of the measurements, the groundwater level ranges from 1.9 m to 2.8 m (Elevation 68.0 m to Elevation 66.6 m).

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



Site Classification for Seismic Site Response and Liquefaction Potential of Soils

6.1 Liquefaction Potential of Soils

The seismic shear wave velocity soundings survey report dated May 31,2024 and prepared by GPR is shown in Appendix A. The GPR report indicates the seismic shear wave velocities (Vs) of the subsurface soils are greater than 200 m/s. Therefore, based on the results of the seismic shear wave velocity soundings survey and the results of the additional boreholes drilled as part of the additional geotechnical investigation, the subsurface soils are considered not to be liquefiable during a seismic event.

6.2 Site Classification for Seismic Site Response

For the underside of footings, thickened reinforced concrete pads and grade beams founded 1.7 m or less from the bedrock surface, the site class for seismic response may be taken as **Class A**. For the underside of footings, thickened reinforced concrete padsand grade beams founded greater than 1.7 m but less than 3.0 from the bedrock surface, the site class for seismic response may be taken as **Class B**. If the underside of footings, thickened reinforced pads and grade beams are greater than 3.0 m from the bedrock surface, the site class for seismic response is **Class C**.



7. Grade Raise Restrictions

The borehole information indicates that compressible clays do not exist at the site. Therefore, from a geotechnical perspective, there is no restriction to raising the grades at the site.



8. Site Grading

The borehole information indicates that below the pavement structure, the subsurface conditions at the site for the proposed hydro substation consist of very loose to very dense fill underlain by loose to very dense shaley glacial till followed by shale bedrock at 4.1 m to 5.0 m depths (Elevation 65.8 m to Elevation 64.6 m). The groundwater level ranges from 1.9 m to 2.8 m depths (Elevation 68.0 m to Elevation 66.6 m).

Site grading within the **proposed generator thickened reinforced concrete pad foundation** supported by micro-piles should consist of the excavation and removal of existing fill to the design underside elevation of the thickened reinforced concrete pad to be supported by micro-piles.

Site grading within the **proposed switchgear buildings and XFO foundation footprints** should consist of the excavation and removal of the existing fill, buried topsoil/organic layers and organic stained soils down to the shaley glacial till.

For engineered fill pad areas that will support the foundations and slab-on-grade of the proposed switchgear buildings and reinforced thickened concrete pads for the XFO equipment, the native shaley glacial till subgrade should be examined by a geotechnician. Any loose/soft areas identified during the subgrade examination should be excavated, removed and replaced with Ontario Provincial Standard Specification (OPSS) Granular B Type II material compacted to 100 percent standard Proctor maximum dry density (SPMDD). Once the subgrade has been approved, the grades may be raised to the design underside footing and/or floor slab elevation by an engineered fill pad constructed in accordance with Section 9.1.1 of this report.

The excavations are anticipated to extend below the groundwater level into the shaley glacial till that contains very loose to loose zones. The very loose to loose zones of the shaley glacial till below the groundwater level are susceptible to instability of the base of the excavation in the form of piping or heave. To minimize 'base-heave' type failure of the excavation base, maintain stability of the side slopes of the excavation and conduct the excavation and construction in relatively dry conditions, it is necessary to lower the groundwater table at the site to below the final excavation level prior to the start of the excavation. This may be achieved by installing deep sumps, pumping with high-capacity pumps and pumping on a continuous basis (such as twenty-four (24) hours a day, seven (7) days a week). The groundwater level should be lowered and maintained to at least 1.0 m below the bottom of the excavation until the placement and compaction of the engineered fill pad and other construction activities have been completed to the design subgrade level. Standpipes should also be installed to monitor the groundwater level during initial groundwater lowering and during construction. A specialized dewatering contractor should be consulted to determine the most appropriate dewatering method for the site conditions to allow for the construction of the engineered fill pad and other construction activities to be undertaken in relatively dry conditions.

Site grading outside the proposed switchgear buildings and XFO structures in areas within the **proposed parking lots and access road areas** should consist of the removal of existing pavement structure, and organic stained soils. The subgrade should be proofrolled in the presence of a geotechnician. Any loose/soft areas identified during the proofrolling process should be excavated, removed, and replaced with Ontario Provincial Standard Specification (OPSS) Granular B Type II or OPSS Select Subgrade Material (SSM) compacted to 95 percent standard Proctor maximum dry density (SPMDD). Once the subgrade has been approved, the grades may be raised to the design subgrade level of the pavement structure by approved on site material and/or OPSS Select Subgrade Material (SSM) compacted to 95 percent SPMDD.

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 borehole information indicates that below the pavement structure, the subsurface conditions at the site for the proposed hydro substation consist of very loose to very dense fill underlain by loose to very dense shaley glacial till followed by shale bedrock at 4.1 m to 5.0 m depths (Elevation 65.8 m to Elevation 64.6 m). The groundwater level ranges from 1.9 m to 2.8 m depths (Elevation 68.0 m to Elevation 66.6 m).

The proposed hydro substation will be located in the northwest corner of the OC Transpo facility at 1500 St. Laurent Boulevard in Ottawa. Currently, the site is occupied by an outdoor paved parking lot for buses. Based on available design information provided in the document titled, Technical Specifications for Geotechnical Investigation for the Proposed Substation located at OC Transpo St. Laurent (Rev.0) dated May 6,2022 (prepared by envari and CIMA) and the email dated July 4,2024 with the shop drawing for the proposed generator foundation, Drawing No. S3.1 dated December 7,2023, it is our understanding that the hydro substation will consist of the following:

- Three (3) switchgear buildings Two (2) of the three switchgear buildings will measure 5.84 m by 9.75 m, will be supported by eight (8) isolated footings with a building load of 13 000 kg/footing (128 kN/footing). The third switchgear building will measure 4.83 m by 5.41 m and will be supported by six (6) isolated footings with a building load of 13 000 kg/footing. The switchgear buildings will have a partial basement with the basement set at an approximate 2.0 m depth below final grade. The basement is assumed to be a drained structure. The switchgear buildings are considered to be heated buildings.
- XFO transformer foundations The two (2) XFO transformer foundations will each measure 3.0 m by 5.0 m and each XFO will have an approximate weight of 43 000 kg (422 kN), excluding the weight of the foundation. A below grade oil containment pit will surround the transformers. The depth below final grade of the oil containment pit (tank) at the time of this geotechnical investigation was not available. It is assumed the oil containment pit (tank) will be designed as a water-tight structure. The XFO transformers will be outdoor structures and are considered to be unheated structures.
- Generator foundations The generator foundations will be outdoor structures supported on a thickened reinforced
 concrete pad with the underside of the pad set at 1.050 m below final grade and supported by micro-piles. The generators
 are considered to be unheated structures.

9.1 Proposed Switchgear Building Foundations

A review of the available design information and borehole data indicates that the proposed switchgear buildings with partial basement set at approximately 2.0 m below final grade may be supported by strip and spread footings designed to bear on an engineered fill pad constructed on top of the native shaley glacial till or directly on the shaley glacial till. Alternatively, the proposed switchgear buildings may be supported by caissons socketed into the sound shale bedrock. Piles designed in end bearing and driven to practical refusal into the shale bedrock is not considered practical due to the shallow depth of the bedrock. For the two (2) foundation options, the ground floor of the proposed switchgear buildings may be designed as a slab-on-grade founded on an engineered fill pad constructed on the shaley glacial till. The existing fill and buried topsoil/organic soil are not suitable to support foundations and the basement floor slab-on-grade of the proposed switchgear buildings.

As previously discussed, the excavations are anticipated to extend below the groundwater level into the shaley glacial till that contains very loose to loose zones. The very loose to loose zones of the shaley glacial till below the groundwater level are susceptible to instability of the base of the excavation in the form of piping or heave. To minimize 'base-heave' type failure of the excavation base, maintain stability of the side slopes of the excavation and conduct the excavation and construction in relatively dry conditions, it is necessary to lower the groundwater table at the site to below the final excavation level prior to the start of the excavation. This may be achieved by installing deep sumps, pumping with high-capacity pumps and pumping on a continuous basis (such as twenty-four (24) hours a day, seven (7) days a week). The groundwater level should be lowered and maintained to at least 1.0 m below the bottom of the excavation until the placement and compaction of the engineered fill pad and other construction activities have been completed to the design subgrade level. Standpipes should also be installed to monitor the groundwater level during initial groundwater lowering and during construction. A specialized dewatering contractor should be consulted to determine the most appropriate dewatering method for the site conditions to allow for the construction of the engineered fill pad and other construction activities to be undertaken in relatively dry conditions.

The two (2) foundation options of footings and caissons are discussed in the following sections of this report.



9.1.1 Footings

The proposed switchgear buildings may be supported by strip and spread footings founded on a minimum 300 mm thick engineered fill pad set on the shaley glacial till and constructed in accordance with the procedure below or directly on the shaley glacial till. Footings founded on the properly constructed engineered fill pad or on the shaley glacial till may be designed for a bearing pressure at serviceability limit state (SLS) of 200 kPa and factored geotechnical resistance at ultimate limit state (ULS) of 300 kPa. The factored geotechnical resistance at ULS value includes a geotechnical resistance factor of 0.50. It is recommended that the very loose to loose zone of the shaley glacial till, such as identified in Borehole Nos. 22-13 and 22-14, should be excavated and removed as directed by the geotechnical engineer for the case where the footings will be directly founded on the shaley glacial till.

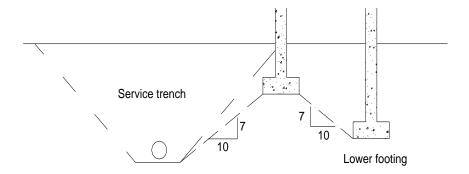
The total and differential settlements of footings designed in accordance with the recommendations of this report and with careful attention to construction detail are expected to be less than 25 mm and 19 mm respectively.

The preparation of the site for engineered fill pad construction requires all fill, surficial and buried topsoil/organic soil be excavated and removed down to the shaley glacial till. The excavation should extend a sufficient distance beyond the limits of the footprint of the proposed building to accommodate a 1.0 m wide bench of engineered fill around the perimeter of the building, which is thereafter sloped at an inclination of 1H:1V down to the approved shaley glacial till. The exposed shaley glacial till subgrade should be proofrolled and examined by a geotechnical engineer. Any loose/soft areas identified during proofrolling operations should be excavated and replaced with Ontario Provincial Standard Specification (OPSS) Granular B Type II compacted to 100 percent standard Proctor maximum dry density (SPMDD).

Following approval of the subgrade for the engineered fill pad, the excavation may be backfilled with the engineered fill consisting of free draining Ontario Provincial Standard Specification (OPSS) Granular B Type II material placed in 300 mm thick lifts and each lift compacted to 100 percent of the SPMDD under the footings and floor slab area. The engineered fill should be placed under the full-time supervision of a geotechnician working under the direction of a geotechnical engineer. In-place density tests should be undertaken on each lift of the engineered fill to ensure that it is properly compacted prior to placement of the subsequent lift.

Reference is made to previous comments dealing with dewatering of the excavation for the construction of the engineered fill pad.

Footings founded in soils at different elevations should be located such that the higher footings are set below a line drawn up at 10 horizontal to 7 vertical (10H:7V) from the near edge of the lower footing, as shown below. This concept should also be applied to service excavation, etc. to ensure that undermining is not a problem.



FOOTINGS NEAR SERVICE TRENCHES OR AT DIFFERENT ELEVATIONS

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

It should be noted that the exposed shaley glacial till subgrade surface is susceptible to disturbance due to movement of workers and construction traffic and the prevailing weather conditions during construction. To prevent disturbance to the soil subgrade, the approved shaley glacial till subgrade should be covered with a layer of engineered fill within the same day of approval if the



structure will be founded on an engineered fil pad or should be covered with a 50 mm thick concrete mud slab within the same day of approval if the footings will be founded directly on the shaley glacial till.

A minimum of 1.5 m of earth cover should be provided to the exterior foundations founded on soil 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 thermal combination of earth cover and rigid insulation board or rigid insulation board alone should be provided. EXP can provide developmental comments in this regard, if required.

9.1.1.1 Resistance to Uplift Forces

9.1.1.1.1 Weight of Footing

Footings may resist uplift forces by the submerged or effective weight of the footing. Alternatively, rock anchors may be used to resist uplift forces.

9.1.1.1.2 Rock Anchors

Post-tensioned rock anchors installed in the bedrock may be required as part of the footing design to resist uplift forces.

Pre-stressed anchors may fail in one or more of the following manners:

- 1. Failure of the grout/tendon bond,
- 2. Failure of the steel tendon or top anchorage,
- 3. Failure of the rock/grout bond; or
- 4. Pull-out failure of the cone-shaped rock mass.

Failure modes a) and b) require review by the structural engineer. Geotechnical related failure modes c) and d) for vertical grouted anchors are discussed below:

Failure of the rock/grout bond:

- The factored ultimate limit state (ULS) bond stress between the sound shale bedrock and the grout may be taken as 600 kPa and includes a resistance factor of 0.3. The unconfined compressive strength of the grout is assumed to be 35 MPa.
- Weathered zones such as in the upper 300 mm of the shale bedrock in Borehole No. 22-13 should not be included in
 the bond length. The depth and presence of the weathered and highly fractured zones of the bedrock may vary at
 locations away from the boreholes. For design purposes, the sound bedrock may be assumed to commence at 1.0 m
 below the bedrock surface.
- The minimum bonded length should be 3.0 m.

Pull-out failure of the cone-shaped rock mass:

- The pull-out failure of the embedment cone-shaped rock mass is defined by a 60 or 90-degree cone in the bedrock with the apex located at the midpoint of the bonded length of the anchor. For the shale bedrock, the apex angle of the rock failure cone should be taken as 60 degrees.
- The unbonded length may be taken as equal to the height of the theoretical rock cone minus half of the bonded length.
- The factored uplift resistance of the anchor should be determined by the submerged weight of the cone-shaped rock mass around the anchor. The submerged weight of the rock cone mass should not be less than the ultimate capacity of the anchor. The submerged unit weight of the shale bedrock equal to 16.2 kN/m³ should be used in the calculations.
- Where the embedment rock cones for a group of anchors overlap with each other, the combined embedment cones for the group of anchors should be used to determine the anchor group resistance to the rock mass pull-out failure.

The installation method of the rock anchors should take into consideration the presence of cobbles and boulders and shale fragments within the soils.



Corrosion Protection of the Anchors:

 Corrosion protection of the anchors should be in accordance with the Ontario Provincial Standard Specification (OPSS) 942.

Testing of Rock Anchors:

Pre-production or design performance tests of permanent rock anchors should be in accordance with the Ontario Provincial Standard Specification (OPSS) 942. Pre-production performance tests should be conducted on selected rock anchors. Proof load tests should be conducted on all anchors and should be in accordance with OPSS 942.

9.1.2 Drilled Shafts (Caissons)

The proposed building may be supported by drilled shafts (caissons) socketed into the sound shale bedrock below the any weathered zones of the bedrock. Based on the borehole information, shale bedrock was contacted at 2.8 m to 4.6 m depths (Elevation 66.9 m to Elevation 65.2 m). For design purposes, the sound bedrock may be assumed to commence at 1.0 m below the bedrock surface.

The axial geotechnical resistance is based on the caisson designed to carry the load based on sidewall (shaft) resistance between the concrete and the sound shale bedrock for the socketed length of the caisson in the sound bedrock and neglecting end bearing capacity. The caissons may be designed for a factored sidewall resistance at ULS of 800 kPa and includes a geotechnical resistance factor of 0.4. Compressive strength of concrete should be 35 MPa. The socket length into the sound bedrock should be at least 3 times the diameter of the caisson and the caissons should be spaced at a minimum of three (3) caisson diameters (centre-to-centre). Uplift forces may be resisted by the submerged weight of the caisson or by rock anchors.

The sidewall resistance of the bedrock at SLS required to produce 25 mm of settlement will be much larger than the recommended value for factored sidewall resistance at ULS. Therefore, the factored geotechnical resistance at ULS will govern the design.

The installation of the caissons should take into consideration the presence of cobbles and boulders and shale fragments within the soils. Installation of the caissons will require the use of at least one liner to minimize soil loss. The liner should be driven to the shale bedrock. It may be necessary to loosen the overburden material by augering through to the shale bedrock. The liner may then be advanced through the soil slurry to the bedrock. It is noted that the caissons will likely require dewatering operations since the groundwater level at the site is high above the bedrock surface. If the caissons cannot be dewatered, concrete may have to be placed by 'tremie' technique. During the withdrawal of the liner, a positive head of concrete would have to be maintained in the liner with respect to the exterior hydrostatic pressure.

It is imperative that the sidewalls of the portion of the caisson socketed into the sound bedrock be cleaned of any soil smearing, to ensure the concrete is in contact with clean bedrock.

All caissons must be inspected by a geotechnician under the supervision of a geotechnical engineer to confirm the factored geotechnical resistance value at ULS of the founding rock and to ensure that the caissons have been prepared satisfactorily and properly cleaned.

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

9.2 XFO Transformer Foundations

The outdoor XFO transformer structures will each have an oil containment pit (tank) and are considered to be unheated structures. The oil containment pits (tanks) should be designed as watertight structures to prevent water seepage into the tank. The design should assume that the highest groundwater table at the site may coincide with the existing ground surface. In this case, the XFO transformer foundation may consist of a thickened reinforced concrete pad founded on an engineered fill pad constructed on top of the shaley glacial till or founded directly on the shaley glacial till. The thickened reinforced concrete pad should be founded at a 2.4 m depth below final grade for frost protection where snow will removed from around the structure



and at a 2.1 m depth below final grade where snow will not be removed around the structure. The thickened reinforced concrete pad constructed on an engineered fill pad or approved shaley glacial till may be designed for a bearing pressure at serviceability limit state (SLS) of 200 kPa and factored geotechnical resistance at ultimate limit state (ULS) of 300 kPa. The factored geotechnical resistance at ULS value includes a geotechnical resistance factor of 0.50. It is recommended that the very loose to loose zone of the shaley glacial till, such as identified in Borehole Nos. 22-13 and 22-14 should be excavated and removed as directed by the geotechnical engineer for the case where the thickened reinforced concrete pad will be directly founded on the shaley glacial till.

The engineered fill pad should be constructed in accordance with section 9.1.1 of this report.

The total and differential settlements of the thickened reinforced concrete pad designed in accordance with the recommendations of this report and with careful attention to construction detail are expected to be less than 25 mm and 19 mm respectively.

Reference is made to previous comments dealing with dewatering of the excavation for the construction of the foundations for the XFO transformers.

The subgrade for the thickened reinforced concrete pad should be examined by a geotechnical engineer to ensure that the founding soil is capable of supporting the bearing pressure at SLS and that the subgrade has been properly prepared.

It should be noted that the exposed shaley glacial till subgrade surface is susceptible to disturbance due to movement of workers and construction traffic and the prevailing weather conditions during construction. To prevent disturbance to the soil subgrade, the approved shaley glacial till subgrade should be covered with a layer of engineered fill within the same day of approval if the structure will be founded on an engineered fil pad or should be covered with a 50 mm thick concrete mud slab within the same day of approval if the thickened reinforced concrete pad will be founded directly on the shaley glacial till.

When earth cover is less than the minimum required of 2.1 m and 2.4 m as previously discussed, an equivalent thermal combination of earth cover and rigid insulation board or rigid insulation board alone should be provided. EXP can provide developmental comments in this regard, if required.

9.3 Generator Foundations

The generator foundations will be outdoor structures supported on a thickened reinforced concrete pad with the underside of the pad set at 1.050 m below final grade and supported by micro-piles socketed into the underlying sound bedrock contacted at 4.1 m to 5.0 m (Elevation 65.8 m to Elevation 64.6 m). It is noted that the depth (elevation) to sound bedrock may vary at locations away from the boreholes.

Micro-piles are a proprietary product that should be designed and installed by a contractor specializing in the design and installation of micro-piles in the province of Ontario.

For guidance, the micro-pile should be cased in the overburden soil and into the upper level of the bedrock with the construction of the remainder of the micro pile completed by drilling an uncased hole into the sound bedrock. Such a pile will carry the load in bond between the grout and the sound bedrock. The bond between the casing and the soil should be neglected. The casing of the micro-pile should extend into the upper level of the bedrock. The load carrying capacity of the micro-pile may be computed from the following expression:

$$P_{\text{ult}} = \pi \alpha_1 l_1 d_1$$

Where Pult = Factored ultimate load carrying capacity of pile, kN

 α_1 = The factored bond between the sound bedrock and grout at ultimate limit state (ULS) is 800 kPa and includes a resistance factor of 0.4. Compressive strength of grout is 35 MPa.

 l_1 = Length of the uncased portion of the pile socketed into the sound bedrock, m

 d_1 = Diameter of drilled hole in bedrock, m



It is noted that the pile borings should be cased in the overburden soil and the shaley glacial till that contains possible cobbles and boulders to prevent cave-in of these materials and to reduce the groundwater seepage into the pile holes. It is imperative that the holes for installation of the piles are cleaned properly so that the grout is in contact with the clean bedrock that is free of any soil smearing. All water should be pumped out from the pile borings prior to the placement of the grout.

It is noted that the overburden soils contain possible boulders and cobbles which the installation contractor should take into consideration when selecting the method of drilling of the micro-piles. The shale bedrock may have fractured zones and the contractor should anticipate the possibility of significant grout takes within the fractured zones of the bedrock during grouting operations. Also, water inflow into the drilled micro-piles holes should be expected.

It is recommended that the pile capacity should be confirmed by conducting pre-production or design performance tests on selected piles and/or proof load test on all piles.

For the underside of the thickened reinforced concrete slab set at 1.050 m below final grade and the generator structure designated as an unheated structure, the micro-pile foundation and concrete will need to be protected from frost action by the placement of rigid board insulation beneath the concrete pad. The insulation should consist of extruded polystyrene rigid insulation board (such as Dow Chemical Canada Inc. Styrofoam Brand HI-60 or equivalent). The insulation board should be 75 mm thick and should extend laterally outward by a horizontal distance of 1.8 m from the outer edge of all sides of the concrete pad. If the depth of the underside of the concrete pad will be different than 1.050 m, EXP should be contacted to provide an updated thickness and horizontal distance for the rigid board insulation.

9.4 Additional Comment for Foundations

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



10. Floor Slab and Drainage Requirements

10.1 Switchgear Buildings

The basement floor of the proposed switchgear buildings may be designed and constructed as a slab-on-grade placed on a 200 mm thick well-packed 19 mm sized clear stone bed placed on a minimum 300 mm thick engineered fill pad set on the approved shaley glacial till. The engineered fill pad should be constructed in accordance with section 9.1.1. of this report. The clear stone will minimize the capillary rise of moisture from the sub-soil to the floor slab. Alternatively, the clear stone layer may be replaced with a 200 mm thick bed of OPSS Granular A compacted to 100 percent SPMDD overlain by a vapour barrier. Adequate saw cuts should be provided in the floor slabs to control cracking.

Reference is made to previous comments dealing with dewatering of the excavation for the construction of the engineered fill pad and other construction activities.

The proposed switchgear buildings will require perimeter and underfloor drainage systems.

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

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

The basement floor slab o the proposed switchgear building should be set at a minimum of 150 mm higher than the final exterior grade surrounding the switchgear building.

The final exterior grade surrounding the switchgear building should be sloped away from the building to prevent ponding of surface water close to the exterior walls of the building.

10.2 Generators

The thickened reinforced concrete pad for the generators should have a perimeter drainage system.

The final exterior grade surrounding the concrete pad for the generator should be sloped away from the building to prevent ponding of surface water close to the exterior walls of the building.

10.3 Vertical Modulus of Subgrade Reaction

For the slab-on-grade founded on the granular material consisting of 200 mm thick well-packed clear stone or OPSS Granular A layer over a minimum 300 mm thick engineered fill pad (OPSS Granular B Type II) compacted to 100 percent SPMDD, the vertical modulus of subgrade reaction is estimated to be 50 MPa/m.

For the thickened reinforced concrete pad for the XFO transformer founded on a minimum 300 mm thick engineered fill pad (OPSS Granular B Type II) compacted to 100 percent SPMDD or on the shaley glacial till with proofrolled very loose to loose zones of the shaley glacial till, the vertical modulus of subgrade reaction is estimated to be 50 MPa/m.



11. Lateral Earth Pressure Against Subsurface Walls

11.1 Switchgear Buildings: Drained Structure

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

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

 $P = K_0 h (\frac{1}{2} \gamma h + q)$

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

K₀ = lateral earth pressure at rest coefficient, assumed to be 0.5 for Granular B Type II

backfill material

 γ = unit weight of free draining granular backfill; Granular B Type II = 22 kN/m³

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

q = surcharge load stress, kPa

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

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

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

H = height of wall, m

 γ = unit weight of backfill material = 22 kN/m³

 $\frac{a_h}{a_h}$ = earth pressure coefficient or Peak Ground Acceleration (PGA) value

= 0.32 (Ottawa area)

F_b = thrust factor = 1.0

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

All subsurface walls should be properly dampproofed.



11.2 XFO Transformers: Water-Tight Structure

The XFO transformer oil containment pits (tanks) are anticipated to be designed as watertight structure, i.e. like a tank with its sides and base waterproofed and designed to resist lateral earth and hydrostatic thrusts.

The lateral static earth thrust on subsurface walls due to earth (static and dynamic conditions) and water pressure may be computed from equation (i) given below. For this purpose, the highest groundwater table at the site should be assumed to coincide with the ground surface.

$$p = \frac{1}{2}k \gamma' H^2 + kqH + \frac{1}{2}\gamma_w H^2 \qquad ------(i)$$

where p = lateral thrust due to earth and water pressure, kN/m

k = lateral earth pressure coefficient at rest, assumed to be 0.5

 $\gamma' = 12 \text{ kN/m}^3$ is the estimated submerged unit weight of the soil

q = is an allowance for surcharge, kPa

H = height of subsurface wall, m

 γ_w = unit weight of water (9.81 kN/m³)

In addition to the static earth and water pressures, the subsurface walls would be subjected to dynamic thrust from the soil. The subsurface walls would also be subjected to hydrodynamic thrust during a seismic event. The soil dynamic thrust (Δ_{Pe}) and the hydrodynamic thrust (P_w) may be computed from equations (ii) and (iii) given below:

$$\Delta_{Pe} = \gamma H^2 \frac{a_h}{a} F_b$$
 (ii)

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

H = height of subsurface wall, m

 γ = unit weight of soil = 22 kN/m³

$$\frac{a_h}{a}$$
 = seismic coefficient = PGA = 0.32

 $F_b = thrust factor = 1.0$

The dynamic thrust acts approximately at 0.63H above the base of the wall.

$$P_{W} = \frac{7}{12} \frac{a_{h}}{a} \gamma_{W} H^{2}$$
 (iii)

where $P_w = hydrodynamic thrust in kN/m of wall$

H = height of wall, m

 γ_w = unit weight of water (9.81 kN/m³)

 $\frac{a_h}{a}$ = earth pressure coefficient = PGA value = 0.32

The hydrodynamic thrust acts at Pw should be assumed to act at 0.6Hw from the top of the water level.

The total lateral thrust due to the water on the face of the wall is the sum of the hydrostatic and hydrodynamic thrusts.

All subsurface walls should be properly waterproofed.



12. Uplift Resistance for XFO Transformers

Th XFO transformers are anticiapted to be designed as water-tight structure to resist hydrostatic pressure and will be subjected to uplift forces. As previously indicated for the design of water-tight structures, the highest groundwater table at the site should be designed to coincide with the existing ground surface. The structures will therefore be subject to flotation when empty if the upward hydrostatic pressure is more than the weight of the structure.

The resistance to uplift of the structure due to extension of the slab beyond the perimeter of the structure may be computed from the following equations:

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

where γ' = submerged weight of granular backfill = 12 kN/m³

h = depth of the basement below ground surface, m

L₁ = extension of basement slab beyond the perimeter of structure, m

B = width of the structure, m

L = length of the structure, m

A geotechnical resistance factor of 0.5 may be applied to R1 to calculate the factored R1 value.

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 = 30 degrees

A geotechnical resistance factor of 0.8 may be applied to R2 to calculate the factored R2 value.

All other terms have been described previously.

Alternatively, the flotation may be resisted by rock anchors discussed in section 9.1.1.1 of this report.



13. Excavation and De-Watering Requirements

13.1 Excess Soil Management

Ontario Regulation 406/19 specifies protocols that are required for the management and disposal of excess soils. As set forth in the regulation, specific analytical testing protocols need to be implemented and followed based on the volume of soil to be managed and the requirements of the receiving site. The testing protocols are specific as to whether the soils are stockpiled or in situ. In either scenario, the testing protocols are far more onerous than have been historically carried out as part of standard industry practices. These decisions should be factored in and accounted for prior to the initiation of the project-defined scope of work. EXP would be pleased to assist with the implementation of a soil management and testing program that would satisfy the requirements of Ontario Regulation 406/19.

Reference is also made to the updated Phase Two ESA completed by EXP as part of this assignment.

13.2 Excavation

Excavations for the construction of the proposed structures and installation of the underground services are anticipated to extend to depths ranging from approximately 3.0 m to 4.0 m below existing grade and are expected to be within the fill and shaley glacial till and not expected to extend into the shale bedrock. Excavations will extend below the groundwater level.

The excavations within the soils may be undertaken by conventional heavy equipment capable of removing possible debris, cobbles and boulders within the fill and cobbles and boulders within the shaley glacial till.

Open cut excavations within the soils above the groundwater level are anticipated to be relatively straight forward.

All excavations must be undertaken in accordance with the Occupational Health and Safety Act (OHSA), Ontario Reg. 213/91. Based on the definitions provided in OHSA, the subsurface soils on site are considered to be Type 3 and as such must be cut back at 1H:1V from the bottom of the excavation. Within zones of seepage, the excavation side slopes are expected to slough and eventually stabilize at 2H:1V to 3H:1V from the bottom of the excavation. For excavations above the groundwater level or properly dewatered (refer to paragraph below), the installation of the municipal underground services may be undertaken within the confines of a prefabricated support system (trench box) designed and installed in accordance with OHSA.

The excavations are anticipated to extend below the groundwater level into the shaley glacial till that contains very loose to loose zones. The very loose to loose zones of the shaley glacial till below the groundwater level are susceptible to instability of the base of the excavation in the form of piping or heave. To minimize 'base-heave' type failure of the excavation base, maintain stability of the side slopes of the excavation and conduct the excavation and construction in relatively dry conditions, it is necessary to lower the groundwater table at the site to below the final excavation level prior to the start of the excavation. This may be achieved by installing deep sumps, pumping with high-capacity pumps and pumping on a continuous basis (such as twenty-four (24) hours a day, seven (7) days a week). The groundwater level should be lowered and maintained to at least 1.0 m below the bottom of the excavation until the placement and compaction of the engineered fill pad and other construction activities have been completed to the design subgrade level. Standpipes should also be installed to monitor the groundwater level during initial groundwater lowering and during construction. A specialized dewatering contractor should be consulted to determine the most appropriate dewatering method for the site conditions to allow for the construction of the engineered fill pad and other construction activities to be undertaken in relatively dry conditions.

If side slopes cannot be achieved due to space restrictions on site such as the proximity of open cut excavations to the property limits, existing infrastructure or to foundations of adjacent existing building(s), the new building construction would have to be undertaken within the confines of an engineered support system (shoring system).

The need for a shoring system, the most appropriate type of shoring system and the design and installation of the shoring system should be determined by the contractors bidding on this project. The design of the shoring system should be undertaken by a professional engineer experienced in shoring design and the installation of the shoring system should be undertaken by a contractor experienced in the installation of shoring systems. The shoring system should be designed and installed in accordance with latest edition of Ontario Regulation 213/91 under the OHSA and the 2006 Fourth Edition of the Canadian Foundation Engineering Manual (CFEM). The shoring system should be monitored on a periodic basis for lateral and vertical movements.



It is recommended that a pre-construction condition survey of adjacent building(s) and infrastructure located within the zone of influence of construction be undertaken prior to any earth (soil) and rock excavation work as well as vibration monitoring during excavation, blasting and construction operations. Prior to the commencement of blasting, a detailed blast methodology should be submitted by the Contractor.

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

13.3 De-Watering Requirements

Above the groundwater level, seepage of the surface and subsurface water into the excavations is anticipated. However, it should be possible remove groundwater entering into excavation by pumping from sumps. In areas of high infiltration or in areas where more permeable soil layers may exist, a higher seepage rate should be anticipated and will require high-capacity pumps to keep the excavation dry (may need to operate 24 hours a day, seven (7) days a week).

As discussed above, to minimize base type failure of excavations that extend below the groundwater level and into the shaley glacial till, it is recommended that the groundwater level should be lowered by at least 1.0 m below the bottom of the excavation prior to the start of excavation. This may be achieved by installing deep sumps and pumping with high-capacity pumps. A specialized dewatering contractor should be consulted to determine the most appropriate dewatering method for the site conditions to allow for the construction to be undertaken in relatively dry conditions.

For construction dewatering, an Environmental Activity and Sector Registry (EASR) approval may be obtained for water takings greater than 50 m³ and less than 400 m³ per day. If more than 400 m³ per day of groundwater are generated for dewatering purposes, then a Category 3 Permit to Take Water (PTTW) must be obtained from the Ministry of the Environment, Conservation and Parks (MECP). A Category 3 PTTW would require a complete hydrogeological assessment and would take at least 90 days for the MECP to process once the application is submitted.

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

13.4 Short and Long-Term Effects of Dewatering on Existing Structures

Based on a review of the subsurface conditions at the site, short-term dewatering of the site during construction and long-term lowering of the groundwater by perimeter and underfloor drainage systems are not anticipated to negatively impact adjacent foundations and infrastructure.



14. Pipe Bedding Requirements

It is anticipated that the subgrade for the proposed underground services will consist of existing fill and shaley glacial till.

The pipe bedding including material specifications, thickness of cover material and compaction requirements should conform to City of Ottawa specifications, drawings and special provisions. The bedding and cover material should be compacted to a minimum of 95 percent standard Proctor maximum dry density (SPMDD).

The bedding thickness may be increased in areas where the subgrade is subject to disturbance. If this is the case, trench base stabilization techniques, such as the removal of loose material, placement of sub-bedding, consisting of OPSS Granular B Type II completely wrapped in a non-woven geotextile, may be used.

For paved surfaces that will be located over service trenches, it is recommended that the trench backfill material within the 1.8 m frost zone, should match the existing material exposed along the trench walls to minimize differential frost heaving of the subgrade. The trench backfill should be placed in 300 mm thick lifts and each lift should be compacted to 95 percent SPMDD. Alternatively, frost tapers may be used.

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



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

The materials to be excavated from the site will comprise of pavement structure, fill (including buried organic soil layer within fill) and shaley glacial till. From a geotechnical perspective, the excavated fill is not considered suitable for reuse as backfill material in the interior or exterior of the switchgear buildings, XFO transformers and beneath the generator foundation and should be discarded. The excavated fill (free of cobbles, boulders and debris) above the groundwater level may be used for general grading purposes in landscaped areas. Portions of the excavated granular fill (base) from the existing pavement structure and shaley glacial till (free of cobbles and boulders) above the groundwater level may be re-used as fill in locations away from the proposed switchgear buildings, XFO transformers and generators as backfill in service trenches and subgrade fill in paved and landscaped areas, subject to further geotechnical examination and testing during construction. These soils are subject to moisture absorption due to precipitation and must be protected at all times from the elements. Subject to additional examination and testing during construction, portions of the shaley glacial till (free of cobbles and boulders) below the groundwater level, may be re-used as fill in locations away from the proposed switchgear buildings, XFO structures and generators as backfill in service trenches and subgrade fill in paved and landscaped areas, but will likely require air-drying to reduce the moisture content to compact the materials to the specified degree of compaction. Air-drying may be problematic (difficult) since it is weather dependent, may take time and that the soils are subject to moisture absorption from precipitation and must be protected at all times from the elements.

Therefore, it is anticipated that the majority of the material required for backfilling purposes in the interior and exterior of the proposed structures (switchgear buildings, XFO transformers and beneath the generators) and in the underground service trenches will need to be imported and should preferably conform to the following specifications:

- Engineered fill under footings, thickened reinforced concrete pads, floor slabs-on-grade OPSS Granular B Type II placed in 300 mm thick lifts and each lift compacted to 100 percent SPMDD,
- Backfill material for footing trenches and against foundation walls located outside the proposed structures OPSS
 Granular B Type II placed in 300 mm thick lifts and each lift compacted to 95 percent SPMDD,
- Trench backfill and subgrade fill away from the structures should consist of OPSS Granular B Type I or OPSS Select Subgrade Material (SSM) placed in 300 mm thick lifts and each lift compacted to 95 percent SPMDD; and
- Landscaped areas Clean fill that is free of organics and deleterious material, cobbles and boulders and is placed in 300 mm thick lifts with each lift compacted to 92 percent of the SPMDD.



16. Pavement Structures for Access Roads and Parking Lots

Subgrade for the proposed paved parking lots and access roads are anticipated to comprise of existing fill, OPSS Granular B Type II material or select subgrade material (SSM) used to raise the grades to the design subgrade level.

Pavement structure thicknesses required for the new paved access roads and parking lots set on the anticipated approved subgrade materials were computed and are shown in Table VIII. The pavement structures assume a 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 VIII: Flexible Pavement Structures – Parking Lots and Access Roads							
Pavement Layer	Compaction Requirements	Computed Pavement Structure					
		Light Duty Traffic (Cars Only)	Heavy Duty Traffic (Buses, Emergency Vehicles and Trucks)				
Asphaltic Concrete	92 percent-97 percent MRD	65 mm HL3/SP12.5 mm/ Cat. B (PG 58-34)	60 mm HL3/SP12.5 Cat. D (PG 64-34) 90 mm HL8/SP 19 Cat. D (PG 64-34)				
OPSS 1010 Granular A Base	100% percent SPMDD	150 mm	150 mm				
OPSS 1010 Granular B Type II Sub-base	100% percent SPMDD	450 mm	600 mm				

Notes:

- 1. SPMDD denotes standard Proctor maximum dry density, ASTM, D-698-12e2.
- 2. MRD denotes Maximum Relative Density, ASTM D2041.
- 3. The upper 300 mm of the subgrade fill must be compacted to 98 percent SPMDD.
- 4. The approved subgrade should be covered with a woven geotextile prior to placement of granular sub-base of the pavement structure.

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

Additional comments for the construction of the access roads and parking lots are as follows:

- 1. As part of the subgrade preparation, the proposed parking areas and the internal access roads should be stripped of existing pavement structure, surficial topsoil and any other unsuitable material. The subgrade should be properly shaped, crowned, then proofrolled with a heavy vibratory roller in the full-time presence by a geotechnician. Any soft or spongy subgrade areas detected should be sub excavated and properly replaced with suitable approved material or approval OPSS Granular B Type II placed in 300 mm lift and each lift compacted to 95 percent SPMDD (ASTM D698-12e2).
- 2. The long-term performance of the pavement structure is highly dependent upon the subgrade support conditions. Stringent construction control procedures should be maintained to ensure that uniform subgrade moisture and density conditions are achieved. The need for adequate drainage cannot be over-emphasized. Subdrains should be installed on both sides of the access road(s). Subdrains must be installed in the proposed parking area and on both sides of the roadways at low points and should be continuous between catchbasins to intercept excess surface and subsurface moisture and to prevent subgrade softening. This will ensure no water collects in the granular course, which could result in pavement failure during the spring thaw.
- 3. To minimize the problems of differential movement between the pavement and catchbasins/manhole due to frost action, the backfill around the structures should consist of free-draining granular preferably conforming to OPSS Granular B Type II material. Weep holes should be provided in the catchbasins/manholes to facilitate drainage of any water that may accumulate in the granular fill.



- 4. The most severe loading conditions on light-duty pavement areas and the subgrade may occur during construction. Consequently, special provisions such as restricted lanes, half-loads during paving, temporary construction roadways, etc., may be required, especially if construction is carried out during unfavorable weather.
- 5. The finished pavement surface should be free of depressions and should be sloped (preferably at a minimum cross fall of 2 percent) to provide effective surface drainage towards catchbasins. Surface water should not be allowed to pond adjacent to the outside edges of paved areas.
- 6. Relatively weaker subgrade may develop over service trenches at subgrade level. These areas may require the use of thicker/coarser sub-base material and the use of a geotextile at the subgrade level. if this is the case, it is recommended that additional 150 mm of granular sub-base Granular B Type II should be provided in these areas in addition to the use of a geotextile at the subgrade level.
- 7. The granular materials used for pavement construction should conform to OPSS 1010 for Granular A and Granular B Type II and should be compacted to 100 percent of the SPMDD (ASTM D698). The asphaltic concrete and its placement should meet OPSS requirements. It should be compacted to 92 to 97 percent of the maximum relative density in accordance with ASTM D2041.

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 MRD (ASTM D2041). Asphalt placement should be in accordance with OPSS 310 and OPSS 313.

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



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17. Corrosion Potential

Chemical tests limited to pH, sulphate, chloride and resistivity were undertaken on four (4) soil samples and two (2) sections of the bedrock cores. A summary of the results is shown in Table IX. The laboratory certificate of analysis is shown in Appendix C.

Table IX: Corrosion Test Results on Soil Samples and Rock Core Sections											
Borehole – Sample/Run No.	Depth (m)	Soil/Bedrock Type	pH Sulphate (%)		Chloride (%)	Resistivity (ohm-cm)					
Soil Samples											
BH 22-11: SS4	2.3-2.9	Fill	7.56	0.0111	0.1660	249					
BH/MW 22-13: SS4	2.3-2.9	Fill	7.72	0.0576	0.0237	676					
BH/MW 22-13: SS6	3.8-4.4	Shaley Glacial Till	7.50	0.0067	0.1630	260					
BH/MW 24-11 : SS5	3.0-3.6	Shaley Glacial Till	7.63	0.0422	0.1370	337					
		Bedro	ock Core Section	ıs							
BH 24-10 : Run 2	5.6-5.7	Shale Bedrock	9.84	0.0029	0.0081	4220					
BH/MW 24-11: Run 1	4.6—4.7	Shale Bedrock	9.23	0.0020	0.0016	6060					

The test results indicate the soils and shale bedrock have a negligible sulphate attack on subsurface concrete. The concrete should be designed in accordance with CSA A.23.1-19.

The results from the resistivity tests indicate that the fill and shaley glacial till are very corrosive and the shale bedrock is mildly corrosive to bare steel as per the National Association of Corrosion Engineers (NACE). Appropriate measures should be taken to protect the buried bare steel from corrosion.



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18. Tree Planting Restrictions

Since sensitive marine clays are not present at the site, there are no restrictions to tree planting with respect to the City of Ottawa 2005 Clay Soils Policy and 2017 Tree Planting in Sensitive Marine Clay Soils Guidelines.



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19. **General Comments**

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

The information contained in this report is not intended to reflect on environmental aspects of the soils and groundwater. Reference should be made to the EXP Phase One ESA and updated Phase Two ESA for the environmental aspects of the soils and groundwater.

We trust that the information contained in this report will be satisfactory for your purposes. Should you have any questions, OFESSIONAL FILE please do not hesitate to contact this office,

Sincerely,

Susan M. Potyondy, P.Eng. Senior Geotechnical Engineer

Earth & Environment

fsmail M. Taki, M.Eng., P.Eng. Senior Manager, Eastern Region

Earth & Environment



EXP Services Inc.

Geotechnical Investigation — Proposed OC Transpo Hydro Substation 1500 St. Laurent Boulevard, Ottawa, ON OTT-22007382-B0 July 11, 2024

Figures



1:1250

LOCATIONS OF PROPOSED STRUCTURES

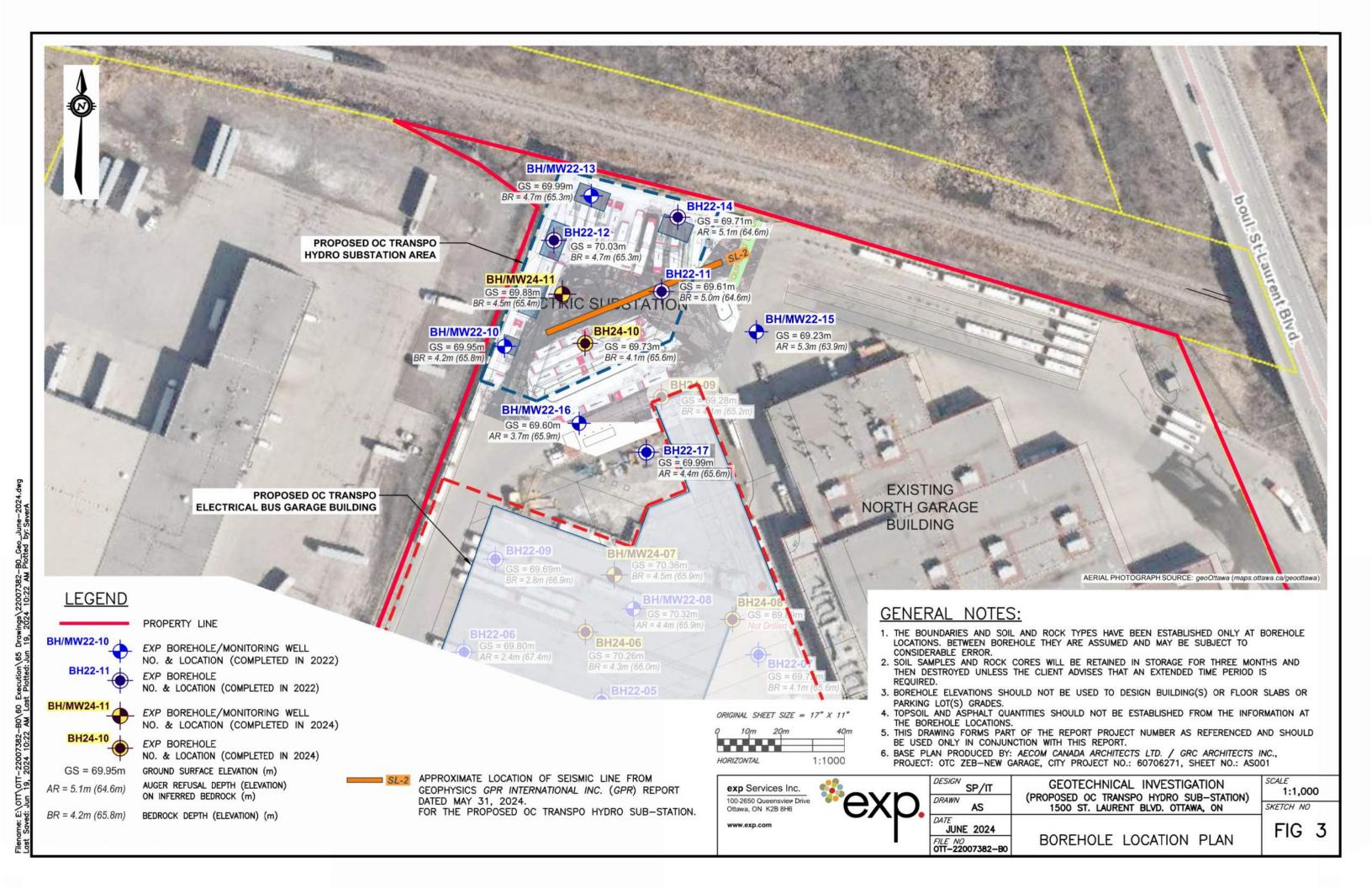
JUNE 2024

FILE NO OTT-22007382-B0 FIG 2

Filename: E:\OTT\OTT-22007382-B0\60 Execution\65 Drawings\22007382-B0_Geo_June-2024.dwg Last Saved: Jun 19, 2024 10:09 AM Last Plotted: Jun 19, 2024 10:10 AM Plotted by: SeverA

ELECTRICAL BUS GARAGE BUILDING AREA

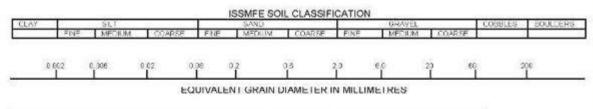
HYDRO SUB-STATION AREA



Geotechnical Investigation – Proposed OC Transpo Hydro Substation 1500 St. Laurent Boulevard, Ottawa, ON OTT-22007382-B0 July 11, 2024

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 Society 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.



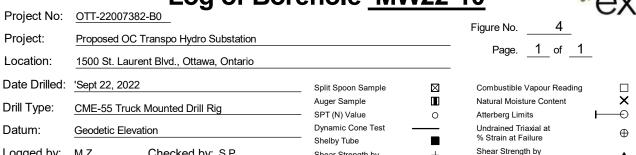
CLAY(PLASTIC) TO	FINE	MEDIUM	CRS	FINE	COARSE
SILT (NONPLASTIC)	1,5000	SAND	The services	0.000	GRAVEL

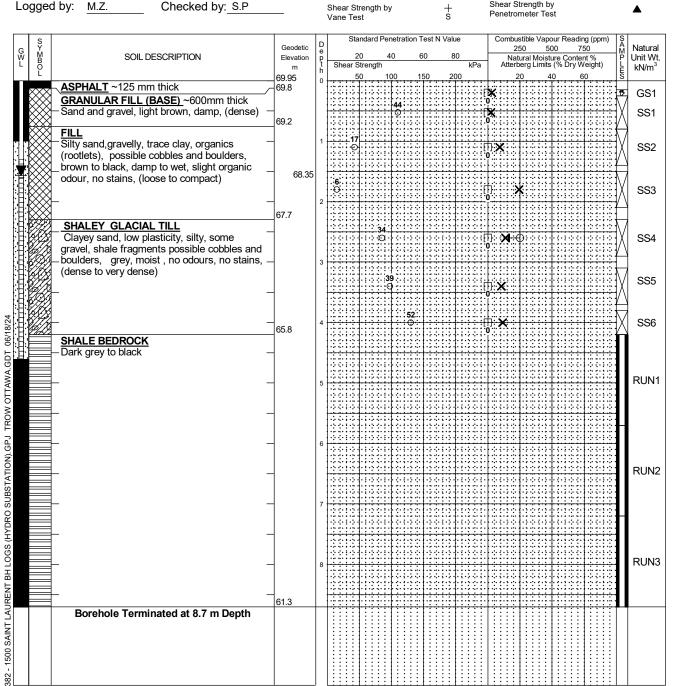
UNIFIED SOIL CLASSIFICATION

- 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 MW22-10





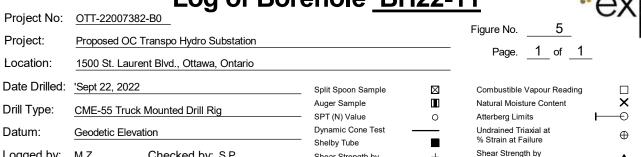
NOTES:

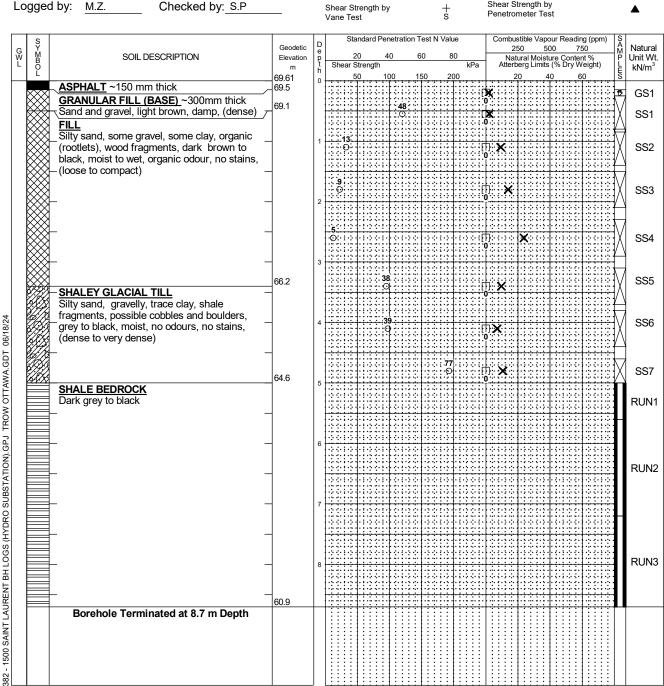
- Borehole data requires interpretation by EXP before use by others
- 2.50 mm monitoring well installed upon completion of drilling.
- 3. Field work supervised by an EXP representative.
- 4. See Notes on Sample Descriptions
- $5. Log\ to\ be\ read\ with\ EXP\ Report\ OTT-22007382-B0$

WA	TER LEVEL RECO	RDS
Date	Water Level (m)	Hole Open To (m)
November 14, 2022	2.0	
'May 30, 2024	1.6	

	CORE DRILLING RECORD										
Run No.	Depth (m)	% Rec.	RQD %								
1	4.2 - 5.7	98	53								
2	5.7 - 7.2	100	53								
3	7.2 - 8.7	100	74								

Log of Borehole BH22-11





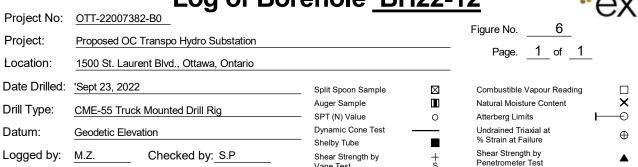
NOTES:

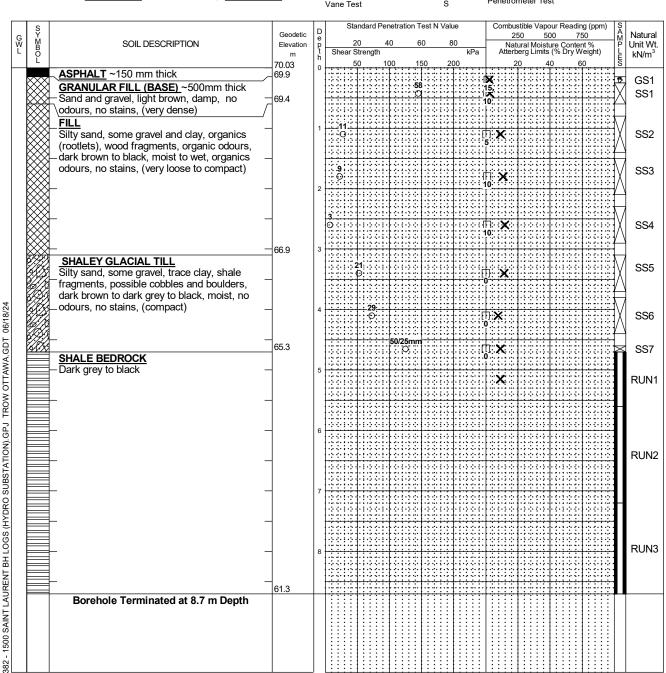
- Borehole data requires interpretation by EXP before
 use by others.
- 2. Borehole backfilled upon completion.
- 3. Field work supervised by an EXP representative.
- 4. See Notes on Sample Descriptions
- 5. Log to be read with EXP Report OTT-22007382-B0

WATER LEVEL RECORDS									
Date	Water Level (m)	Hole Open To (m)							
		4.0							

	CORE DRILLING RECORD										
Run No.	Depth (m)	% Rec.	RQD %								
1	5 - 5.6	100	71								
2	5.6 - 7.2	100	71								
3	7.2 - 8.7	100	91								

Log of Borehole BH22-12





NOTES:

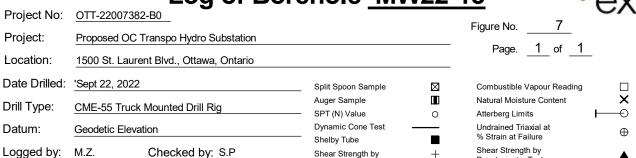
OTT-22007

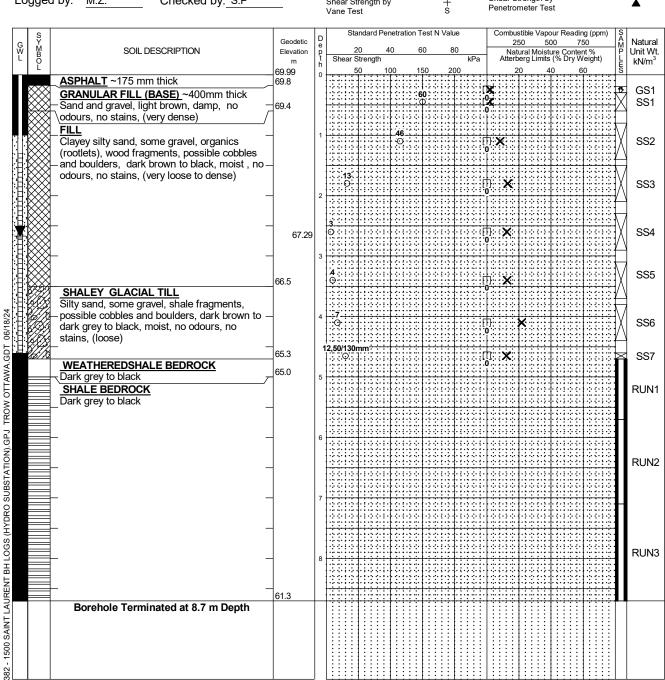
- Borehole data requires interpretation by EXP before
 use by others
- 2. Borehole backfilled upon completion.
- 3. Field work supervised by an EXP representative.
- 4. See Notes on Sample Descriptions
- 5.Log to be read with EXP Report OTT-22007382-B0

WATER LEVEL RECORDS									
Date	Water Level (m)	Hole Open To (m)							
		4.0							

CORE DRILLING RECORD								
	Run No.	Depth (m)	% Rec.	RQD %				
	1	4.7 - 5.6	86	66				
	2	5.6 - 7.2	97	72				
	3	7.2 - 8.7	96	85				

Log of Borehole MW22-13





NOTES:

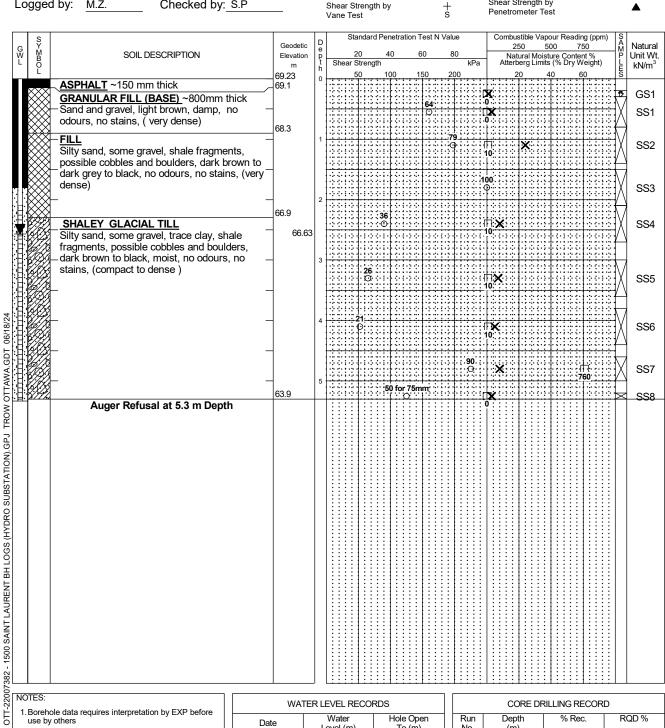
- Borehole data requires interpretation by EXP before use by others
- 2.50 mm monitoring well installed upon completion of drilling.
- 3. Field work supervised by an EXP representative.
- 4. See Notes on Sample Descriptions
- $5. Log\ to\ be\ read\ with\ EXP\ Report\ OTT-22007382-B0$

WATER LEVEL RECORDS									
Date	Water Level (m)	Hole Open To (m)							
November 14, 2022	2.8								
'May 30, 2024	2.7								

	CORE DRILLING RECORD										
Run No.	Depth (m)	% Rec.	RQD %								
1	4.7 - 5.7	95	24								
2	5.7 - 7.1	99	74								
3	7.1 - 8.7	100	93								

roject No											Figure	No.	8			
roject:	Proposed OC Transpo Hydro Su										Pa	age	1_ of	_1_		•
ocation:	1500 St. Laurent Blvd., Ottawa,	Ontario								_						
ate Drilled	d: 'Sept 20, 2022			-	Split Sp			le					apour Rea	-		□ X
rill Type:	CME-55 Truck Mounted Drill Rig	9		-	Auger S SPT (N				0			rg Limit	re Content s	ı		∼
atum:	Geodetic Elevation			_	Dynami Shelby			st				ned Tria: n at Fai				\oplus
ogged by:	M.Z. Checked by:	S.P	_		Shear S	Stren			+ s			Strength ometer 1				A
				_			ard Per	etration	Test N Val	ue	Combi	ustible Va	apour Read	ina (ppm)	Ts	
S Y M B O	SOIL DESCRIPTION		Geodetic Elevation	D e p t		20	4			80 kPa	:	250		750	SAMPLES	Natura Unit W
Ĺ	PRIMIT : 150 mm think	_	69.71	h 0	Sileai	50	10	0 1	50 2	00 100	Allei	20	40 - 1	60	Ē	kN/m
₩ GF	SPHALT ~150 mm thick RANULAR FILL (BASE) ~500mm th	nick	69.6				30				[X				. 0	GS1
	nd and gravel, light brown, damp, nours, no stains, (dense)	io –	69.1				: : : C				.0 .0				X	SS1
₩_FIL				1		18 O					X		;			SS2
fra	gments, organics (rootlets), dark brock, moist to wet, no odours, no stair	own to			.5 (.1.)		· · · · ·	· (· (·) (· · (· (·) (·	· · · · · · · · · · · · · · · · · · ·		0)			-52
	ose to compact)	.5,			13						X					SS3
—		_		2	· · · · · · · · · · · · · · · · · · ·		· · · · · ·	· (· (·) (· · (· (·) (·	12212	# ! * ! * ! ! ! ! ! ! !	0		100000			ļ
		_			5											
					0::::						() ()				ijΛ	SS4
		_		3												
		_			8			· <u>* · ! · </u>			<u>ф</u>	X			ЦХ	SSS
SI SI	HALEY GLACIAL TILL		65.9													1
Sil	ty sand, some gravel, shale fragments sible cobbles and boulders, dark browns	nts,		4			33.13				ф: ж		} 		$\exists \chi$	SS6
da	rk grey to black, moist, no odours, n														- / `	
sta	ins, (loose to very dense)				33.13			52 			ш ж ::				\mathbb{X}	SS7
<i>762</i>	Auger Refusal at 5.1 m Depth	<u> </u>	64.6	5		#					1				7	
OTES:			I .	_	L::::	1:	::::				1::::	1:::	:1::::	1:::	<u>-</u>	<u> </u>
1.Borehole da	ta requires interpretation by EXP before			ER L	EVEL R Water	ECC		Hole Op	en	Run	C		RILLING R			QD %
use by other Borehole ba	s ckfilled upon completion.	Date	e	L	evel (m)	+ '	To (m)		No.	(n		/0 FXE		15	70 ماري
	upervised by an EXP representative.							4.3								
		I	1						- 1	I	l .		I			

		Log of I	3ore)	hole M	W2	22-1	15	-	YY
Proj	ect No:	OTT-22007382-B0						Firmura NIa O		''
Proj	ect:	Proposed OC Transpo Hydro Substation		Figure No. 9 Page. 1 of 1		1				
Loca	ation:	1500 St. Laurent Blvd., Ottawa, Ontario						rage. <u>1</u> 01 <u>1</u>	_	
Date Drilled: 'Nov. 15, 2022					Split Spoon Sample			Combustible Vapour Reading		
Drill Type: CME-55 Truck Mounte		CME-55 Truck Mounted Drill Rig	unted Drill Ria		Auger Sample		_	Natural Moisture Content		×
	Datum: Geodetic Elevation				SPT (N) Value Dynamic Cone Test Shelby Tube		<u> </u>	Atterberg Limits Undrained Triaxial at % Strain at Failure	 	⊕
Logged by:		M.Z. Checked by: S.P			Shear Strength by Vane Test		+ s	Shear Strength by Penetrometer Test		•
G i	В	SOIL DESCRIPTION	Geodetic Elevation m 69.23	D e p t h	Standard Penetrat 20 40 Shear Strength 50 100	60 150	80 kP	Combustible Vapour Reading (p 250 500 750 Natural Moisture Content % Atterberg Limits (% Dry Weigh 20 40 60		Natural Unit Wt kN/m ³



LOG OF BOREHOLE

- 1. Borehole data requires interpretation by EXP before use by others
- 2.50 mm monitoring well installed 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-22007382-B0

WAT	WATER LEVEL RECORDS											
Date	Water Level (m)	Hole Open To (m)										
November 24, 2022	2.1											
'May 30, 2024	2.6											

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

0.9

Log of Borehole BH24-10

Project No:	OTT-22007382-B0			110	10		<u> </u>	147		<u> </u>	ام	10			X
Project:	Proposed OC Transpo Hydro Substation	n							_ '	Ū	_	10	_		ı
Location:	1500 St. Laurent Blvd, Ottawa, Ontario								_	Pag	ge	<u>ı</u> of			
Date Drilled:	'May 9, 2024			Split Spo	on Sam	ple				Combust	tible Vap	our Read	ing		
Drill Type:	CME 75 Track-Mounted Drill Rig			-				1				Content			×
Datum:	Geodetic Elevation			. ,		est				Undraine	ed Triaxia		r		Ф
Logged by:	A.N Checked by: S.P					v		■		Shear St	rength b	у			A
55 ,						,		Ś		Penetror	neter Te	st			_
S Y M B O	SOIL DESCRIPTION	Geodetic Elevation	D e p	2	20	enetr 40			30	25	50 .	500 7	750 /	SAMPLIES	Natural Unit Wt.
L	PHALT~150 mm thick	Page. Auger Sample Auger Sample			weight) 60 1	E S	kN/m³								
GR/	ANULAR FILL(BASE)~535 mm thick	09.60								×					AS1
Silty	sand and gravel, brown, moist, no urs, no stains	69.0												1	
FIL Silty	<u>L</u> sand, some gravel, organics	-	1	13			1.3.4.			×				$\frac{1}{2}$	SS2
(root	tlets), cobbles and boulders, shale ments, no odour, black stains,	68.3												:[/	002
,, ,,, \(con	npact)	1					1.2.0			~				\mathbb{V}	SS3
<u> </u>	GANIC SOIL ure of silty sand, gravel and organic	67.5	2	- Y- 1-5			1 - 5 - 5 -	-3-0-1-5			-1 -1	+ 2-1-5-2 + 2-1-5-2		Δ	555
Soil \	with rootlets, brown and black, moist to organic odour, no stains, (loose)]		3313		40								17	
FIL FIL	L]				φ	1-1-1-	- 3 - 3 - 3 - 3 - 3		×				$\left \right $	SS4
poss	sand, some gravel, shale fragments, sible cobbles and boulders, brown,	66.7	3											1/	
	st, no odours, no stains, (dense) LEY GLACIAL TILL _			-5						×				X	SS5
San	d and gravel, trace silt, shale ments, possible cobbles and boulders,		15	then 50 f	or 25mm										
dark	brown to dark grey to black, moist, no		4	0						×				X	SS6
	urs, no stains, (dense) LE BEDROCK														
	grey														RUN1
	-	1	5				1.3.3.					1000			
				-2 (-1 -2 -			1.3.1				-3 -3 -4 -3				
	_			3 3 1 3											
	-	1	6	-2-6-1-2-			1 - 2 - 2 - 2	-3-0-6-3-		0.000	-3 -5 (+3 -3 -5 (+3	10000			
															RUN2
	_			0.000			1.7.					1000			
	Poroholo Torminated at 7.4 m Danth	62.6	7							1::::::		1::::		Ш	
	Sorehole Terminated at 7.1 m Depth														
Note	_														
	S3 & SS5 samples submitted for ronmental laboratory analyses.														
	, ,														
NOTES:			.[L	L	1	:::		1::::	1::::	l::::	1::::	1::::		

LOG OF BOREHOLE BH LOGS-NEW BUS GARAGE.GPJ TROW OTTAWA.GDT 06/14/24

Borehole data requires interpretation by EXP before use by others

2. Borehole backfilled upon completion of drilling.

 $3. \mbox{{\it Field}}$ work supervised by an EXP representative.

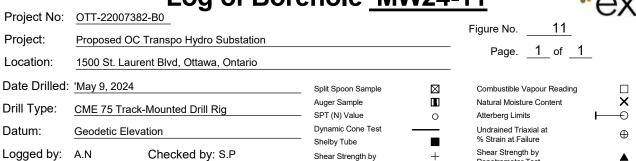
4. See Notes on Sample Descriptions

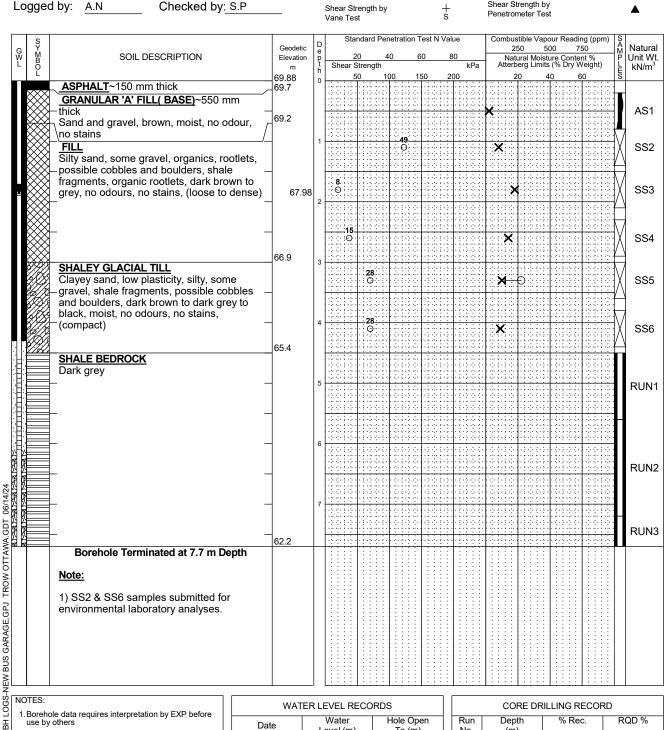
5.Log to be read with EXP Report OTT-22007382-B0

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

	CORE DRILLING RECORD										
Run No.	Depth (m)	% Rec.	RQD %								
1	4.1 - 5.5	100	50								
2	5.5 - 7.1	100	83								

Log of Borehole <u>MW24-11</u>





- Borehole data requires interpretation by EXP before use by others
- 2.A 31 mm diameter monitoring well installed as shown.
- 3. Field work supervised by an EXP representative.
- 4. See Notes on Sample Descriptions
- 5.Log to be read with EXP Report OTT-22007382-B0

WATER LEVEL RECORDS										
Date	Water Level (m)	Hole Open To (m)								
'May 30, 2024	1.9									

	CORE DRILLING RECORD											
Run	Depth	% Rec.	RQD %									
No.	(m)											
1	4.5 - 5.6	91	70									
2	5.6 - 7.2	100	97									
3	7.2 - 7.7	100	95									

Grain-Size Distribution Curve Method of Test For Sieve Analysis of Aggregate ASTM C-136

100-2650 Queensview Drive Ottawa, ON K2B 8H6

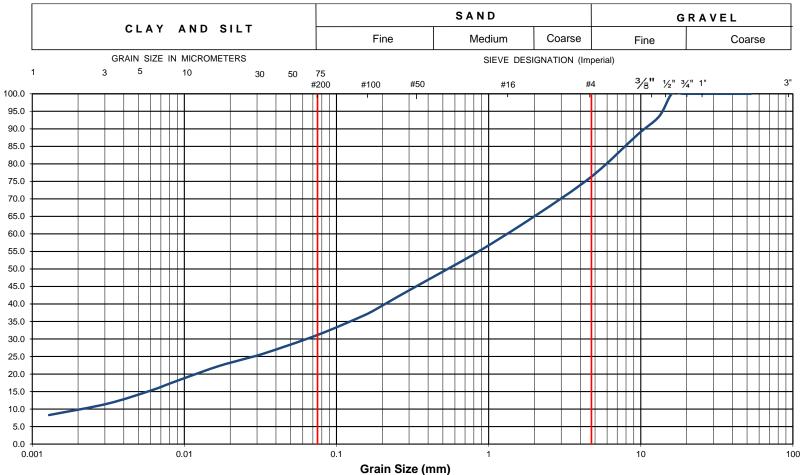


EXP Project No.:	OTT-22007382-B0	Project Name :	oject Name : Proposed OC Transpo Hydro Substation						
Client :	City of Ottawa	Project Location	ject Location: 1500 St. Laurent Blvd., Ottawa, ON						
Date Sampled :	May 9, 2024	Borehole No:		BH24-10	Sample	: A	S1	Depth (m):	0.2-0.6
Sample Composition :		Gravel (%)	38	Sand (%)	42	Silt & Clay (%)	20	Figure :	12
Sample Description :	rigure :	12							



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

100-2650 Queensview Drive Ottawa, ON K2B 8H6

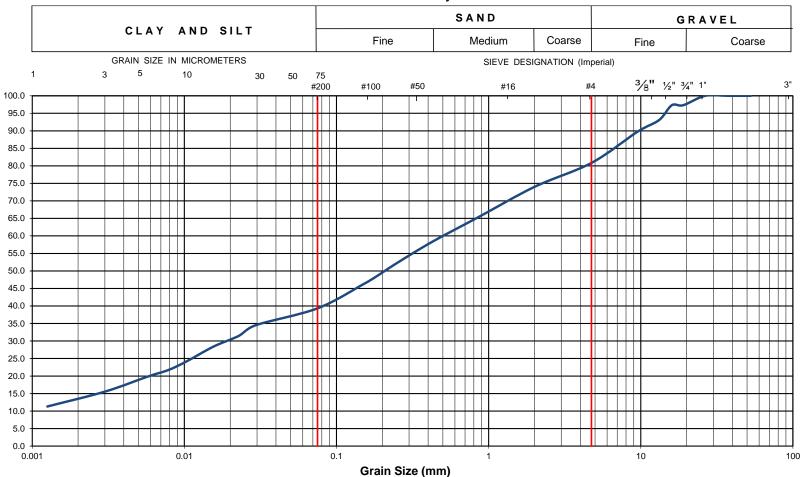


EXP Project No.:	OTT-22007382-B0	Project Name :	roject Name : Proposed OC Transpo Hydro Substation										
Client :	City of Ottawa	Project Location	oject Location : 1500 St Laurent Blvd., Ottawa, ON										
Date Sampled :	September 19, 2022	Borehole No:		22-10 Sample No.: SS2				Depth (m):	0.8-1.4				
Sample Description :		% Silt and Clay	31	% Sand	45	% Gravel		24	Figure :	13			
Sample Description : FILL: Silty Sand (SM) - Gravelly, Trace Clay										13			



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

100-2650 Queensview Drive Ottawa, ON K2B 8H6

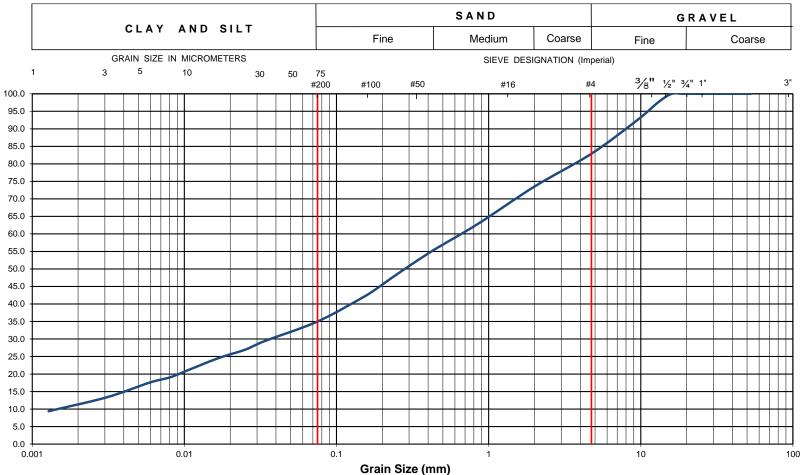


EXP Project No.:	OTT-22007382-B0	Project Name :	roject Name : Proposed OC Transpo Hydro Substation										
Client :	City of Ottawa	Project Location	Project Location: 1500 St Laurent Blvd., Ottawa, ON										
Date Sampled :	September 21, 2022	Borehole No:		22-11	San	ple No.:	S	Depth (m):	0.8-1.4				
Sample Description :		% Silt and Clay	39	% Sand	41	% Gravel		20	Figure :	14			
Sample Description : FILL: Silty Sand (SM) - Some Gravel and Clay										14			



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

100-2650 Queensview Drive Ottawa, ON K2B 8H6

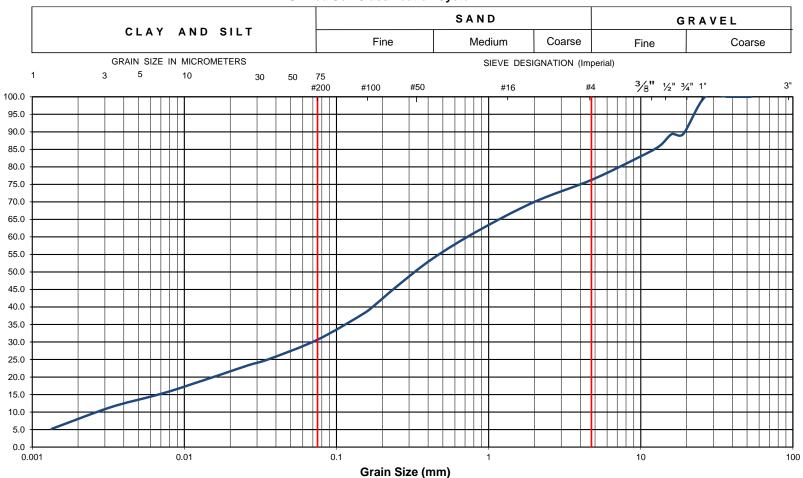


EXP Project No.:	OTT-22007382-B0	Project Name :	roject Name : Proposed OC Transpo Hydro Substation									
Client :	City of Ottawa	Project Location	:									
Date Sampled :	September 23, 2022	Borehole No:		22-12	Sam	ple No.: SS		S3	Depth (m):	1.5-2.1		
Sample Description :		% Silt and Clay	35	% Sand	48	% Gravel		17	Figure :	15		
Sample Description :												



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

100-2650 Queensview Drive Ottawa, ON K2B 8H6

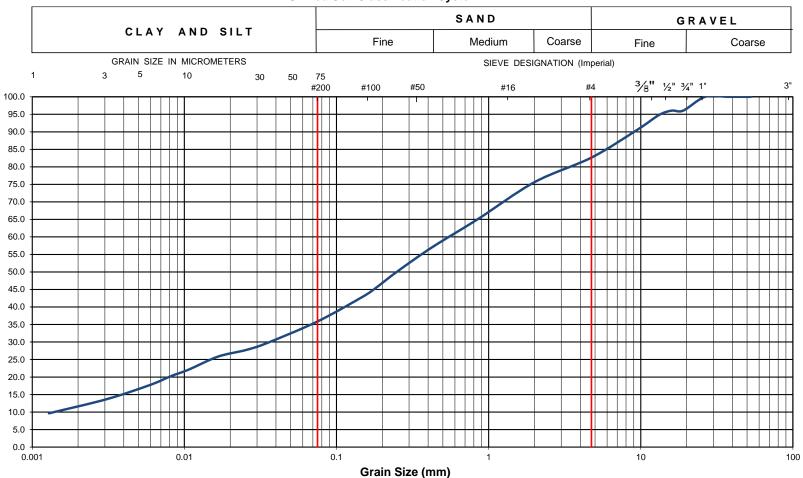


EXP Project No.:	OTT-22007382-B0	Project Name :	Project Name : Proposed OC Transpo Hydro Substation										
Client :	City of Ottawa	Project Location	Project Location : 1500 St Laurent Blvd., Ottawa, ON										
Date Sampled :	September 20, 2022	Borehole No:		22-14 Sample No.: SS3					Depth (m):	1.5-2.1			
Sample Description :		% Silt and Clay	31	% Sand	45	% Gravel		24	Figure :	16			
Sample Description : FILL: Silty Sand (SM) - Gravelly, Trace Clay										10			



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

100-2650 Queensview Drive Ottawa, ON K2B 8H6

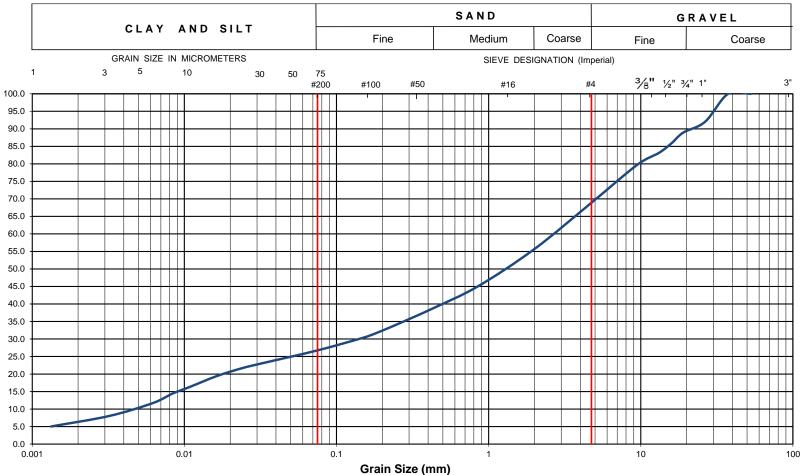


EXP Project No.:	OTT-22007382-B0	Project Name :		Proposed OC T	ranspo l				
Client :	City of Ottawa	Project Location	roject Location: 1500 St Laurent Blvd., Ottawa, ON						
Date Sampled :	September 22, 2022	Borehole No:		22-10	Sample No.: SS4			Depth (m):	2.3-2.9
Sample Description :		% Silt and Clay	36	% Sand 47 % Gravel 17			17	Figure: 17	17
Sample Description :	SHALEY GLACIAL TILL: Clayey Sand (SC) - Low Plasticity, Some Gravel, Silty							rigule .	17



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

100-2650 Queensview Drive Ottawa, ON K2B 8H6

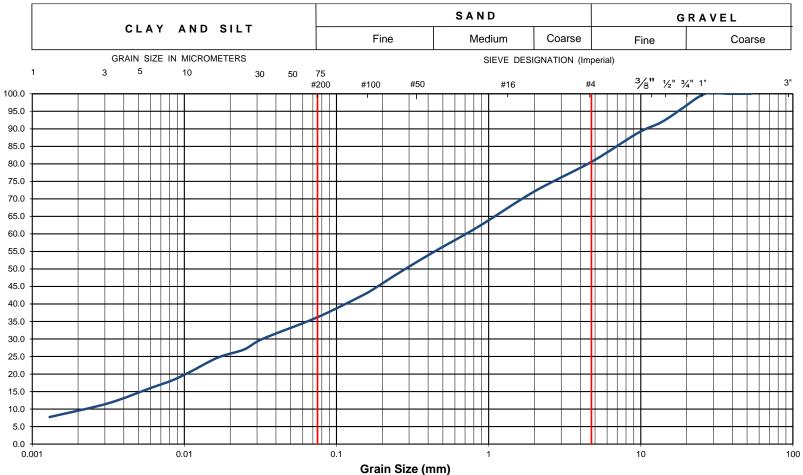


EXP Project No.:	OTT-22007382-B0	Project Name :	roject Name : Proposed Hydro Substation							
Client :	City of Ottawa	Project Location	roject Location: 1500 St Laurent Blvd., Ottawa, ON							
Date Sampled :	September 21, 2022	Borehole No:		22-11 Sample No.: SS7			Depth (m) :	4.6-5.0		
Sample Description :		% Silt and Clay	27	% Sand	42	% Gravel		31	Figure :	18
Sample Description :	SHALEY GLACIAL TILL: Silty Sand (SM) - Gravelly, Trace Clay							rigure .	10	



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

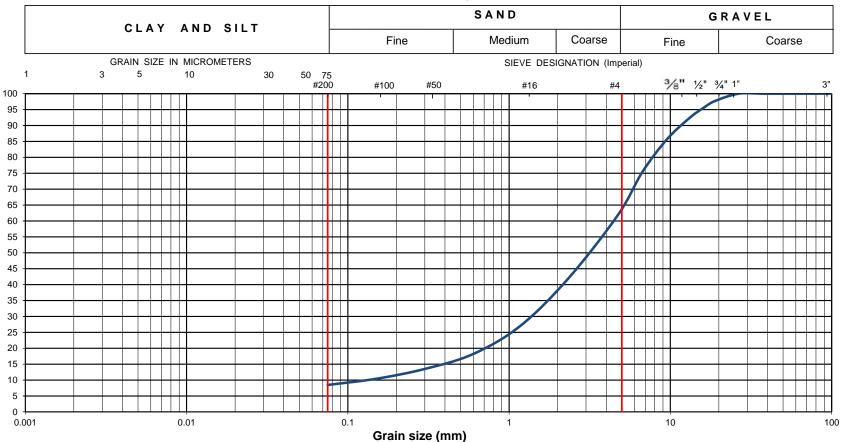
100-2650 Queensview Drive Ottawa, ON K2B 8H6



EXP Project No.:	OTT-22007382-B0	Project Name :	roject Name : Proposed OC Transpo Hydro Substation							
Client :	City of Ottawa	Project Location	roject Location: 1500 St Laurent Blvd., Ottawa, ON							
Date Sampled :	September 23, 2022	Borehole No:		22-12 Sample No.: SS6				Depth (m):	3.8-4.4	
Sample Description :		% Silt and Clay	36	% Sand	45	% Gravel		19	Figure :	19
Sample Description :	SHALEY GLACIAL TILL: Silty Sand (SM) - Some Gravel, Trace Clay							rigure .	19	

Grain-Size Distribution Curve Method of Test For Sieve Analysis of Aggregate ASTM C-136

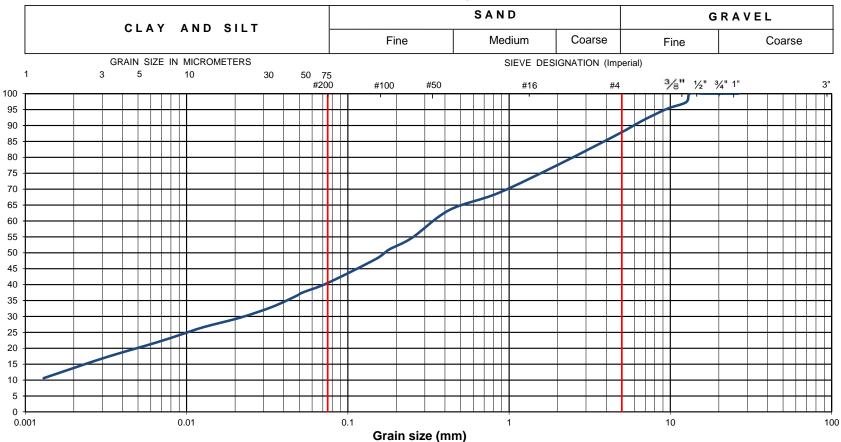
100-2650 Queensview Drive Ottawa, ON K2B 8H6



EXP Project No.:	OTT-22007382-B0	Project Name :		Proposed OC T	ranspo F				
Client :	City of Ottawa	Project Location	1500 St. Lauren	1500 St. Laurent Blvd., Ottawa, ON					
Date Sampled :	May 9, 2024	Borehole No:		BH24-10	Sample:		SS6	Depth (m):	3.8-4.1
Sample Composition :		Gravel (%)	38	Sand (%)	54	Silt & Clay (%)	8	Figure :	20
Sample Description :	SHALEY GLACIAL TILL: Poorly-Graded Sand (SP-SM) and Gravel - Trace Silt						rigure :	20	



Grain-Size Distribution Curve Method of Test For Sieve Analysis of Aggregate ASTM C-136



EXP Project No.:	OTT-22007382-B0	Project Name :		Proposed OC T	ranspo H				
Client :	City of Ottawa	Project Location	ı :	1500 St. Lauren	t Blvd., C				
Date Sampled :	May 9, 2024	Borehole No:		BH24-11	Sample:		SS5	Depth (m) :	3.0-3.6
Sample Composition :		Gravel (%)	13	Sand (%)	47	Silt & Clay (%)	40	Figure :	21
Sample Description :	SHALEY GLACIAL TILL: Clayey Sand (SC) - Low Plasticity, Some Gravel, Silty						rigule:	21	

EXP Services Inc.

Geotechnical Investigation – Proposed OC Transpo Hydro Substation 1500 St. Laurent Boulevard, Ottawa, ON OTT-22007382-B0 July 11, 2024

Appendix A – Seismic Shear Wave Velocity Soundings Survey Report by GPR





May 31st, 2024

Transmitted by email: ismail.taki@exp.com

Our ref: GPR24-05486-b

Mr. Ismail Taki, M.Eng., P.Eng. Senior Manager, Earth & Environment, Eastern Region **exp** Services inc. 100 - 2650 Queensview Drive Ottawa ON K2B 8H6

Subject: **Shear Wave Velocity Soundings for the Site Classes Determination** 1500 St. Laurent Boulevard, Ottawa (ON)

[Project: OTT-22007382-B0]

Dear Mr. Taki,

Geophysics GPR International inc. has been mandated by exp Services inc. to carry out seismic surveys at the OC Transpo Bus Garage Parking, located at 1500 St. Laurent Boulevard, in Ottawa (ON). The geophysical investigation used the Multi-channel Analysis of Surface Waves (MASW), the Spatial AutoCorrelation (SPAC), and the seismic refraction method. From the subsequent results, the seismic shear wave velocity values were calculated for the soils and the rock, to determine two Site Classes.

The surveys were conducted on May 15th, 2024, by Mrs. Karyne Faguy, B.Sc. geophysics and Mr. Charles Trottier, M.Sc. physics. Figure 1 shows the regional location of the site and Figure 2 illustrates the locations of the seismic spreads. Both figures are presented in the Appendix.

The following paragraphs briefly describe the survey design, the principles of the testing methods, and the results presented in table and graph.

MASW Principle

The Multi-channel Analysis of Surface Waves (MASW) and the SPatial AutoCorrelation (SPAC 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 wave. 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 SPAC is considered a "passive" method, using the low frequency "signals" produced far away. The method can also be used with "active" seismic source records. The SPAC method generally allows deeper V_S soundings. Its dispersion curve can then be merged with the one of higher frequency from the MASW to calculate a more complete inversion. The dispersion properties are expressed as a change of velocities with respect to 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/SPAC records, a corresponding spectrogram analysis and resulting 1D V_S model.

INTERPRETATION

The main processing sequence involved data inspection and edition when required; spectral analysis (from MASW and SPAC); picking the fundamental mode; and 1D inversion of the MASW and SPAC 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 around 15% or better.

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 spreads were laid out west of the building (Figure 2). The seismic line SL-1 was located South, and SL-2 was located North. For SL-1, the geophone spacing was 3.0 metres for the main spread, using 24 geophones, and it was 2.5 metres for SL-2. Two shorter seismic spreads, with geophone spacing of 0.5 and 1.0 metre, were dedicated to the near surface materials. The seismic records were produced with a seismograph Terraloc MK6 (from ABEM Instrument), and the geophones were 4.5 Hz.

The seismic records counted 4096 data, sampled at 1000 μ s for the MASW surveys, and at 50 μ s for the seismic refraction. The records included a pre-trigged portion of 10 ms. An 8 kg sledgehammer was used as the energy source, with impacts being recorded off both ends of the seismic spreads. A stacking procedure was also used to improve the Signal / Noise ratio for the seismic records.

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.

RESULTS

The MASW calculated V_S results are illustrated at Figure 5.

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 down to 30 metres, as:

$$\bar{V}_{S30} = \frac{\sum_{i=1}^{N} H_i}{\sum_{i=1}^{N} H_i/V_i} \mid \sum_{i=1}^{N} H_i = 30 \text{ m}$$

(N: number of layers; H_i : thickness of layer "i"; V_i : V_S of layer "i")

Thus, the \overline{V}_{S30} value represents the seismic shear wave velocity of an equivalent homogeneous single layer response, between the surface and 30 metres deep.

The calculated \overline{V}_{830} values of the actual sites are 1171.6 m/s (Table 1) for the South part and 1094.1 m/s (Table 3) for the North part, both corresponding to the Site Class "B". However, the Site Classes A and B are not to be used if there is 3 metres or more of soils between the rock and the bottom of the foundation. In the case there would be 2.6 metres or less of soils at the South location (table 2), and 1.7 metres or less of soils at the North one (Table 4), the \overline{V}_{830} * values would be greater than 1500 m/s, corresponding to the Site Class "A".



Mr. Ismail Taki, M.Eng., P.Eng. May 31st, 2024

4

CONCLUSION

Geophysical surveys were carried out to identify two Site Classes at the OC Transpo Bus Garage Parking, located at 1500 St. Laurent Boulevard, in Ottawa (ON). The seismic surveys used the MASW and the SPAC analysis, and the seismic refraction to calculate the \overline{V}_{S30} values. Their calculations are presented at Table 1 and Table 3.

The \overline{V}_{S30} values of the actual sites are 1172 and 1094 m/s, for the South and the North parts respectively. Both values are corresponding to the Site Class "B" (760 $<\overline{V}_{S30} \le 1500$ m/s), as determined through the MASW and SPAC methods, Table 4.1.8.4.-A of the NBC (2015), and the Building Code, O. Reg. 332/12. It must be noted that the Site Classes A and B are not to be used if there is 3 metres or more of unconsolidated materials between the rock surface and the bottom of spread footing or mat foundation.

In the case there would be 2.6 metres or less of soils at the South location, and 1.7 metres or less of soils at the North one, the \overline{V}_{S30} * values would be greater than 1500 m/s, corresponding to the Site Class "A".

It must also be noted that other geotechnical information gleaned on site; including the presence of liquefiable soils, very soft clays, high moisture content etc. (cf. Table 4.1.8.4.-A of the NBC 2015) 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.

Hoping the whole to your satisfaction, we remain yours truly,

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

Senior Project Manager







Figure 1: Regional location of the Site (Source : OpenStreetMap®)



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



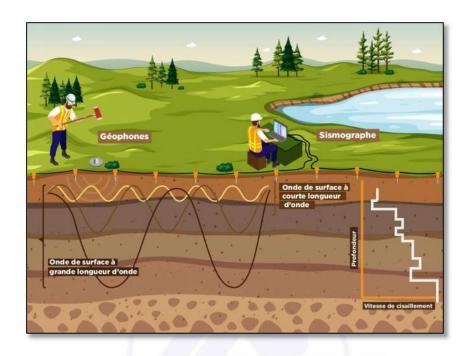


Figure 3: MASW Operating Principle

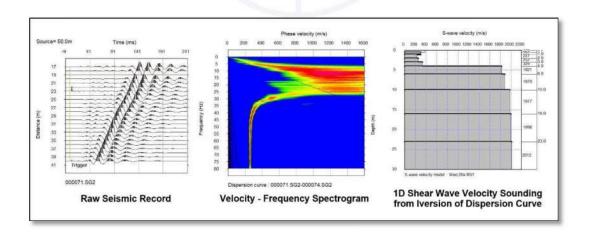


Figure 4: Example of a MASW/SPAC record, Phase Velocity - Frequency curve of the Rayleigh wave and resulting 1D Shear Wave Velocity Model



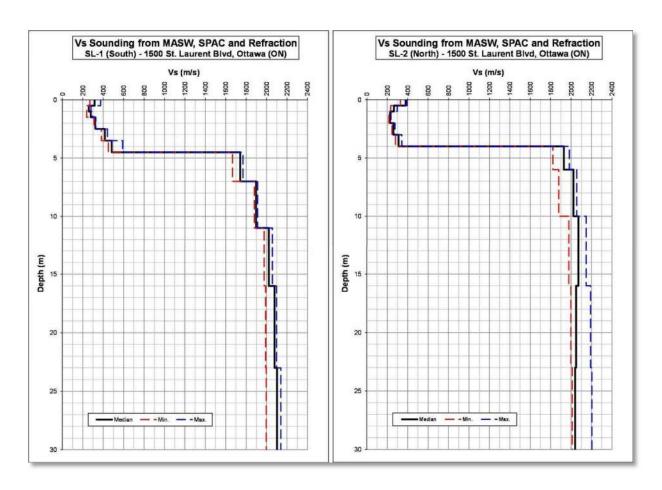


Figure 5: MASW Shear-Wave Velocity Soundings



Depth		Vs		Thickness	Cumulative	Delay for	Cumulative	Vs at given
Deptil	Min.	Median	Max.	THICKHESS	Thickness	med. Vs	Delay	Depth
(m)	(m/s)	(m/s)	(m/s)	(m)	(m)	(s)	(s)	(m/s)
0	269.5	315.9	374.8		Grade	Level (May 15	5 th , 2024)	
0.5	238.4	259.4	280.3	0.50	0.50	0.001583	0.001583	315.9
1.0	238.3	278.0	294.0	0.50	1.00	0.001928	0.003510	284.9
1.5	310.3	321.3	327.0	0.50	1.50	0.001798	0.005309	282.6
2.5	382.1	416.5	441.8	1.00	2.50	0.003113	0.008421	296.9
3.5	450.2	483.3	590.3	1.00	3.50	0.002401	0.010822	323.4
4.5	1665.9	1741.6	1768.9	1.00	4.50	0.002069	0.012891	349.1
7.0	1880.4	1897.0	1912.0	2.50	7.00	0.001435	0.014326	488.6
11.0	1975.7	2021.6	2056.7	4.00	11.00	0.002109	0.016435	669.3
16.0	1990.7	2077.9	2097.2	5.00	16.00	0.002473	0.018908	846.2
23.0	1996.5	2102.5	2139.3	7.00	23.00	0.003369	0.022277	1032.5
30				7.00	30.00	0.003329	0.025606	1171.6

Vs30 (m/s)	1171.6
Class	B ⁽¹⁾

(1) The Site Classes A and B are not to be used if there is 3 metres or more of unconsolidated material between the rock surface and the bottom of the spread footing or the mat foundation.

 ${\color{red}{{\sf TABLE~2}}}$ SL-1 (South) - ${\color{blue}{\bar{V}_{\sf S30}}}$ * Calculation for the Limit of the Site Class A

Depth		Vs		Thickness	Cumulative	Delay for	Cumulative	Vs at given
Deptil	Min.	Median	Max.	HIICKHESS	Thickness	med. Vs	Delay	Depth
(m)	(m/s)	(m/s)	(m/s)	(m)	(m)	(s)	(s)	(m/s)
0	269.5	315.9	374.8					
0.5	238.4	259.4	280.3					
1.0	238.3	278.0	294.0		Limit for the Sit	te Class A (2.0	6 metres of soil	s)
1.5	310.3	321.3	327.0	1				•
1.9	310.3	321.3	327.0					
2.5	382.1	416.5	441.8	0.60	0.60	0.001868	0.001868	321.3
3.5	450.2	483.3	590.3	1.00	1.60	0.002401	0.004268	374.8
4.5	1665.9	1741.6	1768.9	1.00	2.60	0.002069	0.006337	410.3
7.0	1880.4	1897.0	1912.0	2.50	5.10	0.001435	0.007773	656.1
11.0	1975.7	2021.6	2056.7	4.00	9.10	0.002109	0.009881	920.9
16.0	1990.7	2077.9	2097.2	5.00	14.10	0.002473	0.012355	1141.3
23.0	1996.5	2102.5	2139.3	7.00	21.10	0.003369	0.015723	1341.9
31.9				8.90	30.00	0.004233	0.019957	1503.3

Vs30 *	1503.3
Class	A



Depth		Vs		Thickness	Cumulative	Delay for	Cumulative	Vs at given				
Deptil	Min.	Median	Max.	HIIICKHESS	Thickness	med. Vs	Delay	Depth				
(m)	(m/s)	(m/s)	(m/s)	(m)	(m)	(s)	(s)	(m/s)				
0	329.5	378.5	394.5		Grade Level (May 15 th , 2024)							
0.5	233.7	265.4	297.4	0.50	0.50	0.001321	0.001321	378.5				
1.0	215.3	227.3	236.3	0.50	1.00	0.001884	0.003205	312.0				
2.0	246.4	260.6	275.0	1.00	2.00	0.004399	0.007604	263.0				
3.0	280.3	310.3	342.5	1.00	3.00	0.003838	0.011442	262.2				
4.0	1821.3	1929.8	1982.3	1.00	4.00	0.003222	0.014664	272.8				
6.0	1879.0	2023.1	2055.8	2.00	6.00	0.001036	0.015700	382.2				
10.0	1977.9	2072.0	2147.5	4.00	10.00	0.001977	0.017677	565.7				
16.0	1998.4	2049.1	2190.9	6.00	16.00	0.002896	0.020573	777.7				
23.0	2012.4	2039.9	2203.7	7.00	23.00	0.003416	0.023989	958.8				
30				7.00	30.00	0.003432	0.027421	1094.1				

Vs30 (m/s)	1094.1
Class	B ⁽¹⁾

(1) The Site Classes A and B are not to be used if there is 3 metres or more of unconsolidated material between the rock surface and the bottom of the spread footing or the mat foundation.

 ${\color{red}{{\sf TABLE~2}}}$ SL-2 (North) - ${\color{blue}{\bar{V}_{\sf S30}}}$ * Calculation for the Limit of the Site Class A

Depth		Vs		Thickness	Cumulative	Delay for	Cumulative	Vs at given		
Deptil	Min.	Median	Max.	HIIICKIIESS	Thickness	Delay	Depth			
(m)	(m/s)	(m/s)	(m/s)	(m)	(m)	(s)	(s)	(m/s)		
0	329.5	378.5	394.5							
0.5	233.7	265.4	297.4							
1.0	215.3	227.3	236.3		Limit for the Sit	te Class A (1.	7 metres of soil	s)		
2.0	246.4	260.6	275.0							
2.3	246.4	260.6	275.0							
3.0	280.3	310.3	342.5	0.70	0.70	0.002686	0.002686	260.6		
4.0	1821.3	1929.8	1982.3	1.00	1.70	0.003222	0.005909	287.7		
6.0	1879.0	2023.1	2055.8	2.00	3.70	0.001036	0.006945	532.8		
10.0	1977.9	2072.0	2147.5	4.00	7.70	0.001977	0.008922	863.0		
16.0	1998.4	2049.1	2190.9	6.00 13.70 0.002896 0.011818 1159.2						
23.0	2012.4	2039.9	2203.7	7.00	20.70	0.003416	0.015234	1358.8		
32.3				9.30	30.00	0.004559	0.019793	1515.7		

Vs30 *	1515.7
Class	Α



EXP Services Inc.

Geotechnical Investigation – Proposed OC Transpo Hydro Substation 1500 St. Laurent Boulevard, Ottawa, ON OTT-22007382-B0 July 11, 2024

Appendix B – Bedrock Core Photographs



DRY BEDROCK CORES

WET BEDROCK CORES

4.2m





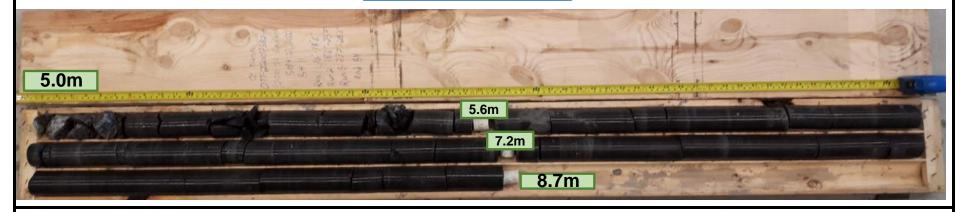


EXP Services Inc. www.exp.com

borehole no.				project no.
BH/MW 22-10	Run 1: 4.2m - 5.7m Run 2: 5.7m - 7.2m Run 3: 7.2m - 8.7m	project	Proposed OC Transpo Hydro Substation - 1500 St. Laurent Blvd., Ottawa, ON	OTT-22007382-B0
date cored				
Sep 22, 2022			Rock Core Photographs	FIG. B-1



WET BEDROCK CORES





EXP Services Inc. www.exp.com

borehole no.				project no.
BH 22-11	Run 1: 5.0m - 5.6m Run 2: 5.6m - 7.2m Run 3: 7.2m - 8.7m	project	Proposed OC Transpo Hydro Substation - 1500 St. Laurent Blvd., Ottawa, ON	OTT-22007382-B0
date cored Sep 22, 2022			Rock Core Photographs	FIG. B-2

DRY BEDROCK CORES

4.7m



WET BEDROCK CORES





EXP Services Inc. www.exp.com

borehole no.				project no.
BH22-12	Run 1: 4.7m - 5.6m Run 2: 5.6m - 7.2m Run 3: 7.2m - 8.7m	project	Proposed OC Transpo Hydro Substation - 1500 St. Laurent Blvd., Ottawa, ON	OTT-22007382-B0
date cored				
Sep 23, 2022			Rock Core Photographs	FIG. B-3







EXP Services Inc. www.exp.com

borehole no.				project no.
BH/MW 22-13	Run 1: 4.7m - 5.7m Run 2: 5.7m - 7.1m Run 3: 7.1m - 8.7m	project	Proposed OC Transpo Hydro Substation - 1500 St. Laurent Blvd., Ottawa, ON	OTT-22007382-B0
date cored				
Sep 22, 2022			Rock Core Photographs	FIG. B-4

DRY BEDROCK CORES

WET BEDROCK CORES







EXP Services Inc. www.exp.com

borehole no.				project no.	
BH24-10	Run 1: 4.1m - 5.5m Run 2: 5.5m - 7.1m end of borehole	project	Proposed OC Transpo Hydro Substation - 1500 St. Laurent Blvd., Ottawa, ON	OTT-22007382-B0	
date cored	51.0 51 551 51.010				
May 09, 2024			Rock Core Photographs	FIG. B-5	





EXP Services Inc. www.exp.com

borehole no.				project no.	
BH/MW 24-11	Run 1: 4.5m - 5.6m Run 2: 5.6m - 7.2m Run 3: 7.2m - 7.7m	project	Proposed OC Transpo Hydro Substation - 1500 St. Laurent Blvd., Ottawa, ON	OTT-22007382-B0	
date cored May 09, 2024	end of borehole		Rock Core Photographs	FIG. B-6	
Way 09, 2024			•		

EXP Services Inc.

Geotechnical Investigation – Proposed OC Transpo Hydro Substation 1500 St. Laurent Boulevard, Ottawa, ON OTT-22007382-B0 July 11, 2024

Appendix C – Laboratory Certificate of Analysis Report by AGAT





CLIENT NAME: EXP SERVICES INC

2650 QUEENSVIEW DRIVE, UNIT 100

OTTAWA, ON K2B8H6

(613) 688-1899

ATTENTION TO: SURINDER AGGARWAL

PROJECT: OTT-22007382-AO

AGAT WORK ORDER: 22Z962626

SOIL ANALYSIS REVIEWED BY: Jacky Zhu, Spectroscopy Technician

DATE REPORTED: Nov 03, 2022

PAGES (INCLUDING COVER): 6 VERSION*: 1

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

Notes	

Disclaimer:

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

AGAT Laboratories (V1)

Page 1 of 6

Member of: Association of Professional Engineers and Geoscientists of Alberta (APEGA)

Western Enviro-Agricultural Laboratory Association (WEALA) Environmental Services Association of Alberta (ESAA)



Certificate of Analysis

AGAT WORK ORDER: 22Z962626 PROJECT: OTT-22007382-AO

FAX (905)/12-5122 http://www.agatlabs.com

5835 COOPERS AVENUE

MISSISSAUGA, ONTARIO CANADA L4Z 1Y2

TEL (905)712-5100 FAX (905)712-5122

ATTENTION TO: SURINDER AGGARWAL

SAMPLED BY:

Anion Scan in Soil

DATE RECEIVED: 2022-10-27								D/	ATE REPOR	TED: 2022-11-03	
				BH 1 SS 2 2.				BH 5 SS 5		BH 7 SS 5	
		SAMPLE DES	CRIPTION:	5'-4.5'		BH 3 SS 3 5'-7'		10'-12'		10'-12'	
		SAM	PLE TYPE:	Soil		Soil		Soil		Soil	
		DATE	SAMPLED:	2022-10-20		2022-10-19		2022-10-19		2022-10-20	
Parameter	Unit	G/S	RDL	4467358	RDL	4467360	RDL	4467361	RDL	4467362	
Chloride (10:1)	mg/kg		40	933	100	1320	20	422	40	1140	
Sulphate (10:1)	mg/kg		40	281	100	819	20	515	40	863	
10:1 (DI water Extr.)			N/A	Υ	N/A	Υ	N/A	Υ	N/A	Υ	
						BH 11 SS 4 7.		BH 13 SS 4 7.		BH 13 SS 6	
		SAMPLE DES	CRIPTION:	BH 9 SS 3 5'-7'		5'-9.5'		5'-9.5'		12.5'-14.5'	
		SAM	PLE TYPE:	Soil		Soil		Soil		Soil	
		DATE	SAMPLED:	2022-10-20		2022-10-21		2022-10-22		2022-10-22	
Parameter	Unit	G/S	RDL	4467363	RDL	4467364	RDL	4467365	RDL	4467366	
Chloride (10:1)	mg/kg		20	518	40	1660	20	237	40	1630	
Sulphate (10:1)	mg/kg		20	116	40	111	20	576	40	67	
10:1 (DI water Extr.)			N/A	Υ	N/A	Υ	N/A	Υ	N/A	Υ	

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

4467358-4467366 Results are based on a dry weight.

CLIENT NAME: EXP SERVICES INC

SAMPLING SITE:

Dilution required, RDL has been increased accordingly.

Analysis performed at AGAT Toronto (unless marked by *)

CHARTERED SHOWN THE CHARTE

Certified By:



Certificate of Analysis

AGAT WORK ORDER: 22Z962626

PROJECT: OTT-22007382-AO
ATTENTION TO: SURINDER AGGARWAL

TENTION TO. SURINDER AGGARWAL

SAMPLED BY:

O. Reg. 153(511) - Resistivity, pH (Soil)

DATE RECEIVED: 2022-10-27 DATE REPORTED: 2022-11-03 BH 1 SS 2 2. **BH 5 SS 5 BH 7 SS 5** SAMPLE DESCRIPTION: 5'-4.5' BH 3 SS 3 5'-7' 10'-12' 10'-12' BH 9 SS 3 5'-7' **SAMPLE TYPE:** Soil Soil Soil Soil Soil DATE SAMPLED: 2022-10-20 2022-10-19 2022-10-19 2022-10-20 2022-10-20

Unit 4467358 4467360 4467361 4467362 4467363 **Parameter** RDL Resistivity (2:1) (Calculated) ohm.cm 362 207 599 265 621 pH, 2:1 CaCl2 Extraction pH Units NA 7.84 7.65 7.54 7.55 7.84

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

4467358-4467366 EC was determined on the DI water extract obtained from the 2:1 leaching procedure (2 parts DI water:1 part soil). pH was determined on the 0.01M CaCl2 extract obtained from 2:1 leaching procedure (2 parts extraction fluid:1 part wet soil).

Analysis performed at AGAT Toronto (unless marked by *)

CLIENT NAME: EXP SERVICES INC

SAMPLING SITE:

CHARTERED CHARTER CHARTERED CHARTER CHARTERED CHARTERED CHARTERED CHARTERED CHARTERED CHARTERED

Certified By:

5835 COOPERS AVENUE

MISSISSAUGA, ONTARIO CANADA L4Z 1Y2

http://www.agatlabs.com

TEL (905)712-5100 FAX (905)712-5122



Quality Assurance

CLIENT NAME: EXP SERVICES INC

AGAT WORK ORDER: 22Z962626

PROJECT: OTT-22007382-AO

SAMPLING SITE:

ATTENTION TO: SURINDER AGGARWAL

SAMPLED BY:

				Soi	il Ana	alysis	5						
RPT Date: Nov 03, 2022			С	DUPLICAT	E		REFEREN	NCE MATERIAL	METHOD	BLANK SPIKE	МАТ	RIX SPI	ΚE
PARAMETER	Batch	Sample Id	Dup #1	Dup #2	RPD	Method Blank	Measured Value	Acceptable Limits	Recovery	Acceptable Limits	Recovery	Lim	ptable nits Upper

O. Reg. 153(511) - Resistivity, pH (Soil)

pH, 2:1 CaCl2 Extraction 4467360 4467360 7.65 7.55 1.3% NA 101% 80% 120%

Comments: NA signifies Not Applicable.

pH duplicates QA acceptance criteria was met relative as stated in Table 5-15 of Analytical Protocol document.

Anion Scan in Soil

Chloride (10:1) 4474463 10 10 NA < 10 97% 80% 120% 95% 90% 110% 96% 80% 120% Sulphate (10:1) 4474463 15 80% 120% 93% 90% 110% 96% 80% 120%

Comments: NA signifies Not Applicable.

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

CHARTERED SOME MANDONG ZHU DHEMIST

Certified By:



Method Summary

CLIENT NAME: EXP SERVICES INC AGAT WORK ORDER: 22Z962626
PROJECT: OTT-22007382-AO ATTENTION TO: SURINDER AGGARWAL

SAMPLING SITE: SAMPLED BY:

PARAMETER	AGAT S.O.P	LITERATURE REFERENCE	ANALYTICAL TECHNIQUE		
Soil Analysis	·				
Chloride (10:1)	INOR-93-6004	McKeague 4.12 & SM 4110 B	ION CHROMATOGRAPH		
Sulphate (10:1)	INOR-93-6004	McKeague 4.12 & SM 4110 B	ION CHROMATOGRAPH		
10:1 (DI water Extr.)		McKeague 4.12	N/A		
Resistivity (2:1) (Calculated)	INOR-93-6036	McKeague 4.12, SM 2510 B,SSA #5 Part 3	EC METER		
pH, 2:1 CaCl2 Extraction	INOR-93-6075	modified from EPA 9045D, MCKEAGUE 3.11 E3137	PC TITRATE		



5835 Coopers Avenue Mississauga, Ontario 147 1Y2 Ph: 905 712.5100 Fax: 905.712.5122 webcarth.ogatloba.com

Laboratory	Use	Only
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Work Order #: 22 6 16 26 26
Ocales Oceanity and the American Company of Company

Cooler Quantity: Na-bag-no 194	SOCIUS
Arrival Temperatures: 21.1 71.2 12	1.2
1-1 3.21 2.815	4.0

Chain of Custody Recor	d If this is a [Prinking Water	sample, plea	se use Drinl	king Water Chaln of Custody Form (po	table water	consumed	by huma	ns)			Arr	ival Ten	nperatu	res:		3.7	7-7	3.8	21.2
Report Information: Company: Contact: Surinder Address: 7650 Queensu OHawa O Phone: Reports to be sent to: 1. Email: Surinder.	9 Fax:	Suite 10		(Picaso	gulatory Requirements: c check all applicable boxes) egulation 153/04 ble Excess Soils Table Indicate One Indicate One Regulation 5 Coarse CCME)ne 58	Prov. Objec	Region Water Q	uality WQO)	n		Tur Reg Rus	rnaro gular T sh TAT	und T TAT (Rush Sur Business	Time	(TA	T) R 5 to 7	equ i Busir iness	□No	□N/A
Project Information: Project: Site Location: Sampled By:	2700738 01+ Blud EXP	2-AO		Red	Is this submission for a Report Guldeline on Certificate of Analysis Yes No Yes No						Please provide prior notification for rush TAT *TAT is exclusive of weekends and statutory holidays For 'Same Day' analysis, please contact your AGAT CPM									
AGAT Quote #: Please note: If quotation number i	P0:			San	nple Matrix Legend	orvi, boc	O. F	eg 153	8		١,	O. Reg		eg 406 eg 406			y.P			ation (Y/N)
Invoice Information: Company: Contact: Address: Email:	Bi	II To Same: Ye	No 🗆	GW O P S SD SW	Ground Water Oil Paint Soil Sediment Surface Water	Field Filtered - Metals, Hg, CrVI, DOC	& Inorganics	□ crvi, □ Hg, □ HWSB	rate ir required 🗆 res			Landfill Disposal Characterization TCLP:		aracterit	Salt - EC/SAR	tone	S. 1 ph. 105	des	to Resistivity	illy Hazardous or High Concentr
Sample Identification	Date Sampled	Time Sampled	# of Containers	Sample Matrix	Comments/ Special Instructions	Y/N	Metals	Metals BTEX,	PAHS	PCBs	VOC	Landfill TCLP: [Excass SPLP:	Excess pH, ICI	Salt - E	PH	4	Ch	Electu	Potentia
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bambios Helinquished by it-rint warre tina signs:	Dalt	Time	Samples Received by (Print Name and Sign)	Date	Time	№ T 133519



CLIENT NAME: EXP SERVICES INC

2650 QUEENSVIEW DRIVE, UNIT 100

OTTAWA, ON K2B8H6

(613) 688-1899

ATTENTION TO: SURINDER AGGARWAL

PROJECT: OTT-22007382-AO

AGAT WORK ORDER: 22Z962626

SOIL ANALYSIS REVIEWED BY: Jacky Zhu, Spectroscopy Technician

DATE REPORTED: Nov 03, 2022

PAGES (INCLUDING COVER): 6 VERSION*: 1

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

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Disclaimer:

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- All work conducted herein has been done using accepted standard protocols, and generally accepted practices and methods. AGAT test methods may
 incorporate modifications from the specified reference methods to improve performance.
- All samples will be disposed of within 30 days after receipt unless a Long Term Storage Agreement is signed and returned. Some specialty analysis may
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 services.
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- The test results reported herewith relate only to the samples as received by the laboratory.
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 merchantability, fitness for a particular purpose, or non-infringement. AGAT assumes no responsibility for any errors or omissions in the guidelines
 contained in this document.
- All reportable information as specified by ISO/IEC 17025:2017 is available from AGAT Laboratories upon request.

AGAT Laboratories (V1)

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CLIENT NAME: EXP SERVICES INC

SAMPLING SITE:



Certificate of Analysis

AGAT WORK ORDER: 22Z962626

PROJECT: OTT-22007382-AO

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

ATTENTION TO: SURINDER AGGARWAL

SAMPLED BY:

	DATE REPORTED: 2022-11-03												
Anion Scan in Soil		TION: YPE:	LED: DL	0	40	lA	IION: I	YPE:	'LED:	JC	20	0.	
		DESCRIPTION: SAMPLE TYPE:	DATE SAMPLED:		4	Ż	SAMPLE DESCRIPTION:	SAMPLE TYPE:	DATE SAMPLED:	G/S RDL	2	Ž	
		SAMPLE D	DAT G/S				SAMPI			g			
	DATE RECEIVED: 2022-10-27	SAMPLE DESCRIPTION: SAMPLE TYPE:	unit G/		mg/kg		SAMPI			Unit	mg/kg	mg/kg	

Comments: RDL - Reported Detection Limit, G / S - Guideline / Standard 4467358-4467366 Results are based on a dry weight.

Dilution required, RDL has been increased accordingly.

Analysis performed at AGAT Toronto (unless marked by *)



CLIENT NAME: EXP SERVICES INC

SAMPLING SITE:

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

Certificate of Analysis

AGAT WORK ORDER: 22Z962626

PROJECT: OTT-22007382-AO

ATTENTION TO: SURINDER AGGARWAL

SAMPLED BY:

	DATE REPORTED: 2022-11-03	BH 11 SS 4 7. BH 13 SS 4 7. BH 13 SS 6	5'-9.5' 5'-9.5' 12.5'-14.5'	Soil Soil Soil	2022-10-21 2022-10-22 2022-10-22	4467364 4467365 4467366	249 676 260	7.56 7.72 7.50
O. Reg. 153(511) - Resistivity, pH (Soil)								
			SAMPLE DESCRIPTION:	SAMPLE TYPE:	DATE SAMPLED:	G/S RDL	1	Y Y
			SAMP			Unit	ohm.cm	pH Units
	DATE RECEIVED: 2022-10-27					Parameter	Resistivity (2:1) (Calculated)	pH, 2:1 CaCl2 Extraction

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

4467358-4467366 EC was determined on the DI water extract obtained from the 2:1 leaching procedure (2 parts DI water:1 part soil). pH was determined on the 0.01M CaCl2 extract obtained from 2:1 leaching procedure (2 parts extraction fluid:1 part wet soil).

Analysis performed at AGAT Toronto (unless marked by *)



Results relate only to the items tested. Results apply to samples as received.



Quality Assurance

CLIENT NAME: EXP SERVICES INC PROJECT: OTT-22007382-AO

AGAT WORK ORDER: 22Z962626
ATTENTION TO: SURINDER AGGARWAL

SAMPLING SITE: SAMPLED BY:

	Soil Analysis														
RPT Date: Nov 03, 2022			С	UPLICAT	E		REFEREN	ICE MA	TERIAL	METHOD	BLANK	SPIKE	MAT	RIX SPI	KE
PARAMETER	Batch	Sample	Dup #1	Dup #2	RPD	Method Blank	Measured		ptable nits	Recovery	1 10	ptable nits	Recovery	Lie	ptable nits
		ld					Value	Lower	Upper		Lower	Upper		Lower	Upper

O. Reg. 153(511) - Resistivity, pH (Soil)

pH, 2:1 CaCl2 Extraction 4467360 4467360 7.65 7.55 1.3% NA 101% 80% 120%

Comments: NA signifies Not Applicable.

pH duplicates QA acceptance criteria was met relative as stated in Table 5-15 of Analytical Protocol document.

Anion Scan in Soil

Chloride (10:1) 4474463 80% 120% 10 10 NA < 10 97% 80% 120% 95% 90% 110% 96% Sulphate (10:1) 4474463 80% 120% 93% 90% 110% 96% 80% 120% 15 NA < 10 94%

Comments: NA signifies Not Applicable.

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

CHARTERED A MEMOCRA CHU

Certified By:



Method Summary

CLIENT NAME: EXP SERVICES INC AGAT WORK ORDER: 22Z962626
PROJECT: OTT-22007382-AO ATTENTION TO: SURINDER AGGARWAL

SAMPLING SITE: SAMPLED BY:

PARAMETER	AGAT S.O.P	LITERATURE REFERENCE	ANALYTICAL TECHNIQUE
Soil Analysis		<u>.</u>	
Chloride (10:1)	INOR-93-6004	McKeague 4.12 & SM 4110 B	ION CHROMATOGRAPH
Sulphate (10:1)	INOR-93-6004	McKeague 4.12 & SM 4110 B	ION CHROMATOGRAPH
10:1 (DI water Extr.)		McKeague 4.12	N/A
Resistivity (2:1) (Calculated)	INOR-93-6036	McKeague 4.12, SM 2510 B,SSA #5 Part 3	EC METER
pH, 2:1 CaCl2 Extraction	INOR-93-6075	modified from EPA 9045D, MCKEAGUE 3.11 E3137	PC TITRATE



Laboratories

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

5835 Coopers Avenue Ph; 905 712,5100 Fax; 905,712,5122 Mississauga, Ontario 147 1Y2 webcarth.agatlaba.com

Laboratory Use Only

Work Order #: 227967

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Turnaround	Regular TAT

Storm

Sewer Use Sanitary

Regulation 153/04 Excess Soils R406

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Report Information:

Company:

Contact: Address:

7650 OLCEASU:PW

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Ottawa

6681-889-217

Reports to be sent to:

 Email: 2. Email:

Table Indicate One

Regulatory Requirements:

Rush TAT (Rush Surcharges Apply)

Prov. Water Quality Objectives (PWQO)

Regulation 558

Other

CCME

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Agriculture ☐ Res/Park

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Bill To Same: Yespat No

number is not provided, client will be billed full price for analysis

Please note: If quotation

AGAT Quote #:

Invoice Information:

Company

Contact:

Address:

Email:

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Site Location: Sampled By:

Project Information:

St. Lavior + Blod, Ottawa

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Special Instructions

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Page 6 of 6

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CLIENT NAME: EXP SERVICES INC 2650 QUEENSVIEW DRIVE, UNIT 100

OTTAWA, ON K2B8H6

(613) 688-1899

ATTENTION TO: Matthew Zammit

PROJECT: OTT-22007382

AGAT WORK ORDER: 24Z154646

SOIL ANALYSIS REVIEWED BY: Nivine Basily, Inorganic Team Lead

DATE REPORTED: Jun 03, 2024

PAGES (INCLUDING COVER): 6 VERSION*: 1

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

*Notes	

Disclaimer:

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 incorporate modifications from the specified reference methods to improve performance.
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 be exempt, please contact your Client Project Manager for details.
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- The test results reported herewith relate only to the samples as received by the laboratory.
- Application of guidelines is provided "as is" without warranty of any kind, either expressed or implied, including, but not limited to, warranties of
 merchantability, fitness for a particular purpose, or non-infringement. AGAT assumes no responsibility for any errors or omissions in the guidelines
 contained in this document.
- All reportable information as specified by ISO/IEC 17025:2017 is available from AGAT Laboratories upon request.
- For environmental samples in the Province of Quebec: The analysis is performed on and results apply to samples as received. A temperature above 6°C upon receipt, as indicated in the Sample Reception Notification (SRN), could indicate the integrity of the samples has been compromised if the delay between sampling and submission to the laboratory could not be minimized.

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Page 1 of 6

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Certificate of Analysis

AGAT WORK ORDER: 24Z154646

PROJECT: OTT-22007382

ATTENTION TO: Matthew Zammit

SAMPLED BY:EXP

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

CLIENT NAME: EXP SERVICES INC

SAMPLING SITE:1500 St Laurent, Ottawa, ON

(Soil) Inorganic Chemistry

				(55.	.,o. ga	ononion y					
DATE RECEIVED: 2024-05-27								С	ATE REPORT	ED: 2024-06-03	
		SAMPLE DES	CRIPTION:	BH24-2 SS6 12.5'-14.5'	BH24-4 SS4 7.5'-9.5'	BH24-5 SS3 5'-7'	BH24-7 SS6 12.5'-14.5'	BH24-12 SS6 12.5'-14.5'	BH24-9 SS4 7.5'-9.5'	BH24-11 SS5 10'-12'	BH24-1 Run1 11'2-11'6
		DATE	PLE TYPE: SAMPLED:	Soil 2024-05-08	Soil 2024-05-03	Soil 2024-05-08	Soil 2024-05-07	Soil 2024-05-10	Soil 2024-05-09	Soil 2024-05-09	Soil 2024-05-10
Parameter	Unit	G/S	RDL	5888898	5888900	5888901	5888902	5888903	5888904	5888905	5888906
Chloride (2:1)	µg/g		2	1250	2570	2350	905	642	810	1370	104
Sulphate (2:1)	μg/g		2	353	639	829	527	429	419	422	55
pH (2:1)	pH Units		NA	6.83	8.38	8.62	8.52	7.30	7.80	7.63	9.89
Resistivity (2:1) (Calculated)	ohm.cm		1	400	167	240	645	800	415	337	1960
				BH24-5 Run2	BH24-7 Run1	BH24-10 Run2	BH24-11 Run1				
		SAMPLE DES	CRIPTION:	3'8-14'3	13'10-14'2	18'4-18'8	15'1-15'7				
		SAM	PLE TYPE:	Soil	Soil	Soil	Soil				
		DATE	SAMPLED:	2024-05-07	2024-05-07	2024-05-09	2024-05-09				
Parameter	Unit	G/S	RDL	5888907	5888908	5888909	5888910				
Chloride (2:1)	µg/g		2	102	87	81	16		<u> </u>		
Sulphate (2:1)	μg/g		2	47	33	29	20				
pH (2:1)	pH Units		NA	9.95	9.29	9.84	9.23				
Resistivity (2:1) (Calculated)	ohm.cm		1	2670	3370	4220	6060				

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

588898-5888910 pH, Chloride and Sulphate were determined on the extract obtained from the 2:1 leaching procedure (2 parts DI water: 1 part soil). Resistivity is a calculated parameter. Analysis performed at AGAT Toronto (unless marked by *)

Certified By: ___





Quality Assurance

CLIENT NAME: EXP SERVICES INC

SAMPLING SITE:1500 St Laurent, Ottawa, ON

PROJECT: OTT-22007382

AGAT WORK ORDER: 24Z154646
ATTENTION TO: Matthew Zammit

SAMPLED BY:EXP

80% 120%

Soil Analysis																	
RPT Date: Jun 03, 2024			С	UPLICAT	E		REFERE	NCE MA	TERIAL	METHOD	BLANK	SPIKE	МАТ	RIX SPI	KE		
PARAMETER	Batch	Sample	Dup #1	Dup #2	RPD	Method Blank	Measured					Recovery	Lir	ptable nits	Recovery	Acceptable Limits	
		ld		.,			Value	Lower	Upper	,	Lower	Upper	,	Lower	Upper		
(Soil) Inorganic Chemistry																	
Chloride (2:1)	5888898 5	5888898	1250	1260	0.4%	< 2	96%	70%	130%	96%	80%	120%	NA	70%	130%		
Sulphate (2:1)	5888898 5	5888898	353	348	1.5%	< 2	95%	70%	130%	104%	80%	120%	99%	70%	130%		

0.0%

Comments: NA signifies Not Applicable.

pH duplicates QA acceptance criteria was met relative as stated in Table 5-15 of Analytical Protocol document.

5888898 5888898

Matrix spike NA: Spike level < native concentration. Matrix spike acceptance limits do not apply and are not calculated.

6.83

6.83

(Soil) Inorganic Chemistry

pH (2:1)

Chloride (2:1)	5888906 5888906	104	102	1.9%	< 2	97%	70%	130%	95%	80%	120%	90%	70%	130%
Sulphate (2:1)	5888906 5888906	55	56	1.8%	< 2	96%	70%	130%	100%	80%	120%	96%	70%	130%
pH (2:1)	5888906 5888906	9.89	9.73	1.6%	NA	101%	80%	120%						

Comments: NA signifies Not Applicable.

pH duplicates QA acceptance criteria was met relative as stated in Table 5-15 of Analytical Protocol document.

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Certified By:



Method Summary

CLIENT NAME: EXP SERVICES INC

AGAT WORK ORDER: 24Z154646

PROJECT: OTT-22007382

ATTENTION TO: Matthew Zammit

SAMPLING SITE:1500 St Laurent, Ottawa, ON SAMPLED BY:EXP

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



Have feedback? Scan here for a quick survey!



Mississauga, Ontano 142 15 Ph; 905,712,5100 Fax: 905,712,512 webearth.agatlabs.co

	Cod Arr De	oler (ival 1	Quanti Tempe Tempe y Seal	ity: pratures ratures	21			2-	100 100			1	icn
	Reg	gula sh T	I r TA AT (Ru 3 Busi Days	sh Surcha	argee Ap	S to plu) 2 E Day	o 7 Bu Jusine	usines ess	ss Day	Ne: Day		siness	
			TAT is Same I	ease pro exclusi Day' an	ive of	week	ends i	and s	tatuto	ry ho	olidays	R	
PUBS: Arociors 🗆	regulation 406 Characterization Package by, Metals, BTEX, F1-F4	EC, SAR	Regulation 406 SPLP Rainwater Leach . Second SPLP: ☐ Metals ☐ VOCs ☐ SVOCs ☐ OC			Иq	Sulphilos	Chloride	Electro Rosistis. 12	2		Potentially Hazardous or High Concentration (Y/N)	
3	E 5	ш 1	-										

Chain of Custody Record If this is a	Orinking Water s	sample, please	use Drini	king Water Chain of Custody Form (pota	ible water	consum	ed by h	umans)					empera empera		_	0.0		0.412	8.7
Report Information: Company: Contact: Hatthew Zamm: t			(Please	Regulatory Requirements: (Flowson check all applicable barea) Regulation 153/04 Regulation 406 Sewer Use							Custody Seal Intact: Yes No Notes: M 155 B 1								
Address: 2650 Queensu:eu Ottoma Ontario		6:6 100 8HG	Tal	Table	- 1	_	Regio				Reg	gula	round ir TAT AT (Rush		, pa	_		r ed: ess Days	
Phone: Reports to be sent to: 1. Email: 2. Email: Reports to be sent to: 1. Email: Reports to be sent to: Reports to be sent to)exp.	COM	Soil Te	Agriculture	8		ective: er	er Quali s (PWQ			Kus [3 Busini Days	ess		2 Busi Days		□ Ne Da es May App	•
2. Email: Project Information: Project: OTT-22007382 Site Location: Sampled By: EXP				is submission for a Record of Site Condition (RSC)? Yes No	Ce		ate o	eline f Anal	ysis		F F	4	Plea TAT is e.	se pro xclusiv	vide p	rior noti veekena	ification	n for rush T. statutory ho	AT olidays
Sampled By: AGAT Quote #: Presse note: # guotation number is not provided, client will	oo billed full price for a	avkatyskis.	Leg	al Sample 🛚	crvi, Doc	0.	Reg 1	53				Reg 4	. 20	J.P. Begggg	е			70	ation (Y/N)
Invoice information: Company: Contact: Address: Email:	II To Same: Ye:	s Ø No 🗆	San GW 0 P s	Ground Water SD Sediment Oil SW Surface Water Paint R Rock/Shale Soil	Field Filtered - Metals, Hg,	& Inorganics	- CrvI, CHg, CHWSB	F1-F4 PHCs		PCBs: Aroclors	Regulation 406 Characterization Package pH, Metals, BTEX, F1-F4	Я	ion 406 SPLP Rainwater Leach . □ Metals □ VOCs □ SVOCs □ OC	Landfill Disposal Characterization TCLP: TCLP: ☐M&I ☐VOCs ☐ABNs ☐B(a)P☐PCBs	Corrosivily. Moisture Sulphide	Н.	locide	eutro Rosistis	Potentially Hazardous or High Concentration (Y/N)
Sample Identification Date Sampled	Time Sampled	Containers	Sample Matrix	Comments/ Special Instructions	Y/N	Metals	Metals	BITEX,	PAHS	PCBs: /	Regulation pH, Metals,	EC, SAR	Regulation mSPLP;□	Landfil TCLP.	Carros	P H		Ele	Potenti
1. BH24-2 SSG 12.5-14.5 May 8	AM PM AM PM							22						_			1	-	
2. BH 24. 4 SSY 7.5'-9.5' Hun 7 3. BH 24-\$5 SS3 5'-7' Hun 8	PM AM PM											- 1.4				1			-2
4. 8 H 24-7 SSG 17.5'-H.S Man 7	AM PM)			EVA											/			
5. BH 24-12 SSG 125'-145' May 10	AM PM	1				1000	11		15							/			
6. BH 24.9 SSY 7.5-9.5 Many 9	AM PM												VVE I			/			
7. BH 24-11 555 10'-12' May 9	AM PM	(3						183							1			
8. BH 24-1 Plus 1 112-116	AM PM							18					19.1			1			
9. BH 24-5 Run 2 138-147	AM PM								ES.		101					/			
10.BH 24-7 Dun 1 13'10-14'2	AM PM								Į.							/			
11. 81+ 74-10 Run 2 18'4-18'3	AM PM							R	13							/ \	1	U	
Samples Relinquished By (Print Name and Sign):	Date	Time		People Received By (Print Name and Signit					0	12	2/2	4	15h	5					

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EXP

077-71007387

Please note: If quotation number is not provided, client will be billed full price for analysis.

Date

Sampled

151-157

Report Information:

Project Information:

Involce Information:

24-11

Sample Identification

Ruz 1

Company:

Contact:

Address:

Phone:

1. Email:

2. Email:

Project:

Site Location: Sampled By:

AGAT Quote #:

Company

Contact:

Address:

Email:

Reports to be sent to:

Have feedback? Scan here for a quick survey!

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

Bill To Same: Yes ☐ No ☐

Time

Sampled

AM PM



Regulatory Requirements:

Is this submission for a Record

of Site Condition (RSC)?

□ No

Comments/

Special Instructions

Regulation 153/04 Regulation 406

☐Res/Park

Agriculture

ССМЕ

Sediment

Surface Water

Rock/Shale

Regulation 558

(Please check all applicable boxes)

☐Ind/Com

☐Res/Park

☐Agriculture

Coarse

☐ Yes

Oil

Sample

Matrix

of

Containers

Paint

Legal Sample

Sample Matrix Legend

Ground Water SD

Soil Texture (Check One)

5835 Coopera Avenue Mississauga, Ontario 142 172 Ph; 905,712,5100 Fax: 905,712,5122 webearth,arjatlabs,com

Sewer Use

Other

☐ Yes

☐ Sanitary ☐ Storm

Prov. Water Quality

Report Guldeline on

Certificate of Analysis

O. Reg 153

□HWSB

Metals - □ CrVI, □ Hg,

Metals & Inorganics

☐ No

Objectives (PWQO)

Laboratory Use Only Work Order #: 24 7	5416	16	
		. T. A.	-
Cooler Quantity:	209- N	120.7	alls
Depot Temperatures: U	14.4	1 4-1	10.7
Custody Seal Intact:	□No	□N/A,	
Turnaround Time (TAT) F	Required:	F	No. o
		* II gl 9	-
Regular TAT 5 to	7 Business Days	S	1
Rush TAT (Rush Surcharges Apply)			
3 Business _ 2 Bus	siness	Next Business	

		☐ 5 t0	/ Business	Days	
Rush	TAT.(Ruch Surcha	ges Apply)			
	3 Business Days	☐ ^{2 Bu}	usiness s		lext Busines
	OR Date Requ	ired (Rush	Surcharges	May A	pply):
8	Please pro	vide prior no ve of weeke			
For	Same Day' an	alysis, pieas	se contact	your A	GAT CSR

PAHS

VOC

PAHS

POBS-Arodors □

Regulation 406 Characterization Padrage
pH, Metals, BTEX, F1-F4

EC, SAR

Regulation 405 SPLP Rainwater Lacth
mSPLP: □ Metals □ Votos □ SVOCs □ OCS

Landfill Disposal Characterization TCLP.
TCLP: □ Metals □ Votos □ SVOCs □ OCS

Corrosivity: □ Moisture □ Sulphide

C Chilora

3.	AM PM			168 - 189
4.	AM PM			
5.	AM PM			
6.	AM PM	1383		
7.	AM PM	B34 E		
8.	AM PM			
9.	AM PM			
10.	AM PM			
11.	AM PM			
Samples Retinquished By (Print Name and Sign):	Date Time	Samples Recesed By (Point Name and Sign):	Date School Time	
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(a to Due	05/27/24/13/00	DA-	mg 28 8:45%	Page of
Samples Relinquished By (Print Name and Sign):	Date Time	Samples Received By (Print Name and Sign):	Date No.	

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Date Emolt 39/38, 2024

Geotechnical Investigation – Proposed OC Transpo Hydro Substation 1500 St. Laurent Boulevard, Ottawa, ON OTT-22007382-B0 July 11, 2024

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Geotechnical Investigation – Proposed OC Transpo Hydro Substation 1500 St. Laurent Boulevard, Ottawa, ON OTT-22007382-B0 July 11, 2024

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