# Updated Geotechnical Investigation Report

## Proposed Industrial Condominium and Warehouse Development
## 4101 Limebank Road,
## Ottawa, ON

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# Table of Contents

Executive Summary ..... 1
1. Introduction ..... 3
2. Site Description ..... 5
3. Procedure ..... 6
4. Geology of the Site and Available Information ..... 7
   4.1 Surficial Geology Map ..... 7
   4.2 Bedrock Geology Map ..... 7
5. Subsurface Conditions and Groundwater Levels ..... 8
   5.1 Topsoil ..... 8
   5.2 Fill ..... 8
   5.3 Silty Clay ..... 8
   5.4 Glacial Till ..... 9
   5.5 Inferred Boulders or Bedrock ..... 10
   5.6 Seismic Cone Penetration Test ..... 10
   5.7 Groundwater Level Measurements ..... 10
6. Site Classification for Seismic Site Response and Liquefaction Potential of Soils ..... 12
   6.1 Site Classification for Seismic Site Response ..... 12
   6.2 Liquefaction Potential of Soils ..... 12
7. Grade Raise Restrictions ..... 13
8. Foundation Considerations ..... 14
   8.1 Spread and Strip Footings ..... 14
   8.2 Pile Foundations ..... 16
9. Floor Slab and Drainage Requirements ..... 18
10. Excavation and De-Watering Requirements ..... 19
   10.1 Excess Soil Management ..... 19
   10.2 Excavation ..... 19
   10.3 De-Watering Requirements ..... 19
11. Pipe Bedding Requirements ..... 21
12. Backfilling Requirements and Suitability of On-Site Soils for Backfilling Purposes ..... 22
13. Access Roads and Parking Lots ..... 23
14. Corrosion Potential ..... 25
15. Tree Planting Restrictions ..... 26

16. Additional Borehole/Study ..... 27
17. General Comments ..... 28

## List of Tables

Table I: Summary of Laboratory Testing Program ..... 6
Table II: Summary of Results from Grain-Size Analysis and Atterberg Limit Determination Silty Clay Samples ..... 9
Table III: Consolidation Test Results – Silty Clay Samples ..... 9
Table IV: Summary of Results from Grain-Size Analysis – Glacial Till Sample ..... 10
Table V: Summary of Groundwater Level Measurements ..... 10
Table VI: Calculated Settlements Based on Average Properties ..... 15
Table VII: Factored Geotechnical Resistance at Ultimate Limit State (ULS) and Estimated Negative Skin Friction of Steel Pipe and H-Piles ..... 16
Table VIII: Recommended Pavement Structure Thicknesses ..... 23
Table IX: Corrosion Test Results on Soil Samples ..... 25

## List of Figures

Figure 1 – Site Location Plan
Figures 2 – Borehole Location Plan
Figures 3 to 19 – Borehole Logs
Figures 20 to 25 – Grain-size Distribution Curves

## Appendices

Appendix A - Consolidation Test Results
Appendix B – Seismic Cone Penetration Test (SCPTu) Results
Appendix C – Certificate of Laboratory Analysis

# Executive Summary

EXP Services Inc. (EXP) is pleased to present the results of the updated geotechnical report for the proposed development to be located at 4101 Limebank Road, Ottawa, Ontario (Figure 1). Terms and conditions of this assignment were outlined in EXP's proposal number: 999-22008699-PP dated September 23, 2023. Written authorization to proceed with this updated geotechnical report was provided on October 10, 2023.

In 2022 EXP carried out a geotechnical investigation at the site for a proposed warehouse development. The results of this investigation were presented in the report titled "Proposed Industrial Development, Leitrim Road and Limebank Road, Ottawa (Gloucester), Ontario", dated June 24, 2022. The conceptual plans for the 2024 development, discussed below, have changed since the 2022 report and EXP was requested to update the existing geotechnical report based on the current design information.

In addition to this updated report, EXP also completed a Phase One Environmental Site Assessment (ESA), dated November 24, 2023, submitted under a separate cover. EXP understands that the ESA and the updated geotechnical report are required for a zoning by-law amendment application.

Drawing A101, dated March 6, 2024, titled "General Site Plan", prepared by Architecture49 (A49) and drawing 23074-S1, dated February 2024, titled "Servicing Plan, Option 1" prepared by Robinson Consultants Inc. (RCI) were provided to EXP in order to prepare this updated report. A topographical survey plan by Annis, 0'Sullivan, Vollebekk Ltd. (AOV), dated December 6, 2023, was also provided.

The A49 plans indicate the development will consist of five blocks of buildings, paved parking lots, access roadways and loading areas and that the southwest corner of the property designated for stormwater management. A 6 m easement for a pipeline is present in the western portion of the site. To the east of the easement, the site will be occupied by two (2) blocks of one-storey industrial condominiums with the northern block consisting of twenty (20) units and the southern block consisting of thirteen (13) units. The central and eastern portions of the site will consist of three (3) blocks of two-storey buildings, each block with three (3) units. The first storey of the buildings will serve as warehouse facilities and the second storey will serve as office facilities. The warehouses from west to east have been given identified as B, C and D.

The RCI plans indicates that the Finished Floor Elevations (FFE) of the buildings range from Elevation 92.70 m (industrial condominiums) to Elevation 93.70 m (Building D, northern unit). The proposed FFE range from approximately 0.4 m to 1.0 m above the existing grade. The plans also indicate that a storm and sanitary sewers are proposed underlying the parking areas between the buildings with the sanitary sewers and storm sewers having diameters of 250 mm and 450 mm, respectively. The invert elevations of the sanitary sewers will range from Elevation 89.9 m to Elevation 89.3 m and the invert elevations of the storm sewers will range from Elevation 91.8 m to Elevation 90.7 m. This corresponds to depths of 0.9 m to 3.0 m below the existing grade. RCI also indicated that a combination of rooftop storage, underground storage and the creation of a dry pond are being considered for stormwater management. Details regarding the storm water management have not been provided at the time of this updated report and geotechnical recommendations can provided once the design details are available.

It is understood that, at this point in the design, the proposed building loadings and expected floor slab loadings on the buildings are not known.

The borehole information indicates the subsurface conditions consist of surficial topsoil layer underlain by deep deposit of silty clay extending to depths of 8.7 m to 11.1 m (Elevation 84.2 m to Elevation 81.8 m). The silty clay is stiff to hard in the upper level and becomes stiff to soft with depth. The silty clay is underlain by glacial till in some of the boreholes. Inferred boulders or bedrock were contacted at 12.5 m to 16.8 m depths (Elevation 80.4 m to Elevation 75.3 m). Based on the groundwater level measurements from May 10,2022, the groundwater level ranges from 0.3 m to 0.7 m depths (Elevation 92.6 m to Elevation 91.1 m). The wells were not present in March 2024 during a return site visit for additional groundwater levels.

The site may be classified as **Class D** for seismic site response in accordance with the 2012 Ontario Building Code (as amended January 1, 2022). The subsurface soils are not considered to be liquefiable during a seismic event.

For design purposes, the feasibility of founding the proposed structures on spread and strip footings as well as on deep foundations (piles) was assessed. A mat (raft) foundation placed on an engineered fill pad constructed on the native silty clay was also considered, however the mat foundation would impose higher loads onto the deeper and weaker silty clay and would cause undue settlement. Therefore, a mat foundation is not considered feasible to support the proposed buildings.

It is understood that based on the proposed FFE of the proposed buildings, the grades of the site will be raised up to 1.0 m. Based on the average thicknesses of the weathered and unweathered silty clay, estimated settlements were presented for two (2) assumed floor loadings and assumed footing loads. For a 15 kPa floor loading it was estimated that the settlements for the floor slab would be 29 mm, the settlement for pad footings with a maximum size of 2 m by 2 m would be 33 mm and settlement for strip footings with a maximum width of 1.5 m would be 43 mm. Similarly, for a 24 kPa floor loading it was estimated that the settlements for the floor slab would be 35 mm, the settlement for pad footings with a maximum size of 2 m by 2 m would be 39 mm and settlement for strip footings with a maximum width of 1.5 m would be 49 mm.

If the estimated settlements can be tolerated, it would likely be possible to found the proposed buildings on spread and strip footings for a 1.0 m site grade raise. If the estimated settlements of the proposed buildings cannot be tolerated, the building and floor slab may be supported on piles foundations with the slab designed as a structural slab. If the settlement of the floor slab can be tolerated, the proposed buildings may be supported by pile foundations and the floor slab may be designed as slab on grade. Alternatively, ground improvement methods may be considered and may allow for the building to be supported by footings and the floor slab to be designed as a slab on grade. EXP can provide further guidance if this option is being considered.

The proposed buildings may be founded on closed end pipe or steel H piles driven to practical refusal in the bedrock. Since the piles are expected to meet refusal in the bedrock, the factored geotechnical resistance at ultimate limit state (ULS) of the piles will govern the design. The ULS values for closed end steel pipe piles and H piles along with the down-drag forces based on a 1.0 m grade raise have been provided in the updated report.

Perimeter drains should be provided for the proposed buildings. The need for underfloor drains can be assessed once the finished floor elevation is known.

All excavations must be undertaken in accordance with the Occupational Health and Safety Act (OHSA), Ontario Reg. 213/91.

Seepage of the surface and subsurface water into the excavations is anticipated and it should be possible to collect water entering the excavations at low points and to remove it by conventional pumping techniques. In areas of high infiltration and below the groundwater level, a higher seepage rate should be anticipated and may require high-capacity pumps to keep the excavation dry.

For site grade raise and backfilling purposes, it is anticipated that the majority of the material would be imported.

For footings design, additional boreholes are recommended to confirm the depth of the silty clay where boreholes terminated within this deposit. For the pile foundation option additional boreholes are recommended to confirm the bedrock depth for pile design.

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

# 1. Introduction

EXP Services Inc. (EXP) is pleased to present the results of the updated geotechnical report for the proposed development to be located at 4101 Limebank Road, Ottawa, Ontario (Figure 1). Terms and conditions of this assignment were outlined in EXP's proposal number: 999-22008699-PP dated September 23, 2023. Written authorization to proceed with this updated geotechnical report was provided on October 10, 2023.

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It is understood that, at this point in the design, the proposed building loadings and expected floor slab loadings on the buildings are not known.

The results of the 2022 geotechnical investigation were used in the preparation of this updated report and include the following:

a) Establish the subsurface soil and groundwater conditions at seventeen (17) boreholes located at the subject site,

b) 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,

c) Comment on grade-raise restrictions,

d) 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,

e) Provide comment regarding slab-on-grade construction and the requirements for perimeter and underfloor drainage systems,

f) Comment on excavation conditions and de-watering requirements during construction,

g) Discuss backfilling requirements and suitability of on-site soils for backfilling purposes,

h) Recommend pavement structure thicknesses for access roads, parking lots and loading areas,

i) Comment on tree planting restrictions, and

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

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 is legally registered as Concession 2RF PTS Lots 16 and 17 RP 5R-9196 Parts 1-3 Gloucester, Ottawa, Ontario and is located south of the intersection of Limebank Road and Leitrim Road in the city of Ottawa. At the time of the 2022 geotechnical report the site is bounded by Limebank Road on the west and agricultural/farmland to the north, south, and east. The site is currently used as farming /agricultural land and is split into two distinct agricultural fields; one on the north side of the property and one on the south side. A drainage ditch surrounds the north field and water flows towards Limebank Road to the west. The drainage ditch had flowing water at the time of the drilling of the boreholes in 2022. There is one driveway entrance to the site via Limebank Road and a culvert provides a crossing over the drainage ditch to access the south field.

Based on the spot elevations provided in the AOV 2023 survey plan the topography of the existing agricultural fields is generally flat with a gradual slope upwards from the west to the east with elevations ranging from Elevation 91.37 m to Elevation 93.17m. The elevation of the drainage ditch running through the site ranges from Elevation 90.93 to Elevation 92.55 m.

# 3. Procedure

The fieldwork for this investigation was undertaken during the period between April 25 and 29, 2022 and consists of the drilling of seventeen (17) boreholes (Borehole Nos. 1 to 17) advanced to termination depths ranging from 7.9 m to 16.8 m (Elevation 84.8 m to Elevation 75.3 m). The fieldwork was supervised on a full-time basis by a representative from EXP.

The borehole locations and geodetic elevations were established by a surveyor from EXP and are shown on the Borehole Location Plan, Figure 2.

The borehole locations were cleared of any private and public underground services, prior to the start of drilling operations by USL-1 cable Locators acting as subcontractor to EXP. The boreholes were drilled using a CME-850 track mounted drill rig equipped with continuous flight hollow stem augers and soil sampling capabilities. Standard penetration tests (SPTs) were performed in all the boreholes at 0.75 m and 1.5 m depth intervals with soil samples retrieved by the split-barrel sampler. Four (4) relatively undisturbed Shelby tube samples were retrieved from two (2) boreholes. The undrained shear strength of the of the cohesive soil was measured by conducting penetrometer and in-situ vane tests. Dynamic cone penetration tests (DCPTs) were conducted in two (2) boreholes. In addition, seismic cone penetration tests (SCPTu) were conducted in two (2) boreholes.

Monitoring wells (50 mm diameter) were installed in Borehole Nos. 1, 3, 8, 11, 12, and 15 for groundwater sampling and long-term monitoring of groundwater levels. Standpipes (38 mm diameter) were installed in Borehole Nos. 7 and 9 for long-term monitoring of the groundwater levels. The standpipes and monitoring wells were installed in accordance with EXP standard practice, and the installation configuration is documented on the respective borehole logs. The boreholes were backfilled upon completion of drilling and the installation of the monitoring wells and standpipes.

Upon completion of the borehole fieldwork, the soil samples were transported to the EXP Ottawa laboratory. The soil samples were visually examined in the laboratory by a geotechnical engineer. The soil samples were classified in accordance with the Unified Soil Classification System (USCS) and the modified Burmeister System (as per the 2006 Fourth Edition Canadian Foundation Engineering Manual (CFEM)).

A summary of the soil sample laboratory testing program is shown in Table I.

**Table I: Summary of Laboratory Testing Program**

| Type of Test | Number of Tests Completed |
|---|---|
| **Soil Samples** | |
| Moisture Content Determination | 100 |
| Unit Weight Determination | 24 |
| Grain Size Analysis | 6 |
| Atterberg Limit Determination | 6 |
| Corrosion Analysis (pH, sulphate, chloride and resistivity) | 3 |
| One-dimensional Consolidation Testing | 2 |

# 4. Geology of the Site and Available Information

## 4.1 Surficial Geology Map

The surficial geology was reviewed via the Google Earth application using the map published by the Ontario Ministry of Energy, Northern Development and Mines available via www.mndm.gov.on.ca/en/mines-and-minerals/applications/ogsearth/surficial-geology and was last modified on May 23, 2017. The map indicates the Site is underlain by fine textured glaciomarine deposits consisting of silt and clay with minor sand. Course textured glaciomarine deposits consisting of sand and gravel with minor silt and clay were noted in the general area. The surficial deposits are shown in Image 1 below.




**Image 1 – Surficial Geology**

## 4.2 Bedrock Geology Map

The bedrock geology was reviewed via the Google Earth application using the map published by the Ontario Ministry of Energy, Northern Development and Mines available via http://www.geologyontario.mndm.gov.on.ca/mines/data/google/MRD219/geology/doc.kml and publish in 2007. The map indicates the site is underlain by sandstone, dolomitic sandstone and dolostone of the Beekmantown Group, March formation. The bedrock geology is show in Image 2 below.




**Image 2 – Bedrock Geology**

# 5. Subsurface Conditions and Groundwater Levels

A detailed description of the subsurface conditions and groundwater levels from the boreholes are given on the attached Borehole Logs, Figure Nos. 3 to 19. The borehole logs and related information depict subsurface conditions only at the specific locations and times indicated. Subsurface conditions and water levels at other locations may differ from conditions at the locations where sampling was conducted. The passage of time 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.

It should be noted that the soil boundaries indicated on the borehole logs are inferred from non-continuous sampling and 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 “Note 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 conditions with depth and groundwater level measurements.

## 5.1 Topsoil

A 220 mm to 350 mm thick surficial topsoil layer was encountered in all seventeen (17) boreholes.

## 5.2 Fill

The topsoil is underlain by fill, consisting of reworked silty clay, 0.3 m to 0.4 m in thickness. The silty clay likely has been reworked due to the farming activities at the property. The natural moisture contents and unit weights of the reworked silty clay ranges from 30 percent to 41 percent and 18.6 kN/m$^3$ to 19.3 kN/m$^3$, respectively.

## 5.3 Silty Clay

The fill is underlain by native undisturbed silty clay in all of the boreholes. The silty clay extends to depths of 8.7 m to 11.1 m below existing grade (Elevation 84.2 m to Elevation 81.8 m) in Borehole Nos. 3, 6 and 8, where the silty clay was fully penetrated. The remaining boreholes terminated within the silty clay at 7.9 m to 8.2 m depths (Elevation 84.8 m to Elevation 83.6 m).

The silty clay consists of an upper weathered desiccated brown silty clay underlain by a weaker unweathered grey silty clay. The undrained shear strength of the upper crust ranges from 77 kPa to 230 kPa indicating a stiff to hard consistency. The lower unweathered grey silty clay shear strength measurements range from 19 kPa to 82 kPa indicating a soft to stiff consistency. The natural moisture contents and unit weights of the undisturbed silty clay ranges from 27 percent to 69 percent and 16.1 kN/m$^3$ to 18.9 kN/m$^3$, respectively.

The results from the grain-size analysis and Atterberg limit determination conducted on five (5) selected samples of the silty clay are summarized in Table II. The grain-size distribution curves are shown in Figures 20 to 24.

| Table II: Summary of Results from Grain-Size Analysis and Atterberg Limit Determination Silty Clay Samples | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Borehole No. (BH) – Sample No. (SS) | Depth (m) | Grain-Size Analysis (%) | | | Atterberg Limits (%) | | | | |
| | | Gravel | Sand | Fines (Silt and Clay) | Moisture Content | Liquid Limit | Plastic Limit | Plasticity Index | Soil Classification (USCS) |
| BH 1 – SS2 | 0.8 – 1.4 | 0 | 3 | 97 | 46 | 55 | 24 | 31 | Brown Clay of High Plasticity (CH) |
| BH 16 – SS3 | 1.5 – 2.1 | 0 | 2 | 98 | 54 | 55 | 20 | 35 | Brown Clay of High Plasticity (CH) |
| BH 3 -SS5 | 4.5 – 5.1 | 0 | 18 | 82 | 37 | 26 | 15 | 11 | Grey Low Plasticity Clay with Sand (CL) |
| BH 9 – SS5 | 6.1 – 6.7 | 0 | 10 | 90 | 37 | 29 | 16 | 13 | Grey Low Plasticity Clay (CL) |
| BH 11 – SS4 | 3.0 – 3.6 | 0 | 1 | 99 | 64 | 46 | 19 | 27 | Grey Low Plasticity Clay (CL) |

Based on a review of the results of the grain-size analysis and Atterberg limits, the soil may be classified as a clay of high plasticity (CH) in the upper brown crust and as a grey clay of low plasticity (CL) with trace to some sand in the lower unweathered clay, in accordance with the Unified Soil Classification System (USCS).

Consolidation tests were performed on two (2) Shelby tube samples of the grey silty clay. The consolidation test results are summarized in Table III and shown in Appendix A. The estimated effective overburden pressure, pre-consolidation pressure, compression and re-compression indices and the over-consolidation ratio are also shown in Table III. The effective overburden pressure was estimated using the 2022 groundwater level measurements and a review of the moisture contents of the soil samples retrieved from the boreholes.

| Table III: Consolidation Test Results – Silty Clay Samples | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Borehole No: Sample No. | Sample Depth (m) | $\sigma'_{v0}$ (kPa) | $W_c$ (%) | $\gamma$ (kN/m$^3$) | $\sigma'_p$ (kPa) | $e_o$ | $C_r$ | $C_c$ | OCR |
| BH-3: ST-4 | 3.0 – 3.6 | 43.4 | 57.0 | 18.5 | 225.0 | 1.736 | 0.0204 | 1.20 | 5.18 |
| BH 3: -ST-6 | 6.1 - 6.6 | 68.2 | 38.1 | 17.8 | 90.0 | 1.210 | 0.0425 | 0.60 | 1.32 |

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

## 5.4 Glacial Till

The silty clay in Borehole Nos. 3, 6 and 8 is underlain by glacial till contacted at 8.7 m to 11.1 m depths (Elevation 84.2 m and Elevation 81.8 m). Borehole No. 6 terminated within the glacial till at a 15.8 m depth (Elevation 76.4 m). The glacial till contains cobbles and boulders. Standard penetration test (SPT) N-values range from 5 to 79 indicating the glacial till is in a loose to very dense state. The natural moisture content of the glacial till ranges from 6 percent to 12 percent.

The results from the grain-size analysis conducted on one (1) sample of the glacial till are summarized in Table IV. The grain-size distribution curve is shown in Figure 25.

| Table IV: Summary of Results from Grain-Size Analysis – Glacial Till Sample | | | | | |
|---|---|---|---|---|---|
| Borehole No. – Sample No. | Depth (m) | Grain-Size Analysis (%) | | | Soil Classification (USCS) |
| | | Gravel | Sand | Fines (Silt and Clay) | |
| BH 6 – SS10 | 13.7 – 14.3 | 19 | 38 | 43 | Silty Sand with Gravel (SM) |

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

## 5.5 Inferred Boulders or Bedrock

Dynamic cone penetration tests (DCPT) were conducted in Borehole Nos. 4 and 7 and DCPT refusal was encountered at 16.8 m and 13.7 m (Elevation 75.3 m and Elevation 78.9 m) in Borehole Nos. 4 and 7, respectively. Auger refusal was encountered in Borehole Nos. 3 and 8 at 14.3 m and 12.5 m (Elevation 78.6 m to Elevation 80.4 m) in Borehole Nos. 3 and 8, respectively. The DCPT and auger refusal may indicate the presence of cobbles or boulders within the glacial till or the bedrock surface.

## 5.6 Seismic Cone Penetration Test

A seismic cone penetration test (SCPTu) was conducted in Borehole Nos. 10 and 17. The results of the SCPTu tests are shown in Appendix B. The SCPTu tests extend to 11.8 m and 11.4 m depths (Elevation 80.2 m and Elevation 81.2 m) in Borehole Nos. 10 and 17, respectively and terminated within the very dense soils.

## 5.7 Groundwater Level Measurements

A summary of the groundwater level measurements taken in the boreholes is shown in Table V.

| Table V: Summary of Groundwater Level Measurements | | | |
|---|---|---|---|
| Borehole No. (BH) | Ground Surface Elevation (m) | Date of Measurement (Elapsed Time in Days from Date of Installation) | Groundwater Depth Below Ground Surface (Elevation), m |
| BH 1 | 91.70 | May 4, 2022 (5 days)<br>May 10, 2022 (11 days) | 0.04 (91.7)<br>0.5 (91.2) |
| BH 3 | 92.88 | May 4, 2022 (8 days)<br>May 10, 2022 (14 days) | 0.2 (92.7<br>0.3 (92.6) |
| BH7 | 92.56 | May 10, 2022 (15 days) | 0.4 (92.2) |
| BH8 | 92.89 | May 4, 2022 (6 days)<br>May 10, 2022 (12 days) | 0.1 (92.8)<br>0.4 (92.5) |
| BH9 | 92.29 | May 4, 2022 (6 days)<br>May 10, 2022 (12 days) | 0.2 (92.1)<br>0.3 (92.0) |
| BH11 | 91.81 | May 4, 2022 (7 days)<br>May 10, 2022 (13 days) | 0.3 (91.5)<br>0.7 (91.1) |
| BH12 | 92.10 | May 4, 2022 (5 days)<br>May 10, 2022 (11 days) | 0.2 (91.9)<br>0.4 (91.7) |
| BH15 | 91.80 | May 4, 2022 (6 days)<br>May 10, 2022 (12 days) | 0.1 (91.7)<br>0.4 (91.4) |

Based on the groundwater level measurements from May 10,2022, the groundwater level ranges from 0.3 m to 0.7 m depths (Elevation 92.6 m to Elevation 91.1 m).

It is suspected that the recorded groundwater readings are likely the perched water level. Based on the moisture content results of the retrieved samples, the stabilized groundwater table at the site is expected to be at approximately 1.5 m to 2.5 m below grade the existing grade.

EXP visited the site on March 15, 2024, and the standpipes/monitoring wells were not found.

Note that fluctuations in the level of groundwater may occur due to a seasonal variation such as precipitation, snowmelt, rainfall activities, and other factors not evident at the time of measurement and therefore may be at a higher level during wet weather periods.

# 6. Site Classification for Seismic Site Response and Liquefaction Potential of Soils

## 6.1 Site Classification for Seismic Site Response

The subsurface conditions identified in the boreholes were examined in relation to Table 4.1.8.4.A of the 2012 Ontario Building Code (OBC) as amended January 1, 2022. The seismic cone penetration test (SCPTu) boreholes completed at the site indicate an average shear wave of 112 m/s within the overburden soils. Based on the assumption that bedrock was encountered at the average refusal (DCPT and auger) depth of 14.3 m (Elevation 78.3 m) on soft rock, the shear wave velocity of the soil was calculated to be 240 m/s. Table 4.1.8.4.A of the 2012 Ontario Building Code (OBC) as amended January 1, 2022, indicates that a shear wave velocity of 240 m/s corresponds to a site classification for seismic response of **Class D**.

A higher site classification, such as **Class C** may be available for the site if a multi-channel analysis of surface waves (MASW) survey is completed at the site.

## 6.2 Liquefaction Potential of Soils

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

# 7. Grade Raise Restrictions

For design purposes, the maximum grade raise at the site should be limited to 1.0 m due to the presence of compressible silly clay. Excavation for the grade raise should not extend into the native highly weathered silty clay crust.

# 8. Foundation Considerations

Based on a review of the borehole information the subsurface conditions at the site consist of 220 mm to 350 mm surficial topsoil layer is underlain by a desiccated silty clay which is 2.0 m to 3.5 m thick. The upper approximate 0.3 m to 0.4 m of the desiccated silty clay crust is re-worked and considered to be fill. The re-worked silty clay fill will have to be replaced with engineered fill. The undrained shear strength of the weathered crust is stiff to hard. It is underlain by soft to stiff grey silty clay which extends to a depth of 8.7 m to 11.3 m (Elevation 84.2 m to Elevation 81.8 m) in the deeper boreholes which penetrated the silty clay. It is noted that the other boreholes were terminated within the silty clay and the thickness of the silty clay layer is not known.

For design purposes, the feasibility of founding the proposed structures on spread and strip footings as well as on deep foundations (piles) was assessed. A mat (raft) foundation placed on an engineered fill pad constructed on the native silty clay was also considered, however the mat foundation would impose higher loads onto the deeper and weaker silty clay and would cause undue settlement. Therefore, a mat foundation is not considered feasible to support the proposed buildings.

## 8.1 Spread and Strip Footings

It is understood that based on the proposed FFE of the buildings, the grades at the site will be raised by up to 1.0 m.

The design of the buildings loadings (foundations and floor slab) should be undertaken such that the soft to stiff silty clay underlying the desiccated brown silty clay crust is not overstressed; otherwise, large settlements of the proposed buildings will result.

The load stress imparted to the silty clay soil below the proposed buildings will be a function of the following:

(1) Footing and floor loads.

(2) Floor slabs and footing elevations.

(3) Change in existing grades whether by placement of fill or by lowering the grades by cutting.

(4) Serviceability Limit State bearing pressure value of the soil.

For design considerations, the settlement of the proposed buildings, using the average thickness of the upper weathered brown silty clay and lower grey silty clay have been calculated for a grade raise of 1.0 m. The proposed building loading and the expected floor loadings are not known at the time of this report and assumed values have been used.

Settlements were estimated based on the following assumptions:

(1) The topsoil and fill (reworked silty clay) have been removed and replaced with engineered fill.

(2) The existing undisturbed weathered brown silty clay has not been stripped.

(3) The assumed maximum size of the column footings is 2 m x 2 m.

(4) The assumed maximum width of strip footings is 1.5 m.

(5) Column and strip footings will be founded at a depth of 0.7 m below the proposed FFE of the buildings. Therefore, it is anticipated that the footings would be founded on an engineered fill pad or on the native silty clay. Also, the footings would have to be insulated to protect against frost damage.

(6) For footings, the bearing pressure at serviceability limit state (SLS) of the soil was taken as 150 kPa with a factored ULS of 225 kPa. The factored geotechnical resistance at ULS includes a geotechnical resistance factor of 0.5.

(7) The floor load is assumed as 15 kPa or 24 kPa.

(8) The groundwater level is at 1.5 m below the existing grade.

A summary of the settlements is presented in Table VI for the 1.0 m grade raise, two (2) assumed floor loadings and the assumed footing loads.

| Table VI: Calculated Settlements Based on Average Properties | | | |
|---|---|---|---|
| Floor Slab Loading (kPa) | Floor Slab Settlement (Including 1.0 m site grade raise and floor slab loading, mm) | Pad Footing Settlement – Max 2 m x 2 m (Including 1.0 m site grade raise and floor slab loading, mm) | Strip Footing Settlement – Max width 1.5 m (Including 1.0 m site grade raise and floor slab loading, mm) |
| 15 | 29 | 33 | 43 |
| 24 | 35 | 39 | 49 |

The distance between adjacent footings is not known. Therefore, the distortion of the structure could not be calculated.

If the computed settlements can be tolerated, it would likely be possible to found the proposed buildings on spread and strip footings for a 1.0 m site grade raise. If the computed settlements of the proposed buildings cannot be tolerated, the building and floor slab may be supported on pile foundations with the slab designed as a structural slab. If the settlement of the floor slab can be tolerated the proposed buildings may be supported by pile foundations and the floor slab may be designed as slab on grade. Alternatively, ground improvement methods may be considered and may allow for the building to be supported by footings and the floor slab to be designed as a slab on grade. EXP can provide further guidance if this option is being considered.

It should be noted that the boreholes along the northern extent of the property terminated within the silt clay deposit and as such the thickness of the silty clay at this location is not known. Additional boreholes are recommended to confirm the depth of the silty clay deposit as well as to collect additional samples for additional engineering analysis and laboratory testing.

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 footings have been properly prepared. 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 compacted to 100 percent standard Proctor maximum dry density (SPMDD). A 50 mm thick concrete mud slab is recommended to be placed on the silty clay subgrade as soon as they are reviewed and approved by the geotechnical engineer or technician.

Once the native subgrade has been approved, the grades may be raised to the design underside footing and floor slab elevation by the construction of an engineered fill pad. The excavation for the removal of fill and topsoil layers should extend to a sufficient distance beyond the limits of the proposed structure to accommodate a 1.0 m wide horizontal bench of engineered fill that extends beyond the perimeter of the proposed building on all sides, which should thereafter be sloped at an inclination of 1H to 1V down to the approved subgrade. The engineered fill should consist of OPSS Granular B Type II or an approved material that is placed in 300 mm thick lifts and each lift compacted to 100 percent SPMDD. The placement and compaction of the engineered fill can in this way be undertaken to the founding level of the footings. From the footing level to the underside of the floor slab, each lift of the Granular B Type II material should be compacted to 98 percent of SPMDD. 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 subsequent lift.

It should be noted that the exposed clay subgrade surface is susceptible to disturbance due to movement of workers and construction traffic and the prevailing weather conditions during construction. As noted above, to prevent disturbance to the clay subgrade, the approved footing beds should be covered or protected with a 50 mm thick concrete mud slab.

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

The recommended factored geotechnical resistances at ULS and bearing pressure at SLS 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.

## 8.2 Pile Foundations

The proposed buildings may be founded on closed end pipe or steel H piles driven to practical refusal in the bedrock. Pipe piles are expected to be more economical compared to H piles, although they may present some problems. If driven in a group or cluster, lateral displacement of the soil may occur during pile driving, which may result in heave and/or displacement of pipe piles already driven.

Auger and dynamic cone penetration test (DCPT) refusal was encountered at depths of 12.5 m to 16.8 m (Elevation 80.4 m to Elevation 75.3 m) on either cobbles or boulders or the bedrock surface. If piles will be considered, it is recommended that additional boreholes be conducted and include the coring of the bedrock to confirm the bedrock depth and assess the quality of the bedrock for pile design.

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

It is noted that the piles will be subjected to down-drag forces (negative skin friction) due to consolidation of the silty clay as a result of the fill placed to raise the grades at the site. The down-drag forces based on a 1.0 m grade raise have been calculated and are shown in Table VII along with the estimated load carrying capacity of the piles. The final down-drag forces for the piles will have to be calculated once the magnitude of the site grade raise and floor slab loading are known.

**Table VII: Factored Geotechnical Resistance at Ultimate Limit State (ULS) and Estimated Negative Skin Friction of Steel Pipe and H-Piles**

| Type | Description | Factored Geotechnical Resistance at ULS (kN) | Estimated Negative Skin Friction (kN) | Estimated Load Carrying Capacity of Pile (kN) |
|---|---|---|---|---|
| Steel Pipe | 245 mm O.D. by 10 mm wall thickness | 1275 | 186 | 1089 |
| | 245 mm O.D. by 12 mm wall thickness | 1445 | 186 | 1259 |
| | 324 mm O.D. by 12 mm wall thickness | 2120 | 246 | 1874 |
| Steel H | HP 310 x 79 | 1260 | 292 | 968 |
| | HP 310 x 110 | 1775 | 298 | 1477 |
| | HP 310 x 125 | 2000 | 301 | 1699 |

Settlements induced by the above recommended pile loads are expected to be less than normally tolerated limits of 25 mm total and 19 mm differential movements.

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

The site may be underlain by glacial till with cobbles and boulders. It is therefore recommended that the piles should be equipped with a driving shoe to protect them from damage during driving as per Ontario Provincial Standard Drawing (OPSD) 3001.100, Type II, Revision No. 2 dated November 2017.

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

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

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

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

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

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

# 9. Floor Slab and Drainage Requirements

The subsurface conditions at the site consist of 220 mm to 350 mm thick topsoil underlain by fill, consisting of reworked silty clay, that extends to 600 mm below the existing grade. For construction of the slab-on-grade floors and for a maximum site grade raise of 1.0 m, it is recommended that the topsoil and the reworked silty clay fill should be stripped from the site to a maximum depth of 0.6 m. The exposed native subgrade should be proof rolled and examined by EXP. Any soft areas identified should be sub-excavated and replaced with engineered fill conforming to Ontario Provincial Standard Specification (OPSS) Granular B Type II and compacted to 100 percent of Standard Proctor Maximum Dry Density (SPMDD).

The slab-on-grade for the proposed buildings may be set on a bed of well compacted 19 mm sized clear stone at least 200 mm thick placed on the approved subgrade. The clear stone would minimize the capillary rise of moisture from the sub-soil to the floor slab. Alternatively, the clear stone may be replaced by 200 mm thick bed of Ontario Provincial Standard Specification (OPSS) Granular A overlain by a vapour barrier. Adequate saw cuts should be provided in the floor slabs to control cracking.

It is recommended that perimeter drains should be provided for the proposed buildings. The need for underfloor drains can be assessed once the finished floor elevation has been finalized. The underfloor drainage system, if required, 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 100 mm thick layer of clear stone and covered on top and sides with 150 mm thick layer of clear stone which should be covered or fully wrapped with an approved porous geotextile membrane, such as Terrafix 270R or equivalent. The perimeter drains may also consist of 100 mm diameter perforated pipe set on the footings and surrounded with 150 mm thick clear stone fully wrapped with a geotextile membrane. The perimeter and underfloor drains should be connected to separate sumps so that at least one system would be operational should the other fail.

The finished floor should be set 150 mm above the surrounding finished grade. The finished exterior grade should be sloped away from the building to prevent ponding of surface water close to the exterior walls of the buildings.

# 10. Excavation and De-Watering Requirements

## 10.1 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.

## 10.2 Excavation

Excavations for the construction of the proposed building foundations and the installation of underground services are anticipated to extend to an approximate depth of 3.5 m depth below the existing grade and will likely be below the groundwater level.

The excavations may be undertaken by conventional equipment.

All excavations must be undertaken in accordance with the Occupational Health and Safety Act (OHSA), Ontario Reg. 213/91. Based on the definitions provided in OHSA, the subsurface soils on site are considered to be Type 3 and as such must be cut back at 1H:1V from the bottom of the excavation. Within zones of seepage and below the groundwater level, the excavation side slopes are expected to slough and eventually stabilize at 2H:1V to 3H:1V from the bottom of the excavation.

A base heave type of failure for excavations that extend to 3.5 m below the existing grade is not anticipated.

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.

## 10.3 De-Watering Requirements

Seepage of the surface and subsurface water into excavations is anticipated and it should be possible to collect water entering the excavations at low points and to remove it by conventional pumping techniques. In areas of high infiltration and below the groundwater level, a higher seepage rate should be anticipated and may require high-capacity pumps to keep the excavation dry.

If less than 50 $m^3$ of water are to be pumped per day, no permits are required. If between 50 $m^3$ and 400 $m^3$ of water is to be pumped per day, then the activity should be registered on the Environmental Activity and Sector Registry (EASR), an online registry maintained by the Ministry of the Environment, Conservation and Parks (MECP). If more than 400 $m^3$ of water is to be pumped per day, then a Category 3 Permit to Take Water (PTTW) is required.

Since water taking can be groundwater, storm water, or a combination of both, the most likely potential for significant volumes of water requiring removal from an excavation at the site is storm water. If a major rain event occurs while a large excavation is open, then it is possible that the total accumulation of water within the excavation will exceed 50 $m^3$. If that occurs, then it may be removed without a permit by pumping over several days during which no single-day water-taking is more than 50 $m^3$. Alternatively, a maximum of 400 $m^3$ of water may be pumped per day once the online EASR application form is filled out and the fee is paid. The EASR application may be completed by the property owner or their delegate. EXP would be pleased to assist with the EASR, should it be deemed necessary. Per the terms of the EASR, the total quantities of water actually removed from the excavation must be reported to the MECP.

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.

# 11. Pipe Bedding Requirements

For site servicing, it is anticipated that the subgrade for the proposed underground services will consist of silty clay.

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

Due to the presence of the silty clay and high groundwater level, it is recommended the pipe bedding consist of 150 mm thick OPSS Granular A underlain by 300 mm thick OPSS Granular B Type II compacted to at least 95 percent standard Proctor maximum dry density (SPMDD).

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

If the backfill for the service trenches will consist of granular fill, clay seals should be installed in the service trenches at select intervals (spacing) as per City of Ottawa Drawing No. S8. The seals should be 1.0 m wide, extend over the entire trench width and from the bottom of the trench to the underside of the pavement structure. The clay should be compacted to 95 percent SPMDD. The purpose of the clay seals is to prevent the permanent lowering of the groundwater level.

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

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

The material to be excavated during construction will consist of the topsoil layer and the reworked silty clay fill. The topsoil is not considered suitable for reuse. The existing fill (reworked silty clay) is not considered suitable for reuse as backfill material in the interior or exterior of the buildings but may be used for general grading purposes in landscaped areas.

It is anticipated that the majority of the material would have to be imported and should preferably conform to the following specification:

- Engineered fill under the footings and the slab-on-grade - OPSS 1010 Granular B Type II placed in 300 mm thick lifts and each lift compacted to 100 percent SPMDD under footings and to 98 percent SPMDD under floor slabs.
- Backfill in footing trenches and against foundation walls – OPSS 1010 Granular B Type II placed in 300 mm thick lifts and each lift compacted to 98 percent of the SPMDD inside the building and 95 percent SPMDD outside the building respectively.
- Backfill in services trenches inside building – OPSS 1010 Granular B Type II placed in 300 mm thick lifts and each lift compacted to 98 percent of the SPMDD.
- Backfill in exterior services trenches – OPSS 1010 Select Subgrade Material (SSM) placed in 300 mm thick lifts and each lift compacted to 95 percent of the SPMDD.

# 13. Access Roads and Parking Lots

Pavement structures for the proposed parking lots, access roads and loading areas are given on Table VIII below for the anticipated engineered fill or silty clay subgrade. The pavement structures are based upon the assumption that the subgrade will be properly prepared and assumes 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: Recommended Pavement Structure Thicknesses**

| Pavement Layer | Compaction Requirements | Computed Pavement Structure | |
|---|---|---|---|
| | | Light Duty Traffic (Parking Lots - Cars Only) | Heavy Duty (Parking Lots and Access Roads) |
| Asphaltic Concrete (PG 58-34) | 92-97% MRD | 65 mm HL3/SP12.5 mm/ Cat. B | 50 mm HL3/SP12.5 Cat. B<br>60 mm HL8/SP 19 Cat. B |
| OPSS 1010 Granular A Base (crushed limestone) | 100% SPMDD | 150 mm | 150 mm |
| OPSS 1010 Granular B Type II Sub-base | 100% SPMDD | 450 mm | 600 mm |

**Notes:**

1. SPMDD denotes standard Proctor maximum dry density, ASTM, D-698-12e2.
2. MRD denotes Maximum Relative Density, ASTM D2041.

The upper 300 mm of the subgrade fill must be compacted to 98% SPMDD.

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

1. As part of the subgrade preparation, the proposed parking lots, access roads and loading areas should be stripped of topsoil and other obviously unsuitable material. The subgrade should be properly shaped, crowned, then proofrolled with a heavy vibratory roller in the full-time presence of a representative of this office. Any soft or spongy subgrade areas detected should be sub excavated and properly replaced with suitable approved backfill compacted to 95 percent SPMDD (ASTM D698-12e2). The subgrade should be covered with geotextile prior to placing granular materials.
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 at low points and should be continuous between catchbasins or open drainage ditches to intercept excess surface and subsurface moisture and to prevent subgrade softening. This will ensure no water collects in the granular course, which could result in pavement failure during the spring thaw. The location and extent of subdrains required within the paved areas should be reviewed by this office in conjunction with the proposed site grading.
3. To minimize the problems of differential movement between the pavement and catchbasins/manhole due to frost action, the backfill around the structures should consist of free-draining granular preferably conforming to OPSS 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 catch basins. 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, OPSS 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 Ontario Provincial Standard Specifications (OPSS 1010) for Granular A and Granular B Type II and should be compacted to 100 percent of the SPMDD.

The asphaltic concrete use and 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.

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

# 14. Corrosion Potential

Chemical tests limited to pH, sulphate, chloride and resistivity were undertaken on three (3) selected samples of the silty clay. 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**

| Borehole – Sample No. | Soil Type | Depth (m) | pH | Sulphate (%) | Chloride (%) | Resistivity (ohm-cm) |
|---|---|---|---|---|---|---|
| BH 5 – SS3 | Silty Clay | 2.3 – 2.9 | 8.00 | 0.0079 | 0.0007 | 4500 |
| BH 9 – SS3 | Silty Clay | 2.3 – 2.9 | 7.88 | 0.0063 | 0.0003 | 4780 |
| BH 16 – SS2 | Silty Clay | 0.8 – 1.4 | 7.54 | 0.0019 | 0.0004 | 12500 |

The results indicate the soils have a negligible sulphate attack on subsurface concrete. The concrete should be designed in accordance with CSA A.23.1-14.

The results of the resistivity tests indicate that the silty clay is mildly-corrosive to bare steel at Borehole Nos. 5 and 9 and non-corrosive at Borehole No. 16, as per the National Association of Corrosion Engineers (NACE). Appropriate measures should be taken to protect the buried bare steel from corrosion.

# 15. Tree Planting Restrictions

Based on the results of the Atterberg limits of the clayey soils and comparison of the results with the City of Ottawa 2005 Clay Soils Policy and 2017 Tree Planting in Sensitive Marine Clay Soils Guidelines (2017 Tree Planting Guidelines), the clayey soils at this site are considered to have a low/medium potential for soil volume change. Therefore, the tree planting should be carried out in accordance with the 2017 City of Ottawa Tree Planting Guidelines.

A landscape architect should be consulted to ensure the tree planting restrictions and setbacks for the proposed development are in accordance with the applicable City of Ottawa guidelines.

# 16. Additional Borehole/Study

Additional boreholes are recommended as follows:

- The boreholes along the northern extent of the property terminated within the silty clay deposit and as such, the thickness of the silty clay at this location is not known. Additional boreholes are recommended to confirm the depth of the silty clay deposit as well as to collect additional samples for additional engineering analysis and laboratory testing.
- Auger and DCPT refusal were encountered at depths of 12.5 m to 16.8 m (Elevation 80.4 m to Elevation 75.3 m) on either cobbles or boulders or on the bedrock surface. If piles will be considered, it is recommended that additional boreholes be conducted and include the coring of the bedrock to confirm the bedrock depth and assess the quality of the bedrock for piles design.
- As the standpipes/monitoring wells installed for the 2022 geotechnical investigation are no longer present on the site, the additional boreholes would also allow for the installation of monitoring wells to measure the groundwater levels at the site.

# 17. 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. Should specific information be required, including for example, the presence of pollutants, contaminants or other hazards in the soil, additional testing may be required.

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

Sincerely,

EXP Services Inc.

Daniel Wall, M.Eng., P.Eng.
Geotechnical Engineer
Earth & Environment

Susan M. Potyondy, P.Eng.
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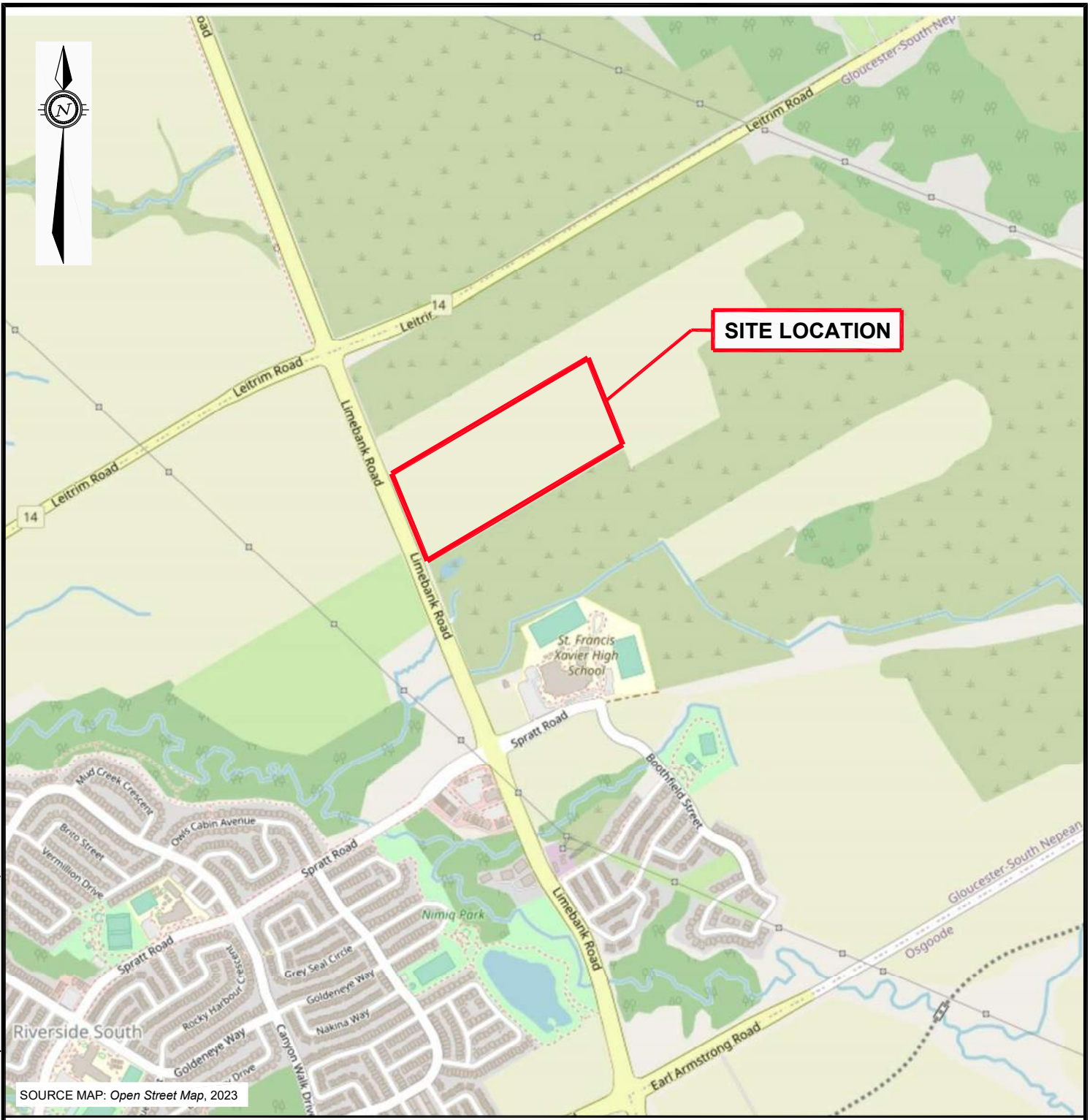
# Figures

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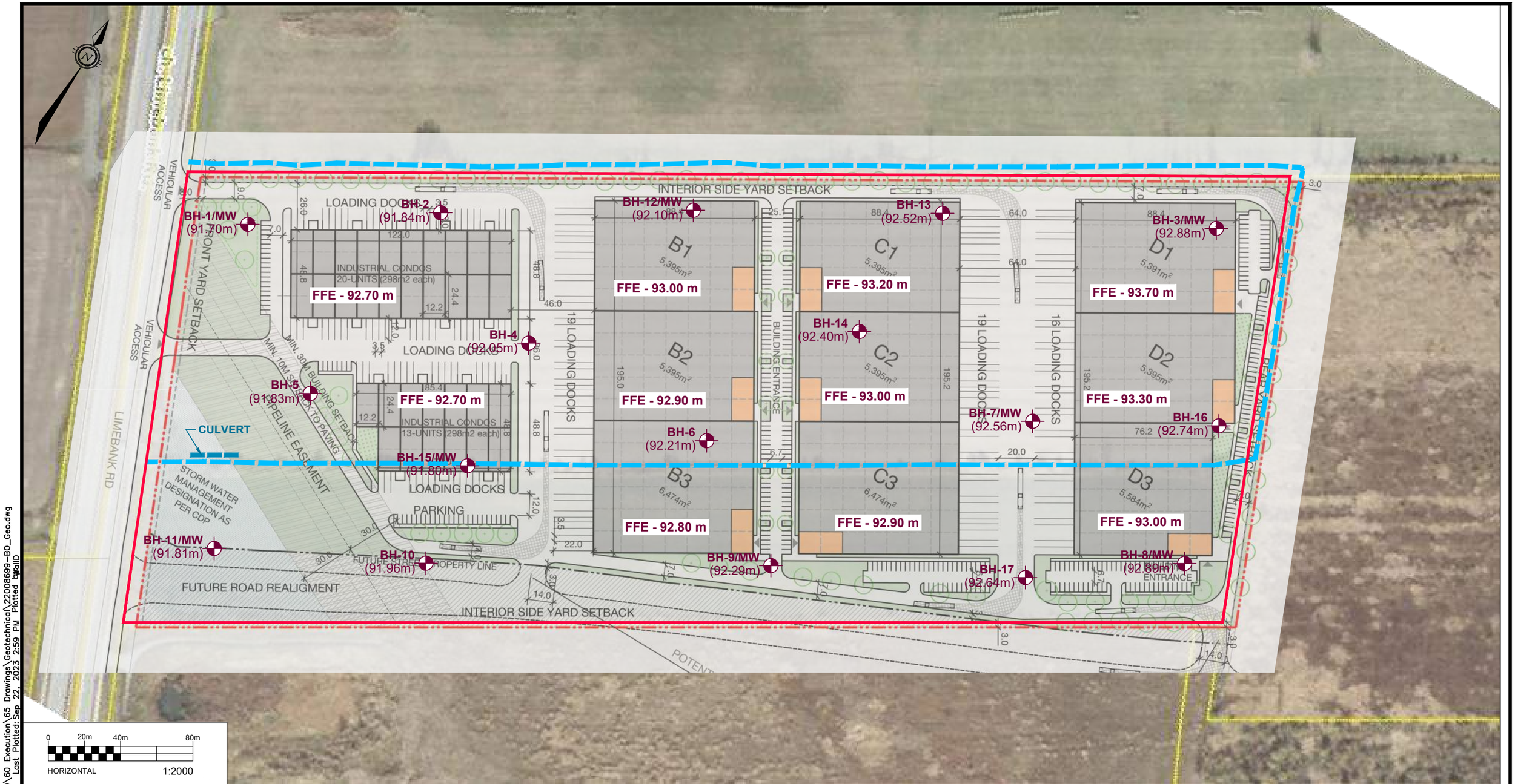
| | | |
|---|---|---|
| DATE: MARCH 2024 | CLIENT: GROUP MONTONI | project no.: OTT-22008699-B0 |
| DESIGN: MZ / DW; CHECKED: IT | | scale: 1:15,000 |
| DRAWN BY: AS | TITLE: SITE LOCATION PLAN<br>4101 LIMEBANK ROAD, OTTAWA, ONTARIO | FIG 1 |

Filename: E:\OTT\OTT-22008699-B0\60 Execution\65 Drawings\Geotechnical\22008699-B0_Geo.dwg
Last Saved: Mar 15, 2024 9:05 AM Last Plotted: Mar 19, 2024 11:03 PM Plotted by: WallD




## LEGEND

- PROPERTY BOUNDARY
- DRAINAGE DITCH
- BH-1 (91.70m) — BOREHOLE NAME & LOCATION (GROUND ELEVATION)
- MW — BOREHOLE WITH MONITORING WELL
- FFE — PROPOSED FINISHED FLOOR ELEVATION (METRES) (BASED ON RCII DRAWING 23074-S1, DATED FEB 2024)

## GENERAL NOTES:

1. THE BOUNDARIES, AND SOIL TYPES HAVE BEEN ESTABLISHED ONLY AT BOREHOLE LOCATIONS. BETWEEN BOREHOLES THEY ARE ASSUMED AND MAY BE SUBJECT TO CONSIDERABLE ERROR.
2. SOIL SAMPLES WILL BE RETAINED IN STORAGE FOR THREE MONTHS AND THEN DESTROYED UNLESS THE CLIENT ADVISES THAT AN EXTENDED TIME PERIOD IS REQUIRED.
3. TOPSOIL QUANTITIES SHOULD NOT BE ESTABLISHED FROM THE INFORMATION PROVIDED AT THE BOREHOLE LOCATIONS.
4. BOREHOLE ELEVATIONS SHOULD NOT BE USED TO DESIGN BUILDING(S) OR FLOOR SLABS OR PARKING LOT(S) GRADES.
5. THIS DRAWING FORMS PART OF THE REPORT PROJECT NUMBER AS REFERENCED AND SHOULD BE USED ONLY IN CONJUNCTION WITH THIS REPORT.
6. BASE PLAN PREPARED BY *ARCHITECTURE49*, DWG. NO.: A101, DATED: MAR 6. 2024.


EXP Services Inc. www.exp.com
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Ottawa, ON K2B 8H6, Canada


| | | | |
|---|---|---|---|
| DATE: MARCH 2024 | CLIENT: GROUP MONTONI | | project no. OTT-22008699-B0 |
| DESIGN: DW | CHECKED: IT | | scale 1:2000 |
| DRAWN BY: AS | TITLE: BOREHOLE LOCATION PLAN<br>4101 LIMEBANK ROAD, OTTAWA, ONTARIO | | FIG 2 |

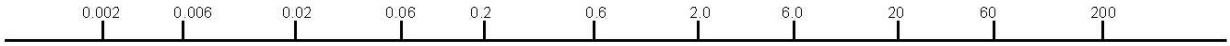

Filename: E:\OTT\OTT-22008699-B0\60 Execution\65 Drawings\Geotechnical\22008699-B0_Geo.dwg
Last Saved: Mar 15, 2024 9:05 AM Last Plotted: Sep 22, 2023 2:59 PM Plotted by: DW

# Notes On Sample Descriptions

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

ISSMFE SOIL CLASSIFICATION

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




EQUIVALENT GRAIN DIAMETER IN MILLIMETRES

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

UNIFIED SOIL CLASSIFICATION

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

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

# Log of Borehole BH-01

Project No: OTT-22008699-B0

Project: Proposed Industrial Condominium and Warehouse Development

Location: 4101 Limebank Road, Ottawa, Ontario

Date Drilled: 'April 29, 2022

Drill Type: CME-850 Track Mounted Drill Rig

Datum: Geodetic Elevation

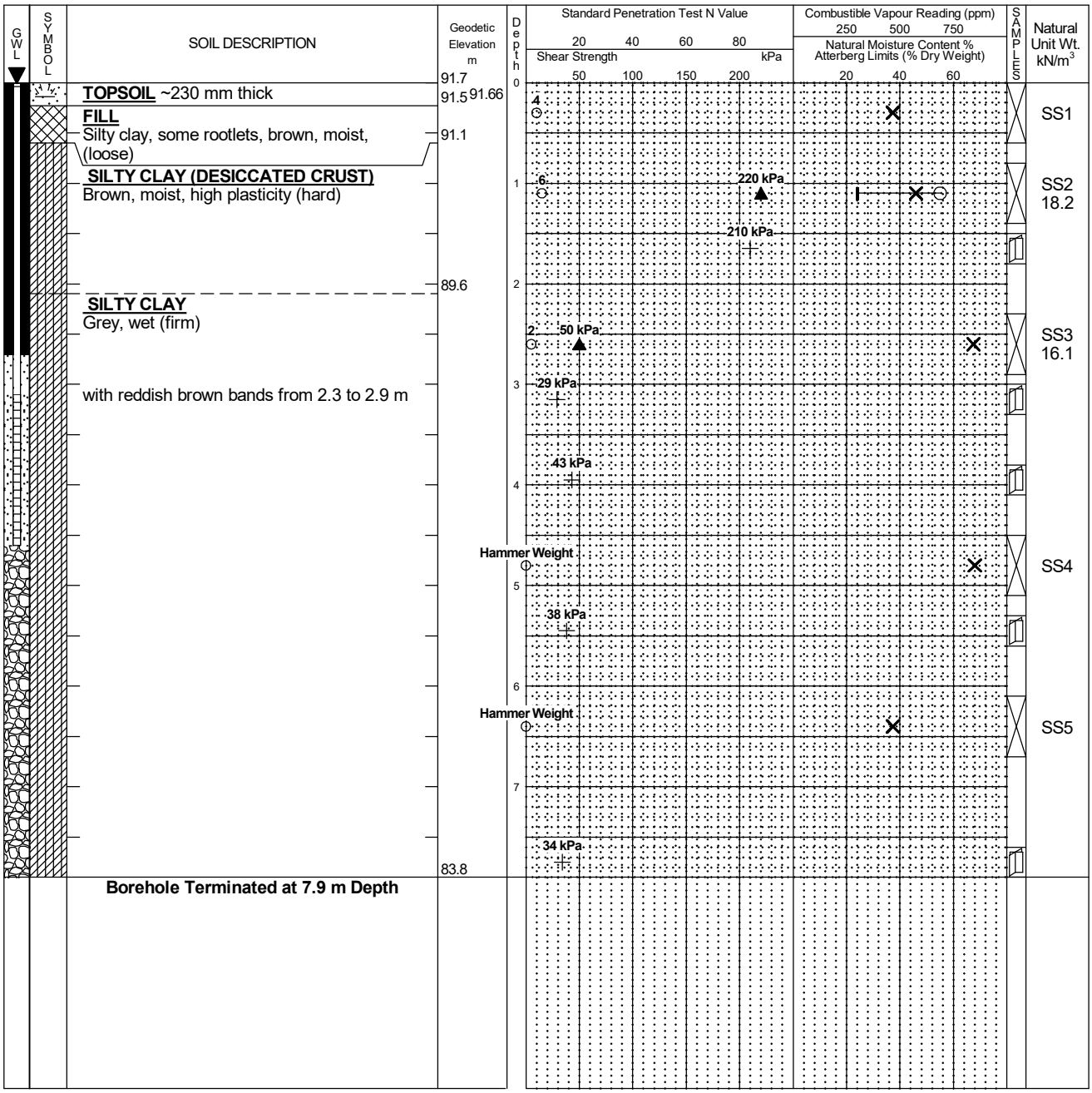
Logged by: M.Z. Checked by: I.T.

Figure No. 3

Page. 1 of 1

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

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




LOG OF BOREHOLE OTT-22008699 - LIETRIM AND LIMEBANK BH LOGS.GPJ TROW OTTAWA.GDT 3/26/24

NOTES:

1. Borehole data requires interpretation by EXP before use by others
2. A 50 mm diameter monitoring well installed as shown.
3. Field work supervised by an EXP representative.
4. See Notes on Sample Descriptions
5. Log to be read with EXP Report OTT-22008699-B0

| WATER LEVEL RECORDS | | |
|---|---|---|
| Date | Water Level (m) | Hole Open To (m) |
| May 4, 2022 | 0.0 | |
| May 10, 2022 | 0.5 | |

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

# Log of Borehole BH-02

Project No: OTT-22008699-B0

Project: Proposed Industrial Condominium and Warehouse Development

Location: 4101 Limebank Road, Ottawa, Ontario

Date Drilled: 'April 29, 2022

Drill Type: CME-55 LC Track Mounted Drill Rig

Datum: Geodetic Elevation

Logged by: M.Z. Checked by: I.T.

Figure No. 4

Page. 1 of 1

| | | | |
|---|---|---|---|
| Split Spoon Sample | ⊠ | Combustible Vapour Reading | □ |
| Auger Sample | ▮ | Natural Moisture Content | × |
| SPT (N) Value | ○ | Atterberg Limits | ⊢—○ |
| Dynamic Cone Test | — | Undrained Triaxial at % Strain at Failure | ⊕ |
| Shelby Tube | ■ | Shear Strength by Penetrometer Test | ▲ |
| Shear Strength by Vane Test | + S | | |

| GWL | SYMBOL | SOIL DESCRIPTION | Geodetic Elevation m | Depth | Standard Penetration Test N Value (20 40 60 80) / Shear Strength kPa (50 100 150 200) | Combustible Vapour Reading (ppm) (250 500 750) / Natural Moisture Content % / Atterberg Limits (% Dry Weight) (20 40 60) | SAMPLES | Natural Unit Wt. kN/m³ |
|---|---|---|---|---|---|---|---|---|
| | | | 91.84 | 0 | | | | |
| | | **TOPSOIL** ~220 mm thick | 91.6 | | 6 | × | | SS1 18.6 |
| | | **FILL** Silty clay, some rootlets, brown, moist, (loose) | 91.2 | | | | | |
| | | **SILTY CLAY (DESICCATED CRUST)** Brown, moist (very stiff) | | 1 | 5 | × | | SS2 17.9 |
| | | | | | 183 kPa | | | |
| | | | 89.7 | 2 | | | | |
| | | **SILTY CLAY** Grey, wet (soft to stiff) | | | 2 | × | | SS3 |
| | | | | 3 | 72 kPa | | | |
| | | | | | Hammer Weight | × | | SS4 |
| | | | | | 62 kPa | | | |
| | | | | 5 | | | | |
| | | | | | Hammer Weight | × | | SS5 |
| | | | | 6 | 19 kPa | | | |
| | | | | | Hammer Weight | × | | SS6 |
| | | | | | 29 kPa | | | |
| | | | 83.9 | | | | | |
| | | **Borehole Terminated at 7.9 m Depth** | | | | | | |

NOTES:

1. Borehole data requires interpretation by EXP before use by others
2. Borehole backfilled upon completion of drilling.
3. Field work supervised by an EXP representative.
4. See Notes on Sample Descriptions
5. Log to be read with EXP Report OTT-22008699-B0

WATER LEVEL RECORDS

| Date | Water Level (m) | Hole Open To (m) |
|---|---|---|
| Upon Completion | 7.0 | no cave |

CORE DRILLING RECORD

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

LOG OF BOREHOLE OTT-22008699 - LIETRIM AND LIMEBANK BH LOGS.GPJ TROW OTTAWA.GDT 3/26/24

# Log of Borehole BH-03

Project No: OTT-22008699-B0

Project: Proposed Industrial Condominium and Warehouse Development

Location: 4101 Limebank Road, Ottawa, Ontario

Date Drilled: 'April 26, 2022

Drill Type: CME-850 Track Mounted Drill Rig

Datum: Geodetic Elevation

Logged by: M.Z. Checked by: I.T.

Figure No. 5

Page. 1 of 2

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

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

| GWL | SYMBOL | SOIL DESCRIPTION | Geodetic Elevation m | Depth |
|---|---|---|---|---|
| | | **TOPSOIL** ~270 mm thick | 92.88 | 0 |
| | | **FILL** | 92.6 | |
| | | Silty clay, some rootlets, brown, moist, (loose) | 92.71 92.3 | |
| | | **SILTY CLAY (DESICCATED CRUST)** Brown, moist (stiff to very stiff) | | 1 |
| | | With reddish brown bands from 1.5 to 2.1 m depths | | 2 |
| | | | 90.2 | 3 |
| | | **SILTY CLAY** With sand, grey, wet, low plasticity (firm) | | 4 |
| | | | | 5 |
| | | | | 6 |
| | | | | 7 |
| | | | | 8 |
| | | | | 9 |
| | | | | 10 |

Standard Penetration Test N Value: 20 40 60 80

Shear Strength kPa: 50 100 150 200

Combustible Vapour Reading (ppm): 250 500 750

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

| SAMPLES | Natural Unit Wt. kN/m³ |
|---|---|
| SS1 | 19.3 |
| SS2 | 18.5 |
| SS3 | |
| ST4 | |
| SS5 | |
| ST6 | |
| SS7 | |
| SS8 | |

5 | 5 147 kPa | 3 77 kPa | 53 kPa | Hammer Weight | 29 kPa | 24 kPa | Hammer Weight | 34 kPa | Hammer Weight

*Continued Next Page*

NOTES:

1. Borehole data requires interpretation by EXP before use by others
2. A 50 mm diameter monitoring well installed as shown.
3. Field work supervised by an EXP representative.
4. See Notes on Sample Descriptions
5. Log to be read with EXP Report OTT-22008699-B0

WATER LEVEL RECORDS

| Date | Water Level (m) | Hole Open To (m) |
|---|---|---|
| May 4, 2022 | 0.2 | |
| May 10, 2022 | 0.3 | |

CORE DRILLING RECORD

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

LOG OF BOREHOLE OTT-22008699 - LIETRIM AND LIMEBANK BH LOGS.GPJ TROW OTTAWA.GDT 3/26/24

# Log of Borehole BH-03

Project No: OTT-22008699-B0

Project: Proposed Industrial Condominium and Warehouse Development

Figure No. 5



| GWL | SYMBOL | SOIL DESCRIPTION | Geodetic Elevation m | Depth | Standard Penetration Test N Value / Shear Strength kPa | Combustible Vapour Reading (ppm) / Natural Moisture Content % / Atterberg Limits (% Dry Weight) | SAMPLES | Natural Unit Wt. kN/m³ |
|---|---|---|---|---|---|---|---|---|
| | | **SILTY CLAY**<br>With sand, grey, wet, low plasticity (firm)<br>*(continued)* | 82.88 | 10 | Shear Strength 53 kPa | | | |
| | | | 81.8 | 11 | 3 | | SS9 | |
| | | **GLACIAL TILL**<br>Silty sand with gravel, boulders and cobbles, grey, wet, (compact) | | 12 | 13 | | SS10 | |
| | | | | 13 | | | | |
| | | | | 14 | 25, then 20/ 0 mm sampler bouncing | | SS11 | |
| | | | 78.6 | | | | | |
| | | **Auger Refusal at 14.3 m Depth** | | | | | | |

LOG OF BOREHOLE OTT-22008699 - LIETRIM AND LIMEBANK BH LOGS.GPJ TROW OTTAWA.GDT 3/26/24

NOTES:

1. Borehole data requires interpretation by EXP before use by others
2. A 50 mm diameter monitoring well installed as shown.
3. Field work supervised by an EXP representative.
4. See Notes on Sample Descriptions
5. Log to be read with EXP Report OTT-22008699-B0

WATER LEVEL RECORDS

| Date | Water Level (m) | Hole Open To (m) |
|---|---|---|
| May 4, 2022 | 0.2 | |
| May 10, 2022 | 0.3 | |

CORE DRILLING RECORD

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

# Log of Borehole BH-04

Project No: OTT-22008699-B0

Project: Proposed Industrial Condominium and Warehouse Development

Location: 4101 Limebank Road, Ottawa, Ontario

Date Drilled: 'April 29, 2022

Drill Type: CME-850 Track Mounted Drill Rig

Datum: Geodetic Elevation

Logged by: M.Z. Checked by: I.T.

Figure No. 6



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

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

| GWL | SYMBOL | SOIL DESCRIPTION | Geodetic Elevation m | Depth |
|---|---|---|---|---|
| | | **TOPSOIL** ~250 mm thick | 92.05 | 0 |
| | | **FILL** Silty clay, some rootlets, brown, moist, (loose) | 91.8 | |
| | | **SILTY CLAY (DESICCATED CRUST)** Brown, moist (stiff to very stiff) | 91.5 | 1 |
| | | | | 2 |
| | | | 89.3 | 3 |
| | | **SILTY CLAY** Grey, wet (firm to stiff) | | 4 |
| | | | | 5 |
| | | | | 6 |
| | | | | 7 |
| | | | 84.2 | 8 |
| | | Dynamic Cone Penetration Test (DCPT) conducted from 7.9 m to cone refusal at 16.8 m depth | | 9 |
| | | | | 10 |

Standard Penetration Test N Value: 20 40 60 80

Shear Strength kPa: 50 100 150 200

Combustible Vapour Reading (ppm): 250 500 750

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

| SAMPLES | Natural Unit Wt. kN/m³ |
|---|---|
| SS1 | |
| SS2 | 18.6 |
| SS3 | |
| SS4 | |
| SS5 | |

5

4 — 122 kPa

80 kPa

86 kPa

Hammer Weight

58 kPa

Hammer Weight

29 kPa

Hammer Weight

38 kPa

*Continued Next Page*

NOTES:

1. Borehole data requires interpretation by EXP before use by others
2. Borehole backfilled upon completion of drilling.
3. Field work supervised by an EXP representative.
4. See Notes on Sample Descriptions
5. Log to be read with EXP Report OTT-22008699-B0

WATER LEVEL RECORDS

| Date | Water Level (m) | Hole Open To (m) |
|---|---|---|
| Upon Completion | 2.5 | no cave |

CORE DRILLING RECORD

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

LOG OF BOREHOLE OTT-22008699 - LIETRIM AND LIMEBANK BH LOGS.GPJ TROW OTTAWA.GDT 3/26/24

# Log of Borehole BH-04

Project No: OTT-22008699-B0

Project: Proposed Industrial Condominium and Warehouse Development

Figure No. 6



| GWL | SYMBOL | SOIL DESCRIPTION | Geodetic Elevation m | Depth | Standard Penetration Test N Value / Shear Strength kPa | Combustible Vapour Reading (ppm) / Natural Moisture Content % / Atterberg Limits (% Dry Weight) | SAMPLES | Natural Unit Wt. kN/m³ |
|---|---|---|---|---|---|---|---|---|
| | | Dynamic Cone Penetration Test (DCPT) conducted from 7.9 m to cone refusal at 16.8 m depth *(continued)* | 82.05 | 10 | 20 40 60 80 / 50 100 150 200 | 250 500 750 / 20 40 60 | | |
| | | | | 11 | | | | |
| | | | | 12 | | | | |
| | | | | 13 | | | | |
| | | | | 14 | | | | |
| | | | | 15 | | | | |
| | | | | 16 | | | | |
| | | **Cone Refusal at 16.8 m Depth** | 75.3 | | | | | |

NOTES:

1. Borehole data requires interpretation by EXP before use by others
2. Borehole backfilled upon completion of drilling.
3. Field work supervised by an EXP representative.
4. See Notes on Sample Descriptions
5. Log to be read with EXP Report OTT-22008699-B0

WATER LEVEL RECORDS

| Date | Water Level (m) | Hole Open To (m) |
|---|---|---|
| Upon Completion | 2.5 | no cave |

CORE DRILLING RECORD

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

LOG OF BOREHOLE OTT-22008699 - LIETRIM AND LIMEBANK.BH LOGS.GPJ TROW OTTAWA.GDT 3/26/24

# Log of Borehole BH-05

Project No: OTT-22008699-B0

Project: Proposed Industrial Condominium and Warehouse Development

Location: 4101 Limebank Road, Ottawa, Ontario

Date Drilled: 'April 29, 2022

Drill Type: CME-850 Track Mounted Drill Rig

Datum: Geodetic Elevation

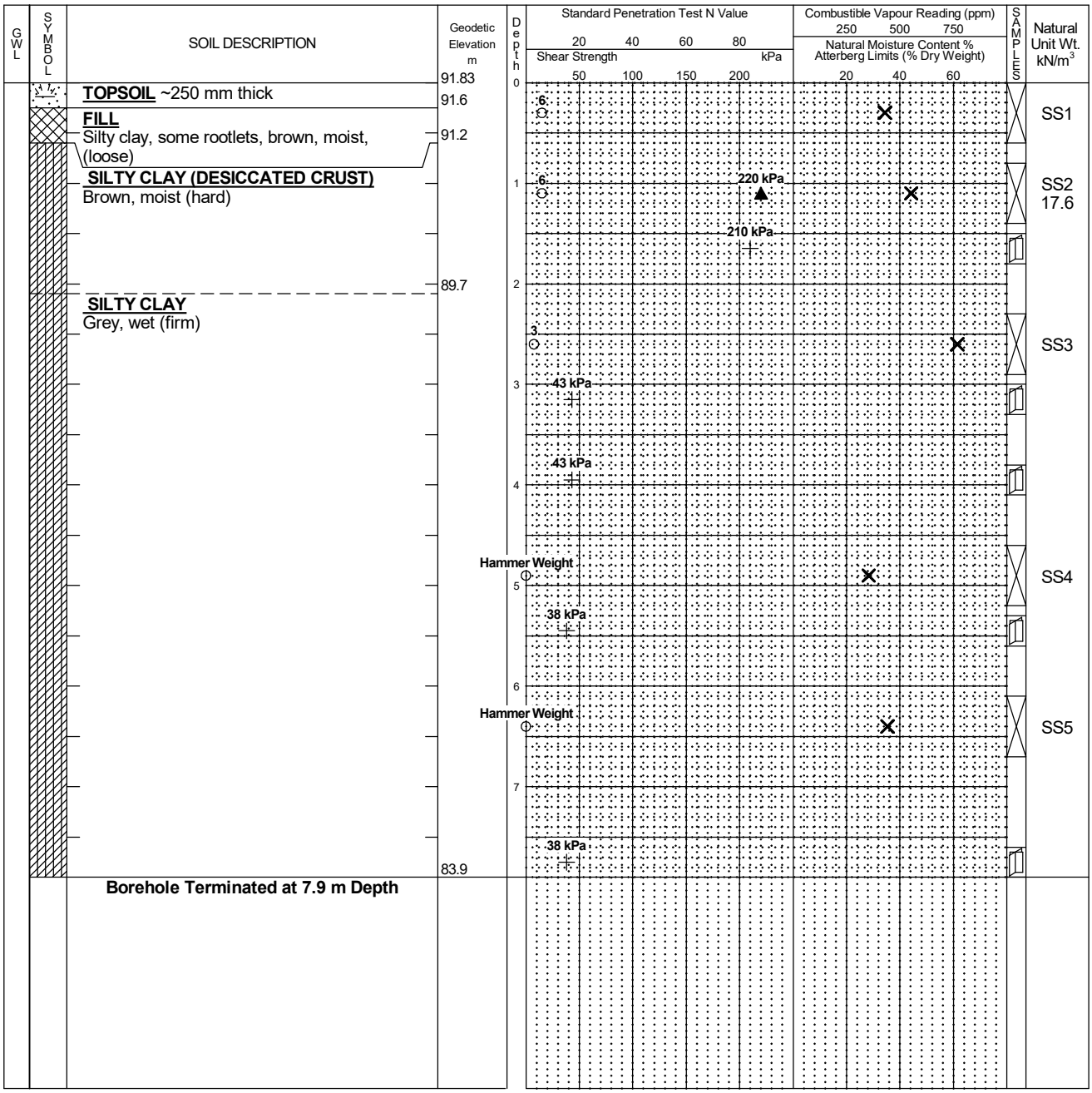
Logged by: M.Z. Checked by: I.T.

Figure No. 7

Page. 1 of 1

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

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




NOTES:

1. Borehole data requires interpretation by EXP before use by others
2. Borehole backfilled upon completion of drilling.
3. Field work supervised by an EXP representative.
4. See Notes on Sample Descriptions
5. Log to be read with EXP Report OTT-22008699-B0

| WATER LEVEL RECORDS | | |
|---|---|---|
| Date | Water Level (m) | Hole Open To (m) |
| Upon Completion | 3.2 | no cave |

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

LOG OF BOREHOLE OTT-22008699 - LIETRIM AND LIMEBANK BH LOGS.GPJ TROW OTTAWA.GDT 3/26/24

# Log of Borehole BH-06

Project No: OTT-22008699-B0

Project: Proposed Industrial Condominium and Warehouse Development

Location: 4101 Limebank Road, Ottawa, Ontario

Date Drilled: 'April 25, 2022

Drill Type: CME-850 Track Mounted Drill Rig

Datum: Geodetic Elevation

Logged by: M.Z. Checked by: I.T.

Figure No. 8

Page. 1 of 2

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

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

| GWL | SYMBOL | SOIL DESCRIPTION | Geodetic Elevation m | Depth | Standard Penetration Test N Value / Shear Strength kPa | Combustible Vapour Reading (ppm) / Natural Moisture Content % / Atterberg Limits (% Dry Weight) | SAMPLES | Natural Unit Wt. kN/m³ |
|---|---|---|---|---|---|---|---|---|
| | | **TOPSOIL** ~230 mm thick | 92.21 | 0 | 5 | | SS1 | |
| | | **FILL** Silty clay, some rootlets, brown, moist, (loose) | 92.0 | | | | | |
| | | **SILTY CLAY (DESICCATED CRUST)** Brown, moist (very stiff to hard) | 91.6 | 1 | 7 | | SS2 | 18.0 |
| | | | | 2 | 230 kPa | | | |
| | | | | | 180 kPa | | | |
| | | **SILTY CLAY** Grey, wet (soft to stiff) | 89.4 | 3 | Hammer Weight | | SS3 | |
| | | | | 4 | 62 kPa | | | |
| | | | | 5 | Hammer Weight | | SS4 | |
| | | | | | 34 kPa | | | |
| | | | | 6 | Hammer Weight | | SS5 | |
| | | | | 7 | 24 kPa | | | |
| | | | | 8 | Hammer Weight | | SS6 | |
| | | | | | 43 kPa | | | |
| | | **GLACIAL TILL** Silty sand with gravel, boulders and cobbles, grey, wet, (loose to very dense) | 83.3 | 9 | 5 | | SS7 | |
| | | | | 10 | | | | |

*Continued Next Page*

NOTES:

1. Borehole data requires interpretation by EXP before use by others
2. Borehole backfilled upon completion of drilling.
3. Field work supervised by an EXP representative.
4. See Notes on Sample Descriptions
5. Log to be read with EXP Report OTT-22008699-B0

WATER LEVEL RECORDS

| Date | Water Level (m) | Hole Open To (m) |
|---|---|---|
| Upon Completion | 9.6 | no cave |

CORE DRILLING RECORD

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

LOG OF BOREHOLE OTT-22008699 - LIETRIM AND LIMEBANK BH LOGS.GPJ TROW OTTAWA.GDT 3/26/24

# Log of Borehole BH-06

Project No: OTT-22008699-B0

Project: Proposed Industrial Condominium and Warehouse Development

Figure No. 8



| GWL | SYMBOL | SOIL DESCRIPTION | Geodetic Elevation m | Depth | Standard Penetration Test N Value / Shear Strength kPa | Combustible Vapour Reading (ppm) / Natural Moisture Content % / Atterberg Limits (% Dry Weight) | SAMPLES | Natural Unit Wt. kN/m³ |
|---|---|---|---|---|---|---|---|---|
| | | **GLACIAL TILL**<br>Silty sand with gravel, boulders and cobbles, grey, wet, (loose to very dense) *(continued)* | 82.21 | 10 | | | | |
| | | | | 11 | 6 | | SS8 | |
| | | | | 12 | 6 | | SS9 | |
| | | | | 13 | | | | |
| | | | | 14 | 40 | | SS10 | |
| | | | | 15 | 79 | | SS11 | 24.7 |
| | | | 76.4 | | | | | |
| | | **Borehole Terminated at 15.8 m Depth** | | | | | | |

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

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

NOTES:

1. Borehole data requires interpretation by EXP before use by others
2. Borehole backfilled upon completion of drilling.
3. Field work supervised by an EXP representative.
4. See Notes on Sample Descriptions
5. Log to be read with EXP Report OTT-22008699-B0

WATER LEVEL RECORDS

| Date | Water Level (m) | Hole Open To (m) |
|---|---|---|
| Upon Completion | 9.6 | no cave |

CORE DRILLING RECORD

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

LOG OF BOREHOLE OTT-22008699 - LIETRIM AND LIMEBANK.BH LOGS.GPJ TROW OTTAWA.GDT 3/26/24

# Log of Borehole BH-07

Project No: OTT-22008699-B0

Project: Proposed Industrial Condominium and Warehouse Development

Location: 4101 Limebank Road, Ottawa, Ontario

Date Drilled: 'April 25, 2022

Drill Type: CME-850 Track Mounted Drill Rig

Datum: Geodetic Elevation

Logged by: M.Z. Checked by: I.T.

Figure No. 9



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

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

| GWL | SYMBOL | SOIL DESCRIPTION | Geodetic Elevation m | Depth | Standard Penetration Test N Value / Shear Strength kPa | Combustible Vapour Reading (ppm) / Natural Moisture Content % / Atterberg Limits (% Dry Weight) | SAMPLES | Natural Unit Wt. kN/m³ |
|---|---|---|---|---|---|---|---|---|
| | | **TOPSOIL** ~250 mm thick | 92.56 | 0 | 6 | × | SS1 | |
| | | **FILL** Silty clay, some rootlets, brown, moist, (loose) | 92.3 | | | | | |
| | | **SILTY CLAY (DESICCATED CRUST)** Brown, moist (hard to very stiff) | 92.0 | 1 | 8 | × | SS2 | 18.8 |
| | | | | | >120 kPa | | | |
| | | | | 2 | 170 kPa | | | |
| | | **SILTY CLAY** Grey, wet (soft to firm) | 89.8 | 3 | Hammer Weight | × | SS3 | |
| | | | | | 29 kPa | | | |
| | | | | 4 | | | | |
| | | | | 5 | Hammer Weight | × | SS4 | |
| | | | | | 24 kPa | | | |
| | | | | 6 | | | | |
| | | | | | Hammer Weight | × | SS5 | |
| | | | | 7 | | | | |
| | | | | | 43 kPa | | | |
| | | Dynamic Cone Penetration Test (DCPT) conducted from 7.9 m to cone refusal at 13.7 m depth | 84.7 | 8 | | | | |
| | | | | 9 | | | | |
| | | | | 10 | | | | |

*Continued Next Page*

NOTES:

1. Borehole data requires interpretation by EXP before use by others
2. A 38 mm diameter standpipe installed as shown.
3. Field work supervised by an EXP representative.
4. See Notes on Sample Descriptions
5. Log to be read with EXP Report OTT-22008699-B0

WATER LEVEL RECORDS

| Date | Water Level (m) | Hole Open To (m) |
|---|---|---|
| May 10, 2022 | 0.4 | |

CORE DRILLING RECORD

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

# Log of Borehole BH-07

Project No: OTT-22008699-B0

Project: Proposed Industrial Condominium and Warehouse Development

Figure No. 9



| GWL | SYMBOL | SOIL DESCRIPTION | Geodetic Elevation m | Depth | Standard Penetration Test N Value / Shear Strength kPa | Combustible Vapour Reading (ppm) / Natural Moisture Content % / Atterberg Limits (% Dry Weight) | SAMPLES | Natural Unit Wt. kN/m³ |
|---|---|---|---|---|---|---|---|---|
| | | Dynamic Cone Penetration Test (DCPT) conducted from 7.9 m to cone refusal at 13.7 m depth *(continued)* | 82.56 | 10 | 20 40 60 80 / 50 100 150 200 | 250 500 750 / 20 40 60 | | |
| | | | | 11 | | | | |
| | | | | 12 | | | | |
| | | | | 13 | | | | |
| | | | 78.9 | | | | | |
| | | **Cone Refusal at 13.7 m Depth** | | | | | | |

NOTES:

1. Borehole data requires interpretation by EXP before use by others
2. A 38 mm diameter standpipe installed as shown.
3. Field work supervised by an EXP representative.
4. See Notes on Sample Descriptions
5. Log to be read with EXP Report OTT-22008699-B0

| WATER LEVEL RECORDS | | |
|---|---|---|
| Date | Water Level (m) | Hole Open To (m) |
| May 10, 2022 | 0.4 | |

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

LOG OF BOREHOLE OTT-22008699 - LIETRIM AND LIMEBANK BH LOGS.GPJ TROW OTTAWA.GDT 3/26/24

# Log of Borehole BH-08

Project No: OTT-22008699-B0

Project: Proposed Industrial Condominium and Warehouse Development

Location: 4101 Limebank Road, Ottawa, Ontario

Date Drilled: 'April 28, 2022

Drill Type: CME-850 Track Mounted Drill Rig

Datum: Geodetic Elevation

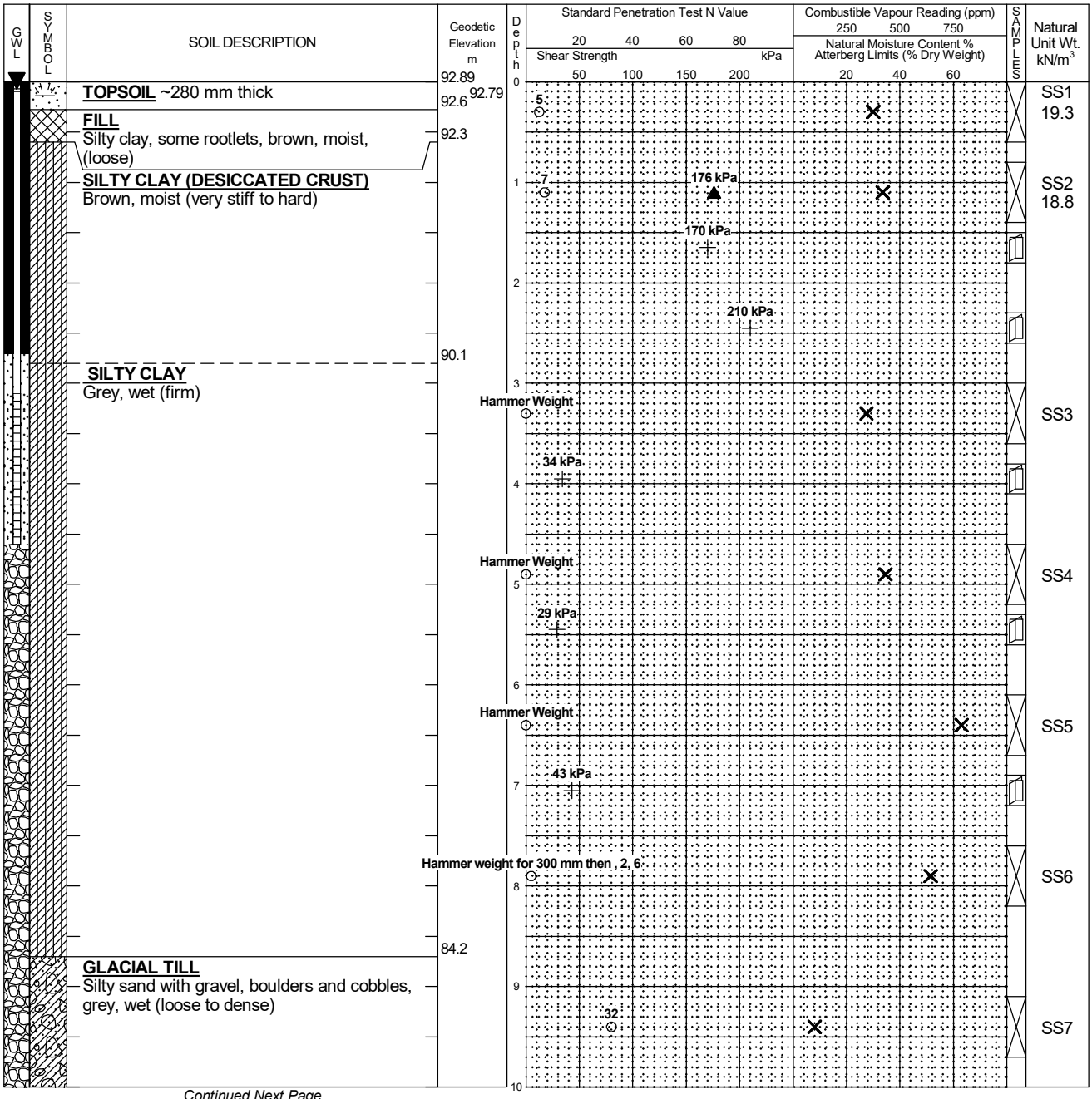
Logged by: M.Z. Checked by: I.T.

Figure No. 10



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

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




*Continued Next Page*

NOTES:

1. Borehole data requires interpretation by EXP before use by others
2. A 50 mm diameter monitoring well installed as shown.
3. Field work supervised by an EXP representative.
4. See Notes on Sample Descriptions
5. Log to be read with EXP Report OTT-22008699-B0

WATER LEVEL RECORDS

| Date | Water Level (m) | Hole Open To (m) |
|---|---|---|
| May 4, 2022 | 0.1 | |
| May 10, 2022 | 0.4 | |

CORE DRILLING RECORD

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

# Log of Borehole BH-08

Project No: OTT-22008699-B0

Project: Proposed Industrial Condominium and Warehouse Development

Figure No. 10



| GWL | SYMBOL | SOIL DESCRIPTION | Geodetic Elevation m | Depth | Standard Penetration Test N Value / Shear Strength kPa | Combustible Vapour Reading (ppm) / Natural Moisture Content % / Atterberg Limits (% Dry Weight) | SAMPLES | Natural Unit Wt. kN/m³ |
|---|---|---|---|---|---|---|---|---|
| | | **GLACIAL TILL** Silty sand with gravel, boulders and cobbles, grey, wet (loose to dense) *(continued)* | 82.89 | 10 | 20 40 60 80 / 50 100 150 200 | 250 500 750 / 20 40 60 | | |
| | | | | 11 | 7 | × | SS8 | |
| | | | | 12 | 27 then 50 for 75 mm | × | SS9 | |
| | | **Auger Refusal at 12.5 m Depth** | 80.4 | | | | | |

NOTES:

1. Borehole data requires interpretation by EXP before use by others
2. A 50 mm diameter monitoring well installed as shown.
3. Field work supervised by an EXP representative.
4. See Notes on Sample Descriptions
5. Log to be read with EXP Report OTT-22008699-B0

WATER LEVEL RECORDS

| Date | Water Level (m) | Hole Open To (m) |
|---|---|---|
| May 4, 2022 | 0.1 | |
| May 10, 2022 | 0.4 | |

CORE DRILLING RECORD

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

LOG OF BOREHOLE OTT-22008699 - LIETRIM AND LIMEBANK BH LOGS.GPJ TROW OTTAWA.GDT 3/26/24

# Log of Borehole BH-09

Project No: OTT-22008699-B0

Project: Proposed Industrial Condominium and Warehouse Development

Location: 4101 Limebank Road, Ottawa, Ontario

Date Drilled: 'April 28, 2022

Drill Type: CME-850 Track Mounted Drill Rig

Datum: Geodetic Elevation

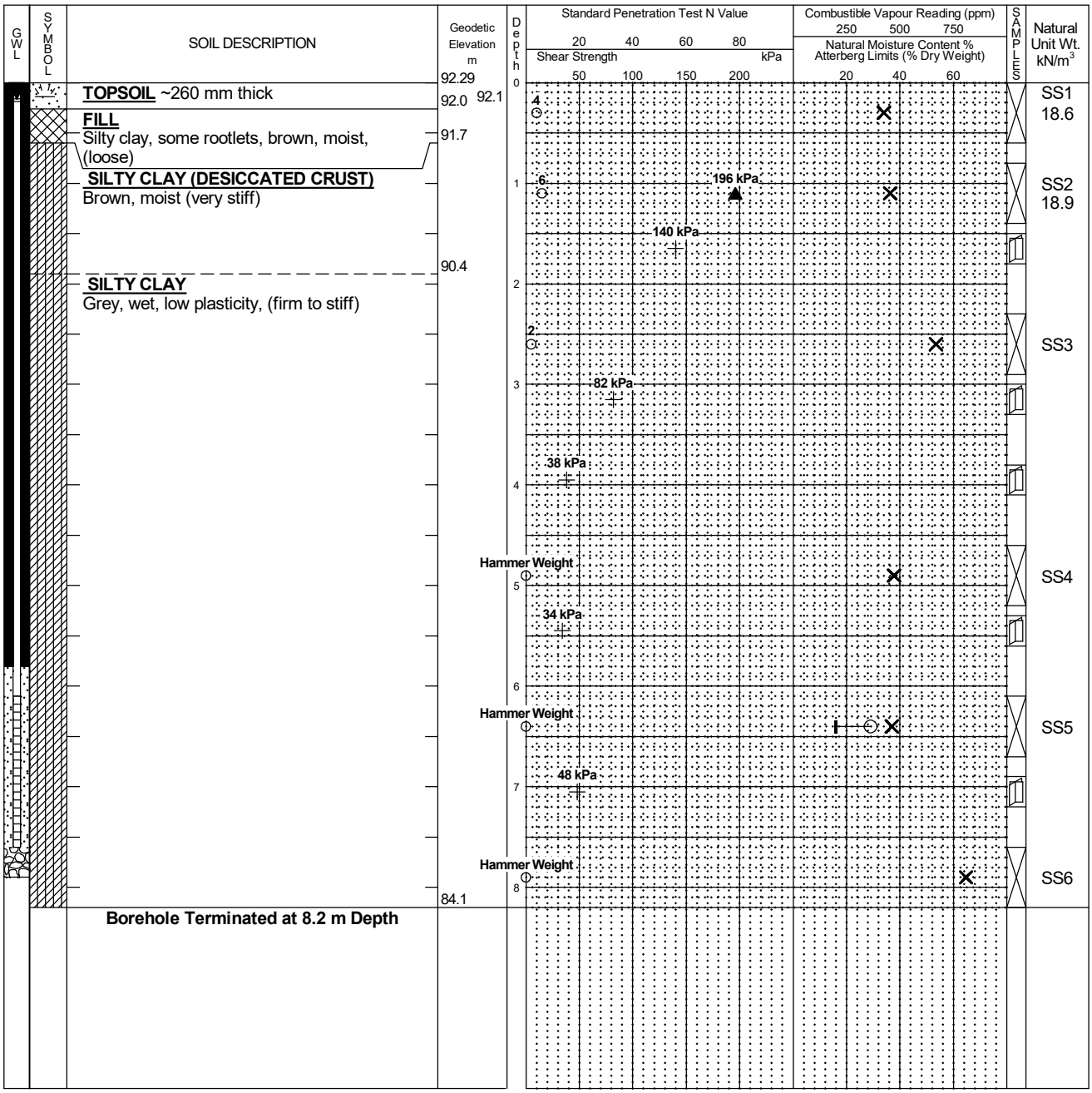
Logged by: M.Z. Checked by: I.T.

Figure No. 11

Page. 1 of 1

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

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




LOG OF BOREHOLE OTT-22008699 - LIETRIM AND LIMEBANK BH LOGS.GPJ TROW OTTAWA.GDT 3/26/24

NOTES:

1. Borehole data requires interpretation by EXP before use by others
2. A 38 mm diameter standpipe installed as shown.
3. Field work supervised by an EXP representative.
4. See Notes on Sample Descriptions
5. Log to be read with EXP Report OTT-22008699-B0

| WATER LEVEL RECORDS | | |
|---|---|---|
| Date | Water Level (m) | Hole Open To (m) |
| May 4, 2022 | 0.2 | |
| May 10, 2022 | 0.3 | |

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

# Log of Borehole BH-10

Project No: OTT-22008699-B0

Project: Proposed Industrial Condominium and Warehouse Development

Location: 4101 Limebank Road, Ottawa, Ontario

Date Drilled: 'April 29, 2022

Drill Type: CME-55 LC Track Mounted Drill Rig

Datum: Geodetic Elevation

Logged by: M.Z. Checked by: I.T.

Figure No. 12

Page. 1 of 2

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

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

| GWL | SYMBOL | SOIL DESCRIPTION | Geodetic Elevation m | Depth |
|---|---|---|---|---|
| | | **TOPSOIL** ~250 mm thick | 91.96 | 0 |
| | | Seismic Cone Penetration Test (SCPTu) conducted from 0.3 m to cone refusal at 11.8 m depth. | 91.7 | |
| | | Refer to Appendix A for inferred soil stratigraphy from SCPTu results. | | |

Standard Penetration Test N Value: 20 40 60 80
Shear Strength kPa: 50 100 150 200
Combustible Vapour Reading (ppm): 250 500 750
Natural Moisture Content % / Atterberg Limits (% Dry Weight): 20 40 60
SAMPLES
Natural Unit Wt. kN/m³

210 kPa
180 kPa
100 kPa
62 kPa
53 kPa
29 kPa
24 kPa
34 kPa

*Continued Next Page*

NOTES:
1. Borehole data requires interpretation by EXP before use by others
2. Borehole backfilled upon completion of drilling.
3. Field work supervised by an EXP representative.
4. See Notes on Sample Descriptions
5. Log to be read with EXP Report OTT-22008699-B0

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

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

LOG OF BOREHOLE OTT-22008699 - LIETRIM AND LIMEBANK BH LOGS.GPJ TROW OTTAWA.GDT 3/26/24

# Log of Borehole BH-10

Project No: OTT-22008699-B0

Project: Proposed Industrial Condominium and Warehouse Development

Figure No. 12



| GWL | SYMBOL | SOIL DESCRIPTION | Geodetic Elevation m | Depth | Standard Penetration Test N Value / Shear Strength kPa (20 40 60 80 / 50 100 150 200) | Combustible Vapour Reading (ppm) 250 500 750 / Natural Moisture Content % Atterberg Limits (% Dry Weight) 20 40 60 | SAMPLES | Natural Unit Wt. kN/m³ |
|---|---|---|---|---|---|---|---|---|
| | | Seismic Cone Penetration Test (SCPTu) conducted from 0.3 m to cone refusal at 11.8 m depth.<br><br>Refer to Appendix A for inferred soil stratigraphy from SCPTu results. *(continued)* | 81.96 | 10<br>11 | | | | |
| | | **SCPTu Cone Refusal at 11.8 m Depth** | 80.2 | | | | | |

NOTES:

1. Borehole data requires interpretation by EXP before use by others
2. Borehole backfilled upon completion of drilling.
3. Field work supervised by an EXP representative.
4. See Notes on Sample Descriptions
5. Log to be read with EXP Report OTT-22008699-B0

WATER LEVEL RECORDS

| Date | Water Level (m) | Hole Open To (m) |
|---|---|---|
| | | |

CORE DRILLING RECORD

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

LOG OF BOREHOLE OTT-22008699 - LIETRIM AND LIMEBANK BH LOGS.GPJ TROW OTTAWA.GDT 3/26/24

# Log of Borehole BH-11

Project No: OTT-22008699-B0

Project: Proposed Industrial Condominium and Warehouse Development

Location: 4101 Limebank Road, Ottawa, Ontario

Figure No. 13

Page. 1 of 1

Date Drilled: 'April 27, 2022

Drill Type: CME-850 Track Mounted Drill Rig

Datum: Geodetic Elevation

Logged by: M.Z. Checked by: I.T.

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

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

| GWL | SYMBOL | SOIL DESCRIPTION | Geodetic Elevation m | Depth |
|---|---|---|---|---|
| | | **TOPSOIL** ~310 mm thick | 91.81 | 0 |
| | | | 91.5 91.55 | |
| | | **FILL** Silty clay, some rootlets, brown, moist, (loose) | 91.2 | |
| | | **SILTY CLAY (DESICCATED CRUST)** Brown, moist (very stiff to hard) | | 1 |
| | | | 89.7 | 2 |
| | | **SILTY CLAY** Grey, wet, low plasticity, (firm) | | 3 |
| | | | | 4 |
| | | | | 5 |
| | | | | 6 |
| | | | | 7 |
| | | | 83.6 | 8 |
| | | **Borehole Terminated at 8.2 m Depth** | | |

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

5
6
122 kPa
220 kPa
225 kPa
1
34 kPa
38 kPa
Hammer Weight
38 kPa

| SAMPLES | Natural Unit Wt. kN/m³ |
|---|---|
| SS1 | |
| SS2 | 18.4 |
| SS3 | |
| SS4 | |
| ST5 | |
| SS6 | |
| ST7 | |

NOTES:
1. Borehole data requires interpretation by EXP before use by others
2. A 50 mm diameter monitoring well installed as shown.
3. Field work supervised by an EXP representative.
4. See Notes on Sample Descriptions
5. Log to be read with EXP Report OTT-22008699-B0

WATER LEVEL RECORDS

| Date | Water Level (m) | Hole Open To (m) |
|---|---|---|
| May 4, 2022 | 0.3 | |
| May 10, 2022 | 0.7 | |

CORE DRILLING RECORD

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

LOG OF BOREHOLE OTT-22008699 - LIETRIM AND LIMEBANK BH LOGS.GPJ TROW OTTAWA.GDT 3/26/24

# Log of Borehole BH-12

Project No: OTT-22008699-B0

Project: Proposed Industrial Condominium and Warehouse Development

Location: 4101 Limebank Road, Ottawa, Ontario

Date Drilled: 'April 29, 2022

Drill Type: CME-850 Track Mounted Drill Rig

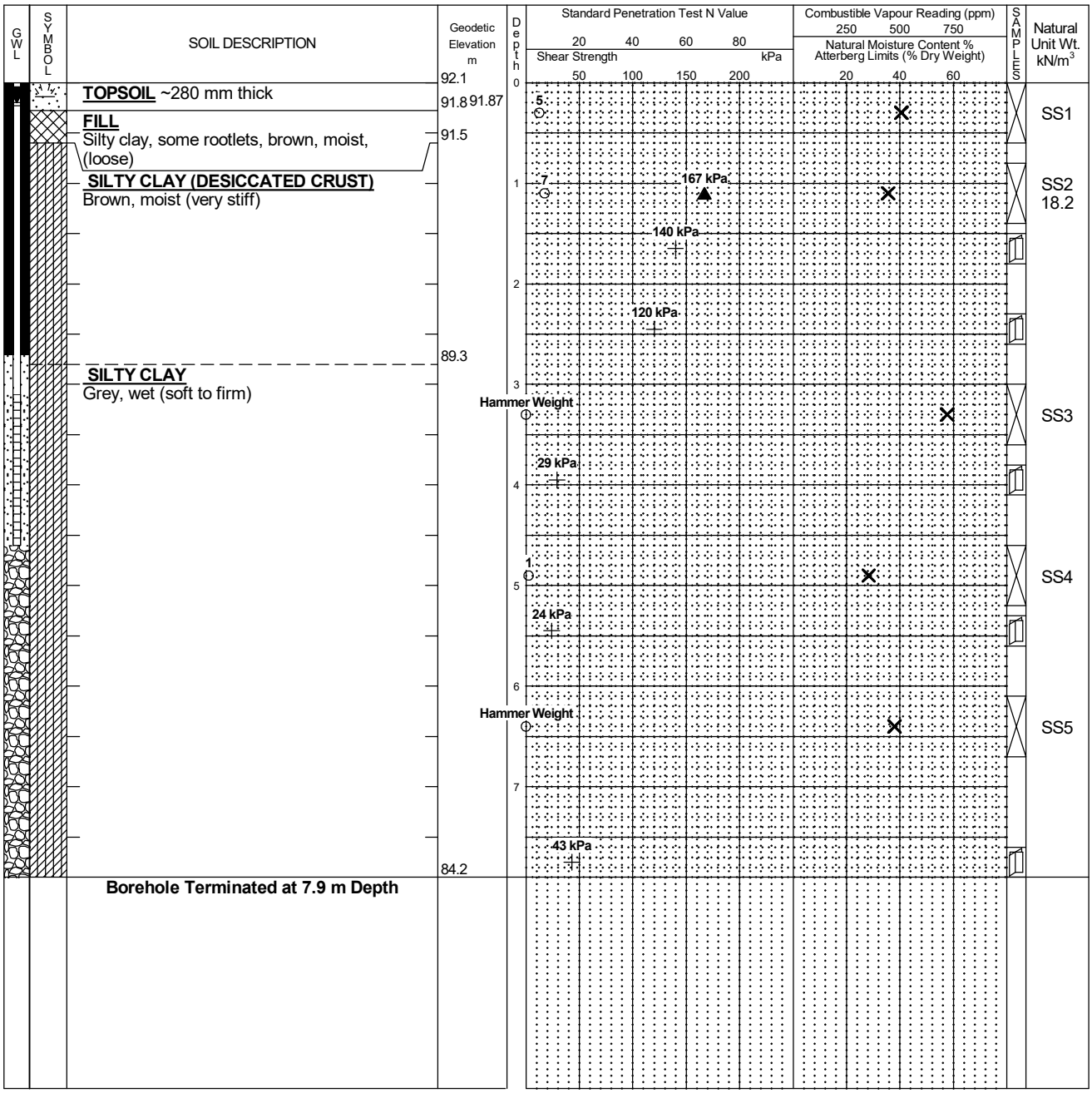
Datum: Geodetic Elevation

Logged by: M.Z. Checked by: I.T.

Figure No. 14

Page. 1 of 1

Split Spoon Sample
Auger Sample
SPT (N) Value
Dynamic Cone Test
Shelby Tube
Shear Strength by Vane Test (S)
Combustible Vapour Reading
Natural Moisture Content
Atterberg Limits
Undrained Triaxial at % Strain at Failure
Shear Strength by Penetrometer Test




LOG OF BOREHOLE OTT-22008699 - LIETRIM AND LIMEBANK BH LOGS.GPJ TROW OTTAWA.GDT 3/26/24

NOTES:

1. Borehole data requires interpretation by EXP before use by others
2. A 50 mm diameter monitoring well installed as shown.
3. Field work supervised by an EXP representative.
4. See Notes on Sample Descriptions
5. Log to be read with EXP Report OTT-22008699-B0

WATER LEVEL RECORDS

| Date | Water Level (m) | Hole Open To (m) |
|---|---|---|
| May 4, 2022 | 0.2 | |
| May 10, 2022 | 0.4 | |

CORE DRILLING RECORD

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

# Log of Borehole BH-13

Project No: OTT-22008699-B0

Project: Proposed Industrial Condominium and Warehouse Development

Location: 4101 Limebank Road, Ottawa, Ontario

Figure No. 15

Page. 1 of 1

Date Drilled: 'April 26, 2022

Drill Type: CME-850 Track Mounted Drill Rig

Datum: Geodetic Elevation

Logged by: M.Z. Checked by: I.T.

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

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

| GWL | SYMBOL | SOIL DESCRIPTION | Geodetic Elevation m | Depth | Standard Penetration Test N Value / Shear Strength kPa | Combustible Vapour Reading (ppm) / Natural Moisture Content % / Atterberg Limits (% Dry Weight) | SAMPLES | Natural Unit Wt. kN/m³ |
|---|---|---|---|---|---|---|---|---|
| | | **TOPSOIL** ~250 mm thick | 92.52 | 0 | 4 | × | SS1 | |
| | | **FILL** Silty clay, some rootlets, brown, moist, (loose) | 92.3 | | | | | |
| | | **SILTY CLAY (DESICCATED CRUST)** Brown, moist (stiff to very stiff) | 91.9 | 1 | 6; 123 kPa; 120 kPa | × | SS2 | 17.3 |
| | | | | 2 | 96 kPa | | | |
| | | **SILTY CLAY** Grey, wet (soft to firm) | 89.5 | 3 | Hammer Weight | × | SS3 | |
| | | | | 4 | 31 kPa | | | |
| | | | | 5 | Hammer Weight; 24 kPa | × | SS4 | |
| | | | | 6 | Hammer Weight | × | SS5 | |
| | | | | 7 | 34 kPa | | | |
| | | **Borehole Terminated at 7.9 m Depth** | 84.6 | | | | | |

NOTES:

1. Borehole data requires interpretation by EXP before use by others
2. Borehole backfilled upon completion of drilling.
3. Field work supervised by an EXP representative.
4. See Notes on Sample Descriptions
5. Log to be read with EXP Report OTT-22008699-B0

WATER LEVEL RECORDS

| Date | Water Level (m) | Hole Open To (m) |
|---|---|---|
| Upon Completion | 4.8 | 4.8 |

CORE DRILLING RECORD

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

LOG OF BOREHOLE OTT-22008699 - LIETRIM AND LIMEBANK BH LOGS.GPJ TROW OTTAWA.GDT 3/26/24

# Log of Borehole BH-14

Project No: OTT-22008699-B0

Project: Proposed Industrial Condominium and Warehouse Development

Location: 4101 Limebank Road, Ottawa, Ontario

Date Drilled: 'April 26, 2022

Drill Type: CME-850 Track Mounted Drill Rig

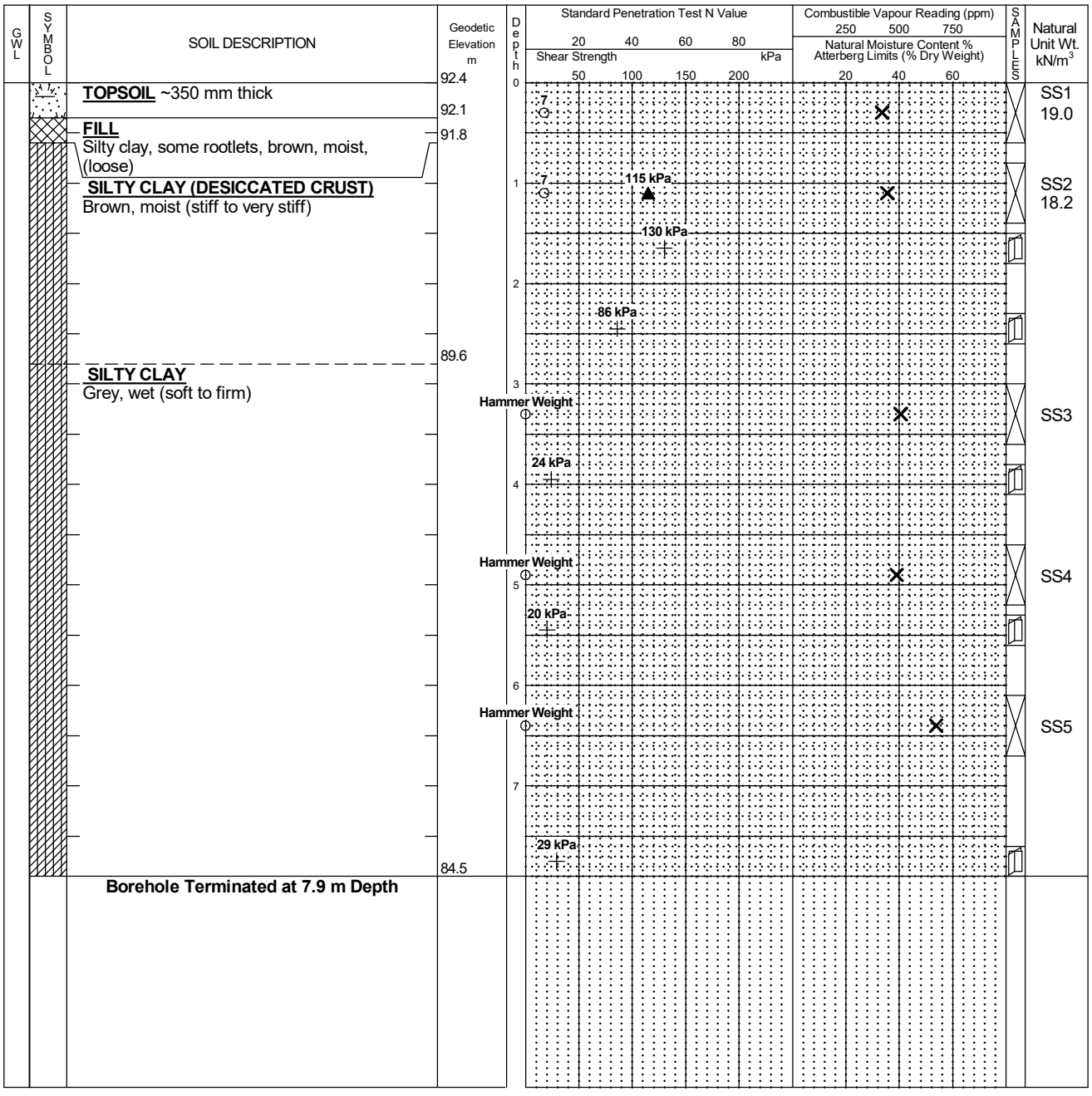
Datum: Geodetic Elevation

Logged by: M.Z. Checked by: I.T.

Figure No. 16

Page. 1 of 1

Split Spoon Sample
Auger Sample
SPT (N) Value
Dynamic Cone Test
Shelby Tube
Shear Strength by Vane Test (S)
Combustible Vapour Reading
Natural Moisture Content
Atterberg Limits
Undrained Triaxial at % Strain at Failure
Shear Strength by Penetrometer Test




LOG OF BOREHOLE OTT-22008699 - LIETRIM AND LIMEBANK BH LOGS.GPJ TROW OTTAWA.GDT 3/26/24

NOTES:

1. Borehole data requires interpretation by EXP before use by others
2. Borehole backfilled upon completion of drilling.
3. Field work supervised by an EXP representative.
4. See Notes on Sample Descriptions
5. Log to be read with EXP Report OTT-22008699-B0

| WATER LEVEL RECORDS | | |
|---|---|---|
| Date | Water Level (m) | Hole Open To (m) |
| Upon Completion | 3.0 | 4.3 |

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

# Log of Borehole BH-15

Project No: OTT-22008699-B0

Project: Proposed Industrial Condominium and Warehouse Development

Location: 4101 Limebank Road, Ottawa, Ontario

Date Drilled: 'April 28, 2022

Drill Type: CME-850 Track Mounted Drill Rig

Datum: Geodetic Elevation

Logged by: M.Z. Checked by: I.T.

Figure No. 17

Page. 1 of 1

| | | | |
|---|---|---|---|
| Split Spoon Sample | ⊠ | Combustible Vapour Reading | □ |
| Auger Sample | ▮ | Natural Moisture Content | × |
| SPT (N) Value | ○ | Atterberg Limits | ├─○ |
| Dynamic Cone Test | ── | Undrained Triaxial at % Strain at Failure | ⊕ |
| Shelby Tube | ■ | Shear Strength by Penetrometer Test | ▲ |
| Shear Strength by Vane Test | + S | | |

| GWL | SYMBOL | SOIL DESCRIPTION | Geodetic Elevation m | Depth | Standard Penetration Test N Value (20, 40, 60, 80) / Shear Strength kPa (50, 100, 150, 200) | Combustible Vapour Reading (ppm) (250, 500, 750) / Natural Moisture Content % / Atterberg Limits (% Dry Weight) (20, 40, 60) | SAMPLES | Natural Unit Wt. kN/m³ |
|---|---|---|---|---|---|---|---|---|
| | | | 91.8 | 0 | | | | |
| | | **TOPSOIL** ~250 mm thick | 91.6 91.68 | | 6 | × | | SS1 19.3 |
| | | **FILL** Silty clay, some rootlets, brown, moist, (loose) | 91.2 | | | | | |
| | | **SILTY CLAY (DESICCATED CRUST)** Brown, moist (very stiff) | | 1 | 6; 186 kPa; 190 kPa | × | | SS2 18.3 |
| | | | 89.8 | 2 | | | | |
| | | **SILTY CLAY** Grey, wet (firm to stiff) | | | 2; 34 kPa | × | | SS3 |
| | | | | 3 | | | | |
| | | | | 4 | 58 kPa | | | |
| | | | | 5 | Hammer Weight; 36 kPa | × | | SS4 |
| | | | | 6 | Hammer Weight | × | | SS5 |
| | | | | 7 | 43 kPa | | | |
| | | | 83.9 | | | | | |
| | | **Borehole Terminated at 7.9 m Depth** | | | | | | |

NOTES:

1. Borehole data requires interpretation by EXP before use by others
2. A 50 mm diameter monitoring well installed as shown.
3. Field work supervised by an EXP representative.
4. See Notes on Sample Descriptions
5. Log to be read with EXP Report OTT-22008699-B0

WATER LEVEL RECORDS

| Date | Water Level (m) | Hole Open To (m) |
|---|---|---|
| May 4, 2022 | 0.1 | |
| May 10, 2022 | 0.4 | |

CORE DRILLING RECORD

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

LOG OF BOREHOLE OTT-22008699 - LIETRIM AND LIMEBANK BH LOGS.GPJ TROW OTTAWA.GDT 3/26/24

# Log of Borehole BH-16

Project No: OTT-22008699-B0

Project: Proposed Industrial Condominium and Warehouse Development

Location: 4101 Limebank Road, Ottawa, Ontario

Figure No. 18

Page. 1 of 1

Date Drilled: 'April 25, 2022

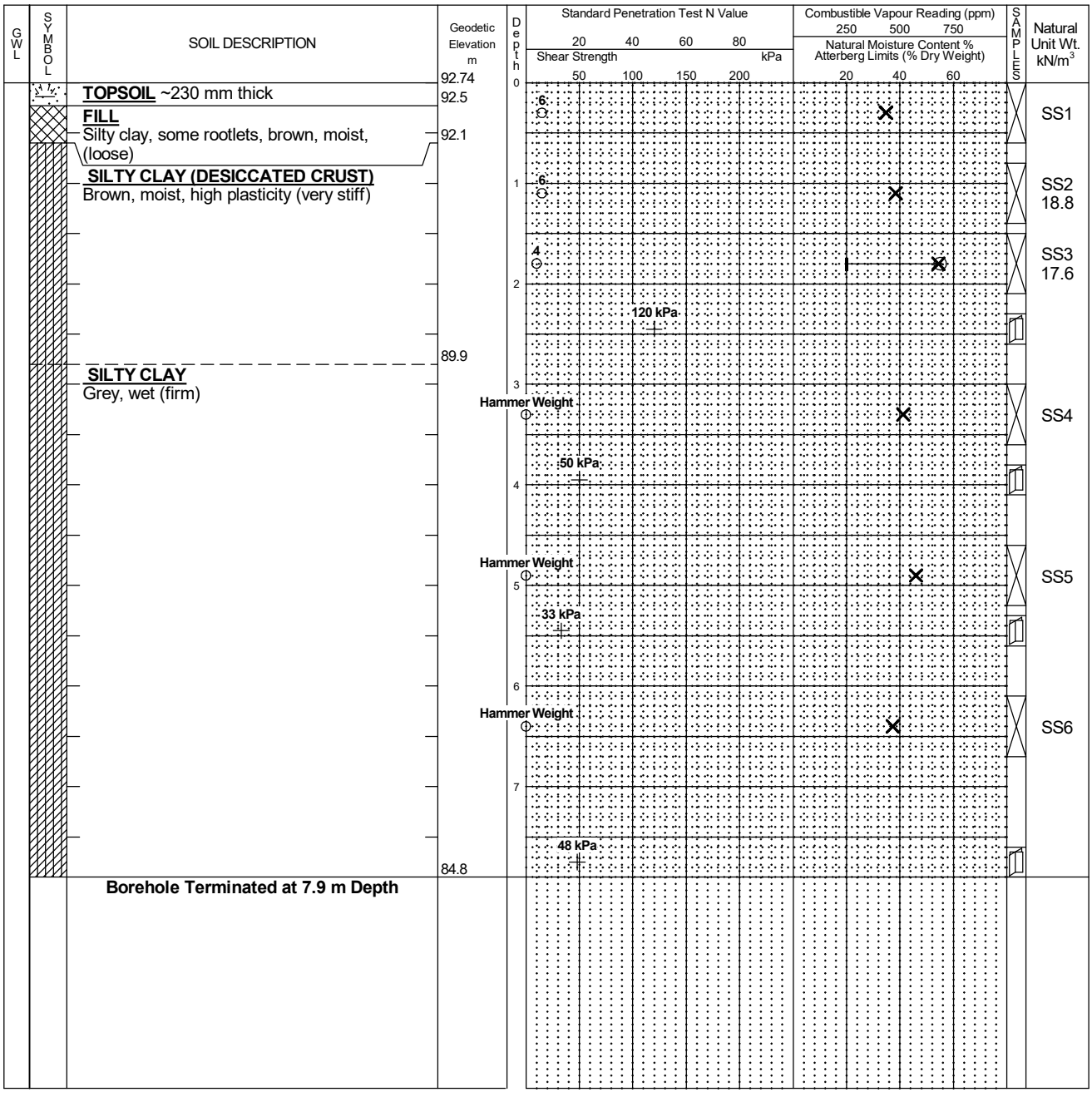
Drill Type: CME-850 Track Mounted Drill Rig

Datum: Geodetic Elevation

Logged by: M.Z. Checked by: I.T.

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

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




NOTES:

1. Borehole data requires interpretation by EXP before use by others
2. Borehole backfilled upon completion of drilling.
3. Field work supervised by an EXP representative.
4. See Notes on Sample Descriptions
5. Log to be read with EXP Report OTT-22008699-B0

| WATER LEVEL RECORDS | | |
|---|---|---|
| Date | Water Level (m) | Hole Open To (m) |
| Upon Completion | 5.1 | 5.6 |

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

LOG OF BOREHOLE OTT-22008699 - LIETRIM AND LIMEBANK BH LOGS.GPJ TROW OTTAWA.GDT 3/26/24

# Log of Borehole BH-17

Project No: OTT-22008699-B0

Project: Proposed Industrial Condominium and Warehouse Development

Location: 4101 Limebank Road, Ottawa, Ontario

Figure No. 19



Date Drilled: 'April 27, 2022

Drill Type: CME-850 Track Mounted Drill Rig

Datum: Geodetic Elevation

Logged by: M.Z. Checked by: I.T.

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

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

| GWL | SYMBOL | SOIL DESCRIPTION | Geodetic Elevation m | Depth |
|---|---|---|---|---|
| | | **TOPSOIL** ~300 mm | 92.64 | 0 |
| | | | 92.3 | |
| | | Seismic Cone Penetration Test (SCPTu) conducted from 0.3 m to cone refusal at 11.4 m depth. | | 1 |
| | | Refer to Appendix A for inferred soil stratigraphy from SCPTu results. | | 2 |
| | | | | 3 |
| | | | | 4 |
| | | | | 5 |
| | | | | 6 |
| | | | | 7 |
| | | | | 8 |
| | | | | 9 |
| | | | | 10 |

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

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

SAMPLES

Natural Unit Wt. kN/m³

*Continued Next Page*

NOTES:

1. Borehole data requires interpretation by EXP before use by others
2. Borehole backfilled upon completion of drilling.
3. Field work supervised by an EXP representative.
4. See Notes on Sample Descriptions
5. Log to be read with EXP Report OTT-22008699-B0

WATER LEVEL RECORDS

| Date | Water Level (m) | Hole Open To (m) |
|---|---|---|
| | | |

CORE DRILLING RECORD

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

# Log of Borehole BH-17

Project No: OTT-22008699-B0

Project: Proposed Industrial Condominium and Warehouse Development

Figure No. 19



| GWL | SYMBOL | SOIL DESCRIPTION | Geodetic Elevation m | Depth | Standard Penetration Test N Value / Shear Strength kPa | Combustible Vapour Reading (ppm) / Natural Moisture Content % / Atterberg Limits (% Dry Weight) | SAMPLES | Natural Unit Wt. kN/m³ |
|---|---|---|---|---|---|---|---|---|
| | | Seismic Cone Penetration Test (SCPTu) conducted from 0.3 m to cone refusal at 11.4 m depth.<br><br>Refer to Appendix A for inferred soil stratigraphy from SCPTu results. *(continued)* | 82.64 | 10<br>11 | 20 40 60 80<br>50 100 150 200 | 250 500 750<br>20 40 60 | | |
| | | **SCPTu Cone Refusal at 11.4 m Depth** | 81.2 | | | | | |

NOTES:

1. Borehole data requires interpretation by EXP before use by others
2. Borehole backfilled upon completion of drilling.
3. Field work supervised by an EXP representative.
4. See Notes on Sample Descriptions
5. Log to be read with EXP Report OTT-22008699-B0

WATER LEVEL RECORDS

| Date | Water Level (m) | Hole Open To (m) |
|---|---|---|
| | | |

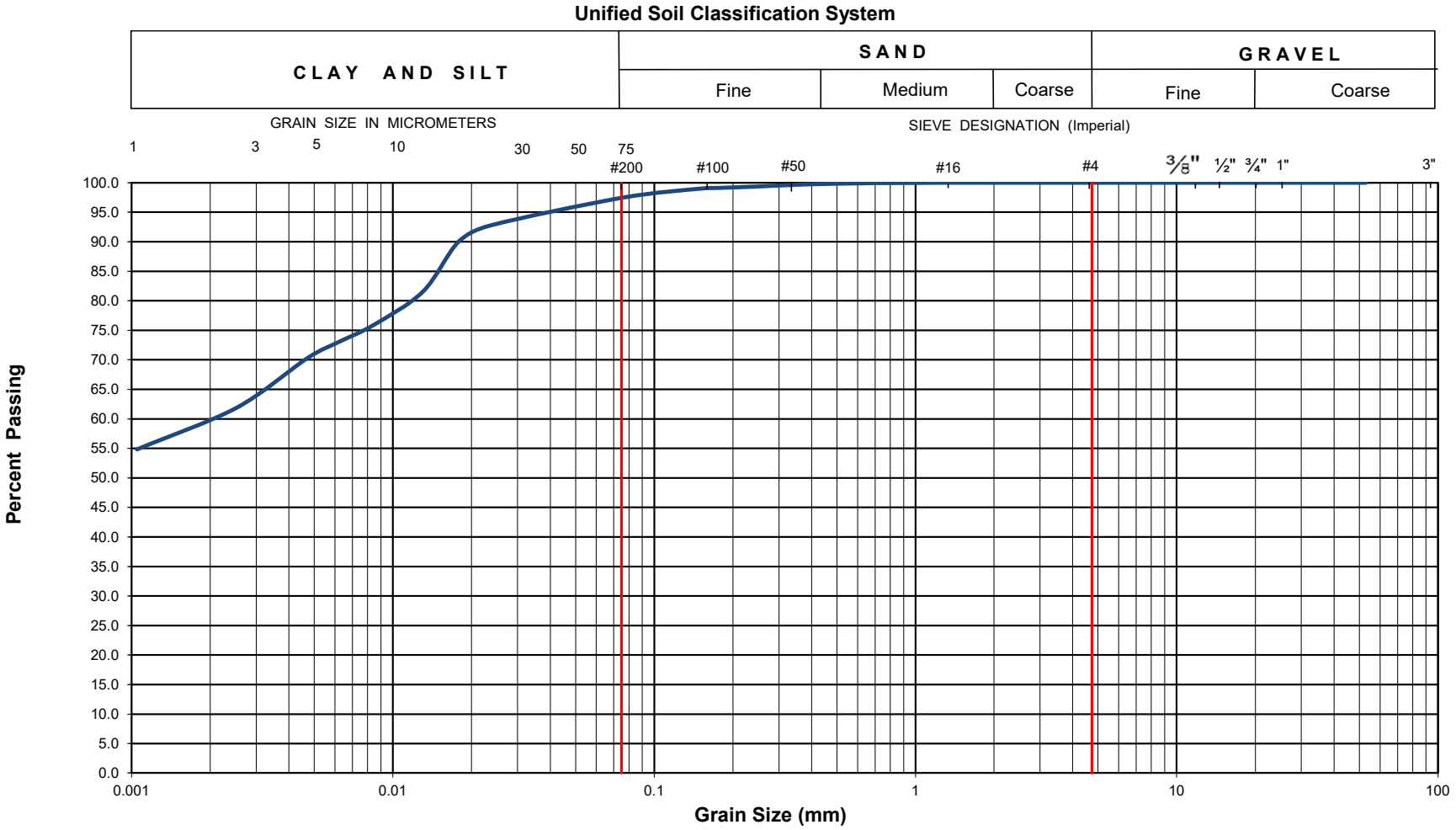
CORE DRILLING RECORD

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

LOG OF BOREHOLE OTT-22008699 - LIETRIM AND LIMEBANK BH LOGS.GPJ TROW OTTAWA.GDT 3/26/24

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

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




| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **EXP Project No.:** | **OTT-22008699-B0** | **Project Name :** | **Proposed Industrial Condominium and Warehouse Development** | | | | | | |
| **Client :** | **Group Montoni** | **Project Location :** | **4101 Limebank Road, Ottawa, Ontario** | | | | | | |
| **Date Sampled :** | **April 29, 2022** | **Borehole No:** | **BH 1** | | **Sample No.:** | **SS2** | | **Depth (m) :** | **0.8-1.4** |
| **Sample Description :** | | **% Silt and Clay** | **97** | **% Sand** | **3** | **% Gravel** | **0** | **Figure :** | **20** |
| **Sample Description :** | | **Brown Clay of High Plasticity (CH)** | | | | | | | |

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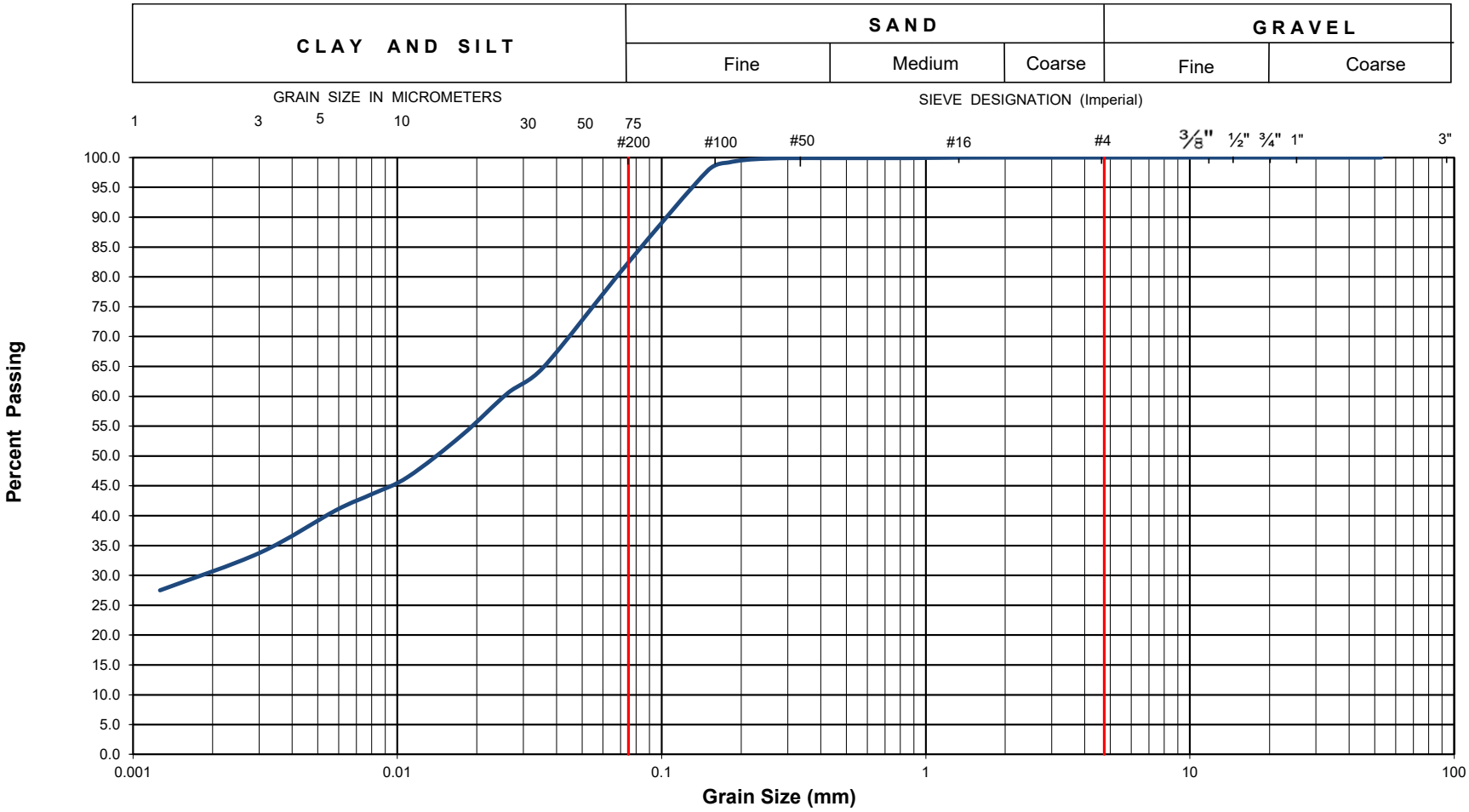
# Grain-Size Distribution Curve
# Method of Test For Particle Size Analysis of Soil
# ASTM C-136/ASTM D422

**Unified Soil Classification System**




| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **EXP Project No.:** | **OTT-22008699-B0** | **Project Name :** | **Proposed Industrial Condominium and Warehouse Development** | | | | | | |
| **Client :** | **Group Montoni** | **Project Location :** | **4101 Limebank Road, Ottawa, Ontario** | | | | | | |
| **Date Sampled :** | **April 26, 2022** | **Borehole No:** | **BH 3** | | **Sample No.:** | **SS5** | | **Depth (m) :** | **4.5-5.1** |
| **Sample Description :** | | **% Silt and Clay** | **82** | **% Sand** | **18** | **% Gravel** | **0** | **Figure :** | **21** |
| **Sample Description :** | | **Grey Low Plasticity Clay with Sand (CL)** | | | | | | | |

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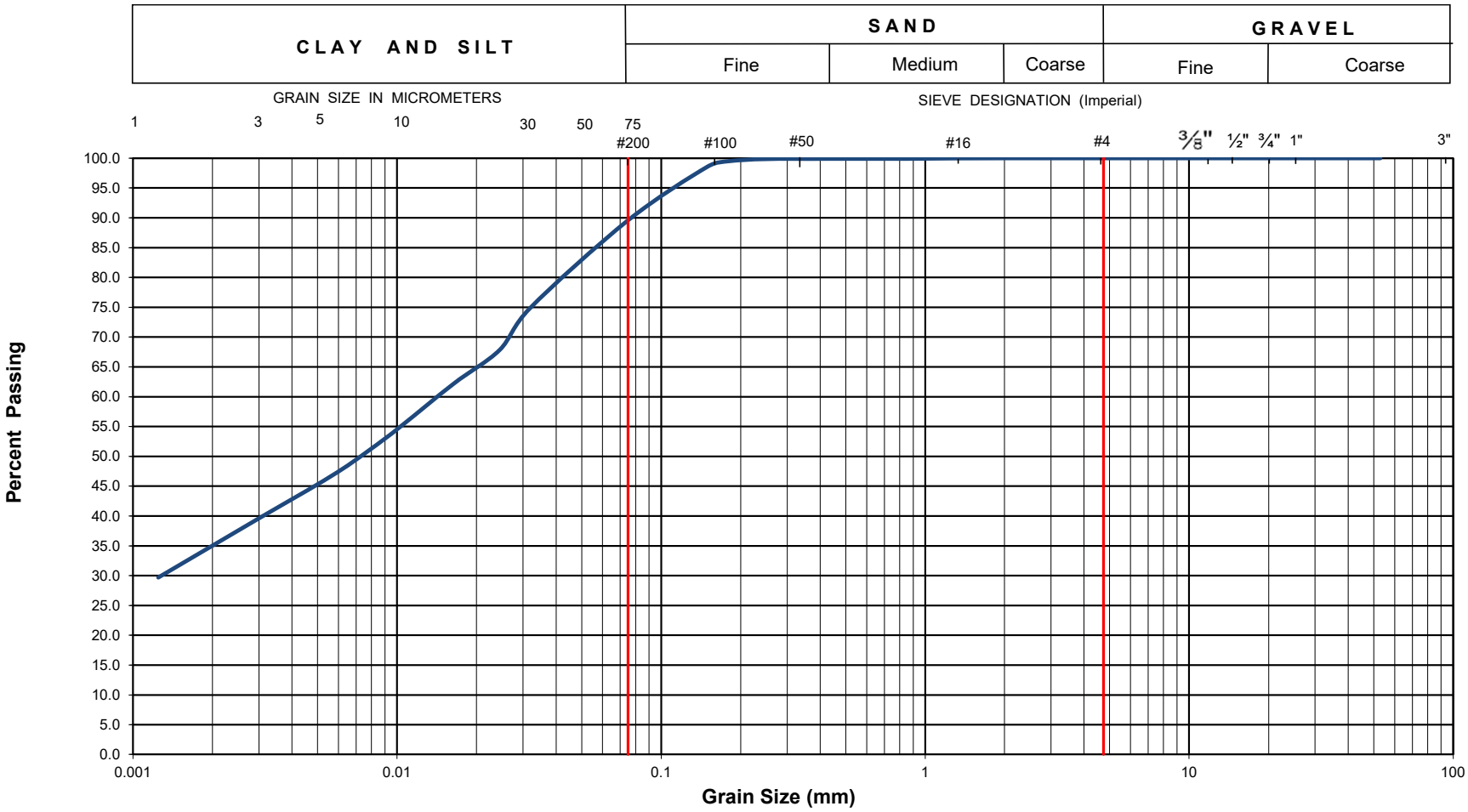
# Grain-Size Distribution Curve
# Method of Test For Particle Size Analysis of Soil
# ASTM C-136/ASTM D422

**Unified Soil Classification System**




| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **EXP Project No.:** | **OTT-22008699-B0** | **Project Name :** | **Proposed Industrial Condominium and Warehouse Development** | | | | | | |
| **Client :** | **Group Montoni** | **Project Location :** | **4101 Limebank Road, Ottawa, Ontario** | | | | | | |
| **Date Sampled :** | **April 28, 2022** | **Borehole No:** | **BH 9** | | **Sample No.:** | **SS5** | | **Depth (m) :** | **6.1-6.7** |
| **Sample Description :** | | **% Silt and Clay** | **90** | **% Sand** | **10** | **% Gravel** | **0** | **Figure :** | **22** |
| **Sample Description :** | | **Grey Low Plasticity Clay (CL), some sand** | | | | | | | |

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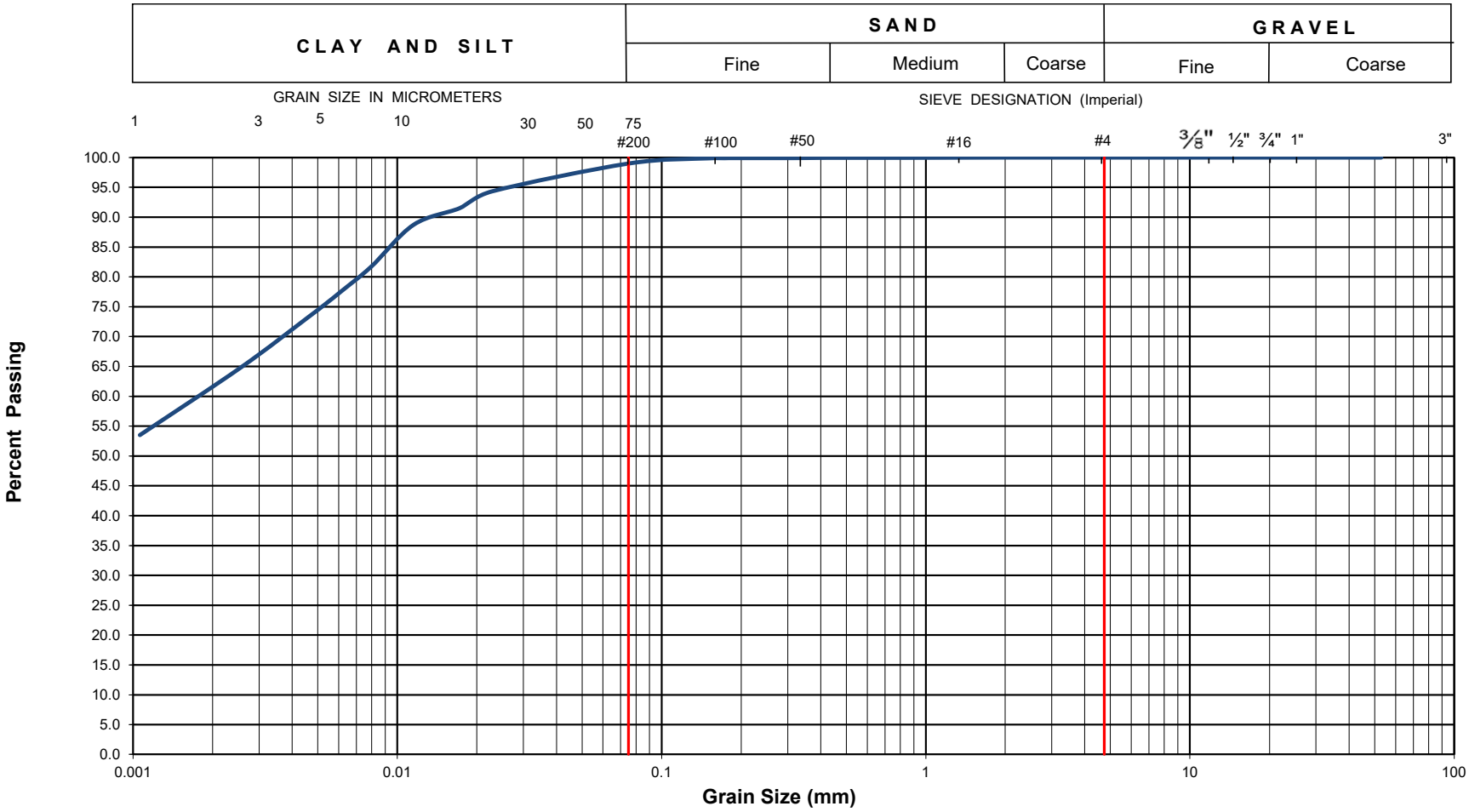
# Grain-Size Distribution Curve
# Method of Test For Particle Size Analysis of Soil
# ASTM C-136/ASTM D422

**Unified Soil Classification System**




| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **EXP Project No.:** | **OTT-22008699-B0** | **Project Name :** | **Proposed Industrial Condominium and Warehouse Development** | | | | | | |
| **Client :** | **Group Montoni** | **Project Location :** | **4101 Limebank Road, Ottawa, Ontario** | | | | | | |
| **Date Sampled :** | **April 27, 2022** | **Borehole No:** | **BH 11** | | **Sample No.:** | **SS4** | | **Depth (m) :** | **3.0-3.7** |
| **Sample Description :** | | **% Silt and Clay** | **99** | **% Sand** | **1** | **% Gravel** | **0** | **Figure :** | **23** |
| **Sample Description :** | | **Grey Low Plasticity Clay (CL)** | | | | | | | |

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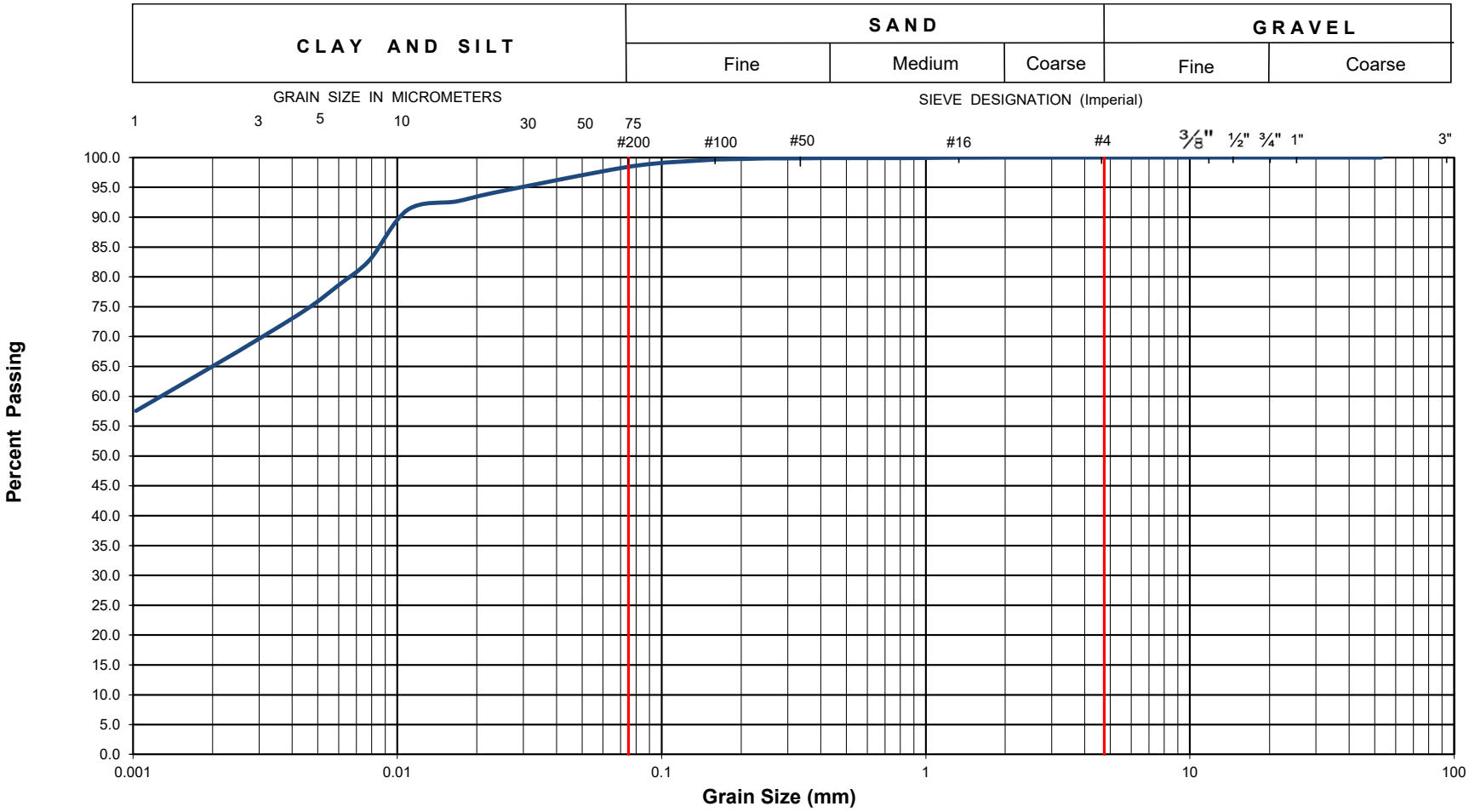
# Grain-Size Distribution Curve
# Method of Test For Particle Size Analysis of Soil
# ASTM C-136/ASTM D422

**Unified Soil Classification System**




| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **EXP Project No.:** | **OTT-22008699-B0** | **Project Name :** | **Proposed Industrial Condominium and Warehouse Development** | | | | | | |
| **Client :** | **Group Montoni** | **Project Location :** | **4101 Limebank Road, Ottawa, Ontario** | | | | | | |
| **Date Sampled :** | **April 25, 2022** | **Borehole No:** | **BH 16** | | **Sample No.:** | **SS3** | | **Depth (m) :** | **1.5-2.1** |
| **Sample Description :** | | **% Silt and Clay** | **98** | **% Sand** | **2** | **% Gravel** | **0** | **Figure :** | **24** |
| **Sample Description :** | | **Brown Clay of High Plasticity (CH)** | | | | | | | |

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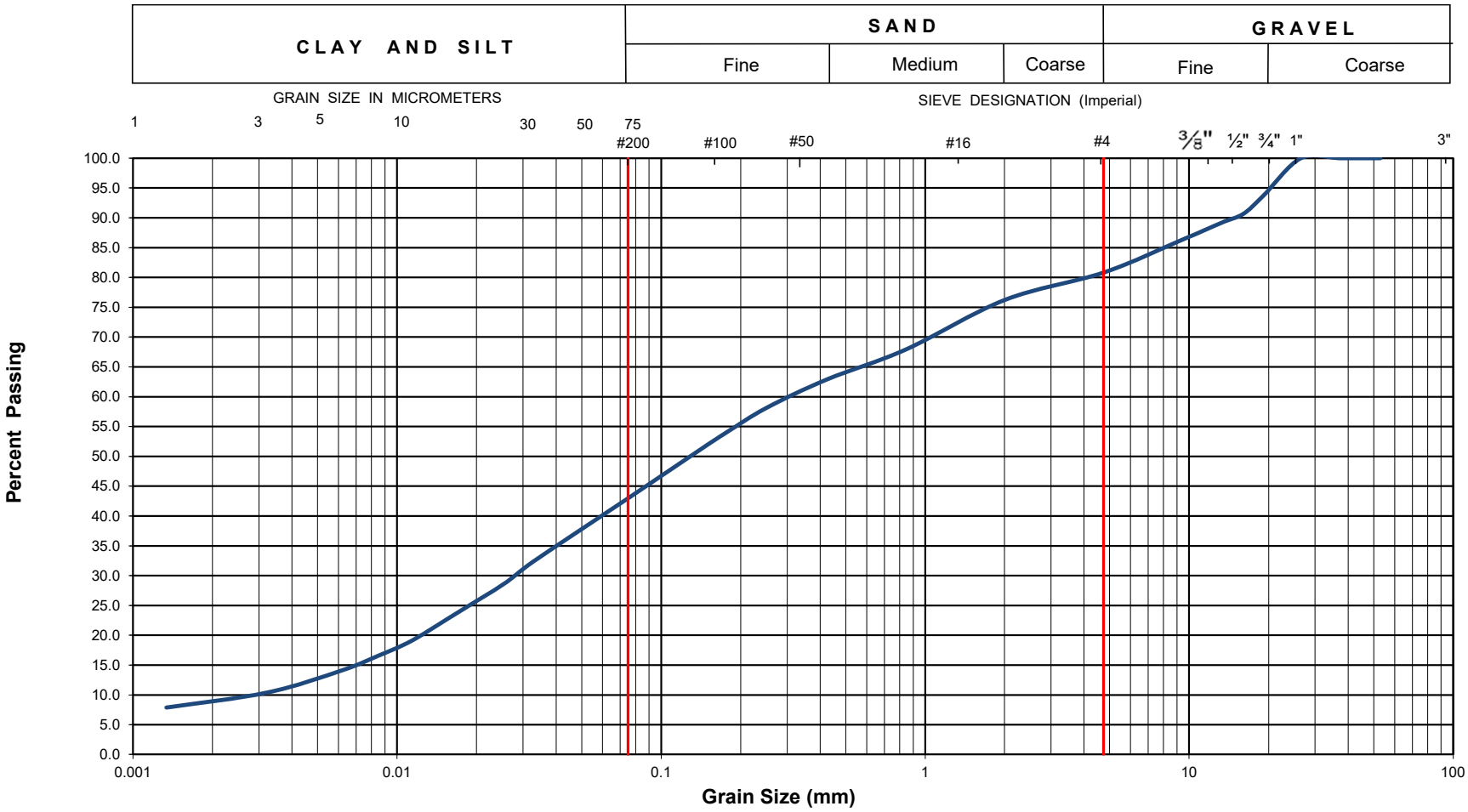
# Grain-Size Distribution Curve
# Method of Test For Particle Size Analysis of Soil
# ASTM C-136/ASTM D422

**Unified Soil Classification System**




| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **EXP Project No.:** | **OTT-22008699-B0** | **Project Name :** | **Proposed Industrial Condominium and Warehouse Development** | | | | | | |
| **Client :** | **Group Montoni** | **Project Location :** | **4101 Limebank Road, Ottawa, Ontario** | | | | | | |
| **Date Sampled :** | **April 25, 2022** | **Borehole No:** | **BH 6A** | **Sample No.:** | **SS10** | **Depth (m) :** | **13.7-14.3** | | |
| **Sample Description :** | | **% Silt and Clay** | **43** | **% Sand** | **38** | **% Gravel** | **19** | **Figure :** | **25** |
| **Sample Description :** | | **Glacial Till: Silty Sand with Gravel (SM)** | | | | | | | |

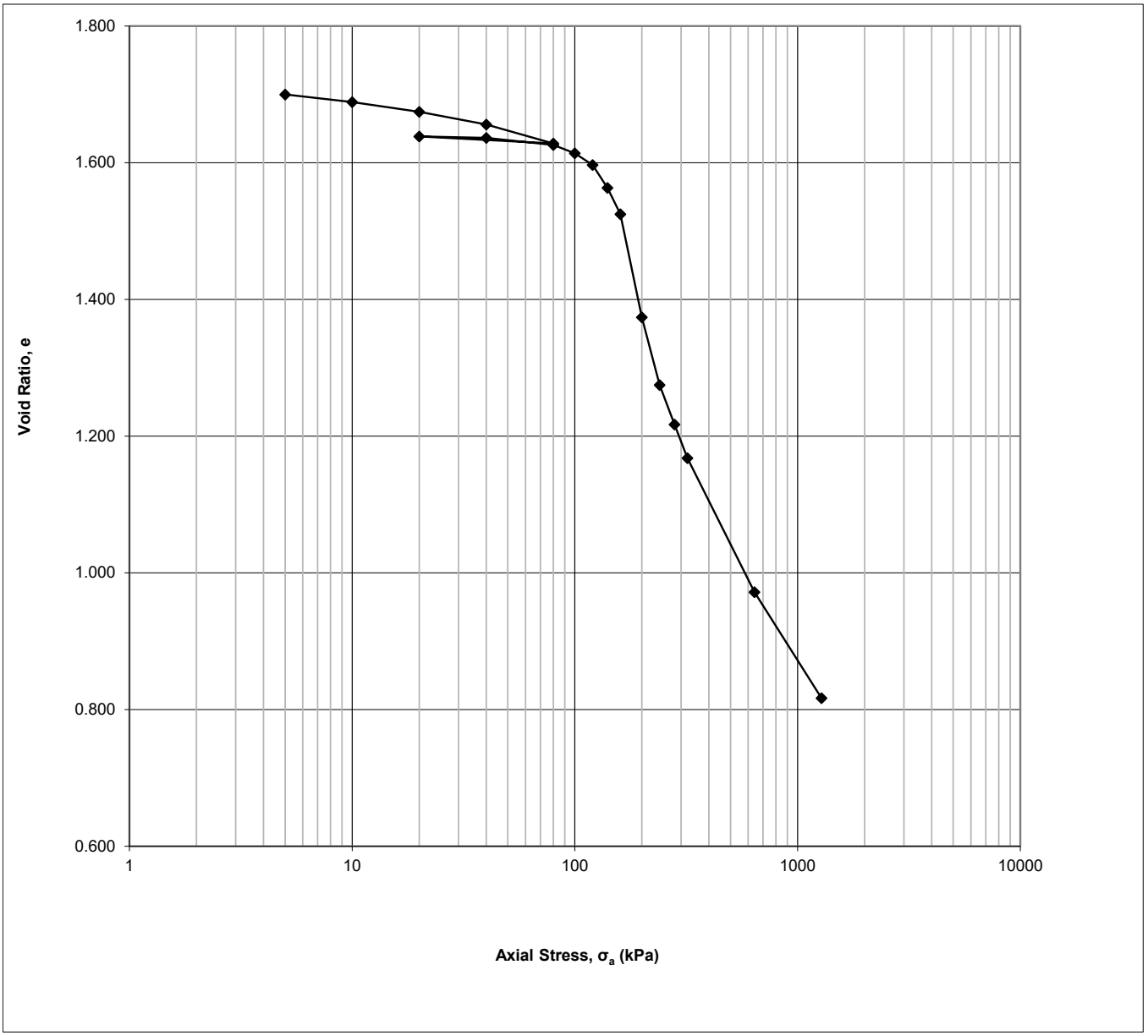
# Appendix A –Consolidation Test Results

Stantec

# One-Dimensional Consolidation Properties of Soils Using Incremental Loading

**ASTM D2435/D2435M - 11(2020)**

| | |
|---|---|
| **Project** | **Exp, File# 0022008699-A0** |
| **Project No.** | **121623683** |
| **Borehole No.** | **BH 3** |
| **Sample No.** | **ST4** |
| **Sample Depth** | **10-12 ft.** |



Stantec

# Stantec Consulting Ltd.

May 16, 2022

Date:

Date:

D. Boateng

Checked by:

Approved by:

## One-Dimensional Consolidation Test using Incremental Loading

ASTM D2435/D2435M - 11(2020)

**Specimen Details**

| | |
|---|---|
| Project Name | Exp, File# 0022008699-A0 |
| Project Location | Leitrim & Limebank, Ottawa,ON |
| Borehole | BH 3 |
| Sample No. | ST4 |
| Depth | 10-12 ft. |
| Sample Date | April 26, 2022 |
| Test Number | One |
| Technician Name | Daniel Boateng |

**Soil Description & Classification**

| | |
|---|---|
| *Silty clay, grey, trace fine sand, moist* | |
| Specific Gravity of Solids | 2.750 |
| Average water content of trimmings % | 57.01 |
| **Additional Notes (information source, occurence and size of large isolated particles etc.)** | |
| *1. Specific Gravity of Solids was Assumed, 2. Loading Schedule was provided by the Client* | |

**Initial Specimen Conditions**

| | | |
|---|---|---|
| Height | mm | 20.00 |
| Diameter | mm | 50.00 |
| Area | $mm^2$ | 1963 |
| Volume | $mm^3$ | 39270 |
| Mass | g | 64.73 |
| Dry Mass | g | 39.68 |
| Density | $Mg/m^3$ | 1.648 |
| Dry Density | $Mg/m^3$ | 1.010 |
| Water Content | % | 63.13 |
| Degree of Saturation | % | 100.0 |
| Height of Solids | mm | 7.35 |
| Initial Void Ratio | | 1.736 |

**Final Specimen Conditions**

| | | |
|---|---|---|
| Water Content | % | 34.20 |
| Final Void Ratio | | 0.817 |
| Final Height | mm | 13.35 |

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# Stantec Consulting Ltd.

Date: May 16, 2022

Date:

D. Boateng

Checked by:

Approved by:

Filename: F:\Exp\OTT-0022008699-A0\[bh3 st4 consolidation report.xls]Report

Date: May 16, 2022

## One-Dimensional Consolidation Test using Incremental Loading

ASTM D2435/D2435M - 11(2020)

**Specimen Details**

| | |
|---|---|
| Project Name | Exp, File# 0022008699-A0 |
| Project Location | Leitrim & Limebank, Ottawa,ON |
| Borehole | BH 3 |
| Sample No. | ST4 |
| Depth | 10-12 ft. |
| Sample Date | April 26, 2022 |
| Test Number | One |
| Technician Name | Daniel Boateng |

**Test Procedure**

| | | |
|---|---|---|
| Date Started | | May 11, 2022 |
| Date Finished | | May 13, 2022 |
| Machine Number | | Frame C |
| Cell Number | | C |
| Ring Number | | C |
| Trimming Procedure | | Trimming turntable/cutting shoe |
| Moisture Condition | | Inundated |
| Axial Stress at Inundation | kPa | 5 |
| Water Used | | Deaired tap water |
| Test Method | | B |
| Interpretation Procedure for $c_v$ | | 2 |

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

**Calculations**

| Load Increment | Increment Duration min | Axial Stress $\sigma_a$ kPa | Corrected Deformation $\Delta H$ mm | Specimen Height H mm | Axial Strain $\varepsilon_a$ % | Void Ratio e |
|---|---|---|---|---|---|---|
| Seating | 0.0 | 0 | 0.0000 | 20.0000 | 0.00 | 1.736 |
| 1 | 20.0 | 5 | 0.1495 | 19.8505 | 0.80 | 1.700 |
| 2 | 20.0 | 10 | 0.2312 | 19.7688 | 1.20 | 1.689 |
| 3 | 21.5 | 20 | 0.3321 | 19.6679 | 1.73 | 1.675 |
| 4 | 24.8 | 40 | 0.4637 | 19.5363 | 2.41 | 1.656 |
| 5 | 36.5 | 80 | 0.6492 | 19.3508 | 3.43 | 1.628 |
| 6 | 20.0 | 20 | 0.6111 | 19.3889 | 3.06 | 1.638 |
| 7 | 20.0 | 40 | 0.6253 | 19.3747 | 3.13 | 1.636 |
| 8 | 23.3 | 80 | 0.6917 | 19.3083 | 3.52 | 1.626 |
| 9 | 36.5 | 100 | 0.7594 | 19.2406 | 3.96 | 1.614 |
| 10 | 54.8 | 120 | 0.8725 | 19.1275 | 4.59 | 1.597 |
| 11 | 149.8 | 140 | 1.0685 | 18.9315 | 5.81 | 1.563 |
| 12 | 128.5 | 160 | 1.1769 | 18.8231 | 7.23 | 1.525 |
| 13 | 348.0 | 200 | 2.1928 | 17.8072 | 12.77 | 1.374 |
| 14 | 256.8 | 240 | 3.2686 | 16.7314 | 16.41 | 1.275 |
| 15 | 162.5 | 280 | 3.2951 | 16.7049 | 18.53 | 1.217 |
| 16 | 162.8 | 320 | 3.7827 | 16.2173 | 20.34 | 1.168 |
| 17 | 120.8 | 640 | 5.2252 | 14.7748 | 27.55 | 0.972 |
| 18 | 98.0 | 1280 | 6.4166 | 13.5834 | 33.25 | 0.817 |

Stantec

# Stantec Consulting Ltd.

Date: May 16, 2022
Date: May 16, 2022
D. Boateng
Checked by:
Approved by:
Filename: F:\Exp\OTT-0022008699-A0\[bh3 st4 consolidation report.xls]Report
Date: May 16, 2022

## One-Dimensional Consolidation Test using Incremental Loading

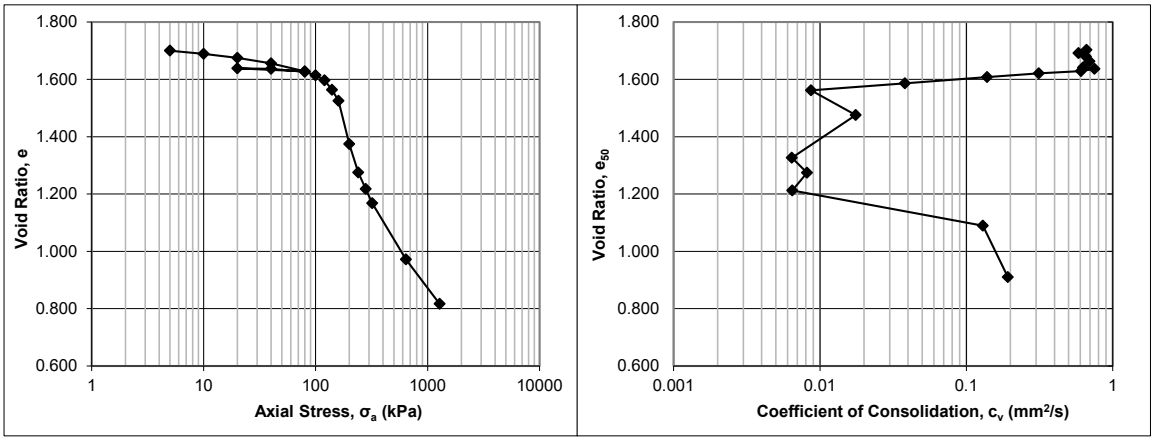
ASTM D2435/D2435M - 11(2020)

**Specimen Details**

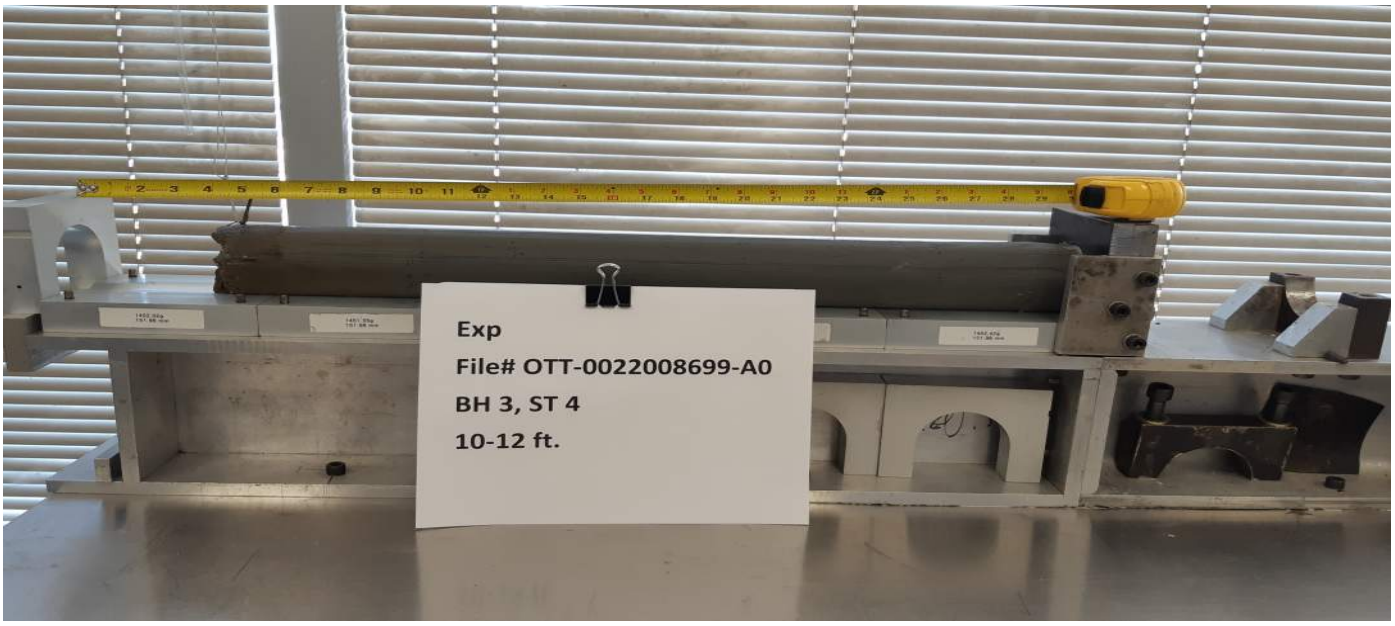
| | |
|---|---|
| Job Ref. | Exp, File# 0022008699-A0 |
| Job Location | Leitrim & Limebank, Ottawa,ON |
| Borehole | BH 3 |
| Sample No. | ST4 |
| Depth | 10-12 ft. |
| Sample Date | April 26, 2022 |
| Test Number | One |
| Technician Name | Daniel Boateng |

**Calculations**

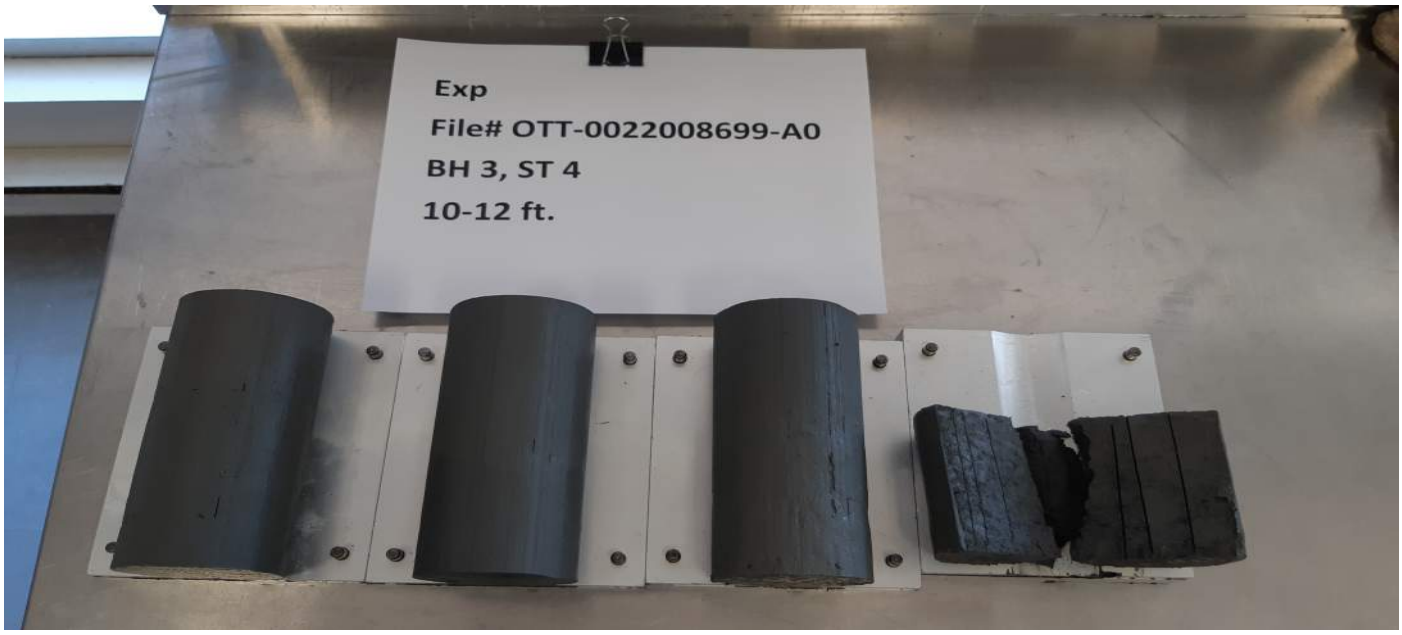
| | | Calculated using Interpretation Procedure 2 | | | | Interpretation Procedure 1 | | Interpretation Procedure 2 | |
|---|---|---|---|---|---|---|---|---|---|
| Load Increment | Axial Stress $\sigma_{a,\ average}$ kPa | Corrected Deformation $\Delta H_{50}$ mm | Specimen Height $H_{50}$ mm | Axial Strain $\varepsilon_{a,50}$ % | Void Ratio $e_{50}$ | Time $t_{50}$ sec | Coeff. Consol. $c_v$ $mm^2/s$ | Time $t_{90}$ sec | Coeff. Consol. $c_v$ $mm^2/s$ |
| Seating | 0 | | | | | | | | |
| 1 | 3 | 0.1362 | 19.8638 | 0.68 | 1.703 | | | 126 | 6.63E-01 |
| 2 | 8 | 0.2199 | 19.7801 | 1.10 | 1.692 | | | 142 | 5.85E-01 |
| 3 | 15 | 0.3080 | 19.6920 | 1.54 | 1.680 | | | 125 | 6.57E-01 |
| 4 | 30 | 0.4294 | 19.5706 | 2.15 | 1.663 | | | 117 | 6.94E-01 |
| 5 | 60 | 0.5938 | 19.4062 | 2.97 | 1.641 | | | 127 | 6.28E-01 |
| 6 | 50 | 0.6290 | 19.3710 | 3.15 | 1.636 | | | | |
| 7 | 30 | 0.6229 | 19.3771 | 3.11 | 1.637 | | | 106 | 7.52E-01 |
| 8 | 60 | 0.6801 | 19.3199 | 3.40 | 1.629 | | | 130 | 6.07E-01 |
| 9 | 90 | 0.7377 | 19.2623 | 3.69 | 1.621 | | | 252 | 3.12E-01 |
| 10 | 110 | 0.8374 | 19.1626 | 4.19 | 1.608 | | | 560 | 1.39E-01 |
| 11 | 130 | 0.9964 | 19.0036 | 4.98 | 1.586 | | | 2010 | 3.81E-02 |
| 12 | 150 | 1.1723 | 18.8277 | 5.86 | 1.562 | | | 8640 | 8.70E-03 |
| 13 | 180 | 1.8057 | 18.1943 | 9.03 | 1.476 | | | 3999 | 1.75E-02 |
| 14 | 220 | 2.9054 | 17.0946 | 14.53 | 1.326 | | | 9633 | 6.43E-03 |
| 15 | 260 | 3.2902 | 16.7098 | 16.45 | 1.274 | | | 7260 | 8.15E-03 |
| 16 | 300 | 3.7451 | 16.2549 | 18.73 | 1.212 | | | 8646 | 6.48E-03 |
| 17 | 480 | 4.6428 | 15.3572 | 23.21 | 1.090 | | | 385 | 1.30E-01 |
| 18 | 960 | 5.9619 | 14.0381 | 29.81 | 0.910 | | | 217 | 1.92E-01 |



| Stantec | Project No.: 121623683<br>Project Name: Exp, File# OTT-0022008699-A0 | Photo Log |
|---|---|---|




| Photo No.: 1 | Borehole: BH3 ST4 | Depth: 10 – 12 ft |
|---|---|---|



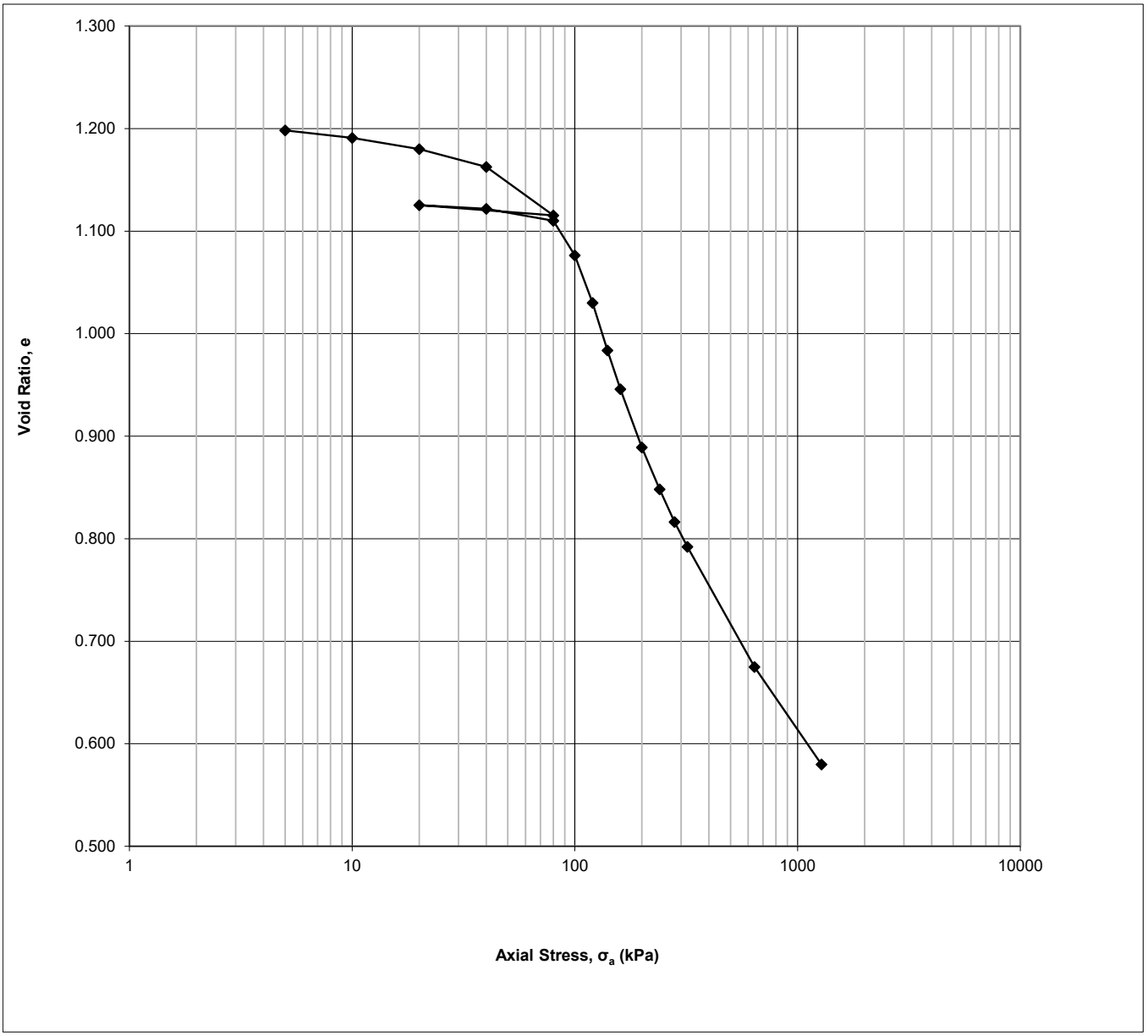

| Photo No.: 2 | Borehole: BH3 ST4 | Depth: 10 – 12 ft |
|---|---|---|

Stantec

# One-Dimensional Consolidation Properties of Soils Using Incremental Loading

**ASTM D2435/D2435M - 11(2020)**

| | |
|---|---|
| **Project** | **Exp, File# 0022008699-A0** |
| **Project No.** | **122410864** |
| **Borehole No.** | **BH 3** |
| **Sample No.** | **ST6** |
| **Sample Depth** | **20-22 ft.** |



Stantec

# Stantec Consulting Ltd.

Date: May 16, 2022
Date: May 16, 2022
D. Boateng
Checked by:
Approved by:

## One-Dimensional Consolidation Test using Incremental Loading

ASTM D2435/D2435M - 11(2020)

**Specimen Details**

| | |
|---|---|
| Project Name | Exp, File# 0022008699-A0 |
| Project Location | Leitrim & Limebank, Ottawa,ON |
| Borehole | BH 3 |
| Sample No. | ST6 |
| Depth | 20-22 ft. |
| Sample Date | April 26, 2022 |
| Test Number | Two |
| Technician Name | Daniel Boateng |

**Soil Description & Classification**

| | |
|---|---|
| *Silty clay, grey, trace fine sand, moist* | |
| Specific Gravity of Solids | 2.750 |
| Average water content of trimmings % | 38.08 |
| **Additional Notes (information source, occurence and size of large isolated particles etc.)** | |
| *1. Specific Gravity of Solids was Assumed, 2. Loading Schedule was provided by the Client* | |

**Initial Specimen Conditions**

| | | |
|---|---|---|
| Height | mm | 20.00 |
| Diameter | mm | 50.00 |
| Area | $mm^2$ | 1963 |
| Volume | $mm^3$ | 39270 |
| Mass | g | 70.05 |
| Dry Mass | g | 48.87 |
| Density | $Mg/m^3$ | 1.784 |
| Dry Density | $Mg/m^3$ | 1.244 |
| Water Content | % | 43.34 |
| Degree of Saturation | % | 98.5 |
| Height of Solids | mm | 9.05 |
| Initial Void Ratio | | 1.210 |

**Final Specimen Conditions**

| | | |
|---|---|---|
| Water Content | % | 23.59 |
| Final Void Ratio | | 0.580 |
| Final Height | mm | 14.30 |

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# Stantec Consulting Ltd.

Filename: F:\Exp\OTT-0022008699-A0\[bh3 st6 consolidation report.xls]Report
Date: May 16, 2022
Checked by: D. Boateng
Date: May 16, 2022
Approved by:
Date: May 16, 2022

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

**Specimen Details**

| | |
|---|---|
| Project Name | Exp, File# 0022008699-A0 |
| Project Location | Leitrim & Limebank, Ottawa,ON |
| Borehole | BH 3 |
| Sample No. | ST6 |
| Depth | 20-22 ft. |
| Sample Date | April 26, 2022 |
| Test Number | Two |
| Technician Name | Daniel Boateng |

**Test Procedure**

| | | |
|---|---|---|
| Date Started | | May 11, 2022 |
| Date Finished | | May 13, 2022 |
| Machine Number | | Frame D |
| Cell Number | | D |
| Ring Number | | D |
| Trimming Procedure | | Trimming turntable/cutting shoe |
| Moisture Condition | | Inundated |
| Axial Stress at Inundation | kPa | 5 |
| Water Used | | Deaired tap water |
| Test Method | | B |
| Interpretation Procedure for $c_v$ | | 2 |

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

**Calculations**

| Load Increment | Increment Duration min | Axial Stress $\sigma_a$ kPa | Corrected Deformation $\Delta H$ mm | Specimen Height H mm | Axial Strain $\varepsilon_a$ % | Void Ratio e |
|---|---|---|---|---|---|---|
| Seating | 0.0 | 0 | 0.0000 | 20.0000 | 0.00 | 1.210 |
| 1 | 20.0 | 5 | 0.0945 | 19.9055 | 0.52 | 1.198 |
| 2 | 21.5 | 10 | 0.1596 | 19.8404 | 0.86 | 1.191 |
| 3 | 23.0 | 20 | 0.2502 | 19.7498 | 1.35 | 1.180 |
| 4 | 29.8 | 40 | 0.3967 | 19.6033 | 2.13 | 1.163 |
| 5 | 81.3 | 80 | 0.6998 | 19.3002 | 4.27 | 1.115 |
| 6 | 20.0 | 20 | 0.7653 | 19.2347 | 3.83 | 1.125 |
| 7 | 20.0 | 40 | 0.7949 | 19.2051 | 3.99 | 1.122 |
| 8 | 33.3 | 80 | 0.8764 | 19.1236 | 4.51 | 1.110 |
| 9 | 133.3 | 100 | 1.1281 | 18.8719 | 6.04 | 1.076 |
| 10 | 170.3 | 120 | 1.6671 | 18.3329 | 8.13 | 1.030 |
| 11 | 182.8 | 140 | 1.6319 | 18.3681 | 10.23 | 0.984 |
| 12 | 168.0 | 160 | 2.0536 | 17.9464 | 11.94 | 0.946 |
| 13 | 157.0 | 200 | 2.8197 | 17.1803 | 14.51 | 0.889 |
| 14 | 136.8 | 240 | 3.2206 | 16.7794 | 16.36 | 0.848 |
| 15 | 129.0 | 280 | 3.5754 | 16.4246 | 17.80 | 0.816 |
| 16 | 97.5 | 320 | 3.5646 | 16.4354 | 18.90 | 0.792 |
| 17 | 83.3 | 640 | 4.5831 | 15.4169 | 24.21 | 0.675 |
| 18 | 80.3 | 1280 | 5.4911 | 14.5089 | 28.51 | 0.580 |

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# Stantec Consulting Ltd.

Filename: F:\Exp\OTT-0022008699-A0\[bh3 st6 consolidation report.xls]Report Date: May 16, 2022
Checked by: D. Boateng Date: May 16, 2022
Approved by: Date:

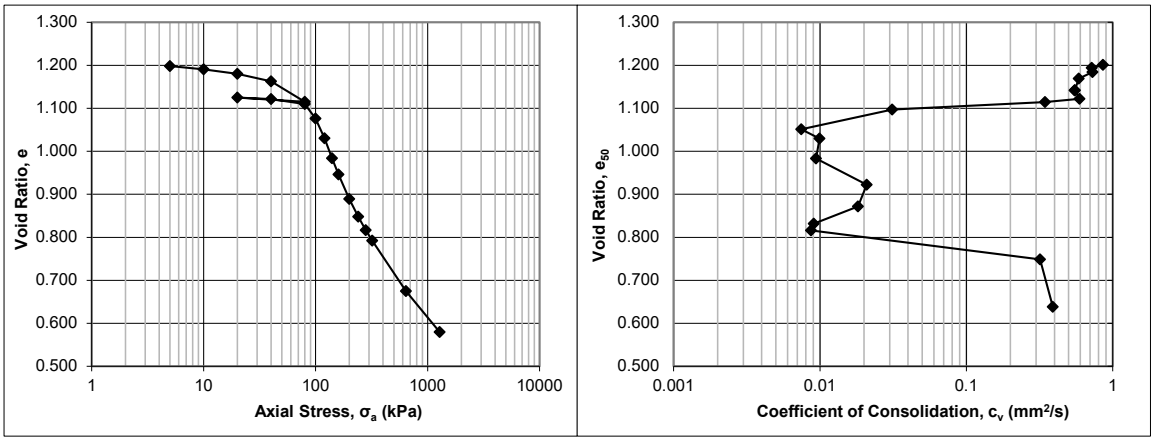
## One-Dimensional Consolidation Test using Incremental Loading
ASTM D2435/D2435M - 11(2020)

**Specimen Details**

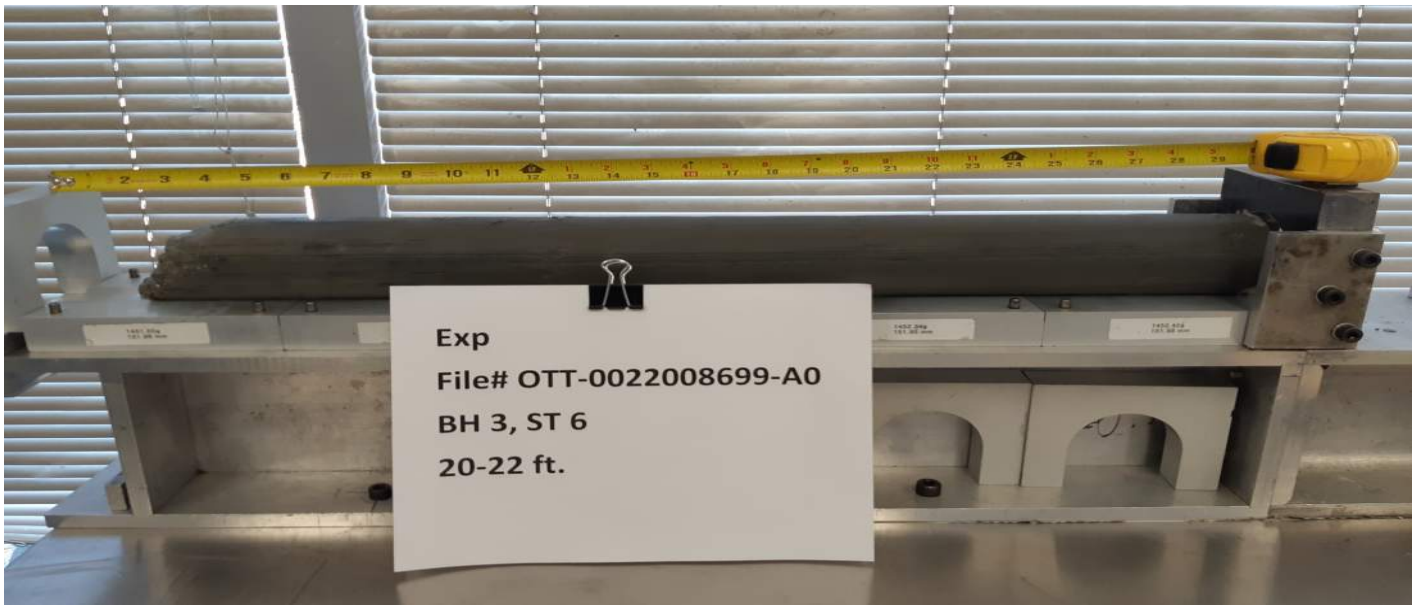
| | |
|---|---|
| Job Ref. | Exp, File# 0022008699-A0 |
| Job Location | Leitrim & Limebank, Ottawa,ON |
| Borehole | BH 3 |
| Sample No. | ST6 |
| Depth | 20-22 ft. |
| Sample Date | April 26, 2022 |
| Test Number | Two |
| Technician Name | Daniel Boateng |

**Calculations**

| | | Calculated using Interpretation Procedure 2 | | | | Interpretation Procedure 1 | | Interpretation Procedure 2 | |
|---|---|---|---|---|---|---|---|---|---|
| Load Increment | Axial Stress $\sigma_{a,\ average}$ kPa | Corrected Deformation $\Delta H_{50}$ mm | Specimen Height $H_{50}$ mm | Axial Strain $\varepsilon_{a,50}$ % | Void Ratio $e_{50}$ | Time $t_{50}$ sec | Coeff. Consol. $c_v$ $mm^2/s$ | Time $t_{90}$ sec | Coeff. Consol. $c_v$ $mm^2/s$ |
| Seating | 0 | | | | | | | | |
| 1 | 3 | 0.0806 | 19.9194 | 0.40 | 1.201 | | | 98 | 8.58E-01 |
| 2 | 8 | 0.1444 | 19.8556 | 0.72 | 1.194 | | | 116 | 7.21E-01 |
| 3 | 15 | 0.2330 | 19.7670 | 1.16 | 1.184 | | | 114 | 7.27E-01 |
| 4 | 30 | 0.3690 | 19.6310 | 1.84 | 1.169 | | | 140 | 5.85E-01 |
| 5 | 60 | 0.6170 | 19.3830 | 3.08 | 1.142 | | | 145 | 5.51E-01 |
| 6 | 50 | 0.7809 | 19.2191 | 3.90 | 1.124 | | | | |
| 7 | 30 | 0.7918 | 19.2082 | 3.96 | 1.122 | | | 132 | 5.94E-01 |
| 8 | 60 | 0.8615 | 19.1385 | 4.31 | 1.115 | | | 225 | 3.45E-01 |
| 9 | 90 | 1.0182 | 18.9818 | 5.09 | 1.097 | | | 2449 | 3.12E-02 |
| 10 | 110 | 1.4362 | 18.5638 | 7.18 | 1.051 | | | 9813 | 7.44E-03 |
| 11 | 130 | 1.6297 | 18.3703 | 8.15 | 1.030 | | | 7200 | 9.94E-03 |
| 12 | 150 | 2.0508 | 17.9492 | 10.25 | 0.983 | | | 7260 | 9.41E-03 |
| 13 | 180 | 2.6026 | 17.3974 | 13.01 | 0.922 | | | 3079 | 2.08E-02 |
| 14 | 220 | 3.0617 | 16.9383 | 15.31 | 0.871 | | | 3346 | 1.82E-02 |
| 15 | 260 | 3.4245 | 16.5755 | 17.12 | 0.831 | | | 6420 | 9.07E-03 |
| 16 | 300 | 3.5631 | 16.4369 | 17.82 | 0.816 | | | 6600 | 8.68E-03 |
| 17 | 480 | 4.1761 | 15.8239 | 20.88 | 0.748 | | | 167 | 3.18E-01 |
| 18 | 960 | 5.1702 | 14.8298 | 25.85 | 0.639 | | | 120 | 3.90E-01 |



| Stantec | Project No.: 121623683<br>Project Name: Exp, File# OTT-0022008699-A0 | Photo Log |
|---|---|---|




| Photo No.: 1 | Borehole: BH3 ST6 | Depth: 20 – 22 ft |
|---|---|---|



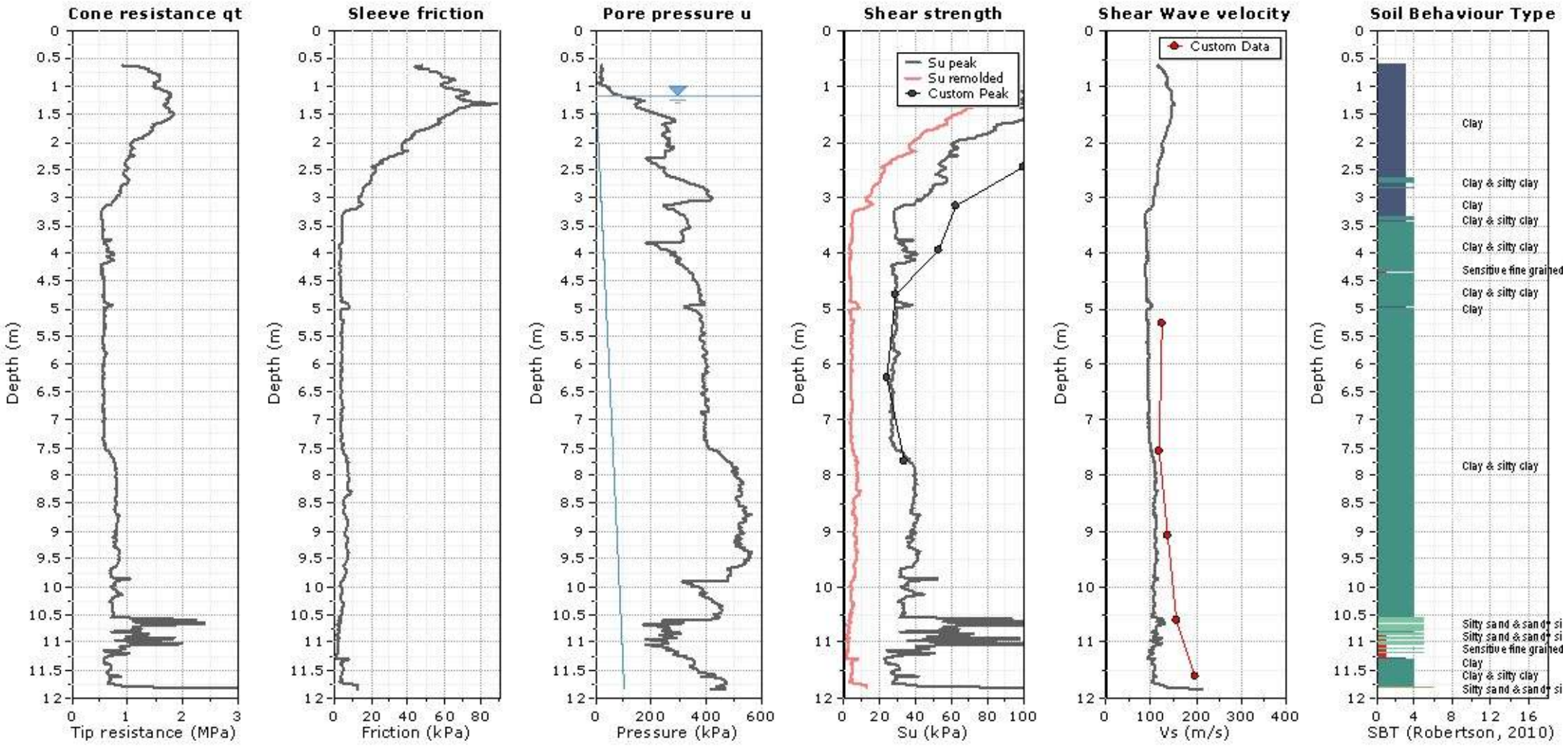

| Photo No.: 2 | Borehole: BH3 ST6 | Depth: 20 – 22 ft |
|---|---|---|

# Appendix B – Seismic Cone Penetration Test (SCPTu) Results

**EXP Services inc.**
2650 Queensview Drive, Suite 100
Ottawa (Ontario) K2B 8H6
http://www.exp.com

**Project:** **OTT-22008699**
**Location:** **Limebank & Leitrim Roads, Ottawa**

**SCPTu-10**
Total depth: 11.85 m, Date: 2022-04-27
Cone Type: 4544 - 5t
Cone Operator: K. Simoneau




**SBTn legend**

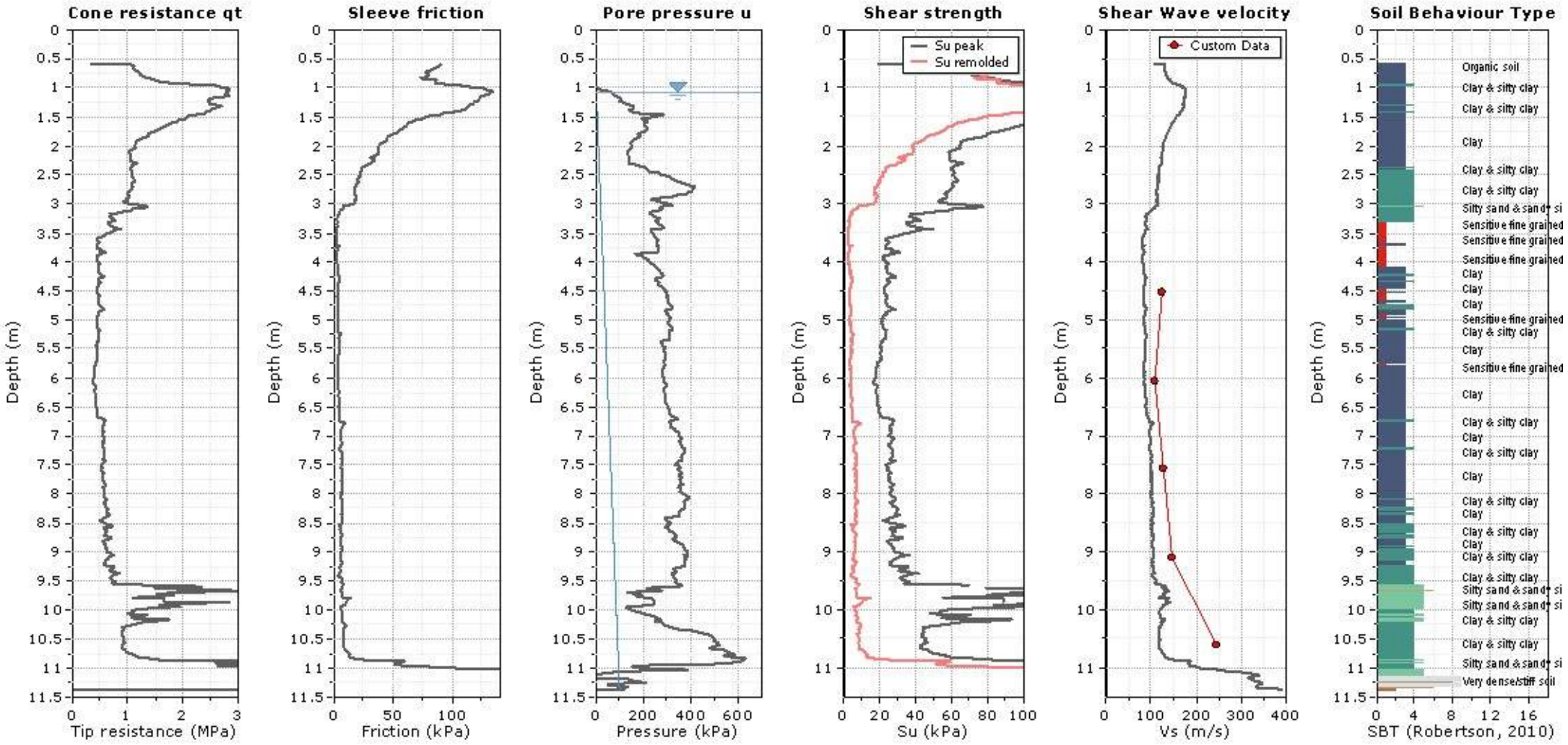
| | | |
|---|---|---|
| 1. Sensitive fine grained | 4. Clayey silt to silty clay | 7. Gravelly sand to sand |
| 2. Organic material | 5. Silty sand to sandy silt | 8. Very stiff sand to clayey sand |
| 3. Clay to silty clay | 6. Clean sand to silty sand | 9. Very stiff fine grained |

**EXP Services inc.**
2650 Queensview Drive, Suite 100
Ottawa (Ontario) K2B 8H6
http://www.exp.com

**Project:** **OTT-22008699**
**Location:** **Limebank & Leitrim Roads, Ottawa**

## SCPTu-17

Total depth: 11.38 m, Date: 2022-04-27
Cone Type: 4544 - 5t
Cone Operator: K. Simoneau




**SBTn legend**

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

# Appendix C – Certificate of Laboratory Analysis

AGAT Laboratories

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

CLIENT NAME: EXP SERVICES INC
2650 QUEENSVIEW DRIVE, UNIT 100
OTTAWA, ON K2B8H6
(613) 688-1899

ATTENTION TO: Matthew Zammit

PROJECT: OTT-22008699-AO

AGAT WORK ORDER: 22Z890910

SOIL ANALYSIS REVIEWED BY: Nivine Basily, Inorganics Report Writer

DATE REPORTED: May 10, 2022

PAGES (INCLUDING COVER): 5

VERSION*: 1

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

*Notes

*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.*
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- *The test results reported herewith relate only to the samples as received by the laboratory.*
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# Certificate of Analysis

AGAT WORK ORDER: 22Z890910

PROJECT: OTT-22008699-AO

CLIENT NAME: EXP SERVICES INC

ATTENTION TO: Matthew Zammit

SAMPLING SITE:

SAMPLED BY:EXP

## (Soil) Inorganics Chemistry

DATE RECEIVED: 2022-05-03

DATE REPORTED: 2022-05-10

| | | | | BH#5 SS3 7. | BH#9 SS3 7. | BH#16 SS2 2. |
|---|---|---|---|---|---|---|
| SAMPLE DESCRIPTION: | | | | 5'-9.5' | 5'-9.5' | 5'-4.5' |
| SAMPLE TYPE: | | | | Soil | Soil | Soil |
| DATE SAMPLED: | | | | 2022-04-29 | 2022-04-28 | 2022-04-25 |
| Parameter | Unit | G / S | RDL | 3815969 | 3815971 | 3815972 |
| Chloride (2:1) | µg/g | | 2 | 7 | 3 | 4 |
| Sulphate (2:1) | µg/g | | 2 | 79 | 63 | 19 |
| pH (2:1) | pH Units | | NA | 8.00 | 7.88 | 7.54 |
| Resistivity (2:1) (Calculated) | ohm.cm | | 1 | 4500 | 4780 | 12500 |

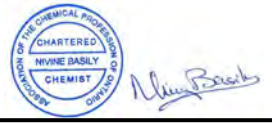
Comments: RDL - Reported Detection Limit; G / S - Guideline / Standard

3815969-3815972 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:






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

AGAT Laboratories

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

# Quality Assurance

CLIENT NAME: EXP SERVICES INC

AGAT WORK ORDER: 22Z890910

PROJECT: OTT-22008699-AO

ATTENTION TO: Matthew Zammit

SAMPLING SITE:

SAMPLED BY:EXP

## Soil Analysis

| RPT Date: May 10, 2022 | | | DUPLICATE | | | | REFERENCE MATERIAL | | | METHOD BLANK SPIKE | | | MATRIX SPIKE | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| PARAMETER | Batch | Sample Id | Dup #1 | Dup #2 | RPD | Method Blank | Measured Value | Acceptable Limits | | Recovery | Acceptable Limits | | Recovery | Acceptable Limits | |
| | | | | | | | | Lower | Upper | | Lower | Upper | | Lower | Upper |
| (Soil) Inorganics Chemistry | | | | | | | | | | | | | | | |
| Chloride (2:1) | 3803427 | | 3 | 2 | NA | < 2 | 97% | 70% | 130% | 107% | 80% | 120% | 98% | 70% | 130% |
| Sulphate (2:1) | 3803427 | | 21 | 21 | 0.0% | < 2 | 102% | 70% | 130% | 106% | 80% | 120% | 101% | 70% | 130% |
| pH (2:1) | 3815969 | 3815969 | 8.00 | 7.94 | 0.8% | NA | 99% | 80% | 120% | | | | | | |

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

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

Certified By:






AGAT Laboratories is accredited to ISO/IEC 17025 by the Canadian Association for Laboratory Accreditation Inc. (CALA) and/or Standards Council of Canada (SCC) for specific tests listed on the scope of accreditation. AGAT Laboratories (Mississauga) is also accredited by the Canadian Association for Laboratory Accreditation Inc. (CALA) for specific drinking water tests. Accreditations are location and parameter specific. A complete listing of parameters for each location is available from www.cala.ca and/or www.scc.ca. The tests in this report may not necessarily be included in the scope of accreditation. RPDs calculated using raw data. The RPD may not be reflective of duplicate values shown, due to rounding of final results.

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

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

# Method Summary

CLIENT NAME: EXP SERVICES INC

AGAT WORK ORDER: 22Z890910

PROJECT: OTT-22008699-AO

ATTENTION TO: Matthew Zammit

SAMPLING SITE:

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 |



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

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Tyler Yakichuk <yakichuk@fotenn.com>