Preliminary Geotechnical Investigation Report – Proposed Land Development at 1010 Somerset Street W, Ottawa, Ontario

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PRELIMINARY GEOTECHNICAL INVESTIGATION REPORT – PROPOSED LAND DEVELOPMENT AT 1010 SOMERSET STREET W, OTTAWA, ONTARIO

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1.0 INTRODUCTION

The City of Ottawa (City, the “Client”) is proposing an Official Plan amendment and Zoning By-law Amendment in order to develop the site at 1010 Somerset Street West in Ottawa, Ontario (the “Site”).

Stantec Consulting Ltd. (Stantec) was retained by the City to complete a preliminary geotechnical investigation to provide an overview of the subsurface conditions at the proposed area by means of advancing seven boreholes and laboratory testing. The interpreted subsurface conditions and available project information were used to provide input related to geotechnical design considerations and identify potential geotechnical issues or concerns associated with the proposed design.

The geotechnical investigation program was completed in accordance with the proposal entitled “Preliminary geotechnical Investigation for Development Project at 1010 Somerset Street W, Ottawa, Ontario,” dated June 25, 2024.

Limitations associated with this report and its contents are provided in the statement of general conditions included in **Appendix A**.

2.0 BACKGROUND INFORMATION

2.1 SITE DESCRIPTION

The Site is located at 1010 Somerset Street West, Ottawa, Ontario. The Site is bound by Somerset Street West to the north, commercial/recreational properties to the east, LRT transitway and commercial/industrial properties to the west, and a large construction site for residential apartment building to the south. The location of the site is shown in Drawing No.1 - Site Location Plan provided in **Appendix B**. The Ontario Ministry of Natural Resources Topographical Map indicates that the site topography is generally flat with a slight slope generally down from southwest to northeast. The grade at the borehole locations for the present investigation ranges from Elevations 58.9 m to 60.5 m. A grade difference of up to about 4 m exists between the Site and Somerset Street. The grade is separated by a retaining wall along Somerset Street at the north side of the property.

The Site of this investigation comprises of currently developed land with one unoccupied two-storey building, several outlying structures and paved parking lots to the south and west of the building.

2.2 PROPOSED DEVELOPMENT

The proposed development plan for this Site is shown in Final Concept Plan presented in **Appendix B**.

The proposed design includes construction of three high-rise buildings and one mid-rise building in the northwest section of the site (Future Residential Development Site), a three-storey recreation and cultural facility structure (RCFS) to the northeast section of the site and a school building with associated pavement and public sports fields in the southern portion of the site. The site development covers an approximate area of 28,400 m² (305,000 ft²).

The proposed development at 930-1010 Somerset Street includes a notable expansion to the Plant Recreation Centre, including demolition of the existing building and adding a bridge to the RCFS Facility. The RCFS facility covers a footprint of 52,850 ft², with a single level underground parking. Surface parking will be maintained as proposed. The school building will occupy an area of 60,060 ft², with no intention of including an underground parking. Construction of a six-storey mid-rise building with one level of underground parking, covering an area of 8,070 ft^2 (750 m^2) is also planned for Ottawa Community Housing. Additionally, a new open space/parkland of 1 hectare will be introduced, while Plouffe Park will remain unchanged, continuing to serve as an emergency overflow stormwater facility.

Three residential towers including Residential A, a 25-storey tower, Residential B, a 20-storey tower, and Residential C, a 15-storey tower will be developed as part of this project. Each residential tower covers and area of about 8,070 ft^2 (750 m^2). Two levels of underground parking are anticipated at the tower areas.

The design finished floor elevations for each proposed structure have yet to be established, however for this report a finished floor elevations were estimated assuming no additional grade raises and considering the number of parking level for each building.

2.3 AVAILABLE GEOLOGICAL AND SUBSURFACE INFORMATION

The Ontario Geological Survey (OGS) mapping data for the physiography of Southern Ontario indicates that the Site is within the Limestone Plains consisting of *sandy silt to silty sand-textured till* rich in clasts and often high in total matrix carbonate content. The Bedrock Geology from the OGS map indicates that the bedrock in the area of the Site is expected to be limestone, dolostone, shale, arkose or sandstone of the Ottawa Group and Shadow Lake Formation.

Site-specific subsurface information is available from previous environmental investigations carried out at this Site and are provided in following reports/documents:

- Golder Associates Limited Report No. 1661627/1000, titled “Phase One Environmental Site Assessment 933 Gladstone Avenue Ottawa, Ontario” and dated December 2016.
- Golder Associates Limited Report No. 1670949, titled “Phase Two Environmental Site Assessment 933 Gladstone Avenue Ottawa, Ontario” and dated March 2017.
- Dillon Consulting Report No. 21-1685, titled “Phase One Environmental Site Assessment at 930 Somerset Street West, Ottawa, Ontario” and dated June 2021
- Dillon Consulting Report No. 21-1685, titled “Phase One Environmental Site Assessment at 1010 Somerset Street West, Ottawa, Ontario” and dated June 2021
- Golder Associates Limited Report No. 21470873-R-001, titled “Phase One Environmental Site Assessment Update North-West 0.47-Hectare Parcel at 933 Gladstone Avenue Ottawa, Ontario” and dated February 2022.

- Golder Associates Limited Report No. 21470873-003-R, titled “Phase Two Environmental Site Assessment North-West 0.47-Hectare Parcel at 933 Gladstone Avenue Ottawa, Ontario” and dated February 2022.
- Report by Englobe Limited, titled “Geotechnical and Hydrogeological Investigation Gladstone GHG Neutral District Energy System” and dated February 2024
- Borehole Record 19124398 titled “Record of Borehole” prepared by Golder Associates, dated October 2019.

Based on previous reports and completed projects in the vicinity of 1010 Somerset Street, the subsurface profile generally consists of variable fill materials extending from 0 to 2 m depth. This fill was followed by a deposit of stiff to very stiff, sensitive marine clay (Champlain Sea/Leda Clay), extending beyond 5 m below the original ground surface. Underlying the clay, a sandy till layer (0.5 to 4 m thick) containing gravel, cobbles, and clay was encountered, transitioning to limestone bedrock. Bedrock was proven to encounter at depths ranging from 7.9 m to 10.0 m. Groundwater levels are typically observed between 2.5 m and 5.5 m below the ground surface. Selected Borehole records from previous investigations are provided in Appendix D.

3.0 METHOD OF INVESTIGATION

3.1 FIELD INVESTIGATION

Prior to commencing the field investigation, Stantec contacted Ontario One Call to confirm the location of public services and utilities and retained the services of a private utility locate company, Multiview Locates Inc., to provide additional utility locate clearances at the intended borehole locations.

Seven (7) boreholes identified as BH24-1 to BH24-7 were advanced at the locations shown in Drawing No. 2 – Borehole Location Plan at the targeted locations of the proposed structures. The boreholes were advanced between October 24 to November 8, 2024, using a CME 55 truck-mounted drill rig equipped with hollow stem augers; supplied and operated by George Downing Estate Drilling Ltd. Boreholes BH24-4 and BH24-7 were first hydro-excavated to depth of 2.5 m to clear utilities before advancing with the drill rig. A hydro-excavation truck was supplied and operated by Badger Daylighting Inc. The boreholes were advanced to depths ranging from 6.9 m to 10.6 m below the existing ground surface. Auger refusal was encountered at boreholes BH24-2 and BH 24-3. Upon encountering auger refusal, borehole BH24-2 was extended into the bedrock to depth of 18.1 m (with total drill length in the bedrock of 7.5 m) using rotary diamond drilling techniques while retrieving HQ sized core.

Soil samples were recovered using a 50 mm (outside diameter) split-barrel sampler by conducting Standard Penetration Tests (SPTs) in accordance with the procedures outlined in ASTM D1586. Soil samples were collected every 0.75 m to the termination depths within the overburden. Field vane shear testing (ASTM D2573) was carried out in the clay layer to measure the undrained shear strength of silty clay deposit. Stantec geotechnical field personnel recorded the conditions encountered in the boreholes. All soil samples recovered from the boreholes were placed in moisture-proof bags and were transported to the Stantec Ottawa laboratory for detailed geotechnical classification and testing.

Two (2) groundwater monitoring wells were installed in boreholes BH24-2 and BH24-5, to allow for groundwater monitoring. The monitoring wells consisted of 50 mm inside diameter, Schedule 40 PVC pipe, with a No. 10 slot screen (0.01-inch slot) and screen length of 1.5 m. The annular space between the monitoring well pipe and surrounding geological formation was backfilled with sand to 0.3 m above the top of screen, with the remainder of the annular space being filled with a granular bentonite to minimize the potential for a hydraulic connection from occurring between the soil layers along the length of the screen. The screen depths relative to the ground surface are noted on the borehole records included in **Appendix C**. Boreholes (without monitoring wells) were backfilled with bentonite and soil cuttings in accordance with the MECP Environmental Protection Act Part 15.1.

Stantec personnel manually measured groundwater levels at the Stantec monitoring wells on October 28th, 2024. Groundwater levels were also recorded at historical wells at the Site identified as MW19-01, MW21-01D, MW21-01S, MW21-06, MW21-10S, MW21-10D, MW21-12, MW21-13, MW21-14, MW21-15, MW21-20S, MW21-20D, MW24-04.

3.2 SURVEYING

The coordinates of the boreholes were determined using a GPS navigation device and measuring borehole locations to a nearby site feature. The approximate borehole elevations were interpolated from the provided topographic survey drawing.

The Universal Transverse Mercator (NAD83 UTM, Zone 18) northing and easting coordinates and ground surface elevations are provided in Table 4.1 below. The termination depths and elevations of the boreholes are also provided in the table for reference.

Table 3.1: Borehole Locations Summary

Borehole No.	UTM Coordinates (NAD83 - Zone 17)		Ground Surface Elevation (m)	Termination Depth (m)	Termination Elevation (m)
	Northing	Easting			
BH24-1	5028422.7	443829.0	60.5	9.0	51.5
BH24-1A	5028422.6	443830.3	60.5	5.2	55.3
BH24-2	5028439.7	443873.0	59.9	18.1	41.8
BH24-3	5028484.1	443959.3	58.9	6.9	52.0
BH24-4	5028443.7	444015.4	59.4	8.2	51.2
BH24-5	5028408.9	444023.4	59.8	8.2	51.6
BH24-6	5028372.5	444013.9	60.3	8.2	52.1
BH24-7	5028397.4	444039.2	60.1	8.2	51.9

The borehole coordinates and estimated geodetic elevations are also shown on the borehole records in **Appendix C** for reference.

3.3 LABORATORY TESTING

Soil samples from the boreholes were subjected to visual and tactile examination upon return to Stantec's geotechnical and materials testing laboratory. Selected soil samples were tested for moisture content, grain size analyses, Atterberg Limits, consolidation testing and corrosivity testing. Unconfined compressive strength testing was also carried out on rock core samples. All laboratory testing except for the corrosivity tests was completed at Stantec's geotechnical and materials testing laboratory to determine engineering properties in accordance with American Society for Testing and Materials (ASTM). Two samples of soil from borehole BH24-2 and BH24-3 was submitted to Paracel Laboratories in Ottawa, Ontario, for chemical analysis to determine the soil corrosivity potential.

The results of the laboratory tests are discussed in the text of this report and are provided on the Borehole Records in **Appendix C**, and on the laboratory testing figures in **Appendix E**.

Samples remaining after testing were placed in storage and will be retained for a period of three months after the date of issue of the final report for this project. After the storage period, the samples will be discarded.

4.0 SUBSURFACE CONDITIONS

4.1 OVERVIEW

In general, the stratigraphy encountered in the boreholes consisted of pavement asphalt or topsoil over fill material that is underlain by a Champlain Sea clay deposit followed by till materials containing cobbles and boulders over shaly limestone bedrock. Auger refusal (inferred to be a result of encountering either bedrock or a boulder) was encountered at boreholes BH24-2 and BH 24-3 at depths of 10.6 m and 6.9 m, respectively.

The subsurface conditions observed in the boreholes are presented in detail on the Borehole Records provided in **Appendix C** and in the following subsections. An explanation of the symbols and terms used to describe the Borehole Records is also provided in **Appendix C**.

The soils encountered in the boreholes and reported herein have been classified in accordance with the Unified Soil Classification System as defined in ASTM D2487 and D2488.

The stratigraphic boundaries on the borehole records are inferred from non-continuous sampling and therefore represent transitions between soil types rather than exact boundaries between geological units. The subsoil conditions will vary between and beyond the borehole locations.

4.1.1 Ground Surface Cover

The ground surface cover at the borehole locations consists of either asphalt pavement at boreholes BH24-2, BH24-3 and BH24-6 or topsoil at boreholes BH24-4, BH24-5 and BH24-7. The asphalt or topsoil ground cover was not present at borehole BH24-1. The thickness of asphalt ranged from 75 mm to 100 mm. The thickness of topsoil was measured at 100 mm at all locations where topsoil was encountered. Topsoil consists of dark brown silty sand with trace gravel and contains rootlets and organic matters.

4.1.2 Fill Materials

A layer of fill material described as brown to grey sand and gravel, silty sand, to sandy clay containing rootles and organics was encountered underlying the ground surface cover at all borehole location except at borehole BH24-1 where fill material was encountered at ground surface. The fill layer typically contained some cobbles and boulders and rock fragments. The fill layer extends to depths of 1.5 m to 3.3 m below existing grade. Based on visual and textural examination, the fill material was assessed as moist. The results of the moisture content tests yielded moisture contents ranging from approximately 3% to 12%.

The N-values obtained from the SPTs advanced in the granular fill material ranged from 8 to more than 50 blows per 0.3 m indicating the granular fill materials are in a loose to dense state.

Two (2) representative sample of the fill was selected for grain size distribution testing and the results are summarized in Table 4.1below. The grain size distribution curve is shown in Figure No. D1 in Appendix D.

Table 4.1: Summary of Grain Size Analysis of Fill

Borehole No.	Sample ID	Depth (m)	Moisture Content (%)	Gravel (%)	Sand (%)	Fines (%) – Silt and Clay
BH24-2	SS3	1.5 – 2.1	2.7	46.8	43.7	9.5
BH24-5	SS3	1.5 – 2.1	19.0	20.3	39.4	40.3

4.1.3 Lean Clay to Clay

A deposit lean clay to clay was encountered underlying the fill material at all borehole locations. The clay extends to depths ranging from 4.6 m to 8.4 m. The upper portion of the clay has been weathered to form a brown crust in boreholes BH24-4 and BH24-7extending to depths of 3.1 m and 4.1 m, respectively. Standard penetration tests carried out within the weathered crust generally gave SPT 'N' values ranging from "weight of hammer" to 10 blows per 0.3 metres of penetration.

The silty clay below the depth of weathering and the silty clay in all other boreholes is grey in colour. Vane shear testing carried out on the grey clay gave undrained shear strength values ranging from about 61 kPa to greater than 118 kPa (the maximum range of reading for the equipment used) indicating a stiff to very stiff consistency. The peak to remoulded shear strength ratio (sensitivity) was estimated at 2 to 4.

Three (3) representative samples were selected for grain size analysis testing. The results are summarized in Table 4.2 below and the grain size distribution curve is shown on Figure No. E2 in Appendix E.

Table 4.2: Grain Size Distribution – Clay

Borehole	Sample	Depth (m)	Moisture Content %	Gravel (%)	Sand (%)	Silt (%)	Clay (%)
BH24-2	SS5	3.8 – 4.4	42.9	0	11	42	47
BH24-3	SS5B/6	2.6 – 4.4	30.8	6	16	47	31
BH24-5	SS4	2.3 – 2.9	30.7	0	10	40	50

Six (6) samples of silty clay were subjected to Atterberg Limits testing. The laboratory results are summarized in Table 4.3 and the corresponding plasticity chart is shown on Figure No. E3 in Appendix E. According to the Unified Soil Classification System (USCS), the clay deposit can be classified low plasticity lean clay (CL) to clay (CH) with high plasticity.

Table 4.3: Atterberg Limits Test – Clay

Borehole	Sample	Depth (m)	Moisture Content (%)	Liquid Limit	Plastic Limit	Plasticity Index
BH24-1	SS6	5.3 – 5.9	50.4	59	24	35
BH24-2	SS5	3.8 – 4.4	42.9	46	23	23
BH24-3	SS5B/6	2.6 – 4.4	30.8	35	16	19
BH24-5	SS4	2.3 – 2.9	30.7	50	23	27
BH24-6	SS4	3.0 – 3.7	49.4	57	23	34

One-dimensional consolidation testing was also carried out on two samples of the clay. A summary of the consolidation testing results is provided in Table 4.4 and the detailed consolidation results are presented in Appendix E.

Table 4.4: Consolidation Test Results Summary – Lean Clay

Borehole/ Samples	Depth m (ft)	Bulk Unit Weight (kN/m^3)	Initial Void Ratio e_o	Compression Index Cc	Recompression Index Cr	Overburden Pressure P_o’ kPa	Pre-consolidation Pressure Pc’ kPa
BH 24-1A, ST1	3.0 – 3.7	18.3	1.05	-*	0.04	49	-*
BH 24-07, ST4	3.8 – 4.4	17.1	1.33	1.15	0.02	70	400

*Sample was disturbed, and the results are not reliable

4.1.4 Glacial Till

A deposit of glacial till was encountered beneath the granular clay at all borehole locations. The till extends to the termination depths of the boreholes at depths ranging from 6.5 m to 10.5 m. The till material consists of grey-colored sandy clay, sandy silt to silty sand till. Trace to some gravel was noted in the samples obtained from the till layer. The presence of cobbles/boulders was inferred in some boreholes due to the auger grinding and presence of rock fragments in the samples obtained from the till layer. The glacial till of the Ottawa area is usually crowded with cobbles and boulders set in a matrix of finer-grained material (gravel, sand, silt and clay); large boulders in excess of 1.0 m are common. It is unsorted and without stratification, but in places contains discontinuous layers or irregular shaped masses of sand and silt. Where glacial till deposits are identified, cobbles and boulders are present and permeable layers of sand and silt may randomly be present; due to the unsorted and unstratified nature of the glacial till, it is possible to advance boreholes while encountering only matrix material.

The N-values obtained from the SPTs advanced in the till layer ranged from 2 to more than 50 blows per 0.3 m, indicating a very loose to very dense consistency.

Based on visual and laboratory examination of the samples, the till was assessed as wet to moist. The moisture content of the samples tested ranged from approximately 7% to 21%.

Grain size distribution tests were completed on seven (7) samples of the till stratum. The results of the tests are shown in Table 4.5 below and the grain size distribution curve is shown on Figure No. E4 in Appendix E.

Table 4.5: Grain Size Distribution – Till

Borehole	Sample	Depth (m)	Moisture Content (%)	Gravel (%)	Sand (%)	Silt (%)	Clay (%)
BH24-1	SS8	8.5	15.8	5	49	31	15
BH24-2	SS10	9.9-10.5	9.1	16	51	33	
BH24-4	SS7	6.5	19.3	8	33	47	12
BH24-4	SS9	7.8	11.9	18	57	20	5
BH24-5	SS8	7.5	10.3	14	49	28	9
BH24-6	SS5	4.7	14.2	13	24	50	13
BH24-6	SS8	6.9-7.5	17.7	0	95.1	4.9	
BH24-7	SS7	6.3	9.2	8	54	38	
BH24-7	SS8	7.2	7.7	18	50	32	

Silt – fraction of particles with sizes smaller than 0.075 mm and greater than 0.002 mm.
Clay – fraction of particles with sizes smaller than 0.002 mm.

In accordance with the Unified Soil Classification System, the samples tested can be classified as Silty Sand (SM), and Sandy Silt (ML).

4.1.5 Refusal and Bedrock

Auger refusal was encountered at boreholes BH24-2 and BH 24-3 at depths of 10.6 m and 6.9 m (elevations 49.3 m and 52.1 m), respectively. In general, auger refusal may represent the bedrock surface; however, it could also represent cobbles or a boulder within or on the surface of the glacial till.

Upon encountering auger refusal, borehole BH24-2 was extended into the bedrock to depth of 18.1 m (with total drill length in the bedrock of 7.5 m) using rotary diamond drilling techniques while retrieving HQ sized core. The depth and elevations of the confirmed (or possible) bedrock surface, as well as the ground surface elevation at the borehole locations from the current and previous investigations, are summarized in the Table 4.6. According to the current and previous investigation, bedrock was confirmed at depths ranging from 7.9 m to 10.6 m (elevations 52.2 m to 49.3 m).

Table 4.6: Bedrock Depth and Elevations

Borehole Number	Existing Ground Surface Elevation (m)	Bedrock Surface	
		Depth (m)	Elevation (m)
BH24-2	59.9	10.6	49.3
BH24-3	58.9	-*	-*
MW23-01	60.6	10.0	50.6
MW21-01D	60.5	10.0	50.5
MW21-04D	61.3	9.1	52.2
MW21-10D	58.8	7.9	50.9
MW21-18	60.3	8.2	52.1

*Bedrock not confirmed

The bedrock core retrieved from the borehole generally consisted of grey limestone with interbedded shale. Photos of the rock core collected from borehole BH24-2 are included in Appendix C.

The bedrock is slightly weathered near the surface, becoming fresh at greater depths. The rock cores display dark gray limestone with prominent horizontal bedding planes. Rock Quality Designation (RQD) values measured on the retrieved bedrock core generally ranged between 33% and 100%, indicating a poor to excellent rock mass quality. The Total Core Recovery (TCR) of the bedrock ranged from 54% to 100%.

Two bedrock core samples were submitted for unconfined compressive strength (UCS) testing, with the results presented in Table 4.1. Based on the results of the UCS test, the bedrock is classified as very strong rock.

Table 4.7: Unconfined Compressive Strength Tests

Borehole	Run No.	Sample Depth (m)	Rock Type	Unconfined Compressive Strength (MPa)
BH24-2	HQ14	12.3–12.5 m	Limestone with shale interbeds	159.2
BH24-2	HQ15	14.3–14.8 m	Limestone with shale interbeds	110.2

4.2 GROUNDWATER

Based on observations made during drilling, the groundwater level was inferred to be at depths of approximately 2.3 m to 6.6 m below ground surface; these inferred water levels do not represent the stabilized water level at the site. The groundwater level (GWL) was recorded on October 28, 2024, in monitoring wells installed in boreholes BH24-2 and BH24-5 and in some historical monitoring wells installed by others. Observed groundwater levels in the monitoring wells are reported below in Table 5.4.

Table 4.8: Summary of Monitoring Well Readings

Borehole	Ground Surface Elevation (m)	Groundwater Levels		Measured Date
		Depth (m)	Elevation (m)	
BH24-2	59.77	4.7	55.07	October 28, 2024
BH24-5	59.69	4.2	55.49	October 28, 2024
MW21-20S	61.28	6.6	54.68	October 28, 2024
MW21-06	59.99	3.8	56.19	October 28, 2024
MW21-12	59.79	4.7	55.09	October 28, 2024
MW21-13	59.18	4.6	54.58	October 28, 2024
MW21-14	59.76	2.2	57.56	October 28, 2024
MW21-15	59.80	6.6	53.20	October 28, 2024
MW19-01	59.73	2.83	56.90	October 28, 2024

Groundwater levels at this site will be subject to fluctuations due to seasonal changes, precipitation events and variations in the water level in the nearby Ottawa River. The water levels should be expected to be higher during the spring season or during and following periods of heavy precipitation or snow melt.

The results of the investigation indicate that the site is underlain by fill materials of varying thickness and composition. Perched groundwater conditions may develop within the fill materials (particularly within near-surface granular fill materials that are underlain by fine-grained soils) and result in groundwater levels rising near to ground surface.

4.3 CHEMICAL ANALYSIS

Two (2) representative soil sample was submitted to Paracel Laboratories in Ottawa, Ontario, for analysis of pH, water soluble sulphate, chloride concentrations, and resistivity. The testing was completed to determine the potential for degradation of the concrete in the presence of soluble sulphates and the potential for corrosion of exposed steel used in foundations and buried infrastructure.

The analysis results are summarized in the following table and are provided in **Appendix E**.

Table 4.9: Chemical Testing Results

Borehole No.	Sample No.	Depth (m)	pH	Chloride (µg/g)	Sulphate (µg/g)	Resistivity (Ohm-m)
BH24-2	SS7	6.9 – 7.5 m	7.95	32	152	24.9
BH24-3	SS7	5.3 – 5.9 m	7.80	159	219	17.8

5.0 DISCUSSION AND RECOMMENDATIONS

This section provides preliminary engineering input related to the geotechnical design aspects of the proposed development based on our interpretation of the available subsurface information described herein and our understanding of the project requirements.

The discussion and recommendations presented in the following sections of this report are intended to provide the designers with preliminary information for planning and design purposes only. Contractors bidding on or undertaking the works should examine the factual results of the investigation, satisfy themselves as to the adequacy of the information for construction, and make their own interpretation of the data as it affects their proposed construction techniques, schedule, safety, and equipment capabilities.

The following geotechnical input is based on the information that was available at the time of writing this report. As not all details (e.g., final building configurations and site grades, structural loads etc.) related to the proposed development were available at the time of preparation of this report, all geotechnical comments and input provided herein should be reviewed and revised, as required, as the design progresses and once the final plans become available.

5.1 KEY GEOTECHNICAL ISSUES

The following general development considerations and constraints are provided with respect to observations made during the investigation, the subsurface conditions encountered, and the intended scope of development:

- It is anticipated that the existing Plant Recreation building and associated infrastructure will be demolished and/or decommissioned as a component of the re-development of the site. Excavations created through the demolition and decommissioning process should be backfilled with approved, compacted engineered fill materials, or concrete.
- Given the site is already developed, a significant cut and fill program to adjust site grade is not anticipated to be required for the proposed redevelopment.
- The site includes a 1.5 m to 3.3 m thick layer of fill which is not suitable for supporting foundation and construction of slab-on-grade. Therefore, as part of the site preparation works, the fill will need to be removed from the building footprint. All topsoil and/or organic soils should be removed from the proposed paved areas.
- The site is underlain by 2.0 m to 6.1 m thick, compressible deposit of Champlain Sea clay, typically extending to 4.6 m to 8.4 m below the existing ground surface. The clay deposit has a stiff to very stiff consistency and has a limited capacity to support new loads (e.g., from site grade fill placement, foundation, and floor loads and/or potential groundwater level lowering, etc.).
- Due to the presence of the clay deposit, it is recommended that the deep foundations be incorporated in the design to support the multi-storey building and for all residential towers. Recommendations for the deep foundation options are provided in the following sections.
- The proposed basement floor level is not known at this time; however, considering number of underground parking levels for each building (as discussed in Section 2), it is anticipated that the first floor elevation for the residential towers, mid-rise building and RCFS building will be below the

groundwater level. As such, an under-slab drainage system will be required to control groundwater. The measured groundwater depth on October 28, 2024, was at 2.2 m to 6.6 m.

- The Champlain Sea clay is typically sensitive to settlement from the water demand from trees. The selection and planting of trees should follow the City of Ottawa guidelines for tree planting in sensitive marine clay. The overgrowth of tree roots, as well as the phenomenon of tree root removing moisture from surrounding soils, may modify the soils properties. Therefore, species of tree with characteristics matching these concerns should not be proposed in the landscape areas. In general, the planting of trees should be offset from foundations by a distance equal to at least the theoretical mature height of trees.
- The Champlain Sea clay deposit is underlain by a silty sand till deposit in a very loose to dense state. The liquefaction assessment indicates that a portion of this deposit between 5.6 m to 9.2 m depths is potentially susceptible to liquefaction.
- Based on the results of the investigation and considering the presence of the liquifiable soil, this Site could be considered as Site Class 'F' based on Table 4.1.8.4.A of the NBCC. Additional analysis will be required to assess site-specific seismic response data.

Preliminary geotechnical comments, discussion, and recommendations are provided in the following sections with respect to the design and construction of the planned scope.

5.2 SITE PREPARATION

The subsurface conditions encountered at the site typically consist of surficial topsoil or pavement and fill materials overlying the native very stiff to hard weathered clay crust over silty sand glacial till. In preparation for construction of the buildings, all organic soil (including topsoil), vegetation and tree roots, fill material, and any loose, wet, and/or otherwise disturbed native material should be removed from within the footprint of the proposed structures and foundations. Any existing infrastructure (e.g. existing buried services/utilities) should also be removed/relocated from within the influence zone of new foundations.

Beneath pavement areas, non-clay fill material, free of deleterious material, can be left in place and surface compacted to act as a subgrade for the proposed paved areas. Existing clay fill material should be removed up to 1.5 m from below the top of proposed pavement; clay fill material within 1.5 m from existing surface was observed only within borehole BH24-3.

The prepared subgrade soils will require inspection by geotechnical personnel prior to structural fill placement to verify all unsuitable material has been removed.

Beneath all buildings and foundations, site grades should then be raised, if needed, using Structural Fill consisting of Ontario Provincial Standard Specification (OPSS) Granular B Type I or II materials that are placed in lifts no thicker than 300 mm and compacted to at least 95% of the material's Standard Proctor Maximum Dry Density (SPMDD). The final layer of fill should consist of OPSS Granular A materials with a minimum thickness of 300 mm beneath the floor slabs and 200 mm in other areas, excluding basement areas where a drainage system will be required.

Beneath pavement and sidewalks, site grades should be raised using OPSS Select Subgrade Material (SSM) compacted in lifts not exceeding 300 mm to 95% of the material's Standard Proctor Maximum Dry Density (SPMDD)

The placement of all engineered fill materials should be monitored on a full-time basis by qualified and experienced geotechnical personnel under the supervision of a geotechnical engineer, with the authority to stop the placement of fill at any time when conditions are unacceptable.

All fill materials imported to the site must meet all applicable municipal, provincial, and federal guidelines and requirements associated with environmental characterization of the materials.

The contractor should be responsible for protecting the subgrade soils from disturbance due to construction traffic. This may require that construction access routes are temporarily overbuilt (i.e., provided with increased granular fill) and/or geotextiles are provided between the granular fill and the subgrade surface.

Imported fill materials should be tested and approved by a geotechnical engineering firm prior to delivery/use. Monitoring of fill placement and in situ compaction testing should be carried out to confirm that all fill is placed and compacted to the required degree.

5.2.1 Grade Raise Restrictions

The native subsurface materials present at the site consist of a sensitive, Champlain Sea clay deposit that extends to depths ranging from 4.6 m to 8.4 below ground surface. Based on the preconsolidation pressures of the clayey soils estimated from the undrained shear strengths, the clay deposit is considered to be over-consolidated.

Based on the proposed development plans, the new facilities will be constructed at or near existing grades and, as such, it is understood that significant grade raises are not planned as part of the new developments at the site. Large consolidation settlements may occur when the application of new loads such as site grade fills and building loads result in final loads exceeding the maximum past loading conditions (i.e., the preconsolidation pressure or yield stress) of the Champlain Sea clays.

Should minor grade raises (i.e. up to 1 m) be required in localized areas and away from the building foundations, such grade raises are not considered to result in settlements of the underlying soils that would adversely affect the performance of the proposed or existing facilities. If any grade raises greater than 1 m are planned, the final loading configuration should be reviewed to confirm that unacceptable settlements of the new and existing facilities foundations would not occur under the proposed loading.

5.2.2 Demolition and Decommissioning

It is anticipated that the demolition and decommissioning of the existing Plant Recreation building including removal of the superstructure, floor slabs and foundations will be required. It is also anticipated that decommissioning and removal/relocation of buried services will be required, particularly in the area immediately west of the existing RCFS building. All demolition and stripped materials should be removed to an approved off-site location.

Excavations created through the demolition and decommissioning process should be backfilled with approved fill materials. Material for this purpose should consist of approved portions of the existing granular fill materials (as further discussed below), imported material meeting the requirements of OPSS

SSM or OPSS Granular B (either Type I or II). Further comment with respect to the use of these materials in specific applications is provided as follows.

Where the proposed buildings will not cover the footprint of the demolished structures, backfilling to grade will be required.

5.3 FROST CONSIDERATION

The Ontario Building Code and the guidelines in the Canadian Foundation Engineering Manual require any exterior foundations and foundations in unheated areas exposed to freezing temperatures be provided with adequate protection against frost. Based on OPSD 3090.101, Foundation Frost Depths for Southern Ontario, the depth of frost penetration for the Site area is 1.8 m. All perimeter footings and/or pile caps for unheated structures or isolated exterior footings should be protected from frost action by a minimum soil cover of 1.8 m. All of building foundations (exterior pile caps, grade beams, footings, etc.) for heated structures should be placed at least 1.5 m beneath the final exterior grade in order to provide adequate frost protection.

Where adequate earth cover for frost protection cannot be provided, the use of rigid insulation can be considered. As a general guideline, 25 mm of rigid insulation may be assumed to provide approximately 300 mm of equivalent soil cover.

5.4 SEISMIC DESIGN CONSIDERATIONS

5.4.1 Liquefaction Potential

The potential liquefaction of the site soils under seismic loading conditions was assessed using the analysis methodology suggested by Idriss and Boulanger (2008)[1] for silty sand till layer and Boulanger and Idriss (2004)[2] for clay deposit. The evaluation was completed based on the SPT resistance values (SPT-N values with depth) for granular material and undrained shear strength values for the cohesive soil. The cyclic shear stresses induced in clay deposits are estimated to be lower than the measured undrained shear strength (i.e., shear strength values of 61 kPa to greater than 118 kPa) within the clay deposit, therefore significant deformation of clay deposits is not a concern during an earthquake event. Settle 3 software was used to evaluate liquefaction susceptibility of the silty sand glacial till layer using the in-situ testing data collected at each borehole location. The assessment was based on an earthquake with a magnitude of 6.2 and a peak ground acceleration of 0.367 g (The site specified design PGA value for a Site Class D site). A copy of the NBC 2020 Seismic Hazard Calculation Data sheet is provided in **Appendix F** for reference.

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[1] Idriss, I.M. and Boulanger, R.W. (2008). "Soil Liquefaction During Earthquakes", Earthquake Engineering Research Institute, Monograph MNO-12, 2008

[2] Boulanger, R.W. and Idriss, I.M. and (2004). "Evaluating the Potential for Liquefaction or Cyclic Failure of Silt and Clay, Center for Geotechnical Modeling, University of California at Davis, Report No., UCD/CGM-04/01, December 2004

The formulation by Idriss and Boulanger (2008) compares the earthquake induced cyclic stress ratios (CSR) with the cyclic resistance ratios (CRR) of the soil based on the soil SPT-values. The calculated factor of Safety values based on the recorded SPT-N values within the till from the different boreholes versus depth are presented in Figures F1 to F4 in **Appendix F**. Liquefaction is predicted to occur when the available penetration resistance is less than the resistance required.

The assessment indicates that the silty sand till soils below the clay layer are considered susceptible to liquefaction (factor of safety against liquefaction of less than 1) at the following depths and locations:

- From 8.4 m to 9.0 m at BH24-1 (elevations 52.1 m to 51.5 m).
- From 7.8 m to 9.3 m at BH24-2 (elevations 52.1 m to 50.6 m).
- From 5.6 m to 6.4 m at BH24-4 (elevations.54.0 m to 53.2 m).
- From 5.6 m to 7.1 m at BH24-5 (elevations 53.3 m to51.8 m).

The anticipated total and differential settlements of the liquefiable layer under the analyzed earthquake event could be up to about 65 mm with differential settlements on the order of 50 mm. The amount of settlement is highly dependent on the earthquake event, the thickness of the deposit, and its liquefaction potential, and therefore settlements could be highly variable. Given that deep foundations are recommended to support the residential tower structure, these settlements would apply only to non-pile supported elements and foundations.

It is recommended that further investigation to measure shear wave velocity and additional undisturbed in-situ testing such as cone penetration testing (CPT) is carried out to re-evaluate the liquefaction potential and mitigate the risk of liquefaction.

5.4.2 Site Classification

The seismic Site Class value, as defined in Section A-4.1.8.4 of the of the 2024 Ontario Building Code (OBC), contains a seismic analysis and design methodology which uses a seismic site response and site classification defined by the shear stiffness of the upper 30 m of the ground below the foundation level. There are six site classification (from A to F), decreasing in stiffness from A (hard rock) to E (soft soil); Site Class F denotes mostly liquefiable soil type defined by the normalized SPT blow counts and/or undrained shear strength.

Based on the measured undrained shear strength values within the clay deposit and the measure N values in granular materials, in case of building period less than 0.5 sec, and in accordance with OBC 2024, the site class is classified as Class ‘D’. The site adjusted PGA for Site Class D, based on a 2475-year return period, is 0.386g. However, Section A-4.1.8.4 of OBC 2024 also specifies circumstances for which a Site Class F is applicable, and a site-specific response evaluation must be carried out; the presence of liquefiable soils is one of those conditions. As presented in Section 5.4.1, this site is underlain by soils which may undergo liquefaction under the design earthquake event. In addition, given that the fundamental period of the high-rise and mid-rise buildings will likely be greater than 0.5 seconds, the special condition in Section A-4.1.8.4 of OBC 2024 that allows for Site Class determination assuming that the soils are not liquefiable would not apply. The Ontario Building Code allows the use of a “non-liquefied” Site Class for sites with liquefiable soils, provided structures have a fundamental period of vibration less than or equal to 0.5 seconds. This is likely the case for the school and RCFS buildings; however, this must be verified by the structural engineer before the non-liquifiable Site Class is implemented for design.

It is recommended that a site-specific evaluation and measurement of shear wave velocities is undertaken during the detail design phase to model the dynamic ground response at the site and develop site-specific design spectra for liquifiable soil.

5.5 FOUNDATION DESIGN CONSIDERATIONS

The project consists of a mix of low-rise, mid-rise, and high-rise residential tower structures. The foundation types should be selected based on the structural loads, soil conditions, and groundwater considerations.

Based on the proposed underground level of parking for each structure and assumed finished floor elevations (FFE) and footing depths, the following foundation options are recommended for the construction of each building.

5.5.1 School and RCFS Facility Structures

In general, the stratigraphy encountered in the boreholes consisted of pavement asphalt or topsoil over fill material that is underlain by a Champlain Sea clay deposit at depths of 1.5 m to 2.3 m (i.e., elevations 55.6 to 58.8 m) followed by till materials containing cobbles and boulders. The ‘looser’ portions of the till deposit are potentially liquefiable as discussed in Section 5.4.1.

For low-rise buildings (such as RCFS, School), shallow foundations (spread footings) may be feasible. However, it should be noted that due to the presence of loose liquefiable till deposit at the location of school building, this building should be designed to withstand the post-liquefaction total and differential settlements of up to 65 mm and 50 mm, respectively, as discussed in Section 5.4.1. If the structure is not capable of accommodating the impacts of the liquefaction, then deep foundation could be used to mitigate the impact of liquifiable soil on the structures. Additional guideline for the deep foundation options is provided in Sections 5.5.2 and 5.5.3.

It is understood that one level of underground parking is being considered for RCFS structure and no parking level is considered for the school building. In absence of the proposed finish floor elevation and assuming the number of underground levels and frost penetration depth for this site, the underside of foundations will likely be at elevations 58 m and 55 m for the school and RCFS facility, respectively. Based on these elevations and the borehole data, the foundation for these buildings can be supported on shallow foundations bearing directly on the undisturbed native clay or on Structural Fill placed above the native clay. However, it is noted that the native clayey soils are prone to frost heave due to ice lensing and that the grey, unweathered/intact portions of the clay are susceptible to significant frost heave when frozen for the first time (e.g. due to exposure in new excavations). Therefore, it is essential that the foundation subgrade should not be exposed to freezing conditions/must be protected from freezing.

Shallow foundations can be designed using the factored geotechnical resistance values presented in Table 5.1 below. The resistances in Table 5.1 apply to shallow foundations founded within the upper portion of the stiff to very stiff clay at or above elevation 55 m. Additional input should be provided by the geotechnical engineer if the foundation sizes or embedment depths are outside of the ranges outlined above.

Table 5.1: Geotechnical Resistance for Shallow Footings – Founded Above Elevation 55 m

Range of Footing Dimensions (m)	Minimum Footing Embedment Elevation (m)	Factored Geotechnical Resistance at ULS (kPa)	Geotechnical Resistance at SLS (kPa)
Square/Pad Footings			
1 to 3 m	55	200	90
Strip Footings			
0.6 to 1.0	55	210	100

Notes:

1) all foundations in unheated areas must be provided with sufficient protection against frost action as outlined in Section 5.3.

2) The geotechnical resistances in the above table are provided for the range of footing widths and the minimum footing embedment depths listed in the above table.

5.5.1 Residential Tower and Mid-Rise Buildings

Considering the presence of the compressible clay deposit at the site and relatively high load expected for the multi-story and high-rise tower buildings as well as the presence of liquifiable soil, a shallow foundation is not feasible. Deep foundation systems are considered feasible for the residential tower and mid-rise community housing at this Site. The buildings could be supported on deep foundations transferring the foundation loads to below the compressible Champlain Sea clay and loose till layer (i.e., down to the bedrock surface). The piles would however be subject to down drag loads, following a seismic event, and the structural capacity of the piles to support those loads would need to be evaluated.

The following deep foundation options could be considered.

Driven piles: Piles driven to refusal within the limestone bedrock are feasible for support of the structure, however, given the presence of cobbles and boulders inferred to be present within the till deposit, difficulty driving piles through the glacially derived soils may be encountered, including the possibility of piles meeting refusal on cobbles/boulders above the bedrock elevation and/or piles deflecting off line.

Rock Socketed Caissons: Caissons deriving their support from bearing within the shale bedrock are also feasible for this site. In addition, the caissons would have to be socketed at least 1 m into the fair to good quality bedrock to advance below the weathered bedrock.

Driven piles are discussed in the following section, micro-piles and caisson options in later sections.

5.5.2 Driven Piles

Driven piles to support building foundations may consist of concrete filled steel pipe piles (driven closed-ended) or H-piles, with the piles driven to refusal within or upon underlying bedrock. The bedrock was confirmed in borehole BH24-2 at depth of 10.6 m (elevation 49.3). The piles may attain refusal at the surface of the weathered bedrock or within the till layer due to the presence of cobbles or boulder;. Because of the presence of boulders within the till, it is recommended that driving shoes be included to protect the pile tips.

For piles attaining refusal at or slightly below the bedrock surface, settlement at the toe will be negligible and the total pile head settlement will correspond to the elastic deformation of the piles. The ultimate limit state (ULS) axial geotechnical resistance in compression of piles driven to refusal on bedrock (or slightly within) at the site should be the structural capacity of the pile.

It should be noted that the ultimate bearing capacity of the steel piles driven to bedrock is usually governed by the structural capacity of the piles. Due to stresses imposed by the pile driving methods and to avoid damaging the steel during driving, it is recommended that the ULS geotechnical resistance be limited to 140 N/mm^2 of the steel cross-sectional area of the piles. In case where pipe piles are to be filled with concrete and the pile driving contractor proposes higher capacities to incorporate the structural benefits of the concrete, the contractor would be required to demonstrate that the piles have achieved the proposed higher capacities by field testing. Based on a limiting stress value of 140 N/mm^2 against steel cross-sectional area, the following ULS resistances may be considered:

HP 310x110	1975 kN at ULS
Pipe 324 mm diameter, 11 mm thick wall	1530 kN at ULS

The actual piles selected will depend on the pile load requirements and the pile cap configurations. It is anticipated that piles will be spaced more than three diameters apart and that pile groups will contain relative few piles. Therefore, group effects requiring reduction in pile capacities or resulting in significant ground heaving around the piles are not anticipated.

For piles driven to bedrock, the geotechnical resistance at serviceability limit state (SLS) exceeds the ULS value and therefore is considered not to be applicable to the design.

The pile driving contractor should be required to submit the following information prior to mobilizing to the site:

- Outline of proposed pile driving equipment
- Pile driving refusal criteria to provide the ULS design value selected for the project

Pile caps/grade beams for unheated areas such as exterior structures should be provided with 1.8 m of soil cover. 10% of the driven piles should be subjected to dynamic pile testing to confirm that they are well seated on bedrock and that the pile driving strategy did not damage the piles upon reaching bedrock. Dynamic testing should be carried out using a pile driving analyser (PDA).

Downdrag due to potential soil liquefaction

The till which underlies the clay is sporadically considered potentially susceptible to liquefaction during a design seismic event. Based on the conducted liquefaction analyses, settlements associated with liquefaction could reach 30 mm to 50 mm. Therefore, drag loads should be incorporated in the design. For design, the following can be considered for a pile (up to 10 m long).

$$D_L = P_p \times 388 \text{ kN/m}$$

where:

D_L = Unfactored drag load in kN

P_p = Perimeter of pile in metres

For longer piles the above D_L value should be proportionally adjusted.

The structural capacity of the pile would need to account for drag load imposed during a seismic event. The geotechnical capacity is not affected by the drag loads. These values are only to be used to validate the structural capacity of the pile.

As discussed elsewhere in this report, a grade-raise restriction of 1 m is required at the site to prevent soil consolidation at the edges of footprint of the proposed building. Therefore, it has been assumed that drag loads due to soil settlements may not be considered in the design.

5.5.3 Rock Socketed Caissons

Rock socketed caissons constructed using a steel liner, combined with the tremie technique to place concrete may be considered for design. The use of a steel liner and the tremie technique would be required due to the presence of the highly permeable till deposit.

The caissons are recommended to be socketed into the bedrock for a minimum length of one diameter of the caisson into fair to good quality bedrock (an RQD greater than 50 percent) and incorporate concrete with a minimum compressive strength of 35 MPa. Given the fracture nature of the bedrock at the top, the top 0.5 m of the rock socket is not to be included in the calculated capacity.

A resistance factor of 0.4 has been used to develop the factored geotechnical resistance at ULS. The following caisson capacities may be considered for design purposes:

Table 5.2: Caisson Capacities at ULS$_f$ (f=0.4)

Caisson Diameter (m)	Socket Length (m)	Factored Geotechnical Resistance at ULS$_f$ (kN)
0.9	1.5	1,600
	2.1	2,700
1.2	1.7	2,700
	2.3	4,000

*Notes: - The above geotechnical resistance reflects only the shaft resistance within the rock socket.

- The parameters used for the analysis were as follows: UCS of 110 MPa; RQD of 90 for the Williams and Pells shaft resistance correction factor (j); empirical factor 'b' of 1.41 as per Table 9.17 of the CFEM.

Cassion should have a minimum pile spacing of 2.5 times the largest nominal pile dimension (i.e. diameter) measured centre-to-centre within pile groups. Caissons bearing on bedrock will develop the majority of their capacity from toe resistance, and therefore, a reduction in pile capacity may not be required to account for pile group effects. If pile groups are required for the proposed structures, Stantec geotechnical personnel should be contacted to review the requirement for a group reduction factor based on details of each specific pile group (i.e. pile layout, spacing, etc.). For piles end-bearing on bedrock, SLS conditions do not typically govern the design since the loads required to induce 25 mm of movement exceed those at ULS.

Construction Inspection

It is anticipated that contractor would use flight augers to construct the caissons. The following should be anticipated.

- That caissons would need be to clean and dewatered to allow for inspection to ensure that all loose materials are removed and that the sidewalks are free of debris
- That concrete should not be placed within a dewatered caisson since waterflow from the fractured bedrock would wash out the cement paste from the concrete
- The caissons would need to be filled with water prior to concreting to allow for use of the tremie method where concrete is pumped underwater, from the bottom of the caisson, while displacing the overlying water
- That full time inspection by a geotechnical engineer's representative would be required while constructing caissons, including placement of concrete by the tremie method

5.6 BACKFILL

5.6.1 Perimeter Foundation Wall Backfill

The free-draining granular backfill placed adjacent to the exterior (perimeter) walls should be placed in loose lifts having a maximum thickness of 300 mm.

Each lift should be uniformly compacted using suitable compaction equipment for the purpose intended, to achieve a minimum of 95% of the material's SPMDD.

5.6.2 Bedding and Cover and Backfill Material for Buried Services & Utilities

OPSS Granular A materials should be placed below sewer and water pipes as bedding material. The bedding should have a minimum thickness of 150 mm or more to meet City of Ottawa standards. Where unavoidable disturbance to the subgrade surface does occur, it may be necessary to thicken the bedding layer or provide a sub-bedding layer of compacted Granular B Type II materials. Pipe backfill and cover materials should also consist of OPSS Granular A material. A minimum of 300 mm vertical and side cover should be provided. These materials should be compacted to at least 95% of the material's SPMDD in lifts no greater than 300 mm. Clear crushed stone backfill should not be permitted as pipe bedding materials.

Where the pipe trenches will be covered with hard-surfaced areas, the type of native material placed in the frost zone (i.e. between subgrade level and 1.8 meters depth or the top of the pipe cover materials) should match the soil exposed on the trench walls for frost heave compatibility.

Trench backfill should be placed in maximum 300 mm thick lifts and should be compacted to at least 98 percent of the material's standard Proctor maximum dry density using suitable compaction equipment.

If there is insufficient reusable material at the site, any bulk fill required to raise the site grades should consist of imported granular fill meeting the requirements of OPSS Select Subgrade Material (SSM).

All imported fill materials should be tested and approved by a geotechnical engineering firm prior to delivery to the site.

5.7 PAVEMENT DESIGN RECOMMENDATIONS

Provided that subgrade preparation below pavements will comply with the requirements outlined in Section 5.2 of this report, the pavement structure provided in Table 5.3 below may be used for design. Where required, site grades below pavement structures are to be raised using imported soils meeting the requirements of OPSS Select Subgrade Material (SSM).

Table 5.3: Recommended Pavement Structure

Location	Asphalt Thickness	Base Thickness OPSS Granular A (mm)	Subbase Thickness Granular B Type II (mm)
Standard Duty Parking Areas	60 mm SP12.5 mm	150	300
Fire Route/Heavy Duty Parking	40 mm SP12.5 mm 50 mm SP SP19.0 mm	150	400

Notes:

- The above pavement structure assumes that the subgrade will consist of either the existing granular fill materials or OPSS SSM material, and that all areas where clay fill subgrade is present, it will be sub excavated to at least 1.5 m below the proposed pavement level and replaced with compacted OPSS SSM material.

- The pavement subgrade must be proof rolled under the supervision of geotechnical personnel prior to subbase or engineered fill placement. Any soft areas identified during proof rolling may require subexcavation and replacement with additional Granular 'B'. Where required, site grades below pavement structures are to be raised using subgrade fill.
- The finished subgrade surface and the pavement surface should be crowned and graded to direct runoff water away from the development and associated infrastructure.
- Given the low permeability of the native subgrade soils, perimeter drains and pavement subdrains connected to catch basins are recommended to promote drainage of the pavement structure. The subdrains should comprise 100 mm or 150 mm diameter perforated corrugated pipes with filter socks bedded in sand. The top of pipe should be below the lower limit of the granular subbase.
- Asphalt performance grade PG 58-34 should be specified.
- Based on the Ontario Provincial Standard Specification "Material Specification for Superpave and Stone Mastic Asphalt Mixtures" OPSS.MUNI 1151 (April 2018) a Superpave Traffic Category of A is suitable.
- A tack coat is recommended between asphalt layers and along the edges of any cuts in asphalt.
- In the event that the asphalt layer is not placed at the same time as the granular sub-base/base and the base is left exposed for a period of time, the top layer of granular material should be re-shaped, surface compacted and replaced with a fresh layer of Granular A prior to the placement of the asphalt surface.
- Control of surface water is a critical factor in achieving good performance over the pavement structure life. In this regard, the elevations of the surface of the parking areas should be designed to promote adequate surface drainage.

Compaction Requirements:

- The finished sub-grade surface must be compacted to achieve a minimum of 95% of the materials SPMDD immediately prior to placement of the granular materials.
- All granular materials should be in accordance with the requirements of OPSS Specification. These materials should be compacted to at least 100% of the material's Standard Proctor maximum dry density (SPMDD) in lifts no greater than 300 mm.
- The compaction of the asphalt layers should be to at least 92.5% Maximum Theoretical Relative Density (MTRD) in accordance with OPSS 310.

5.8 TEMPORARY EXCAVATIONS

All temporary excavations should be carried out in accordance with the Occupational Health and Safety Act and Regulations for Construction Projects. Care should be taken to direct surface water away from open excavations.

It is anticipated that shallow open cut excavations to extend to depths of 4 m or less below existing ground surface is required for school, midrise community housing and RCFS building. Deeper excavation depth to as high as 6 m may be required for residential towers with two levels of underground parking. However, it may not be practical for unsupported excavation side slopes to be used in all in the area of tower buildings, particularly given the constraints of the existing bridge structure to the west of the tower buildings and the existing retaining wall to the south of the proposed tower location. Shoring system may be required for deeper excavations if space is limited. Additional recommendations on the type of shoring system will be provided as the design progress and required excavation depths are known.

Based on the boreholes advanced within the site, excavations within the upper 4 m of existing site grades are expected to be within the fill layers or the clay deposit. This material would be classified as Type 3 soils, as defined by the Occupational Health and Safety Act and Regulations for Construction Projects. Provided that appropriate groundwater control is provided to maintain the water level below the base of the excavation, OHSA indicates that temporary excavations made within Type 3 soils should be developed with side slopes no steeper than 1H:1V. Saturated till encountered below the water table would be classified as Type 4 soils unless dewatered prior to excavation. In accordance with the Occupational Health and Safety Act (OHSA), Ontario Regulation 213/91, excavations in Type 4 soils must be sloped no steeper than three horizontal to one vertical (3H:1V) from the bottom of the excavation or a fully-braced, engineered support system must be provided. Based on OHSA requirements, the soil must be classified as the type with highest classification of the types of soils present if an excavation contains more than one soil type (e.g. if both Type 3 and Type 4 soils are present within the excavation, the excavation must be sloped or supported in accordance with the requirements for Type 4 soils).

The stability of the wall of the excavation may be affected by surcharge loads, stockpiles as well as groundwater seepage conditions. Therefore, soils excavated from the trenches and/or construction materials should not be stockpiled adjacent to excavations.

Steeper side slopes would require shoring to meet the requirements of the OHSA. All shoring systems should be designed and approved by a qualified Professional Engineer. Shoring systems are understood to be required for at least portions of the excavations for the high-rise buildings, specially near the existing retaining wall. Both soldier pile and lagging and/or sheet pile wall support systems are considered feasible for use based on the ground conditions present at this site. For each of these systems, some form of lateral support is generally required for excavations that extend to depths of about 3 m or more below ground surface. For the relatively narrow excavations, the lateral restraint could include waler beams with bracing at corner points and/or interior struts connected to the opposite sides of the excavation. Lateral restraint for wider excavations is typically provided by ground (soil or rock) anchors, dead-man anchors or raker footings.

The contractor is fully responsible to select, design and implement a temporary support/shoring system meeting the requirements of OPSS.PROV 539, including establishing suitable geotechnical design parameters for the soil and groundwater conditions at the site. The earth pressure distributions to be used in the design of the shoring system will depend on the lateral support methods used (e.g. cantilever, dead man anchors, rakers, and bracing etc.); appropriate pressure distribution(s) may be selected from Chapter 26 of the Canadian Foundation Engineering Manual.

5.9 GROUNDWATER CONTROL

The groundwater level was recorded at depths ranging from 2.2 m to 4.7 m in the monitoring wells installed at the site. Given the fine-grained nature of the native silty clay soils, the rate of seepage into small and shallow excavations of less than 4.0 m deep developed within the fill material and clay deposit (such as excavations required for the school building, mid-rise building and RCFS facility) may not be significant. As such, it should be possible to effectively handle the groundwater inflows into the excavation by pumping from sumps located within the excavation, provided that the excavations do not remain open beyond 1 to 2 weeks and precipitation does not occur during this period.

More significant groundwater inflows should be expected for deeper excavations, especially the excavations extending below the prevailing groundwater level. Monitoring well installed in borehole BH24-2 indicates upward hydraulic pressure in the bedrock, hence excavation below the water table (i.e., below 4 m) can cause substantial upward groundwater flow at the excavation floor. Therefore, more extensive dewatering systems could be required for such conditions requiring Ministry of the Environment and Climate Change (MOECC) permitting. Additional hydrogeological investigation will be required to estimate the groundwater inflow rate within deeper excavation required for the high-rise buildings once the final basement elevations are confirmed.

The preceding comments are intended for general reference and information only. The Contractor is solely responsible for the design and implementation of any required unwatering and/or dewatering, including requirements for withdrawal, handling, treatment, and discharge.

6.0 CONSTRUCTION CONSIDERATIONS AND CONSTRAINTS

6.1 UNDERFLOOR DRAINAGE

The proposed development is to include a basement level; therefore, it is recommended that both a perimeter drainage and an under-slab drainage system be included in the design. The following is recommended for the underslab drainage system.

- Concrete floor
- Vapour barrier
- 50 mm of compacted OPSS Granular A, as a working surface
- 250 mm of 19 mm clearstone
- 100 mm perforated drains placed up to 6 m apart
- Filtering, non-woven geotextile between the clearstone and the native soil

The underfloor drainage system should be designed to accommodate the highwater levels associated with spring conditions. Unless seasonal water levels are taken, it should be assumed that the water level could be as high as 1 m below ground surface for brief periods of time.

The required capacity of the groundwater handling system will need to be assessed by a hydrogeologist once the final basement elevations are confirmed. Significantly different volumes would be anticipated for a shallower basement floor resting on clay, compared to a deeper basement floor resting on the till. The proposed basement floor level is not known at this time; the required capacity of the groundwater handling system should be estimated based on future hydrogeological assessment

6.2 REUSE OF ON-SITE MATERIALS

The surficial topsoil materials are unsuitable for reuse in any application except for general landscaping purposes.

The fill material is not considered to be suitable for reuse as engineered/structural fill below or adjacent to new foundations. These materials that are free of organic matter and other deleterious materials, may be considered suitable for reuse as trench backfill (outside of foundation areas) or as general site grade fill (i.e. materials used to raise the site grade to the design elevations outside building footprints).

The ability to compact these materials to required levels is dependent on the moisture content of the materials; thus, the amount of re-useable material will be dependent on the natural moisture content, weather conditions and the construction techniques at the time of excavation and placement. Although not expected for this site, any boulders or cobbles with dimensions greater than 150 mm should be removed from these materials prior to placement.

The Champlain Sea clay soils encountered at site are not considered to be suitable for foundation backfill due to its poor free-draining and frost susceptible characteristics. It may, however, be reused as grading fill for landscaped areas if the moisture content permit. These materials could behave like a fluid once excavated/disturbed and could require drying of the soil prior to transport.

6.3 COLD WEATHER CONSTRUCTION

Placement of fill materials in cold weather requires a considerable increase in effort from that required in “better” weather conditions. Additional costs are typically incurred as a result, and general productivity can be expected to suffer. In addition to the prevailing weather conditions, the quantity of fill to be placed, the required lateral extent and thickness, the equipment used for placement and compaction, and the protection methods employed by the contractor, will all have an influence on the success of placing fill in adverse weather conditions.

Notwithstanding the comments provided in the previous sections of this report pertaining to backfilling and engineered fill, when construction is undertaken during periods of inclement weather or when freezing conditions exist, the placement of fill materials for any purpose should consider the comments provided below.

- Foundations/pile caps/slabs shall be constructed on non-frozen ground only, where non-frozen ground includes the material at surface and all underlying soils. The non-frozen nature of the ground must be confirmed by a geotechnical inspection within 1 hour of concrete placement.
- Following construction of foundations/pile caps/slabs, protection measures must be provided to prevent freezing of the foundation subgrade/bearing soils and for protection of the concrete during curing. The protective measures must also keep the subgrade soils beneath the foundations from freezing after the concrete has cured.
- Foundations/pile caps shall be backfilled with free-draining granular material and drainage shall be provided to prevent lifting of the foundations due to adfreeze during the construction period.
- Structural fill shall not be placed on frozen ground and the structural fill materials shall be free of snow and frozen material.

- Overnight frost penetration into the existing sub-grade or the structural fill must be prevented. Alternatively, the frozen fill must be completely removed prior to placing subsequent lifts. Breaking the frost in-situ is not considered acceptable.
- Moisture adjustment of the fill materials (i.e., adding water or allowing fill to dry) is not practical in freezing conditions. Therefore, obtaining the required compaction levels of 100 percent of the materials Standard Proctor maximum dry density for Structural Fill will not be practical if the fill materials are not supplied to the site near their optimum water content for compaction.
- Regular checks of the temperature of the fill should be made. The soil temperature should be greater than +2C to allow for compaction to the specified degree.
- Imported fill should not be stockpiled on site in such a condition where freezing of the material in the stockpile can develop. Direct import, placement, and compaction is recommended.
- Full-time inspection and testing services is required during earthworks in winter conditions.

6.4 CEMENT TYPE AND CORROSION POTENTIAL

Two soil samples, one from each borehole BH 24-2 and BH24-3, were submitted to Paracel Laboratories Ltd. in Ottawa, Ontario for analysis of pH, water soluble sulphate and chloride concentrations, and resistivity. The testing was completed to determine the potential for degradation of the concrete in the presence of soluble sulphates and the potential for corrosion of exposed steel used in foundations and buried infrastructure. The results of the analysis are summarized in Table 5.6 in a preceding section of this report.

The concentration of soluble sulphates provides an indication of the degree of sulphate attack that is expected for concrete in contact with soil and groundwater. The soluble sulphate concentrations for the soil samples tested are 152 and 219 µg/g, respectively. Soluble sulphate concentrations less than 1000 µg/g generally indicate that a low degree of sulphate attack is expected for concrete in contact with soil and groundwater. In addition, the analytical test results were compared to CSA A23.1 Section 9 Table 3 (Additional requirements for concrete subjected to sulphate attack). The sulphate concentrations measured in the tested samples are below the minimum threshold value for the lowest sulphate exposure class of S-3 (Moderate). Therefore, based on the two soil samples tested, when the designer is selecting the exposure class for the structure, the effects of sulphates would not need to be considered.

The final selection of exposure class and corrosion mitigation measures should be a decision of the design engineer who takes into account all design and service considerations including CSA A23.1 Section 4.1.1. (Durability Requirements) .

The pH, resistivity, and chloride concentration provide an indication of the degree of corrosiveness of the sub-surface environment. The soil samples pH values were 7.95 and 7.80. The normal range for soil pH is considered to be between 5.5 to 9.0.

The resistivity of the tested clay and till samples are reported as 24.9 and 17.8 (ohm-m) suggesting a moderate to severe corrosive environment. For preliminary assessment purposes, the test results provided in Table 5.6 may be used to aid in the selection of coatings and corrosion protection systems for buried infrastructure incorporating steel components.

7.0 REFERENCES

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Ontario Ministry of the Environment, Conservation and Park (MECP) Water Well Record database.

8.0 CLOSURE

This report documents work that was performed in accordance with generally accepted professional standards at the time and location in which the services were provided. No other representations, warranties or guarantees are made concerning the accuracy or completeness of the data or conclusions contained within this report, including no assurance that this work has uncovered all potential liabilities associated with the identified property.

This report provides an evaluation of selected geotechnical conditions associated with the identified portion of the property that was assessed at the time the work was conducted and is based on information obtained by and/or provided to Stantec at that time. There are no assurances regarding the accuracy and completeness of this information. All information received from the client or third parties in the preparation of this report has been assumed by Stantec to be correct. Stantec assumes no responsibility for any deficiency or inaccuracy in information received from others.

Conclusions made within this report consist of Stantec's professional opinion as of the time of the writing of this report and are based solely on the scope of work described in the report, the limited data available and the results of the work. They are not a certification of the property's environmental condition. This report should not be construed as legal advice.

This report has been prepared for the exclusive use of the client identified herein and any use by any third party is prohibited. Stantec assumes no responsibility for losses, damages, liabilities, or claims, howsoever arising, from third party use of this report.

Should additional information become available which differs significantly from our understanding of conditions presented in this report, Stantec requests that this information be brought to our attention so that we may reassess the conclusions provided herein.

We trust that the information contained in this report is adequate for your present purposes. If you have any questions about the contents of the report or if we can be of any other assistance, please contact us at your convenience.

APPENDIX A

A.1 STATEMENT OF GENERAL CONDITIONS

STATEMENT OF GENERAL CONDITIONS

USE OF THIS REPORT: This report has been prepared for the sole benefit of the Client or its agent and may not be used by any third party without the express written consent of Stantec Consulting Ltd. and the Client. Any use which a third party makes of this report is the responsibility of such third party.

BASIS OF THE REPORT: The information, opinions, and/or recommendations made in this report are in accordance with Stantec Consulting Ltd.'s present understanding of the site specific project as described by the Client. The applicability of these is restricted to the site conditions encountered at the time of the investigation or study. If the proposed site specific project differs or is modified from what is described in this report or if the site conditions are altered, this report is no longer valid unless Stantec Consulting Ltd. is requested by the Client to review and revise the report to reflect the differing or modified project specifics and/or the altered site conditions.

STANDARD OF CARE: Preparation of this report, and all associated work, was carried out in accordance with the normally accepted standard of care in the state or province of execution for the specific professional service provided to the Client. No other warranty is made.

INTERPRETATION OF SITE CONDITIONS: Soil, rock, or other material descriptions, and statements regarding their condition, made in this report are based on site conditions encountered by Stantec Consulting Ltd. at the time of the work and at the specific testing and/or sampling locations. Classifications and statements of condition have been made in accordance with normally accepted practices which are judgmental in nature; no specific description should be considered exact, but rather reflective of the anticipated material behavior. Extrapolation of in situ conditions can only be made to some limited extent beyond the sampling or test points. The extent depends on variability of the soil, rock and groundwater conditions as influenced by geological processes, construction activity, and site use.

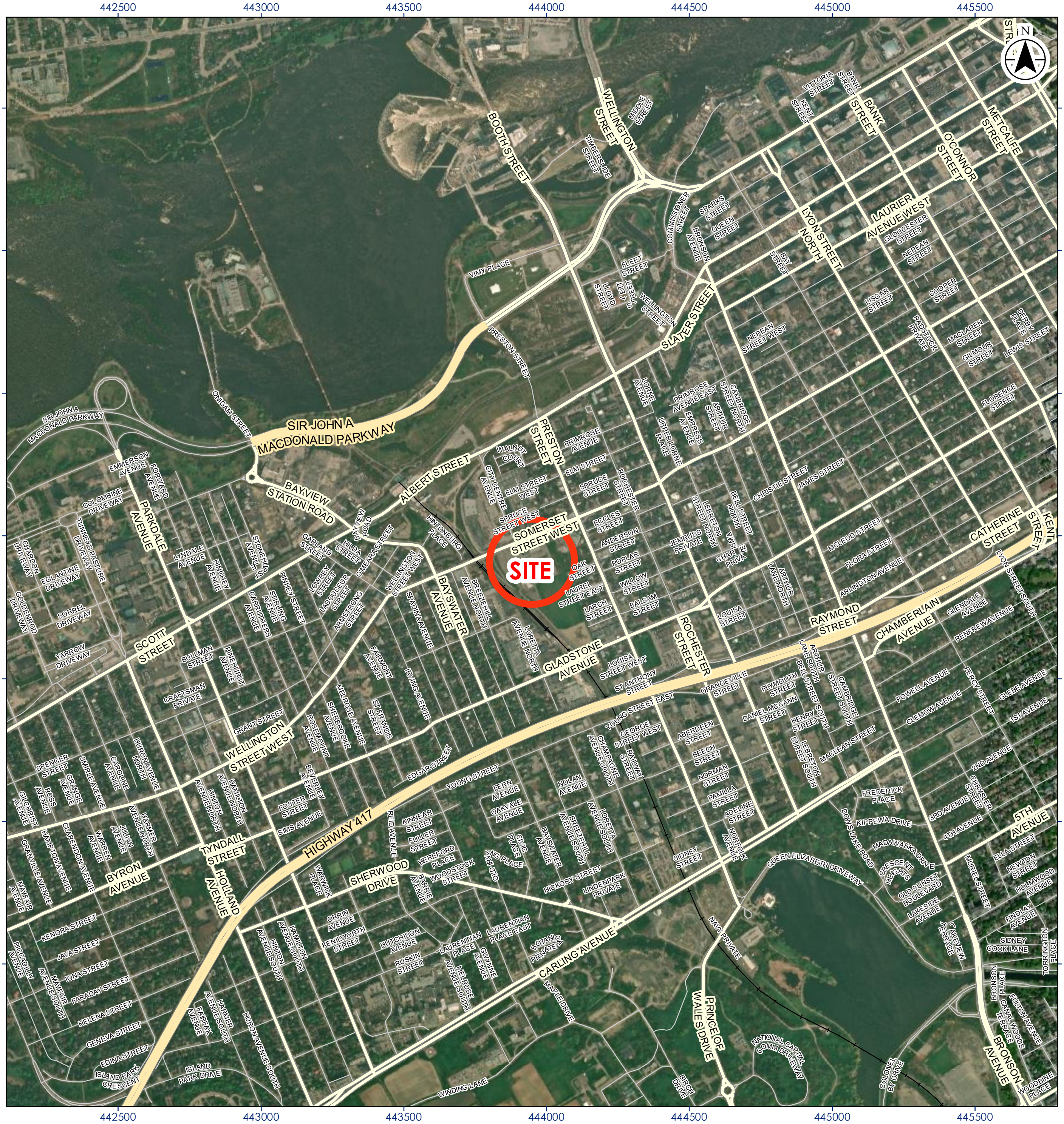
VARYING OR UNEXPECTED CONDITIONS: Should any site or subsurface conditions be encountered that are different from those described in this report or encountered at the test locations, Stantec Consulting Ltd. must be notified immediately to assess if the varying or unexpected conditions are substantial and if reassessments of the report conclusions or recommendations are required. Stantec Consulting Ltd. will not be responsible to any party for damages incurred as a result of failing to notify Stantec Consulting Ltd. that differing site or sub-surface conditions are present upon becoming aware of such conditions.

PLANNING, DESIGN, OR CONSTRUCTION: Development or design plans and specifications should be reviewed by Stantec Consulting Ltd., sufficiently ahead of initiating the next project stage (property acquisition, tender, construction, etc), to confirm that this report completely addresses the elaborated project specifics and that the contents of this report have been properly interpreted. Specialty quality assurance services (field observations and testing) during construction are a necessary part of the evaluation of sub-subsurface conditions and site preparation works. Site work relating to the recommendations included in this report should only be carried out in the presence of a qualified geotechnical engineer; Stantec Consulting Ltd. cannot be responsible for site work carried out without being present.

APPENDIX B

B.1 SITE LOCATION PLAN, BOREHOLE LOCATIONS AND CONCEPTUAL DESIGN DRAWINGS

T:\Autocad\Drawings\Project Drawings\2025\160402067\Site Location Plan\160402067_Site Location Plan.mxd Revised: 2025-01-17 By: gbriones



Legend

- ─┼─ Railway
- ▬ Expressway / Highway
- ═ Major Road
- ─ Minor Road

0 200 400 600 800 metres

1:20,000 (at original document size of 8.5x11)

Stantec

Project Location	Project No. 160402067
1010 Somerset Street Ottawa, Ontario	Prepared by G. Briones on 2025-01-17

Client/Project

CITY OF OTTAWA
GEOTECHNICAL INVESTIGATION

Drawing No.
1

Title
SITE LOCATION PLAN

Notes
1. Coordinate System: NAD 1983 UTM Zone 18N
2. Base features produced under license with the Ontario Ministry of Natural Resources and Forestry © Queen's Printer for Ontario, 2025.
3. Imagery provided by Esri ©2025.

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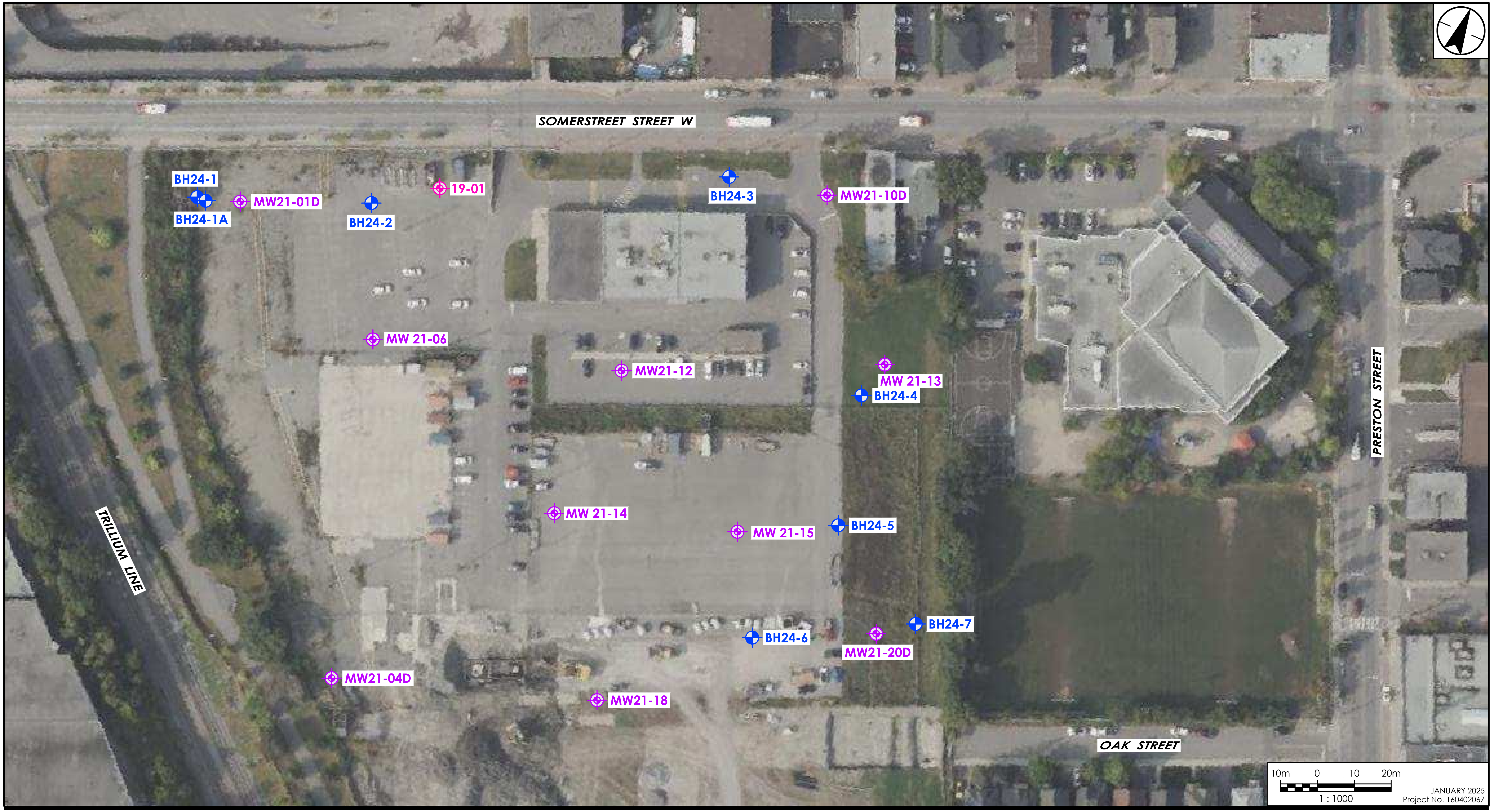
Printed: Jan 31, 2025 By: G. Briones



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LEGEND

- ⊕ BOREHOLE (STANTEC, 2025)
- ⊕ MONITORING WELL (DILLON, 2021)
- ⊕ MONITORING WELL (GOLDER, 2019)

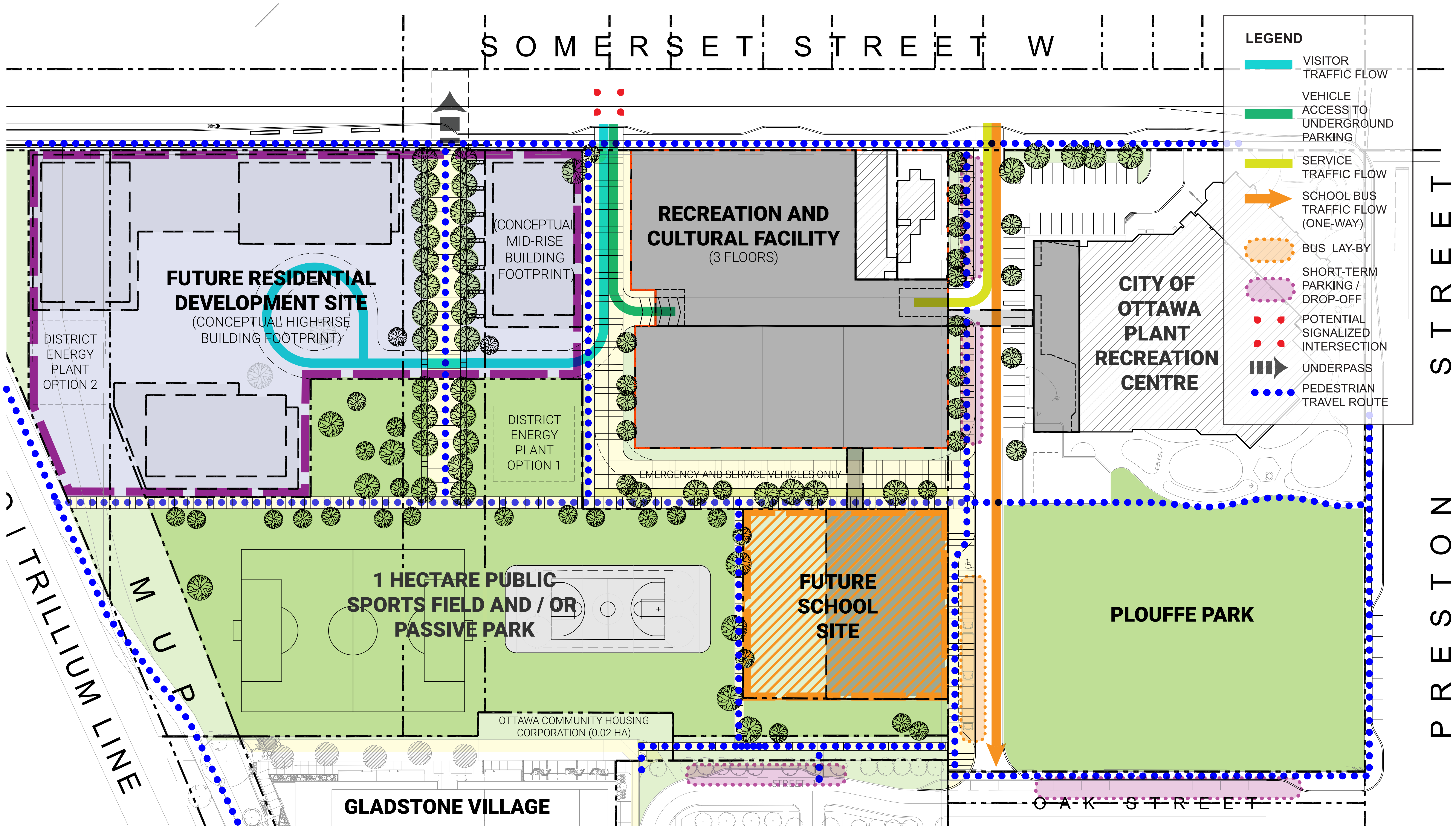
NOTES

1. COORDINATE SYSTEM: NAD 1983 UTM ZONE 18N.
2. IMAGERY:IMAGERY: © 2024 MICROSOFT CORPORATION © 2024 MAXAR © CNES (2024) DISTRIBUTION AIRBUS DS.

Client/Project
CITY OF OTTAWA
GEOTECHNICAL INVESTIGATION
1010 SOMERSET STREET, OTTAWA, ONTARIO

Drawing No.
1

Title
BOREHOLE LOCATION PLAN



HOBIN

1010 SOMERSET

FINAL CONCEPT PLAN

SCALE 1:800

MAY 3, 2024

APPENDIX C

SYMBOLS AND TERMS USED ON BOREHOLE AND TEST PIT RECORDS

SOIL DESCRIPTION

Terminology describing common soil genesis:

Rootmat	- vegetation, roots and moss with organic matter and topsoil typically forming a mattress at the ground surface
Topsoil	- mixture of soil and humus capable of supporting vegetative growth
Peat	- mixture of visible and invisible fragments of decayed organic matter
Till	- unstratified glacial deposit which may range from clay to boulders
Fill	- material below the surface identified as placed by humans (excluding buried services)

Terminology describing soil structure:

Desiccated	- having visible signs of weathering by oxidization of clay minerals, shrinkage cracks, etc.
Fissured	- having cracks, and hence a blocky structure
Varved	- composed of regular alternating layers of silt and clay
Stratified	- composed of alternating successions of different soil types, e.g. silt and sand
Layer	- > 75 mm in thickness
Seam	- 2 mm to 75 mm in thickness
Parting	- < 2 mm in thickness

Terminology describing soil types:
The classification of soil types are made on the basis of grain size and plasticity in accordance with the Unified Soil Classification System (USCS) (ASTM D 2487 or D 2488) which excludes particles larger than 75 mm. For particles larger than 75 mm, and for defining percent clay fraction in hydrometer results, definitions proposed by Canadian Foundation Engineering Manual, 4th Edition are used. The USCS provides a group symbol (e.g. SM) and group name (e.g. silty sand) for identification.

Terminology describing cobbles, boulders, and non-matrix materials (organic matter or debris):
Terminology describing materials outside the USCS, (e.g. particles larger than 75 mm, visible organic matter, and construction debris) is based upon the proportion of these materials present:

Trace, or occasional	Less than 10%
Some	10-20%
Frequent	> 20%

Terminology describing compactness of cohesionless soils:
The standard terminology to describe cohesionless soils includes compactness (formerly "relative density"), as determined by the Standard Penetration Test (SPT) N-Value - also known as N-Index. The SPT N-Value is described further on page 3. A relationship between compactness condition and N-Value is shown in the following table.

Compactness Condition	SPT N-Value
Very Loose	<4
Loose	4-10
Compact	10-30
Dense	30-50
Very Dense	>50

Terminology describing consistency of cohesive soils:
The standard terminology to describe cohesive soils includes the consistency, which is based on undrained shear strength as measured by *in situ* vane tests, penetrometer tests, or unconfined compression tests. Consistency may be crudely estimated from SPT N-Value based on the correlation shown in the following table (Terzaghi and Peck, 1967). The correlation to SPT N-Value is used with caution as it is only very approximate.

Consistency	Undrained Shear Strength		Approximate SPT N-Value
	kips/sq.ft.	kPa	
Very Soft	<0.25	<12.5	<2
Soft	0.25 - 0.5	12.5 - 25	2-4
Firm	0.5 - 1.0	25 - 50	4-8
Stiff	1.0 - 2.0	50 – 100	8-15
Very Stiff	2.0 - 4.0	100 - 200	15-30
Hard	>4.0	>200	>30

ROCK DESCRIPTION

Except where specified below, terminology for describing rock is as defined by the International Society for Rock Mechanics (ISRM) 2007 publication "The Complete ISRM Suggested Methods for Rock Characterization, Testing and Monitoring: 1974-2006"

Terminology describing rock quality:

RQD	Rock Mass Quality
0-25	*Very Poor Quality*
25-50	*Poor Quality*
50-75	*Fair Quality*
75-90	*Good Quality*
90-100	*Excellent Quality*

Alternate (Colloquial) Rock Mass Quality	
Very Severely Fractured	*Crushed*
Severely Fractured	*Shattered or Very Blocky*
Fractured	*Blocky*
Moderately Jointed	*Sound*
Intact	*Very Sound*

RQD (Rock Quality Designation) denotes the percentage of intact and sound rock retrieved from a borehole of any orientation. All pieces of intact and sound rock core equal to or greater than 100 mm (4 in.) long are summed and divided by the total length of the core run. RQD is determined in accordance with ASTM D6032.

SCR (Solid Core Recovery) denotes the percentage of solid core (cylindrical) retrieved from a borehole of any orientation. All pieces of solid (cylindrical) core are summed and divided by the total length of the core run (It excludes all portions of core pieces that are not fully cylindrical as well as crushed or rubble zones).

Fracture Index (FI) is defined as the number of naturally occurring fractures within a given length of core. The Fracture Index is reported as a simple count of natural occurring fractures.

Terminology describing rock with respect to discontinuity and bedding spacing:

Spacing (mm)	Discontinuities	Bedding
>6000	*Extremely Wide*	-
2000-6000	*Very Wide*	*Very Thick*
600-2000	*Wide*	*Thick*
200-600	*Moderate*	*Medium*
60-200	*Close*	*Thin*
20-60	*Very Close*	*Very Thin*
<20	*Extremely Close*	*Laminated*
<6	-	*Thinly Laminated*

Terminology describing rock strength:

Strength Classification	Grade	Unconfined Compressive Strength (MPa)
Extremely Weak	R0	<1
Very Weak	R1	1 – 5
Weak	R2	5 – 25
Medium Strong	R3	25 – 50
Strong	R4	50 – 100
Very Strong	R5	100 – 250
Extremely Strong	R6	>250

Terminology describing rock weathering:

Term	Symbol	Description
Fresh	W1	No visible signs of rock weathering. Slight discoloration along major discontinuities
Slightly	W2	Discoloration indicates weathering of rock on discontinuity surfaces. All the rock material may be discolored.
Moderately	W3	Less than half the rock is decomposed and/or disintegrated into soil.
Highly	W4	More than half the rock is decomposed and/or disintegrated into soil.
Completely	W5	All the rock material is decomposed and/or disintegrated into soil. The original mass structure is still largely intact.
Residual Soil	W6	All the rock converted to soil. Structure and fabric destroyed.

STRATA PLOT

Strata plots symbolize the soil or bedrock description. They are combinations of the following basic symbols. The dimensions within the strata symbols are not indicative of the particle size, layer thickness, etc.

SAMPLE TYPE

SS	Split spoon sample (obtained by performing the Standard Penetration Test)
ST	Shelby tube or thin wall tube
DP	Direct-Push sample (small diameter tube sampler hydraulically advanced)
PS	Piston sample
BS	Bulk sample
HQ, NQ, BQ, etc.	Rock core samples obtained with the use of standard size diamond coring bits.

WATER LEVEL MEASUREMENT

▼	measured in standpipe, piezometer, or well
▽	inferred

RECOVERY

For soil samples, the recovery is recorded as the length of the soil sample recovered. For rock core, recovery is defined as the total cumulative length of all core recovered in the core barrel divided by the length drilled and is recorded as a percentage on a per run basis.

N-VALUE

Numbers in this column are the field results of the Standard Penetration Test: the number of blows of a 140 pound (63.5 kg) hammer falling 30 inches (760 mm), required to drive a 2 inch (50.8 mm) O.D. split spoon sampler one foot (300 mm) into the soil. In accordance with ASTM D1586, the N-Value equals the sum of the number of blows (N) required to drive the sampler over the interval of 6 to 18 in. (150 to 450 mm). However, when a 24 in. (610 mm) sampler is used, the number of blows (N) required to drive the sampler over the interval of 12 to 24 in. (300 to 610 mm) may be reported if this value is lower. For split spoon samples where insufficient penetration was achieved and N-Values cannot be presented, the number of blows are reported over sampler penetration in millimetres (e.g. 50/75). Some design methods make use of N-values corrected for various factors such as overburden pressure, energy ratio, borehole diameter, etc. No corrections have been applied to the N-values presented on the log.

DYNAMIC CONE PENETRATION TEST (DCPT)

Dynamic cone penetration tests are performed using a standard 60 degree apex cone connected to 'A' size drill rods with the same standard fall height and weight as the Standard Penetration Test. The DCPT value is the number of blows of the hammer required to drive the cone one foot (300 mm) into the soil. The DCPT is used as a probe to assess soil variability.

OTHER TESTS

S	Sieve analysis
H	Hydrometer analysis
k	Laboratory permeability
γ	Unit weight
G_s	Specific gravity of soil particles
CD	Consolidated drained triaxial
CU	Consolidated undrained triaxial with pore pressure measurements
UU	Unconsolidated undrained triaxial
DS	Direct Shear
C	Consolidation
Q_u	Unconfined compression
I_p	Point Load Index (I_p on Borehole Record equals $I_p(50)$ in which the index is corrected to a reference diameter of 50 mm)

↧	Single packer permeability test; test interval from depth shown to bottom of borehole
⌶	Double packer permeability test; test interval as indicated
↓	Falling head permeability test using casing
↓	Falling head permeability test using well point or piezometer

BOREHOLE RECORD

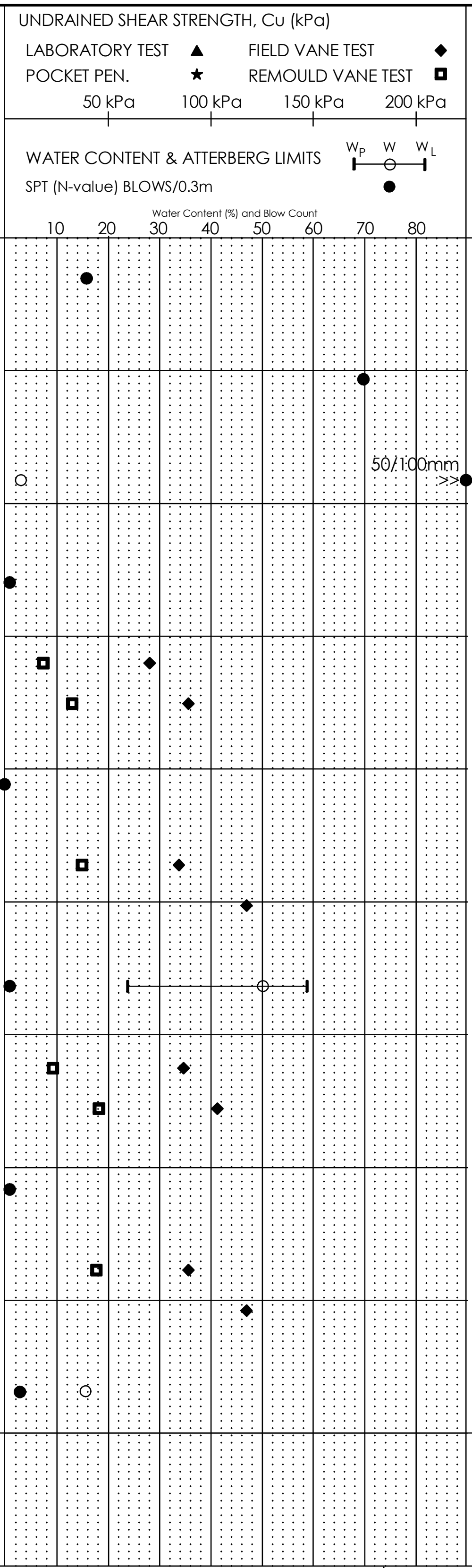
BH24-1

CLIENT: **City of Ottawa**
PROJECT: **1010 Somerset**
LOCATION: **1010 Somerset, Ottawa, ON**
DATE BORED: **10/24/2024**

BH COORDINATES
5028422.7N 443829.0E
WATER LEVEL: **N/A**

PROJECT NO. : **160402067**
BH ELEVATION: **60.52m**
DATUM: **Geodetic**

DEPTH (m)	ELEVATION (m)	SOIL DESCRIPTION (USCS)	TYPE	NUMBER	RECOVERY (mm) or TCR %	N-VALUE or RQD %	OTHER TESTS / REMARKS
0	60.5	FILL: brown silty sand with gravel containing some organics - moist	SS	1	430	16	
	59.9	FILL: light brown sand and gravel containing cobbles and boulders - moist	SS	2	460	70	
			SS	3	480	-	
	58.2	Fim to very stiff grey CLAY (CH) - trace sand - wet - low sensitivity	SS	4	480	1	
			SV	-	-	-	
			SV	-	-	-	
			SS	5	610	0	
			SV	-	-	-	
		* Undrained Shear Strength >118 kPa	SV	-	-	-	
			SS	6	610	1	
			SV	-	-	-	
			SV	-	-	-	
			SS	7	610	1	
			SV	-	-	-	
		* Undrained Shear Strength >118 kPa	SV	-	-	-	
	52.1	Very loose grey silty sand (SM) with clay TILL - trace gravel - wet	SS	8	200	3	Sieve/Hydrometer G 5% S 49% M 31% C 15%
9	51.5	End of Borehole Groundwater was encountered at a depth of 2.3 m in the open borehole					



BACKFILL/ MONITOR WELL/ PIEZOMETER

ELEVATION (m): 60, 59, 58, 57, 56, 55, 54, 53, 52, 51

BACKFILL SYMBOL: ASPHALT, GROUT, CONCRETE, BENTONITE, DRILL CUTTINGS, SAND, SLOUGH

Drilling Contractor: Downing	Logged By: MG
Drilling Method: HSA	Reviewed By: SS
Completion Depth: 9 m	Page 1 of 1

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Printed Feb 5 2025 9:8:5

BOREHOLE RECORD

BH24-1A

Stantec

CLIENT: **City of Ottawa**

PROJECT: **1010 Somerset**

LOCATION: **1010 Somerset, Ottawa, ON**

DATE BORED: **11/08/2024**

BH COORDINATES

5028422.7N 443831.5E

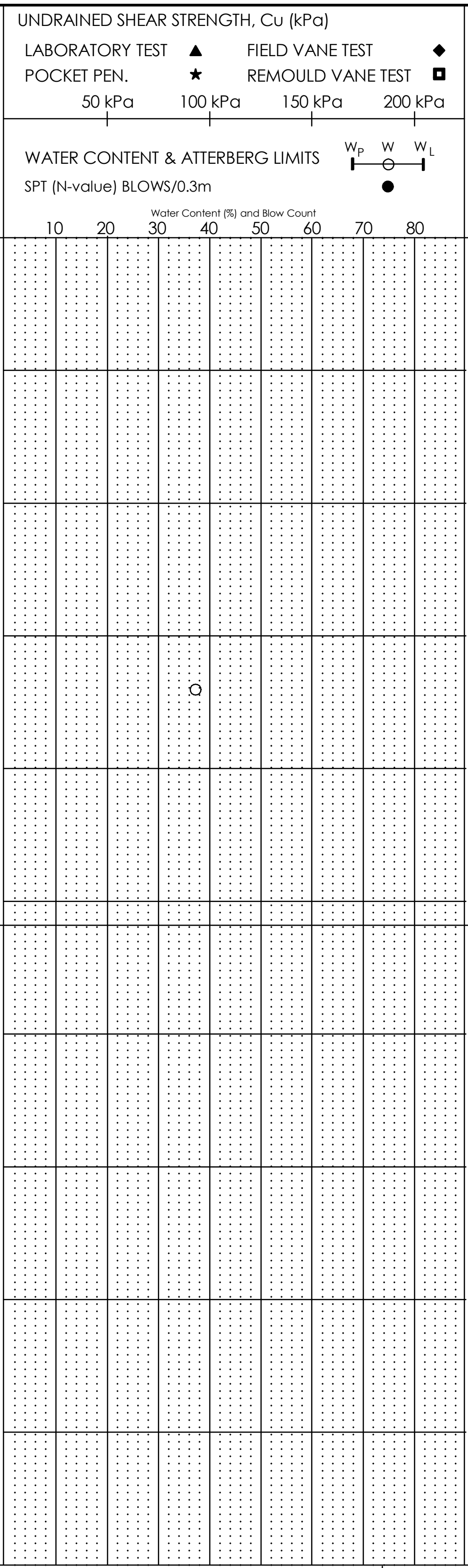
WATER LEVEL: **N/A**

PROJECT NO.: **160402067**

BH ELEVATION: **60.52m**

DATUM: **Geodetic**

DEPTH (m)	ELEVATION (m)	SOIL DESCRIPTION (USCS)	STRATA PLOT	SAMPLES TYPE	SAMPLES NUMBER	RECOVERY (mm) or TCR %	N-VALUE or RQD %	OTHER TESTS / REMARKS
0	60.5	(Stratigraphy inferred from BH24-1) FILL: brown silty sand with gravel containing some organics - moist						
	59.9	FILL: light brown sand and gravel containing cobbles and boulders - moist						
	58.2	Firm to very stiff grey CLAY (CH) - trace sand - wet - low sensitivity						
				ST	1	-	-	
				ST	2	-	-	
	55.3	End of Borehole						



BACKFILL/ MONITOR WELL/ PIEZOMETER

ELEVATION (m): 60, 59, 58, 57, 56, 55, 54, 53, 52, 51

DEPTH (m): 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10

BACKFILL SYMBOL ▨ ASPHALT ▨ GROUT ▨ CONCRETE

■ BENTONITE ☒ DRILL CUTTINGS ▨ SAND ▨ SLOUGH

Drilling Contractor: Downing	Logged By: MG
Drilling Method: HSA	Reviewed By: SS
Completion Depth: 5.18 m	Page 1 of 1

Printed Feb 5 2025 9:8:6 STANTEC GEO 2016 160402067_1010-SOMERSET.GPJ GINT_1233_SOIL_2018_DATA_TEMP_REV2.GDT 2/5/25

Stantec

MONITORING WELL RECORD

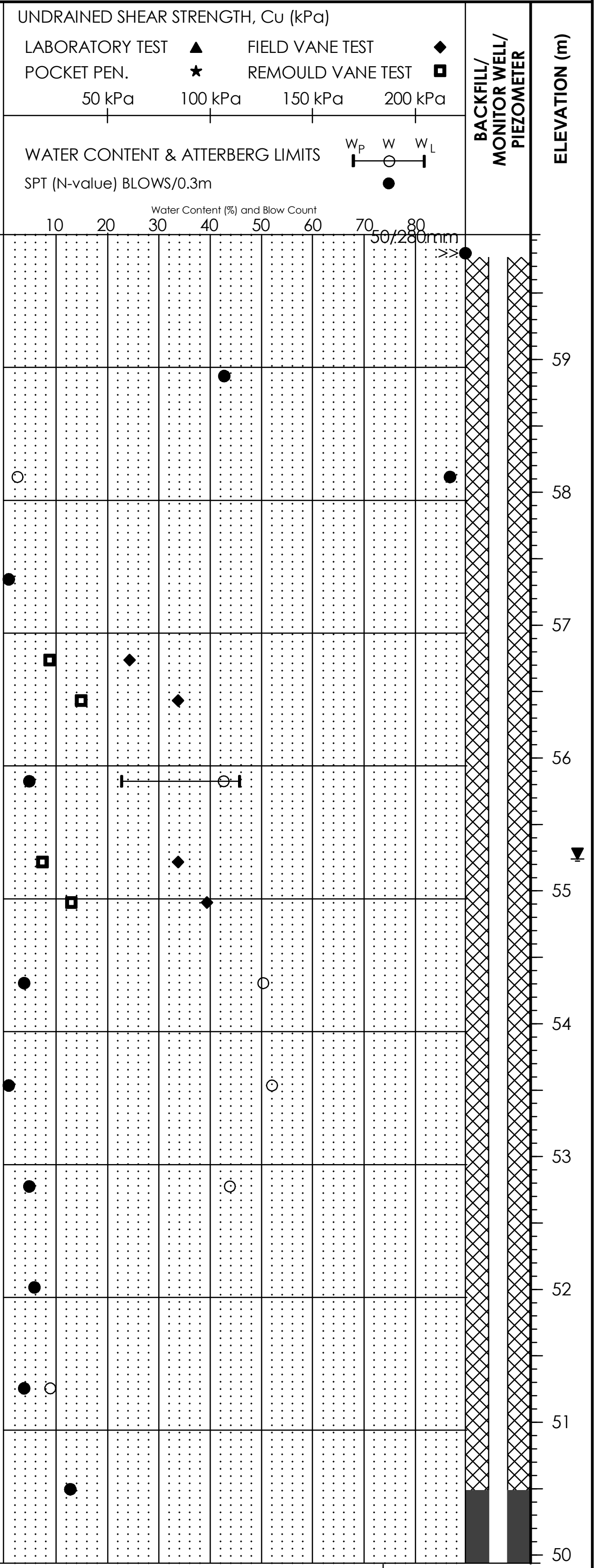
BH24-2

CLIENT: **City of Ottawa**
PROJECT: **1010 Somerset**
LOCATION: **1010 Somerset, Ottawa, ON**
DATE BORED: **10/25/2024**

MW COORDINATES
5028439.7N 443873.0E
WATER LEVEL: **4.7 m on 10/28/2024**

PROJECT NO. : **160402067**
MW ELEVATION: **59.94m**
DATUM: **Geodetic**

DEPTH (m)	ELEVATION (m)	SOIL DESCRIPTION (USCS)	TYPE	NUMBER	RECOVERY (mm) or TCR %	N-VALUE or RQD %	OTHER TESTS / REMARKS
0	59.9 59.8	ASPHALT - 100 mm FILL: brown sand and gravel containing rock fragments	SS	1	180	-	
1			SS	2	380	43	
			SS	3	360	87	Sieve G 47% S 44% Fines 9%
2	57.7	Firm to stiff grey lean CLAY (CL) - wet	SS	4	610	1	
3			SV	-	-	-	
			SV	-	-	-	
4			SS	5	510	5	Sieve/Hydrometer G 0% S 11% M 42% C 47%
			SV	-	-	-	
5			SV	-	-	-	
			SS	6	610	4	
6			SS	7	610	1	
7	53.1	Firm grey sandy clay (CL) with gravel TILL - wet	SS	8	280	5	
8			SS	9	610	6	
	51.6	Loose to compact grey clayey sand (SC) with gravel TILL - wet	SS	10	610	4	
9			SS	11	380	13	
10	50.0						



▼ Water Level Measured On Date Indicated

BACKFILL SYMBOL: ▨ ASPHALT ▨ GROUT ▨ CONCRETE ■ BENTONITE ▨ DRILL CUTTINGS ▨ SAND ▨ SLOUGH

Drilling Contractor: Downing	Logged By: MG
Drilling Method: HSA, HW, HQ	Reviewed By: SS
Completion Depth: 18.11 m	Page 1 of 2

MONITORING WELL RECORD

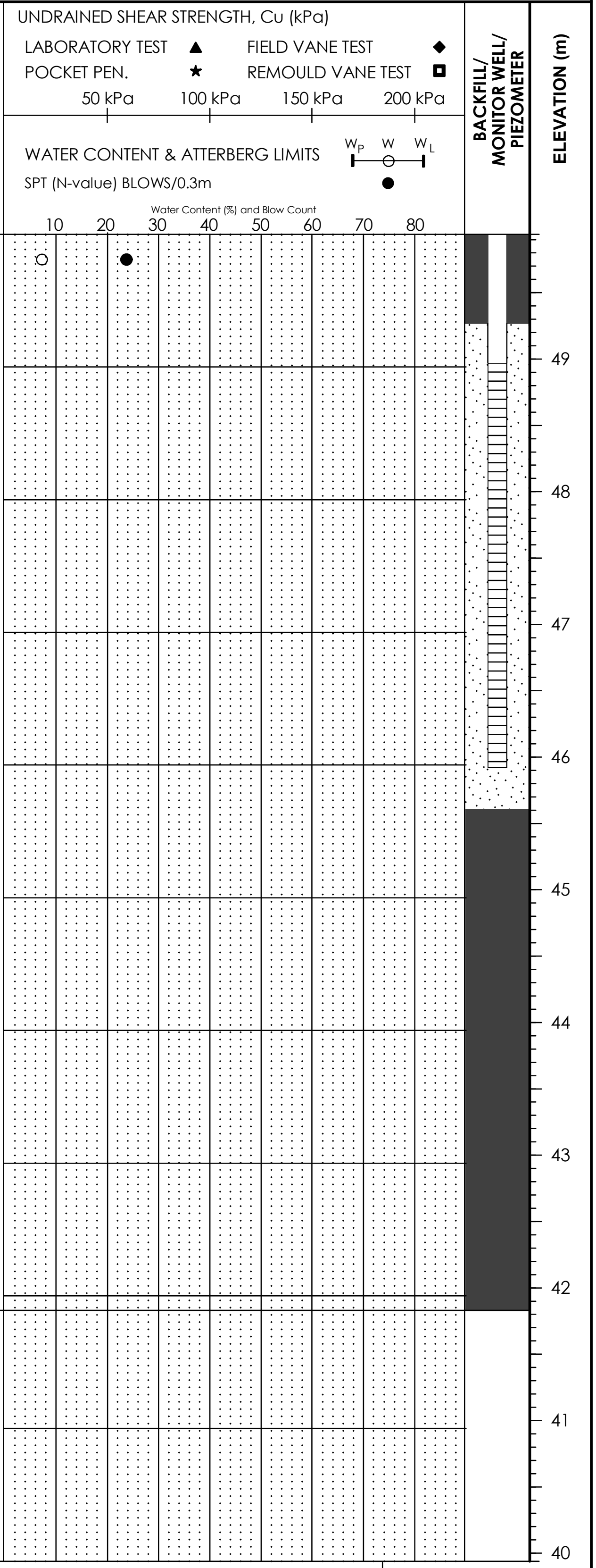
BH24-2

CLIENT: **City of Ottawa**
PROJECT: **1010 Somerset**
LOCATION: **1010 Somerset, Ottawa, ON**
DATE BORED: **10/25/2024**

MW COORDINATES
5028439.7N 443873.0E
WATER LEVEL: **4.7 m on 10/28/2024**

PROJECT NO. : **160402067**
MW ELEVATION: **59.94m**
DATUM: **Geodetic**

DEPTH (m)	ELEVATION (m)	SOIL DESCRIPTION (USCS)	TYPE	NUMBER	RECOVERY (mm) or TCR %	N-VALUE or RQD %	OTHER TESTS / REMARKS
10	49.3	Compact grey silty sand (SM) with gravel TILL - wet - contains cobbles and boulders	SS	12	250	24	
		Poor to excellent quality dark grey LIMESTONE interbedded with black SHALE - slightly weathered to fresh - very strong	HQ	13	54%	33%	
			HQ	14	98%	98%	UCS = 159.2 MPa
			HQ	15	100%	98%	UCS = 110.2 MPa
			HQ	16	98%	93.5%	
	41.8		HQ	17	100%	100%	
18		End of Borehole					



▼ Water Level Measured On Date Indicated

BACKFILL SYMBOL
- ▨ ASPHALT
- ▨ GROUT
- ▨ CONCRETE
- ■ BENTONITE
- ☒ DRILL CUTTINGS
- ▨ SAND
- ▨ SLOUGH

Drilling Contractor: Downing
Drilling Method: HSA, HW, HQ
Completion Depth: 18.11 m

Logged By: MG
Reviewed By: SS

Stantec

BOREHOLE RECORD

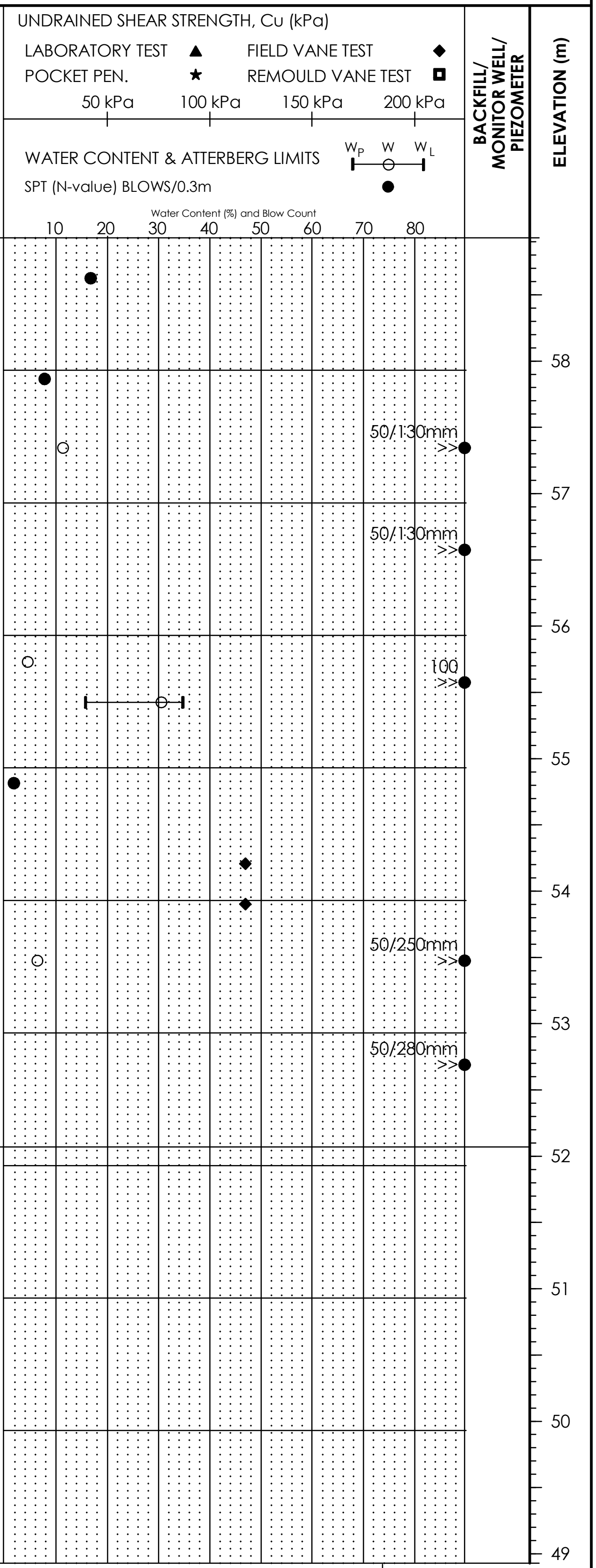
BH24-3

CLIENT: **City of Ottawa**
PROJECT: **1010 Somerset**
LOCATION: **1010 Somerset, Ottawa, ON**
DATE BORED: **10/24/2024**

BH COORDINATES
5028484.1N 443959.3E
WATER LEVEL: **N/A**

PROJECT NO. : **160402067**
BH ELEVATION: **58.93m**
DATUM: **Geodetic**

ELEVATION (m)	SOIL DESCRIPTION (USCS)	TYPE	NUMBER	RECOVERY (mm) or TCR %	N-VALUE or RQD %	OTHER TESTS / REMARKS
58.9						
58.8	ASPHALT - 100 mm					
	FILL: brown silty sand with gravel containing traces of organics - moist	SS	1	305	17	
		SS	2	100	8	
57.4	FILL: brown silty clay with gravel - moist	SS	3	25	-	
56.6	FILL: brown sand with gravel containing cobbles and boulders - moist	SS	4	25	-	
55.6	Stiff to hard grey lean CLAY (CL) with sand - trace gravel - moist	SS	5	430	100	Sieve/Hydrometer G 6% S 16% M 47% C 31%
		SS	6	50	2	
	* Undrained Shear Strength >118 kPa	SV	-	-	-	
	* Undrained Shear Strength >118 kPa	SV	-	-	-	
53.6	Very dense grey clayey sand (SC) with gravel TILL - moist	SS	7	130	-	
52.8	Very dense brown sand (SP) with gravel TILL - trace silt and clay - with occasional to frequent cobbles and boulders - moist	SS	8	305	-	
52.1	End of Borehole Auger Refusal at 6.9 m Groundwater was encountered at a depth of 6.1 m in the open borehole					



BACKFILL SYMBOL ▩ ASPHALT ▨ GROUT ▧ CONCRETE
■ BENTONITE ▨ DRILL CUTTINGS ▨ SAND ▩ SLOUGH

Drilling Contractor: Downing	Logged By: MG
Drilling Method: HSA	Reviewed By: SS
Completion Depth: 6.86 m	Page 1 of 1

BOREHOLE RECORD

Stantec

BH24-4

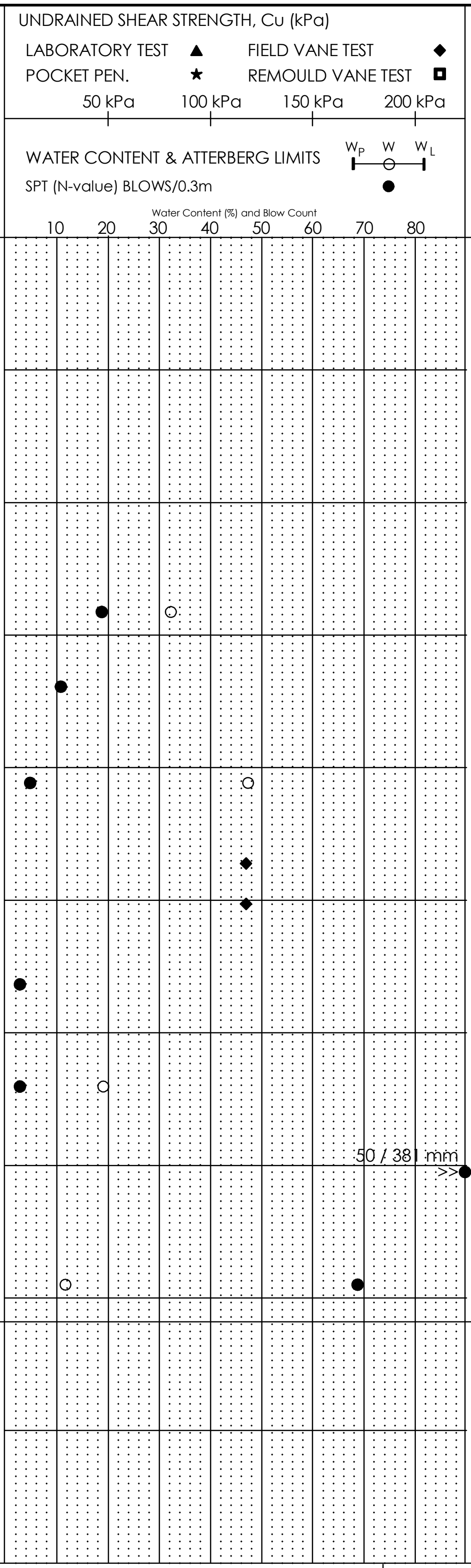
CLIENT: **City of Ottawa**
PROJECT: **1010 Somerset**
LOCATION: **1010 Somerset, Ottawa, ON**
DATE BORED: **11/08/2024**

BH COORDINATES
5028443.7N 444015.4E
WATER LEVEL: **N/A**

PROJECT NO. : **160402067**
BH ELEVATION: **59.41m**
DATUM: **Geodetic**

ELEVATION (m)	SOIL DESCRIPTION (USCS)	TYPE	NUMBER	RECOVERY (mm) or TCR %	N-VALUE or RQD %	OTHER TESTS / REMARKS
59.4 59.3	TOPSOIL - silty sand containing rootlets and organics	GS	1	-	-	
	FILL: grey sandy clay with gravel containing cobbles and boulders - moist	GS	2	-	-	
57.4	Very stiff brown lean CLAY (CL) - weathered crust - moist	SS	3	559	19	
56.3	Firm to very stiff grey lean CLAY to CLAY (CL-CH) - moist	SS	4	508	11	
		SS	5	610	5	
		SV	-	-	-	
		SV	-	-	-	
54.0	Very loose to dense grey sandy silt (ML) with clay TILL - trace gravel - wet	SS	6	152	3	
		SS	7	457	3	Sieve/Hydrometer G 8% S 33% M 47% C 12%
		SS	8	381	50	
51.8	Very dense grey silty sand (SM) with gravel TILL - wet	SS	9	483	69	Sieve G 18% S 57% Fines 25%
51.2	End of Borehole Groundwater was encountered at a depth of 6.8 m in the open borehole					

DEPTH (m): 0 – 10



BACKFILL/ MONITOR WELL/ PIEZOMETER

ELEVATION (m): 59, 58, 57, 56, 55, 54, 53, 52, 51, 50

Drilling Contractor: Downing	Logged By: MG
Drilling Method: HSA	Reviewed By: SS
Completion Depth: 8.18 m	Page 1 of 1

BACKFILL SYMBOL
■ BENTONITE
ASPHALT
☒ DRILL CUTTINGS
GROUT
SAND
CONCRETE
▩ SLOUGH

MONITORING WELL RECORD

BH24-5

CLIENT: **City of Ottawa**

PROJECT: **1010 Somerset**

LOCATION: **1010 Somerset, Ottawa, ON**

DATE BORED: **10/24/2024 to 10/25/2024**

MW COORDINATES

5028408.9N 444023.4E

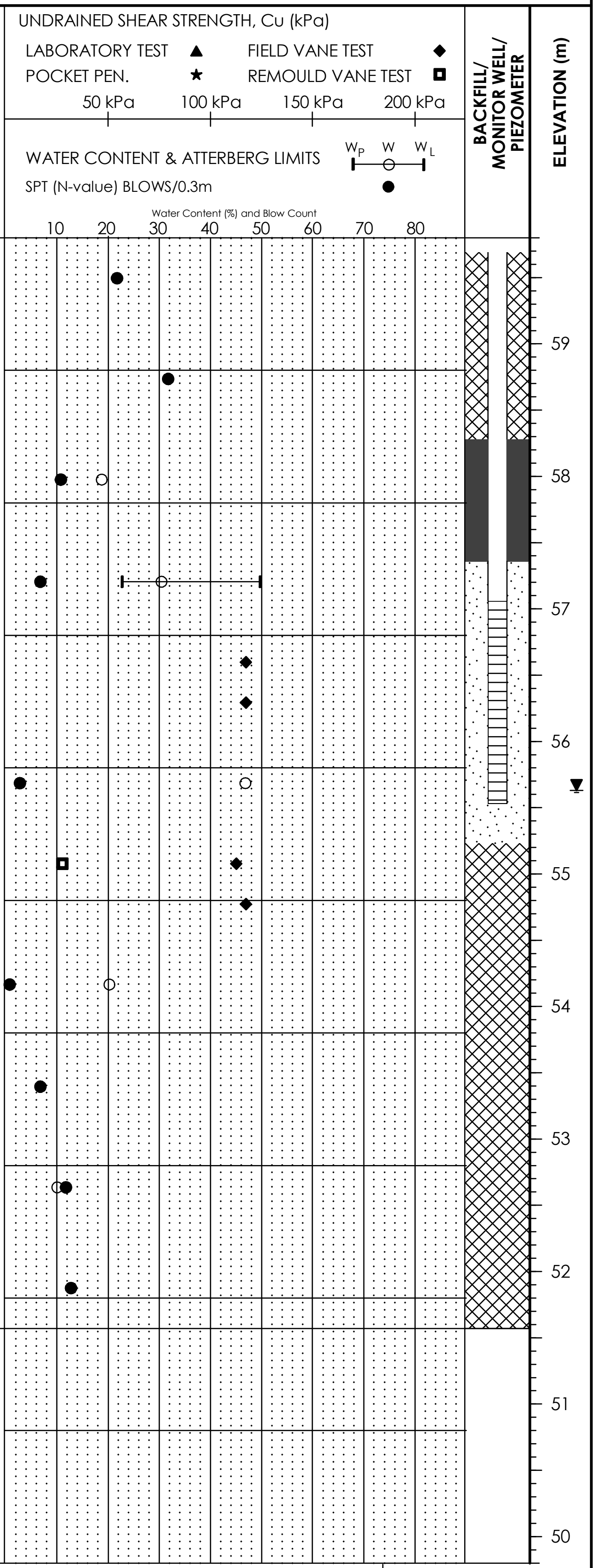
WATER LEVEL: **4.2 m on 10/28/2024**

PROJECT NO. : **160402067**

MW ELEVATION: **59.80m**

DATUM: **Geodetic**

ELEVATION (m)	SOIL DESCRIPTION (USCS)	SAMPLES TYPE	NUMBER	RECOVERY (mm) or TCR %	N-VALUE or RQD %	OTHER TESTS / REMARKS
59.8						
59.7	TOPSOIL - silty sand containing rootlets and organics FILL: grey sand with gravel - moist	SS	1	360	22	
		SS	2	410	32	
58.3	FILL: brown silty sand with gravel - moist	SS	3	360	11	Sieve G 20% S 39% Fines 41%
57.5	Very stiff grey CLAY (CH) - moist	SS	4	610	7	Sieve/Hydrometer G 0% S 10% M 40% C 50%
	* Undrained Shear Strength >118 kPa	SV	-	-	-	
	* Undrained Shear Strength >118 kPa	SV	-	-	-	
		SS	5	610	3	
		SV	-	-	-	
	* Undrained Shear Strength >118 kPa	SV	-	-	-	
54.5	Loose to compact grey silty sand (SM) with gravel TILL - with occasional to frequent cobbles and boulders - trace clay - wet	SS	6	610	1	
		SS	7	560	7	
		SS	8	610	12	Sieve/Hydrometer G 14% S 49% M 28% C 9%
51.6		SS	9	560	13	
	End of Borehole					



▼ Water Level Measured On Date Indicated

BACKFILL SYMBOL ▨ ASPHALT ▨ GROUT ▨ CONCRETE

■ BENTONITE ⊠ DRILL CUTTINGS ⁙ SAND ▩ SLOUGH

Drilling Contractor: Downing	Logged By: MG
Drilling Method: HSA	Reviewed By: SS
Completion Depth: 8.23 m	Page 1 of 1

Stantec

BOREHOLE RECORD

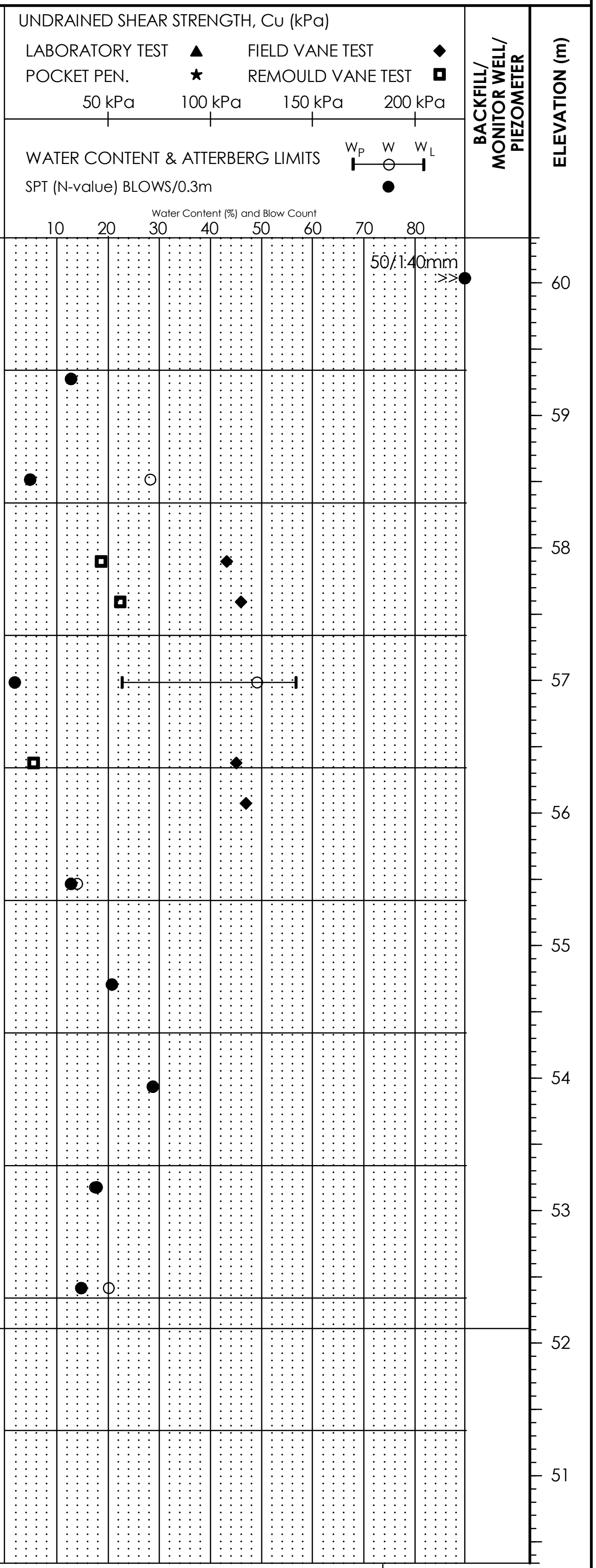
BH24-6

CLIENT: **City of Ottawa**
PROJECT: **1010 Somerset**
LOCATION: **1010 Somerset, Ottawa, ON**
DATE BORED: **10/24/2024**

BH COORDINATES
5028372.5N 444013.9E
WATER LEVEL: **N/A**

PROJECT NO. : **160402067**
BH ELEVATION: **60.34m**
DATUM: **Geodetic**

DEPTH (m)	ELEVATION (m)	SOIL DESCRIPTION (USCS)	STRATA PLOT	SAMPLES TYPE	NUMBER	RECOVERY (mm) or TCR %	N-VALUE or RQD %	OTHER TESTS / REMARKS
0	60.3							
	60.3	ASPHALT - 75 mm						
		FILL: brown sand with gravel - moist		SS	1	50	-	
	59.6	FILL: brown sand with gravel - moist		SS	2	25	13	
	58.8	Stiff to very stiff grey CLAY (CH) - moist - low to medium sensitivity		SS	3	610	5	
				SV	-	-	-	
				SV	-	-	-	
				SS	4	610	2	
				SV	-	-	-	
		* Undrained Shear Strength >118 kPa		SV	-	-	-	
	55.8	Compact grey sandy silt (ML) with clay and gravel TILL - wet		SS	5	280	13	Sieve/Hydrometer G 13% S 24% M 50% C 13%
	55.2	Compact grey clayey sand (SC) with gravel TILL - moist		SS	6	305	21	
	54.1	Compact grey silty sand (SM) TILL - wet		SS	7	410	29	
				SS	8	380	18	
				SS	9	430	15	
	52.1	End of Borehole						
10								



Drilling Contractor: Downing	Logged By: MG
Drilling Method: HSA	Reviewed By: SS
Completion Depth: 8.23 m	Page 1 of 1

BACKFILL SYMBOL
▨ ASPHALT
▨ GROUT
▨ CONCRETE
■ BENTONITE
☒ DRILL CUTTINGS
▨ SAND
▨ SLOUGH

Stantec

BOREHOLE RECORD

BH24-7

CLIENT: **City of Ottawa**

PROJECT: **1010 Somerset**

LOCATION: **1010 Somerset, Ottawa, ON**

DATE BORED: **11/08/2024**

BH COORDINATES

5028397.4N 444039.2E

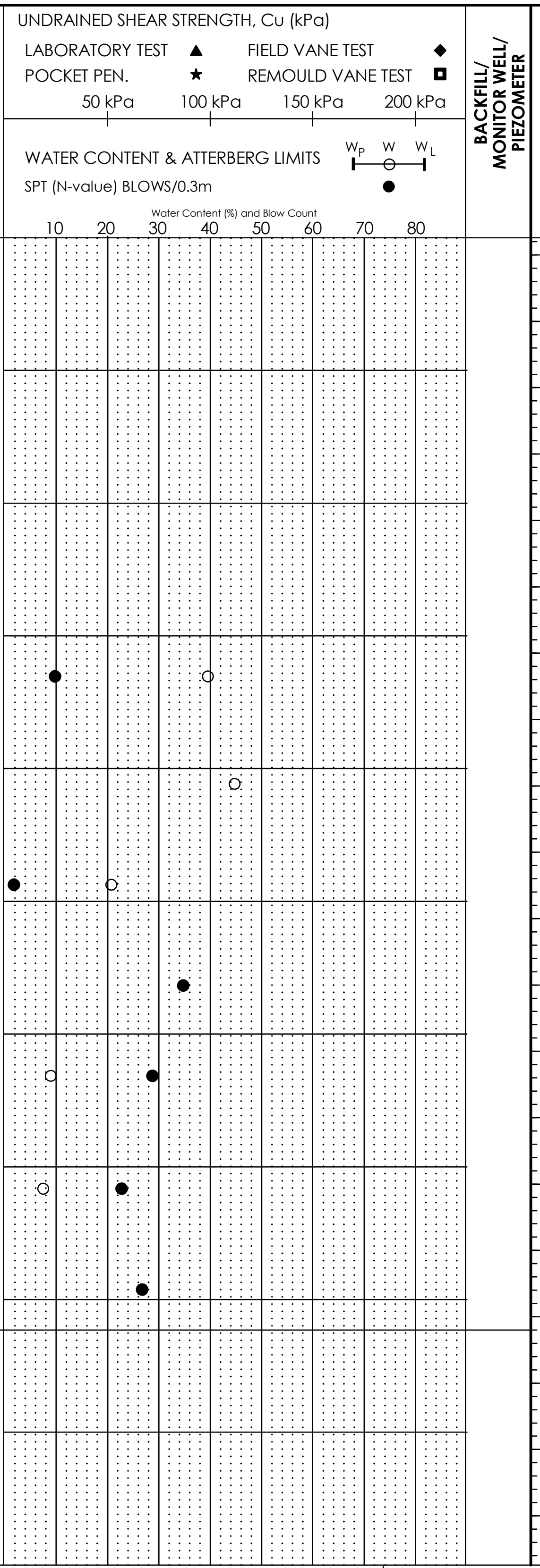
WATER LEVEL: **N/A**

PROJECT NO. : **160402067**

BH ELEVATION: **60.13m**

DATUM: **Geodetic**

DEPTH (m)	ELEVATION (m)	SOIL DESCRIPTION (USCS)	TYPE	NUMBER	RECOVERY (mm) or TCR %	N-VALUE or RQD %	OTHER TESTS / REMARKS
0	60.1						
	60.1	TOPSOIL - silty sand with gravel containing rootlets and organics	GS	1	-	-	
		FILL: brown clayey silty sand with gravel containing cobbles, boulders, and debris of asphalt and concrete - moist - contains cobbles and boulders - contains miscellaneous debris including asphalt and concrete	GS	2	-	-	
	57.5	Stiff brown lean CLAY (CL) - weathered crust - moist	SS	3	610	10	
			ST	4	-	-	
	55.6	Soft grey lean CLAY to Clayey SILT (CL-ML) with gravel - wet	SS	5	483	2	
	54.8	Dense grey silty sand (SM) TILL - trace clay - moist	SS	6	483	35	
	54.1	Compact grey clayey sand (SC) TILL - trace to some gravel - moist to wet	SS	7	381	29	Sieve G 8% S 54% Fines 38%
			SS	8	203	23	Sieve G 18% S 50% Fines 32%
			SS	9	356	27	
	51.9	End of Borehole Groundwater encountered at a depth of 4.6 m in the open borehole					



BACKFILL SYMBOL ▩ ASPHALT ▨ GROUT ▧ CONCRETE

■ BENTONITE ☒ DRILL CUTTINGS ⬚ SAND ▩ SLOUGH

Drilling Contractor: Downing

Drilling Method: HSA

Completion Depth: 8.23 m

Logged By: MG

Reviewed By: SS

Stantec	Project No.: 160402067	Rock Core Photograph
	Project Name: 1010 Somerset	

Rock Core Photo No.: 1	Borehole: BH24-02	Depth: 10.6 m to 12.0 m

Project No.: 160402067

Project Name: 1010 Somerset

Rock Core Photograph

Rock Core Photo No.: 2

Borehole: BH24-02

Depth: 12.0 m to 13.4 m

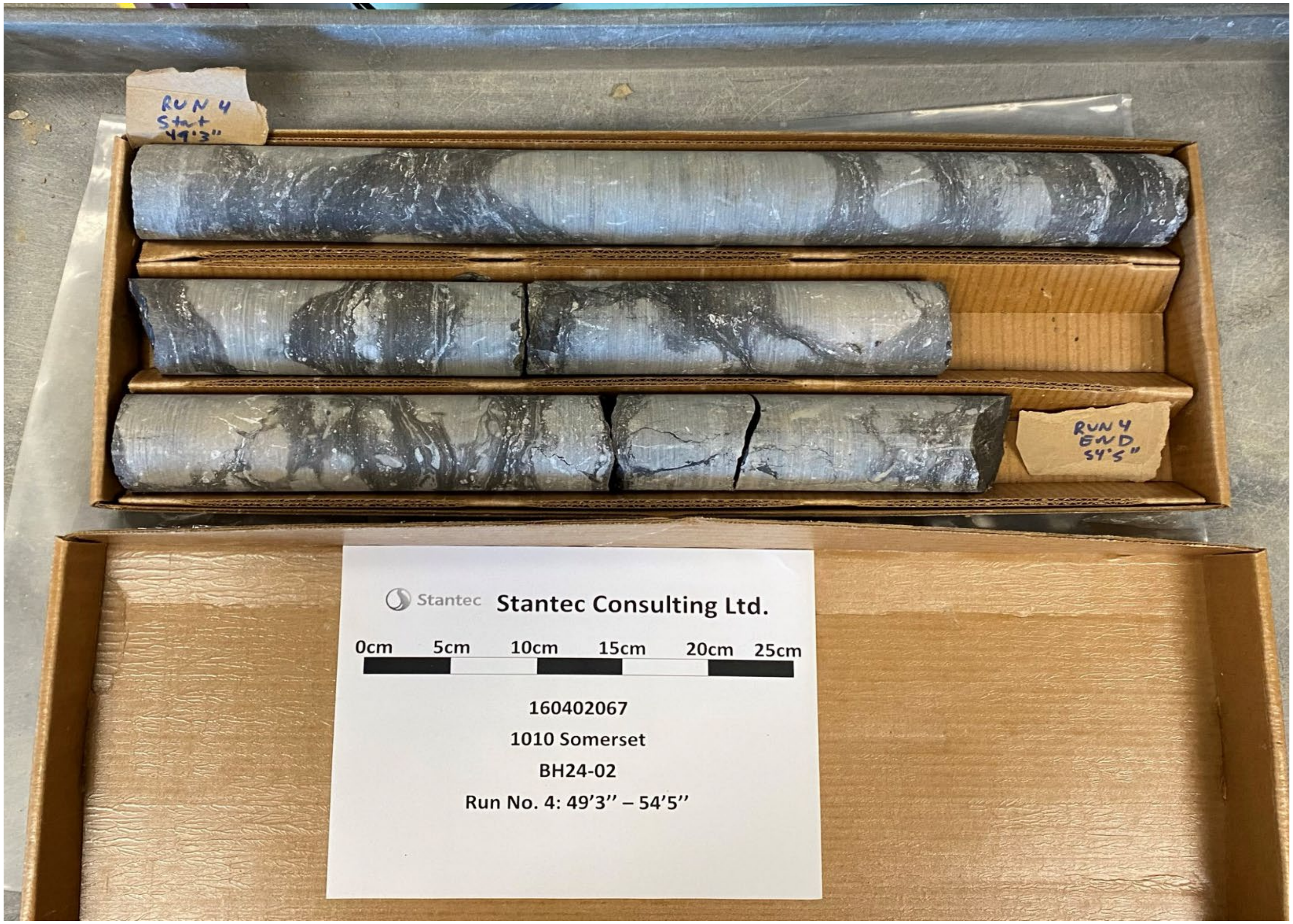
Stantec	Project No.: 160402067 Project Name: 1010 Somerset	Rock Core Photograph

Rock Core Photo No.: 3	Borehole: BH24-02	Depth: 13.4 m to 16.6 m

Project No.: 160402067

Project Name: 1010 Somerset

Rock Core Photograph



Rock Core Photo No.: 4

Borehole: BH24-02

Depth: 15.0 m to 16.6 m

Stantec

Project No.: 160402067

Project Name: 1010 Somerset

Rock Core Photograph

Stantec Stantec Consulting Ltd.

160402067

1010 Somerset

BH24-02

Run No. 5: 54’5’’ – 59’5’’

Rock Core Photo No.: 5

Borehole: BH24-02

Depth: 16.6 m to 18.1 m

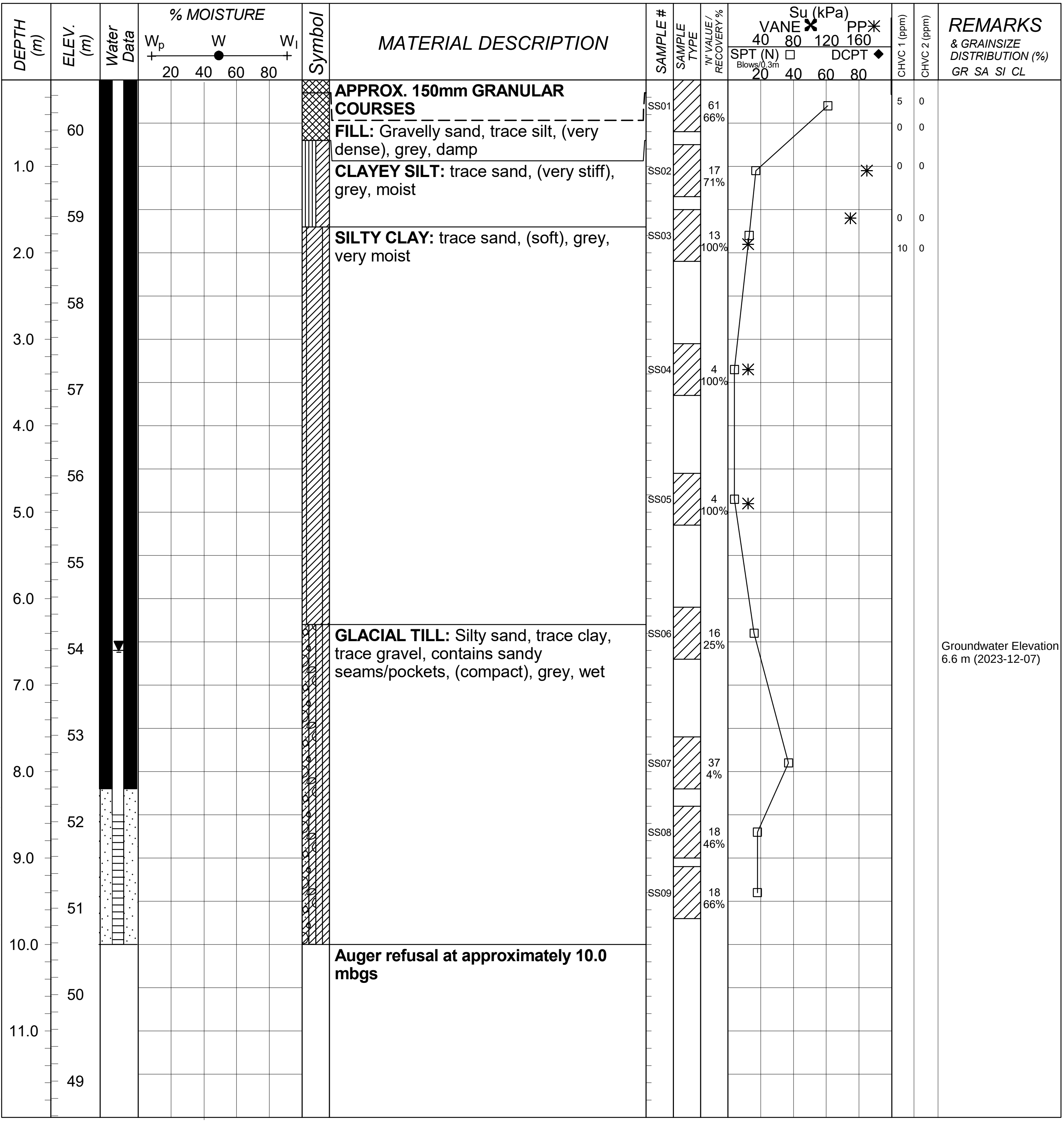
APPENDIX D

BOREHOLE LOGS -PREVIOUS INVESTIGATIONS

LOG OF BOREHOLE MW23-01S

ENGLOBE REF. No.: **02208303**
CLIENT: **FVB Energy**
PROJECT: **Gladstone GHG Neutral District Energy System**
LOCATION: **1010 Somerset Street West**
SURFACE ELEV.: **60.58 metres**
**Elevations are not geodetic, for reference within this report only.*

Drilling Data
METHOD: **150mm Hollow Stem Augers**
START DATE: **2023-11-08**
COMPLETION DATE: **2023-11-08**
COORDINATES: **443861.173** m N, **5028383.908** m E



APPROX. 150mm GRANULAR COURSES

FILL: Gravelly sand, trace silt, (very dense), grey, damp

CLAYEY SILT: trace sand, (very stiff), grey, moist

SILTY CLAY: trace sand, (soft), grey, very moist

GLACIAL TILL: Silty sand, trace clay, trace gravel, contains sandy seams/pockets, (compact), grey, wet

Auger refusal at approximately 10.0 mbgs

SAMPLE #	'N' VALUE / RECOVERY %	CHVC 1 (ppm)	CHVC 2 (ppm)
SS01	61 66%	5	0
		0	0
SS02	17 71%	0	0
		0	0
SS03	13 100%	10	0
SS04	4 100%		
SS05	4 100%		
SS06	16 25%		
SS07	37 4%		
SS08	18 46%		
SS09	18 66%		

Groundwater Elevation 6.6 m (2023-12-07)

BOREHOLE (THUNDER BAY) GEOTECH-ENVIRO-OTTAWA (USE THIS FOR VANE).GPJ DATA TEMPLATE.GDT 24-01-11

ENGLOBE
101-2713 LANCASTER ROAD
OTTAWA, ON, K1B 5R6
PH: 1-877-300-4800
FX: 1-888-979-6772
Web: www.englobecorp.com

SAMPLE TYPE LEGEND

☰ Auger Sample	▩ Rock Core
▨ Split Spoon Sample	▥ Core Sample
┆ Bulk Sample	◫ Shelby Tube

WELL LEGEND

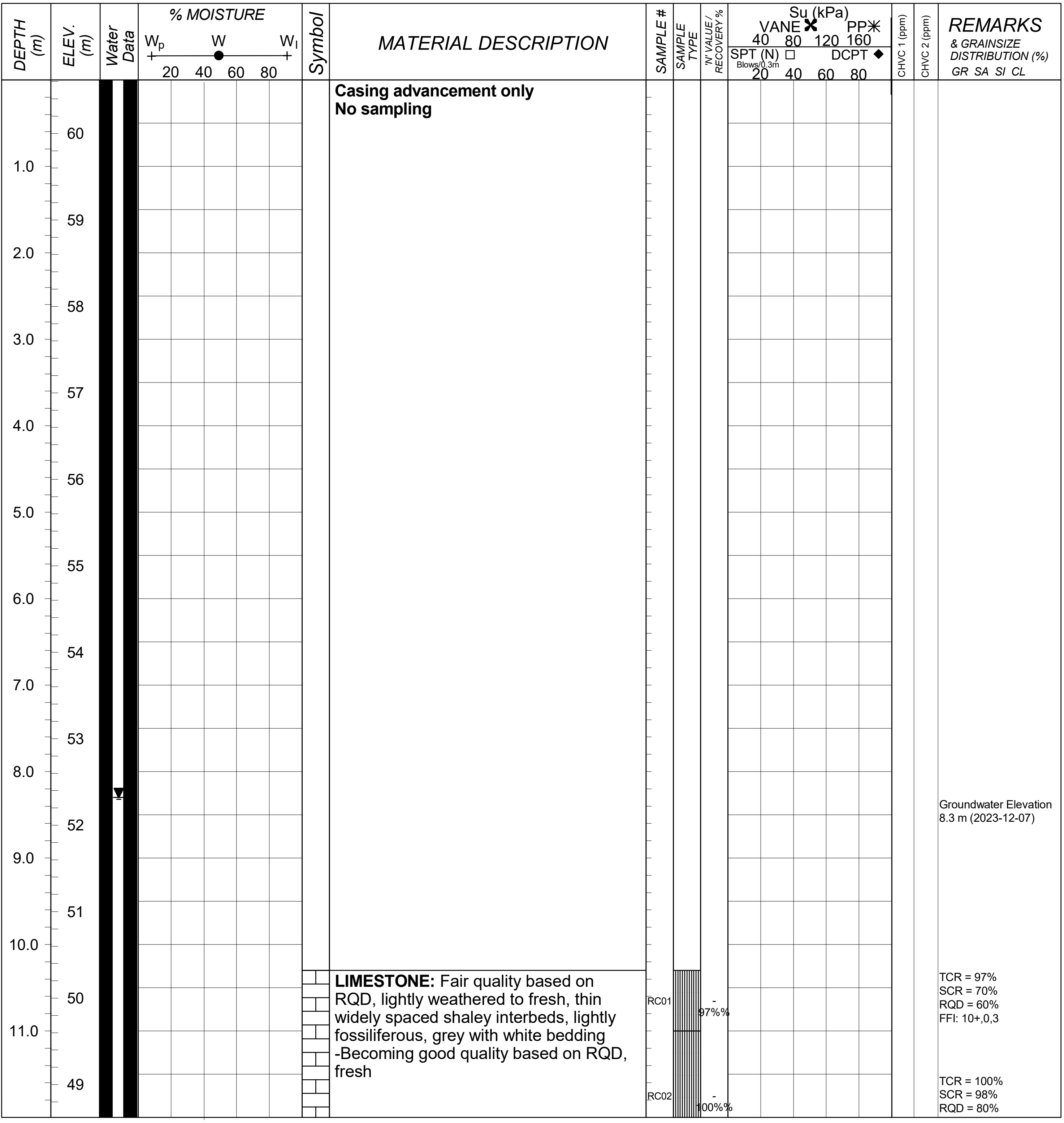
- ■ Bentonite
- ░ Sand
- ▤ Screen

$\times^3$ Numbers refers to Sensitivity
PP: Pocket Penetrometer
CHVC: Combustable Headspace Vapor Concentration
NFP: No Further Penetration

LOG OF BOREHOLE MW23-01D

ENGLOBE REF. No.: **02208303**
CLIENT: **FVB Energy**
PROJECT: **Gladstone GHG Neutral District Energy System**
LOCATION: **1010 Somerset Street West**
SURFACE ELEV.: **60.62 metres**
**Elevations are not geodetic, for reference within this report only.*

Drilling Data
METHOD: **HQ Diamond Core Drilling**
START DATE: **2023-11-08**
COMPLETION DATE: **2023-11-09**
COORDINATES: **443861.234** m N, **5028385.185** m E



Casing advancement only
No sampling

LIMESTONE: Fair quality based on RQD, lightly weathered to fresh, thin widely spaced shaley interbeds, lightly fossiliferous, grey with white bedding
-Becoming good quality based on RQD, fresh

SAMPLE #	'N' VALUE / RECOVERY %	REMARKS
RC01	- 97%%	TCR = 97% SCR = 70% RQD = 60% FFI: 10+,0,3
RC02	- 100%%	TCR = 100% SCR = 98% RQD = 80%

Groundwater Elevation
8.3 m (2023-12-07)

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SAMPLE TYPE LEGEND

- ▤ Auger Sample
- ▨ Split Spoon Sample
- ▥ Bulk Sample
- ▩ Rock Core
- ▥ Core Sample
- ▯ Shelby Tube

WELL LEGEND

- ■ Bentonite
- ▦ Sand
- ▦ Screen

$\times^3$ Numbers refers to Sensitivity
PP: Pocket Penetrometer
CHVC: Combustable Headspace Vapor Concentration
NFP: No Further Penetration

LOG OF BOREHOLE MW23-01D

ENGLOBE REF. No.: **02208303**
CLIENT: **FVB Energy**
PROJECT: **Gladstone GHG Neutral District Energy System**
LOCATION: **1010 Somerset Street West**
SURFACE ELEV.: **60.62 metres**
**Elevations are not geodetic, for reference within this report only.*

Drilling Data
METHOD: **HQ Diamond Core Drilling**
START DATE: **2023-11-08**
COMPLETION DATE: **2023-11-09**
COORDINATES: **443861.234** m N, **5028385.185** m E

DEPTH (m)	ELEV. (m)	MATERIAL DESCRIPTION	SAMPLE #	'N' VALUE / RECOVERY %	REMARKS & GRAINSIZE DISTRIBUTION (%) GR SA SI CL
					FFI: 2,1,4,1,1
	48				
13.0			RC03	- 100%%	TCR = 100% SCR = 92% RQD = 78% FFI: 2,2,2,4,1
	47				
14.0		-Becoming excellent quality based on RQD			
	46		RC04	- 100%%	TCR = 100% SCR = 100% RQD = 100% FFI: 0,0,1,1,1
15.0					
	45				
16.0			RC05	- 100%%	TCR = 100% SCR = 100% RQD = 97% FFI: 0,2,0,0,1
	44				
17.0					
	43		RC06	- 100%%	TCR = 100% SCR = 91% RQD = 86% FFI: 1,1,1,1,1
18.0					
	42				
19.0			RC07	- 100%%	TCR = 100% SCR = 92% RQD = 87% FFI: 0,0,0,1,2
	41				
20.0		-Open joint at approximately 20.1 mbgs: rough/irregular joint face, fresh with no alteration or infill			
	40		RC08	- 98%%	TCR = 98% SCR = 98% RQD = 97% FFI: 1,0,0,1,1
21.0					
	39				
22.0			RC09	- 100%%	TCR = 100% SCR = 100% RQD = 100% FFI: 0,1,0,1,0
	38				
23.0					
	37		RC10	-	TCR = 100% SCR = 100%

Column headings: Water Data; % MOISTURE Wp W Wl 20 40 60 80; Symbol; SAMPLE TYPE; Su (kPa) VANE ✖ PP✳ 40 80 120 160; SPT (N) □ Blows/0.3m DCPT ◆ 20 40 60 80; CHVC 1 (ppm); CHVC 2 (ppm)

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OTTAWA, ON, K1B 5R6
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SAMPLE TYPE LEGEND
- ▤ Auger Sample
- ▨ Split Spoon Sample
- Bulk Sample
- ▩ Rock Core
- ▥ Core Sample
- Shelby Tube

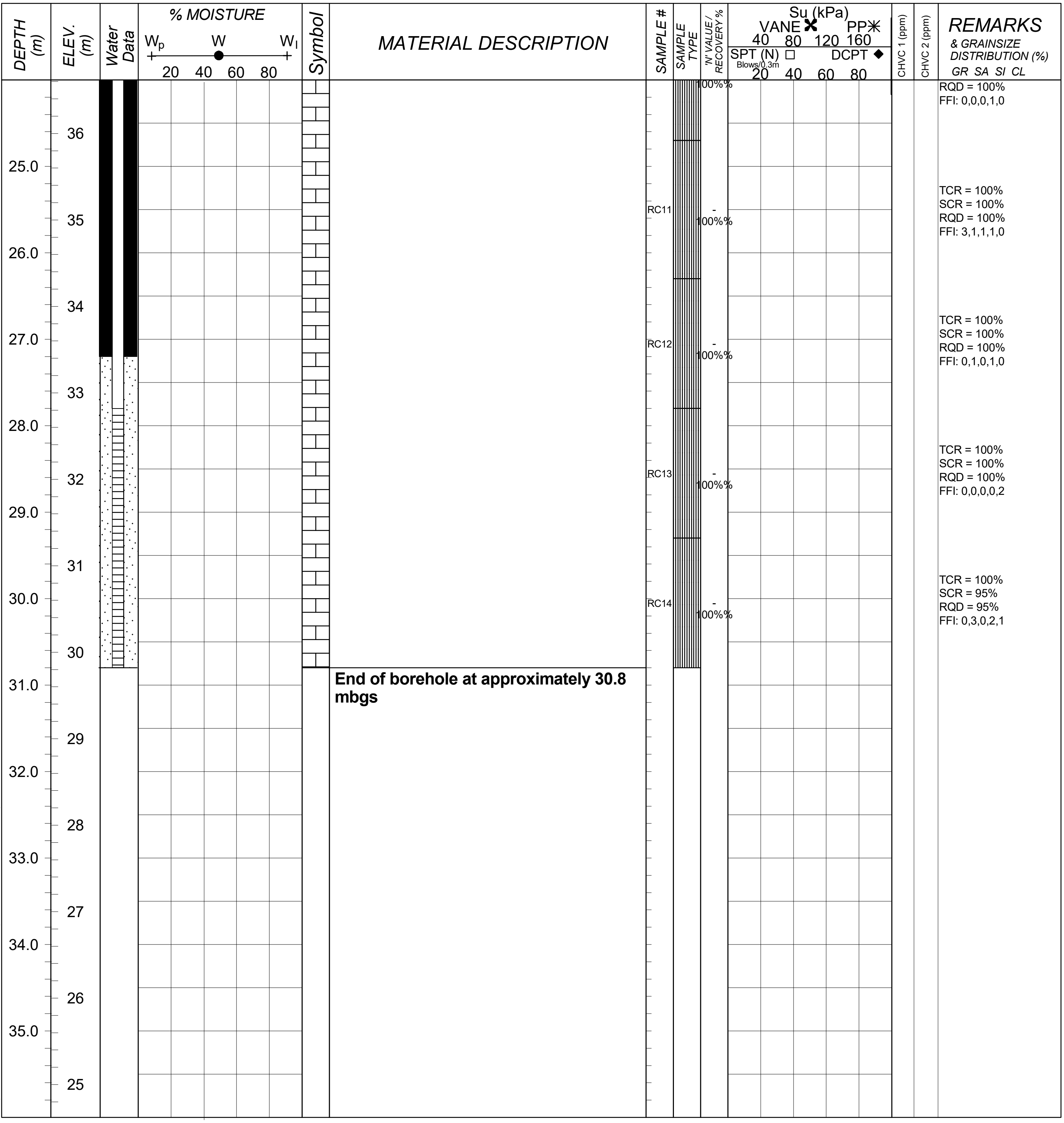
WELL LEGEND
- ■ Bentonite
- Sand
- Screen

✖^{3} Numbers refers to Sensitivity
PP: Pocket Penetrometer
CHVC: Combustable Headspace Vapor Concentration
NFP: No Further Penetration

LOG OF BOREHOLE MW23-01D

ENGLOBE REF. No.: **02208303**
CLIENT: **FVB Energy**
PROJECT: **Gladstone GHG Neutral District Energy System**
LOCATION: **1010 Somerset Street West**
SURFACE ELEV.: **60.62 metres**
**Elevations are not geodetic, for reference within this report only.*

Drilling Data
METHOD: **HQ Diamond Core Drilling**
START DATE: **2023-11-08**
COMPLETION DATE: **2023-11-09**
COORDINATES: **443861.234** m N, **5028385.185** m E



End of borehole at approximately 30.8 mbgs

SAMPLE #	'N' VALUE / RECOVERY %	REMARKS
	100%%	RQD = 100% FFI: 0,0,0,1,0
RC11	- 100%%	TCR = 100% SCR = 100% RQD = 100% FFI: 3,1,1,1,0
RC12	- 100%%	TCR = 100% SCR = 100% RQD = 100% FFI: 0,1,0,1,0
RC13	- 100%%	TCR = 100% SCR = 100% RQD = 100% FFI: 0,0,0,0,2
RC14	- 100%%	TCR = 100% SCR = 95% RQD = 95% FFI: 0,3,0,2,1

ENGLOBE
101-2713 LANCASTER ROAD
OTTAWA, ON, K1B 5R6
PH: 1-877-300-4800
FX: 1-888-979-6772
Web: www.englobecorp.com

SAMPLE TYPE LEGEND

☰	Auger Sample	▩	Rock Core
▨	Split Spoon Sample	▥	Core Sample
▯	Bulk Sample	◫	Shelby Tube

WELL LEGEND

■	Bentonite
⬚	Sand
▦	Screen

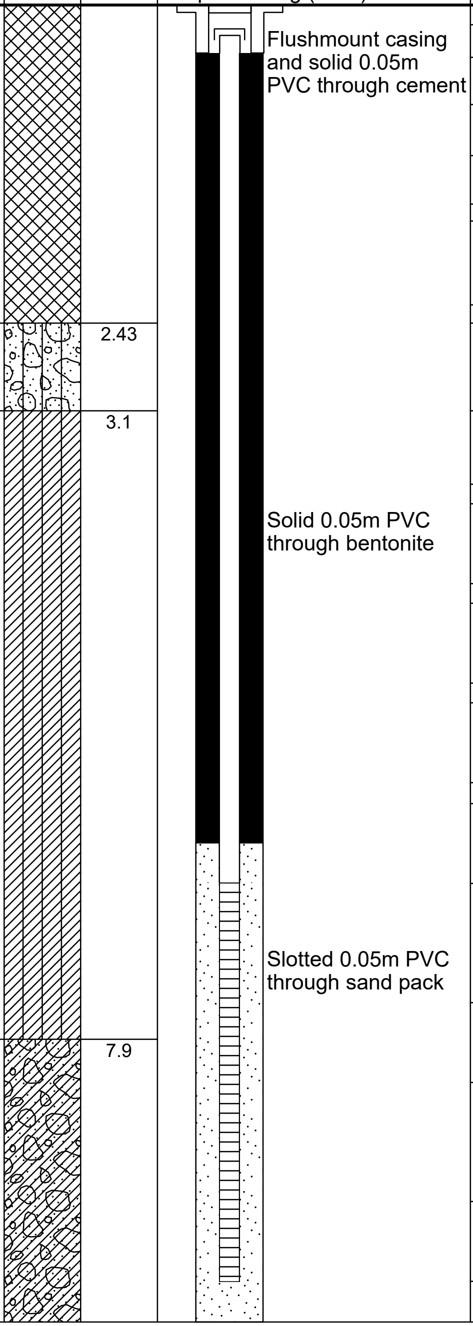
✕³ Numbers refers to Sensitivity
PP: Pocket Penetrometer
CHVC: Combustable Headspace Vapor Concentration
NFP: No Further Penetration

MW21-01S

Client: City of Ottawa
Project No.: 21-2419
Drilling Co.: Aardvark
Supervised by: EB
Project: 1010 Somerset Street West
Location: Ottawa, Ontario
Drilling Method: Auger/ Air Hammer
Date Started: 2021-09-20 Date Completed: 2021-09-20

Surface Elevation (masl): 60.53
Top of casing (masl): 60.44

Depth (m)	Stratigraphic Description
	Fill Dark brown gravelly sand, transitioning to light brown at 0.4m, some pieces of red brick, cinders between 0.15m to 0.4m
2.43	**Gravelly Sandy Clay** Transition between fill and brown grey gravelly sandy clay, damp
3.1	**Silty Clay** Grey silty clay, soft, wet, small pieces of shell (<1mm) from 3.81m to 5.33m
7.9	**Till** Sandy silty till, gravel (2-5cm) throughout
10.06	End of borehole



Method	Number	PID	Rec %
Split Spoon	SS1	---	81
Split Spoon	SS2*	---	65
Split Spoon	SS3	---	21
Split Spoon	SS4	---	69
Split Spoon	SS5	85/3	100
Split Spoon	SS6*	10/1	100
Split Spoon	SS7	0/0	100
Split Spoon	SS8	0/1	100
Split Spoon	SS9	30/3	100
Split Spoon	SS10	---	100
Split Spoon	SS11*	35/1	65

Depth Scale (m): 1.0, 2.0, 3.0, 4.0, 5.0, 6.0, 7.0, 8.0, 9.0, 10.0

m bgs - meters below ground surface
m asl - meters above sea level
* Indicates sample submitted for analysis

LITHOLOGY SYMBOLS: ▨ Fill (made ground); ▨ Silt / Clay; ▨ Silty Sand and Gravel; ▨ Glacial Till

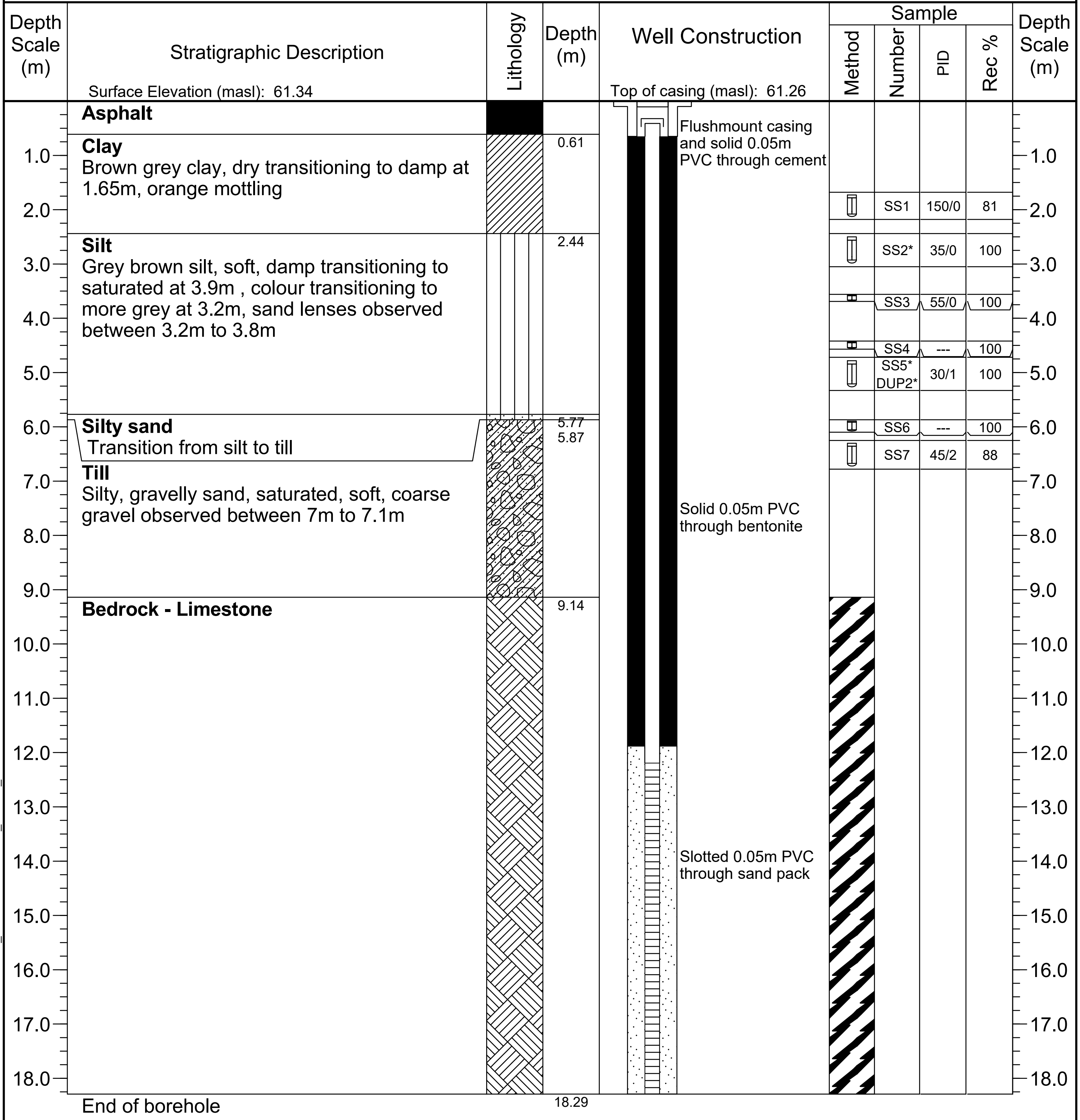
SAMPLE TYPE: ▯ Split Spoon

MW21-04D

Client: City of Ottawa
Project No.: 21-2419
Drilling Co.: Aardvark
Supervised by: EB

Project: 1010 Somerset Street West
Location: Ottawa, Ontario
Drilling Method: Auger/ Air Hammer
Date Started: 2021-09-21 Date Completed: 2021-09-21

Surface Elevation (masl): 61.34
Top of casing (masl): 61.26



Stratigraphic Description	Depth (m)
Asphalt	
Clay Brown grey clay, dry transitioning to damp at 1.65m, orange mottling	0.61
Silt Grey brown silt, soft, damp transitioning to saturated at 3.9m , colour transitioning to more grey at 3.2m, sand lenses observed between 3.2m to 3.8m	2.44
Silty sand Transition from silt to till	5.77
Till Silty, gravelly sand, saturated, soft, coarse gravel observed between 7m to 7.1m	5.87
Bedrock - Limestone	9.14
End of borehole	18.29

Sample Number	PID	Rec %
SS1	150/0	81
SS2*	35/0	100
SS3	55/0	100
SS4	---	100
SS5* DUP2*	30/1	100
SS6	---	100
SS7	45/2	88

m bgs - meters below ground surface
m asl - meters above sea level
* Indicates sample submitted for analysis

LITHOLOGY SYMBOLS
■ Asphalt
▥ Silt
▨ Glacial Till
▨ Clay
▥ Sandy Silt
▨ Bedrock

SAMPLE TYPE
▯ Split Spoon
▰ Air Rotary Drill

DILLON MW 212419 - 1010 SOMERSET_REV2.GPJ DILLON_MAY13_05.GDT 21-12-13

MW21-04S

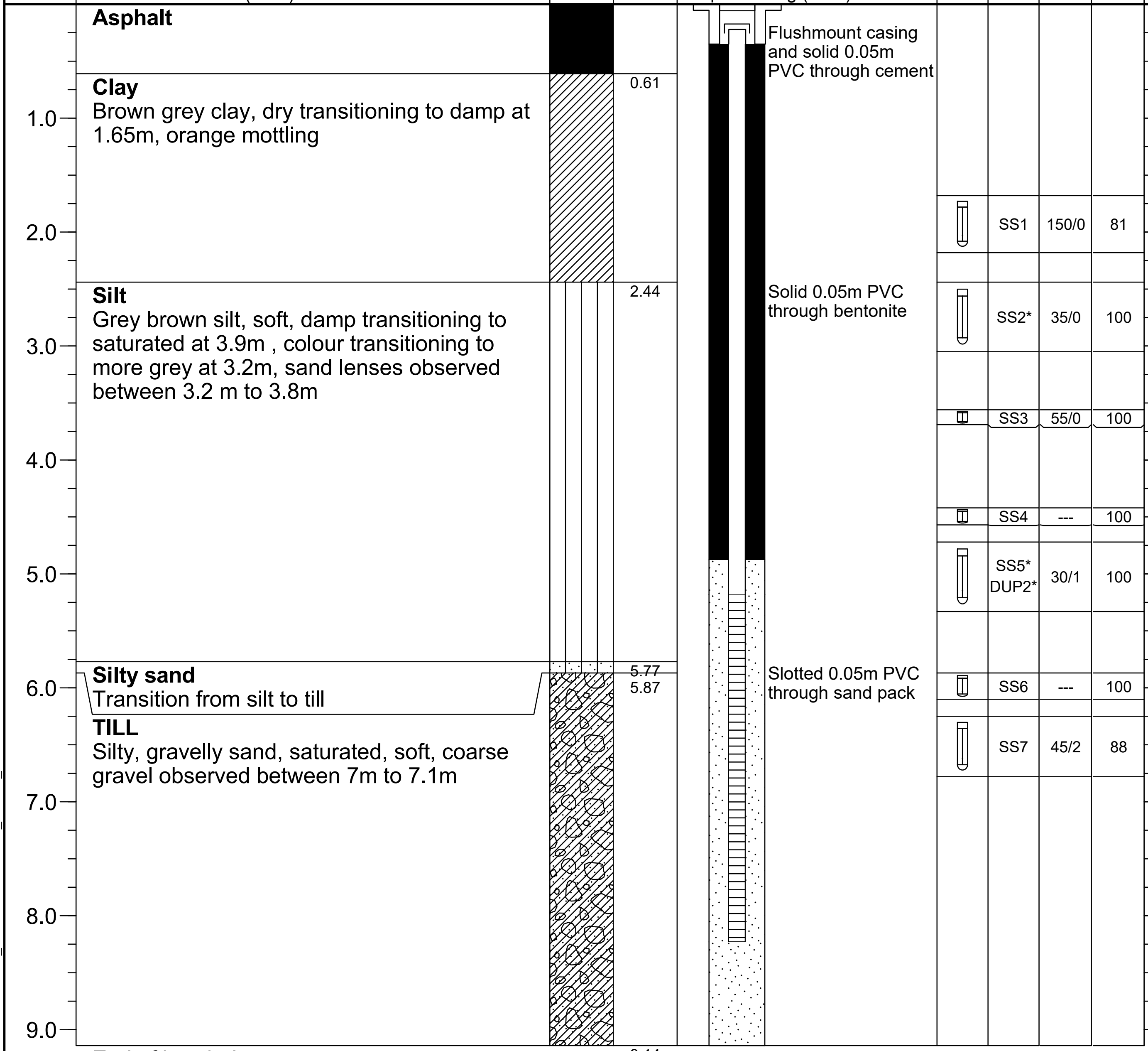
Client: City of Ottawa
Project No.: 21-2419
Drilling Co.: Aardvark
Supervised by: EB

Project: 1010 Somerset Street West
Location: Ottawa, Ontario
Drilling Method: Auger/ Air Hammer
Date Started: 2021-09-21 Date Completed: 2021-09-21

Surface Elevation (masl): 61.28

Top of casing (masl): 61.14

Depth (m)	Stratigraphic Description
	Asphalt
0.61	**Clay** Brown grey clay, dry transitioning to damp at 1.65m, orange mottling
2.44	**Silt** Grey brown silt, soft, damp transitioning to saturated at 3.9m , colour transitioning to more grey at 3.2m, sand lenses observed between 3.2 m to 3.8m
5.77 5.87	**Silty sand** Transition from silt to till **TILL** Silty, gravelly sand, saturated, soft, coarse gravel observed between 7m to 7.1m
9.14	End of borehole



Flushmount casing and solid 0.05m PVC through cement

Solid 0.05m PVC through bentonite

Slotted 0.05m PVC through sand pack

Method	Number	PID	Rec %
Split Spoon	SS1	150/0	81
Split Spoon	SS2*	35/0	100
Split Spoon	SS3	55/0	100
Split Spoon	SS4	---	100
Split Spoon	SS5* DUP2*	30/1	100
Split Spoon	SS6	---	100
Split Spoon	SS7	45/2	88

m bgs - meters below ground surface
m asl - meters above sea level
* Indicates sample submitted for analysis

LITHOLOGY SYMBOLS
- ■ Asphalt
- ▨ Clay
- ▥ Silt
- ⁞ Sandy Silt
- ▩ Glacial Till

SAMPLE TYPE
- ▯ Split Spoon

DILLON CONSULTING

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BH21-05

Client: City of Ottawa
Project No.: 21-2419
Drilling Co.: Aardvark
Supervised by: EB

Project: 1010 Somerset Street West
Location: Ottawa, Ontario
Drilling Method: Auger/ Air Hammer
Date Started: 2021-09-21 Date Completed: 2021-09-21

Depth Scale (m)	Stratigraphic Description Surface Elevation (masl): 59.91	Lithology	Depth (m)	Well Construction	Sample Method	Sample Number	Sample PID	Sample Rec %	Depth Scale (m)
	Asphalt	■							
	Fill Gravel	▩	0.1		▯	SS1	0/2	69	
	Fill Light-dark brown sand, dry, granite/feldspar pieces (~4cm) starting at 0.75m	▩	0.2		▯	SS2*	---	58	
1.0	**Clay** Brown-grey clay, orange mottling, dry, transition to damp at 3.0m, some sand at 3.0m	▨	1.04		▯	SS3	60/0	100	1.0
2.0 3.0 4.0	**Silty clay** Dark grey silty clay, damp transition to wet at 2.3m and saturated at 3.0m. Small shells (1 cm) observed at 3.8m	▥	1.8		▯ ▯ ▯	SS4* SS5 SS6	30/0 80/7 40/4	100 100 100	2.0 3.0 4.0
	End of borehole		4.32						

DILLON MW 212419 - 1010 SOMERSET_REV2.GPJ DILLON_MAY13_05.GDT 21-12-13

m bgs - meters below ground surface
m asl - meters above sea level
* Indicates sample submitted for analysis

LITHOLOGY SYMBOLS
■ Asphalt
▨ Clay
▩ Fill (made ground)
▥ Silt / Clay

SAMPLE TYPE
▯ Split Spoon

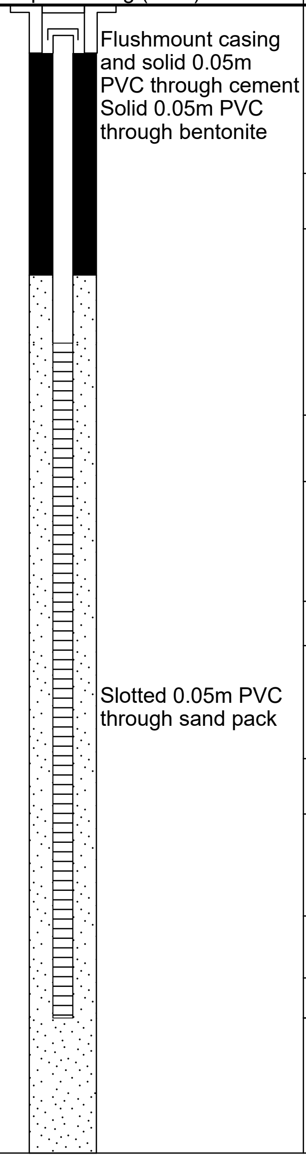
MW21-06

Client: City of Ottawa
Project No.: 21-2419
Drilling Co.: Aardvark
Supervised by: EB

Project: 1010 Somerset Street West
Location: Ottawa, Ontario
Drilling Method: Auger/ Air Hammer
Date Started: 2021-09-21 Date Completed: 2021-09-21

Surface Elevation (masl): 59.99
Top of casing (masl): 59.85

Depth (m)	Stratigraphic Description	Lithology
0.00	**Silty clay** Soft, moist, some orange sand	▨
1.37	**Silt** Brown silt, soft, damp, orange coloured sand, small shells, transition to grey and wet at 2.3m	▥
3.05	**Silty clay** Grey, soft, saturated, small pieces of shell (~1mm)	▨
4.57	**Clayey silt** Grey, soft, no pieces of shell	▨
5.18	End of borehole	



Method	Number	PID	Rec %
Split Spoon	SS1*	---	42
Split Spoon	SS2	90/0	100
Split Spoon	SS3	45/0	100
Split Spoon	SS4	45/1	100
Split Spoon	SS5*	55/1	100
	SS6	25/0	100

m bgs - meters below ground surface
m asl - meters above sea level
* Indicates sample submitted for analysis

LITHOLOGY SYMBOLS: ▨ Silt / Clay ▥ Silt

SAMPLE TYPE: Split Spoon

DILLON CONSULTING

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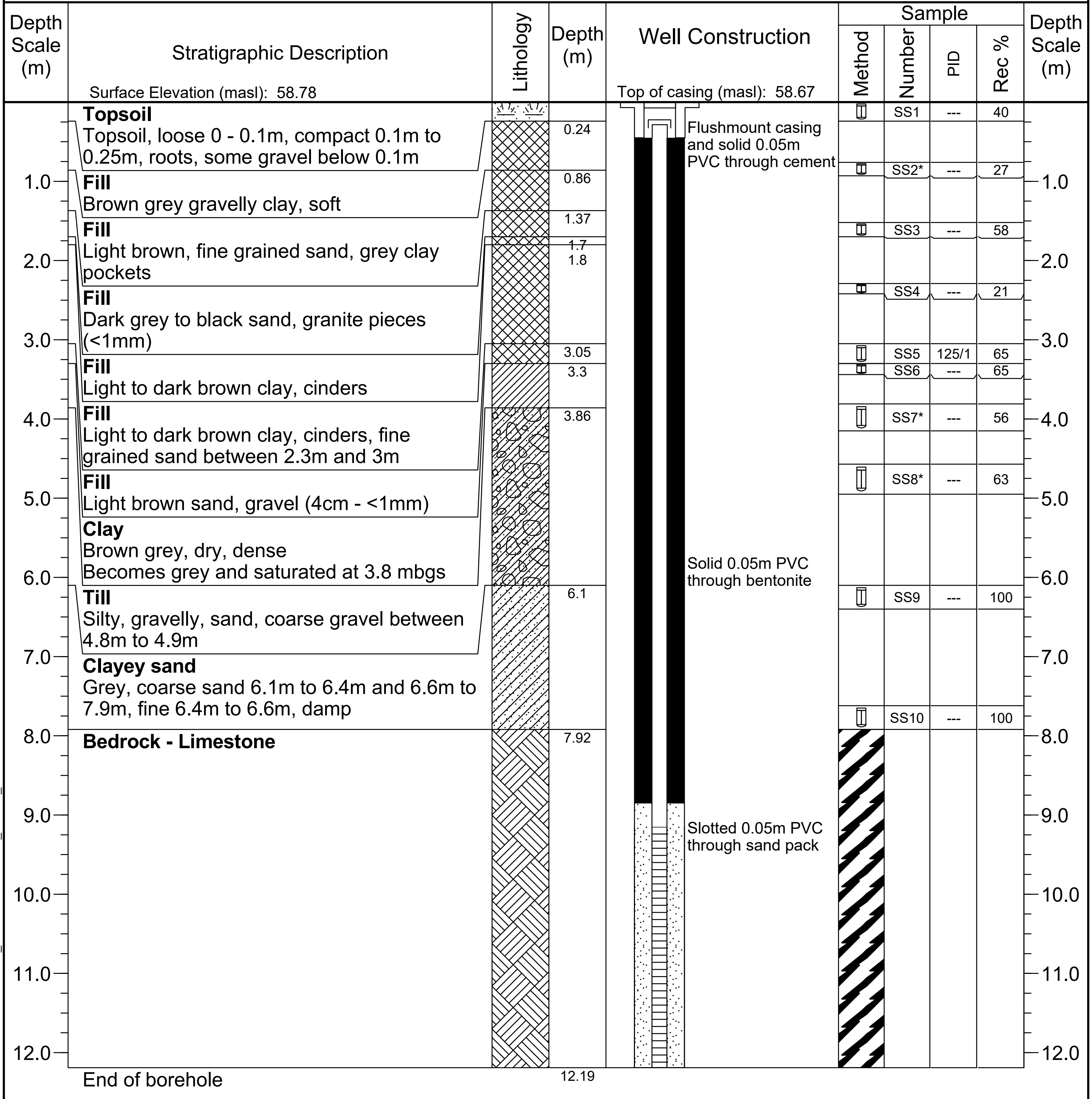
MW21-10D

Client: City of Ottawa
Project No.: 21-2419
Drilling Co.: Aardvark
Supervised by: EB

Project: 1010 Somerset Street West
Location: Ottawa, Ontario
Drilling Method: Auger/ Air Hammer
Date Started: 2021-09-24 Date Completed: 2021-09-24



Surface Elevation (masl): 58.78

Top of casing (masl): 58.67

Depth (m)	Stratigraphic Description
	Topsoil Topsoil, loose 0 - 0.1m, compact 0.1m to 0.25m, roots, some gravel below 0.1m
0.24	**Fill** Brown grey gravelly clay, soft
0.86	**Fill** Light brown, fine grained sand, grey clay pockets
1.37	**Fill** Dark grey to black sand, granite pieces (<1mm)
1.7	**Fill** Light to dark brown clay, cinders
1.8	**Fill** Light to dark brown clay, cinders, fine grained sand between 2.3m and 3m
3.05	**Fill** Light brown sand, gravel (4cm - <1mm)
3.3	**Clay** Brown grey, dry, dense Becomes grey and saturated at 3.8 mbgs
3.86	**Till** Silty, gravelly, sand, coarse gravel between 4.8m to 4.9m
6.1	**Clayey sand** Grey, coarse sand 6.1m to 6.4m and 6.6m to 7.9m, fine 6.4m to 6.6m, damp
7.92	**Bedrock - Limestone**
12.19	End of borehole

Well Construction:

Flushmount casing and solid 0.05m PVC through cement

Solid 0.05m PVC through bentonite

Slotted 0.05m PVC through sand pack

Method	Number	PID	Rec %
▯	SS1	---	40
▯	SS2*	---	27
▯	SS3	---	58
▯	SS4	---	21
▯	SS5	125/1	65
▯	SS6	---	65
▯	SS7*	---	56
▯	SS8*	---	63
▯	SS9	---	100
▯	SS10	---	100

Depth Scale (m): 1.0, 2.0, 3.0, 4.0, 5.0, 6.0, 7.0, 8.0, 9.0, 10.0, 11.0, 12.0

m bgs - meters below ground surface
m asl - meters above sea level
* Indicates sample submitted for analysis

LITHOLOGY SYMBOLS

▨ Organics	▨ Fill (made ground)
▨ Clay	▨ Glacial Till
▨ Clayey Sand	▨ Bedrock

SAMPLE TYPE

▯	Split Spoon
▰	Air Rotary Drill

DILLON MW 212419 - 1010 SOMERSET_REV2.GPJ DILLON_MAY13_05.GDT 21-12-13

MW21-10S

Client: City of Ottawa
Project No.: 21-2419
Drilling Co.: Aardvark
Supervised by: EB

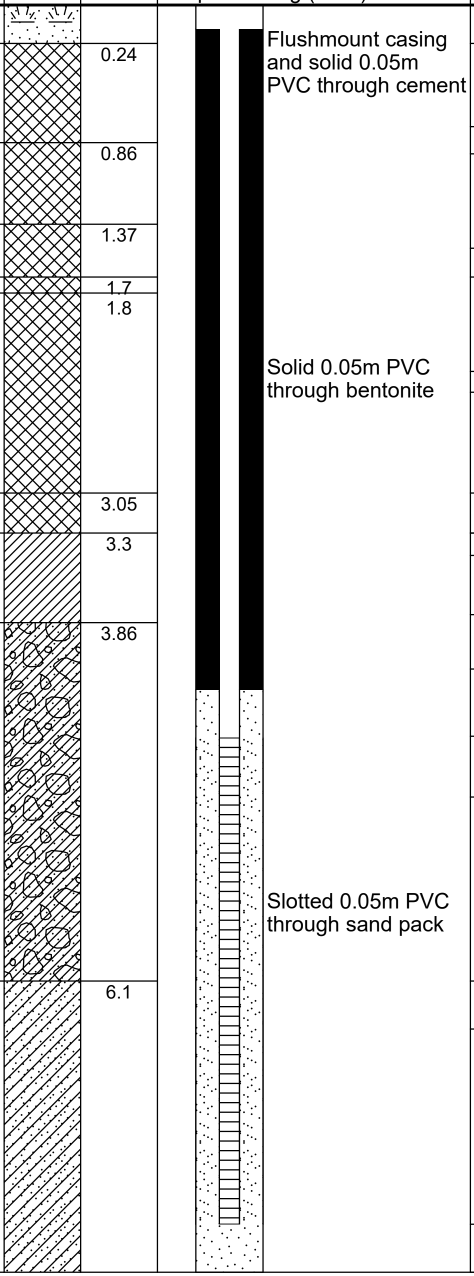
Project: 1010 Somerset Street West
Location: Ottawa, Ontario
Drilling Method: Auger/ Air Hammer
Date Started: 2021-09-24 Date Completed: 2021-09-24

Surface Elevation (masl): 58.67

Top of casing (masl): 58.53

Stratigraphic Description	Depth (m)
Topsoil Topsoil, loose 0 - 0.1m, compact 0.1m to 0.25m, roots, some gravel below 0.1m	0.24
Fill Brown grey gravelly clay, soft	0.86
Fill Light brown, fine grained sand, grey clay pockets	1.37
Fill Dark grey to black sand, granite pieces (<1mm)	1.7
Fill Light to dark brown clay, cinders	1.8
Fill Light to dark brown clay, cinders, fine grained sand between 2.3m and 3m	3.05
Fill Light brown sand, gravel (4cm - <1mm)	3.3
Clay Brown grey, dry, dense Becomes grey and saturated at 3.8 mbgs	3.86
Till Silty, gravelly, sand, coarse gravel between 4.8m to 4.9m	6.1
Clayey sand Grey, coarse sand 6.1m to 6.4m and 6.6m to 7.9m, fine 6.4m to 6.6m, damp	7.92
Bedrock - Limestone End of Borehole	

Depth Scale (m): 1.0, 2.0, 3.0, 4.0, 5.0, 6.0, 7.0



Method	Number	PID	Rec %
▯	SS1	---	40
▯	SS2*	---	27
▯	SS3	---	58
▯	SS4	---	21
▯	SS5	125/1	65
▯	SS6	---	65
▯	SS7*	---	56
▯	SS8*	---	63
▯	SS9	---	100
▯	SS10	---	100

m bgs - meters below ground surface
m asl - meters above sea level
* Indicates sample submitted for analysis

LITHOLOGY SYMBOLS

▨ Organics	▨ Fill (made ground)
▨ Clay	▨ Glacial Till
▨ Clayey Sand	

SAMPLE TYPE ▯ Split Spoon

Page 1 of 1

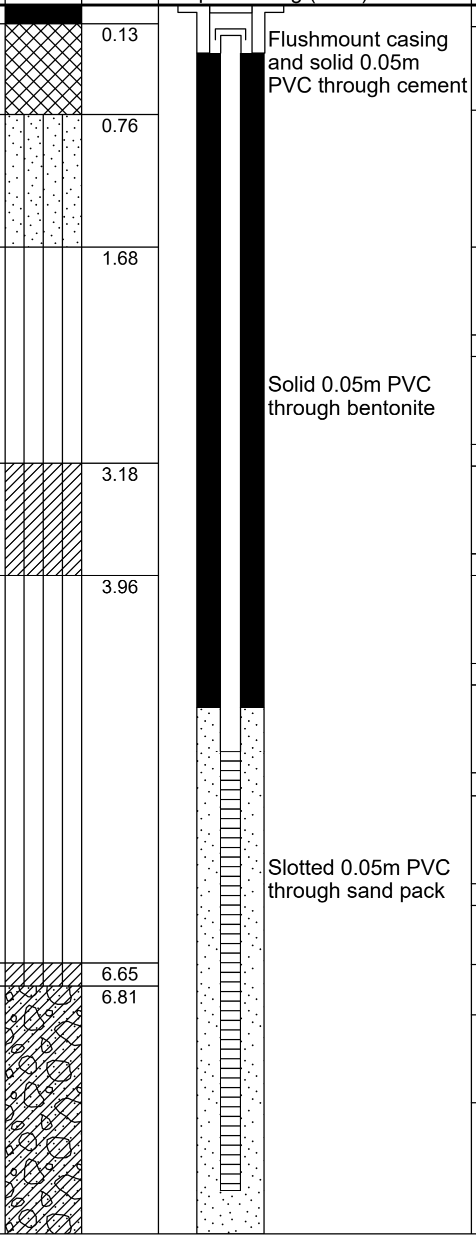
MW21-12

Client: City of Ottawa
Project No.: 21-2419
Drilling Co.: Aardvark
Supervised by: EB

Project: 1010 Somerset Street West
Location: Ottawa, Ontario
Drilling Method: Auger/ Air Hammer
Date Started: 2021-09-22 Date Completed: 2021-09-22

Surface Elevation (masl): 59.79

Top of casing (masl): 59.66



Stratigraphic Description	Lithology	Depth (m)
Asphalt	Asphalt	0.13
Fill Dark grey gravelly sand, transition to light grey at 0.5m	Fill (made ground)	0.76
Sandy silt Grey brown sandy silt, damp, some gravel	Sandy Silt	1.68
Silt Brown grey silt, damp, some orange mottling	Silt	3.18
Silty clay Minor sand lenses, some orange mottling, damp	Silt / Clay	3.96
Silt Grey silt, damp to wet, shells, orange mottling	Silt	6.65
Silty clay Grey	Silt / Clay	6.81
Till Silty sandy gravel, rocks	Glacial Till	8.53
Bedrock - Limestone End of Borehole		

Well Construction:
Flushmount casing and solid 0.05m PVC through cement
Solid 0.05m PVC through bentonite
Slotted 0.05m PVC through sand pack

Method	Number	PID	Rec %
Split Spoon	SS1*	---	67
Split Spoon	SS2	0/6	100
Split Spoon	SS3*	15/5	100
Split Spoon	SS4	5/7	100
Split Spoon	SS5	0/6	100
Split Spoon	SS6	0/6	100
Split Spoon	SS7	0/6	100
Split Spoon	SS8	---	100
Split Spoon	SS9*	0/5	100

Depth Scale (m): 1.0, 2.0, 3.0, 4.0, 5.0, 6.0, 7.0, 8.0

m bgs - meters below ground surface
m asl - meters above sea level
* Indicates sample submitted for analysis

LITHOLOGY SYMBOLS
- ■ Asphalt
- ▥ Sandy Silt
- ▨ Silt / Clay
- ▩ Fill (made ground)
- ▥ Silt
- ▨ Glacial Till

SAMPLE TYPE
- ▯ Split Spoon

DILLON CONSULTING

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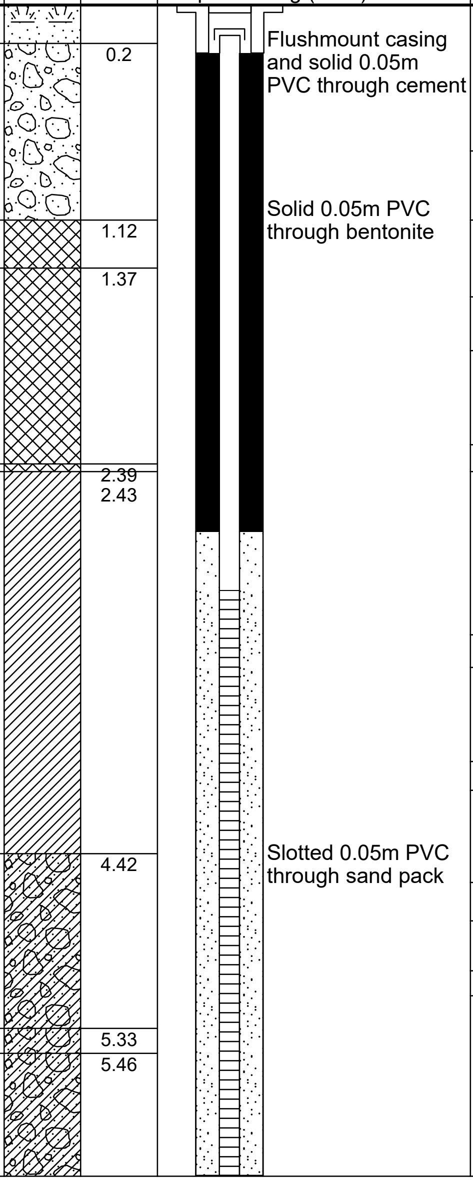
MW21-13

Client: City of Ottawa
Project No.: 21-2419
Drilling Co.: Aardvark
Supervised by: EB

Project: 1010 Somerset Street West
Location: Ottawa, Ontario
Drilling Method: Auger/ Air Hammer
Date Started: 2021-09-13 Date Completed: 2021-09-13

Surface Elevation (masl): 59.18

Top of casing (masl): 59.03



Stratigraphic Description	Lithology	Depth (m)
Topsoil Brown, organics (roots)	Organics	0.2
Sandy gravel	Sandy Gravel	1.12
Fill Sandy clay, dry, some organics (roots)	Fill (made ground)	1.37
Fill Grey clay, some rocks, dry, dense, bits of cinder	Fill (made ground)	2.39
Fill Red brown gravelly sand, dry, loose	Fill (made ground)	2.43
Clay Grey brown clay, dry transitioning to moist at 3.8m to saturated at 4.25m, dense	Clay	4.42
Till Sandy gravelly grey clay, saturated	Glacial Till	5.33
Till Silty clay till	Glacial Till	5.46
TILL Sandy silt and gravel	Glacial Till	6.1
End of borehole		

Method	Number	PID	Rec %
Split Spoon	SS2	45/8	85
Split Spoon	SS3*	65/10	58
Split Spoon	SS4	---	23
Split Spoon	SS5	45/2	79
Split Spoon	SS6*	60/6	100
Split Spoon	SS7	75/11	94
Split Spoon	SS8	---	42

Depth Scale (m): 1.0, 2.0, 3.0, 4.0, 5.0, 6.0

DILLON MW 212419 - 1010 SOMERSET_REV2.GPJ DILLON_MAY13_05.GDT 21-12-13

m bgs - meters below ground surface
m asl - meters above sea level
* Indicates sample submitted for analysis

LITHOLOGY SYMBOLS: Organics; Fill (made ground); Glacial Till; Sandy Gravel; Clay

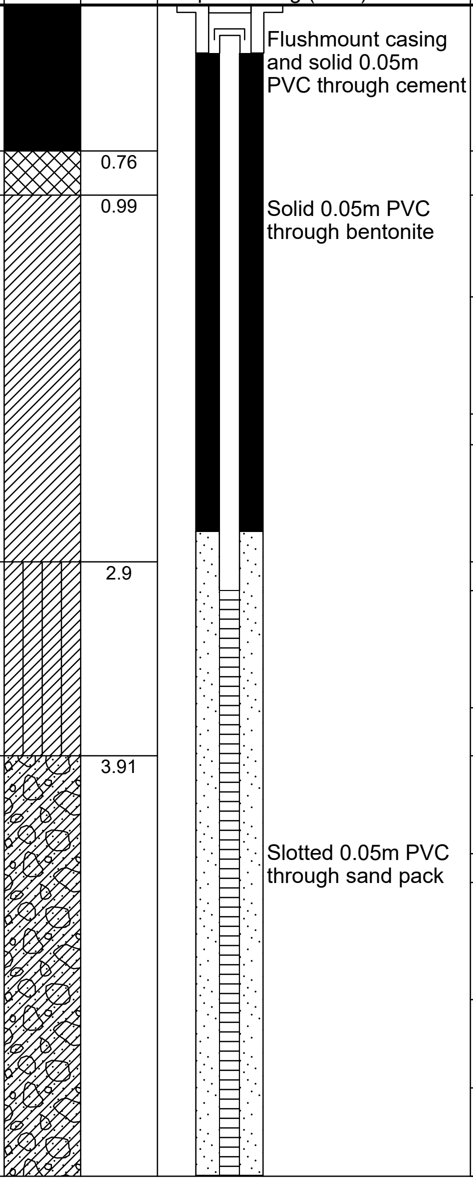
SAMPLE TYPE: Split Spoon

MW21-14

Client: City of Ottawa
Project No.: 21-2419
Drilling Co.: Aardvark
Supervised by: EB
Project: 1010 Somerset Street West
Location: Ottawa, Ontario
Drilling Method: Auger/ Air Hammer
Date Started: 2021-09-24
Date Completed: 2021-09-24

Surface Elevation (masl): 59.76
Top of casing (masl): 59.63

Depth (m)	Stratigraphic Description
	Asphalt
0.76	**Fill** Sand, small pieces of red brick and gravel, damp
0.99	**Clay** Brown grey clay with orange mottling, dry transitioning to damp at 1.5m, small shells between 2.3m and 2.9m
2.9	**Silty clay** Grey, very soft, damp to wet
3.91	**Till** Dark grey silty sand, gravel (1-5cm), wet to saturated, soft
6.1	End of borehole



Well Construction

Flushmount casing and solid 0.05m PVC through cement

Solid 0.05m PVC through bentonite

Slotted 0.05m PVC through sand pack

Method	Number	PID	Rec %
Split Spoon	SS1*	---	75
Split Spoon	SS2	0/5	100
Split Spoon	SS3*	15/6	100
Split Spoon	SS4	15/4	100
Split Spoon	SS5	---	100
Split Spoon	SS6	---	69
Split Spoon	SS7	---	58

m bgs - meters below ground surface
m asl - meters above sea level
* Indicates sample submitted for analysis

LITHOLOGY SYMBOLS
- ■ Asphalt
- ▨ Clay
- ▨ Glacial Till
- ▩ Fill (made ground)
- ▥ Silt / Clay

SAMPLE TYPE
- Split Spoon

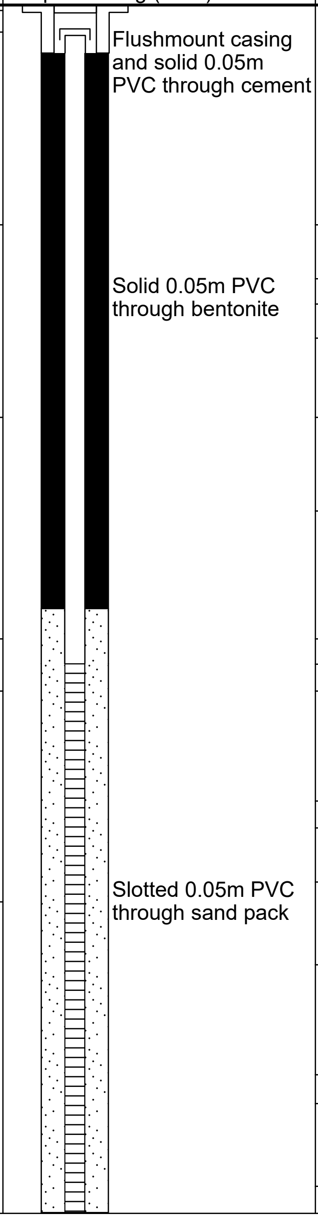
MW21-15

Client: City of Ottawa
Project No.: 21-2419
Drilling Co.: Aardvark
Supervised by: EB
Project: 1010 Somerset Street West
Location: Ottawa, Ontario
Drilling Method: Auger/ Air Hammer
Date Started: 2021-09-13 Date Completed: 2021-09-14

Surface Elevation (masl): 59.80

Top of casing (masl): 59.67

Stratigraphic Description	Lithology	Depth (m)
Asphalt	■	0.03
Fill Light grey gravelly sand, dry	▩	0.15
Asphalt	■	
Fill Clayey sand, red brick pieces, some small gravel at 1.5m, compact	▩	1.22
Clay Dry, compact	▨	2.29
Silty clay Less compact	▧	3.52
Silt Grey, soft, damp transition to wet at 4.8m	▥	3.81
Sandy silt Wet, some rocks observed at 5.3m	⁙	4.98
End of borehole		6.71



Method	Number	PID	Rec %
▯	SS1*	5/5	73
▯	SS2	---	54
▯	SS3	---	85
▯	SS4	40/7	100
▯	SS5*	70/7	100
▯	SS6	---	100
▯	SS7	55/5	100
▯	SS8	50/0	75

m bgs - meters below ground surface
m asl - meters above sea level
* Indicates sample submitted for analysis

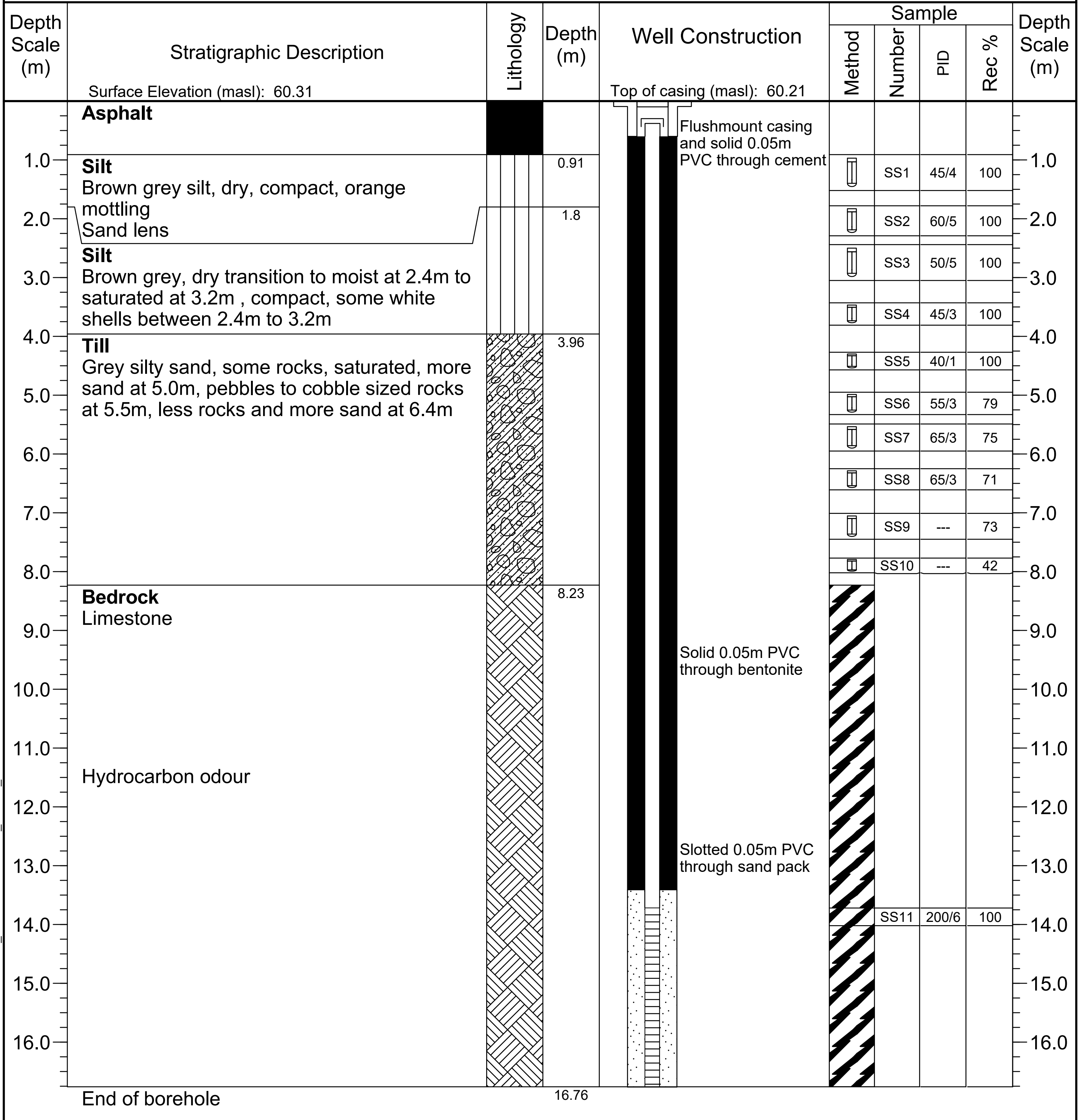
LITHOLOGY SYMBOLS
■ Asphalt
▨ Clay
▥ Silt
▩ Fill (made ground)
▧ Silt / Clay
⁙ Sandy Silt

SAMPLE TYPE
▯ Split Spoon

MW21-18

Client: City of Ottawa
Project No.: 21-2419
Drilling Co.: Aardvark
Supervised by: EB

Project: 1010 Somerset Street West
Location: Ottawa, Ontario
Drilling Method: Auger/ Air Hammer
Date Started: 2021-09-14 Date Completed: 2021-09-14



Surface Elevation (masl): 60.31

Top of casing (masl): 60.21

Depth (m)	Stratigraphic Description	Lithology
	Asphalt	■
0.91	**Silt** Brown grey silt, dry, compact, orange mottling	Silt
1.8	Sand lens **Silt** Brown grey, dry transition to moist at 2.4m to saturated at 3.2m , compact, some white shells between 2.4m to 3.2m	Silt
3.96	**Till** Grey silty sand, some rocks, saturated, more sand at 5.0m, pebbles to cobble sized rocks at 5.5m, less rocks and more sand at 6.4m	Glacial Till
8.23	**Bedrock** Limestone Hydrocarbon odour	Bedrock
16.76	End of borehole	

Well Construction:

Flushmount casing and solid 0.05m PVC through cement

Solid 0.05m PVC through bentonite

Slotted 0.05m PVC through sand pack

Sample Method	Number	PID	Rec %
Split Spoon	SS1	45/4	100
Split Spoon	SS2	60/5	100
Split Spoon	SS3	50/5	100
Split Spoon	SS4	45/3	100
Split Spoon	SS5	40/1	100
Split Spoon	SS6	55/3	79
Split Spoon	SS7	65/3	75
Split Spoon	SS8	65/3	71
Split Spoon	SS9	---	73
Split Spoon	SS10	---	42
Air Rotary Drill	SS11	200/6	100

m bgs - meters below ground surface
m asl - meters above sea level
* Indicates sample submitted for analysis

LITHOLOGY SYMBOLS: ■ Asphalt, ▨ Glacial Till, ▥ Silt, ▨ Bedrock

SAMPLE TYPE: ▯ Split Spoon, ▰ Air Rotary Drill

DILLON CONSULTING

Page 1 of 1

MW21-20D

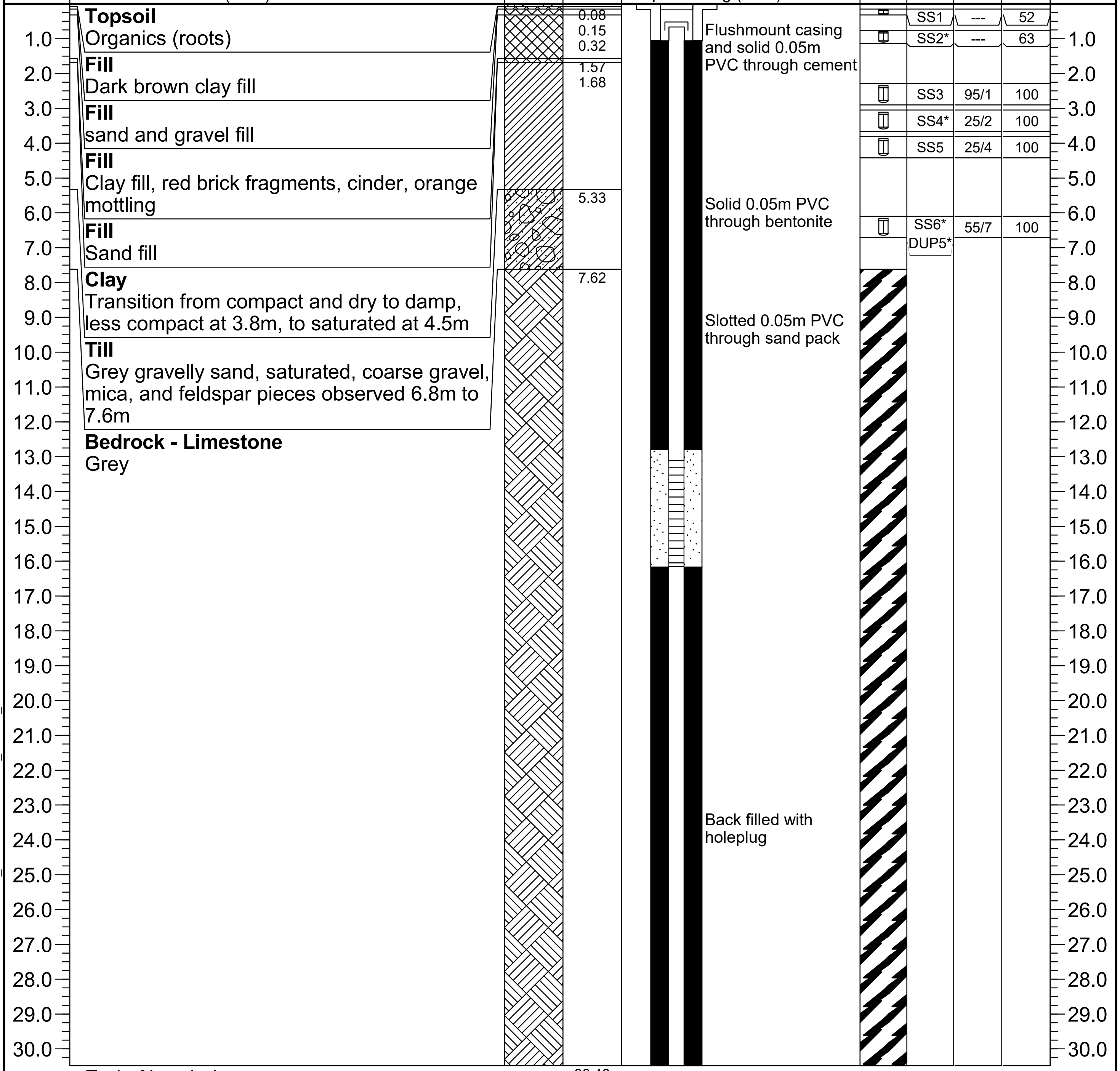
Client: City of Ottawa
Project No.: 21-2419
Drilling Co.: Aardvark
Supervised by: EB

Project: 1010 Somerset Street West
Location: Ottawa, Ontario
Drilling Method: Auger/ Air Hammer
Date Started: 2021-09-15 Date Completed: 2021-09-15

Surface Elevation (masl): 60.04

Top of casing (masl): 59.94

Depth (m)	Stratigraphic Description
0.08 0.15 0.32	**Topsoil** Organics (roots)
	Fill Dark brown clay fill
	Fill sand and gravel fill
1.57 1.68	**Fill** Clay fill, red brick fragments, cinder, orange mottling
	Fill Sand fill
5.33	**Clay** Transition from compact and dry to damp, less compact at 3.8m, to saturated at 4.5m
7.62	**Till** Grey gravelly sand, saturated, coarse gravel, mica, and feldspar pieces observed 6.8m to 7.6m
	Bedrock - Limestone Grey
30.48	End of borehole



Well Construction:
- Flushmount casing and solid 0.05m PVC through cement
- Solid 0.05m PVC through bentonite
- Slotted 0.05m PVC through sand pack
- Back filled with holeplug

Sample Number	PID	Rec %
SS1	---	52
SS2*	---	63
SS3	95/1	100
SS4*	25/2	100
SS5	25/4	100
SS6* DUP5*	55/7	100

m bgs - meters below ground surface
m asl - meters above sea level
* Indicates sample submitted for analysis

LITHOLOGY SYMBOLS
- ▨ Organics
- ▨ Clay
- ▨ Bedrock
- ▩ Fill (made ground)
- ▨ Glacial Till

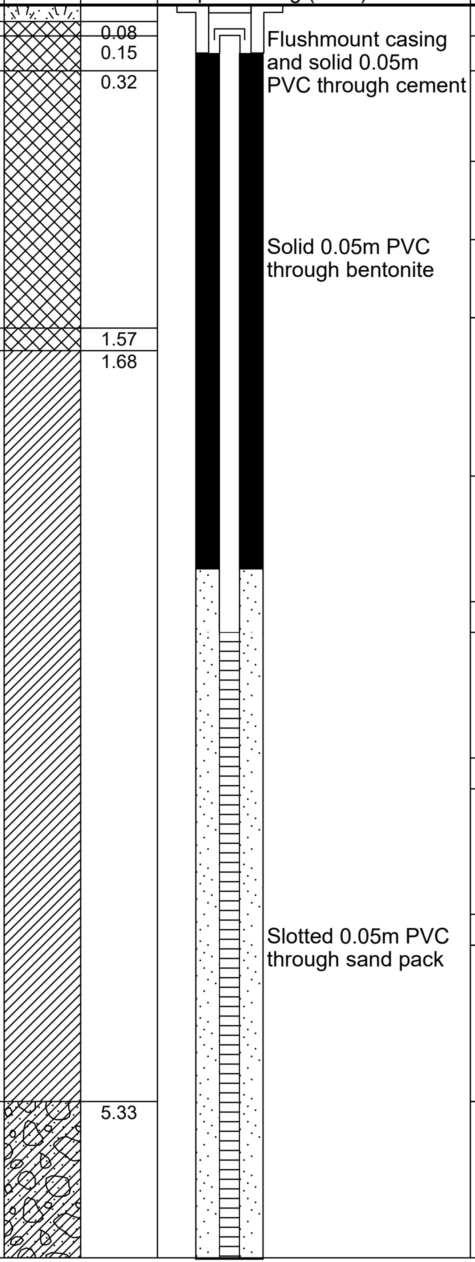
SAMPLE TYPE
- ▯ Split Spoon
- ▰ Air Rotary Drill

MW21-20S

Client: City of Ottawa
Project No.: 21-2419
Drilling Co.: Aardvark
Supervised by: EB
Project: 1010 Somerset Street West
Location: Ottawa, Ontario
Drilling Method: Auger/ Air Hammer
Date Started: 2021-09-15 Date Completed: 2021-09-15

Surface Elevation (masl): 60.09
Top of casing (masl): 59.96

Stratigraphic Description	Depth (m)
Topsoil Organics (roots)	0.08 0.15
Fill Dark brown clay fill	0.32
Fill sand and gravel fill	
Fill Clay fill, red brick fragments, cinder, orange mottling	
Fill Sand fill	1.57 1.68
Clay Transition from compact and dry to damp, less compact at 3.8m, to saturated at 4.5m	
Till Grey gravelly sand, saturated, coarse gravel, mica, and feldspar pieces observed 6.8m to 7.6m	5.33
End of borehole	6.09



Well Construction:

Flushmount casing and solid 0.05m PVC through cement

Solid 0.05m PVC through bentonite

Slotted 0.05m PVC through sand pack

Sample Method	Number	PID	Rec %
Split Spoon	SS1	---	52
Split Spoon	SS2*	---	63
	---	---	33
Split Spoon	SS3	95/1	100
Split Spoon	SS4*	25/2	100
Split Spoon	SS5	25/4	100
	---	---	13
	---	---	13

Depth Scale (m): 1.0, 2.0, 3.0, 4.0, 5.0, 6.0

m bgs - meters below ground surface
m asl - meters above sea level
* Indicates sample submitted for analysis

LITHOLOGY SYMBOLS
- Organics
- Clay
- Fill (made ground)
- Glacial Till

SAMPLE TYPE
- Split Spoon

PROJECT: 19124398

RECORD OF BOREHOLE: 19-01

SHEET 1 OF 1

LOCATION: See Site Plan

BORING DATE: October 17, 2019

DATUM: CGVD28

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE DESCRIPTION	ELEV. DEPTH (m)	SAMPLES NUMBER	SAMPLES TYPE	BLOWS/0.30m	HEADSPACE COMBUSTIBLE VAPOUR CONCENTRATIONS [PPM] ⊕ ND = Not Detected	PIEZOMETER OR STANDPIPE INSTALLATION
		GROUND SURFACE	59.73					
0	Geomachine Direct Push	ASPHALTIC CONCRETE	0.00					Flush Mount Casing
		FILL - (SW) gravelly SAND; brown grey, contains silt layer; moist, dense	0.08	1	SS	-	⊕ ND	
1		Inferred GRAVEL, COBBLES, BOULDERS, SAND	58.66 1.07					Bentonite Seal
2								Silica Sand
		FILL - (SW) SAND, some silt and gravel, trace clay; brown; moist, compact	57.10 2.63	2	SS	-	⊕ ND	▽
3		(CL) SILTY CLAY, some sand; brown; w~PL, firm	56.68 3.05	3	SS	-	⊕ ND	
4		(CL) SILTY CLAY, trace sand; grey, contains shells; w>PL, soft	56.00 3.73	4	SS	-	⊕ ND	51 mm Diam. PVC #10 Slot Screen
5				5	SS	-	⊕ ND	
		(ML-CL) CLAYEY SILT/SILTY CLAY; grey, contains shells; w>PL to w~PL, soft to firm	54.36 5.37	6	SS	-	⊕ ND	Silica Sand
6		End of Borehole	53.63 6.10					W.L. in Screen at Elev. 57.05 m on October 23, 2019
7								
8								
9								
10								

HEADSPACE ORGANIC VAPOUR CONCENTRATIONS [PPM] ☐ ND = Not Detected

HYDRAULIC CONDUCTIVITY, k, cm/s: 10^{-6} 10^{-5} 10^{-4} 10^{-3}

WATER CONTENT PERCENT: Wp ⊢—○W—⊣ Wl

ADDITIONAL LAB. TESTING

DEPTH SCALE

1 : 50

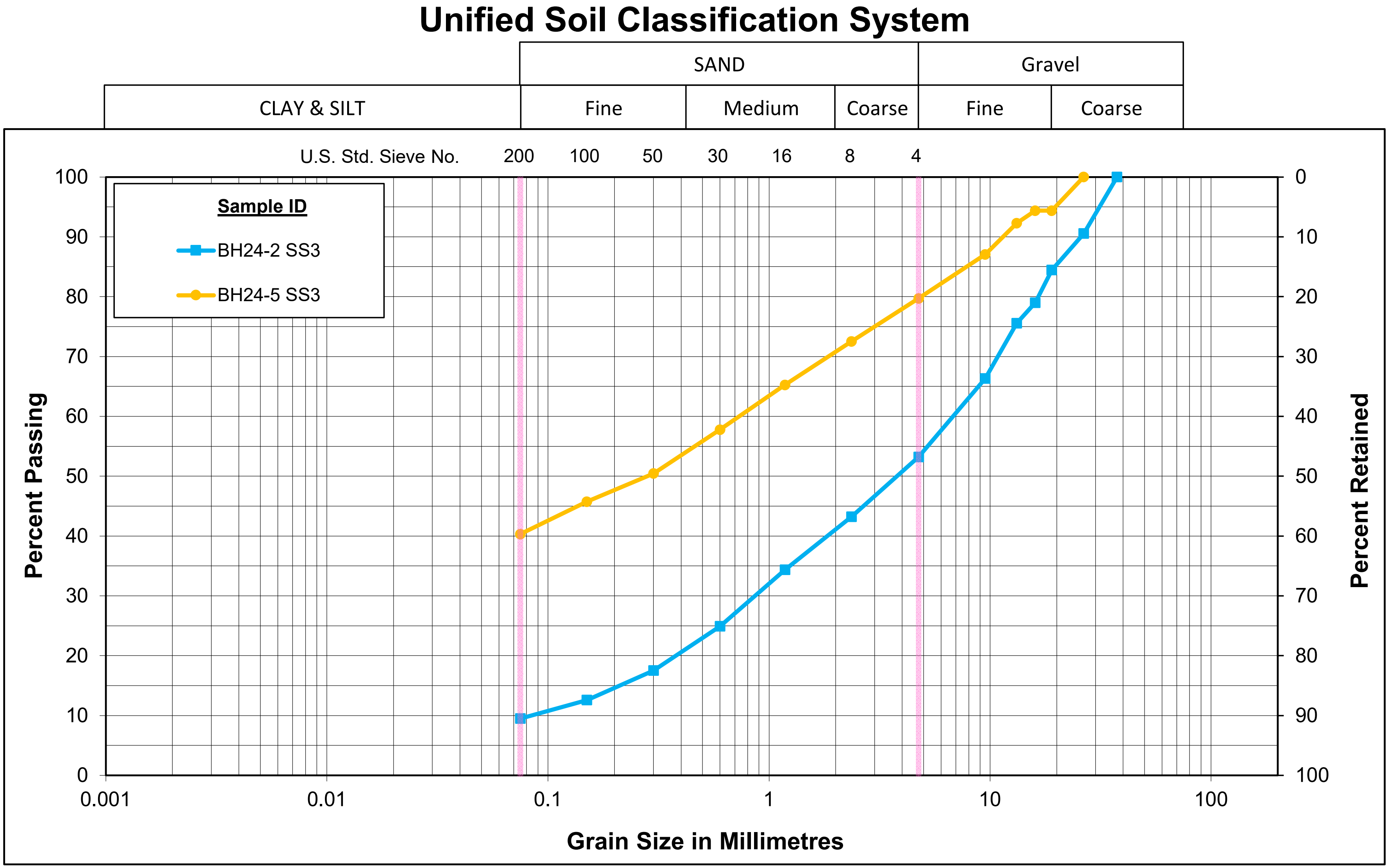
GOLDER

LOGGED: JS

CHECKED: JD

APPENDIX E

LABORATORY TEST RESULTS



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GRAIN SIZE DISTRIBUTION

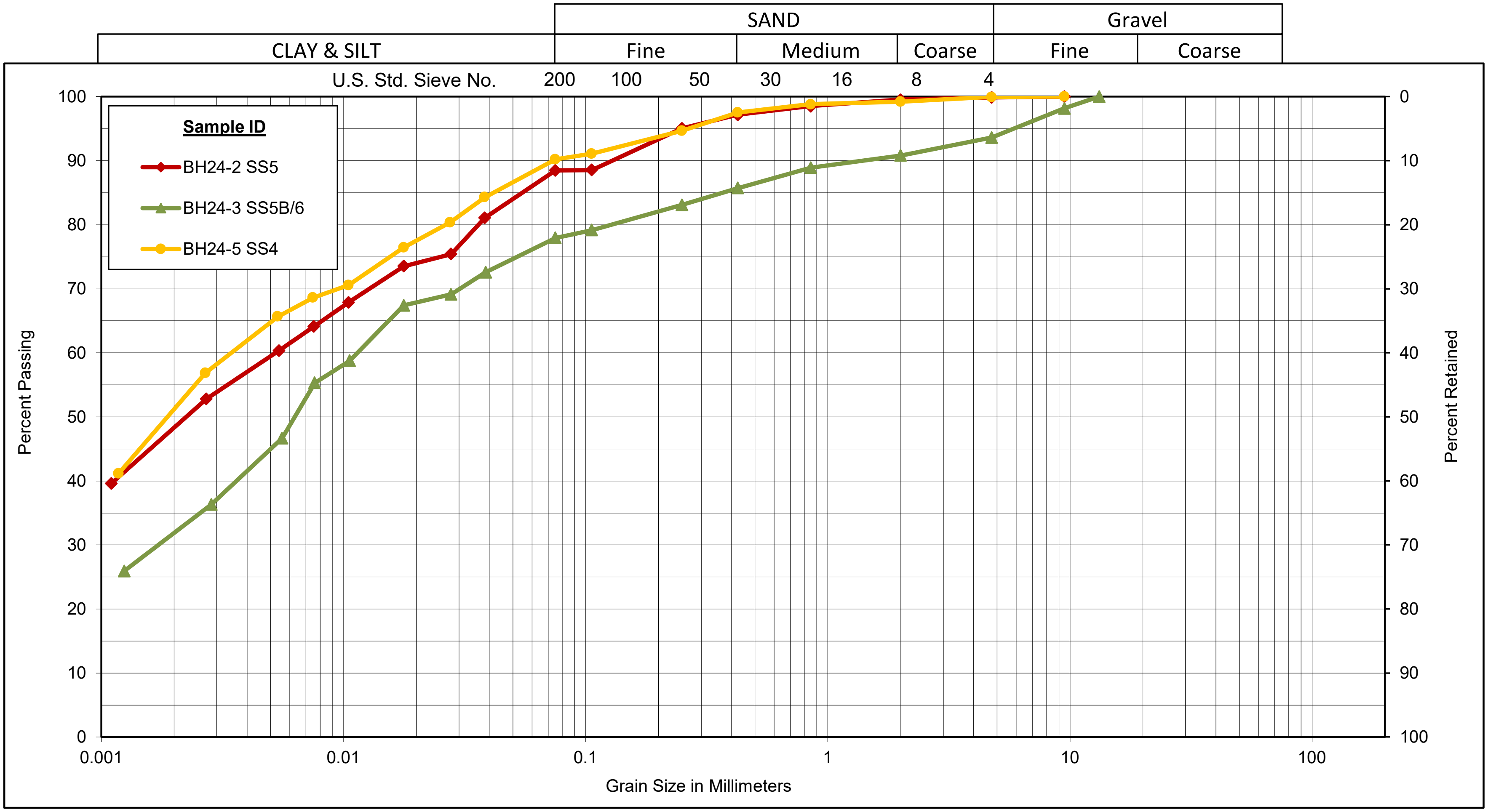
Fill Material

1010 Somerset West Ottawa

Figure No. E1

Project No. 160402067

Unified Soil Classification System



Sample ID	Depth	% Gravel	% Sand	% Silt	% Clay
BH24-2 SS5	12'6"-14'6"	0.1	11.4	41.5	47.0
BH24-3 SS5B/6	8'6"-14'6"	6.4	15.7	46.9	31.0
BH24-5 SS4	7'6"-9'6"	0.1	9.7	40.2	50.0

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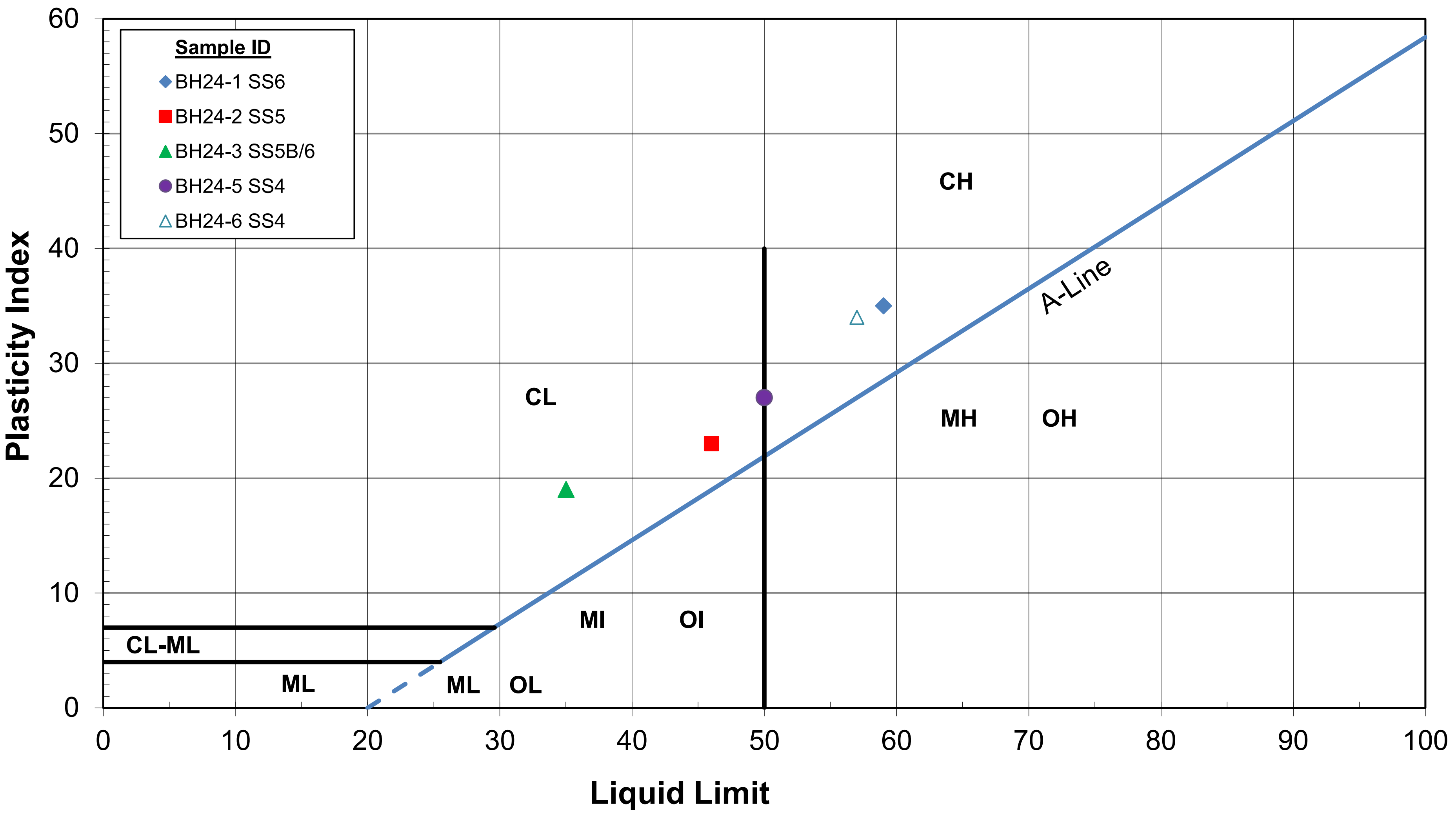
GRAIN SIZE DISTRIBUTION

Silty Clay (CL)

1010 Somerset West Ottawa

Figure No. E2

Project No. 160402067



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Silty Clay (CL-CH)

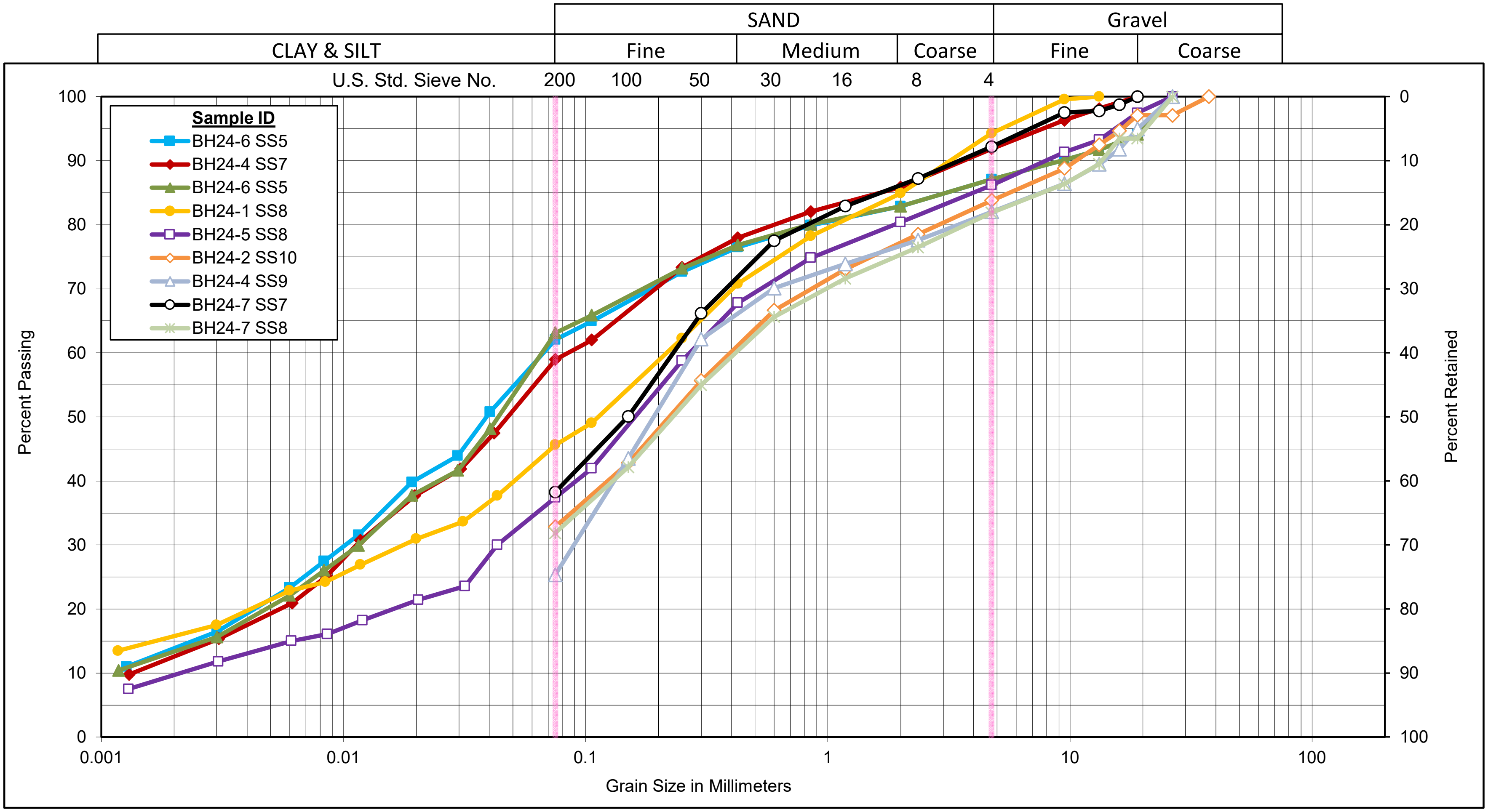
1010 Somerset West Ottawa

PLASTICITY CHART

Figure No. E3

Project No. 160402067

Unified Soil Classification System



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GRAIN SIZE DISTRIBUTION

Glacial Till (SM-ML)

1010 Somerset West Ottawa

Figure No. E4

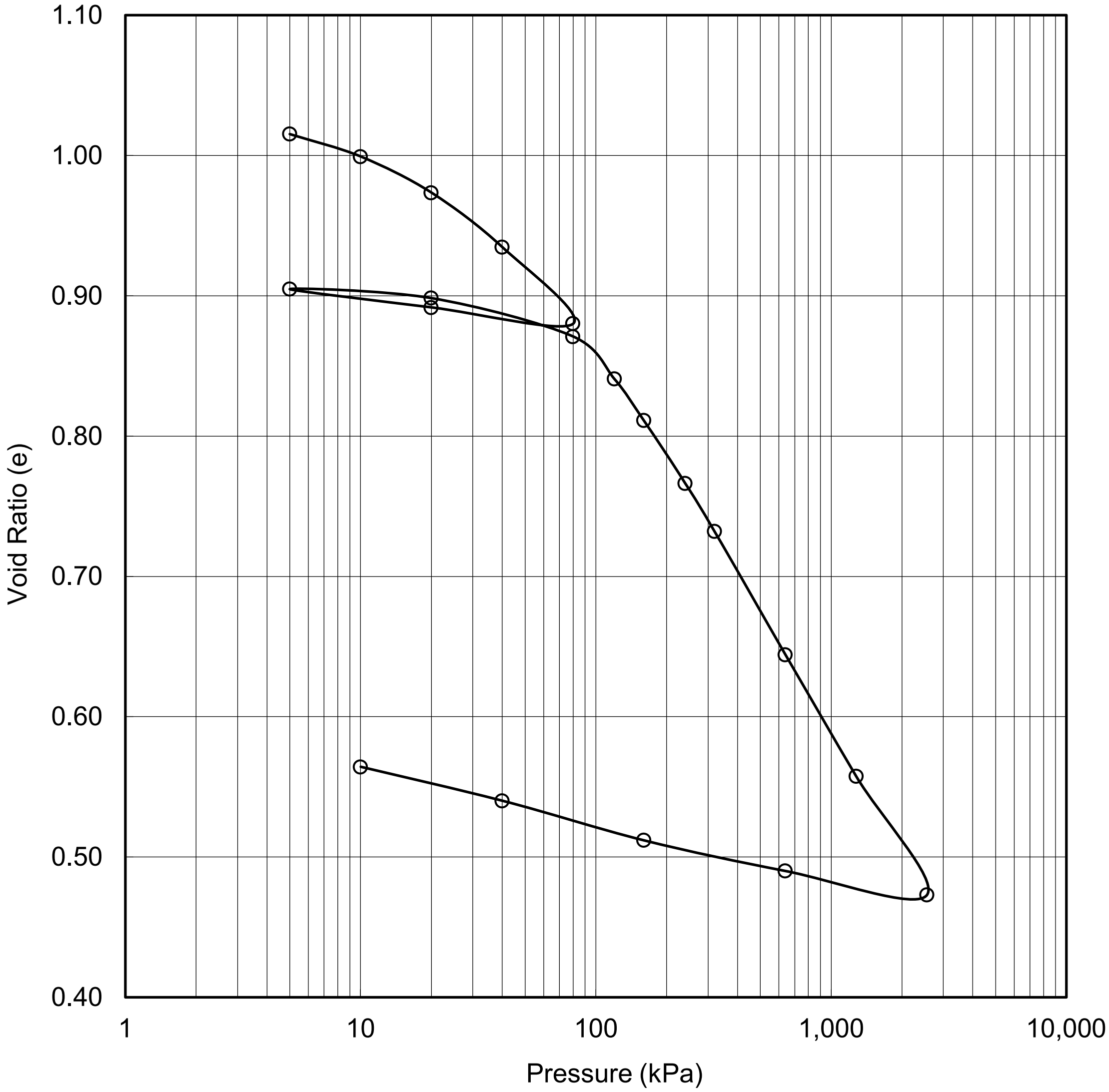
Project No. 160402067

CONSOLIDATION TEST	FIGURE E5

1010 Somerset West, Ottawa

BH 24-1A, ST1

Void Ratio vs Pressure



Soil Type : *Lean clay of low to medium plasticity, grey, very moist, CL/CI*

e_o =	1.055	w_L =	35.1%	σ_{v0}' =	49 kPa
w =	37.5%	w_P =	16.6%	σ_P' =	-- kPa
γ =	18.3 kN/m^3	PI =	18.5%	Cr	0.036
Gs =	2.786			Cc	0.273

Project No. : 160402067.600
Date : 29-Jan-25

Stantec

Prepared By : DB
Checked By : RG

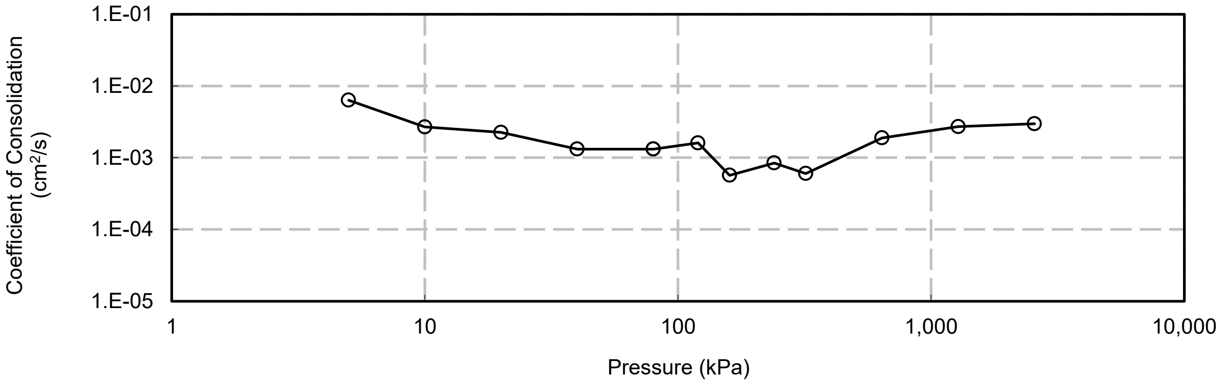
CONSOLIDATION TEST

FIGURES E6

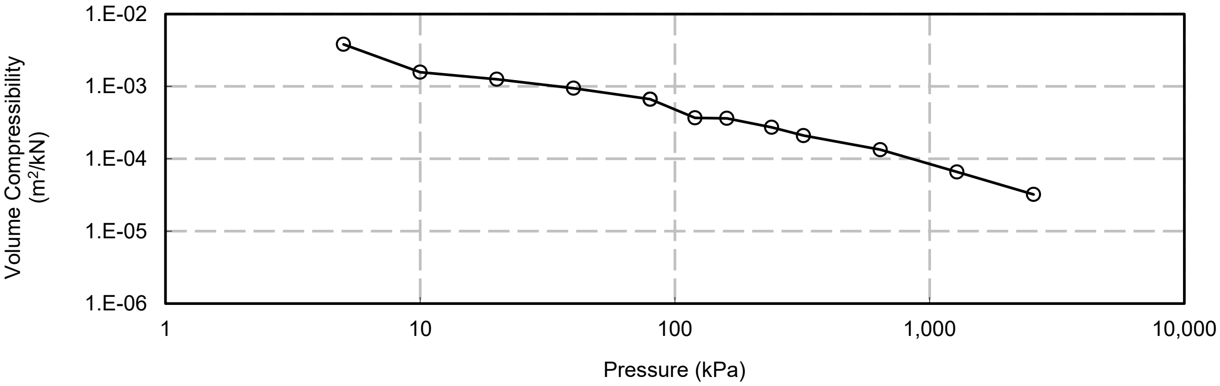
1010 Somerset West, Ottawa

BH 24-1A, ST1

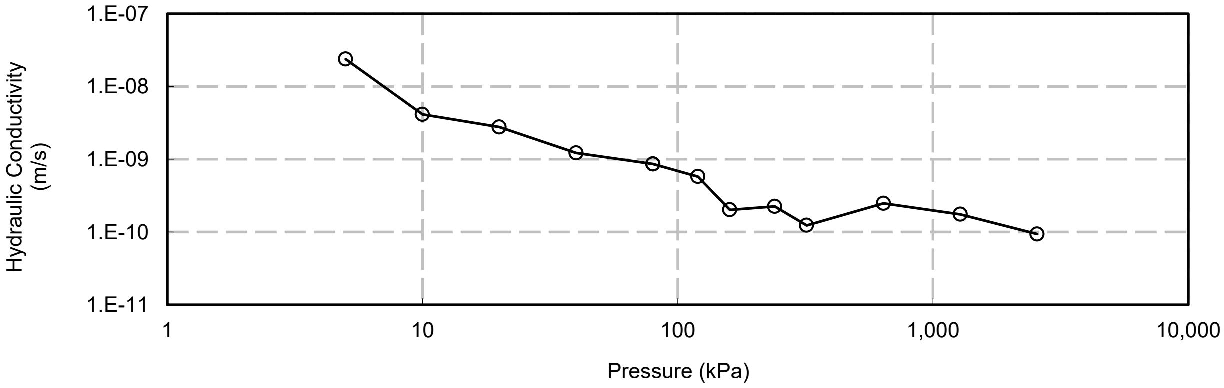
Cv vs Pressure



mv vs Pressure



k vs Pressure



Project No. : 160402067.600
Date : 29-Jan-25

Stantec

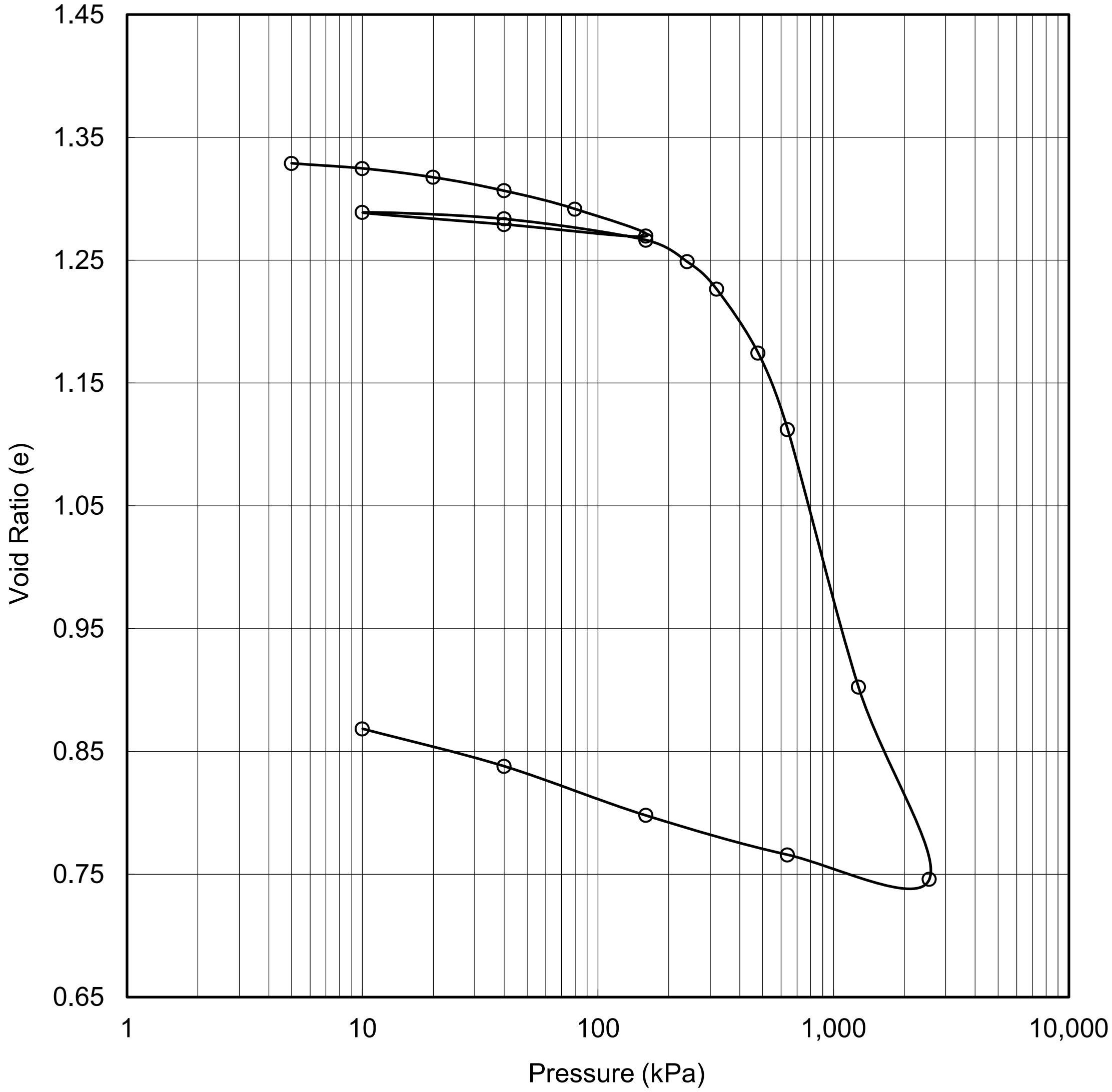
Prepared By : DB
Checked By : RG

CONSOLIDATION TEST	**FIGURE E7**

1010 Somerset West, Ottawa

BH 24-07, ST4

Void Ratio vs Pressure



Soil Type : *Fat clay, brown, fissured, moist, CH*

e_o =	1.334	w_L =	69.7%	σ_{v0}' =	70 kPa
w =	45.2%	w_P =	25.1%	σ_P' =	400.0 kPa
γ =	17.1 kN/m^3	PI =	44.6%	C_c =	1.146
Gs =	2.805			C_r =	0.020

Project No. : 160402067.600
Date : 29-Jan-25

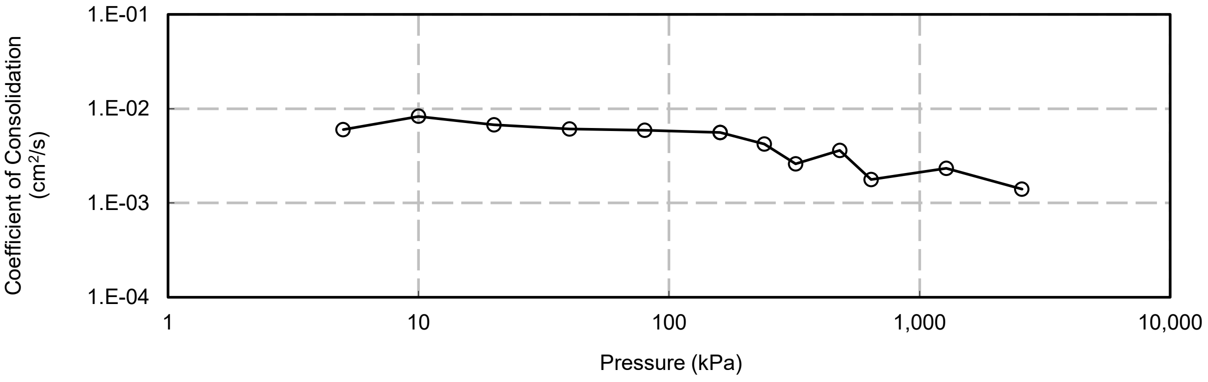
Prepared By : DB
Checked By : RG

CONSOLIDATION TEST	FIGURES E8

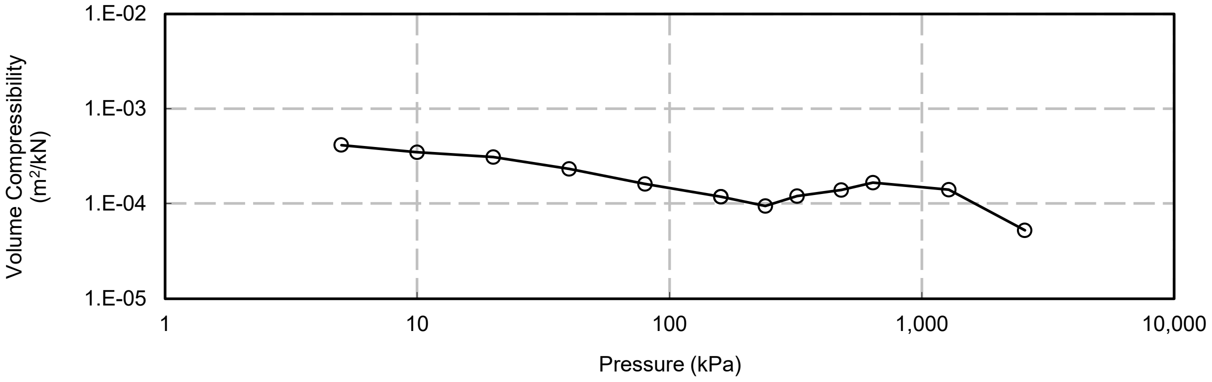
1010 Somerset West, Ottawa

BH 24-07, ST4

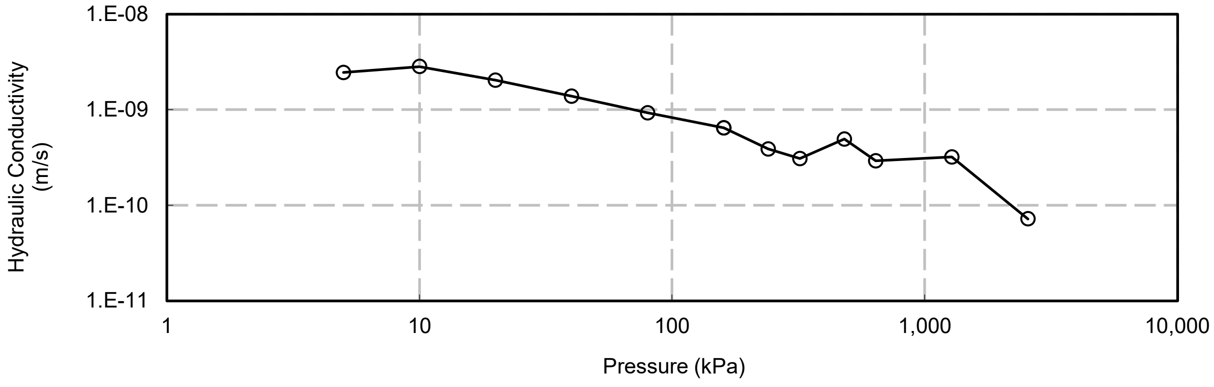
Cv vs Pressure



mv vs Pressure



k vs Pressure



Project No. :	160402067.600	Prepared By :	DB
Date :	29-Jan-25	Checked By :	RG

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Certificate of Analysis

Stantec Consulting Ltd. (Ottawa)
2781 Lancaster Road, Suite 101
Ottawa, ON K1B 1A7
Attn: Omar Elghazal

Report Date: 14-Nov-2024
Order Date: 11-Nov-2024

Client PO: 1010 Somerset
Project: 160402067.200
Custody:

Order #: 2446075

This Certificate of Analysis contains analytical data applicable to the following samples as submitted:

Paracel ID	Client ID
2446075-01	BH24-02, SS7. 22'6"-24'6"
2446075-02	BH24-03, SS7. 17'6"-19'6"

Approved By: Mark Foto

Mark Foto, M.Sc.

Lab Supervisor

Report Date: 14-Nov-2024

Client: **Stantec Consulting Ltd. (Ottawa)**

Order Date: 11-Nov-2024

Client PO: 1010 Somerset

Project Description: 160402067.200

Analysis Summary Table

Analysis	Method Reference/Description	Extraction Date	Analysis Date
Anions	EPA 300.1 - IC, water extraction	12-Nov-24	12-Nov-24
pH, soil	EPA 150.1 - pH probe @ 25 °C, CaCl buffered ext.	13-Nov-24	13-Nov-24
Resistivity	EPA 120.1 - probe, water extraction	12-Nov-24	12-Nov-24
Solids, %	CWS Tier 1 - Gravimetric	11-Nov-24	13-Nov-24

Certificate of Analysis

Report Date: 14-Nov-2024

Client: **Stantec Consulting Ltd. (Ottawa)**

Order Date: 11-Nov-2024

Client PO: 1010 Somerset

Project Description: 160402067.200

Client ID:		BH24-02, SS7. 22'6"-24'6"	BH24-03, SS7. 17'6"-19'6"	-	-		
Sample Date:		25-Oct-24 09:00	24-Oct-24 09:00	-	-	-	-
Sample ID:		2446075-01	2446075-02	-	-		
Matrix:		Soil	Soil	-	-		
	MDL/Units						
Physical Characteristics							
% Solids	0.1 % by Wt.	67.9	99.7	-	-	-	-
General Inorganics							
pH	0.05 pH Units	7.95	7.80	-	-	-	-
Resistivity	0.1 Ohm.m	24.9	17.8	-	-	-	-
Anions							
Chloride	10 ug/g	32	159	-	-	-	-
Sulphate	10 ug/g	152	219	-	-	-	-

Method Quality Control: Blank

Analyte	Result	Reporting Limit	Units	%REC	%REC Limit	RPD	RPD Limit	Notes
Anions								
Chloride	ND	10	ug/g					
Sulphate	ND	10	ug/g					
General Inorganics								
Resistivity	ND	0.1	Ohm.m					

Method Quality Control: Duplicate

Analyte	Result	Reporting Limit	Units	Source Result	%REC	%REC Limit	RPD	RPD Limit	Notes
Anions									
Chloride	285	10	ug/g	278			2.8	35	
Sulphate	30.6	10	ug/g	29.6			3.2	35	
General Inorganics									
pH	6.39	0.05	pH Units	6.44			0.8	2.3	
Resistivity	60.5	0.1	Ohm.m	61.8			2.1	20	
Physical Characteristics									
% Solids	93.0	0.1	% by Wt.	93.0			0.0	25	

Method Quality Control: Spike

Analyte	Result	Reporting Limit	Units	Source Result	%REC	%REC Limit	RPD	RPD Limit	Notes
Anions									
Chloride	380	10	ug/g	278	102	82-118			
Sulphate	131	10	ug/g	29.6	101	80-120			

APPENDIX F

F.1 SEISMIC LIQUEFACTION ASSESSMENT

Government of Canada Gouvernement du Canada

Canada.ca › Natural Resources Canada › Earthquakes Canada

2020 National Building Code of Canada Seismic Hazard Tool

This application provides seismic values for the design of buildings in Canada under Part 4 of the National Building Code of Canada (NBC) 2020 as prescribed in Article 1.1.3.1. of Division B of the NBC 2020.

Seismic Hazard Values

User requested values

Code edition	NBC 2020
Site designation X_S	X_D
Latitude (°)	45.407
Longitude (°)	-75.718

Please select one of the tabs below.

NBC 2020 | Additional Values | Plots | API | Background Information

The NBC 5% damped spectral acceleration values can be viewed in the NBC tab. Additional hazard values for your site can be found below.

The 5%-damped spectral acceleration ($S_a(T)$, where T is the period, in s) and peak ground acceleration (PGA) values are given in units of acceleration due to gravity (g, 9.81 m/s^2). Peak ground velocity (PGV) is given in m/s. Probability is expressed in terms of percent (%) exceedance in 50 years.

By
designations can be selected from the respective drop-down menu in the table. In low hazard regions, a minimum value of 0.001g for T ≤ 2.0s and of 0.0001g for T > 2.0s is

assigned. Further information on the calculation of seismic hazard is provided in the *Background Information* tab.

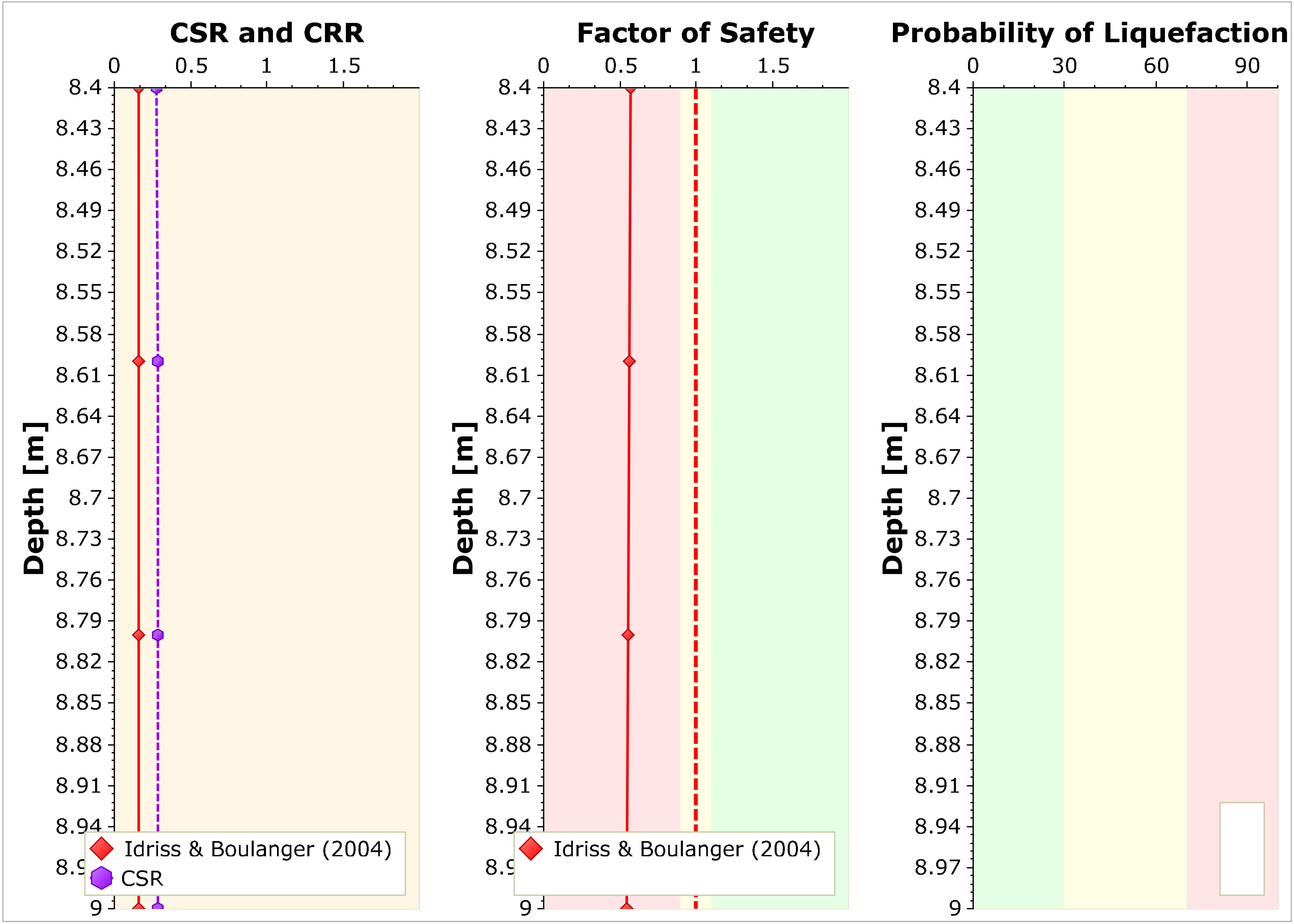
Site Designation XD	**Probability** All	**$S_a(0.05)$**	**$S_a(0.1)$**	**$S_a(0.2)$**	**$S_a(0.3)$**	**$S_a(0.5)$**	**$S_a(1.0)$**	**$S_a(2.0)$**	**$S_a(5.0)$**	**$S_a(10.0)$**	**PGA**	**PGV**
X_D	2	0.67	0.718	0.629	0.57	0.515	0.306	0.146	0.0408	0.0128	0.367	0.36
X_D	2.5	0.589	0.637	0.557	0.524	0.469	0.276	0.131	0.0357	0.0111	0.335	0.322
X_D	3.5	0.481	0.527	0.481	0.455	0.407	0.233	0.109	0.029	0.00898	0.294	0.271
X_D	5	0.39	0.436	0.412	0.388	0.344	0.193	0.0887	0.0229	0.00703	0.254	0.223
X_D	7	0.332	0.371	0.349	0.33	0.289	0.159	0.0718	0.0179	0.00549	0.217	0.182
X_D	10	0.272	0.306	0.287	0.271	0.237	0.127	0.0562	0.0135	0.00412	0.18	0.144
X_D	14	0.219	0.249	0.233	0.22	0.191	0.101	0.0434	0.0101	0.00307	0.147	0.113
X_D	20	0.167	0.193	0.181	0.172	0.148	0.0762	0.032	0.00708	0.00216	0.114	0.0846
X_D	30	0.115	0.137	0.129	0.122	0.105	0.0528	0.0214	0.00448	0.00135	0.0807	0.0575
X_D	40	0.0833	0.102	0.0971	0.092	0.0782	0.0388	0.0153	0.00303	0.000911	0.0599	0.0416

Download CSV

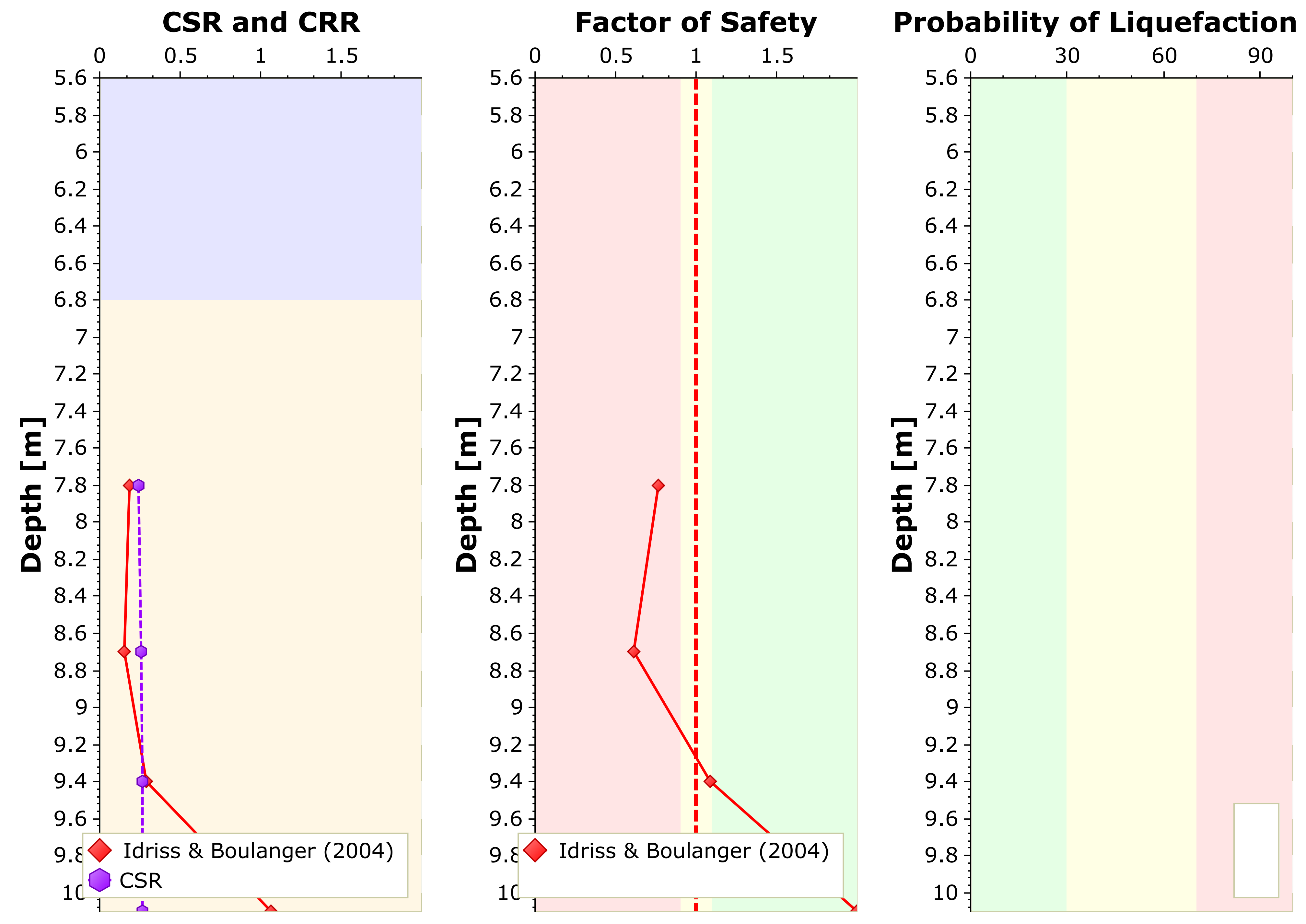
🡐 Go back to the seismic hazard calculator form

Date modified: 2021-04-06

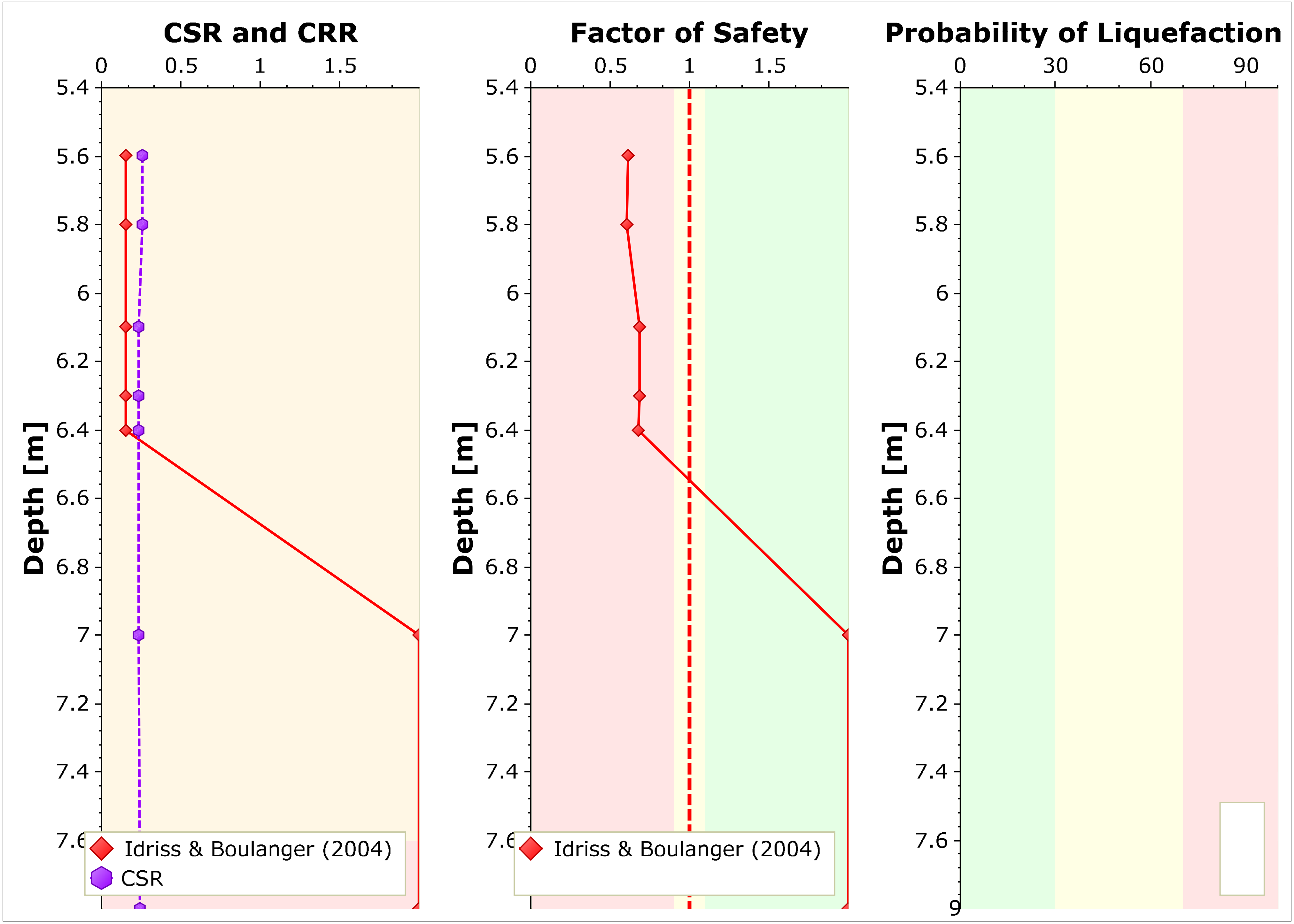
Stantec



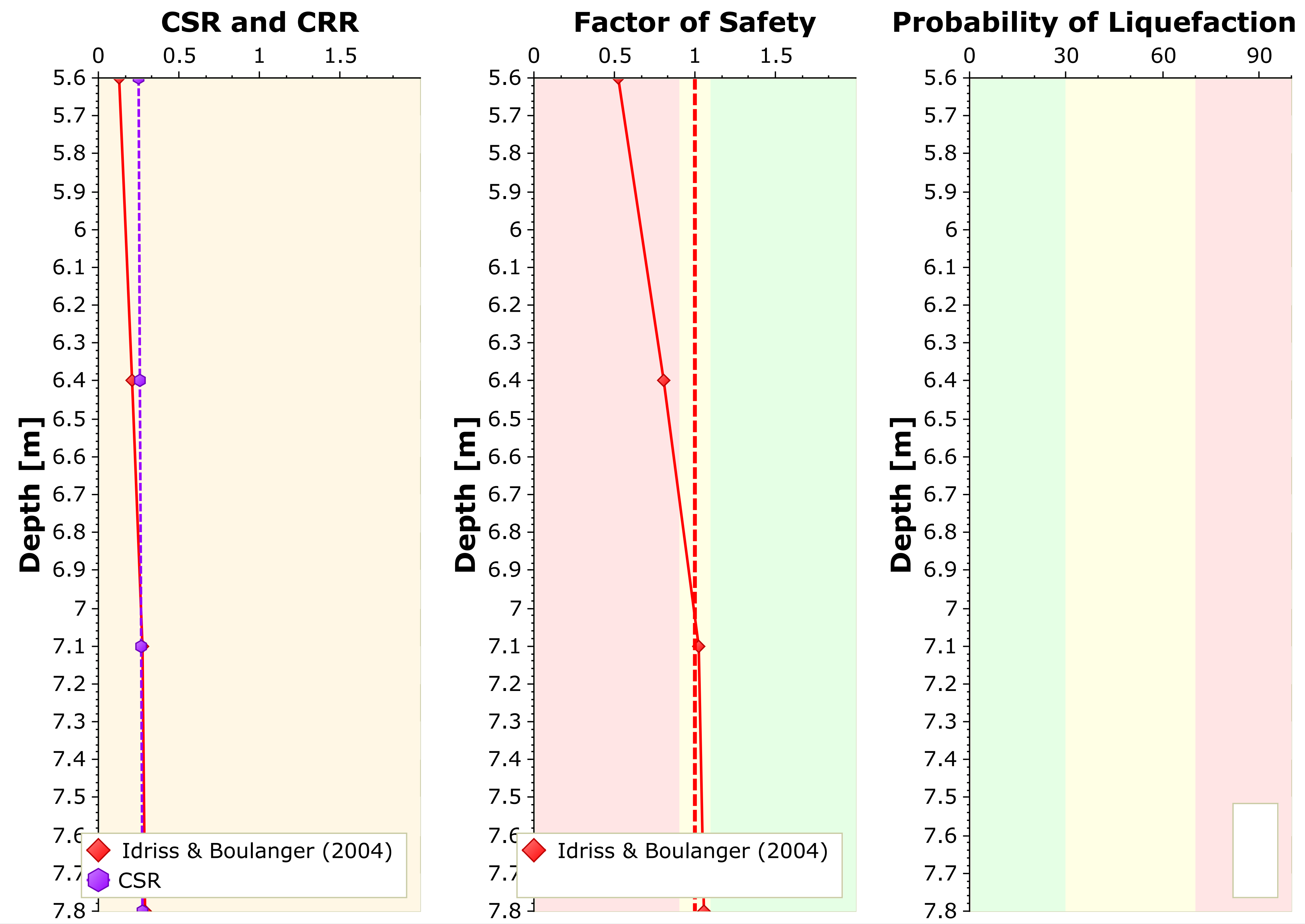
Project No.: 160402067 **Project Name:** Proposed Land Development at 1010 Somerset Street W, Ottawa, Ontario **Title**: Liquefaction analysis Figure F1- BH24-1



Project No.: 160402067 **Project Name:** Proposed Land Development at 1010 Somerset Street W, Ottawa, Ontario **Title**: Liquefaction analysis Figure F2- BH24-2



Project No.: 160402067 **Project Name:** Proposed Land Development at 1010 Somerset Street W, Ottawa, Ontario **Title**: Liquefaction analysis Figure F3- BH24-4



Project No.: 160402067 **Project Name:** Proposed Land Development at 1010 Somerset Street W, Ottawa, Ontario **Title**: Liquefaction analysis Figure F4- BH24-5