415 LEGGET DRIVE SITE PLAN CONTROL APPLICATION FOR RENOVATIONS, FIT-UP AND NEW SITE DEVELOPMENTS

ACCESS PROPERTY DEVELOPMENT

DRAFT GEOTECHNICAL REPORT, REV. 1

PROJECT NO.: 219-00058-03
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1 INTRODUCTION

1.1 CONTEXT

WSP was retained by Access Property Development (APD) to prepare this geotechnical report (the "Report") in support of a Site Plan Control application for the properties municipally known as 415 Legget Drive and 2700 Solandt Road ("the site"), in the City of Ottawa.

The purpose of the geotechnical investigation is to obtain subsurface information at the site by means of exploratory boreholes and a geophysical survey. The geotechnical investigation was divided into Phase 1, the investigation within the existing structure and Phase 2, the investigation for the new building construction. The geophysical investigation was carried out at the Site to determine the subsurface conditions between the geotechnical boreholes and Multichannel Analysis of Surface Waves (MASW) to determine the seismic site classification. This report will be submitted under a separate cover. This report presents the findings of the investigation and provides comments and recommendations which may affect the design of the proposed building upgrades and new constructions.

1.2 PROJECT AND SITE DESCRIPTION

It is understood that Access Property Development is intending to transform the existing office to serve as a storage facility by retrofitting the structure and constructing two new buildings.

There is an existing 18,084.7 m^2 (194,662 ft^2) two-storey flex/office building at 415 Legget Drive. Existing parking for the existing building is located at the north and east sides of the site. There is an existing stormwater pond at the northeast corner of the site. The redevelopment of the site is split into two (2) phases. Phase 1 includes the change of use from existing office and manufacturing occupancy building to 2-storey self storage and single-storey high bay warehousing occupancy. A partial removal of the second storey is proposed which will reduce the overall GFA of the building to approximately 14,347 m^2.

The proposed development for Phase 2 consists of two (2) one-storey, storage warehouse buildings, with a proposed total gross floor area of approximately 18,580 m^2 (199,993.4 ft^2), to be located on existing parking areas north and east of the existing building at 415 Legget Drive. The two (2) warehouse buildings are proposed to contain light industrial warehousing and ancillary office uses. Building A will be located north of the existing building at 415 Legget Drive and will have a gross floor area of 11,400 m^2. Building B is proposed to be located east of the existing building and will have a gross floor area of 7,180 m^2. Phase 2 of the project will require Site Plan approval.

On the northeast corner of the Site, to the north of Proposed Building B is an existing stormwater management pond.

1.3 OBJECTIVES AND LIMITATIONS

This report was prepared by WSP for A49 and Access Property Development in accordance with the agreed upon work order as detailed in the WSP proposal "*Renovation and Demolition Structural Engineering Services- 415 Legget Drive, Ottawa*", dated June 22, 2021. This report was prepared at the request of, and for the sole use of A49/ Access Property Development, according to the specific terms of the mandate given to WSP. The use of this report by any third party, as well as any decision based upon this report, is under that party's sole discretion and responsibility. WSP may not be held accountable for any possible damages resulting from third party decisions based on this report or its associated information.

Furthermore, any opinions regarding conformity with laws and regulations expressed in this report are technical in nature; the report is not and shall not, in any case, be considered as a legal opinion. Information in this report is only valid for the historical and supplemental borehole locations as described.

Reference should be made to the Limitations of this Report, attached in **Appendix D**, which follows the text but forms an integral part of this document.

2 SITE INVESTIGATION

2.1 SCOPE OF WORK

The geotechnical scope of work for this assignment included:

- A desktop study and review of existing geotechnical information in the general area;
- Laying out the boreholes and obtaining utility locates at the project site;
- Drilling exploratory boreholes within the interior of the building;
- In-situ soil sampling and testing, including Standard Penetration Testing (SPT) and shear vane testing;
- Obtaining soil samples for additional review and laboratory testing;
- Laboratory testing;
- Geotechnical analysis; and
- Preparation of this report which presents the results of the investigation and provides geotechnical recommendations related to the proposed building retrofit and the construction of the proposed buildings.

2.2 INVESTIGATION PROCEDURES

WSP carried out the interior geotechnical investigation in September and October 2021.

2.2.1 DESKTOP STUDY

Published surficial geology maps indicate the area is underlain by fine-textured glaciomarine deposits consisting of clay, silty clay and silt with minor sand and gravel deposits. To the north of the site, the surficial geology maps indicate alluvial deposits consisting of silty sand, silt, sand and clay. Bedrock geology includes sandstone of the Nepean Formation.

2.2.2 FIELD INVESTIGATION

WSP carried out a geotechnical drilling program for Phase 1 between September 29 and October 4, 2021. The program consisted of drilling four boreholes through the existing concrete slab within the office space using hand portable drilling equipment supplied and operated by Ohlmann Geotechnical Services (OGS) Inc of Almonte, ON. The boreholes were advanced to depths ranging from of 4.9 m to 6.4 m below the existing slab surface.

WSP carried out a geotechnical drilling program for Phase 2 between September 24 and 29, 2021. The program consisted of drilling eight boreholes, seven within the existing parking lot and one in a landscaped area using a truck mounted CME drill rig, again supplied and operated by Ohlmann Geotechnical Services (OGS) Inc of Almonte, ON. The boreholes were advanced to depths ranging from of 2.8 m to 8.7 m below the existing ground surface.

2.2.3 LABORATORY TESTING

Upon completion of drilling and in-situ testing, soil samples were returned to WSP's laboratory for further examination, classification and testing. The testing program consists of the determination of natural water content, grain size distribution, Atterberg limits (Plasticity) and chemical analyses of soil corrosivity (sulphate content, chloride content, pH, and resistivity) are presented in A**ppendix C**. The results of determination of grain size distribution and Atterberg limits results are summarized on the individual borehole logs and are presented in Appendix C. The natural water content results are pending and will be included in the final report.

3 SUBSURFACE GEOTECHNICAL CONDITIONS

The subsurface conditions encountered within the boreholes are discussed in the following sections. Detailed descriptions of the soil and groundwater conditions encountered at each of the borehole locations are included in the individual borehole logs in **Appendix B**.

3.1 SOIL CONDITIONS

The following provides a general description of the major soil types encountered during the current geotechnical investigation. It should be noted that the following discussion includes some simplifications for the purposes of discussing broadly similar soil strata. It should also be noted that the differences in soil types and changes between various soil strata are often gradational, as opposed to precise boundaries of geological change.

A detailed description of the soil stratigraphy encountered at each borehole location is shown on the individual borehole log shown in **Appendix B**. Please note that the factual descriptions shown in each log takes precedence over the generalized (and simplified) descriptions presented below. Also, consider the fact that borehole represent the very location of these holes and not necessarily mean it represents the soil formation in the surrounding area.

3.1.1 INTERIOR INVESTIGATION

CONCRETE SLAB-ON-GRADE

Prior to the drilling of boreholes BH21-01i thru BH21-04i the concrete slab was scanned for rebar and subsurface obstructions. The results of the scanning did not indicate any reinforcement, either rebar or wire mesh, within the slab at these select locations. The thickness of the concrete slab ranged from 110 mm to 150 mm. No rebar or wire mesh was encountered during the coring of the concrete. A plastic vapour barrier was encountered between the concrete slab and the underlying layer of granular base.

Photos of cores of the concrete slab have been included in Drawing No. 3.

A layer of granular base which ranged in consistency from crushed sand and gravel to sandy gravel was encountered underlying boreholes BH21-2i thru BH21-4i. This layer of extended to depths ranging from 0.23 m to 0.43 m below the existing ground surface and ranged in thickness from 0.1 m to 0.32 m. Grain size distributions of two sample of the granular base is presented in **Appendix C**. A summary of these grain size distributions is also presented in the table below.

Table 3-1 Results of Grain Size Analysis for Granular Base

BOREHOLE NO.	SAMPLE NO.	GRAIN SIZE DISTRIBUTION		
		% Gravel	% Sand	% Fines (< 75µm)
BH21-3i	Grab 1 (0.15 – 0.25)	72	26	2
BH21-2i	Grab 1 (0.15 – 0.3)	54	43	3

In borehole BH21-1i a layer of sand with trace gravel and trace silt was encountered underlying the concrete slab serving as a granular base. This layer extended to a depth of 0.37 m below the existing ground surface and was 0.22 m thick. A grain size distribution of one sample of this sand is presented in **Appendix C**. A summary of this grain size distribution is also presented in the table below.

Table 3-2 Results of Grain Size Analysis for Sand

BOREHOLE NO.	SAMPLE NO.	GRAIN SIZE DISTRIBUTION		
		% Gravel	% Sand	% Fines (< 75µm)
BH21-1i	Grab 1 (0.2 – 0.4)	9	84	7

GRANULAR FILL

Underlying the granular base in the boreholes a granular fill was encountered. This layer consists of gravel and cobble fragments and may contain sand and silt infilling. This layer of extended to depths ranging from 1.7 m to 2.0 m below the existing ground surface and ranged in thickness from 1.5 m to 1.7 m.

SILTY CLAY

Underlying the granular fill in the four boreholes is a layer of sensitive silty clay. This deposit generally consists of interlayered clay, silty clay and silt. Sand lenses may also be present. For simplicity this deposit is referred to in this report as silty clay (as this is the predominant soil type). The silty clay extended to the depth of drilling, up to 6.2 m below the existing ground surface.

The upper portion of the silty clay has been weathered to form a grey-brown crust. The weathered zone extended to depths ranging from approximately 3.7 m to 4.6 m below the existing ground surface. Standard penetration tests carried out within the weathered crust gave SPT ‘N’ values ranging from 3 blows to 31 blows per 305 mm of penetration, indicating a firm to hard consistency.

The silty clay below the depth of weathering is grey in colour. This unweathered silty clay extended to the termination depths, ranging from 5.3 m to 6.4 m below the existing ground surface. The SPT ‘N’ values within the unweathered silty clay ranged from 2 blows to 5 blows per 305 mm of penetration. Shear vane testing within the silty clay deposit yielded shear strengths ranging from 28 kPa to 79 kPa, indicating a firm to stiff consistency.

SAMPLER REFUSAL AND BEDROCK

Sampler refusal was not encountered at the boreholes within the building and the bedrock depth within the building footprint is inferred to be greater than the depth of drilling at the borehole locations, which ranged from 5.3 m to 6.4 m in depth.

3.1.2 EXTERIOR INVESTIGATION

PAVEMENT STRUCTURE

Asphaltic concrete was encountered in boreholes BH21-01s thru BH21-07s drilled in the paved areas. The asphaltic concrete ranged in thickness from 20 mm to 45 mm. Underlying the asphalt was a layer which ranged in consistency from sandy gravel to sand and gravel which served as a granular base. This layer ranged in thickness from 160 mm to 260 mm.

A grain size distribution of one sample of this sand and gravel is presented in **Appendix C**. A summary of this grain size distribution is also presented in the table below.

Table 3-3 Results of Grain Size Analysis for Sand and Gravel

BOREHOLE NO.	SAMPLE NO.	GRAIN SIZE DISTRIBUTION		
		% Gravel	% Sand	% Fines (< 75µm)
BH21-2s	Grab 1 (0.15 – 0.3)	66	27	7

TOPSOIL

Underling the surface in borehole BH21-08s a layer of topsoil was encountered. This layer was 75 mm in thickness.

FILL

In borehole BH21-04 a layer of Silty Clay fill was encountered in borehole BH21-04s which extended from 0.2 m to 1.0 m below the existing ground surface. This layer was not encountered in any other borehole.

SILTY SAND/SAND AND SILT

A layer which ranged in consistency from silt and sand to silty sand was encountered underlying the pavement structure, fill or the topsoil in all the boreholes drilled at the site with the exception of boreholes BH21-01s and BH21-03s. This layer extended to depths ranging from 0.8 m to 2.3 m below the existing ground surface. The SPT "N" values within the silty sand ranged from 3 blows to 19 blows per 305 mm of penetration indicating a loose to compact state of packing. A grain size distribution of this silty sand/silt and sand is presented in **Appendix C**. A summary of this grain size distribution is also presented in the table below.

Table 3-4 Results of Grain Size Analysis for Sand and Silt

BOREHOLE NO.	SAMPLE NO.	GRAIN SIZE DISTRIBUTION			
		% Gravel	% Sand	% Silt	% Clay
BH21-5s	SS2 (0.8 – 1.4)	0	56	37	7

SILTY CLAY

Underlying the asphaltic concrete pavement structure, fill or sand and silt/silty sand a layer of sensitive silty clay was encountered. This deposit generally consists of interlayered clay, silty clay and silt. Sand lenses may also be present. For simplicity this deposit is referred to in this report as silty clay (as this is the predominant soil type).

The upper portion of the silty clay in boreholes BH21-01s thru BH21-03S and BH21-06s thru BH21-08s has been weathered to form a grey-brown crust. The weathered zone extended to depths ranging from approximately 1.5 m to 3.1 m below the existing ground surface. Standard penetration tests carried out within the weathered crust gave SPT 'N' values ranging from 3 blows to 15 blows per 305 mm of penetration, indicating a firm to hard consistency.

The silty clay below the depth of weathering is grey in colour. In boreholes BH21-01s and boreholes BH21-03s thru BH21-07s the unweathered silty clay layer was fully penetrated and extended to depths ranging from 3.7 m to 7.6 m below the existing ground surface. In boreholes BH21-02s the borehole terminated within the unweathered silty clay layer at 8.1 m in depth. Borehole BH21-08s terminated at 2.8 m in depth due to auger refusal without encountering the unweathered silty clay. The SPT 'N' values within the unweathered silty clay ranged from the weight of the SPT hammer to 3 blows per 305 mm of penetration. Shear vane testing within the silty clay deposit yielded shear strengths ranging from 23 kPa to 100 kPa, indicating a soft to very stiff consistency.

The results of Atterberg limit testing was carried out on three samples of the silty clay gave plasticity index values of ranging from 9 percent to 29 percent and liquid limit values ranging from 20 percent to 53 percent, indicating a low to medium plasticity soil.

GLACIAL TILL

Underlying the silty clay in boreholes BH21-01s and borehole BH21-03s thru BH21-07s a layer of glacial till was encountered which extended to the depth of auger refusal, which ranged from 4.0 m to 8.7 m in depth. Glacial till is a heterogeneous mixture of clay, silt, sand and gravel with cobbles and boulders. During this investigation, the glacial till encountered consisted of silty clay with some gravel and some sand. Cobbles and boulders are typical within this deposit and should be anticipated during construction.

The SPT "N" values within the glacial till ranged from 2 to 5 blow to per 305 mm of penetration indicating a loose to very dense state of packing.

AUGER REFUSAL AND BEDROCK

Auger refusal was encountered in all the exterior borehole with the exception of BH21-02s. The depth of auger refusal ranged from 2.8 m to 8.7 m in depth. Auger refusal was encountered in the boreholes drilled exterior of the building. This refusal may represent the bedrock surface or cobbles/boulders within the layer of glacial till. The depth of bedrock is inferred to be greater than 8.1 m in depth in borehole BH21-02s.

3.2 GROUNDWATER CONDITIONS

INTERIOR BOREHOLES

Boreholes BH21-1i thru BH21-3i were left open upon completion of drilling and groundwater was allowed to infiltrate into the borehole. Boreholes BH21-1i and BH21-2i were left open for 3 days and 2 days, respectively, and groundwater was found to be at 1.2 m below the existing ground surface. Borehole BH21-3i caved to 0.4 m in depth and was dry.

EXTERIOR BOREHOLES

Standpipe piezometers were installed in boreholes BH21-01s, BH21-03s, BH21-04s and BH21-07s. Groundwater observations were taken on October 19, 2021, approximately 3 weeks after the completion of the drilling operations and the results are summarized in the table below. It should be noted that water levels vary seasonably and are expected to be higher during the spring period.

Table 3.5 Groundwater Levels

Borehole No.	Groundwater Level (m)
21-01s	0.6
21-03s	1.1
21-04s	2.9
21-07s	3.1

3.3 SUMMARY

The following table provides an overview of the soil strata encountered at each of the borehole locations.

Table 3-6 Simplified Soil and Groundwater Conditions – Interior Investigaiton

Borehole (Elev. m)	Simplified Stratigraphy (Depth in metres)					Notes
	Concrete Slab	Granular Base	Granular Fill	Weathered Silty Clay	Unweathered Silty Clay	
BH21-01i (78.5)	0 – 0.15	0.15 – 0.37	0.37 – 2.0	2.0 – 4.6	4.6 – 5.8	Water noted at 1.2 m in depth in open borehole.
BH21-02i (78.5)	0 – 0.13	0.13 – 0.23	0.23 – 1.7	1.7 - 4.1	4.1 - 5.3	Water noted at 1.2 m in depth in open borehole.
BH21-03i (78.5)	0 – 0.12	0.12 – 0.28	0.28 – 1.8	1.8 - 3.7	3.7 - 6.1	Borehole open to 0.4 m in depth and dry.
BH21-04i (78.5)	0 – 0.11	0.11 – 0.43	0.43 – 2.0	2.0 - 3.8	3.8 - 6.4	--

Table 3-7 Simplified Soil and Groundwater Conditions – Exterior Investigaiton – Building B

Borehole (Elev. m)	Simplified Stratigraphy (Depth in metres)								Measured Groundwater Depth (m)	Notes
	Asphaltic Concrete	Topsoil	Granular Base	Fill	Silty Sand	Weathered Silty Clay	Unweathered Silty Clay	Glacial Till		
21-01s (77.3)	0 - 0.04	--	0.04 - 0.3	--	--	0.3 - 3.1	3.1 - 4.6	4.6 - 4.9	0.6	Auger refusal at 4.9 m in depth.
21-02s (76.8)	0 - 0.03	--	0.03 - 0.23	--	0.23 - 0.83	0.83- 2.3	2.3 - 8.1	--	--	Borehole terminated at 8.1 m in depth.
21-03s (76.6)	0 - 0.02	--	0.02 - 0.2	--	--	0.2- 1.5	1.5 - 7.6	7.6 - 8.7	1.0	Auger refusal at 8.7 m in depth.

Table 3-8 Simplified Soil and Groundwater Conditions – Exterior Investigaiton – Building A

Borehole	Simplified Stratigraphy (Depth in metres)								Measured Groundwater Depth (m)	Notes
	Asphaltic Concrete	Topsoil	Granular Base	Fill	Silty Sand	Weathered Silty Clay	Unweathered Silty Clay	Glacial Till		
21-04s (77.4)	0 - 0.04	--	0.04 - 0.23	0.23 - 1.0	1.0 - 1.7		1.7 - 7.6	7.6 - 8.2	2.9	Auger refusal at 8.2 m in depth
21-05s (77.7)	0 - 0.02	--	0.02 -0.23	--	0.23 - 1.2		1.2 - 4.6	4.6 - 5.1	--	Auger refusal at 5.1 m in depth
21-06s (77.1)	0 - 0.045	--	0.045 - 0.21	--	0.21 - 0.85	0.85- 1.5	1.5 - 3.7	3.7 - 4.0	--	Auger refusal at 4.0 m in depth
21-07s (77.3)	0 - 0.04	--	0.04 - 0.2	--	0.2 - 1.2	1.2 - 1.5	1.5 - 6.5	--	3.1	Auger refusal at 6.5 m in depth
21-08s (77.3)	--	0 - 0.075		--	0.075 - 2.3	2.3 - 2.8	--	--	--	Auger refusal at 2.8 m in depth

4 RECOMMENDATIONS

4.1 GENERAL

This section of the report provides an engineering guidance related to the geotechnical design aspects of the project based on our interpretation of the available information described herein and project requirements. 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 factual data as it affects their proposed construction techniques, schedule, safety, and equipment capabilities. Reference should be made to the Limitations of this Report, attached in **Appendix D**, which follows the text but forms an integral part of this document.

The general subsurface conditions encountered outside the existing building consists of an asphalt pavement structure overlying sensitive silty clay. In some locations a thin layer of silty sand was encountered between the asphalt pavement structure and the silty clay. The general subsurface conditions encountered inside the existing building consists of a concrete slab on grade overlying a layer of fill which in turn is underlain by silty clay which extended to the depth of drilling. SPT sampler refusal was not encountered within the boreholes in the interior investigation and the bedrock depth is inferred to be greater than the depth of drilling at each location. Auger refusal was encountered during the exterior borehole investigation, which is inferred as bedrock.

4.2 SEISMIC SITE CLASSIFICATION

4.2.1 LIQUIFACTION

The soils at the site are not considered to be susceptible to seismic liquefaction based on the soil types encountered at the site, the SPT N-values and shear strength values collected within these soils and the groundwater level observed at the site.

4.2.1 SEISMIC SITE CLASSIFICATION

As outlined in the 2012 Ontario Building Code, building foundations must be designed to resist a minimum earthquake force. In accordance with Table 4.1.8.4.A of the 2012 Ontario Building Code, the seismic site response for foundations placed on native silty clay or engineered fill would have a site classification of Class D.

Multichannel Analysis of Surface Waves (MASW) was carried out in September 2021 to determine the seismic site classification. The results of the MSAW testing will be submitted in the finalized report.

4.3 SITE PREPARATION AND GRADING

At this time, only preliminary building details of the proposed building are available and is has been assumed that the desired finished grade elevation will match the existing ground surface, therefore very little to no engineered fill will be required to be placed and compacted within the building area. Based on our assessment of the subsurface conditions encountered on this site, a grade raise restriction of 0.3 m should be applied to limit potential settlement within the underlying silty clay.

The existing topsoil and the existing asphaltic concrete should be removed from the entire new building footprints. At the completion of the topsoil stripping and prior to any placement of new fill, the subgrade within the building area should be proof-rolled. The purpose of the proof-rolling is to provide surficial densification and to locate any isolated areas of soft or loose soils. Unsuitable areas should be removed and replaced with compacted fill meeting the requirement described later in this report. Both stripping and proof-rolling operations should be observed and carried out to the satisfaction of geotechnical personnel. All stripping and earthwork activities should be performed in a manner consistent with good erosion and sediment control practices. Prior to placement of any new granular material, the exposed top of subgrade should be inspected and approved by qualified personnel to ensure drainage is maintained across the footprint of the foundation of the new warehouse buildings.

4.4 MATERIAL REUSE

The native soils (silty clay and glacial till) are not considered to be suitable for reuse as structural engineered fill. However, these soils could be reused in general earth borrow in non-structural areas (i.e., landscaping) depending upon its environmental suitability, which is not included as part of this assignment. The granular base immediately below the asphaltic concrete in the existing parking lots can be reused as engineered fill provided it is properly segregated from the silty clay below during its excavation.

It is anticipated that during the excavation for new foundations within the existing building the soils will become mixed and segregation is not realistic; therefore these excavated materials are not suitable for reuse, but could be used as general site fill in landscaped areas.

Excess soils will need to be properly removed from site based on the new environmental regulations. An environmental investigation maybe required if excess soils need to be removed from the site.

4.5 ENGINEERED FILL

Prior to placing engineered fill, the exposed subgrade should be inspected by qualified geotechnical personnel to confirm that the exposed soils are suitable and undisturbed and have been adequately cleaned of ponded water and all disturbed, loosened, softened, organic and other deleterious material. Remedial work (i.e. further sub-excavation and replacement) should be carried out as directed by geotechnical personnel.

Imported materials to be used for engineered fill should be approved by geotechnical personnel. In this regard, imported materials which meet the requirements for OPSS Granular A or Granular B Type I or II would be suitable for use as engineered fill under footings or other foundation elements.

The approved materials for engineered fill should be placed in maximum 300 mm loose lifts and be uniformly compacted to 98 percent of SPMDD throughout using suitable vibratory compaction equipment. The placement of engineered fill must be monitored by qualified geotechnical personnel on a full-time basis. The top surface of the engineered fill should be protected as necessary from construction traffic and should be sloped to provide positive drainage for surface water during the construction period.

The upper surface of the engineered fill should extend to a minimum of 1 m outside of the outer edge of the exterior building foundation envelope (in all directions) and should be sloped downward and outward at no steeper than 1 horizontal to 1 vertical (1H:1V). Engineered fill slopes that will become permanently exposed fill slopes at the development, if any, should be flattened to 2H:1V or flatter, and should be covered with topsoil and sodded or otherwise treated to reduce erosion. Maintenance will be required over the first several years until the vegetative mat has taken root.

The placement of fill for paved areas (parking areas and access roads) may be required at the site. Imported materials which meet the requirements for OPSS earth borrow would be suitable for use as fill. This fill should be compacted to at least 95 percent of SPMMD. The placement of the fill should be monitored by geotechnical personnel on a regular basis. Placement of the upper 450 mm should be monitored on a full-time basis.

4.6 FOUNDATIONS

4.6.1 FROST PROTECTION

All exterior footings and any footings located in unheated portions of the building should be protected against frost heave by providing a minimum of 1.8 m of earth cover or the thermal equivalent if insulation is used in areas where snow will remain during winter months. In areas where the exterior grade is cleared during the winter months and exposed to freezing temperature, such as sidewalks, paved areas, etc. foundations in these areas should be provided with a minimum of 1.8 m of earth cover or the thermal equivalent if insulation is used.

In the event that foundations are to be constructed during the winter months, foundation soils are required to be protected from freezing temperatures using suitable construction techniques. Therefore, the base of all excavations should be insulated from freezing temperatures immediately upon exposure, until the time that heat can be supplied to the building interior and/or the foundations have sufficient earth cover to prevent freezing of the subgrade soils.

4.6.2 BEARING CAPACITY / RESISTANCES

For this assignment the geotechnical bearing resistances was evaluated for both the soils below the existing building and at frost depth for two the new buildings.

For this analysis, limited structural drawings have been provided for the existing building showing the interior pad foundations and the perimeter strip foundations. For these drawings it appears that the existing perimeter footings have been constructed at approximately 1.5 m below the existing ground surface. The existing internal foundations have been constructed at approximately 0.6 m below the existing floor slabs. The width of the existing perimeter strip foundations appears to be 1.2 m wide. The interior column pad foundations appear to vary in size from 1.7 m by 1.7 m to 2.75 m by 2.75 m.

It is not known at this time what additional footings will be required for the retrofit, however Table 4.1 provides various geotechnical resistances for both the existing and new foundations at various depths and sizes at different founding depths and subgrades. The provided geotechnical resistances for the new buildings accounts for additional site fill being limited to 0.3 m or less from existing grades. If additional site fill is required, then these geotechnical resistances will need to be reviewed.

Table 4.1 Summary of Geotechnical Resistances

Location	New/Existing Foundation Width, B (m)	Depth below Finished Floor Slab (m)	Founding Materials	Factored Ultimate Limit States, ULS (kPa)	Serviceability Limit States, SLS (kPa)
Phase I – Existing Building - Perimeter	1.2	1.5	Existing Granular Fill	100	90
Phase I – Existing Building - Interior	1.7	0.6	Existing Granular Fill	105	95
	2.1	0.6	Existing Granular Fill	110	100
	2.45	0.6	Existing Granular Fill	115	105
	2.75	0.6	Existing Granular Fill	115	105

Location	**New/Existing Foundation Width, B (m)**	**Depth below Finished Floor Slab (m)**	**Founding Materials**	**Factored Ultimate Limit States, ULS (kPa)**	**Serviceability Limit States, SLS (kPa)**
Phase II – Proposed Buildings A & B - Perimeter	1.2	1.8	Native Grey Silty Clay	85	40
	1.5	1.8	Native Grey Silty Clay	90	40
	2.0	1.8	Native Grey Silty Clay	95	40
Phase II – Buildings A & B, Interior	1.2	0.6	Weathered Silty Clay or Native Silty Sand	85	75
	1.5	0.6	Weathered Silty Clay or Native Silty Sand	90	80
	2.0	0.6	Weathered Silty Clay or Native Silty Sand	95	85

Provided that the foundation subgrade is properly prepared, and not unduly disturbed by construction activities, total and differential settlements associated with the above SLS resistance values are expected to be less than 25 mm and 20 mm, respectively.

All bearing surfaces should be checked, evaluated and approved at the time of construction by a geotechnical engineer who is familiar with the findings of this investigation and the design and construction of similar projects prior to placement of any concrete, back fill, etc.

Additional guidance related to bearing resistances can be provided based on preliminary designs. In particular, bearing resistances should be reviewed if the foundations are lower than previously indicated or if the foundation loads are too large for the assumed shallow foundation sizes.

4.7 SLAB ON GRADE

It is understood that at this point in the design, the concrete slab on grade is to remain inside the existing building.

The geotechnical resistance of the slab-on-grade itself at SLS will depend on the settlement characteristics of the soil below the slab, as well as the magnitude and geometry of loading. The geotechnical parameter typically used for analysis of settlement below a raft or slab is the vertical modulus of subgrade reaction. The modulus of vertical subgrade reaction is defined as:

$$K_{BxB}=q/\delta$$

Where:

q = applied bearing or contact pressure on footing

δ = settlement of footing under applied pressure q

Based on the field investigation a value of 75 MPa/m may be used for the modulus of subgrade reaction for the existing granular fill inside the building or for new compacted granular fill for Buildings A and B. A value of 20 MPa/m may be used for the modulus of subgrade reaction for very stiff weathered silty clay below.

The modulus of subgrade reaction is not a fundamental soil property, but is dependent upon the size and shape of the loaded area, soil type, relative stiffness of the raft and soil, duration of loading, etc. As a result, the modulus for a 300 mm square footing is typically used as a standard basis.

For loaded rectangular area greater than 300 mm square supported on granular fill the above value should be multiplied as follows:

$$k_{(BXB)} = k_{0.3}\left(\frac{B+0.3}{2B}\right)^2$$

For loaded rectangular area greater than 300 mm square on silty clay the above value should be multiplied as follows:

$$k_{(BXB)} = k_{0.3}\left(\frac{0.3}{B}\right)$$

Where:

k_{BxB} = the modulus for a square loaded area of length and width B (kN/m^3)

$k_{0.3}$ = Use 75 MPa/m (new or existing granular fill)

$k_{0.3}$ = Use 20 MPa/m (weathered very stiff silty clay) and

B = width of the loaded area;

For predictable performance of new floor slabs in Buildings A and B, the underslab fill should be prepared as previously described in Section 4.3 of this report. Provision should be made for at least 150 millimetres of OPSS Granular A to form the base for the floor slab.

A modulus of subgrade reaction value for the slab subgrade may be required by the structural engineer. A value of 20 MPa/m may be used provided at least 150 millimetres of OPSS Granular A is placed beneath the floor slab.

4.8 LATERAL EARTH PRESSURES

This section applies to below grade walls or retaining walls where either earth or granular backfill is in contact with the wall. Below grade walls that have earth or engineered fill up against them will be subject to lateral earth pressures. The following geotechnical parameters can be used for below grade walls that are backfill with granular materials.

Table 4.2 Lateral Earth Pressure Parameters (Granular Fills)

Parameter	OPSS Select Subgrade Material (SSM)	OPSS Granular A or Granular B, Type II
Unit Weight, γ_{moist}	20.0 kN/m^3	22.0 kN/m^3
Unit Weight, $\gamma_{submerged}$	10.0 kN/m^3	12.0 kN/m^3
Angle of Internal Friction (compacted), ϕ	32 degrees	35 degrees
Coefficient of Passive Earth Pressure, K_p	3.25	3.69
Coefficient of Active Earth Pressure, K_a	0.31	0.27
Coefficient of at-Rest Earth Pressure, K_o	0.47	0.43
Combined Active and Seismic Earth Pressure Coefficient, K_{AE}	0.61	0.55

4.8.1 STATIC LATERAL EARTH PRESSURE

The lateral static earth forces acting on permanent retaining walls and temporary shoring, etc. may be calculated using the following expressions:

$P = ½ K\gamma H^2$ and $P_{surcharge} = KqH$

Where:

P = lateral earth pressure forces (kN): earth force acts at $\frac{1}{3}$H and surcharge force acts at $\frac{1}{2}$H above the bottom of wall;

K = earth pressure coefficient; for unrestrained walls and structures where some movement is acceptable (such as retaining walls) use a coefficient of active earth pressure (K_a) and for restrained walls (such as basement walls) use the coefficient of earth pressure at rest (K_o)

γ = the moist unit weight of retained fill

H = the wall height (m)

q = the magnitude of any design surcharge at the ground surface, typically 12 kPa for standard vehicles;

Hydrostatic pressure should also be applied to the wall if submerged conditions are to be expected. Hydrostatic force should be applied at $\frac{1}{3}$H above bottom of the wall.

4.8.2 SEISMIC EARTH PRESSURE

Earth pressures will be higher under seismic loading conditions. The Mononobe-Okabe (M-O) method (see CFEM, 2006) is a pseudo-static analysis of seismic earth pressures during an earthquake. In order to account for seismic earth pressures, the total lateral thrust and its components during a seismic event (including both the seismic and static components) may be calculated as:

$P_{AE} = ½ K_{AE}\gamma H^2(1-k_v)$ and $P_A = ½ K_A\gamma H^2$ with $\Delta P_{AE} = P_{AE} - P_A$

Where: P_{AE} = the total active seismic thrust component (kN);

P_A = Static component of the lateral thrust, acting at $\frac{1}{3}$H above bottom of the wall;

ΔP_{AE} = Dynamic component of the lateral thrust, acting at 0.6H above the bottom of the wall;

K_{AE} = the combined active earth pressure and seismic earth pressure coefficient;

K_A = the coefficient of static active earth pressure;

γ = the moist unit weight of retained fill;

H = the total height of the wall (m).

It should be noted that earth pressure distributions are applicable over the full height of the wall. It should also be noted that the above lateral earth pressures are unfactored for limit states design.

4.8.3 HYDRODYNAMIC PRESSURE

For granular backfilled walls in potentially submerged conditions, the hydrodynamic pressure should be taken into account using the following expression:

$$P_w = (7/12)\ k_h \gamma_w H^2$$

Where:

k_h = horizontal peak ground acceleration (0.28)

γ_w = unit weight of water (9.8 kN/m^3)

H = height of wall (m)

According to CFEM (2006) the total thrust of water on the wall during a seismic event is the sum of the hydrostatic and hydrodynamic forces. The hydrostatic and hydrodynamic forces should be applied at 1/3H above bottom of the wall.

4.8.4 SLIDING RESISTANCE

Sliding resistance can be calculated using the following unfactored friction coefficients.

Table 4.3 Summary of Sliding Coefficients

Condition	Unfactored Friction Coefficient, tan δ	Interfacial Friction Angle, δ (degrees)
Between Concrete and Engineered Granular Fill	0.4	22
Between Concrete and Native Silty Sand	0.45	24
Between Concrete and Native Silty Clay	0.3	17
Between Reinforced Concrete and Lean Concrete or Mud Slab	0.6	31

4.9 FOUNDATION WALL BACKFILL

The native soils at this site may be potentially frost susceptible and should not be used as backfill against exterior or unheated foundation elements (e.g., footing, foundation walls, sunken loading docks, etc.). To avoid problems with frost adhesion and heaving, these foundation elements should be backfilled with one or more of the following:

- Non-frost-susceptible sand and/or gravel which meets that gradation requirements for OPSS Granular A or Granular B;
- Existing non frost susceptible soils salvaged from onsite excavations provided that the material is reviewed by a qualified geotechnical personnel prior to reuse; and ,
- 19 millimetre clear crushed stone, which is separated from other soils with a Class II non-woven geotextile having an FOS not exceeding 100 microns to prevent loss of adjacent sand, or silty soils into the clear stone. It should be noted that the use of clear stone as foundation backfill may lead to unfavourable growing conditions for plant matter placed in overlying topsoil.

Backfill should be placed in shallow lifts, not exceeding 200 mm loose thickness, and compacted to 98% SPMDD where it is supporting any structures or services, or 95% in other areas.

To avoid damaging or laterally displacing the structures, care should be exercised when compacting fill adjacent to new structures. Heavy equipment should be kept a minimum of 1 m away from the structure during backfilling. The 1 m width adjacent to the wall should be compacted using hand-operated equipment unless otherwise authorized.

In areas where pavement or other hard surfacing will be in contact the building, differential frost heaving could occur between the granular fill (if sand or crushed stone is used) and other areas. To reduce this differential heaving, the backfill adjacent to the wall should be placed to form a frost taper. The frost taper should be brought up to pavement subgrade level from 1.5 metres below finished exterior grade at a slope of 3 horizontal to 1 vertical, or flatter, away from the wall. The fill should be placed in maximum 300-millimetre thick lifts and should be compacted to at least 95 percent of the material's standard Proctor maximum dry density using suitable vibratory compaction equipment.

4.10 SITE SERVICES

Excavation for new site services up to approximately 1.5 m below the existing ground surface are expected to be within the native silty sands or weathered silty clay. Below 1.5 m from the ground surface, grey sensitive silty clay will likely be encountered. The bedrock surface at the site is highly variable and could be encountered at depths as shallow as 2.8 m or deeper than 8.1 m. If bedrock is encountered within the service excavation, the bedrock removal could be carried out using line drilling and mechanical methods of rock removal (such as hoe ramming), however, this work would likely be slow and tedious. Based on the close distance to other structures, controlled blasting is not recommended.

Details of the proposed site services are not available at this time; however, it is assumed that they will include localized trenches throughout the site. Trenches can be temporarily supported using sloped excavations or trench boxes as outlined in Section 4.13.2 of this report.

The water and sewer services will need to be protected against freezing conditions and water-bearing services should be placed a minimum of 2.4 m below grade to provide protection from frost. Alternatively, equivalent insulation cover may be provided in lieu of burial.

Bedding and cover components for municipal services (water, storm sewer and sanitary sewer) should be in accordance with corresponding City of Ottawa Specifications and Standard Drawings W17 and S6. Service excavations that encounter bedrock at or above the bedding level do require different bedding requirements as shown in Standard Drawings W17 and S6. Recommendations for bedding and cover for the project specific heating and cooling distribution piping should be covered in the geotechnical report prepared for the Distribution Network (separate cover).

Bedding for site services should be in accordance with the relevant OPSD standard drawing and would typically consist of Granular "A" compacted to 95% SPMDD. Where wet or disturbed conditions are encountered in the base of the trench it may be necessary to over-excavate and replace unsuitable soils with compacted granular fill to provide a stable sub-grade for the bedding. The use of clear stone as a bedding and cover material is not recommended as the finer particles of the native soils and backfill may migrate into the voids of the clear stone, resulting in loss of pipe support.

Cover material above the spring line should consist of Granular "A" or Granular "B" material with a maximum particle size of 25 mm. Cover material should be compacted to a minimum of 95% SPMDD.

Backfill may consist of additional granular fill, or properly moisture conditioned native silty clay and should be compacted to 95% SPMDD (98% if below structures). Where backfill is within the frost depth, the backfill profile (above the minimum cover required) in the trench should be made to match the native soils on either side as much as is practical in order to minimize the potential for differential frost heave. As a result, portions of the silty clay above the water table may be retained, moisture conditioned (if necessary) and re-used.

Any service trenches which extend below the water table should have clay cut-offs installed across the trench at regular intervals (typically 100 m) to prevent the trench acting as a drain and lowering the groundwater table in the general area. These cut-offs should extend the full width of the trench and must completely penetrate the bedding, cover and any other granular materials in the trench.

The above are general guidelines for typical site services. All services installations should be completed in accordance with the relevant OPSS's and OPSD's for the particular application and size. WSP can provide additional review during detailed design based on the actual services proposed if required.

4.11 PAVEMENTS

The existing pavement structure at the site is quite thin with asphaltic concrete thickness varying from 20 mm to 45 mm and the underlying granular base is approximately 180 mm thick. This light duty flexible pavement will likely not be remaining in a serviceable condition after construction of the new buildings is complete. Either full depth replacement or partial depth replacement should be planned for this site after construction is complete. Partial depth replacement would consist of removing the broken asphaltic concrete, regrading the existing granular base, placing the recommendation additional granular base depending on the anticipated traffic loading and place new asphaltic concrete. If grade raise restriction do not allow for the additional thickness of the new pavement structure, then full depth reconstruction of the pavement areas would be necessary. For either option the asphalt pavement sections in the following section should be ultimately constructed.

4.11.1 FLEXIBLE PAVEMENTS

Detailed traffic loads have not been provided at this time, however based on the subsoil conditions encountered, conventional asphaltic (flexible) pavement designs are considered to be appropriate for proposed paved parking areas for cars and light weight trucks, driveways and access roads. Based on the results of this investigation and experience, the following asphaltic pavement design is recommended for the indicated areas.

Table 4.4 Recommended Pavement Structures

Pavement Layer	Light Duty Traffic and Parking Areas for Cars and Light weight trucks	Heavy Duty Traffic Areas (Delivery Trucks, Fire Routes, Access Roads, etc.)
Asphaltic Concrete	50 mm HL-3 or SP 12.5, Surface Course	40 mm HL-3 or SP 12.5, Surface Course 50 mm HL-8 or SP 19.0, Base Course
Granular Base Course	150 mm OPSS Granular “A”	150 mm OPSS Granular “A”
Granular Sub-base Course	300 mm of New OPSS Granular “B” or combined thickness of 300 mm with the existing granular base	450 mm New OPSS Granular “B” or combined thickness of 450 mm with the existing granular base

Asphalt materials and placement specifications should be in accordance with relevant Provincial standard specifications. The asphaltic cement should be PG 58-34.

A functional design life of eight to ten years has been used to establish the flexible pavement recommendations. This represents the number of years to the first rehabilitation, assuming regular maintenance is carried out. If required, a more refined pavement structure design can be performed based on specific traffic data and design life requirements provided by the client.

Sidewalks and Unit Pavers should be constructed. in general accordance with City of Ottawa Standard Specifications and Detail Drawings, such as No. SC4 and No. SC9, respectively.

4.11.2 RIGID PAVEMENTS

Rigid pavements could be considered sunken loading dock areas, in areas where heavy vehicles will be parked or standing for prolonged periods of time and in heavy trafficked entry and exit areas for heavy vehicles. Rigid pavement will perform better than a flexible section in these critical areas.

The following pavement structure is recommended for the rigid (concrete) pavement areas:

Table 4.5 Recommended Rigid Pavement Structure

Pavement Layer	Material
Rigid Pavement	180 mm of Concrete
Granular Base Course	400 mm OPSS Granular "A"

It would be prudent to provide the same subgrade level across rigid and flexible pavement sections and thus prevent the need to construct frost tapers.

The concrete should satisfy the requirements of CAN/CSA A 23.1 Class C-2 concrete with a minimum compressive strength of 32 MPa and should have a minimum flexural strength of 4.1 MPa. The base should be compacted to 100 percent of its standard Proctor maximum dry density.

The pavement could be expected to perform better in the long term if the granular backfill against the foundation walls is drained by means of a perforated pipe subdrain in a surround of 19 millimetre clear stone, fully wrapped in geotextile, which leads by gravity drainage to a positive outlet as outlined above.

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

4.11.3 PAVEMENT TRANSITIONS

Excavation of the existing and reinstatement of the granular base material should be such that the surface of the new pavement matches the elevation of the existing pavement surface, as adjusted during the detailed design. Construction traffic is to be controlled to minimize damage and protect the integrity of the subgrade, base and subbase layers during construction. Butt joints, step joints, and tack coating are recommended to tie the new pavement with the existing pavement. In areas where the new pavement will abut the existing pavement, the depth of the granular sub-base should taper up or down at a 5 horizontal to 1 vertical, or flatter, to match the depths of the existing granular material(s) exposed in the existing pavement.

4.11.4 PAVEMENT DRAINAGE

Adequate drainage of the pavement granular materials and subgrade is important for the long-term performance of the pavement at this site. Site grading is recommended to provide positive drainage in the new pavement areas; the pavement subgrade should be shaped and crowned to promote drainage of the pavement area granular materials. The subgrade should be sloped at a minimum of 1 percent to provide adequate sheet flow. Where storm sewers are used to convey surface water runoff, stub drains should be constructed at each catch basin, and extend a minimum of 3 m in at least two directions from each catch basin at the pavement subgrade level. Perimeter drainage is also suggested.

Stub drains and perimeter subdrains should be a minimum of 300 mm below the bottom of the granular subbase and be connected to the catch basins to provide positive drainage. The subgrade drains should consist of 100 or 150 mm diameter geotextile wrapped perforated pipe, surrounded on all sides by at least 150 mm of 16 or 19-millimetre clear crushed stone. The pipes should be placed such that the top of the clear stone is at subgrade level.

4.11.5 CONSTRUCTION CONSIDERATIONS

The long-term performance of the pavement is highly dependent upon the subgrade support conditions. Stringent construction control procedures should be maintained to ensure uniform subgrade moisture and density conditions are achieved. In addition, the need for adequate drainage cannot be over-emphasized. The finished pavement surface and underlying subgrade should be free of depressions and should be sloped to provide effective surface drainage toward catch basins. Surface water should not be allowed to pond adjacent to the outside edges of pavement areas. Subdrains can also be placed at catch basins and along curb lines to further improve sub-surface drainage.

As part of the subgrade preparation, proposed parking areas and access roadways should be stripped of topsoil and other obvious objectionable material. Fill required to raise the grades to design elevations should conform to backfill requirements outlined in previous sections of this report. The subgrade should be properly shaped, crowned then proof-rolled in the full-time presence of a representative of this office. Soft or "spongy" subgrade areas should be sub-excavated and properly replaced with suitable approved backfill compacted to 98% SPMDD. Base and sub-base layers should be compacted to 100% of SPMDD.

The most severe loading conditions on light-duty pavement areas and the subgrade may occur during construction. Consequently, special provisions such as restricted access lanes, half-loads during paving, etc., may be required, especially if construction is carried out during unfavourable weather.

4.12 CORROSION AND CEMENT TYPE

Four samples were submitted to Eurofins for testing related to soil corrosivity and potential exposure of concrete elements to sulphate attack. The results this testing is included in **Appendix C** and summarized in table below.

Table 4-6 Results of Soil Corrosivity Testing

Borehole/ Sample No.	Depth (m)	Chloride (%)	Electrical Conductivity (mS/cm)	pH	Resistivity (ohm-cm)	Sulphate (%)
BH21-1i	0.3-0.4m	0.004	0.24	8.12	4,170	0.04
BH21-4i	2.0-2.6m	0.006	0.20	8.07	5,260	0.02
BH21-2s	0.8 - 1.4	0.032	0.47	8.05	2,130	<0.01
BH21-5s	1.5 -2.1	0.018	0.29	8.18	3,570	0.01

The soil resistivity values show a moderate to high corrosive environment for buried steel elements. These values must be taken into consideration during design of below-grade steel elements.

The test results indicate a low soluble sulphate content and sulphate resistant Portland cement is not required.

4.13 CONSTRUCTION CONSIDERATIONS

It is understood that excavation work will be required as part of the overall construction of the new fire pump house building. Where work is required near the existing and new structural elements, the following recommendations are provided:

4.13.1 TEMPORARY DEWATERING

The groundwater level at the site was found to vary between 0.6 m and 3.1 m below the existing ground surface and is generally higher along the northeast portion of the site. This maybe the result of the stormwater management pond located at the southeast corner of the site. The groundwater appears to be within the native silty clay at the site. For excavations above the water table and slightly below (less than 0.5 m) the water table, it is likely that seepage into the excavations can be managed using properly filtered sumps, ditches, etc. For deeper excavations, additional or more complex dewatering may be required, especially if the excavation enters the underlying bedrock. WSP can provide additional guidance based on the size and depth of anticipated excavations, if required during detailed design.

Assuming that the new construction will be at or above the groundwater level observed in the standpipe piezometer then in this situation any groundwater inflows encountered would be expected to be low and manageable by pumping from closely spaced, properly filtered sumps. The excavation would not be expected to require a MOECC Environmental Activity and Sector Registration (EASR – which covers construction dewatering up to 400,000 l/day) or a Permit to Take Water (PTTW – which is required for dewatering in excess of 400,000 l/day). If substantially deeper excavations are required, fractured bedrock is encountered or construction is scheduled during wetter periods (such as the spring) then this assumption should be reviewed during detailed design. It should be noted that this discussion applies to groundwater flows. An assessment of the requirements for surface water diversion should be made by others.

The soils present at the site are expected to be sensitive to disturbance and proper control of the groundwater infiltration (by construction of sumps, use of well points, etc.) will be required to prevent excessive disturbance. Failure to adequately control groundwater inflows may result in disturbance of the subgrade and a need for over-excavation and replacement of disturbed subgrade soil.

4.13.2 TEMPORARY EXCAVATIONS

All excavations should be carried out in accordance with the most recent Occupational Health and Safety Act (OHSA), Part III of Ontario Regulation 213/91.

The soils within the expected excavation include topsoil, silty sand and silty clay above the groundwater level. These soils above the groundwater level or depth of dewatering can be classified as Type 3 soils and Type 4 soils below the groundwater table (or depth of watering). These classifications must be reviewed and confirmed by a qualified person during excavation. Excavations within Type 3 soil require side slopes with a minimum gradient of 1 horizontal to 1 vertical and excavations within Type 4 soil require side slopes of 3 horizontal to 1 vertical.

If limited space is available, a temporary shoring system may be used. Once the location of the building and various excavations are determined the potential need for vertical shoring can be reviewed. The design of any the shoring system must be carried out by a professional engineer and take into consideration the stability of the excavation as well as the effect of the excavation upon the neighbouring buildings and structures. The contractor is typically responsible for the detailed design of temporary shoring.

If required, WSP can provide additional guidance based on preliminary excavation plans, depths, etc. during the detailed design phase of the project.

4.13.3 SUBGRADE PREPARATION

The geotechnical bearing resistances provided in Section 4.6 assume that the foundation soils will not be disturbed by construction activities. Proper de-watering and protection of exposed soil subgrades will be important to the construction of the foundations. All excavated surfaces should be kept free of frost, water, etc. during the course of construction. All excavated surfaces should be inspected by a qualified geotechnical engineer who is familiar with the findings of this investigation and the design and construction of similar structures.

The foundations soils at the site are expected to be sensitive to disturbance from ponded water and construction traffic if the subgrade for the foundations and floor slab is exposed for a prolonged duration and/or exposed to construction traffic then placement of a mud slab directly on the subgrade may be required to protect the subgrade from these elements.

4.13.4 WINTER CONSTRUCTION

Should construction be carried out during freezing temperatures, exposed frost susceptible subgrade fill should be protected immediately from freezing using one or a combination of: straw, propane heaters, polystyrene insulation, insulated tarpaulins, or other suitable means that prevent the underlying soil from freezing, which could cause frost heave.

5 CLOSURE

The Limitations of Report, as presented in **Appendix D**, are an integral part of this report.

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

WSP Canada Inc.

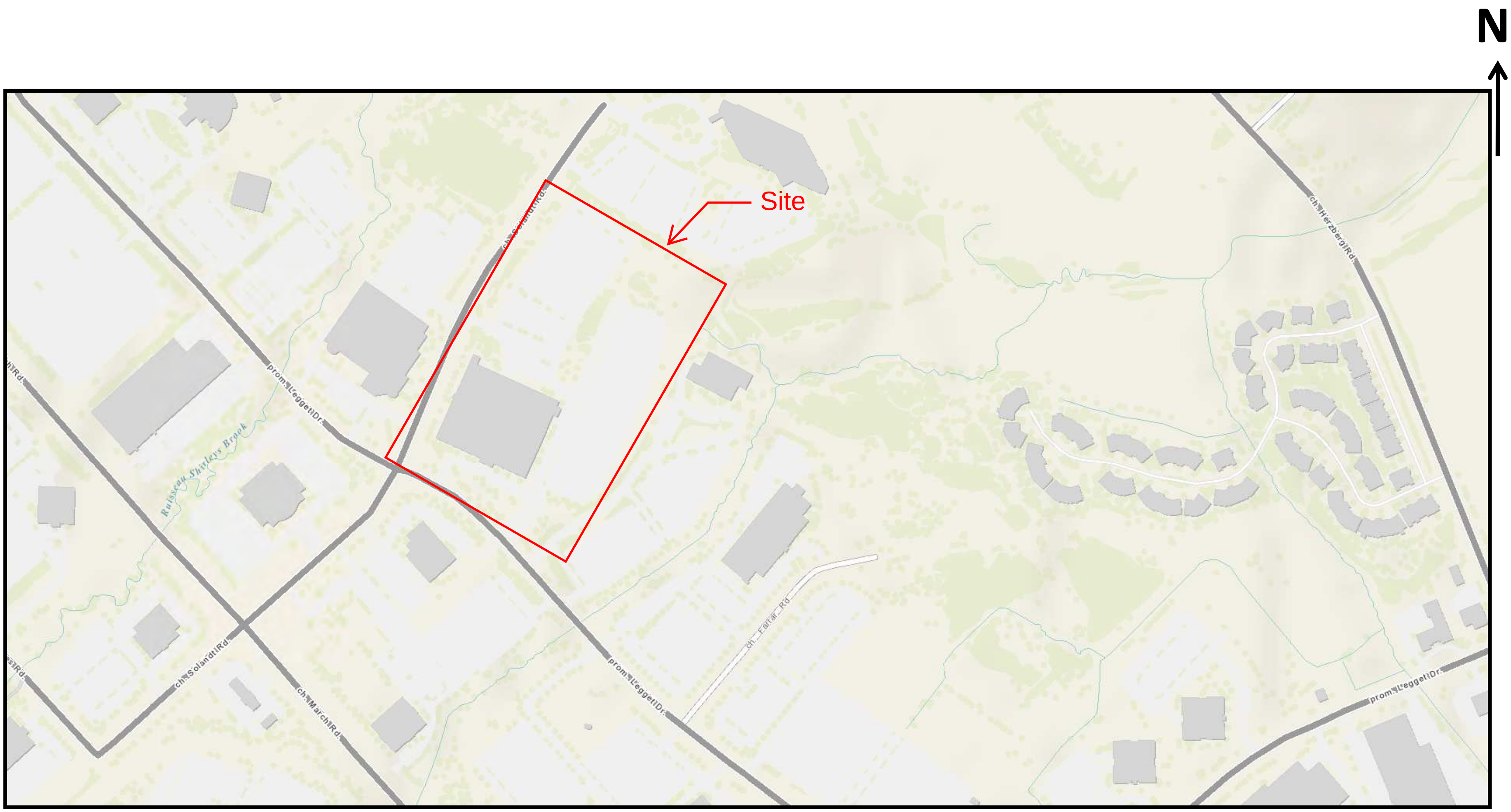
Report prepared by:

Daniel Wall, P.Eng.	Bruce Goddard, P.Eng.
Geotechnical Engineer	Senior Geotechnical Engineer

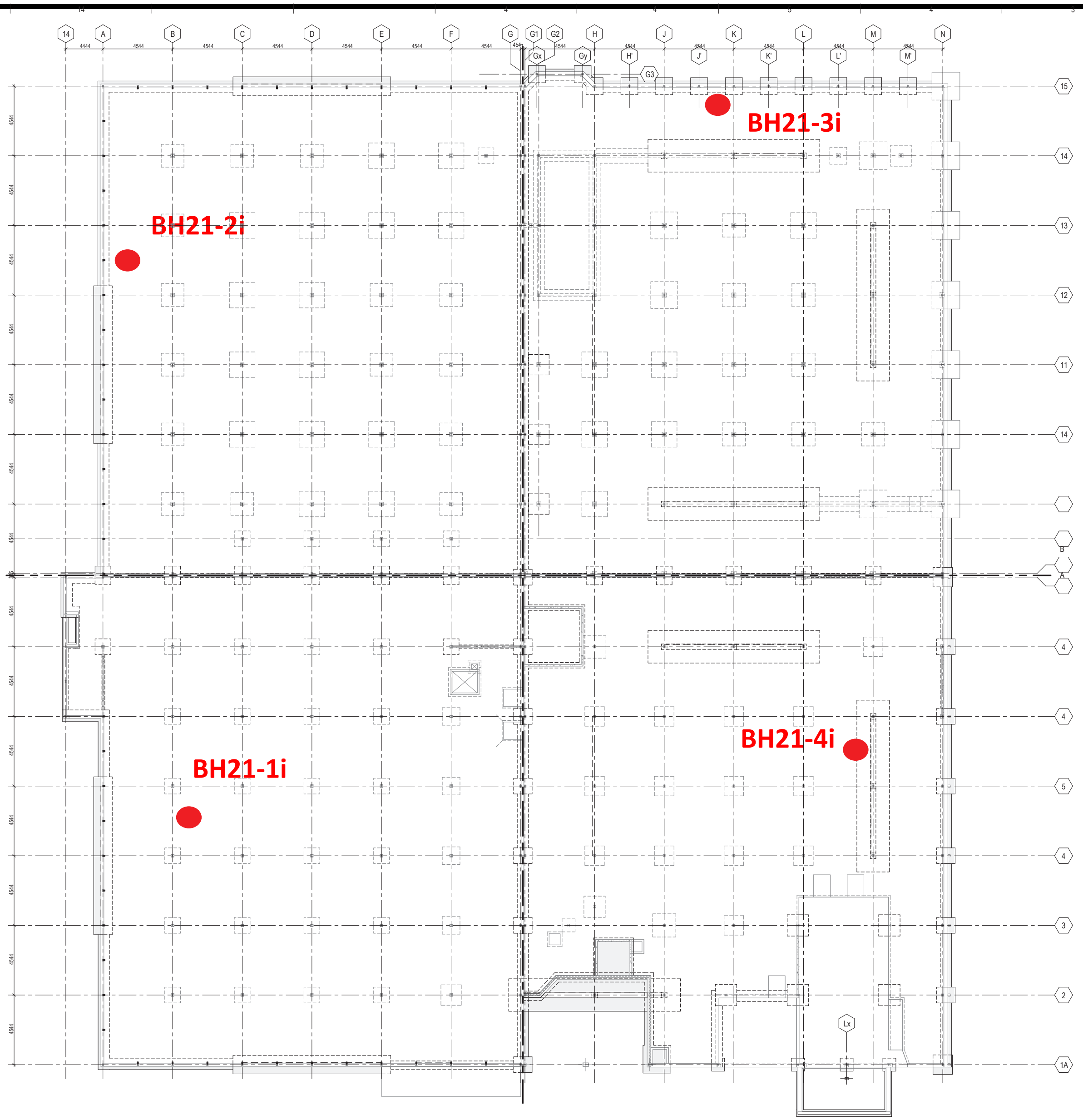
APPENDIX

A

DRAWINGS



Client:	Access Property Development			Title:	Site Location Plan
Project#:	219-00058-03	DWG #:	1	Project:	Geotechnical Investigation 415 Legget Drive
Drawn:	DW	Approved:	BG		
Date:	October 2021	Scale:	N. T. S.		
Size:	Letter	Rev:	0		



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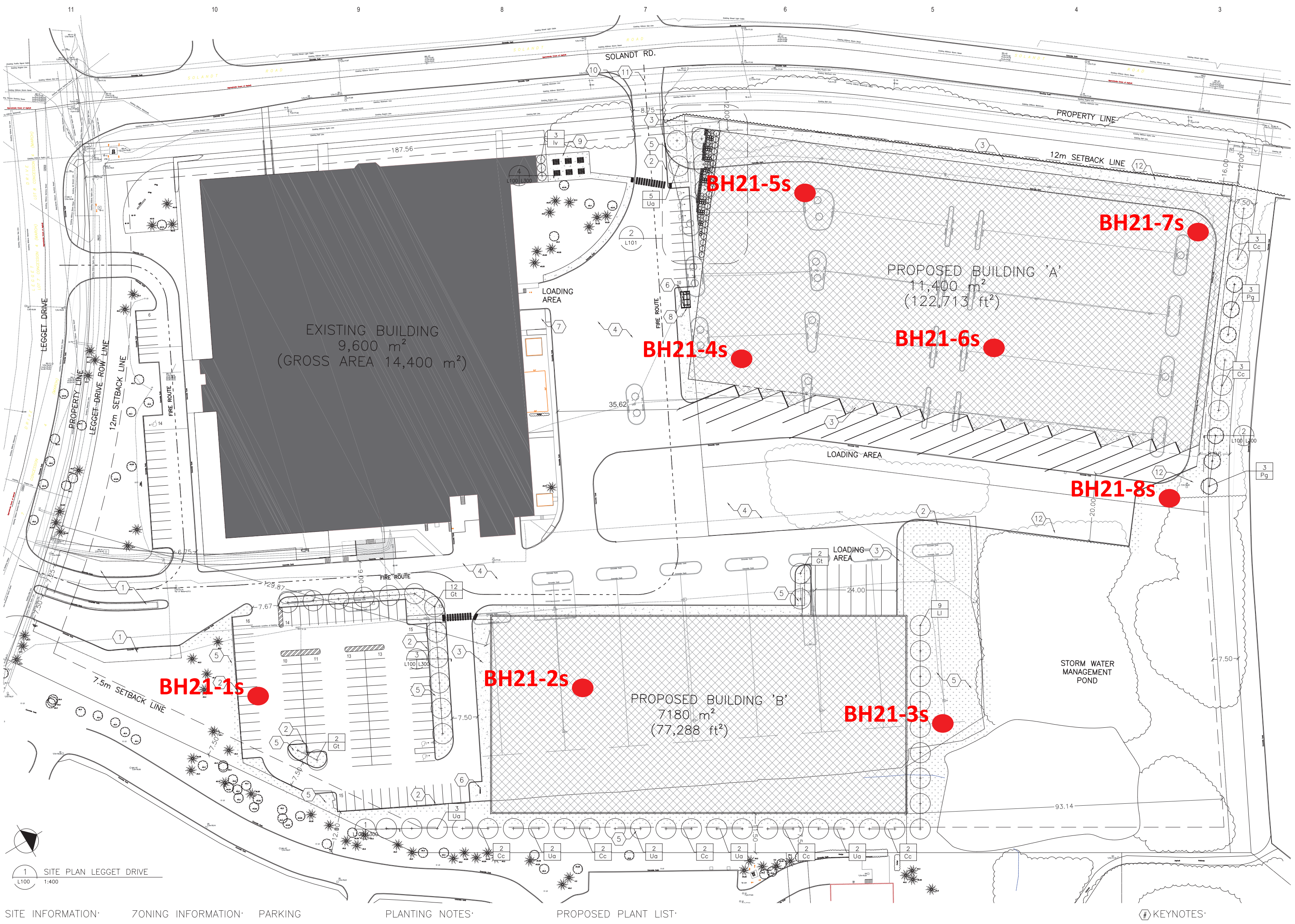
Project#:	219-00058-03	DWG #:	2A	Project:	Geotechnical Investigation 415 Legget Drive
Drawn:	DW	Approved:	BG		
Date:	October 2021	Scale:	N. T. S.		
Size:	Letter	Rev:	0		



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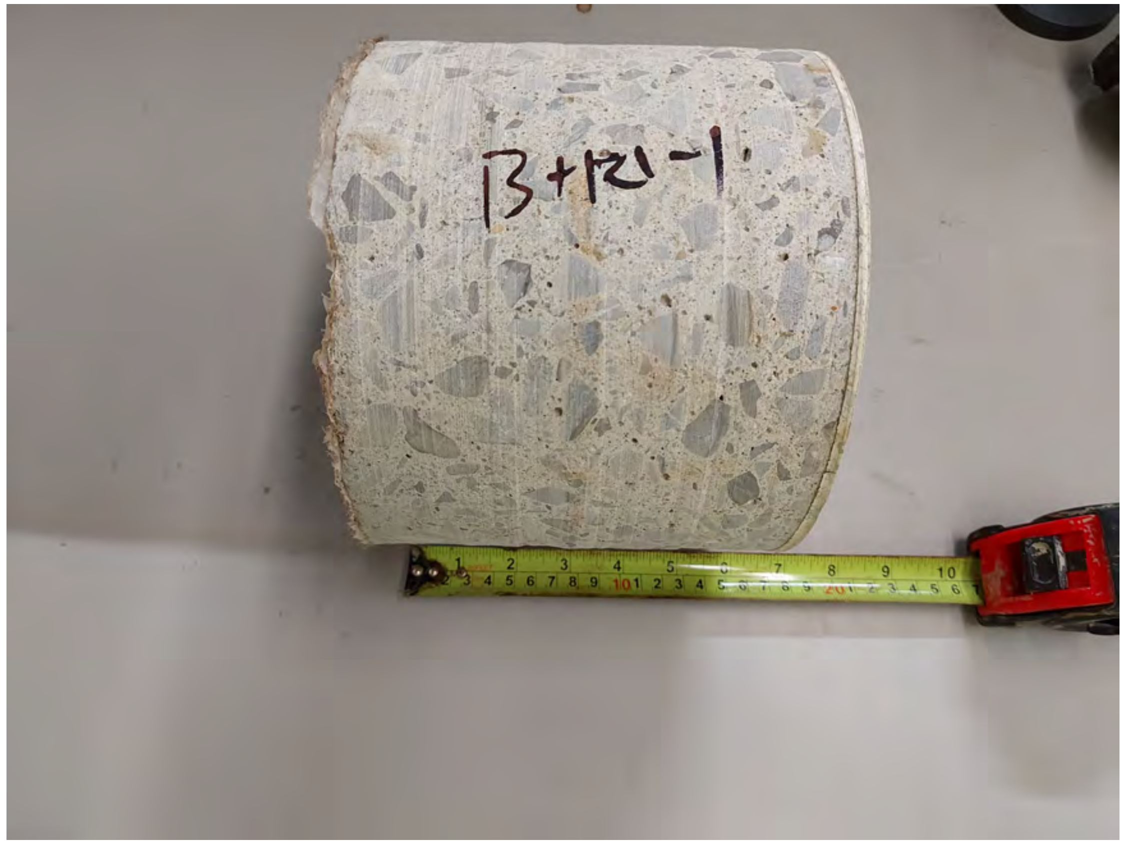
Project#:	219-00058-03	DWG #:	2B	Project:	Geotechnical Investigation 415 Legget Drive
Drawn:	DW	Approved:	BG		
Date:	October 2021	Scale:	N. T. S.		
Size:	Letter	Rev:	0		

Borehole BH 21-01i



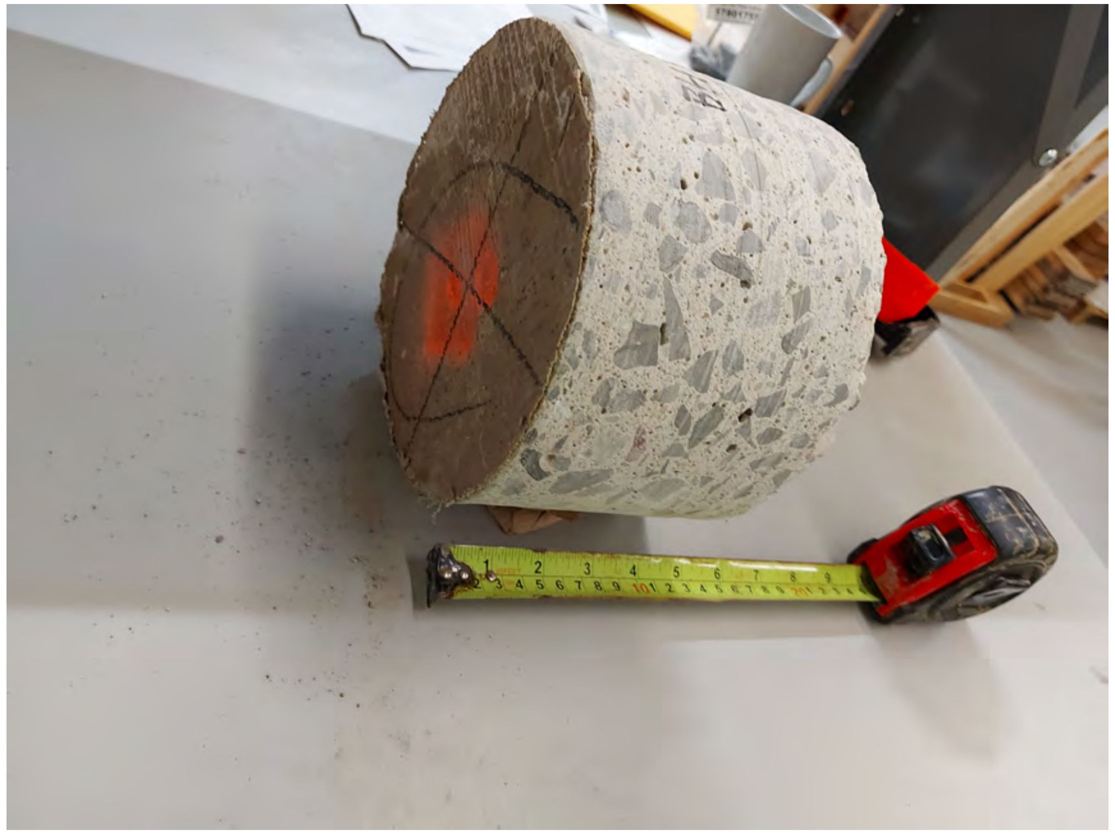
Side View

Top View

Client:	Access Property Development			Title:	Concrete Core Photos
Project#:	219-00058-03	DWG #:	3A	Project:	Geotechnical Investigation 415 Legget Drive
Drawn:	DW	Approved:	BG		
Date:	October 2021	Scale:	N. T. S.		
Size:	Letter	Rev:	0		

Borehole BH 21-02i

Side View



Top View

Client:	Access Property Development			Title:	Concrete Core Photos
Project#:	219-00058-03	DWG #:	3B	Project:	Geotechnical Investigation 415 Legget Drive
Drawn:	DW	Approved:	BG		
Date:	October 2021	Scale:	N. T. S.		
Size:	Letter	Rev:	0		

Borehole BH 21-03i

Side View

Top View

Client:	Access Property Development	Title:	Concrete Core Photos
Project#:	219-00058-03	DWG #:	3C
Drawn:	DW	Approved:	BG
Date:	October 2021	Scale:	N. T. S.
Size:	Letter	Rev:	0

Project: Geotechnical Investigation
415 Legget Drive

Borehole BH 21-04i

Side View

Top View

Client:	Access Property Development			Title:	Concrete Core Photos
Project#:	219-00058-03	DWG #:	3D	Project:	Geotechnical Investigation 415 Legget Drive
Drawn:	DW	Approved:	BG		
Date:	October 2021	Scale:	N. T. S.		
Size:	Letter	Rev:	0		

APPENDIX

B

BOREHOLE LOGS

EXPLANATION OF TERMS USED IN BOREHOLE RECORDS

LOG OF BOREHOLE 21-01i

PROJECT: Access Storage - 415 Legget Drive
CLIENT: Access Property Development
PROJECT LOCATION: 415 Legget Drive, Ottawa, ON
DATUM: Geodetic
BH LOCATION: See Borehole Location Plan

DRILLING DATA
Method: Hand Portable Drilling
Diameter: 76 mm
Date: Sep/29/2021

REF. NO.: 219-00058-03
ENCL NO.:

(m) ELEV / DEPTH	SOIL PROFILE: DESCRIPTION	SAMPLES: NUMBER	TYPE	"N" BLOWS / 0.3 m	GROUND WATER CONDITIONS	REMARKS AND GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
78.5						
0.0	**CONCRETE - 150 mm**					
78.4 0.2	**SAND ,** trace silt, trace gravel, brown, moist (Granular Base)	1	GRAB			9 84 (7)
78.1 0.4	**GRAVEL and COBBLE,** possible sand and silt infilling, wet (FILL)	2	GRAB			
		1	CORE		▽ W. L. 77.3 m October 4th, 2021	
76.5 2.0	**SILTY CLAY,** brown grey, wet, stiff to very stiff (Weathered Crust)	3	SS	23		
		4	SS	31		
		5	SS	10		

ELEVATION: 78, 77, 76, 75
DEPTH: 1, 2, 3, 4

DYNAMIC CONE PENETRATION RESISTANCE PLOT: 20 40 60 80 100
SHEAR STRENGTH (kPa): ○ UNCONFINED + FIELD VANE & Sensitivity ● QUICK TRIAXIAL × LAB VANE: 25 50 75 100 125
PLASTIC LIMIT W_P — NATURAL MOISTURE CONTENT W — LIQUID LIMIT W_L
WATER CONTENT (%): 20 40 60
POCKET PEN. (Cu) (kPa)
NATURAL UNIT WT (kN/m^3)

Continued Next Page

GROUNDWATER ELEVATIONS
Measurement 1st ▽ 2nd ▼ 3rd ▼ 4th ▼

GRAPH NOTES: $+^3, \times^3$: Numbers refer to Sensitivity ○ ^{8}=3% Strain at Failure

WSP SOIL LOG-LARGE SCALE-2016-1WELL GINT.GPJ SPL.GDT 10/22/21

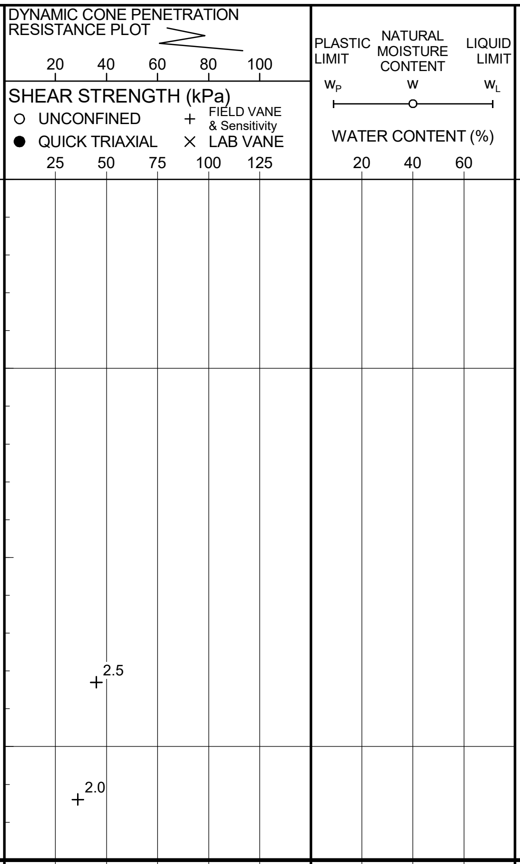
LOG OF BOREHOLE 21-01i

PROJECT: Access Storage - 415 Legget Drive
CLIENT: Access Property Development
PROJECT LOCATION: 415 Legget Drive, Ottawa, ON
DATUM: Geodetic
BH LOCATION: See Borehole Location Plan

DRILLING DATA
Method: Hand Portable Drilling
Diameter: 76 mm
Date: Sep/29/2021

REF. NO.: 219-00058-03
ENCL NO.:

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION	REMARKS AND GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
(m) ELEV / DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE	"N" BLOWS / 0.3 m			
	SILTY CLAY, brown grey, wet, stiff to very stiff (Weathered Crust)(Continued)	▨	6	SS	8			
73.9 4.6	**SILTY CLAY,** grey, wet, firm	▨	7	SS	5		74	
		▨		VANE				
		▨		VANE			73	
72.7 5.8	END OF BOREHOLE Notes: 1. Borehole was sampled using a third weight hammer. The blows in this log have been corrected 2. Borehole is left open for 3 days. Water noted at 1.2 m in depth. Borehole is open to 2.0 m in depth.							



POCKET PEN. (Cu) (kPa)

NATURAL UNIT WT (kN/m^3)

5

GROUNDWATER ELEVATIONS
Measurement 1st ▽ 2nd ▼ 3rd ▼ 4th ▼

GRAPH NOTES
$+^3, \times^3$: Numbers refer to Sensitivity
○ ^{8}=3% Strain at Failure

LOG OF BOREHOLE 21-02i

PROJECT: Access Storage - 415 Legget Drive
CLIENT: Access Property Development
PROJECT LOCATION: 415 Legget Drive, Ottawa, ON
DATUM: Geodetic
BH LOCATION: See Borehole Location Plan

DRILLING DATA
Method: Hollow Stem Augers
Diameter: 76 mm
Date: Sep/30/2021

REF. NO.: 219-00058-03
ENCL NO.:

DYNAMIC CONE PENETRATION RESISTANCE PLOT: 20 40 60 80 100
SHEAR STRENGTH (kPa): ○ UNCONFINED + FIELD VANE & Sensitivity ● QUICK TRIAXIAL × LAB VANE: 25 50 75 100 125
PLASTIC LIMIT w_P — NATURAL MOISTURE CONTENT w — LIQUID LIMIT w_L; WATER CONTENT (%): 20 40 60
POCKET PEN. (Cu) (kPa)
NATURAL UNIT WT (kN/m^3)

SOIL PROFILE (m) ELEV / DEPTH	DESCRIPTION	SAMPLES NUMBER	TYPE	"N" BLOWS / 0.3 m	GROUND WATER CONDITIONS	ELEVATION	GR	SA	SI	CL
78.5										
0.0	**CONCRETE - 130 mm**									
78.4 0.1	**CRUSHED SAND AND GRAVEL,** grey, moist (Granular Base)	1	GRAB					54	43	(3)
78.3 0.2	**GRAVEL and COBBLE,** possible sand and silt infilling, wet (FILL)					78				
		2	GRAB							
1		1	CORE		∇ W. L. 77.3 m October 4th, 2021	77				
76.8 1.7	**SILTY CLAY,** brown grey, wet, stiff (Weathered Crust)									
2		3	SS	23		76				
		4	SS	31						
3		5	SS	10		75				
4		6	SS	8						

Continued Next Page

GROUNDWATER ELEVATIONS
Measurement 1st ∇ 2nd ▼ 3rd ▼ 4th ▼

GRAPH NOTES
$+^3, \times^3$: Numbers refer to Sensitivity
○ ε=3% Strain at Failure

LOG OF BOREHOLE 21-02i

PROJECT: Access Storage - 415 Legget Drive
CLIENT: Access Property Development
PROJECT LOCATION: 415 Legget Drive, Ottawa, ON
DATUM: Geodetic
BH LOCATION: See Borehole Location Plan

DRILLING DATA
Method: Hollow Stem Augers
Diameter: 76 mm
Date: Sep/30/2021

REF. NO.: 219-00058-03
ENCL NO.:

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH (kPa) ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE & Sensitivity × LAB VANE (25 50 75 100 125)	PLASTIC LIMIT W_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT W_L — WATER CONTENT (%) (20 40 60)	POCKET PEN. (Cu) (kPa)	NATURAL UNIT WT (kN/m^3)	REMARKS AND GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
(m) ELEV / DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE	"N" BLOWS / 0.3 m							
74.4		▨										
4.1	**SILTY CLAY,** grey, wet, stiff	▨	7	SS	5		74					
		▨		VANE				+ 3.0				
5		▨		VANE				+ 2.5				
73.2		▨										
5.3	END OF BOREHOLE Notes: 1. Borehole was sampled using a third weight hammer. The blows in this log have been corrected 2. Borehole is left open for 3 days. Water noted at 1.2 m in depth. Borehole is open to 2.3 m in depth.											

GROUNDWATER ELEVATIONS
Measurement 1st ▽ 2nd ▼ 3rd ▼ 4th ▼

GRAPH NOTES
+ 3, × 3: Numbers refer to Sensitivity
○ ε=3% Strain at Failure

LOG OF BOREHOLE 21-03i

PROJECT: Access Storage - 415 Legget Drive
CLIENT: Access Property Development
PROJECT LOCATION: 415 Legget Drive, Ottawa, ON
DATUM: Geodetic
BH LOCATION: See Borehole Location Plan

DRILLING DATA
Method: Hollow Stem Augers
Diameter: 76 mm
Date: Oct/01/2021

REF. NO.: 219-00058-03
ENCL NO.:

(m) ELEV / DEPTH	DESCRIPTION	NUMBER	TYPE	"N" BLOWS / 0.3 m	ELEVATION	REMARKS AND GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
78.5						
0.0	**CONCRETE - 120 mm**					
78.4 0.1	**CRUSHED SANDY GRAVEL,** grey, moist (Granular Base)	1	GRAB			72 26 (2)
78.2 0.3	**GRAVEL and COBBLE,** possible sand and silt infilling, wet (FILL)	2	GRAB			
		1	CORE		78 77	
76.7 1.8	**SILTY CLAY,** brown grey, wet, stiff (Weathered Crust)	3	SS	8		
		4	SS	15	76	
		5	SS	3	75	
74.8 3.7	**SILTY CLAY,** grey, wet, firm	6	SS	2		

DYNAMIC CONE PENETRATION RESISTANCE PLOT: 20 40 60 80 100
SHEAR STRENGTH (kPa): ○ UNCONFINED, + FIELD VANE & Sensitivity, ● QUICK TRIAXIAL, × LAB VANE: 25 50 75 100 125
PLASTIC LIMIT w_P, NATURAL MOISTURE CONTENT w, LIQUID LIMIT w_L; WATER CONTENT (%): 20 40 60
POCKET PEN. (Cu) (kPa)
NATURAL UNIT WT (kN/m^3)
STRATA PLOT
GROUND WATER CONDITIONS

Continued Next Page

GROUNDWATER ELEVATIONS
Measurement 1st ▽ 2nd ▼ 3rd ▼ 4th ▼

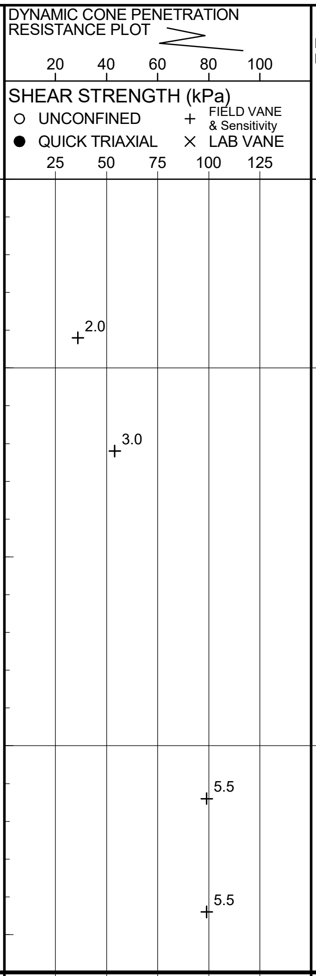
GRAPH NOTES: $+^3, \times^3$: Numbers refer to Sensitivity ○ ε=3% Strain at Failure

LOG OF BOREHOLE 21-03i

PROJECT: Access Storage - 415 Legget Drive
CLIENT: Access Property Development
PROJECT LOCATION: 415 Legget Drive, Ottawa, ON
DATUM: Geodetic
BH LOCATION: See Borehole Location Plan

DRILLING DATA
Method: Hollow Stem Augers
Diameter: 76 mm
Date: Oct/01/2021

REF. NO.: 219-00058-03
ENCL NO.:



(m) ELEV DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE	"N" BLOWS 0.3 m	GROUND WATER CONDITIONS	ELEVATION	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	POCKET PEN. (Cu) (kPa)	NATURAL UNIT WT (kN/m^3)	REMARKS AND GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	SILTY CLAY, grey, wet, firm(Continued)										
				VANE							
							74				
				VANE							
	- stiff below 4.9 m in depth										
5											
			7	SS	3						
							73				
				VANE							
				VANE							
6											
72.4 6.1	END OF BOREHOLE										

Notes:
1. Borehole was sampled using a third weight hammer. The blows in this log have been corrected
2. Borehole is left open for 2 days. Borehole is open to 0.4 m in depth and is dry.

GROUNDWATER ELEVATIONS
Measurement 1st ▽ 2nd ▼ 3rd ▼ 4th ▼

GRAPH NOTES $+^3$, $\times^3$: Numbers refer to Sensitivity ○ ε=3% Strain at Failure

LOG OF BOREHOLE 21-04i

PROJECT: Access Storage - 415 Legget Drive
CLIENT: Access Property Development
PROJECT LOCATION: 415 Legget Drive, Ottawa, ON
DATUM: Geodetic
BH LOCATION: See Borehole Location Plan

DRILLING DATA
Method: Hollow Stem Augers
Diameter: 76 mm
Date: Oct/04/2021

REF. NO.: 219-00058-03
ENCL NO.:

SOIL PROFILE			SAMPLES					DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH (kPa) ○ UNCONFINED + FIELD VANE & Sensitivity ● QUICK TRIAXIAL × LAB VANE 25 50 75 100 125	PLASTIC LIMIT w_P NATURAL MOISTURE CONTENT w LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	POCKET PEN. (Cu) (kPa)	NATURAL UNIT WT (kN/m^3)	REMARKS AND GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
(m) ELEV DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE	"N" BLOWS/0.3 m	GROUND WATER CONDITIONS	ELEVATION					
78.5												
0.0	**CONCRETE - 110 mm**											
78.4 0.1	**CRUSHED SAND AND GRAVEL,** grey (Granular Base)		1	GRAB								
78.1 0.4	**GRAVEL and COBBLE,** possible sand and silt infilling, wet (FILL)		2	GRAB			78					
			1	CORE			77					
76.5 2.0	**SILTY CLAY,** brown grey, wet, stiff (Weathered Crust)		3	SS	12		76					
			4	SS	7							
			5	SS	14		75					
74.7 3.8	**SILTY CLAY,** grey, wet, firm to stiff											

Continued Next Page

GROUNDWATER ELEVATIONS
Measurement 1st ▽ 2nd ▼ 3rd ▼ 4th ▼

GRAPH NOTES $+^3, \times^3$: Numbers refer to Sensitivity ○ ε=3% Strain at Failure

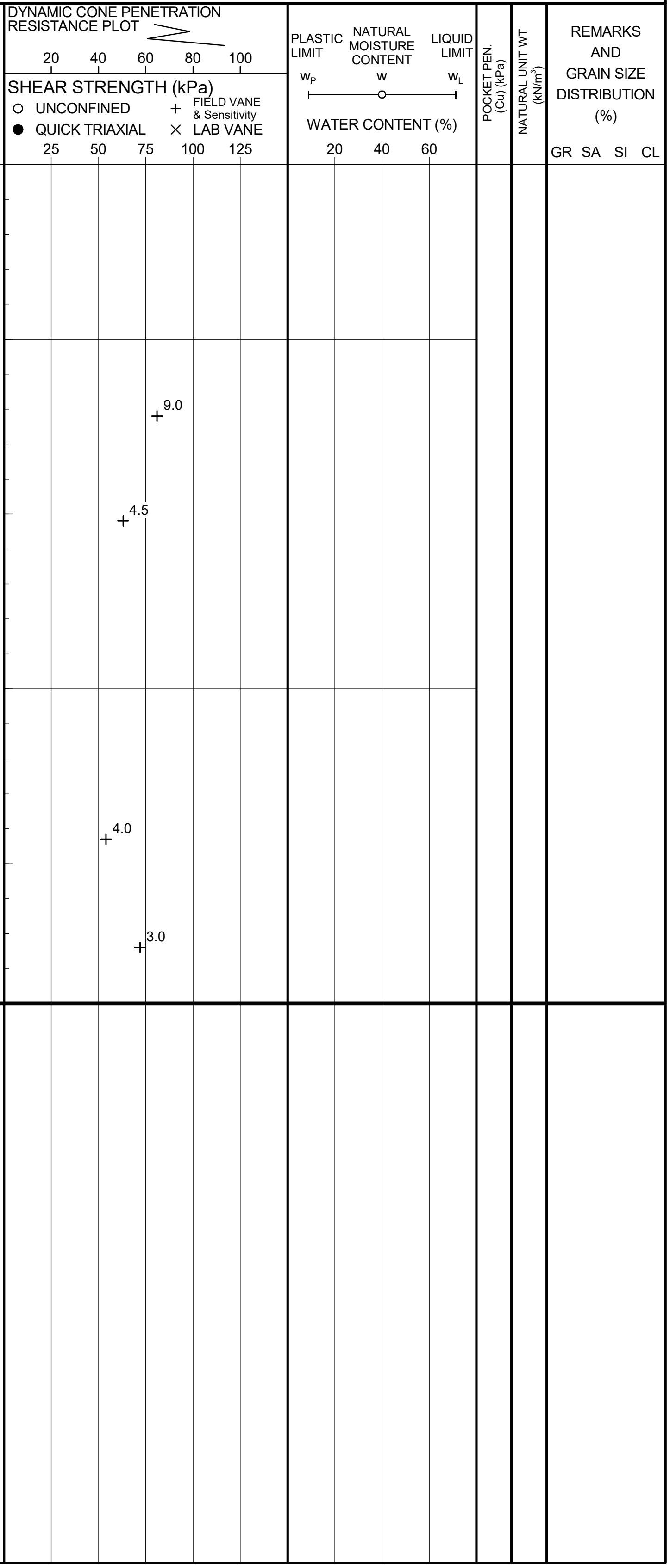
LOG OF BOREHOLE 21-04i

PROJECT: Access Storage - 415 Legget Drive
CLIENT: Access Property Development
PROJECT LOCATION: 415 Legget Drive, Ottawa, ON
DATUM: Geodetic
BH LOCATION: See Borehole Location Plan

DRILLING DATA
Method: Hollow Stem Augers
Diameter: 76 mm
Date: Oct/04/2021

REF. NO.: 219-00058-03
ENCL NO.:

SOIL PROFILE		SAMPLES						
(m) ELEV DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE	"N" BLOWS/0.3 m	GROUND WATER CONDITIONS	ELEVATION	REMARKS AND GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	SILTY CLAY, grey, wet, firm to stiff(Continued)	▨	6	SS	2			
		▨					74	
		▨		VANE				
5		▨		VANE				
		▨	7	SS	4		73	
6		▨		VANE				
72.1		▨		VANE				
6.4	END OF BOREHOLE Notes: 1. Borehole was sampled using a third weight hammer. The blows in this log have been corrected							



GROUNDWATER ELEVATIONS
Measurement 1st ▽ 2nd ▼ 3rd ▼ 4th ▼

GRAPH NOTES + 3, × 3: Numbers refer to Sensitivity ○ ε=3% Strain at Failure

LOG OF BOREHOLE 21-01s

PROJECT: Access Storage - 415 Legget Drive
CLIENT: Access Property Development
PROJECT LOCATION: 415 Legget Drive, Ottawa, ON
DATUM: Geodetic
BH LOCATION: See Borehole Location Plan

DRILLING DATA
Method: Hollow Stem Augers
Diameter: 203 mm
Date: Sep/24/2021

REF. NO.: 219-00058-03
ENCL NO.:

(m) ELEV / DEPTH	DESCRIPTION	NUMBER	TYPE	"N" BLOWS / 0.3 m	GROUND WATER CONDITIONS	ELEVATION
77.3						
77.3 / 0.0	**ASPHALT - 40 mm**					
0.0	**CRUSHED SAND AND GRAVEL,** grey, moist (Granular Base)	0	GRAB			
77.0 / 0.3	**SILTY CLAY,** brown grey, moist, stiff (Weathered Crust)					77
					W. L. 76.7 m October 25th, 2021	
		1	SS	9	Cuttings	
						76
		2	SS	6		
						75
		3	SS	5	Bentonite	
74.3 / 3.1	**SILTY CLAY,** grey, wet, firm	4	SS	3		74
			VANE		Sand	

DYNAMIC CONE PENETRATION RESISTANCE PLOT: 20 40 60 80 100

SHEAR STRENGTH (kPa): ○ UNCONFINED; + FIELD VANE & Sensitivity; ● QUICK TRIAXIAL; × LAB VANE — 25 50 75 100 125

Field vane: + 18.0

PLASTIC LIMIT W_P — NATURAL MOISTURE CONTENT w — LIQUID LIMIT W_L; WATER CONTENT (%) 20 40 60

POCKET PEN. (Cu) (kPa) | NATURAL UNIT WT (kN/m^3) | REMARKS AND GRAIN SIZE DISTRIBUTION (%): GR SA SI CL

Depth scale: 1, 2, 3, 4

Continued Next Page

GROUNDWATER ELEVATIONS
Measurement 1st ▽ 2nd ▼ 3rd ▼ 4th ▼

GRAPH NOTES: $+^3, \times^3$: Numbers refer to Sensitivity; ○ ε=3% Strain at Failure

LOG OF BOREHOLE 21-01s

PROJECT: Access Storage - 415 Legget Drive
CLIENT: Access Property Development
PROJECT LOCATION: 415 Legget Drive, Ottawa, ON
DATUM: Geodetic
BH LOCATION: See Borehole Location Plan

DRILLING DATA
Method: Hollow Stem Augers
Diameter: 203 mm
Date: Sep/24/2021

REF. NO.: 219-00058-03
ENCL NO.:

SOIL PROFILE			SAMPLES					DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 SHEAR STRENGTH (kPa) ○ UNCONFINED + FIELD VANE & Sensitivity ● QUICK TRIAXIAL × LAB VANE 25 50 75 100 125	PLASTIC LIMIT W_P NATURAL MOISTURE CONTENT W LIQUID LIMIT W_L WATER CONTENT (%) 20 40 60	POCKET PEN. (Cu) (kPa)	NATURAL UNIT WT (kN/m^3)	REMARKS AND GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
(m) ELEV DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE	"N" BLOWS/0.3 m	GROUND WATER CONDITIONS	ELEVATION					
	SILTY CLAY, grey, wet, firm(Continued)			VANE		Screen	73	+ 4.5				
72.7 4.6	**CLAYEY SILTY SAND,** some gravel, grey, wet (GLACIAL TILL)		5	SS	50/0 mm							
72.4 4.9	END OF BOREHOLE											

Notes:
1. Borehole terminated at 4.9 m in depth after auger refusal.
2. Monitoring well installed at 4.9 m in depth
3. Date Groundwater Depth

Date	Groundwater Depth
October 15, 2021	0.6 m

GROUNDWATER ELEVATIONS
Measurement 1st ▽ 2nd ▼ 3rd ▼ 4th ▼

GRAPH NOTES $+^3, \times^3$: Numbers refer to Sensitivity ○ ε=3% Strain at Failure

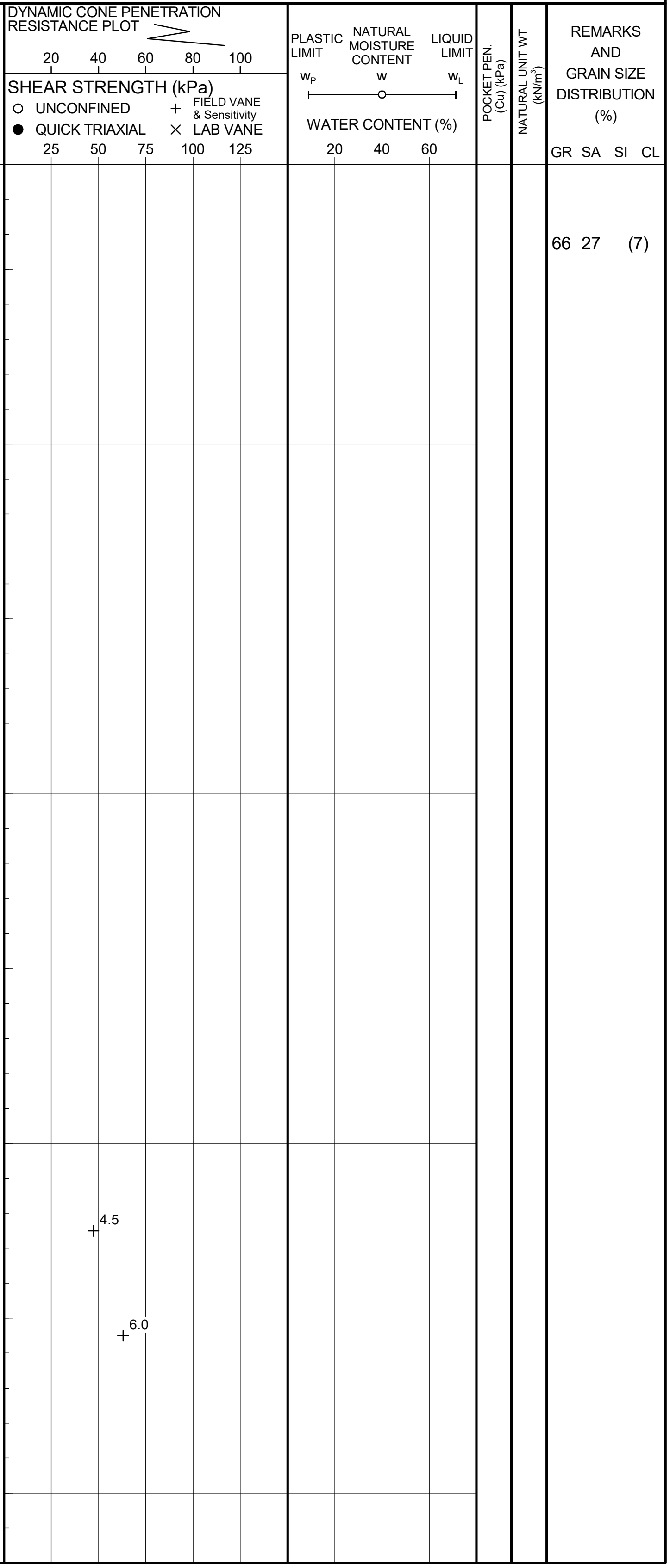
LOG OF BOREHOLE 21-02s

PROJECT: Access Storage - 415 Legget Drive
CLIENT: Access Property Development
PROJECT LOCATION: 415 Legget Drive, Ottawa, ON
DATUM: Geodetic
BH LOCATION: See Borehole Location Plan

DRILLING DATA
Method: Hollow Stem Augers
Diameter: 203 mm
Date: Sep/27/2021

REF. NO.: 219-00058-03
ENCL NO.:

SOIL PROFILE (m) ELEV DEPTH	DESCRIPTION	SAMPLES NUMBER	TYPE	"N" BLOWS 0.3 m	GROUND WATER CONDITIONS	ELEVATION	REMARKS AND GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
76.8							
76.8 0.0	**ASPHALT - 30 mm**						
	CRUSHED SANDY GRAVEL, grey, moist (Granular Base)						
76.6 0.2	**SILTY SAND,** trace gravel, grey, wet	1	GRAB				66 27 (7)
76.0 0.8	**SILTY CLAY,** brown grey, moist, stiff (Weathered Crust)	2A				76	
		2B	SS	5			
		3	SS	3		75	
74.5 2.3	**SILTY CLAY,** grey, wet, firm to very stiff	4	SS	1		74	
			VANE				
			VANE			73	



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GROUNDWATER ELEVATIONS
Measurement 1st ▽ 2nd ▼ 3rd ▽ 4th ▼

GRAPH NOTES: $+^3$, $\times^3$: Numbers refer to Sensitivity ○ ε=3% Strain at Failure

LOG OF BOREHOLE 21-02s

PROJECT: Access Storage - 415 Legget Drive
CLIENT: Access Property Development
PROJECT LOCATION: 415 Legget Drive, Ottawa, ON
DATUM: Geodetic
BH LOCATION: See Borehole Location Plan

DRILLING DATA
Method: Hollow Stem Augers
Diameter: 203 mm
Date: Sep/27/2021

REF. NO.: 219-00058-03
ENCL NO.:

SOIL PROFILE — (m) ELEV / DEPTH: 5, 6, 7, 8

SILTY CLAY, grey, wet, firm to very stiff(Continued)

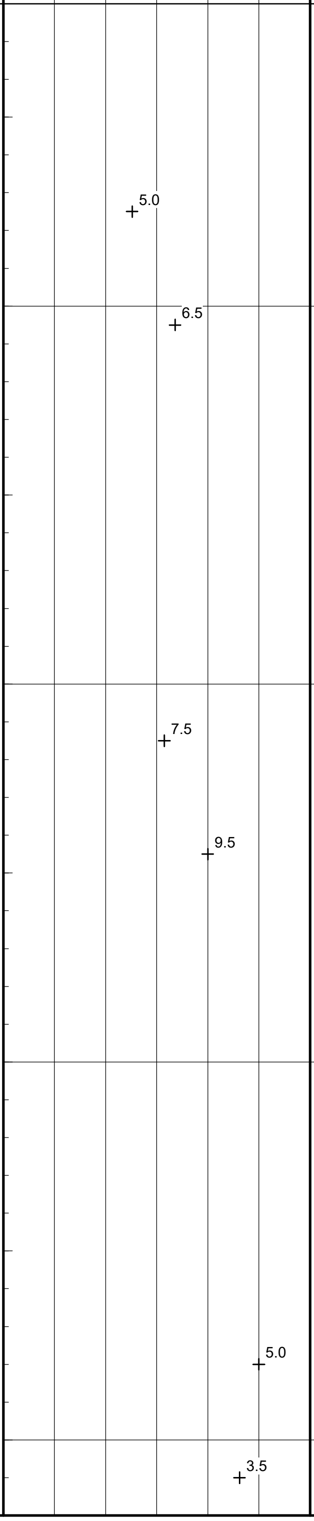
SAMPLES NUMBER	TYPE	"N" BLOWS / 0.3 m
5	SS	1
	VANE	
	VANE	
6	SS	WH
	VANE	
	VANE	
6	SS	WH
	VANE	
	VANE	

GROUND WATER CONDITIONS

ELEVATION: 72, 71, 70, 69

DYNAMIC CONE PENETRATION RESISTANCE PLOT: 20, 40, 60, 80, 100

SHEAR STRENGTH (kPa): ○ UNCONFINED; ● QUICK TRIAXIAL; + FIELD VANE & Sensitivity; × LAB VANE; 25, 50, 75, 100, 125



PLASTIC LIMIT W_P — NATURAL MOISTURE CONTENT W — LIQUID LIMIT W_L; WATER CONTENT (%): 20, 40, 60

POCKET PEN. (Cu) (kPa)

NATURAL UNIT WT (kN/m^3)

REMARKS AND GRAIN SIZE DISTRIBUTION (%): GR SA SI CL

Continued Next Page

GROUNDWATER ELEVATIONS
Measurement 1st ▽ 2nd ▼ 3rd ▼ 4th ▼

GRAPH NOTES: $+^3, \times^3$: Numbers refer to Sensitivity; ○ ε=3% Strain at Failure

LOG OF BOREHOLE 21-02s

PROJECT: Access Storage - 415 Legget Drive
CLIENT: Access Property Development
PROJECT LOCATION: 415 Legget Drive, Ottawa, ON
DATUM: Geodetic
BH LOCATION: See Borehole Location Plan

DRILLING DATA
Method: Hollow Stem Augers
Diameter: 203 mm
Date: Sep/27/2021

REF. NO.: 219-00058-03
ENCL NO.:

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 SHEAR STRENGTH (kPa) ○ UNCONFINED + FIELD VANE & Sensitivity ● QUICK TRIAXIAL × LAB VANE 25 50 75 100 125	PLASTIC LIMIT W_P NATURAL MOISTURE CONTENT W LIQUID LIMIT W_L WATER CONTENT (%) 20 40 60	POCKET PEN. (Cu) (kPa)	NATURAL UNIT WT (kN/m³)	REMARKS AND GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
(m) ELEV DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE	"N" BLOWS/0.3 m							
68.8 8.1	END OF BOREHOLE Notes: 1. Borehole terminated at 8.1 m in depth and was open to upon to 6.7 m in depth. 2. Standing water in the borehole at 6.6 m in depth.											

GROUNDWATER ELEVATIONS
Measurement 1st ▽ 2nd ▼ 3rd ▼ 4th ▼

GRAPH NOTES
$+^3$, $\times^3$: Numbers refer to Sensitivity
○ ε=3% Strain at Failure

LOG OF BOREHOLE 21-03s

1 OF 3

PROJECT: Access Storage - 415 Legget Drive
CLIENT: Access Property Development
PROJECT LOCATION: 415 Legget Drive, Ottawa, ON
DATUM: Geodetic
BH LOCATION: See Borehole Location Plan

DRILLING DATA
Method: Hollow Stem Augers
Diameter: 203 mm
Date: Sep/24/2021

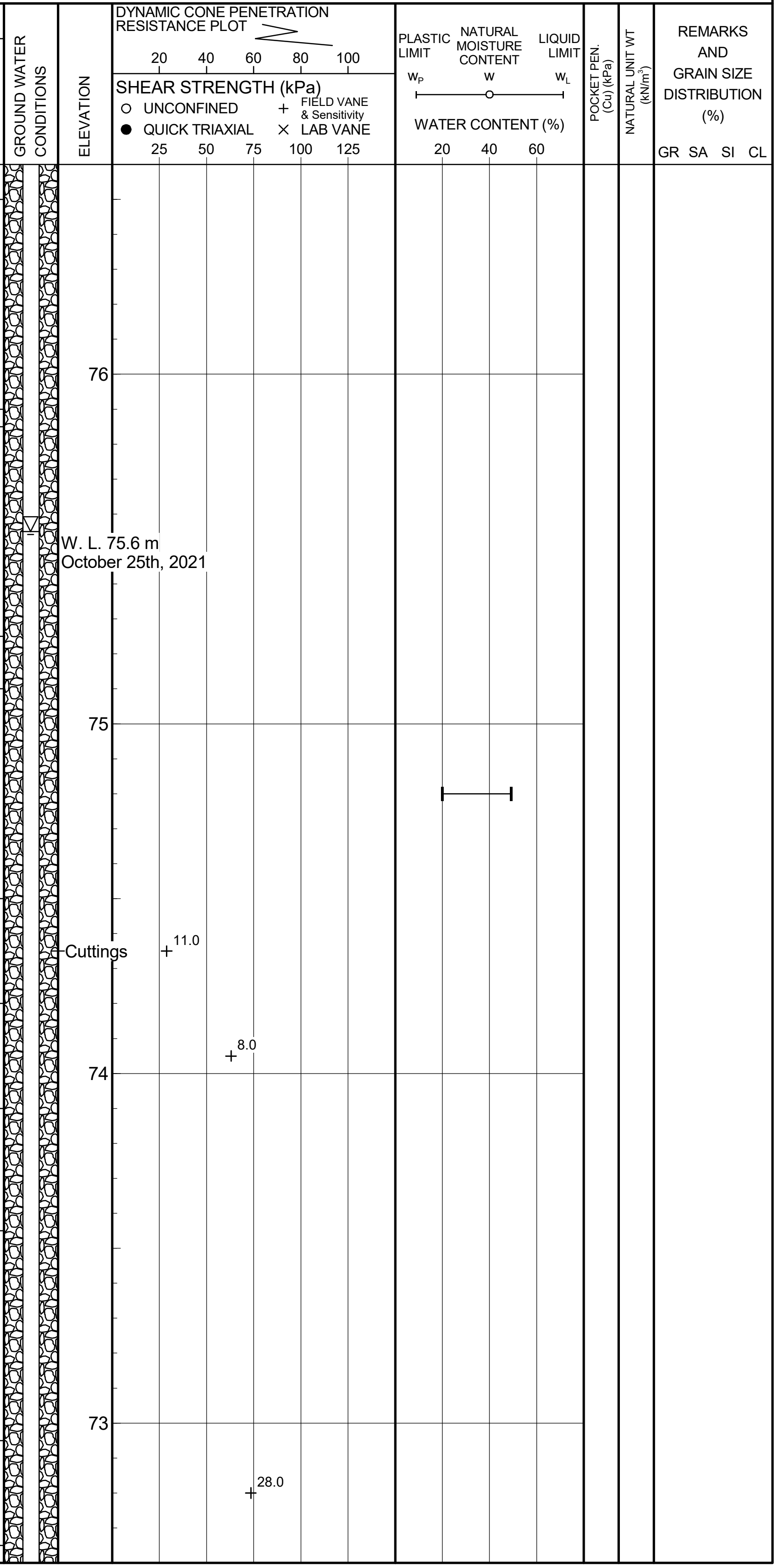
REF. NO.: 219-00058-03
ENCL NO.:

SOIL PROFILE

(m) ELEV DEPTH	DESCRIPTION
76.6	
76.6 0.0	**ASPHALT - 20 mm**
	CRUSHED SAND AND GRAVEL, grey, moist (Granular Base)
76.4 0.2	**SILTY CLAY,** brown grey, moist, stiff (Weathered Crust)
75.1 1.5	**SILTY CLAY,** grey, wet, firm to stiff

SAMPLES

NUMBER	TYPE	"N" BLOWS/0.3 m
1	SS	13
2	SS	3
3	SS	2
	VANE	
	VANE	
4	SS	WH
	VANE	



W. L. 75.6 m
October 25th, 2021

Cuttings

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GROUNDWATER ELEVATIONS
Measurement 1st ▽ 2nd ▼ 3rd ▼ 4th ▼

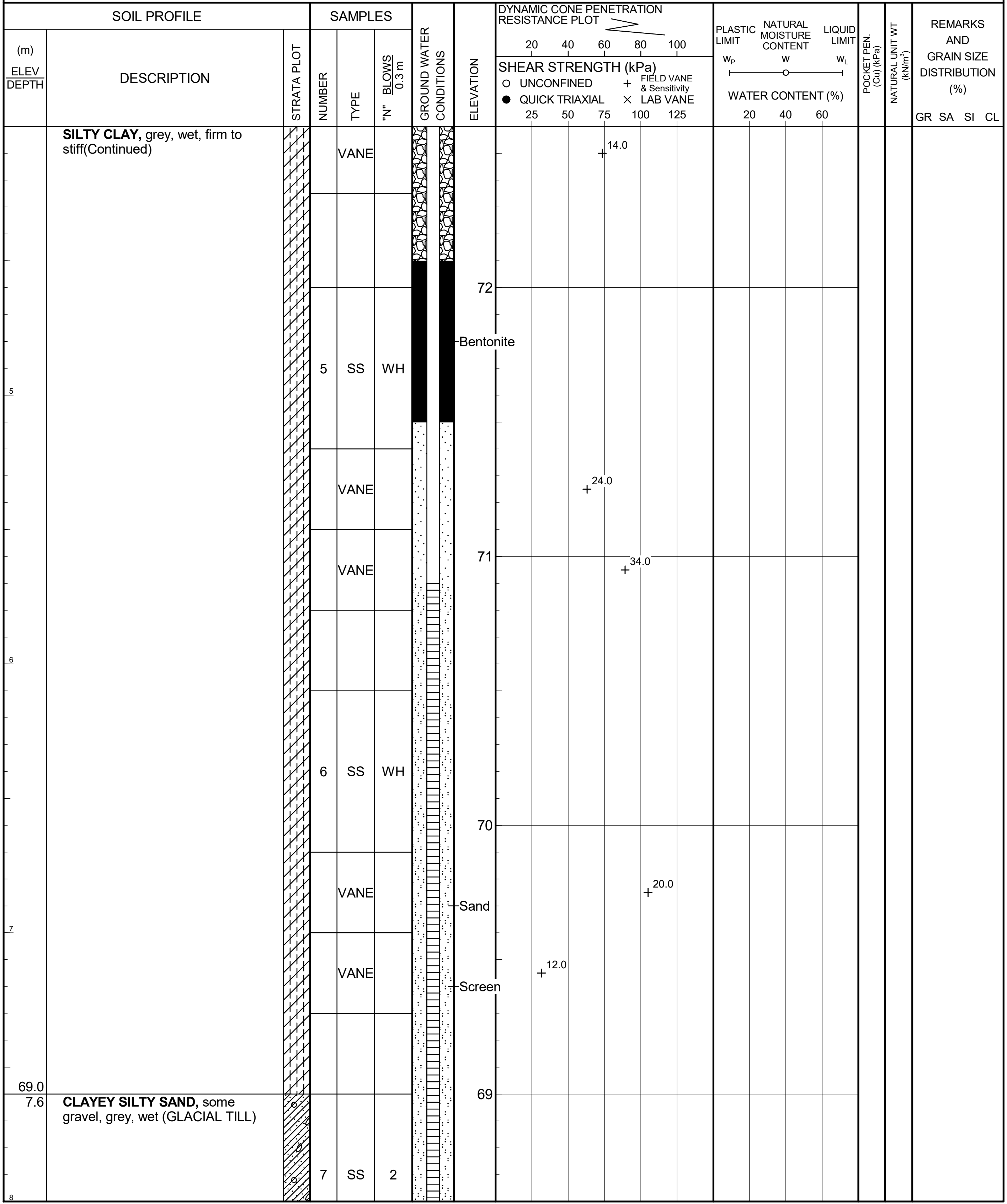
GRAPH NOTES
+ 3, × 3: Numbers refer to Sensitivity
○ ε=3% Strain at Failure

LOG OF BOREHOLE 21-03s

PROJECT: Access Storage - 415 Legget Drive
CLIENT: Access Property Development
PROJECT LOCATION: 415 Legget Drive, Ottawa, ON
DATUM: Geodetic
BH LOCATION: See Borehole Location Plan

DRILLING DATA
Method: Hollow Stem Augers
Diameter: 203 mm
Date: Sep/24/2021

REF. NO.: 219-00058-03
ENCL NO.:



ELEV DEPTH (m)	DESCRIPTION	NUMBER	TYPE	"N" BLOWS/0.3 m	GROUND WATER CONDITIONS	SHEAR STRENGTH (kPa)
	SILTY CLAY, grey, wet, firm to stiff(Continued)		VANE			+ 14.0
		5	SS	WH	Bentonite	
			VANE			+ 24.0
			VANE			+ 34.0
		6	SS	WH		
			VANE		Sand	+ 20.0
			VANE		Screen	+ 12.0
69.0 7.6	**CLAYEY SILTY SAND,** some gravel, grey, wet (GLACIAL TILL)	7	SS	2		

Continued Next Page

GROUNDWATER ELEVATIONS
Measurement 1st ▽ 2nd ▼ 3rd ▼ 4th ▼

GRAPH NOTES
+ 3, × 3: Numbers refer to Sensitivity
○ 8=3% Strain at Failure

LOG OF BOREHOLE 21-03s

PROJECT: Access Storage - 415 Legget Drive
CLIENT: Access Property Development
PROJECT LOCATION: 415 Legget Drive, Ottawa, ON
DATUM: Geodetic
BH LOCATION: See Borehole Location Plan

DRILLING DATA
Method: Hollow Stem Augers
Diameter: 203 mm
Date: Sep/24/2021

REF. NO.: 219-00058-03
ENCL NO.:

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 SHEAR STRENGTH (kPa) ○ UNCONFINED + FIELD VANE & Sensitivity ● QUICK TRIAXIAL × LAB VANE 25 50 75 100 125	PLASTIC LIMIT w_P NATURAL MOISTURE CONTENT w LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	POCKET PEN. (Cu) (kPa)	NATURAL UNIT WT (kN/m^3)	REMARKS AND GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
(m) ELEV DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE	"N" BLOWS/0.3 m							
	CLAYEY SILTY SAND, some gravel, grey, wet (GLACIAL TILL)(Continued)		8	SS	50/25 mm		68					
67.9 8.7	END OF BOREHOLE											

Notes:
1. Borehole terminated at 8.7 m in depth after auger refusal.
2. Standing water in the borehole at 0.15 m in depth.
3. Monitoring well installed at 8.7 m in depth
4.

Date	Groundwater Depth
October 15, 2021	1.0 m

GROUNDWATER ELEVATIONS
Measurement 1st ▽ 2nd ▼ 3rd ▼ 4th ▼

GRAPH NOTES $+^3, \times^3$: Numbers refer to Sensitivity ○ ε=3% Strain at Failure

LOG OF BOREHOLE 21-04s

PROJECT: Access Storage - 415 Legget Drive
CLIENT: Access Property Development
PROJECT LOCATION: 415 Legget Drive, Ottawa, ON
DATUM: Geodetic
BH LOCATION: See Borehole Location Plan

DRILLING DATA
Method: Hollow Stem Augers
Diameter: 203 mm
Date: Sep/27/2021

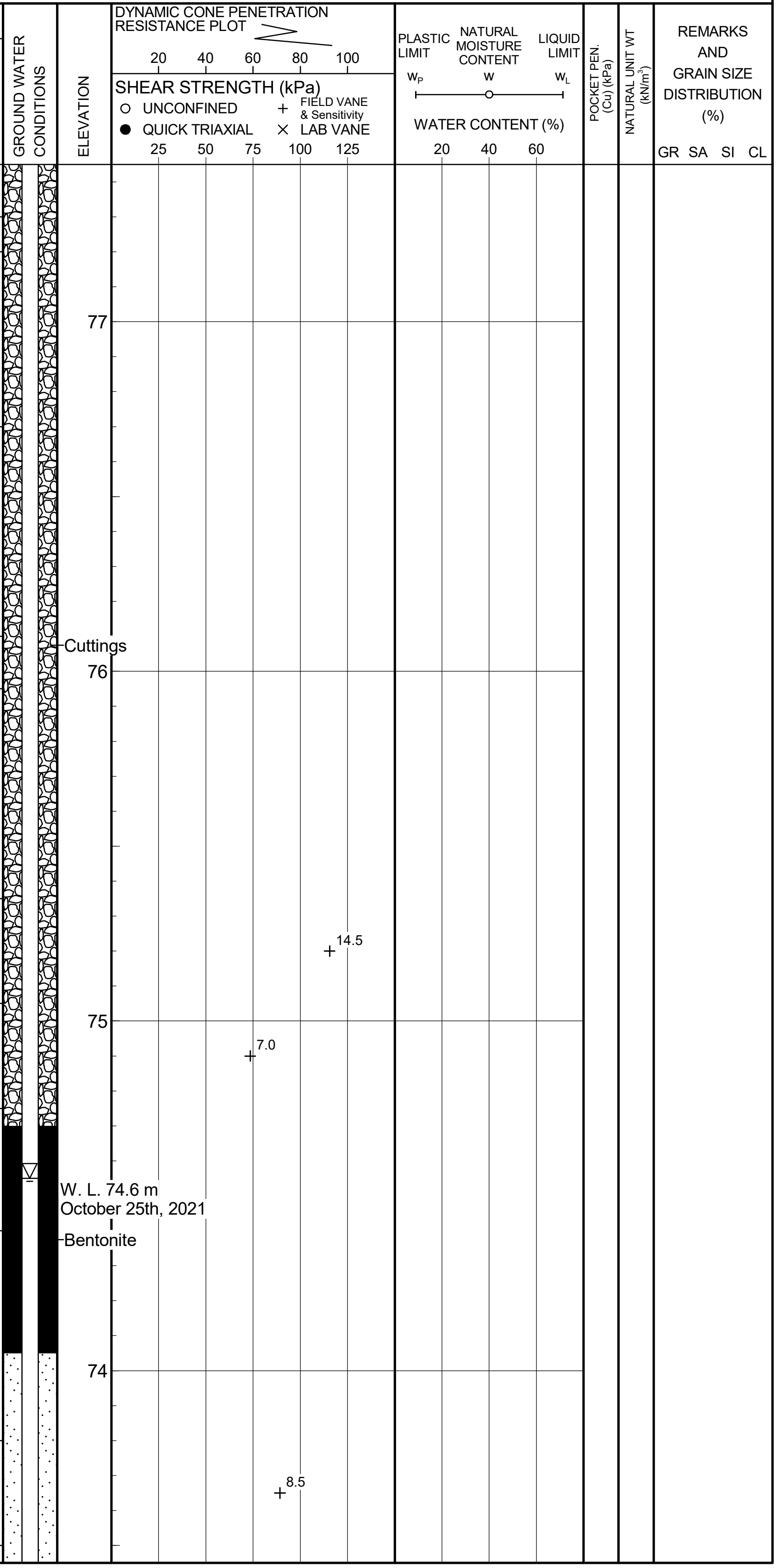
REF. NO.: 219-00058-03
ENCL NO.:

SOIL PROFILE

(m) ELEV / DEPTH	DESCRIPTION
77.5	
0.0	**ASPHALT - 40 mm**
77.4 / 0.0	**CRUSHED SAND AND GRAVEL,** grey, moist (Granular Base)
77.2 / 0.2	**SILTY CLAY,** some sand, brown, grey, moist (FILL)
76.5 / 1.0	**SILTY SAND,** trace gravel, brown, moist, compact
75.8 / 1.7	**SILTY CLAY,** grey, wet, stiff

SAMPLES

NUMBER	TYPE	"N" BLOWS / 0.3 m
1	GRAB	
2A 2B	SS	19
3A 3B	SS	3
	VANE	
	VANE	
4	SS	1
	VANE	



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GROUNDWATER ELEVATIONS
Measurement 1st ∇ 2nd ▼ 3rd ▼ 4th ▼

GRAPH NOTES + 3, × 3: Numbers refer to Sensitivity ○ 8=3% Strain at Failure

WSP SOIL LOG-LARGE SCALE-2016-1WELL GINT.GPJ SPL.GDT 10/22/21

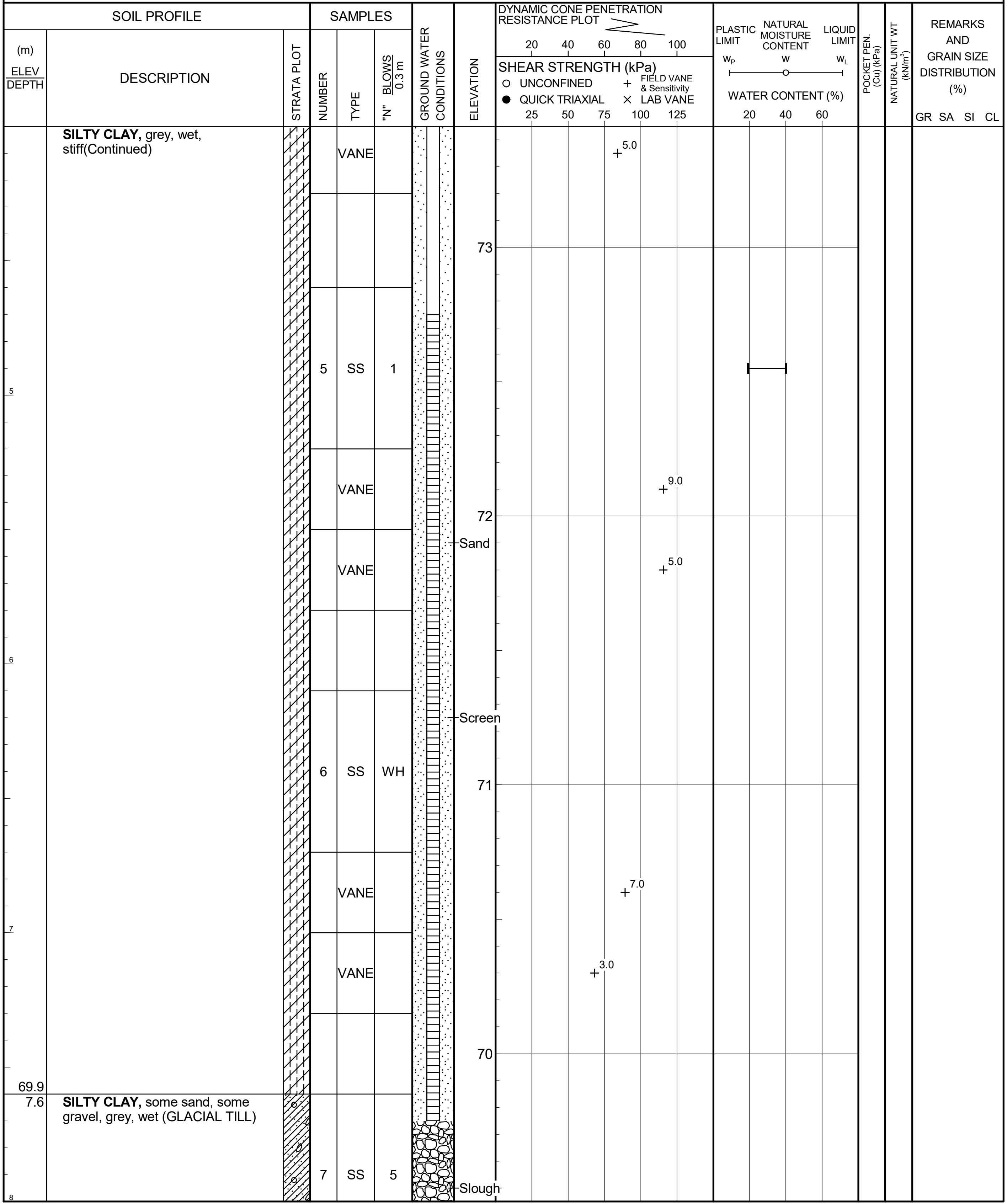
LOG OF BOREHOLE 21-04s

PROJECT: Access Storage - 415 Legget Drive
CLIENT: Access Property Development
PROJECT LOCATION: 415 Legget Drive, Ottawa, ON
DATUM: Geodetic
BH LOCATION: See Borehole Location Plan

DRILLING DATA
Method: Hollow Stem Augers
Diameter: 203 mm
Date: Sep/27/2021

REF. NO.: 219-00058-03
ENCL NO.:

SOIL PROFILE		SAMPLES		
(m) ELEV DEPTH	DESCRIPTION	NUMBER	TYPE	"N" BLOWS 0.3 m
	SILTY CLAY, grey, wet, stiff(Continued)		VANE	
		5	SS	1
			VANE	
			VANE	
		6	SS	WH
			VANE	
			VANE	
69.9 7.6	**SILTY CLAY,** some sand, some gravel, grey, wet (GLACIAL TILL)	7	SS	5



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GROUNDWATER ELEVATIONS
Measurement 1st ▽ 2nd ▼ 3rd ▼ 4th ▼

GRAPH NOTES
+ 3, × 3: Numbers refer to Sensitivity
○ ε=3% Strain at Failure

LOG OF BOREHOLE 21-04s

PROJECT: Access Storage - 415 Legget Drive
CLIENT: Access Property Development
PROJECT LOCATION: 415 Legget Drive, Ottawa, ON
DATUM: Geodetic
BH LOCATION: See Borehole Location Plan

DRILLING DATA
Method: Hollow Stem Augers
Diameter: 203 mm
Date: Sep/27/2021

REF. NO.: 219-00058-03
ENCL NO.:

SOIL PROFILE			SAMPLES					DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 SHEAR STRENGTH (kPa) ○ UNCONFINED + FIELD VANE & Sensitivity ● QUICK TRIAXIAL × LAB VANE 25 50 75 100 125	PLASTIC LIMIT w_P NATURAL MOISTURE CONTENT w LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	POCKET PEN. (Cu) (kPa)	NATURAL UNIT WT (kN/m^3)	REMARKS AND GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
(m) ELEV DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE	"N" BLOWS / 0.3 m	GROUND WATER CONDITIONS	ELEVATION					
69.3	**SILTY CLAY,** some sand, some gravel, grey, wet (GLACIAL TILL)(Continued)	▨				▨						
8.2	END OF BOREHOLE Notes: 1. Borehole terminated at 8.2 m in depth after auger refusal. 2. Standing water in the borehole at 3.9 m in depth. 3. Monitoring well installed at 7.6 m in depth 4. Date Groundwater Depth --- October 15, 2021 2.9 m											

GROUNDWATER ELEVATIONS

Measurement 1st ▽ 2nd ▼ 3rd ▼ 4th ▼

GRAPH NOTES + 3, × 3: Numbers refer to Sensitivity ○ ε=3% Strain at Failure

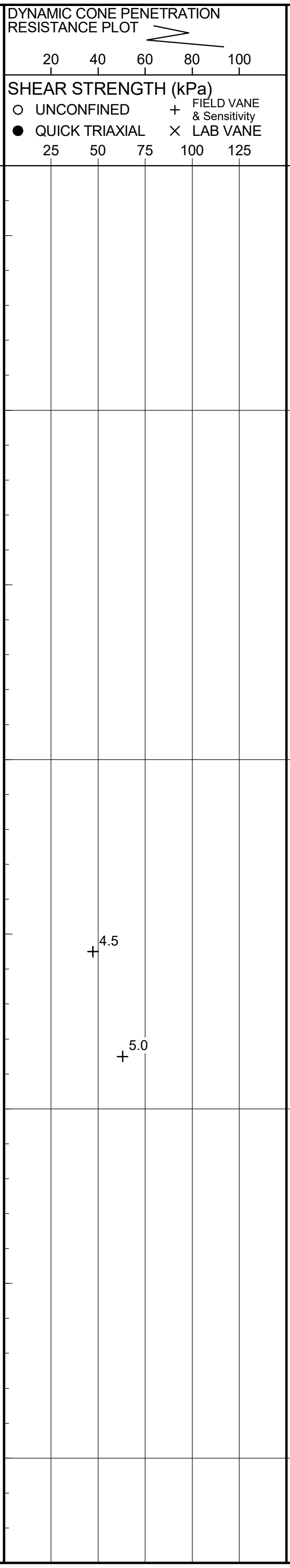
LOG OF BOREHOLE 21-05s

PROJECT: Access Storage - 415 Legget Drive
CLIENT: Access Property Development
PROJECT LOCATION: 415 Legget Drive, Ottawa, ON
DATUM: Geodetic
BH LOCATION: See Borehole Location Plan

DRILLING DATA
Method: Hollow Stem Augers
Diameter: 203 mm
Date: Sep/28/2021

REF. NO.: 219-00058-03
ENCL NO.:

(m) ELEV DEPTH	DESCRIPTION	NUMBER	TYPE	"N" BLOWS / 0.3 m	REMARKS AND GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
77.7 0.0	**ASPHALT - 20 mm** (FILL)				
	CRUSHED SAND AND GRAVEL, grey, moist (Granular Base)	1	GRAB		
77.5 0.2	**SILTY SAND,** brown, moist, compact	2	SS	15	
		3A	SS	5	0 56 37 7
76.5 1.2	**SILTY CLAY,** grey, firm to stiff, wet	3B	SS		
		4	SS	1	
			VANE		
			VANE		



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GROUNDWATER ELEVATIONS
Measurement 1st ▽ 2nd ▼ 3rd ▼ 4th ▼

GRAPH NOTES + 3, × 3: Numbers refer to Sensitivity ○ ε=3% Strain at Failure

LOG OF BOREHOLE 21-05s

PROJECT: Access Storage - 415 Legget Drive
CLIENT: Access Property Development
PROJECT LOCATION: 415 Legget Drive, Ottawa, ON
DATUM: Geodetic
BH LOCATION: See Borehole Location Plan

DRILLING DATA
Method: Hollow Stem Augers
Diameter: 203 mm
Date: Sep/28/2021

REF. NO.: 219-00058-03
ENCL NO.:

SOIL PROFILE			SAMPLES					DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 SHEAR STRENGTH (kPa) ○ UNCONFINED + FIELD VANE & Sensitivity ● QUICK TRIAXIAL × LAB VANE 25 50 75 100 125	PLASTIC LIMIT W_P NATURAL MOISTURE CONTENT W LIQUID LIMIT W_L WATER CONTENT (%) 20 40 60	POCKET PEN. (Cu) (kPa)	NATURAL UNIT WT (kN/m^3)	REMARKS AND GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
(m) ELEV DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE	"N" BLOWS 0.3 m	GROUND WATER CONDITIONS	ELEVATION					
	SILTY CLAY, grey, firm to stiff, wet(Continued)		5	SS	WH							
73.1 4.6	**SILTY CLAY,** some sand, some gravel, grey, wet (GLACIAL TILL)		6	SS	50/0 mm		73					
5 72.6 5.1	END OF BOREHOLE Notes: 1. Borehole terminated at 5,1 m in depth after auger refusal. 2. Standing water in the borehole at 4.7 m in depth.											

GROUNDWATER ELEVATIONS
Measurement 1st ▽ 2nd ▼ 3rd ▼ 4th ▼

GRAPH NOTES $+^3, \times^3$: Numbers refer to Sensitivity ○ ε=3% Strain at Failure

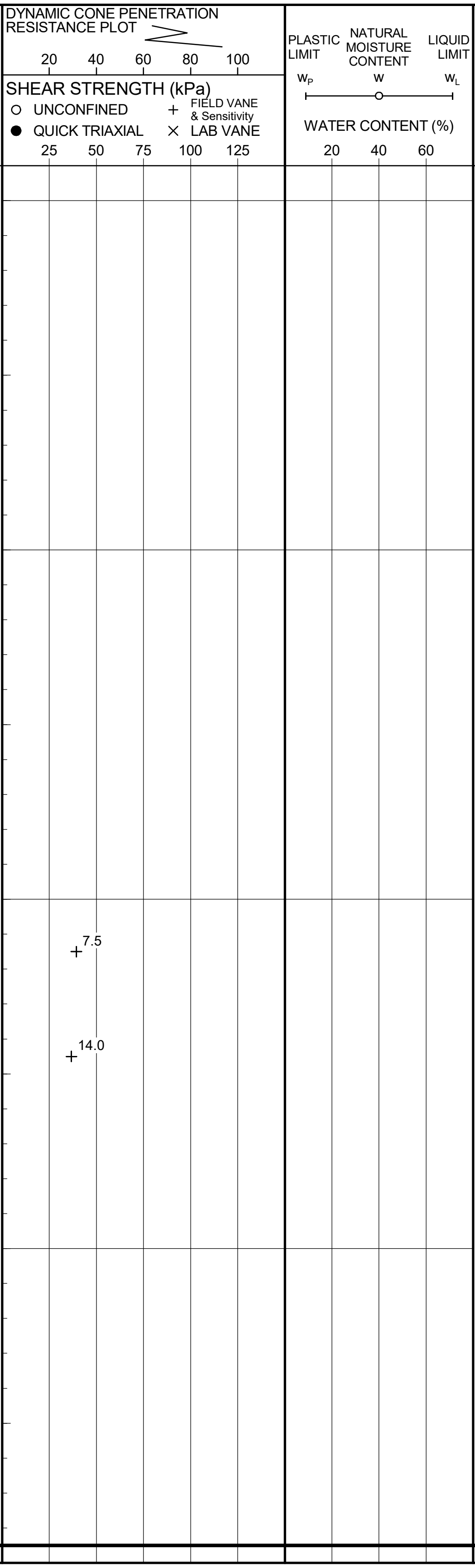
LOG OF BOREHOLE 21-06s

PROJECT: Access Storage - 415 Legget Drive
CLIENT: Access Property Development
PROJECT LOCATION: 415 Legget Drive, Ottawa, ON
DATUM: Geodetic
BH LOCATION: See Borehole Location Plan

DRILLING DATA
Method: Hollow Stem Augers
Diameter: 203 mm
Date: Sep/29/2021

REF. NO.: 219-00058-03
ENCL NO.:

(m) ELEV DEPTH	DESCRIPTION	NUMBER	TYPE	"N" BLOWS/0.3 m	GROUND WATER CONDITIONS	ELEVATION
77.1						
77.0 0.0	**ASPHALT - 45 mm** (FILL)					
0.0	**CRUSHED SAND AND GRAVEL,** grey, moist (Granular Base)	1	GRAB			77
76.9 0.2	**SILTY SAND,** brown, moist	2A				
76.3 0.9	**SILTY CLAY,** brown grey, moist, stiff (Weathered Crust)	2B	SS	4		76
75.6 1.5	**SILTY CLAY,** grey, wet, firm	3	SS	3		75
			VANE			
			VANE			74
		4	SS	WH		
73.5 3.7	**SILTY CLAY,** some sand, some gravel, grey, wet (GLACIAL TILL)	5	SS	50/25 mm		
73.2 4.0	END OF BOREHOLE					



POCKET PEN. (Cu) (kPa) | NATURAL UNIT WT (kN/m^3) | REMARKS AND GRAIN SIZE DISTRIBUTION (%) GR SA SI CL

Continued Next Page

GROUNDWATER ELEVATIONS
Measurement 1st ▽ 2nd ▼ 3rd ▼ 4th ▼

GRAPH NOTES +3, ×3: Numbers refer to Sensitivity ○ ε=3% Strain at Failure

LOG OF BOREHOLE 21-06s

PROJECT: Access Storage - 415 Legget Drive
CLIENT: Access Property Development
PROJECT LOCATION: 415 Legget Drive, Ottawa, ON
DATUM: Geodetic
BH LOCATION: See Borehole Location Plan

DRILLING DATA
Method: Hollow Stem Augers
Diameter: 203 mm
Date: Sep/29/2021

REF. NO.: 219-00058-03
ENCL NO.:

SOIL PROFILE			SAMPLES						
(m) ELEV DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE	"N" BLOWS/0.3 m	GROUND WATER CONDITIONS	ELEVATION	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 SHEAR STRENGTH (kPa) ○ UNCONFINED + FIELD VANE & Sensitivity ● QUICK TRIAXIAL × LAB VANE 25 50 75 100 125	PLASTIC LIMIT W_P NATURAL MOISTURE CONTENT W LIQUID LIMIT W_L WATER CONTENT (%) 20 40 60	POCKET PEN. (Cu) (kPa)	NATURAL UNIT WT (kN/m^3)	REMARKS AND GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Notes: 1. Borehole terminated at 4.0 m in depth after auger refusal.											

GROUNDWATER ELEVATIONS
Measurement 1st ▽ 2nd ▼ 3rd ▼ 4th ▼

GRAPH NOTES
+ 3, × 3: Numbers refer to Sensitivity
○ ε=3% Strain at Failure

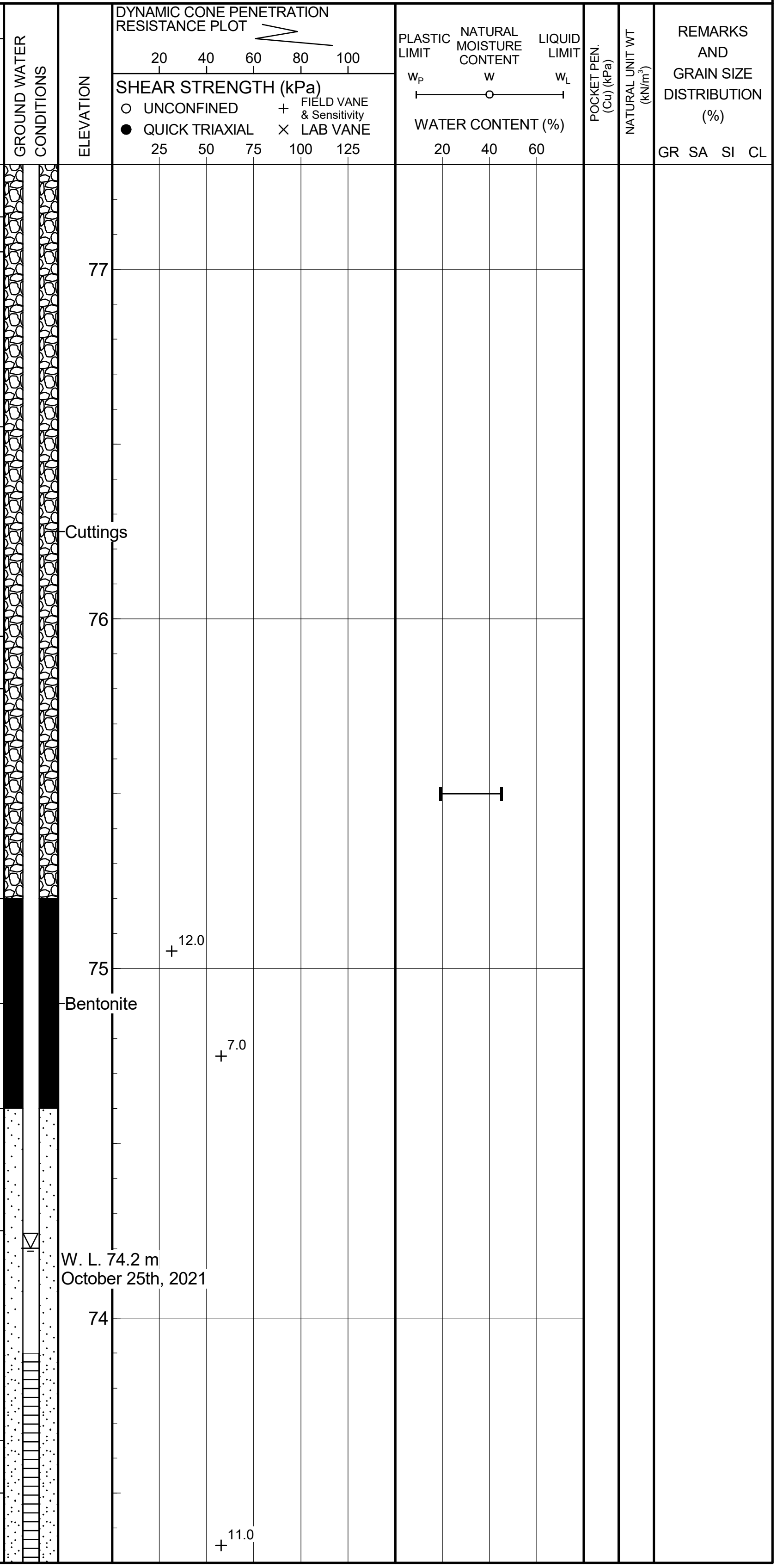
LOG OF BOREHOLE 21-07s

PROJECT: Access Storage - 415 Legget Drive
CLIENT: Access Property Development
PROJECT LOCATION: 415 Legget Drive, Ottawa, ON
DATUM: Geodetic
BH LOCATION: See Borehole Location Plan

DRILLING DATA
Method: Hollow Stem Augers
Diameter: 203 mm
Date: Sep/29/2021

REF. NO.: 219-00058-03
ENCL NO.:

(m) ELEV / DEPTH	DESCRIPTION	SAMPLES NUMBER	TYPE	"N" BLOWS / 0.3 m
77.3				
77.3 0.0	**ASPHALT - 40 mm**			
0.0	**CRUSHED SAND AND GRAVEL,** grey, moist (Granular Base)	1	GRAB	
77.1 0.2	**SILTY SAND,** brown, moist, compact	2A	SS	15
76.1 1.2	**SILTY CLAY,** brown grey, moist to wet, stiff (Weathered Clay)	2B		
75.8 1.5	**SILTY CLAY,** grey, wet, firm to stiff	3	SS	2
			VANE	
			VANE	
		3	SS	0
			VANE	



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GROUNDWATER ELEVATIONS
Measurement 1st ▽ 2nd ▼ 3rd ▼ 4th ▼

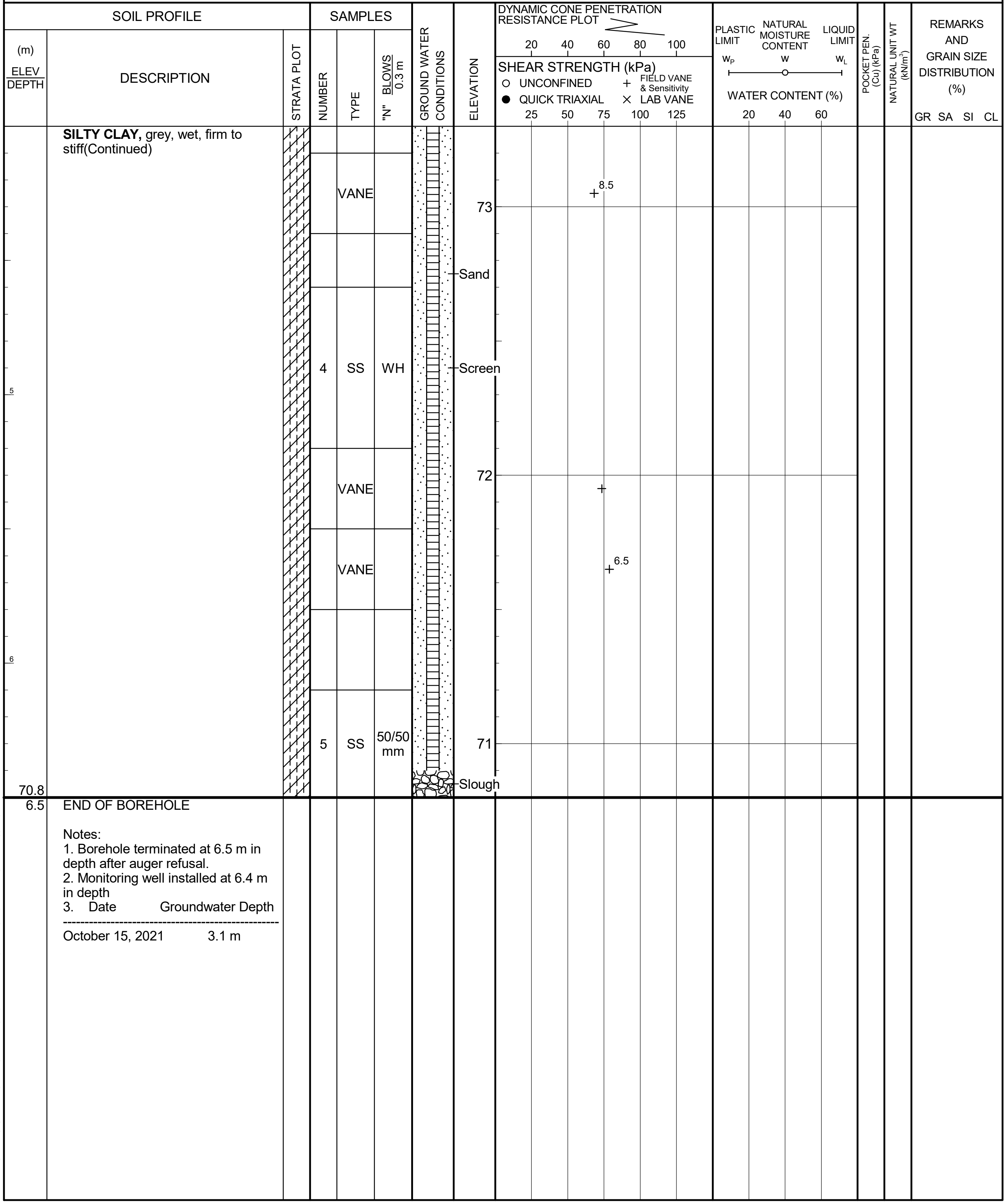
GRAPH NOTES: $+^3, \times^3$: Numbers refer to Sensitivity ○ ε=3% Strain at Failure

LOG OF BOREHOLE 21-07s

PROJECT: Access Storage - 415 Legget Drive
CLIENT: Access Property Development
PROJECT LOCATION: 415 Legget Drive, Ottawa, ON
DATUM: Geodetic
BH LOCATION: See Borehole Location Plan

DRILLING DATA
Method: Hollow Stem Augers
Diameter: 203 mm
Date: Sep/29/2021

REF. NO.: 219-00058-03
ENCL NO.:



(m) ELEV DEPTH	DESCRIPTION	SAMPLES NUMBER	TYPE	"N" BLOWS/0.3 m	GROUND WATER CONDITIONS	ELEVATION	SHEAR STRENGTH (kPa)
	SILTY CLAY, grey, wet, firm to stiff(Continued)						
			VANE			73	+ 8.5
					Sand		
		4	SS	WH	Screen		
			VANE			72	+
			VANE				+ 6.5
		5	SS	50/50 mm		71	
70.8 6.5	END OF BOREHOLE				Slough		

Notes:
1. Borehole terminated at 6.5 m in depth after auger refusal.
2. Monitoring well installed at 6.4 m in depth
3. Date Groundwater Depth

Date	Groundwater Depth
October 15, 2021	3.1 m

GROUNDWATER ELEVATIONS
Measurement 1st ▽ 2nd ▼ 3rd ▼ 4th ▼

GRAPH NOTES
+ 3, × 3: Numbers refer to Sensitivity
○ ε=3% Strain at Failure

LOG OF BOREHOLE 21-08s

PROJECT: Access Storage - 415 Legget Drive
CLIENT: Access Property Development
PROJECT LOCATION: 415 Legget Drive, Ottawa, ON
DATUM: Geodetic
BH LOCATION: See Borehole Location Plan

DRILLING DATA
Method: Hollow Stem Augers
Diameter: 203 mm
Date: Sep/29/2021

REF. NO.: 219-00058-03
ENCL NO.:

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH (kPa) ○ UNCONFINED + FIELD VANE & Sensitivity ● QUICK TRIAXIAL × LAB VANE 25 50 75 100 125	PLASTIC LIMIT W_P NATURAL MOISTURE CONTENT w LIQUID LIMIT W_L / WATER CONTENT (%) 20 40 60	POCKET PEN. (Cu) (kPa)	NATURAL UNIT WT (kN/m³)	REMARKS AND GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
(m) ELEV / DEPTH	DESCRIPTION	NUMBER	TYPE	"N" BLOWS / 0.3 m							
77.3 0.0											
77.2 0.1	**TOPSOIL - 75 mm**										
	SILTY SAND, brown, moist, very loose to compact					77					
		1	GRAB								
		2	SS	10							
						76					
		3	SS	3							
75.0 2.3	**SILTY CLAY,** trace sand, brown, moist (Weathered Clay)					75					
		4	SS	50/0 mm							
74.5 2.8	END OF BOREHOLE Notes: 1. Borehole is open and dry upon completion										

GROUNDWATER ELEVATIONS
Measurement 1st ▽ 2nd ▼ 3rd ▼ 4th ▼

GRAPH NOTES
+ 3, × 3: Numbers refer to Sensitivity
○ ε=3% Strain at Failure

Explanation of Terms Used in the Record of Boreholes

Sample Type

AS	Auger sample
BS	Block sample
CS	Chunk sample
DO	Drive open
DS	Dimension type sample
FS	Foil sample
RC	Rock core
SC	Soil core
SS	Spoon sample
SH	Shelby tube Sample
ST	Slotted tube
TO	Thin-walled, open
TP	Thin-walled, piston
WS	Wash sample

Penetration Resistance

Standard Penetration Resistance (SPT), N:

The number of blows by a 63.5 kg (140 lb) hammer dropped 760 mm (30 in) required to drive a 50 mm (2 in) drive open sampler for a distance of 300 mm (12 in).

WH – Samples sinks under “weight of hammer”

Dynamic Cone Penetration Resistance, N_d:

The number of blows by a 63.5 kg (140 lb) hammer dropped 760 mm (30 in) to drive uncased a 50 mm (2 in) diameter, 60° cone attached to “A” size drill rods for a distance of 300 mm (12 in).

Textural Classification of Soils

Classification	**Particle Size**
Boulders	> 200 mm
Cobbles	75 mm - 200 mm
Gravel	4.75 mm - 75 mm
Sand	0.075 mm – 4.75 mm
Silt	0.002 mm-0.075 mm
Clay	<0.002 mm

Coarse Grain Soil Description (50% greater than 0.075 mm)

Terminology	**Proportion**
Trace	0-10%
Some	10-20%
Adjective (e.g. silty or sandy)	20-35%
And (e.g. sand and gravel)	> 35%

Soil Description

a) Cohesive Soils(*)

Consistency	**Undrained Shear Strength (kPa)**	**SPT “N” Value**
Very soft	<12	0-2
Soft	12-25	2-4
Firm	25-50	4-8
Stiff	50-100	8-15
Very stiff	100-200	15-30
Hard	>200	>30

(*) Hierarchy of Shear Strength prediction

1. Lab triaxial test
2. Field vane shear test
3. Lab. vane shear test
4. SPT “N” value
5. Pocket penetrometer

b) Cohesionless Soils

Density Index (Relative Density)	**SPT “N” Value**
Very loose	<4
Loose	4-10
Compact	10-30
Dense	30-50
Very dense	>50

Soil Tests

w	Water content
w_p	Plastic limit
w_l	Liquid limit
C	Consolidation (oedometer) test
CID	Consolidated isotropically drained triaxial test
CIU	consolidated isotropically undrained triaxial test with porewater pressure measurement
D_R	Relative density (specific gravity, Gs)
DS	Direct shear test
ENV	Environmental/ chemical analysis
M	Sieve analysis for particle size
MH	Combined sieve and hydrometer (H) analysis
MPC	Modified proctor compaction test
SPC	Standard proctor compaction test
OC	Organic content test
U	Unconsolidated Undrained Triaxial Test
V	Field vane (LV-laboratory vane test)
γ	Unit weight

APPENDIX

C

LABORATORY TESTING RESULTS

ATTERBERG LIMITS

ASTM D4318

Date:	19-Oct-21	Job No.:	219-00058-03
Project Name:	415 Legget Drive	Tech.:	LEK
Borehole/Sample No.:	BH21-1i / SS3 / 1.5-2.1m		

Liquid Limit Test

Number of Shocks	33	23	16
Tin No.			
Tin + Wet soil	29.9	37.5	29.1
Tin + Dry soil	26.5	34.3	25.8
Wt. of Water	3.4	3.2	3.3
Wt. of Tin	19.8	28.2	19.8
Wt. of Dry Soil	6.7	6.1	6.0
Water Content	51	53	55

Plastic Limit Test

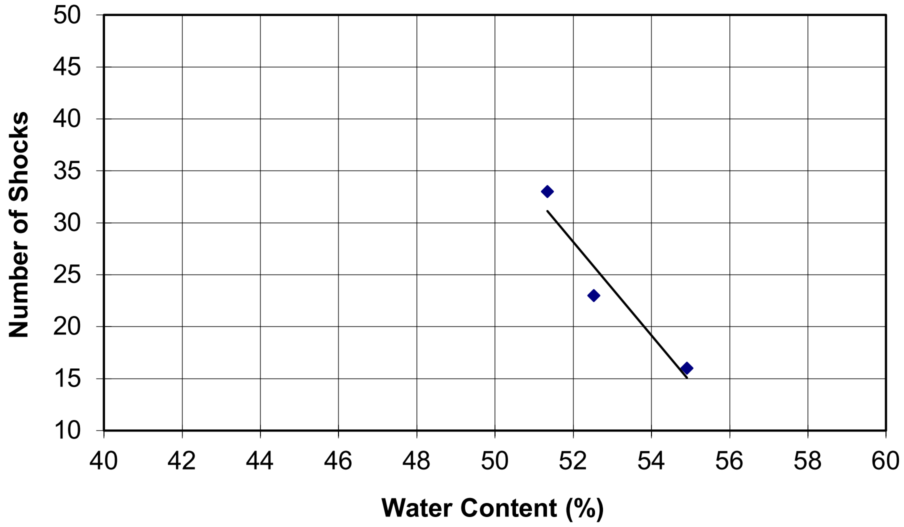
Tin No.		
Tin + Wet soil	29.4	28.5
Tin + Dry soil	27.7	27.0
Wt. of Water	1.7	1.6
Wt. of Tin	19.8	19.7
Wt. of Dry Soil	7.9	7.3
Water Content	22	22

Liquid Limit, (W_L) 53
Plastic Limit, (WP) 22
Plasticity Index (I_P=W_L-W_P) 31

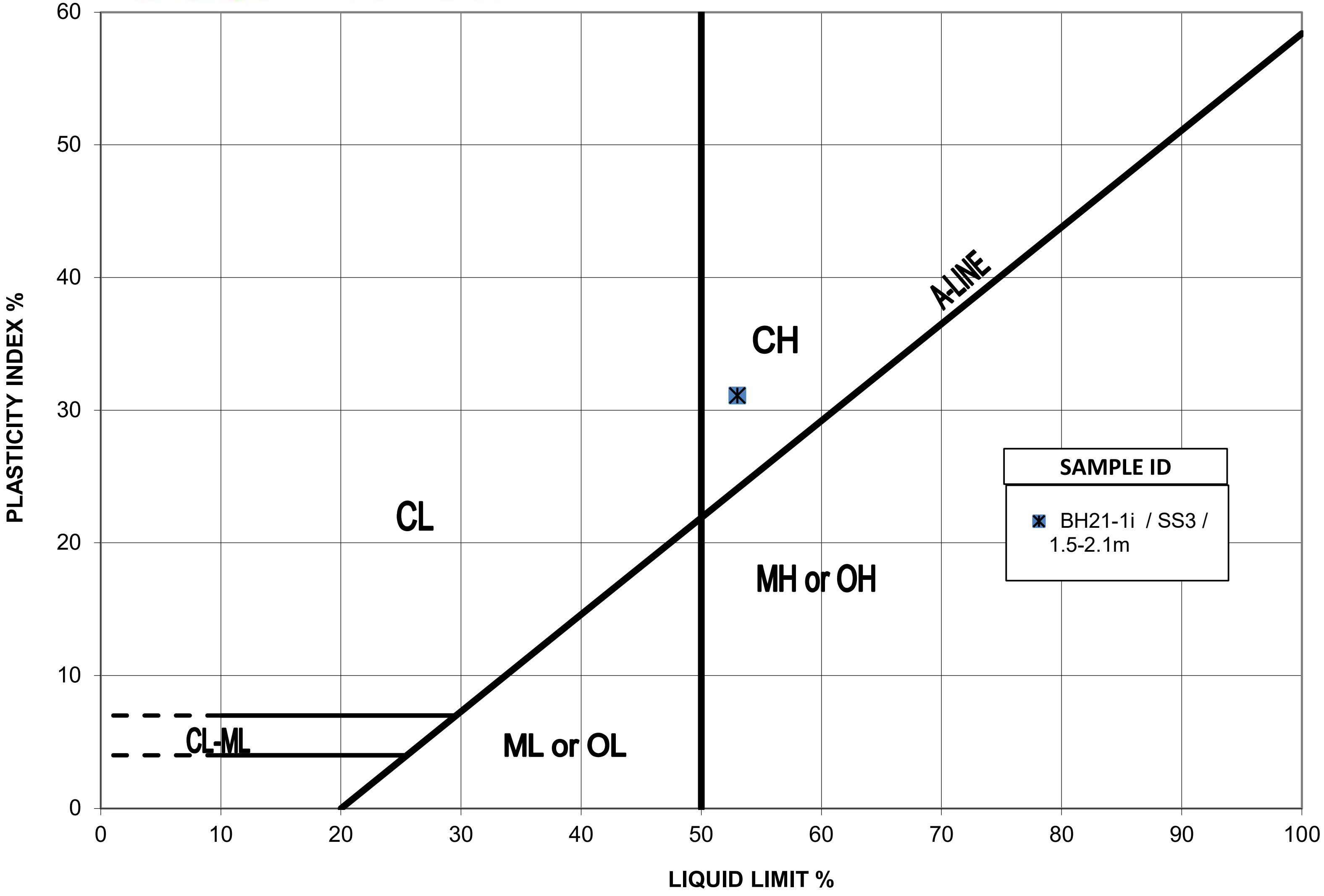
Control Results

Liquid Limit, (W_L) 31
Plastic Limit, (WP) 20
Plasticity Index (I_P=W_L-W_P) 11

Liquid Limit



Atterberg Limits Plasticity Chart
415 Legget Drive
219-00058-03



ATTERBERG LIMITS

ASTM D4318

Date:	19-Oct-21	Job No.:	219-00058-03
Project Name:	415 Legget Drive	Tech.:	LEK
Borehole/Sample No.:	BH21-3s / SS3 / 1.5-2.1m		

Liquid Limit Test

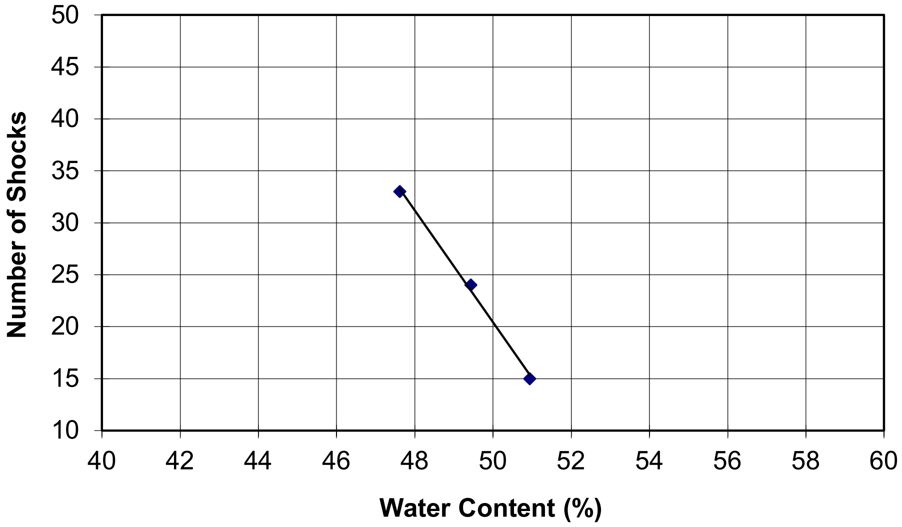
Number of Shocks	33	24	15
Tin No.			
Tin + Wet soil	35.9	38.9	36.4
Tin + Dry soil	33.5	35.4	33.7
Wt. of Water	2.4	3.5	2.7
Wt. of Tin	28.5	28.3	28.4
Wt. of Dry Soil	5.0	7.1	5.3
Water Content	48	49	51

Plastic Limit Test

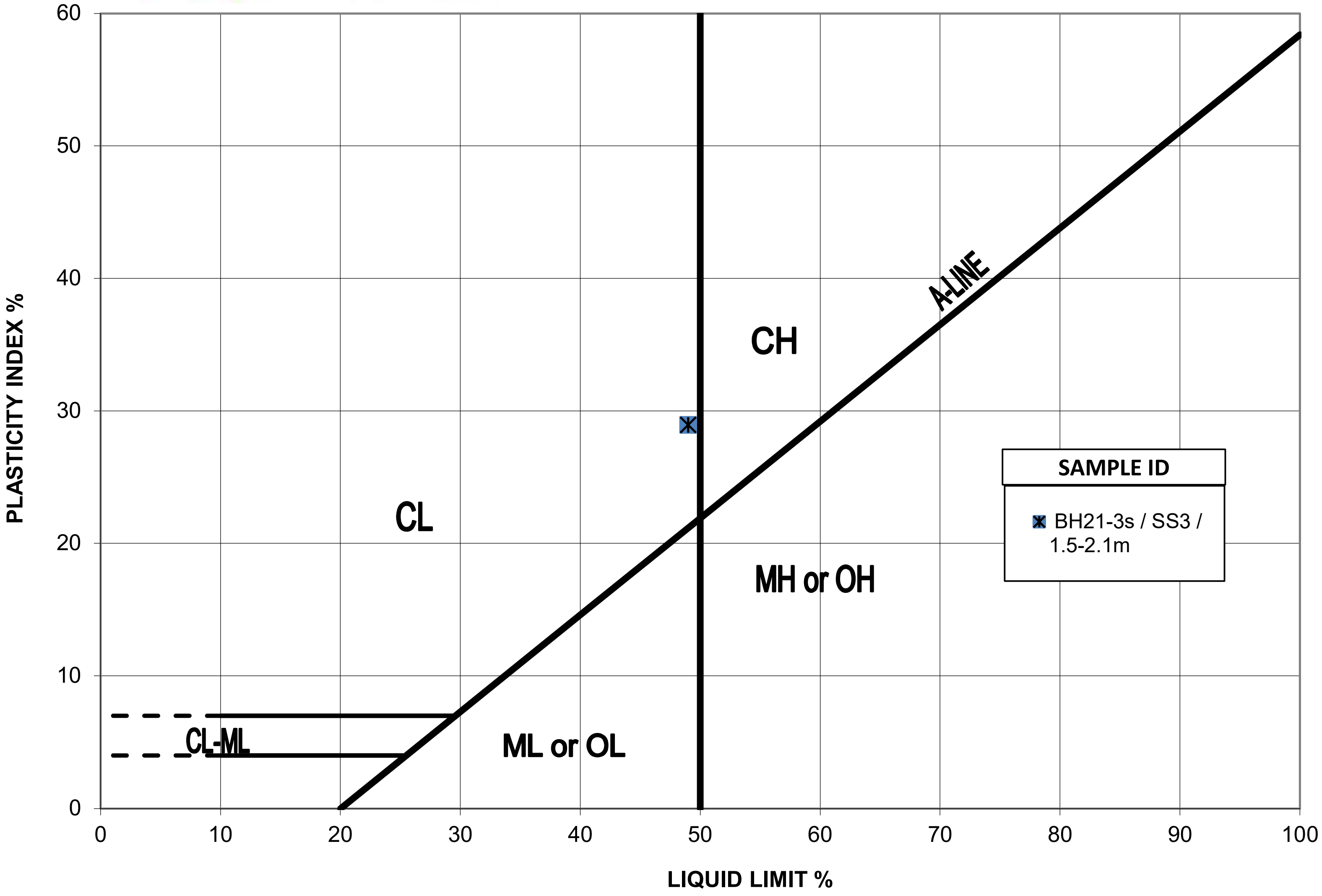
Tin No.		
Tin + Wet soil	27.8	35.2
Tin + Dry soil	26.6	34.1
Wt. of Water	1.3	1.1
Wt. of Tin	20.0	28.6
Wt. of Dry Soil	6.5	5.5
Water Content	19	21

		Control Results	
Liquid Limit, (W_L)	49	Liquid Limit, (W_L)	31
Plastic Limit, (WP)	20	Plastic Limit, (WP)	20
Plasticity Index (I_P=W_L-W_P)	29	Plasticity Index (I_P=W_L-W_P)	11

Liquid Limit



Atterberg Limits Plasticity Chart
415 Legget Drive
219-00058-03



ATTERBERG LIMITS

ASTM D4318

Date:	19-Oct-21	Job No.:	219-00058-03
Project Name:	415 Legget Drive	Tech.:	LEK
Borehole/Sample No.:	BH21-4s / SS5 / 4.6-5.2m		

Liquid Limit Test

Number of Shocks	18	24	33
Tin No.			
Tin + Wet soil	31.2	24.8	25.7
Tin + Dry soil	27.9	21.8	22.5
Wt. of Water	3.3	3.0	3.2
Wt. of Tin	19.8	14.1	14.2
Wt. of Dry Soil	8.1	7.7	8.2
Water Content	41	40	39

Plastic Limit Test

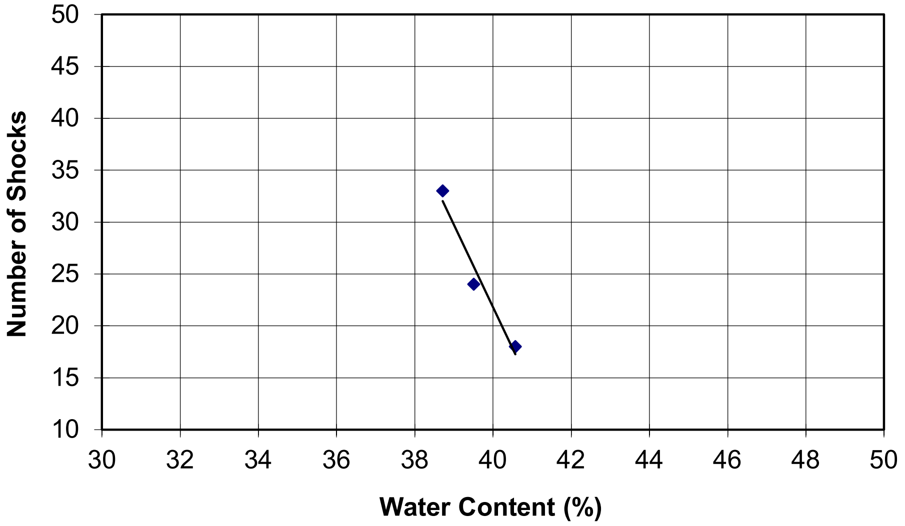
Tin No.		
Tin + Wet soil	39.3	29.7
Tin + Dry soil	37.6	28.2
Wt. of Water	1.7	1.6
Wt. of Tin	28.5	20.0
Wt. of Dry Soil	9.1	8.2
Water Content	19	19

Liquid Limit, (W_L)	40
Plastic Limit, (WP)	19
Plasticity Index (I_P=W_L-W_P)	21

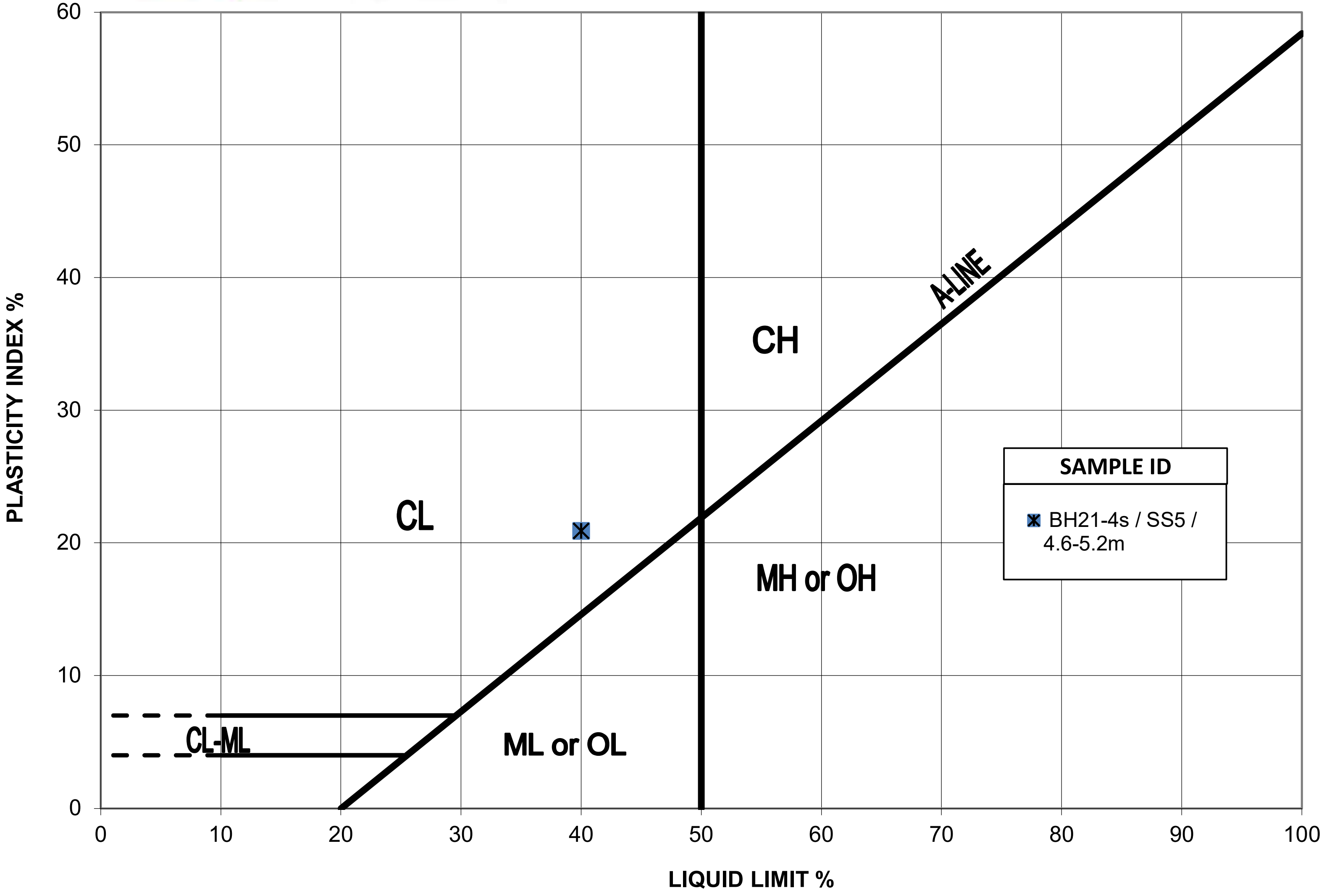
Control Results

Liquid Limit, (W_L)	31
Plastic Limit, (WP)	20
Plasticity Index (I_P=W_L-W_P)	11

Liquid Limit



Atterberg Limits Plasticity Chart
415 Legget Drive
219-00058-03



ATTERBERG LIMITS

ASTM D4318

Date:	19-Oct-21	Job No.:	211-00058-03
Project Name:	415 Legget Drive	Tech.:	LEK/NLO
Borehole/Sample No.:	BH21-7s / SS3A / 1.5-2.1m		

Liquid Limit Test

Number of Shocks	33	23	16
Tin No.			
Tin + Wet soil	36.9	37.0	37.5
Tin + Dry soil	34.3	34.2	34.6
Wt. of Water	2.6	2.8	3.0
Wt. of Tin	28.3	28.1	28.1
Wt. of Dry Soil	6.0	6.2	6.4
Water Content	44	45	46

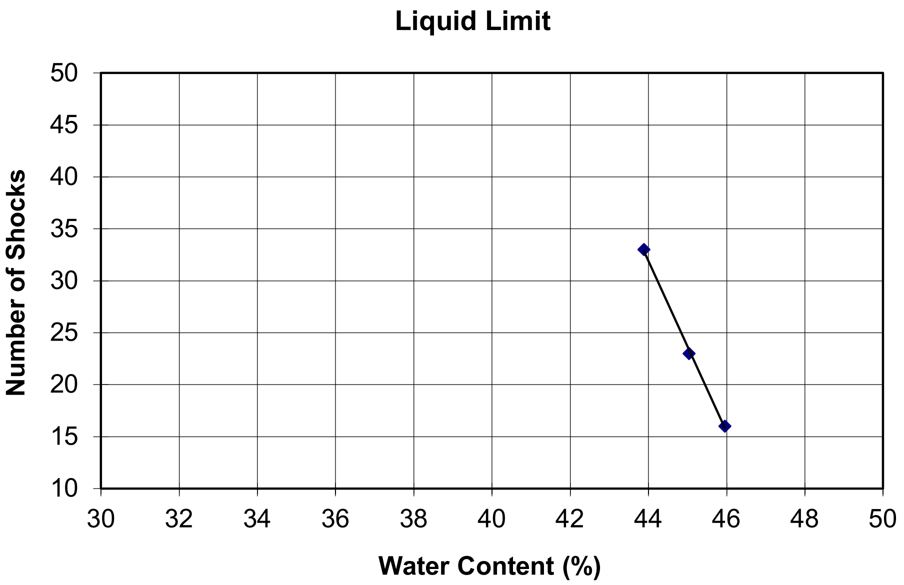
Plastic Limit Test

Tin No.		
Tin + Wet soil	25.4	34.3
Tin + Dry soil	24.5	33.4
Wt. of Water	0.9	0.9
Wt. of Tin	19.9	28.5
Wt. of Dry Soil	4.6	4.8
Water Content	19	19

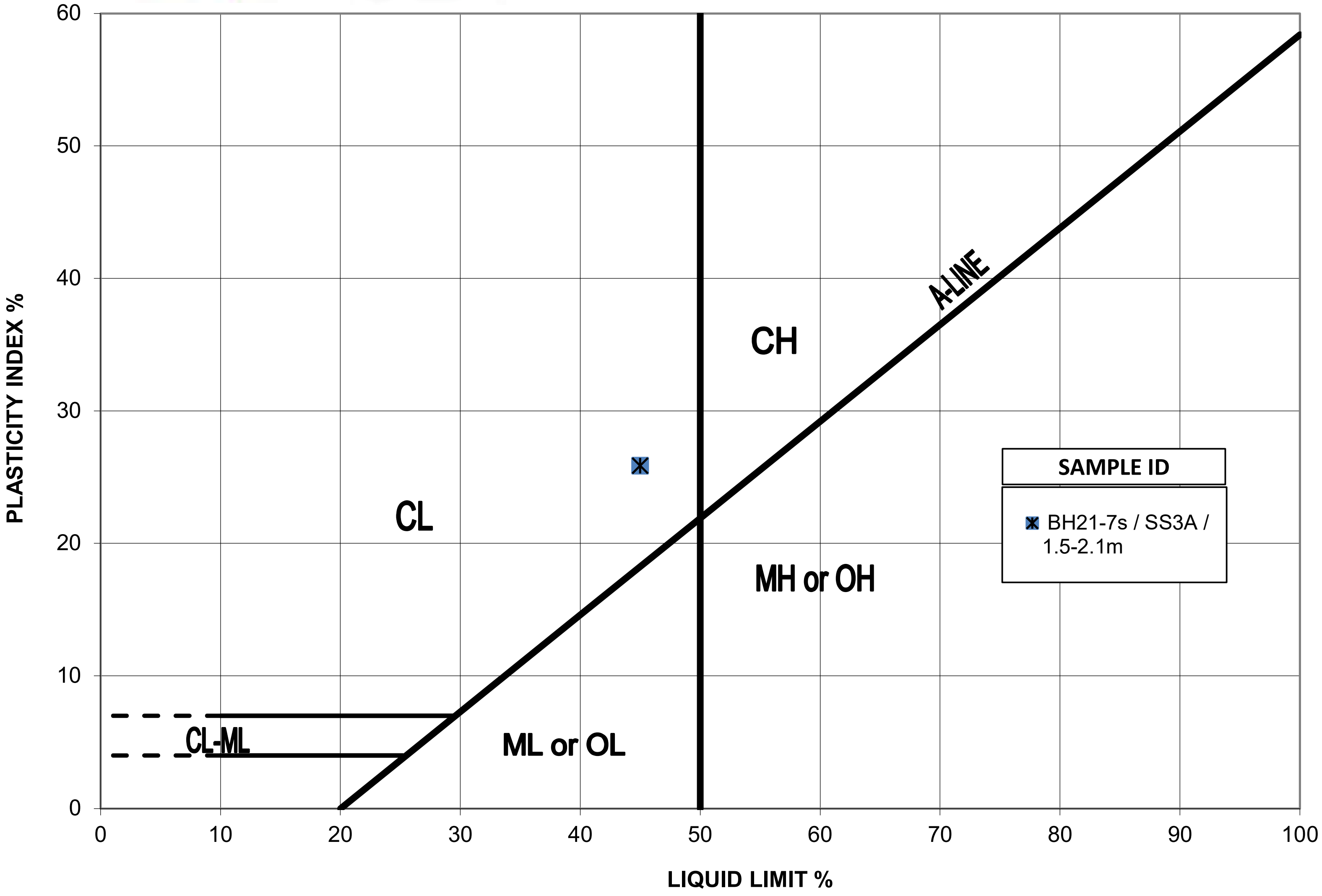
Liquid Limit, (W_L)	45
Plastic Limit, (WP)	19
Plasticity Index (I_P=W_L-W_P)	26

Control Results

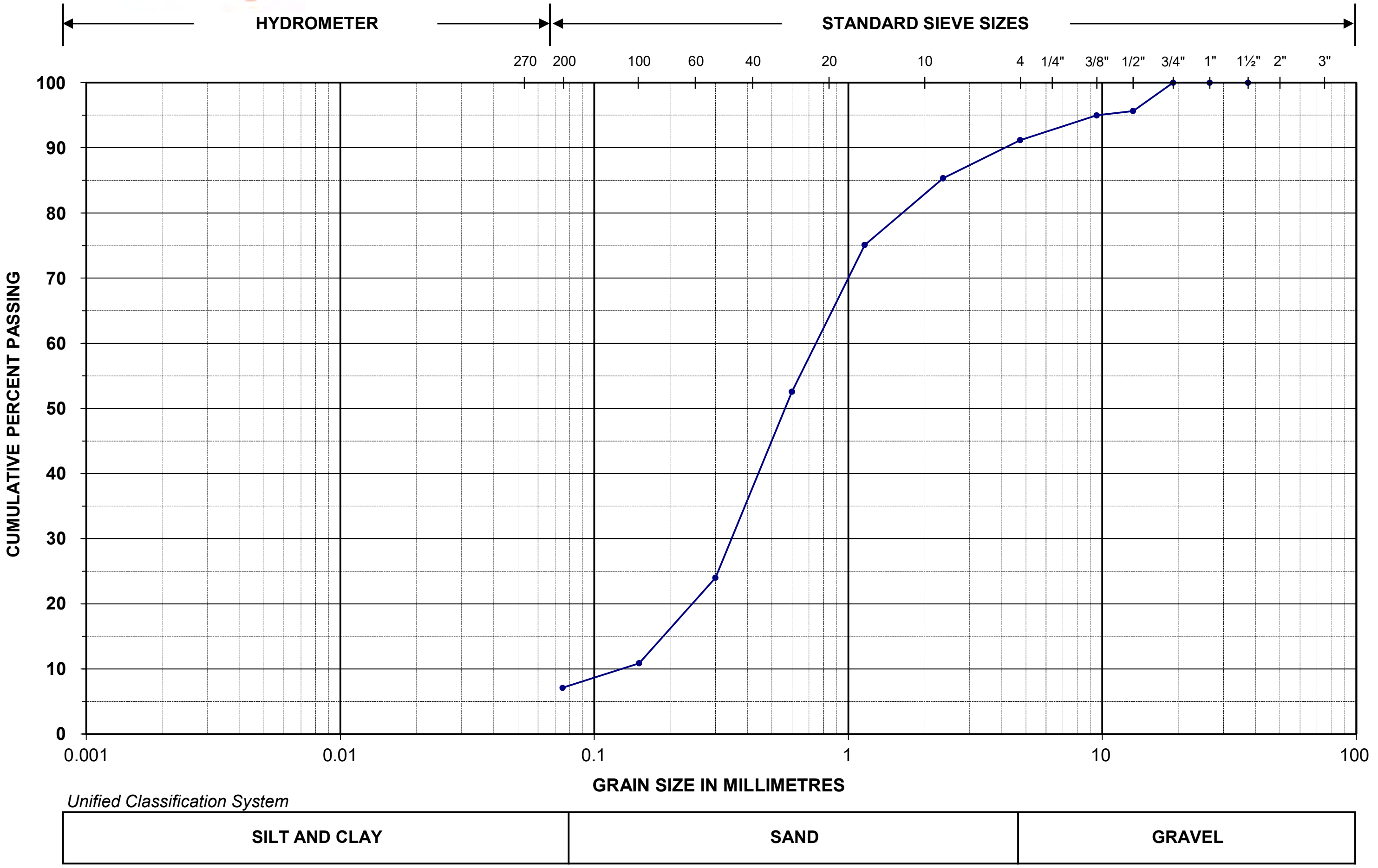
Liquid Limit, (W_L)	31
Plastic Limit, (WP)	20
Plasticity Index (I_P=W_L-W_P)	11



Atterberg Limits Plasticity Chart
415 Legget Drive
211-00058-03



PARTICLE SIZE DISTRIBUTION



Project Name: 415 Legger Drive
Project No.: 219-00058-03
Location ID.: BH21-1i
Sample No./Depth: Grab 1 / 0.2-0.25m

Sieve Size	% Passing Coarse	Sieve Size	% Passing Fine
37.5 mm	100.0	**2.36 mm**	85.3
26.5 mm	100.0	**1.16 mm**	75.1
19.0 mm	100.0	**0.60 mm**	52.6
13.2 mm	95.6	**0.30 mm**	24.0
9.5 mm	95.0	**0.15 mm**	10.9
4.75 mm	91.2	**0.075 mm**	7.1

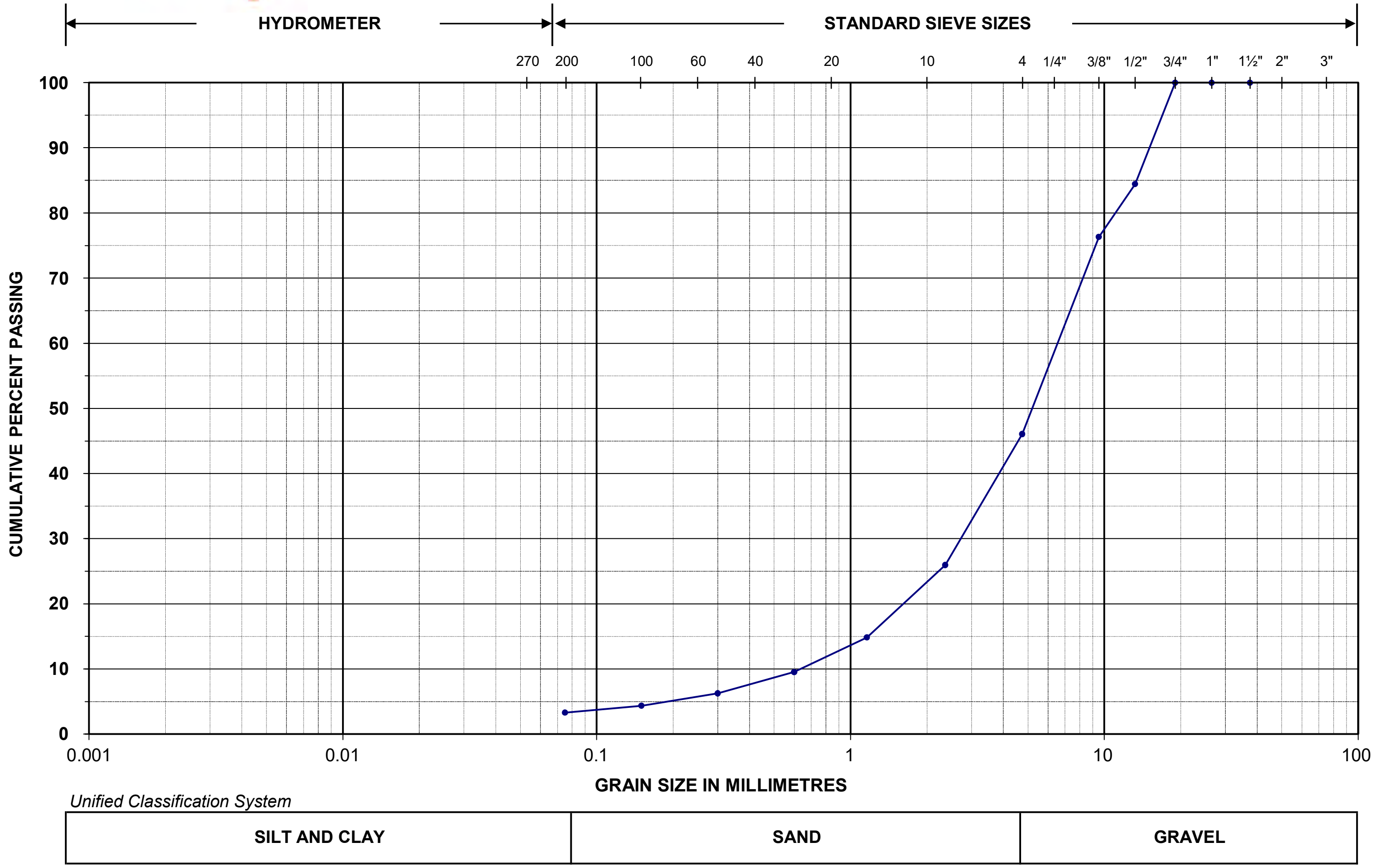
Note: More information is available upon request.

Tested by: LEK

Reviewed by:

Date: 15-Oct-21

PARTICLE SIZE DISTRIBUTION



Project Name: 415 Legget Drive
Project No.: 219-00058-03
Location ID.: BH21-2i
Sample No./Depth: Grab 1 / 0.08-0.15m

Sieve Size	% Passing Coarse	Sieve Size	% Passing Fine
37.5 mm	100.0	**2.36 mm**	26.0
26.5 mm	100.0	**1.16 mm**	14.8
19.0 mm	100.0	**0.60 mm**	9.5
13.2 mm	84.4	**0.30 mm**	6.2
9.5 mm	76.3	**0.15 mm**	4.4
4.75 mm	46.1	**0.075 mm**	3.3

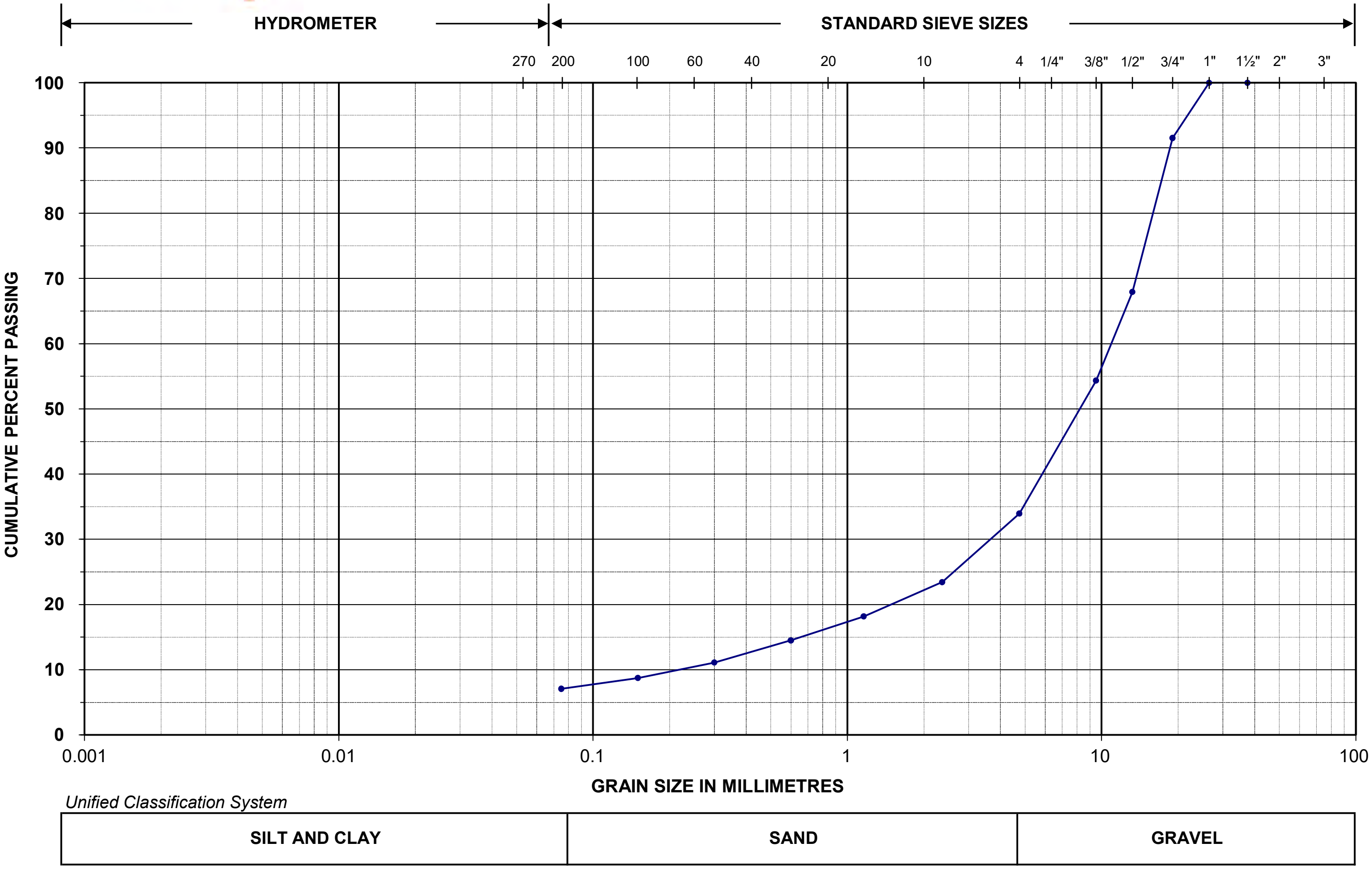
Note: More information is available upon request.

Tested by: LEK/NLO

Reviewed by:

Date: 15-Oct-21

PARTICLE SIZE DISTRIBUTION



Project Name: 415 Legget Drive
Project No.: 219-00058-03
Location ID.: BH21-2s
Sample No./Depth: Grab 1 / 0.15-0.30m

Sieve Size	% Passing Coarse	Sieve Size	% Passing Fine
37.5 mm	100.0	**2.36 mm**	23.4
26.5 mm	100.0	**1.16 mm**	18.2
19.0 mm	91.5	**0.60 mm**	14.5
13.2 mm	67.9	**0.30 mm**	11.1
9.5 mm	54.3	**0.15 mm**	8.7
4.75 mm	33.9	**0.075 mm**	7.1

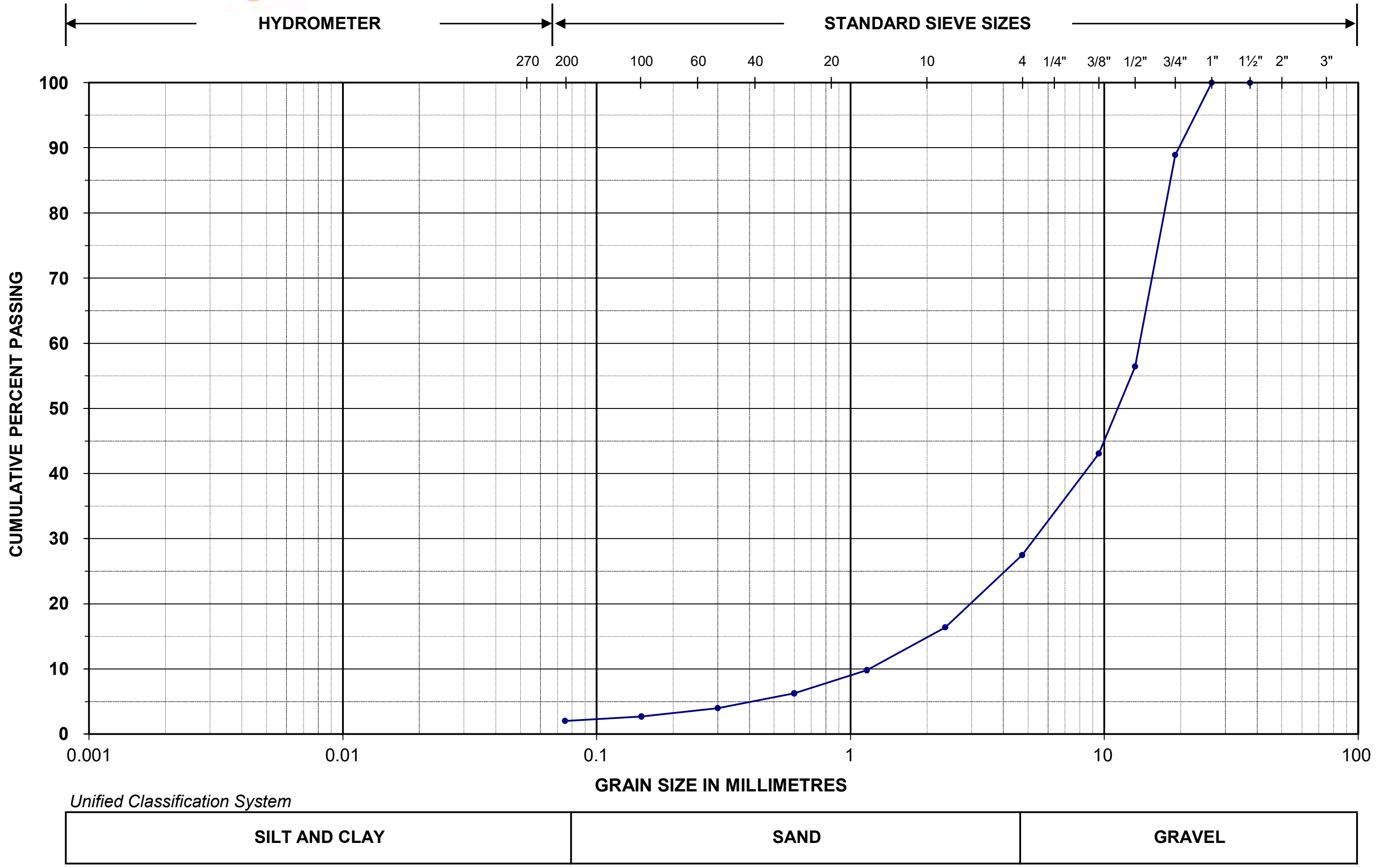
Note: More information is available upon request.

Tested by: LEK

Reviewed by:

Date: 19-Oct-21

PARTICLE SIZE DISTRIBUTION



Project Name: 415 Legget Drive

Project No.: 219-00058-03

Location ID.: BH21-3i

Sample No./Depth: Grab 1 / 0.15-0.25m

Sieve Size	% Passing Coarse	Sieve Size	% Passing Fine
37.5 mm	100.0	**2.36 mm**	16.4
26.5 mm	100.0	**1.16 mm**	9.8
19.0 mm	88.9	**0.60 mm**	6.3
13.2 mm	56.4	**0.30 mm**	4.0
9.5 mm	43.1	**0.15 mm**	2.7
4.75 mm	27.5	**0.075 mm**	2.0

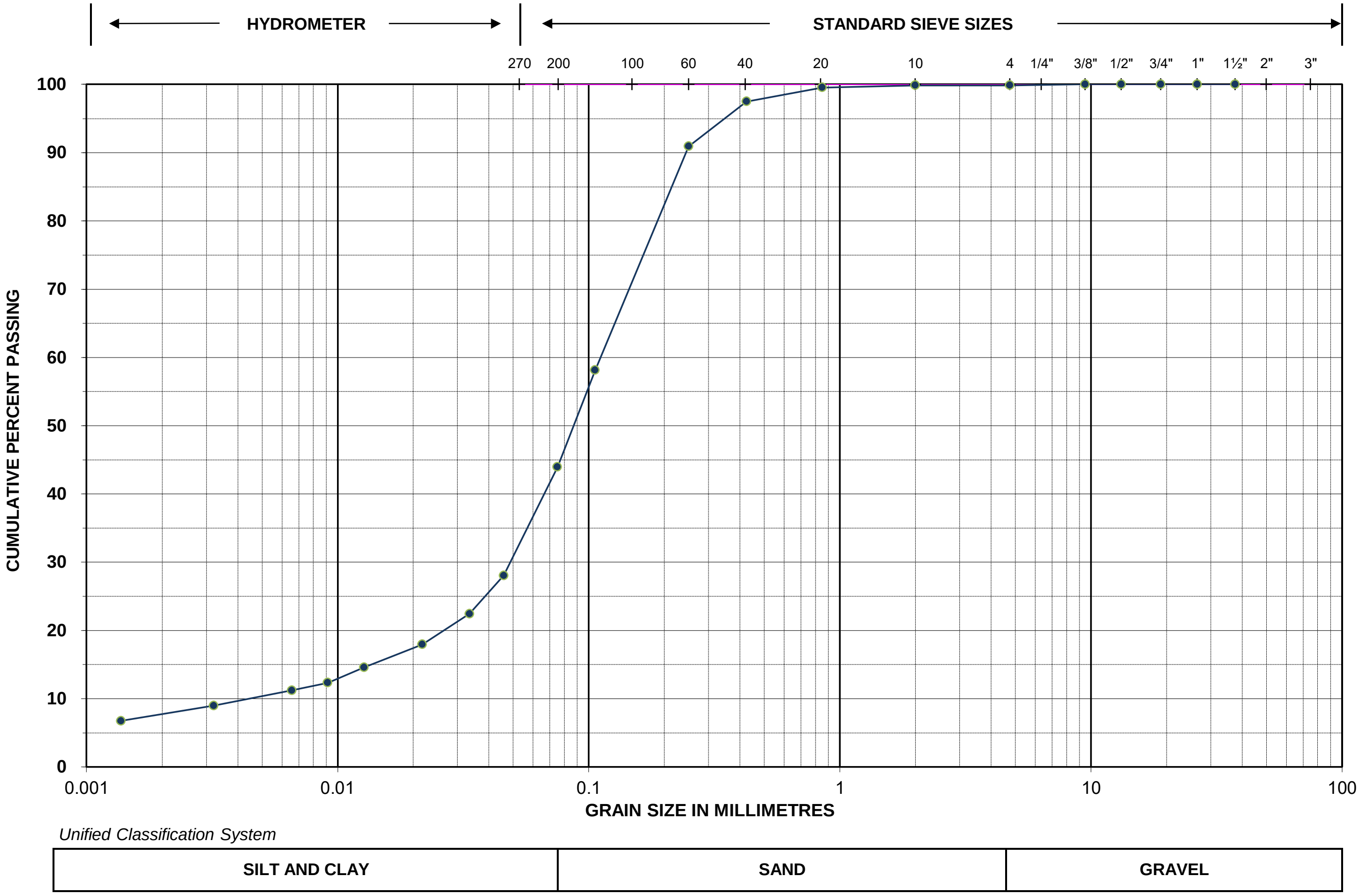
Note: More information is available upon request.

Tested by: LEK

Reviewed by:

Date: 15-Oct-21

PARTICLE SIZE DISTRIBUTION LS702/ASTM D422



Project Name: 415 Legget Drive
Project No.: 219-00058-31
Location ID.: BH21-5s
Sample No./Depth: SS2 / 0.8-1.4m

Sieve Size	% Passing Coarse	Sieve Size	% Passing Fine	Hydrometer (mm)	% Passing
37.5 mm	100.0	**2.00 mm**	99.9	**0.046**	28.0
26.5 mm	100.0	**0.850 mm**	99.5	**0.022**	18.0
19.0 mm	100.0	**0.425 mm**	97.5	**0.009**	12.3
13.2 mm	100.0	**0.250 mm**	90.9	**0.003**	9.0
9.50 mm	100.0	**0.106 mm**	58.1	**0.001**	6.7
4.75 mm	99.9	**0.075 mm**	43.9		

Note: More information is available upon request.

Tested by: NLO/LEK

Reviewed by: K Conlon

Date: 20/Oct/21

eurofins | Environment Testing

Certificate of Analysis

Client:	WSP (Ottawa) 2611Queensview Dr. Ottawa, ON K2B 8K1
Attention:	Nathan Christie
PO#:	
Invoice to:	WSP Canada Inc.

Report Number:	1964299
Date Submitted:	2021-10-07
Date Reported:	2021-10-14
Project:	219-00058-03
COC #:	214930

				Lab I.D. Sample Matrix Sample Type Sampling Date Sample I.D.	1587905 Soil 2021-09-30 BH21-1i 0.3-0.4m	1587906 Soil 2021-10-03 BH21-4i 2.0-2.6m	1587907 Soil 2021-09-27 BH21-2s SS2	1587908 Soil 2021-09-28 BH21-5s SS4
Group	**Analyte**	**MRL**	**Units**	**Guideline**				
Anions	Cl	0.002	%		0.004	0.006	0.032	0.018
	SO4	0.01	%		0.04	0.02	<0.01	0.01
General Chemistry	Electrical Conductivity	0.05	mS/cm		0.24	0.20	0.47	0.29
	pH	2.00			8.12	8.07	8.05	8.18
	Resistivity	1	ohm-cm		4170	5260	2130	3570

Guideline = *** = Guideline Exceedence**

Results relate only to the parameters tested on the samples submitted.
Methods references and/or additional QA/QC information available on request.

MRL = Method Reporting Limit, AO = Aesthetic Objective, OG = Operational Guideline, MAC = Maximum Acceptable Concentration, IMAC = Interim Maximum Acceptable Concentration, STD = Standard, PWQO = Provincial Water Quality Guideline, IPWQO = Interim Provincial Water Quality Objective, TDR = Typical Desired Range

APPENDIX

D

LIMITATIONS OF THIS REPORT

LIMITATIONS OF REPORT

This report is intended solely for the Client named. The material in it reflects our best judgment in light of the information available to WSP Canada Incorporated (WSP) at the time of preparation. Unless otherwise agreed in writing by WSP, it shall not be used to express or imply warranty as to the fitness of the property for a particular purpose. No portion of this report may be used as a separate entity, it is written to be read in its entirety.

The conclusions and recommendations given in this report are based on information determined at the test hole locations. The information contained herein in no way reflects on the environment aspects of the project, unless otherwise stated. Subsurface and groundwater conditions between and beyond the test holes may differ from those encountered at the test hole locations, and conditions may become apparent during construction, which could not be detected or anticipated at the time of the site investigation. The benchmark and elevations used in this report are primarily to establish relative elevation differences between the test hole locations and should not be used for other purposes, such as grading, excavating, planning, development, etc.

The design recommendations given in this report are applicable only to the project described in the text and then only if constructed substantially in accordance with the details stated in this report.

The comments made in this report on potential construction problems and possible methods are intended only for the guidance of the designer. The number of test holes may not be sufficient to determine all the factors that may affect construction methods and costs. For example, the thickness of surficial topsoil or fill layers may vary markedly and unpredictably. The contractors bidding on this project or undertaking the construction should, therefore, make their own interpretation of the factual information presented and draw their own conclusions as to how the subsurface conditions may affect their work. This work has been undertaken in accordance with normally accepted geotechnical engineering practices.

Any use which a third party makes of this report, or any reliance on or decisions to be made based on it, are the responsibility of such third parties. WSP accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions based on this report.

We accept no responsibility for any decisions made or actions taken as a result of this report unless we are specifically advised of and participate in such action, in which case our responsibility will be as agreed to at that time.