REPORT

Geotechnical Exploration

Proposed Redevelopment of 895 Lawrence Avenue East, North York, Ontario

Submitted to:

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1.0 INTRODUCTION

Golder Associates Ltd., a Member of WSP, ("Golder") has been retained by First Capital Asset Management LP ("FCAM" or "Client") to provide geotechnical and hydrogeological consulting services in support of the design for the proposed commercial and residential development (the "project") to be located southwest of the intersection of Lawrence Avenue East and The Donway West (the "site") in Toronto, Ontario, at the location shown on the Key Plan, Figure 1 in ***Appendix B***. The terms of reference for the geotechnical consulting services are included in Golder's proposal No. P19129915 dated October 4, 2019. Authorization to proceed with the investigation was received in the form of the signed proposal received on February 25, 2020, from FCAM.

The purpose of the field work and testing was to obtain information on the general subsurface soil and groundwater conditions at the site by means of a limited number of boreholes and laboratory tests. Based on an interpretation of the data available for this site, this report provides engineering comments, recommendations, and parameters for the geotechnical design aspects of the project, including selected construction considerations which could influence design decisions. It should be noted that this report addresses only the geotechnical (physical) aspects of the subsurface conditions at the site. The geo-environmental (chemical) aspects, including the consequences of possible surface and/or subsurface contamination resulting from previous activities or uses of the site and/or resulting from the introduction onto the site of materials from off-site sources, are beyond the terms of reference for this assignment and are not addressed herein. The hydrogeological assessment report for the proposed development will be submitted separately.

This report provides the results of the geotechnical exploration and testing and should be read in conjunction with the *"Important Information and Limitations of This Report"* in ***Appendix A*** which forms an integral part of this document. The reader's attention is specifically drawn to this information, as it is essential for the proper use and interpretation of this report. The data, interpretations and recommendations contained in this report pertain to a specific project as described in the report and are not applicable to any other project or site location. If the project is modified in concept, location or elevation, or if the project is not initiated within eighteen months of the date of the report, Golder should be given an opportunity to confirm that the recommendations in this report are still valid.

2.0 SITE AND PROJECT DESCRIPTION

The site is located southwest of the intersection of Lawrence Avenue East and The Donway West in Toronto, Ontario, as shown on the Borehole Location Plan, Figure 2 in ***Appendix B***. The site is bordered on the north by Lawrence Avenue East, on the east and south by The Donway West and on the west a four-storey and a one-storey commercial buildings. The site is currently occupied by a one-storey commercial building in the northwest portion of the site and a paved parking area and access roads in the remainder of the site. Based on the topographic survey of the site, the ground surface generally slopes from the west to the east with geodetic elevations ranging from approximately 146 metres (m) to 143 m. Along the western boundary of the site, a retaining wall about 1 m to 1.5 m high separates the property from the neighbouring property, which is at a higher elevation.

At the time of preparing this report, the conceptual drawings provided by FCAM indicate that the proposed development consist of two towers 22 and 17 storeys connected by a 6-storey podium. The towers will be for residential use and the podium will be mixed-use commercial and residential. All of the buildings will have a common underground parking structure extending to two levels below grade, which will be approximately 6 m below finished grade.

3.0 INVESTIGATION PROCEDURE

3.1 Drilling Program

The combined hydrogeological and geotechnical field investigation for this assignment was carried out from March 19 to 27, 2020, during which time five boreholes (designated as BH20-1 to BH20-5) were advanced. The boreholes for the investigation were drilled using a standard truck mounted CME75 drill rig supplied and operated by DBW Drilling Limited of Ajax, Ontario, subcontracted to Golder. A summary of the drilling program is presented in Table 1. The approximate borehole locations are shown on the Borehole Location Plan, Figure 2 in ***Appendix B***. The results of the subsurface investigation are presented on the Record of Borehole sheets in ***Appendix C*** and the results of geotechnical laboratory testing in ***Appendix D***.

Table 1: Drilling Program

Borehole ID	Borehole Depth (m)	Finished Elevation (m)	Notes
BH20-1	17.0	125.9	50-mm diameter monitoring well installed
BH20-2	17.0	127.0	50-mm diameter monitoring well installed
BH20-3	16.9	128.9	50-mm diameter monitoring well installed
BH20-4	17.2	126.4	50-mm diameter monitoring well installed
BH20-5	17.0	127.6	50-mm diameter monitoring well installed

Standard Penetration Testing (SPT) and sampling were carried out at regular intervals of depth in the boreholes using conventional 38-millimetre (mm) internal diameter split spoon sampling equipment driven by an automatic hammer in accordance with the SPT procedures outlined in ASTM International standard D1586: “Standard Test Method for Standard Penetration Test (SPT) and Split-Barrel Sampling of Soils”. The split-spoon samplers used in the investigation limit the maximum particle size that can be sampled and tested to about 40 mm. Therefore, particles or objects that may exist within the soils that are larger than this dimension were not sampled and are not represented in the grain size distributions contained herein. The results of the field tests (i.e., SPT “N”-values) as presented on the Record of Borehole sheets and in subsequent sections of this report are the values measured directly in the field and are unfactored.

The groundwater conditions were noted in the open boreholes during and upon completion of drilling and monitoring wells were installed in five boreholes (see Table 1) following the completion of drilling to allow for subsequent groundwater measurements and hydrogeological testing. Each monitoring well consists of a 50-mm diameter PVC riser pipe, with a slotted screen sealed at a selected depth within the borehole. A sand filter pack surrounded the screen, and above the screen the borehole and annulus surrounding the riser pipe were backfilled to the surface with bentonite. The well installation details, and groundwater level readings are presented on the Record of Borehole sheets in ***Appendix C***.

The field work for this investigation was observed by members of Golder’s technical staff, who located the boreholes in the field, arranged for the clearance of underground utilities, observed the borehole drilling, sampling and in situ testing operations, logged the boreholes as well as examined and took custody of the recovered soil samples. The samples were identified in the field, placed in appropriate containers, labelled and transported to our Whitby geotechnical laboratory for further visual examination by the project engineer and for laboratory testing.

Index and classification tests, consisting of water content determinations and gradation analyses, were carried out on selected soil samples and the results are presented in ***Appendix D*** and also on the Record of Borehole sheets in ***Appendix C***.

The geodetic ground surface elevations at the borehole locations were determined from elevation references taken from a survey plan provided by FCAM, titled, "*Topographic Plan of Part of Blocks B and C, Registered Plan 4545, City of Toronto,*" prepared by Schaeffer Dzaldov Bennett Ltd., dated June 26, 2013, and as such, the elevations given on the Record of Borehole sheets and referred to herein should be considered as approximate. The borehole locations were referenced to existing prominent site features and plotted on the plan provided in the preparation of Figure 2, Borehole Location Plan. As such, the borehole locations shown on Figure 2 in ***Appendix B*** should also be considered to be approximate.

4.0 SITE GEOLOGY AND STRATIGRAPHY

4.1 Regional Geology

The surficial geology aspects of the general site area are referenced from the following publication:

- Chapman, L.J., and Putnam, D.F., 2007, *"The Physiography of Southern Ontario"*; 4th Edition, Ontario Geological Survey.

Physiographic mapping in the area according to the above-noted reference indicates that the site lies within the physiographic region of southern Ontario known as the South Slope. The South Slope region slopes gradually downward towards Lake Ontario. The overburden immediately below ground surface within the South Slope generally consists of clayey silt till and silty clay till and at depth consists of alternating deposits of dense lacustrine sands and silts and overconsolidated lacustrine clays and clay tills overlying the bedrock. Surficial geology mapping indicates that the site lies within an area of drumlinized till plain.

The subsurface conditions encountered during the investigation are generally consistent with the physiographic mapping.

4.2 Subsurface Conditions

The detailed subsurface soil and groundwater conditions encountered in the boreholes advanced at the site for this report along with the results of geotechnical laboratory testing are shown on the Record of Borehole sheets in ***Appendix C***. Golder's "*Methods of Soil Classification*", "*Abbreviations and Terms Used on Records of Boreholes and Test Pits*" and "*List of Symbols*" are provided in ***Appendix C*** to assist in the interpretation of the Record of Borehole sheets. The detailed results of geotechnical laboratory testing on selected soil samples are presented in ***Appendix D***.

The Record of Borehole sheets indicate the subsurface conditions at the borehole locations only. The stratigraphic boundaries shown on the borehole records are inferred from non-continuous sampling, observations of drilling progress as well as results of Standard Penetration Tests and, therefore, typically represent transitions between soil types rather than exact planes of geological/stratigraphic change. Subsurface soil conditions will vary between and beyond the borehole locations.

In general, the subsurface conditions encountered at the boreholes consisted of the pavement structure underlain by fill, extending to depths ranging from about 0.3 to 1.0 m below the existing ground surface overlying both cohesive and non-cohesive glacial deposits. Non-cohesive deposits consisting of silty sand to silt were encountered interlayered with the glacial till deposits. The compactness and consistency of the encountered soils generally improved with depth.

The subsurface soil and groundwater conditions encountered in the boreholes drilled at the site are described in the following sections.

4.2.1 Pavement Structure

Asphalt with a thickness of about 130 mm was encountered at the ground surface in all the borehole locations. The pavement structure, which includes the granular base and subbase, extended to depths ranging from about 0.3 m to 0.7 m below the existing ground surface (approximate Elevations 142.9 m to 145.8 m).

4.2.2 Fill

Cohesive clayey silt fill was encountered underlying the pavement structure at BH20-4 extending to a depth of about 1.0 m (approximate Elevation 142.6 m).

Standard Penetration Test (SPT) “N”-values were measured within the clayey silt fill at 9 blows and 14 blows per 0.3 m of penetration suggesting a stiff consistency. The water content measured on samples of the cohesive fill were at approximately 11 per cent and 14 per cent.

4.2.3 Silty Clay to Clayey Silt Till

Deposits of cohesive silty clay to clayey silt till were encountered interlayered with sandy silt till and non-cohesive deposits in all the boreholes at various depths.

At BH20-1 and BH20-1, silty clay to clayey silt till deposits were encountered underlying the pavement structure. The SPT “N”-values measured within the upper portions of the silty clay to clayey silt till deposit were at 10 blows and 18 blows per 0.3 m of penetration, indicating a stiff to very stiff consistency. However, the SPT “N”-values measured at greater depths within the silty clay to clayey silt till deposits ranged from 25 blows per 0.3 m of penetration to 50 blows per 0.05 m of penetration, indicating a very stiff to hard consistency, but generally hard.

The natural water content measured on samples of the silty clay to clayey silt till deposit ranged from approximately 6 per cent to 16 per cent.

4.2.4 Silty Sand to Sandy Silt Till Deposits

Deposits of silty sand to sandy silt till were encountered interlayered with silty clay to clayey silt till and non-cohesive deposits in all the boreholes at various depths.

At BH20-3 to BH20-5, silty sand to sandy silt till deposits were encountered underlying the pavement structure or near surface fill. The SPT “N”-values measured within the upper portions of the silty sand to sandy silt till deposit ranged from 14 blows and 23 blows per 0.3 m of penetration, indicating a compact to dense degree of compactness. However, SPT “N”-values measured at greater depths within the silty sand to sandy silt till deposits ranged from 30 blows per 0.3 m of penetration to 50 blows per 0.05 m of penetration, indicating a dense to very dense state of compactness. The natural water content measured on samples of the silty sand to sandy silt till deposits ranged from approximately 3 per cent to 12 per cent.

4.2.5 Non-cohesive Deposits

Non cohesive deposits were encountered in all the boreholes interlayered with the glacial till deposits. The non-cohesive deposits in general consisted of deposits of silty sand to sandy silt. At BH20-3, a deposit of silt was encountered between depths of about 8.6 m and 11.7 m (approximate Elevation 137.2 m and 134.1 m).

SPT “N”-values measured within the non-cohesive deposits ranged from 48 blows per 0.3 m of penetration to 50 blows per 0.13 m of penetration, indicating a dense to very dense degree of compactness, but generally very dense. The natural water content measured on samples of the non-cohesive deposits ranged from approximately 11 per cent to 19 per cent.

Two SPT "N"-values of 38 and 40 blows per 0.3 m of penetration were measured within the silt deposit, indicating a dense degree of compactness. The natural water content was measured on two samples of the silt at approximately 16 per cent and 17 per cent.

4.2.6 Geotechnical Laboratory Testing

The results of grain size distribution analyses carried out on two samples of the native gravelly sand deposits are shown on Figure D3 in ***Appendix D***. The results of a grain size distribution analysis carried out on a sample of the clayey sand deposits are shown on Figure D4 in ***Appendix D.*** The results of grain size distribution analyses carried out on three samples of the silty sand to sand deposits are shown on Figure D5 in ***Appendix D.*** A summary of the grain size distribution analyses is presented below in ***Table 2.***

Table 2: Results of Grain Size Distribution Analyses

Borehole ID	Sample Number	Depth (m)	Soil Classification	Notes
BH20-2	7	6.1 to 6.6	SM	Figure D1 Silty sand
BH20-5	8	7.6 to 7.9	SM	Figure D2 Silty sand

4.2.7 Pressuremeter Testing Results

Golder retained In-Depth Geotechnical Inc. to carry out pressuremeter testing in Borehole 22-1 and 22-3 at depths ranging from about 5.84 to 16.00 m below grade. The tests were completed using a TEXAM pressuremeter in accordance with the procedure outlined in ASTM International D4719-00. The full report is presented in Appendix E. The results are summarized below in Table 3

Table 3: Pressuremeter Testing Results

Borehole	Test No.	Depth (m)	Pressuremeter Modulus E_{PMT} (MPa)	Limit Pressure p^*_L (kPa)	Young's Modulus E_{young} (MPa)	Soil Type
BH22-1	1	5.84	64	7,288	236	Very dense sandy silt
	2	8.33	45.1	5,771	151	Very dense sandy silt
	3	11.43	285.1	8,676	472	Hard silty clay
	4	14.48	113.5	5,096	194	Hard silty clay
BH22-3	1	6.55	61	5,286	174	Very dense silt to sandy silt
	2	9.8	213.2	12,798	575	Hard silty clay till

Borehole	Test No.	Depth (m)	Pressuremeter Modulus E_{PMT} (MPa)	Limit Pressure p^*_L (kPa)	Young's Modulus E_{young} (MPa)	Soil Type
	3	12.85	165.1	8,580	351	Hard silty clay till
	4	16	149,.2	5,512	219	Hard silty clay till

4.2.8 Groundwater Conditions

The groundwater conditions encountered in each of the boreholes during drilling and measured in the monitoring wells are shown in detail on the Record of Borehole sheets in ***Appendix B***. Groundwater levels were measured in the monitoring wells from May to June 2020 and are provided below in ***Table 4***.

Table 4: Groundwater Level Measurements

Date	Depth / Elevation (m)	Borehole ID				
		BH20-1	BH20-2	BH20-3	BH20-4	BH20-5
May 13, 2020	Depth (m)	4.4	3.5	4.5	3.3	3.6
	Elevation (m)	138.5	140.5	141.3	140.3	141.0
May 21, 2020	Depth (m)	4.4	3.9	4.5	3.3	3.5
	Elevation (m)	138.5	140.1	141.3	140.3	141.1
June 5, 2020	Depth (m)	4.4	3.8	4.5	3.3	3.6
	Elevation (m)	138.5	140.2	141.3	140.3	141.0
June 16, 2020	Depth (m)	4.4	3.7	4.5	3.3	3.6
	Elevation (m)	138.5	140.3	141.3	140.3	141.0

It should be noted that the encountered and measured groundwater levels reflect the groundwater conditions in the boreholes at the time of the field work from May to June 2020. Groundwater levels at the site are anticipated to vary between and beyond the borehole locations and to fluctuate with seasonal variations in precipitation and snowmelt.

5.0 DISCUSSION AND RECOMMENDATIONS

This section of the report provides engineering information on, and recommendations for, the preliminary geotechnical design aspects of the project based on our interpretation of the borehole information, the laboratory test data and our understanding of the project requirements. The information in this portion of the report is provided for planning and design purposes for the guidance of the design engineers and architects. Where comments are made on construction, they are provided only in order to highlight aspects of construction which could affect the design of the project. Contractors bidding on or undertaking any work at the site should examine the factual results of the investigation, satisfy themselves as to the adequacy of the information for construction and make their own independent interpretation of the factual data as it affects their proposed construction techniques, schedule, equipment capabilities, costs, sequencing and the like.

At the time of preparing this report, the conceptual drawings provided by FCAM indicate that the proposed development consist of two towers 22 and 17 storeys connected by a 6-storey podium. All of the buildings will have a common underground parking structure extending to two levels below grade, which will be approximately 6 m below finished grade. Footing bases and elevator shafts are anticipated to be about 1 m to 2 m below the finished basement floor.

Since the proposed development is at the conceptual stage, the recommendations in the following sections should be revised once the design of the proposed development has progressed further.

5.1 Geotechnical Recommendations

5.1.1 Raft Foundation

We have reviewed the preliminary foundation design (by WZMH Architects., Dwg. No. A-201, revision 1, dated July 18, 2022) and understand that the entire footprint of the tower will be supported on a concrete raft foundation bearing at an elevation of about 138 to 138.5 m.

The current foundation design drawings indicate that the raft foundation will be generally trapezoid in shape; the plan dimensions of the larger portion are about 103 m by 74 m and the adjacent smaller portion has plan dimensions of about 56 m by 82 m. Analyses were carried out to evaluate the soil bearing capacity and associated settlement for the raft foundation.

Settlement analyses were carried out using the commercially available software Settle3D (version 5-Westergaard method) produced by RocScience Inc.

The numerical analysis for a uniformly loaded raft foundation indicates that a uniform bearing pressure of 200 kPa will result in negligible settlement as this pressure would essentially be compensated for by the effective stress reduction imparted by the soil removal above the founding level. Each additional increase of 150 kPa would generate an additional 25 mm of settlement. Thus, mobilizing a **net** geotechnical reaction at Serviceability Limit States (SLS) of 150 kPa (total raft pressure of 350 kPa) will generate 25 mm of settlement, and a **net** mobilized geotechnical reaction at SLS of 350 kPa (total raft pressure of 500 kPa) will generate 50 mm of settlement. These estimated settlement values are based on Young’s Moduli for the load-bearing strata as estimated from the in situ pressuremeter testing.

Based on the SLS geotechnical reaction and settlement values noted above, the moduli of subgrade reaction appropriate for a raft supported on the hard silty clay and very dense sandy silt are 25 MN/m^3 and 20 MN/m^3 for 25 mm and 50 mm of settlement, respectively.

The modulus of subgrade reaction or soil “spring constants” is a concept used in structural engineering; however, it is not related to fundamental soil properties. Because the values of “spring constants” are highly dependent upon the combination of the dimensions of loaded areas and the relative flexibility or stiffness of the structural system as well as fundamental soil properties (that can be dependent upon depth), spring constants for raft design can only be evaluated following a detailed settlement analysis and should be considered approximate only. As such, Golder should be given the chance to review the resultant bearing pressures and settlement values and revise/update the subgrade reaction moduli should the design of the raft foundation alter. To further refine site and design specific moduli values and optimize design, further settlement analyses should be undertaken as the design progresses that better represent the soil-structure interaction. For final design, this is often an iterative process.

The raft design parameters are provided on the basis of a uniform load imparted on the foundation. In reality, raft loads will likely be concentrated around the core and will decrease away from the core. Consequently, raft foundation detailed design is typically an iterative process between the structural and geotechnical engineers.

Once the preliminary structural design is completed using the preliminary moduli of subgrade reaction provided above, the resulting non-uniform stresses at the base of the raft must be assessed by Golder to determine the amount of settlement generated by non-uniform structural loading. The settlement results are then forwarded to the structural engineer, and loads are redistributed as needed. Recommendations and discussion pertaining to differential settlement must be carefully reviewed.

During construction, the subgrade at founding elevation should be cut neat, inspected, and immediately protected by a minimum 200-mm thick mud slab (comprising lean concrete) to provide a working surface. The raft slab is then constructed on top of the mud slab. Prior to pouring the mud mat and foundation, the foundation subgrade must be cleaned of all deleterious materials such as softened, disturbed or caved materials, or standing water. If construction proceeds during freezing weather conditions, adequate temporary frost protection for the raft foundation base and concrete must be provided. The foundation base must be inspected and approved by Golder. Groundwater control as deemed necessary must be carried out.

Temporary Excavation and Support

Excavations for the construction of the foundations will extend through the near surface fill at BH20-4 and into the underlying stiff to hard silty clay to clayey silt till, compact to very dense silty sand to sandy silt till and dense to very dense silty sand to sandy silt deposits. No unusual problems are anticipated in excavating in the overburden soil using conventional hydraulic excavating equipment. The soils at this site are glacially derived and as such should be expected to contain cobbles and boulders, which could affect excavations for the buildings and site services. The contractor should be made aware of the potential presence of cobbles and/or boulders within the overburden soils. Further, excavations should not undermine any existing foundations for adjacent structures or existing infrastructure.

It is anticipated that temporary excavations above the groundwater table level will consist of conventional temporary open cuts with side slopes not steeper than 1 horizontal to 1 vertical (1H:1V)) for Type 2 (BH20-1 and BH20-5) and Type 3 (near surface soils at BH20-2 to BH20-3) soils as classified by Ontario Health and Safety Act and Regulations for Construction Projects (OHSA). For Type 3 soils the slope should be from the base of the excavation and for Type 2 soils, the slope may be vertical within 1.2 m from the base of the excavation. Where the side slopes consist of more than one soil type, the soil shall be classified as the type with the highest number among the types present. Please note that if the excavation extends below the groundwater table without adequate dewatering, the soil at the face of the excavation would be classified as Type 4 and a maximum side slope inclination of 3H:1V would be required for OHSA compliance.

However, depending upon the construction procedures adopted by the contractor, actual groundwater seepage conditions, the success of the contractor’s groundwater control methods and weather conditions at the time of construction, some flattening and/or blanketing of the slopes may be required. Care should be taken to direct surface runoff away from the open excavations. Stockpiles of excavated materials should be kept at least the same horizontal distance from the top edge of the excavation as the depth to not negatively impact excavation slope stability, subject to confirmation by a geotechnical engineer in the field during construction. Care should also be taken to avoid overloading of any underground services / structures by stockpiles.

Where space is not available for unsupported open cut excavations, some form of temporary shoring will be needed to support the excavations for the proposed building. In general, there are three basic shoring methods that are commonly used in local practice: steel soldier piles and timber lagging; driven interlocking steel sheet piles; and continuous concrete (secant pile or diaphragm) walls, each with appropriate lateral support (rakers, braces and/or tie-back anchors).

Soldier piles and lagging is suitable where the objective is to maintain an essentially vertical excavation wall and the movements above and behind the wall need only be sufficiently limited that relatively flexible features (such as roadways) will not be adversely affected. As a result, steel soldier piles installed in pre-augered sockets, with timber lagging may be feasible at this site where excavations are adequately dewatered and are not located adjacent to settlement sensitive structures. A soldier pile and lagging system does not provide a groundwater cut-off. Where soldier pile and lagging shoring walls are used, these may require groundwater lowering (i.e., proactive dewatering) to be undertaken if the excavation extends into the granular deposits below the groundwater table prior to the excavation through these materials.

Due to the hard and very dense soils present at the site, the use of steel sheet piles for shoring is infeasible unless extensive pre-drilling of the sheet pile alignment is implemented.

Where existing buildings or certain buried services lie within the zone of influence of the shoring (such as adjacent to the west limits of the site) and the shoring deflections need to be strictly limited, secant pile or diaphragm walls would be appropriate due to their stiffer structural characteristics.

Design of the shoring should include an evaluation of base stability, soil squeezing stability and hydraulic uplift stability as defined in the Canadian Foundation Engineering Manual (CFEM, 2006). The shoring system should be designed to account for horizontal/lateral earth loads, surcharge loads, groundwater pressure and the effects of weather as well as the project requirements for controlling ground displacements. Lateral pressures for design of the temporary structures will depend on the temporary structure design and the nature of the lateral support provided. The distribution of lateral pressures on a shoring system depends greatly on the methods used, the stiffness, and the degree of lateral bracing or restraint. As such, the distribution of lateral earth pressures for such a system is best left to the ultimate specialist designer of the shoring who can best account for such conditions. It is a common practice for a specialist contractor to design and install the excavation support system. Golder can provide shoring design services for initial costing or to evaluate the suitability of the specialist contractor's design.

Although the final design of the shoring will be completed by the contractor, the parameters in ***Table 5*** are provided to enable the structural designer to develop a conceptual design and assess the approximate construction costs for the shoring systems.

Table 2: Coefficients of Static Lateral Earth Pressure

Soil Description	Unit Weight	Internal Angle of Friction	Undrained Shear Strength	Coefficient of Earth Pressure[1]		
	(ϒ, kN/m^3)	(ϕ, degrees)	(kPa)	Active K_a	At Rest K_o	Passive K_p[2]
Stiff to very stiff silty clay to clayey silt till	19	30	200	0.33	0.50	3.00
Hard silty clay till	20	32	200	0.31	0.47	3.25

Soil Description	Unit Weight	Internal Angle of Friction	Undrained Shear Strength	Coefficient of Earth Pressure[1]		
	(ϒ, kN/m^3)	(ϕ, degrees)	(kPa)	Active K_a	At Rest K_o	Passive K_p[2]
Compact silty sand to sandy silt till and non-cohesive deposits	20	30	-	0.33	0.50	3.00
Dense to very dense silty sand to sandy silt till and non-cohesive deposits	21	35	-	0.27	0.43	3.69

1) The earth pressure coefficients noted above are based on a horizontal surface adjacent to the excavation. If sloped surfaces are present, the coefficient of earth pressure should be adjusted accordingly.
2) The total passive resistance below the base of the excavation (i.e., adjacent to the temporary protection system) may be calculated based on the values of K_p indicated above but reduced by an appropriate factor that considers the allowable wall movement to account for the fact that a large strain would be required for mobilization of the full passive resistance.
3) For longer-term (drained) analyses, cohesion should be assumed to be nil for all soil types.

5.1.2 Lateral Earth Pressure for Below Grade Walls

The design of the foundation walls for the proposed buildings should take into account the horizontal soil loads, hydrostatic pressure, as well as surcharge loads that may occur during or after construction. The permanent below-grade wall is considered to be a rigid structure and should be designed to resist at-rest lateral earth pressures calculated as follows:

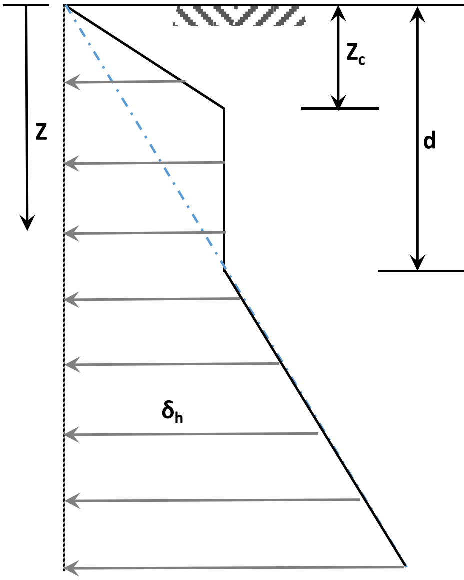
$$p= K(\gamma h + q)$$

where:

p = lateral earth pressure acting depth z, kPa
$K = K_o$ = at rest earth pressure coefficient, use 0.5 for the foundation wall
γ = unit weight of retained soil/backfill, a value of 21 kN/m^3 may be assumed
h =depth to point of interest in soil, m
q =equivalent value of surcharge on the ground surface, kPa

The above expression assumes that the perimeter drainage system prevents the build-up of any hydrostatic pressure behind the wall. Should hydrostatic pressures be considered to build-up behind the walls (such as in the case of a fully waterproofed or “tanked” basement), they must be included in calculating the lateral earth pressures and other measures to address possible buoyancy and waterproofing may need to be considered. The lateral earth pressures acting on the below-grade walls will depend on the type and method of placement of the backfill materials, the nature of the soils behind the wall, the magnitude of surcharge including construction loadings from equipment or materials, the freedom of lateral movement of the structure, and the drainage conditions behind the walls. Surcharge pressures from any adjacent foundations and/or roads should also be included in the design as indicated.

To account for lateral pressures induced by the compaction effort adjacent to foundation walls, small walk-behind compaction equipment should be used within the zone of influence of the wall, as defined by a line extending upwards and outwards from the base of the wall at an inclination of 1 horizontal to 1.5 vertical, and the design lateral earth pressure distribution should consist of a combined trapezoidal/triangular distribution as depicted below. Typical roller loads are provided for reference.



$Zc = K_o(2P/\pi\gamma)^{0.5}$

$d = 1/K_o(2P/\pi\gamma)^{0.5}$

At $Z = Z_c$ and at $Z = d$: $\delta_h = (2P\gamma/\pi)^{0.5}$

For $Z > d$: $\delta h = K_o\gamma Z$

γ = soil unit wieght

K_o = at rest earth pressure coefficient

P = roller load

$= \frac{\text{(roller weight + centrifugal force)}}{\text{(roller width)}}$

Typical Roller Loads

Roller Type	Weight (kN)	Cent. Force (kN)	Width (mm)	P (kN/m)
1-drum walk-behind	2.3	8.3	560	18.9
2-drum walk-behind	1.6	10.1	560	20.9
2-drum walk-behind	12.1	8.8	760	27.5
2-drum walk-behind	9.2	19.8	750	38.7

To avoid detrimental impacts from frost adhesion and heaving, the excavated areas behind foundation walls for the basement levels or any below grade foundation elements should be backfilled with non-frost susceptible granular material conforming to the requirements for OPSS.MUNI 1010 Granular “B” Type I material. In areas where pavement or other hard surfacing will abut the building, differential frost heaving could occur between the granular fill immediately adjacent to the building and the more frost susceptible native materials which exist beyond the wall backfill. To reduce the severity of 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 1.2 m below finished exterior grade at a slope of 3 horizontal to 1 vertical, or flatter, away from the wall. The backfill materials should be placed evenly in lifts not exceeding 200 mm in loose thickness. The layers should be uniformly compacted to at least 95 per cent of the material’s SPMDD. Light compaction equipment should be used immediately adjacent to the wall; otherwise, compaction stresses on the wall may be greater than that imposed by the backfill material. The upper 0.3 m of backfill should consist of clayey material (where appropriate) to provide a relatively low-permeability cap and the exterior grade should also be shaped to slope away from the building.

The lateral earth pressure equation outlined above is given in an unfactored format and will need to be factored for Limit States Design purposes.

5.1.3 Site Classification for Seismic Site Response

Seismic hazard is defined in the 2012 Ontario Building Code (OBC) by uniform hazard spectra (UHS) at spectral coordinates of 0.2 second, 0.5 second, 1.0 second and 2.0 seconds and a probability of exceedance of 2% in

50 years. The OBC method uses a site classification system defined by the average soil/bedrock properties (e.g., shear wave velocity, Standard Penetration Test (SPT) resistance, undrained soil shear strength, etc.) in the 30 m of the soil profile extending below the foundation level. There are 6 site classes from A to F, decreasing in ground stiffness from A, hard rock, to E, soft soil; with site class F used to denote problematic soils (e.g., sites underlain by thick peat deposits and/or liquefiable/collapsible soils). The site class is then used to obtain acceleration and velocity-based site coefficients F_a and F_v, respectively, used to modify the UHS to account for the effects of site-specific soil conditions in design.

The results of the borehole investigation indicate the average SPT "N"-value below the recommended founding depths (as discussed in ***Section 5.1.1***) is generally greater than 50 blows per 0.3 m of penetration and the soil undrained shear strength is greater than 100 kPa. Based on these results, **Site Class C** may be used for design. The site classification may be improved by site-specific testing such as multi-channel analysis of surface waves (MASW) testing.

5.2 Temporary Groundwater Control

As noted in Section 2.0, the estimated FFE for the lowest parking level will be approximately 6 m below the existing ground surface. The measured groundwater level on site ranged from about 3.3 m to 4.5 m below the existing ground surface (approximate Elevations 138.5 m to 141.3 m).

Where the excavations for the proposed structures are expected to extend below the water table*,* provisions will be required to maintain sufficiently dry excavations to maintain stability, control ground loss and permit safe working conditions. In this context, the groundwater level should be drawn down to at least 1 m below the base of the excavation, prior to the excavations reaching the base level, to reduce the potential for loosening of the excavation base due to seepage pressures. Further, care should be taken to direct surface water away from the open excavations. Excavations extending below the groundwater table through, or into, the saturated non-cohesive deposits will require the use of positive dewatering in the form of perimeter trenching with sumps and pumps, and/or well points, and/or eductors.

Water takings in excess of 50 m^3/day are regulated by the Ministry of the Environment, Conservation and Parks (MECP). Certain takings of groundwater and storm water for construction site dewatering purposes with a combined total less than 400 m^3/day qualify for self-registration on the MECP's Environmental Activity and Sector Registry ("EASR"). Registration on the EASR replaces the need to obtain a PTTW and a Section 53 approval. A Category 3 PTTW is required where the proposed water taking is greater than 400 m^3/day.

The dewatering system is the Contractor's responsibility and the rate and volume required for dewatering is dependent on the construction methods and staging chosen by the contractor. Further, the contractor will be responsible for obtaining any required discharge approvals. The report on the hydrogeological assessment being carried out by Golder will be submitted separately.

6.0 MONITORING WELL DECOMMISSIONING

As previously indicated, monitoring wells were installed in the boreholes to permit monitoring of the groundwater levels. Ontario Regulation (O.Reg.) 903 as amended, of the Ontario Water Resources Act, requires that wells be properly abandoned / decommissioned by qualified and licensed personnel. It is recommended that the decommissioning of the wells be carried out as part of the construction activities at the site so that additional water level measurements can be taken leading up to, and immediately prior to, construction and/or so that the wells can be potentially used to evaluate the effectiveness of the dewatering system during construction. If requested, Golder could provide assistance to the owner in arranging for the decommissioning of the wells by a MECP-licensed water well drilling contractor.

7.0 ADDITIONAL CONSIDERATIONS

During construction, a sufficient degree of foundation inspections, subgrade inspections, and an adequate number of in situ density tests and materials testing should be carried out to confirm that the conditions exposed are consistent with those encountered in the boreholes, and to monitor conformance to the pertinent project specifications. Concrete testing should be carried out on both the plastic material in the field and of set cylinder samples in a CSA certified laboratory.

The soils at this site are sensitive to disturbance from ponded water, construction traffic and frost. All bearing surfaces must be inspected by Golder prior to filling or concreting to ensure that strata having adequate bearing capacity have been reached and that the bearing surfaces have been properly prepared.

8.0 CLOSURE

We trust that this report provides sufficient geotechnical engineering information to facilitate the preliminary design of this project. If you have any questions regarding the contents of this report or require additional information, please do not hesitate to contact this office.

Signature Page

Golder Associates Ltd.

LICENSED PROFESSIONAL ENGINEER

December 14, 2022

M. REZVANI

100233333

PROVINCE OF ONTARIO

Mehran Rezvani

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APPENDIX A

Important Information and Limitations of This Report

IMPORTANT INFORMATION AND LIMITATIONS OF THIS REPORT

Standard of Care: Golder Associates Ltd. (Golder) has prepared this report in a manner consistent with that level of care and skill ordinarily exercised by members of the engineering and science professions currently practising under similar conditions in the jurisdiction in which the services are provided, subject to the time limits and physical constraints applicable to this report. No other warranty, expressed or implied is made.

Basis and Use of the Report: This report has been prepared for the specific site, design objective, development and purpose described to Golder by the Client. The factual data, interpretations and recommendations pertain to a specific project as described in this report and are not applicable to any other project or site location. Any change of site conditions, purpose, development plans or if the project is not initiated within eighteen months of the date of the report may alter the validity of the report. Golder cannot be responsible for use of this report, or portions thereof, unless Golder is requested to review and, if necessary, revise the report.

The information, recommendations and opinions expressed in this report are for the sole benefit of the Client. No other party may use or rely on this report or any portion thereof without Golder's express written consent. If the report was prepared to be included for a specific permit application process, then upon the reasonable request of the client, Golder may authorize in writing the use of this report by the regulatory agency as an Approved User for the specific and identified purpose of the applicable permit review process. Any other use of this report by others is prohibited and is without responsibility to Golder. The report, all plans, data, drawings and other documents as well as all electronic media prepared by Golder are considered its professional work product and shall remain the copyright property of Golder, who authorizes only the Client and Approved Users to make copies of the report, but only in such quantities as are reasonably necessary for the use of the report by those parties. The Client and Approved Users may not give, lend, sell, or otherwise make available the report or any portion thereof to any other party without the express written permission of Golder. The Client acknowledges that electronic media is susceptible to unauthorized modification, deterioration and incompatibility and therefore the Client can not rely upon the electronic media versions of Golder's report or other work products.

The report is of a summary nature and is not intended to stand alone without reference to the instructions given to Golder by the Client, communications between Golder and the Client, and to any other reports prepared by Golder for the Client relative to the specific site described in the report. In order to properly understand the suggestions, recommendations and opinions expressed in this report, reference must be made to the whole of the report. Golder can not be responsible for use of portions of the report without reference to the entire report.

Unless otherwise stated, the suggestions, recommendations and opinions given in this report are intended only for the guidance of the Client in the design of the specific project. The extent and detail of investigations, including the number of test holes, necessary to determine all of the relevant conditions which may affect construction costs would normally be greater than has been carried out for design purposes. Contractors bidding on, or undertaking the work, should rely on their own investigations, as well as their own interpretations of the factual data presented in the report, as to how subsurface conditions may affect their work, including but not limited to proposed construction techniques, schedule, safety and equipment capabilities.

Soil, Rock and Ground Water Conditions: Classification and identification of soils, rocks, and geologic units have been based on commonly accepted methods employed in the practice of geotechnical engineering and related disciplines. Classification and identification of the type and condition of these materials or units involves judgment, and boundaries between different soil, rock or geologic types or units may be transitional rather than abrupt. Accordingly, Golder does not warrant or guarantee the exactness of the descriptions.

Special risks occur whenever engineering or related disciplines are applied to identify subsurface conditions and even a comprehensive investigation, sampling and testing program may fail to detect all or certain subsurface conditions. The environmental, geologic, geotechnical, geochemical and hydrogeologic conditions that Golder interprets to exist between and beyond sampling points may differ from those that actually exist. In addition to soil variability, fill of variable physical and chemical composition can be present over portions of the site or on adjacent properties. The professional services retained for this project include only the geotechnical aspects of the subsurface conditions at the site, unless otherwise specifically stated and identified in the report. The presence or implication(s) of possible surface and/or subsurface contamination resulting from previous activities or uses of the site and/or resulting from the introduction onto the site of materials from off-site sources are outside the terms of reference for this project and have not been investigated or addressed.

Soil and groundwater conditions shown in the factual data and described in the report are the observed conditions at the time of their determination or measurement. Unless otherwise noted, those conditions form the basis of the recommendations in the report. Groundwater conditions may vary between and beyond reported locations and can be affected by annual, seasonal and meteorological conditions. The condition of the soil, rock and groundwater may be significantly altered by construction activities (traffic, excavation, groundwater level lowering, pile driving, blasting, etc.) on the site or on adjacent sites. Excavation may expose the soils to changes due to wetting, drying or frost. Unless otherwise indicated the soil must be protected from these changes during construction.

Sample Disposal: Golder will dispose of all uncontaminated soil and/or rock samples 90 days following issue of this report or, upon written request of the Client, will store uncontaminated samples and materials at the Client’s expense. In the event that actual contaminated soils, fills or groundwater are encountered or are inferred to be present, all contaminated samples shall remain the property and responsibility of the Client for proper disposal.

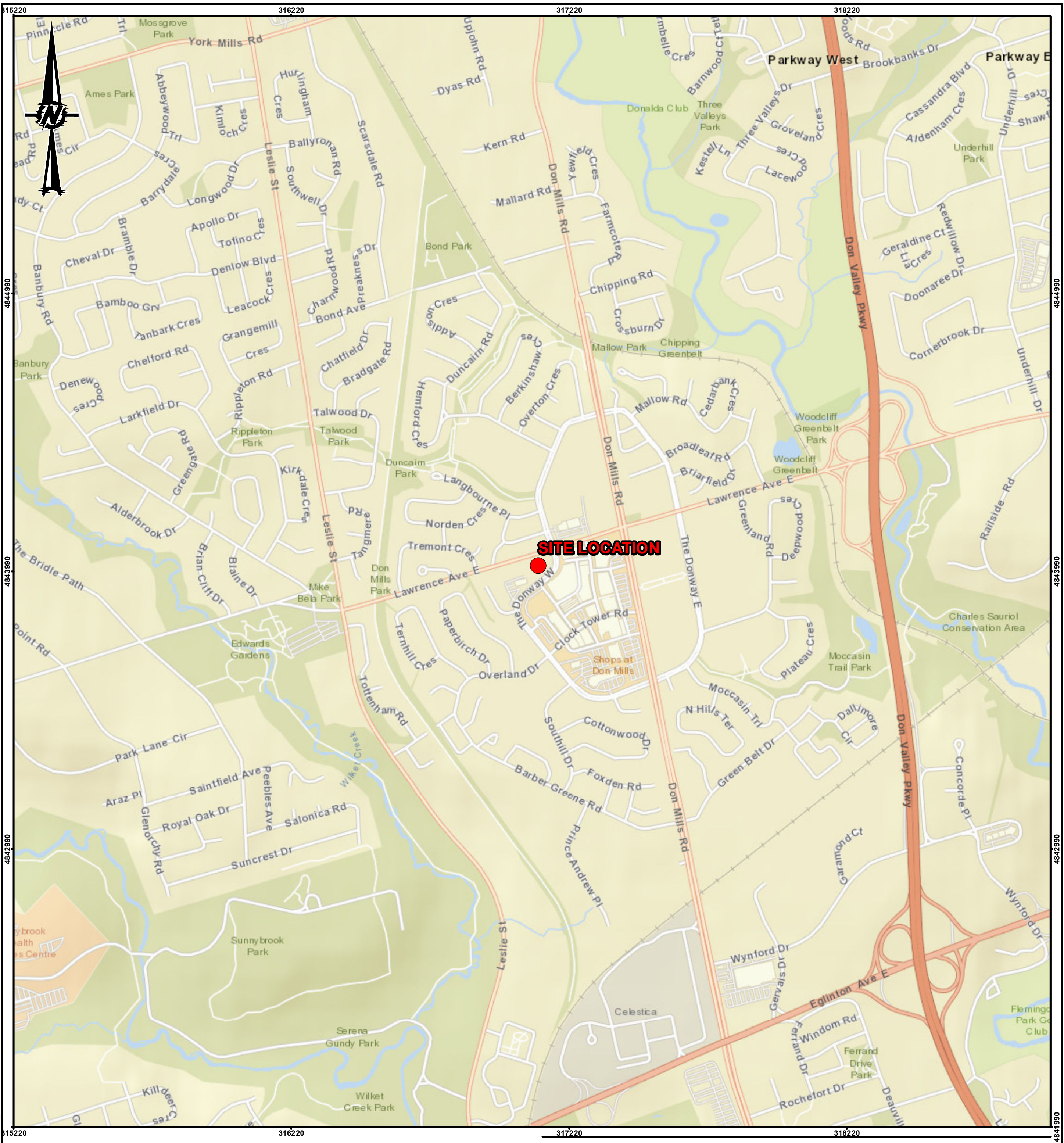
Follow-Up and Construction Services: All details of the design were not known at the time of submission of Golder’s report. Golder should be retained to review the final design, project plans and documents prior to construction, to confirm that they are consistent with the intent of Golder’s report.

During construction, Golder should be retained to perform sufficient and timely observations of encountered conditions to confirm and document that the subsurface conditions do not materially differ from those interpreted conditions considered in the preparation of Golder’s report and to confirm and document that construction activities do not adversely affect the suggestions, recommendations and opinions contained in Golder’s report. Adequate field review, observation and testing during construction are necessary for Golder to be able to provide letters of assurance, in accordance with the requirements of many regulatory authorities. In cases where this recommendation is not followed, Golder’s responsibility is limited to interpreting accurately the information encountered at the borehole locations, at the time of their initial determination or measurement during the preparation of the Report.

APPENDIX B

Figure 1 – Key Plan

Figure 2 – Borehole Location Plan



0 500 1,000

1:20,000 METRES

REFERENCE(S)

SERVICE LAYER CREDITS: SOURCES: ESRI, HERE, GARMIN, USGS, INTERMAP, INCREMENT P, NRCAN, ESRI JAPAN, METI, ESRI CHINA (HONG KONG), ESRI KOREA, ESRI (THAILAND), NGCC, (C) OPENSTREETMAP CONTRIBUTORS, AND THE GIS USER COMMUNITY

PROJECTION: TRANSVERSE MERCATOR DATUM: NAD 83 COORDINATE SYSTEM: UTM ZONE 17N

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CLIENT	FIRST CAPITAL ASSET MANAGEMENT (FCAM) LP
PROJECT	GEOTECHNICAL EXPLORATION PROPOSED REDEVELOPMENT OF 895 LAWRENCE AVENUE EAST, NORTH YORK, ONTARIO
TITLE	**KEY PLAN**

CONSULTANT

GOLDER

YYYY-MM-DD	2020-04-08
DESIGNED	
PREPARED	MK
REVIEWED	RA
APPROVED	MAS

PROJECT NO.	CONTROL	REV.	FIGURE
19129918			1

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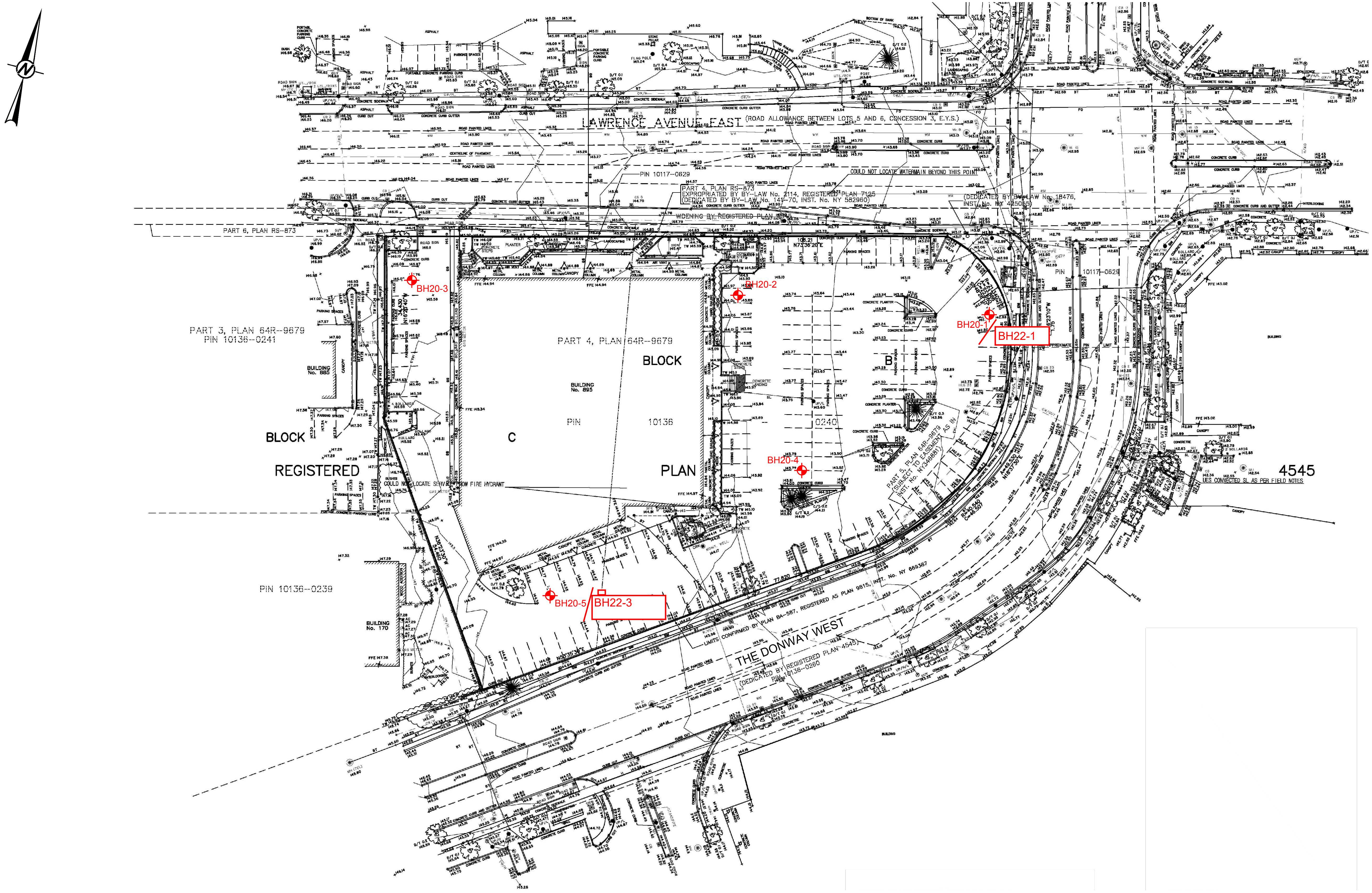

LEGEND

⌖ BOREHOLE LOCATION

REFERENCE(S)

BASE MAP TAKEN FROM SCHAEFFER DZALDOV BENNETT LTD., DATED JUNE, 2013, DELIVERED IN FORMAT PDF

0 5 10

1:250 METRES

CLIENT

FIRST CAPITAL ASSET MANAGEMENT (FCAM) LP

CONSULTANT

GOLDER

YYYY-MM-DD	2020-04-06
DESIGNED	
PREPARED	HJL
REVIEWED	RA
APPROVED	MAS

PROJECT

GEOTECHNICAL EXPLORATION
PROPOSED REDEVELOPMENT OF 895 LAWRENCE AVENUE EAST, NORTH YORK, ONTARIO

TITLE

BOREHOLE LOCATION PLAN

PROJECT NO.	CONTROL	REV.	FIGURE
19129918		----	2

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APPENDIX C

Method of Soil Classification

Symbols and Terms used on Records of Boreholes and Test Pits

List of Symbols

Record of Borehole Sheets

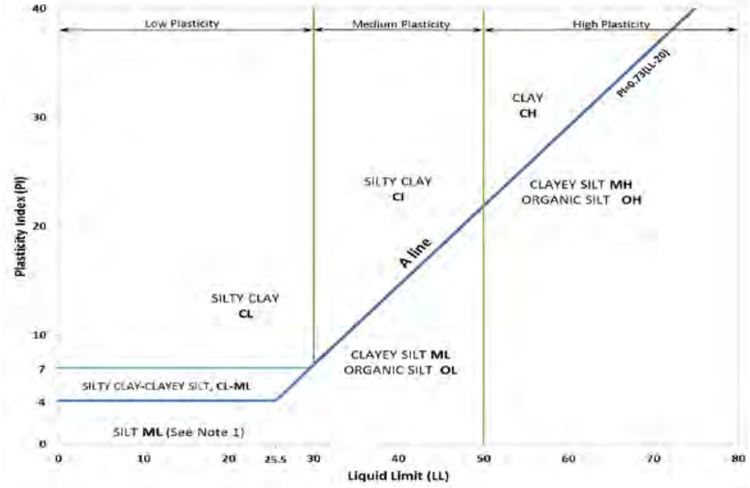
Boreholes BH20-1 to BH20-5

METHOD OF SOIL CLASSIFICATION

The Golder Associates Ltd. Soil Classification System is based on the Unified Soil Classification System (USCS)

Organic or Inorganic	Soil Group	Type of Soil		Gradation or Plasticity	$Cu = \frac{D_{60}}{D_{10}}$	$Cc = \frac{(D_{30})^2}{D_{10}xD_{60}}$	Organic Content	USCS Group Symbol	Group Name
INORGANIC (Organic Content ≤30% by mass)	COARSE-GRAINED SOILS (>50% by mass is larger than 0.075 mm)	GRAVELS (>50% by mass of coarse fraction is larger than 4.75 mm)	Gravels with ≤12% fines (by mass)	Poorly Graded	<4	≤1 or ≥3	≤30%	GP	GRAVEL
				Well Graded	≥4	1 to 3		GW	GRAVEL
			Gravels with >12% fines (by mass)	Below A Line	n/a			GM	SILTY GRAVEL
				Above A Line	n/a			GC	CLAYEY GRAVEL
		SANDS (≥50% by mass of coarse fraction is smaller than 4.75 mm)	Sands with ≤12% fines (by mass)	Poorly Graded	<6	≤1 or ≥3		SP	SAND
				Well Graded	≥6	1 to 3		SW	SAND
			Sands with >12% fines (by mass)	Below A Line	n/a			SM	SILTY SAND
				Above A Line	n/a			SC	CLAYEY SAND

Organic or Inorganic	Soil Group	Type of Soil	Laboratory Tests	Field Indicators					Organic Content	USCS Group Symbol	Primary Name
				Dilatancy	Dry Strength	Shine Test	Thread Diameter	Toughness (of 3 mm thread)			
INORGANIC (Organic Content ≤30% by mass)	FINE-GRAINED SOILS (≥50% by mass is smaller than 0.075 mm)	SILTS (Non-Plastic or PI and LL plot below A-Line on Plasticity Chart below)	Liquid Limit <50	Rapid	None	None	>6 mm	N/A (can't roll 3 mm thread)	<5%	ML	SILT
				Slow	None to Low	Dull	3mm to 6 mm	None to low	<5%	ML	CLAYEY SILT
				Slow to very slow	Low to medium	Dull to slight	3mm to 6 mm	Low	5% to 30%	OL	ORGANIC SILT
			Liquid Limit ≥50	Slow to very slow	Low to medium	Slight	3mm to 6 mm	Low to medium	<5%	MH	CLAYEY SILT
				None	Medium to high	Dull to slight	1 mm to 3 mm	Medium to high	5% to 30%	OH	ORGANIC SILT
		CLAYS (PI and LL plot above A-Line on Plasticity Chart below)	Liquid Limit <30	None	Low to medium	Slight to shiny	~ 3 mm	Low to medium	0% to 30% (see Note 2)	CL	SILTY CLAY
			Liquid Limit 30 to 50	None	Medium to high	Slight to shiny	1 mm to 3 mm	Medium		CI	SILTY CLAY
			Liquid Limit ≥50	None	High	Shiny	<1 mm	High		CH	CLAY
HIGHLY ORGANIC SOILS (Organic Content >30% by mass)		Peat and mineral soil mixtures							30% to 75%	PT	SILTY PEAT, SANDY PEAT
		Predominantly peat, may contain some mineral soil, fibrous or amorphous peat							75% to 100%		PEAT



Note 1 – Fine grained materials with PI and LL that plot in this area are named (ML) SILT with slight plasticity. Fine-grained materials which are non-plastic (i.e. a PL cannot be measured) are named SILT.
Note 2 – For soils with <5% organic content, include the descriptor "trace organics" for soils with between 5% and 30% organic content include the prefix "organic" before the Primary name.

Dual Symbol — A dual symbol is two symbols separated by a hyphen, for example, GP-GM, SW-SC and CL-ML.
For non-cohesive soils, the dual symbols must be used when the soil has between 5% and 12% fines (i.e. to identify transitional material between "clean" and "dirty" sand or gravel.
For cohesive soils, the dual symbol must be used when the liquid limit and plasticity index values plot in the CL-ML area of the plasticity chart (see Plasticity Chart at left).

Borderline Symbol — A borderline symbol is two symbols separated by a slash, for example, CL/CI, GM/SM, CL/ML.
A borderline symbol should be used to indicate that the soil has been identified as having properties that are on the transition between similar materials. In addition, a borderline symbol may be used to indicate a range of similar soil types within a stratum.

ABBREVIATIONS AND TERMS USED ON RECORDS OF BOREHOLES AND TEST PITS

PARTICLE SIZES OF CONSTITUENTS

Soil Constituent	Particle Size Description	Millimetres	Inches (US Std. Sieve Size)
BOULDERS	Not Applicable	>300	>12
COBBLES	Not Applicable	75 to 300	3 to 12
GRAVEL	Coarse Fine	19 to 75 4.75 to 19	0.75 to 3 (4) to 0.75
SAND	Coarse Medium Fine	2.00 to 4.75 0.425 to 2.00 0.075 to 0.425	(10) to (4) (40) to (10) (200) to (40)
SILT/CLAY	Classified by plasticity	<0.075	< (200)

MODIFIERS FOR SECONDARY AND MINOR CONSTITUENTS

Percentage by Mass	Modifier
>35	Use 'and' to combine major constituents (*i.e.,* SAND and GRAVEL)
> 12 to 35	Primary soil name prefixed with "gravelly, sandy, SILTY, CLAYEY" as applicable
> 5 to 12	some
≤ 5	trace

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.) split-spoon sampler for a distance of 300 mm (12 in.). Values reported are as recorded in the field and are uncorrected.

Cone Penetration Test (CPT)

An electronic cone penetrometer with a 60° conical tip and a project end area of 10 cm^2 pushed through ground at a penetration rate of 2 cm/s. Measurements of tip resistance (q_t), porewater pressure (u) and sleeve frictions are recorded electronically at 25 mm penetration intervals.

Dynamic Cone Penetration Resistance (DCPT); 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.).

PH:	Sampler advanced by hydraulic pressure
PM:	Sampler advanced by manual pressure
WH:	Sampler advanced by static weight of hammer
WR:	Sampler advanced by weight of sampler and rod

SAMPLES

AS	Auger sample
BS	Block sample
CS	Chunk sample
DD	Diamond Drilling
DO or DP	Seamless open ended, driven or pushed tube sampler – note size
DS	Denison type sample
GS	Grab Sample
MC	Modified California Samples
MS	Modified Shelby (for frozen soil)
RC	Rock core
SC	Soil core
SS	Split spoon sampler – note size
ST	Slotted tube
TO	Thin-walled, open – note size (Shelby tube)
TP	Thin-walled, piston – note size (Shelby tube)
WS	Wash sample

SOIL TESTS

w	water content
PL , w_p	plastic limit
LL , w_L	liquid limit
C	consolidation (oedometer) test
CHEM	chemical analysis (refer to text)
CID	consolidated isotropically drained triaxial test[1]
CIU	consolidated isotropically undrained triaxial test with porewater pressure measurement[1]
D_R	relative density (specific gravity, Gs)
DS	direct shear test
GS	specific gravity
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
SO_4	concentration of water-soluble sulphates
UC	unconfined compression test
UU	unconsolidated undrained triaxial test
V (FV)	field vane (LV-laboratory vane test)
γ	unit weight

1. Tests anisotropically consolidated prior to shear are shown as CAD, CAU.

NON-COHESIVE (COHESIONLESS) SOILS

Compactness[2]

Term	SPT 'N' (blows/0.3m)[1]
Very Loose	0 to 4
Loose	4 to 10
Compact	10 to 30
Dense	30 to 50
Very Dense	>50

1. SPT 'N' in accordance with ASTM D1586, uncorrected for the effects of overburden pressure.
2. Definition of compactness terms are based on SPT 'N' ranges as provided in Terzaghi, Peck and Mesri (1996). Many factors affect the recorded SPT 'N' value, including hammer efficiency (which may be greater than 60% in automatic trip hammers), overburden pressure, groundwater conditions, and grainsize. As such, the recorded SPT 'N' value(s) should be considered only an approximate guide to the soil compactness. These factors need to be considered when evaluating the results, and the stated compactness terms should not be relied upon for design or construction.

Field Moisture Condition

Term	Description
Dry	Soil flows freely through fingers.
Moist	Soils are darker than in the dry condition and may feel cool.
Wet	As moist, but with free water forming on hands when handled.

COHESIVE SOILS

Consistency

Term	Undrained Shear Strength (kPa)	SPT 'N'[1,2] (blows/0.3m)
Very Soft	<12	0 to 2
Soft	12 to 25	2 to 4
Firm	25 to 50	4 to 8
Stiff	50 to 100	8 to 15
Very Stiff	100 to 200	15 to 30
Hard	>200	>30

1. SPT 'N' in accordance with ASTM D1586, uncorrected for overburden pressure effects; approximate only.
2. SPT 'N' values should be considered ONLY an approximate guide to consistency; for sensitive clays (e.g., Champlain Sea clays), the N-value approximation for consistency terms does NOT apply. Rely on direct measurement of undrained shear strength or other manual observations.

Water Content

Term	Description
w < PL	Material is estimated to be drier than the Plastic Limit.
w ~ PL	Material is estimated to be close to the Plastic Limit.
w > PL	Material is estimated to be wetter than the Plastic Limit.

LIST OF SYMBOLS

Unless otherwise stated, the symbols employed in the report are as follows:

I. GENERAL

π	3.1416
ln x	natural logarithm of x
$\log_{10}$	x or log x, logarithm of x to base 10
g	acceleration due to gravity
t	time

II. STRESS AND STRAIN

γ	shear strain
Δ	change in, e.g. in stress: $\Delta\ \sigma$
ε	linear strain
ε_v	volumetric strain
η	coefficient of viscosity
υ	Poisson's ratio
σ	total stress
σ'	effective stress ($\sigma' = \sigma - u$)
σ'_{vo}	initial effective overburden stress
$\sigma_1, \sigma_2, \sigma_3$	principal stress (major, intermediate, minor)
σ_{oct}	mean stress or octahedral stress $= (\sigma_1 + \sigma_2 + \sigma_3)/3$
τ	shear stress
u	porewater pressure
E	modulus of deformation
G	shear modulus of deformation
K	bulk modulus of compressibility

III. SOIL PROPERTIES

(a) Index Properties

$\rho(\gamma)$	bulk density (bulk unit weight)*
$\rho_d(\gamma_d)$	dry density (dry unit weight)
$\rho_w(\gamma_w)$	density (unit weight) of water
$\rho_s(\gamma_s)$	density (unit weight) of solid particles
γ'	unit weight of submerged soil ($\gamma' = \gamma - \gamma_w$)
D_R	relative density (specific gravity) of solid particles ($D_R = \rho_s / \rho_w$) (formerly G_s)
e	void ratio
n	porosity
S	degree of saturation

* Density symbol is ρ. Unit weight symbol is γ where $\gamma = \rho g$ (i.e. mass density multiplied by acceleration due to gravity)

(a) Index Properties (continued)

w	water content
w_l or LL	liquid limit
w_p or PL	plastic limit
I_p or PI	plasticity index = $(w_l - w_p)$
NP	non-plastic
w_s	shrinkage limit
I_L	liquidity index = $(w - w_p) / I_p$
I_C	consistency index = $(w_l - w) / I_p$
e_{max}	void ratio in loosest state
e_{min}	void ratio in densest state
I_D	density index = $(e_{max} - e) / (e_{max} - e_{min})$ (formerly relative density)

(b) Hydraulic Properties

h	hydraulic head or potential
q	rate of flow
v	velocity of flow
i	hydraulic gradient
k	hydraulic conductivity (coefficient of permeability)
j	seepage force per unit volume

(c) Consolidation (one-dimensional)

C_c	compression index (normally consolidated range)
C_r	recompression index (over-consolidated range)
C_s	swelling index
C_α	secondary compression index
m_v	coefficient of volume change
c_v	coefficient of consolidation (vertical direction)
c_h	coefficient of consolidation (horizontal direction)
T_v	time factor (vertical direction)
U	degree of consolidation
σ'_p	pre-consolidation stress
OCR	over-consolidation ratio = σ'_p / σ'_{vo}

(d) Shear Strength

τ_p, τ_r	peak and residual shear strength
ϕ'	effective angle of internal friction
δ	angle of interface friction
μ	coefficient of friction = $\tan \delta$
c'	effective cohesion
c_u, s_u	undrained shear strength ($\phi = 0$ analysis)
p	mean total stress $(\sigma_1 + \sigma_3)/2$
p′	mean effective stress $(\sigma'_1 + \sigma'_3)/2$
q	$(\sigma_1 - \sigma_3)/2$ or $(\sigma'_1 - \sigma'_3)/2$
q_u	compressive strength $(\sigma_1 - \sigma_3)$
S_t	sensitivity

Notes: 1 $\tau = c' + \sigma' \tan \phi'$

2 shear strength = (compressive strength)/2

PROJECT: 19129918 (1000)

LOCATION: See Figure 2

RECORD OF BOREHOLE: BH20-1

BORING DATE: March 19, 2020

SHEET 1 OF 2

DATUM: Geodetic

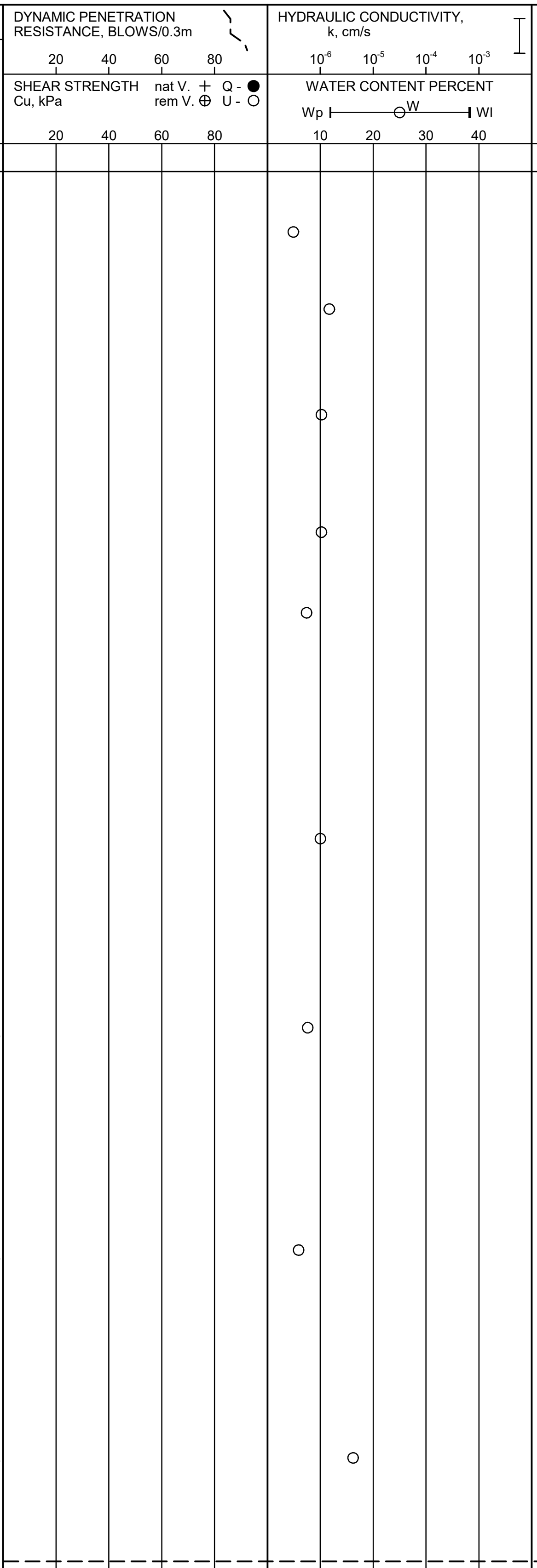
SPT/DCPT HAMMER: MASS, 63kg; DROP, 760mm

HAMMER TYPE: AUTOMATIC

BORING METHOD: CME 75 Truck Mounted Rig; 140 mm Solid Stem Augers

SOIL PROFILE DESCRIPTION	ELEV. DEPTH (m)
GROUND SURFACE	142.90
ASPHALT (~130 mm thick)	0.00
FILL - (SP/GP) SAND and GRAVEL, some fines; brown; non-cohesive, moist	0.13
(CL) SILTY CLAY, some sand, trace gravel; brown (TILL); oxidation stains; cohesive, w<PL, very stiff	142.47 0.43
(ML) sandy SILT, trace gravel; brown to grey (TILL); non-cohesive, moist, dense to very dense - Becomes grey at a depth of about 3.3 m	141.53 1.37
(CL-ML) SILTY CLAY to CLAYEY SILT, trace sand, trace gravel; grey (TILL); cohesive, w<PL, hard	138.96 3.94
(ML) sandy SILT, trace gravel; grey (TILL); non-cohesive, moist, very dense	137.34 5.56
(CL-ML) SILTY CLAY to CLAYEY SILT, trace sand, trace gravel; grey (TILL); cohesive, w<PL, hard	134.37 8.53
	132.90
CONTINUED NEXT PAGE	

SAMPLES NUMBER	TYPE	BLOWS/0.3m
1	SS	12
2	SS	18
3	SS	30
4	SS	57
5	SS	50/ 0.1
6	SS	46
7	SS	50/ 0.13
8	SS	50/ 0.13
9	SS	50/ 0.07



ADDITIONAL LAB. TESTING

PIEZOMETER OR STANDPIPE INSTALLATION:

- Concrete
- 50 mm Diameter Monitoring Well
- Bentonite Seal
- ∇ June 16, 2020
- Sand
- Silica Sand Filter and Screen

DEPTH SCALE METRES: 0 1 2 3 4 5 6 7 8 9 10

DEPTH SCALE

1 : 50

GOLDER

LOGGED: AD/SS

CHECKED: RA

PROJECT: 19129918 (1000)
LOCATION: See Figure 2

RECORD OF BOREHOLE: BH20-1

BORING DATE: March 19, 2020

SHEET 2 OF 2
DATUM: Geodetic

SPT/DCPT HAMMER: MASS, 63kg; DROP, 760mm
HAMMER TYPE: AUTOMATIC

BORING METHOD: CME 75 Truck Mounted Rig; 140 mm Solid Stem Augers

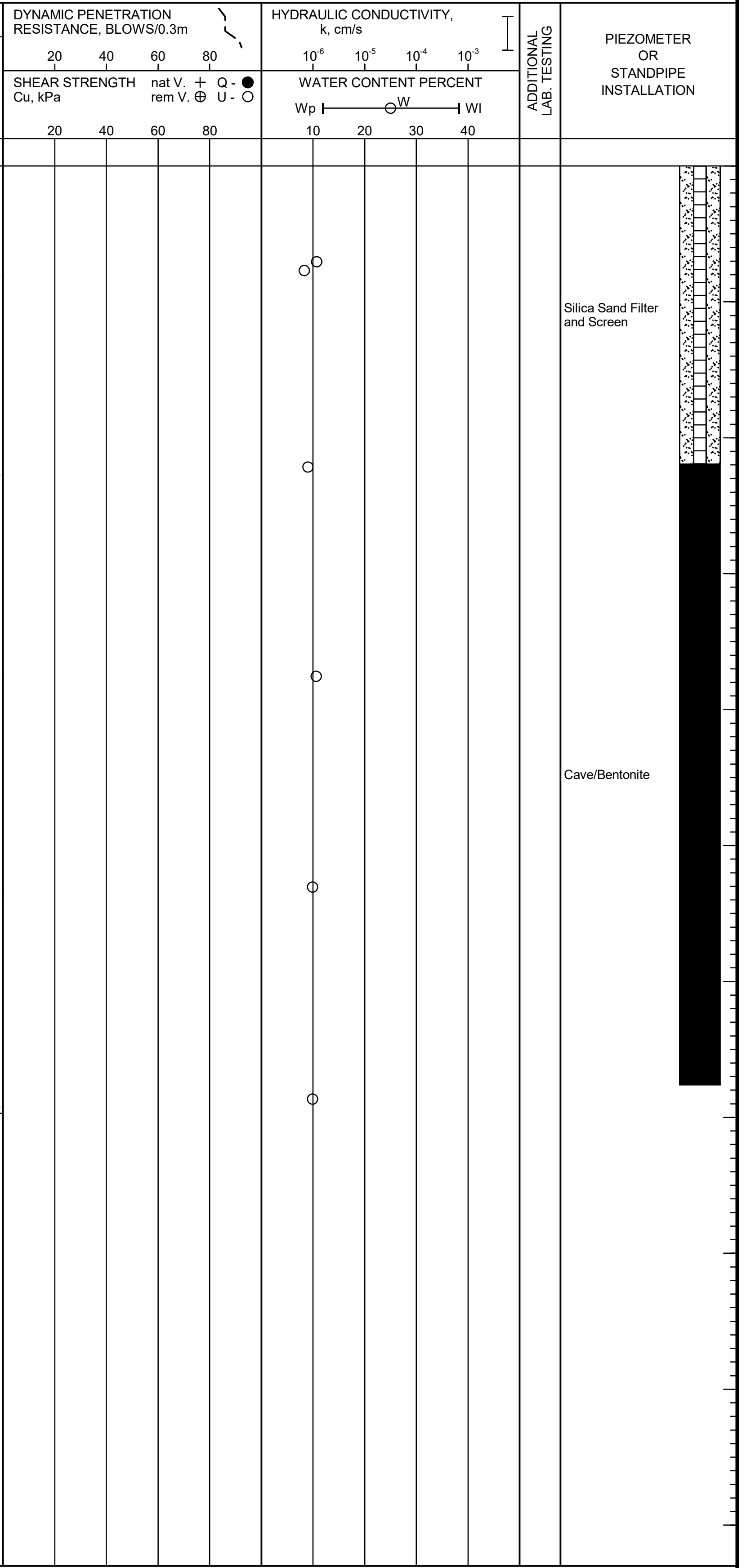
SOIL PROFILE DESCRIPTION	ELEV. / DEPTH (m)	SAMPLES NUMBER	TYPE	BLOWS/0.3m
--- *CONTINUED FROM PREVIOUS PAGE* ---				
(SM) SILTY SAND, some gravel; grey; non-cohesive, moist, very dense	10.00			
		10A 10B	SS	50/ 0.13
(CL-ML) SILTY CLAY to CLAYEY SILT, some sand, some gravel; grey (TILL); cohesive, w<PL, hard	132.16 10.74			
(ML) sandy SILT, some gravel; grey (TILL); non-cohesive, moist, very dense	131.39 11.51	11	SS	50/ 0.05
(CL-ML) SILTY CLAY to CLAYEY SILT, trace to some sand, trace gravel; grey (TILL); cohesive, w<PL, hard	129.92 12.98	12	SS	50/ 0.07
		13	SS	50/ 0.13
		14	SS	50/ 0.05
END OF BOREHOLE	125.93 16.97			

NOTES:

1. Borehole caved at a depth of about 11.3 mbgs upon completion of drilling.

2. Groundwater level measured in monitoring well as follows:

Date	Depth(m)	Elev. (m)
13/05/2020	4.4	138.5
21/05/2020	4.4	138.5
05/06/2020	4.4	138.5
16/06/2020	4.4	138.5



DEPTH SCALE
1 : 50

GOLDER

LOGGED: AD/SS
CHECKED: RA

PROJECT: 19129918 (1000)

LOCATION: See Figure 2

RECORD OF BOREHOLE: BH20-2

BORING DATE: March 19 to 24, 2020

SHEET 1 OF 2

DATUM: Geodetic

SPT/DCPT HAMMER: MASS, 63kg; DROP, 760mm

HAMMER TYPE: AUTOMATIC

BORING METHOD: CME 75 Truck Mounted Rig; 140 mm I.D. Hollow Stem Augers (0 to 3.05 m); 98 mm Dia Tricone - Mud Rotary Drilling (3.05 to 10 m)

SOIL PROFILE DESCRIPTION	ELEV. DEPTH (m)
GROUND SURFACE	144.00
ASPHALT (~130mm thick)	0.00
FILL - (SP/GP) SAND and GRAVEL, some fines; brown; non-cohesive, moist, loose	0.13
(CL) SILTY CLAY, some sand, trace gravel; brown (TILL); oxidation stains; cohesive, w<PL, firm to stiff	143.64 0.36
(ML) sandy SILT, trace gravel; brown (TILL), oxidation stains; non-cohesive, moist, very dense	142.63 1.37
(CL) SILTY CLAY, some sand, trace gravel; grey (TILL); cohesive, w<PL, hard	140.11 3.89
(SM) SILTY SAND, some gravel; grey; non-cohesive, moist, very dense	138.44 5.56
(ML) sandy SILT, trace gravel; grey (TILL); non-cohesive, moist, very dense	136.91 7.09

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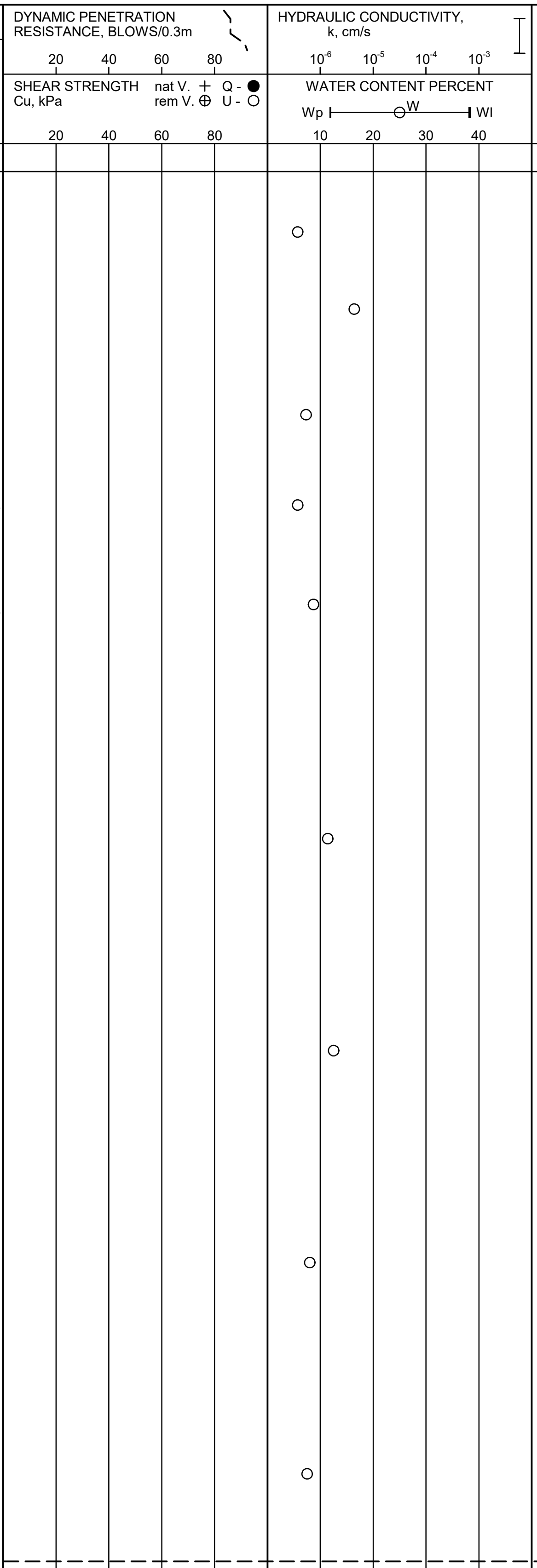
SAMPLES NUMBER	TYPE	BLOWS/0.3m	ADDITIONAL LAB. TESTING
1	SS	6	
2	SS	10	
3	SS	65	
4	SS	50/ 0.07	
5	SS	50/ 0.13	
6	SS	42	
7	SS	80	M
8	SS	56	
9	SS	54	



PIEZOMETER OR STANDPIPE INSTALLATION

Concrete

50 mm Diameter Monitoring Well

June 16, 2020

Bentonite Seal

DEPTH SCALE

1 : 50

GOLDER

LOGGED: AD/SS

CHECKED: RA

PROJECT: 19129918 (1000)

LOCATION: See Figure 2

RECORD OF BOREHOLE: BH20-2

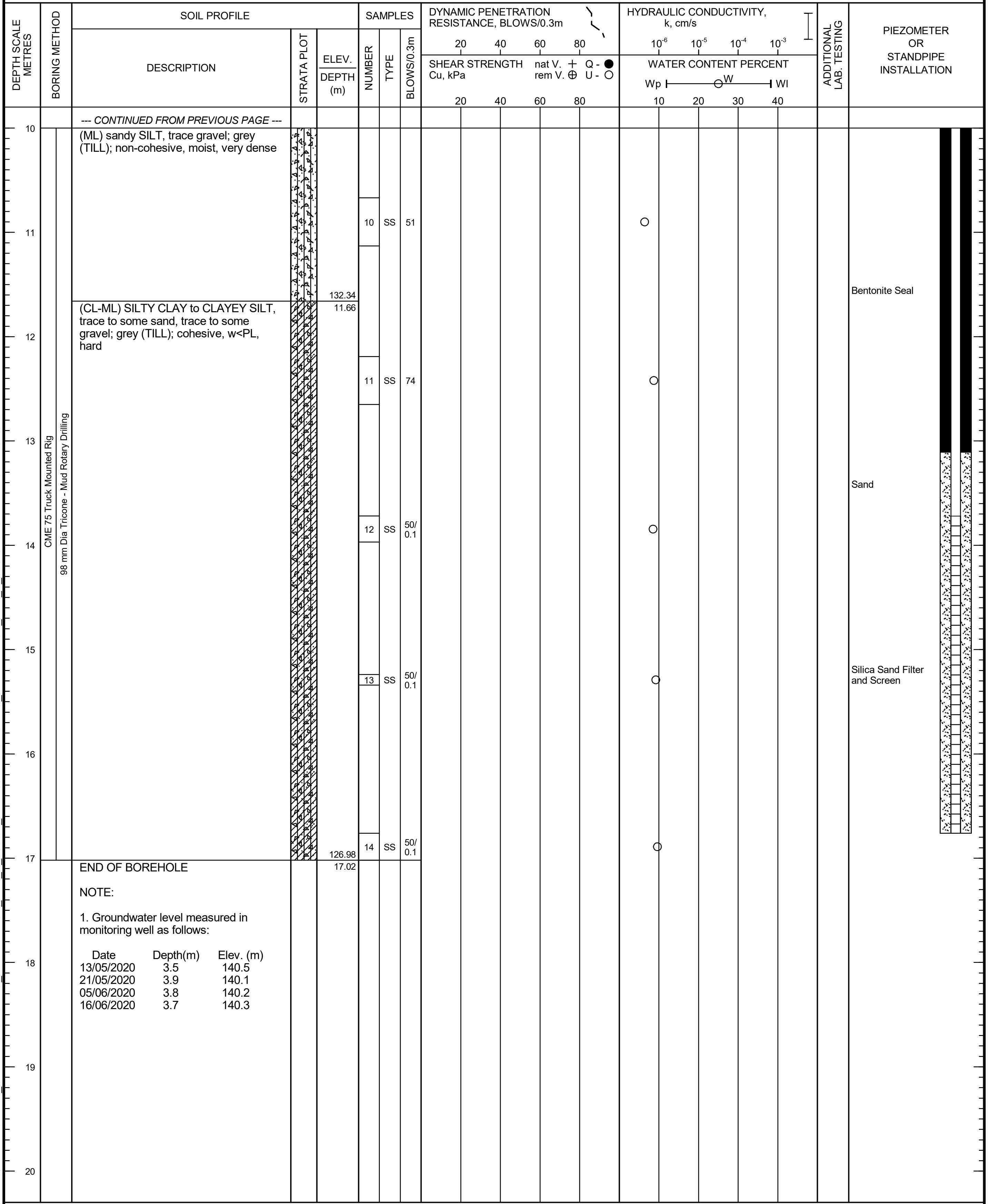
SHEET 2 OF 2

DATUM: Geodetic

BORING DATE: March 19 to 24, 2020

SPT/DCPT HAMMER: MASS, 63kg; DROP, 760mm

HAMMER TYPE: AUTOMATIC



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DESCRIPTION	ELEV. DEPTH (m)	NUMBER	TYPE	BLOWS/0.3m
(ML) sandy SILT, trace gravel; grey (TILL); non-cohesive, moist, very dense		10	SS	51
(CL-ML) SILTY CLAY to CLAYEY SILT, trace to some sand, trace to some gravel; grey (TILL); cohesive, w<PL, hard	132.34 11.66	11	SS	74
		12	SS	50/ 0.1
		13	SS	50/ 0.1
		14	SS	50/ 0.1
END OF BOREHOLE	126.98 17.02			

NOTE:

1. Groundwater level measured in monitoring well as follows:

Date	Depth(m)	Elev. (m)
13/05/2020	3.5	140.5
21/05/2020	3.9	140.1
05/06/2020	3.8	140.2
16/06/2020	3.7	140.3

DEPTH SCALE

1 : 50

GOLDER

LOGGED: AD/SS

CHECKED: RA

PROJECT: 19129918 (1000)
LOCATION: See Figure 2

RECORD OF BOREHOLE: BH20-3

BORING DATE: March 27, 2020

SHEET 1 OF 2
DATUM: Geodetic

SPT/DCPT HAMMER: MASS, 63kg; DROP, 760mm

HAMMER TYPE: AUTOMATIC

BORING METHOD: 140 mm I.D. Hollow Stem Augers (0 to approx. 3.05 m); 98 mm Dia Tricone - Mud Rotary Drilling (below); CME 75 Truck Mounted Rig

DESCRIPTION	ELEV.	DEPTH (m)
GROUND SURFACE	145.80	
ASPHALT (~130 mm thick)		0.00
FILL - (SP/GP) SAND and GRAVEL, trace fines; brown; non-cohesive, moist, compact		0.13
(ML) sandy SILT, trace gravel; brown (TILL), oxidation stains; non-cohesive, moist, compact to dense	145.06	0.74
(CL-ML) SILTY CLAY to CLAYEY SILT, some sand, trace gravel; grey (TILL); cohesive, w<PL, cohesive, w<PL, hard	142.90	2.90
(SM/ML) SILTY SAND to sandy SILT, some gravel; grey (TILL); non-cohesive, moist, dense to very dense	140.24	5.56
(ML) sandy SILT, grey; non-cohesive, wet, very dense	137.88	7.92
(ML) SILT, trace to some sand, trace gravel; grey; slight plasticity; non-cohesive, moist, dense	137.19	8.61

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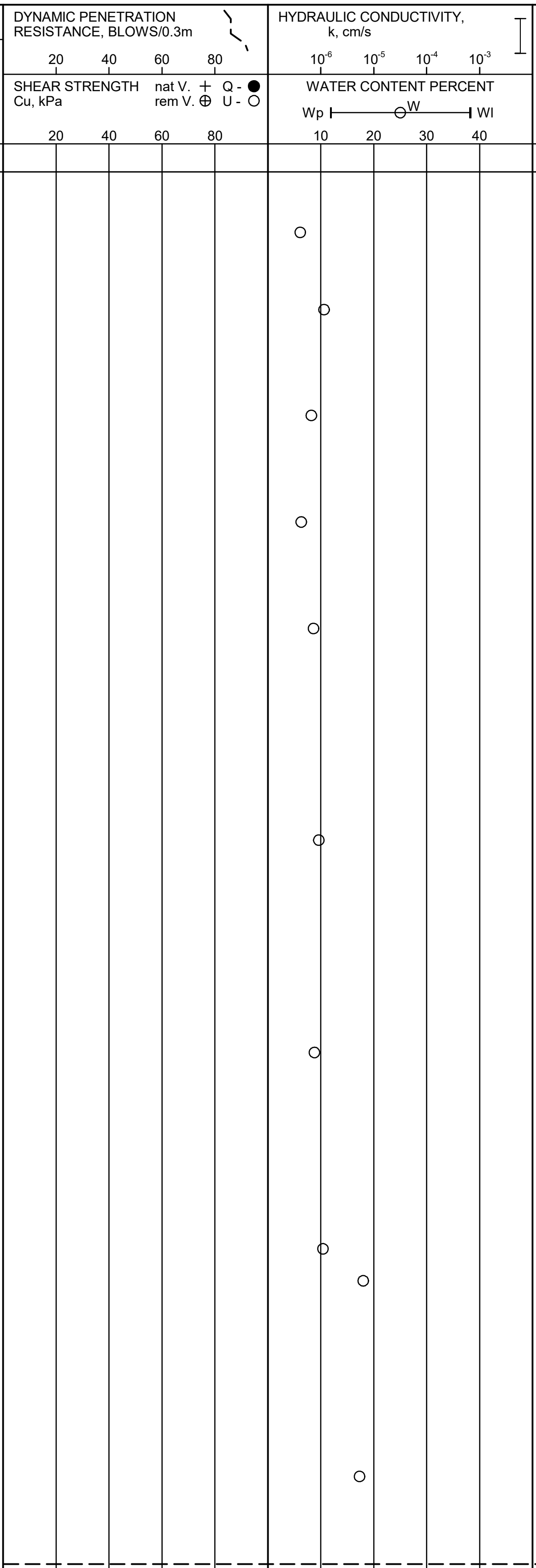
NUMBER	TYPE	BLOWS/0.3m
1	SS	23
2	SS	18
3	SS	37
4	SS	44
5	SS	31
6	SS	30
7	SS	31
8A 8B	SS	76
9	SS	40



ADDITIONAL LAB. TESTING

PIEZOMETER OR STANDPIPE INSTALLATION:
- Concrete
- 50 mm Diameter Monitoring Well
- Bentonite Seal ▽ June 16, 2020
- Sand
- Silica Sand Filter and Screen

DEPTH SCALE 1 : 50

LOGGED: AD/SS
CHECKED: RA

PROJECT: 19129918 (1000)

LOCATION: See Figure 2

RECORD OF BOREHOLE: BH20-3

BORING DATE: March 27, 2020

SHEET 2 OF 2

DATUM: Geodetic

SPT/DCPT HAMMER: MASS, 63kg; DROP, 760mm

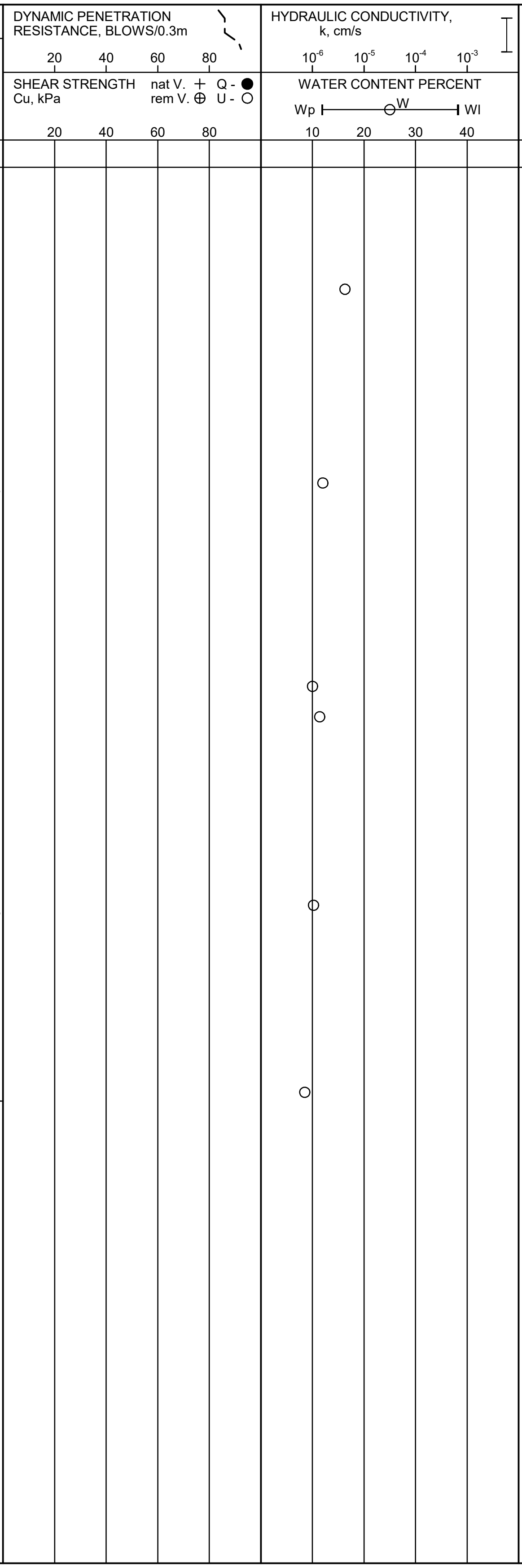
HAMMER TYPE: AUTOMATIC

BORING METHOD: CME 75 Truck Mounted Rig; 98 mm Dia Tricone - Mud Rotary Drilling

--- *CONTINUED FROM PREVIOUS PAGE* ---

SOIL PROFILE DESCRIPTION	ELEV. / DEPTH (m)
(ML) SILT, trace to some sand, trace gravel; grey; slight plasticity; non-cohesive, moist, dense	
(ML) sandy SILT, trace gravel; grey (TILL); non-cohesive, moist, very dense	134.14 11.66
(CL-ML) SILTY CLAY to CLAYEY SILT, trace to some sand, trace gravel; grey (TILL); cohesive, w<PL, hard	131.86 13.94
END OF BOREHOLE	128.91 16.89

SAMPLES NUMBER	TYPE	BLOWS/0.3m
10	SS	38
11	SS	50/ 0.13
12A	SS	57
12B		
13	SS	91/ 0.25
14	SS	50/ 0.13



PIEZOMETER OR STANDPIPE INSTALLATION: Silica Sand Filter and Screen; Bentonite

NOTE:

1. Groundwater level measured in monitoring well as follows:

Date	Depth(m)	Elev. (m)
13/05/2020	4.5	141.3
21/05/2020	4.5	141.3
05/06/2020	4.5	141.3
16/06/2020	4.5	141.3

DEPTH SCALE

1 : 50

GOLDER

LOGGED: AD/SS

CHECKED: RA

PROJECT: 19129918 (1000)

LOCATION: See Figure 2

RECORD OF BOREHOLE: BH20-4

BORING DATE: March 25, 2020

SHEET 1 OF 2

DATUM: Geodetic

SPT/DCPT HAMMER: MASS, 63kg; DROP, 760mm

HAMMER TYPE: AUTOMATIC

BORING METHOD: CME 75 Truck Mounted Rig; 140 mm I.D. Hollow Stem Augers (0 to ~3 m); 98 mm Dia Tricone - Mud Rotary Drilling (~3 to 10 m)

SOIL PROFILE DESCRIPTION	ELEV. / DEPTH (m)	SAMPLE NUMBER	TYPE	BLOWS/0.3m	PIEZOMETER OR STANDPIPE INSTALLATION
GROUND SURFACE	143.60				
ASPHALT (~130 mm thick)	0.00				Concrete
FILL - (SP/GP) SAND and GRAVEL, some fines; brown; non-cohesive, moist, loose	0.13				
FILL - (ML) sandy CLAYEY SILT, trace gravel; black, trace organic matter; cohesive, w~PL, stiff	143.22 0.38	1	SS	9	
(ML) sandy SILT, trace gravel; brown (TILL), oxidation stains; non-cohesive, moist, compact to very dense	142.61 0.99	2	SS	14	50 mm Diameter Monitoring Well
		3	SS	30	
		4	SS	58	
(CL-ML) SILTY CLAY to CLAYEY SILT, some sand, trace gravel; grey (TILL); cohesive, w<PL, very stiff	140.70 2.90	5	SS	25	∇ June 16, 2020
(ML) sandy SILT, some gravel; grey (TILL); non-cohesive, moist, dense to very dense	139.56 4.04				Bentonite Seal
		6	SS	46	
		7	SS	67	
- Gravelly between the depths of about 7.6 m and 7.9 m		8	SS	50/ 0.1	
(SM) SILTY SAND, some gravel; grey; non-cohesive, wet, very dense	135.07 8.53				Sand
		9	SS	74	Silica Sand Filter and Screen

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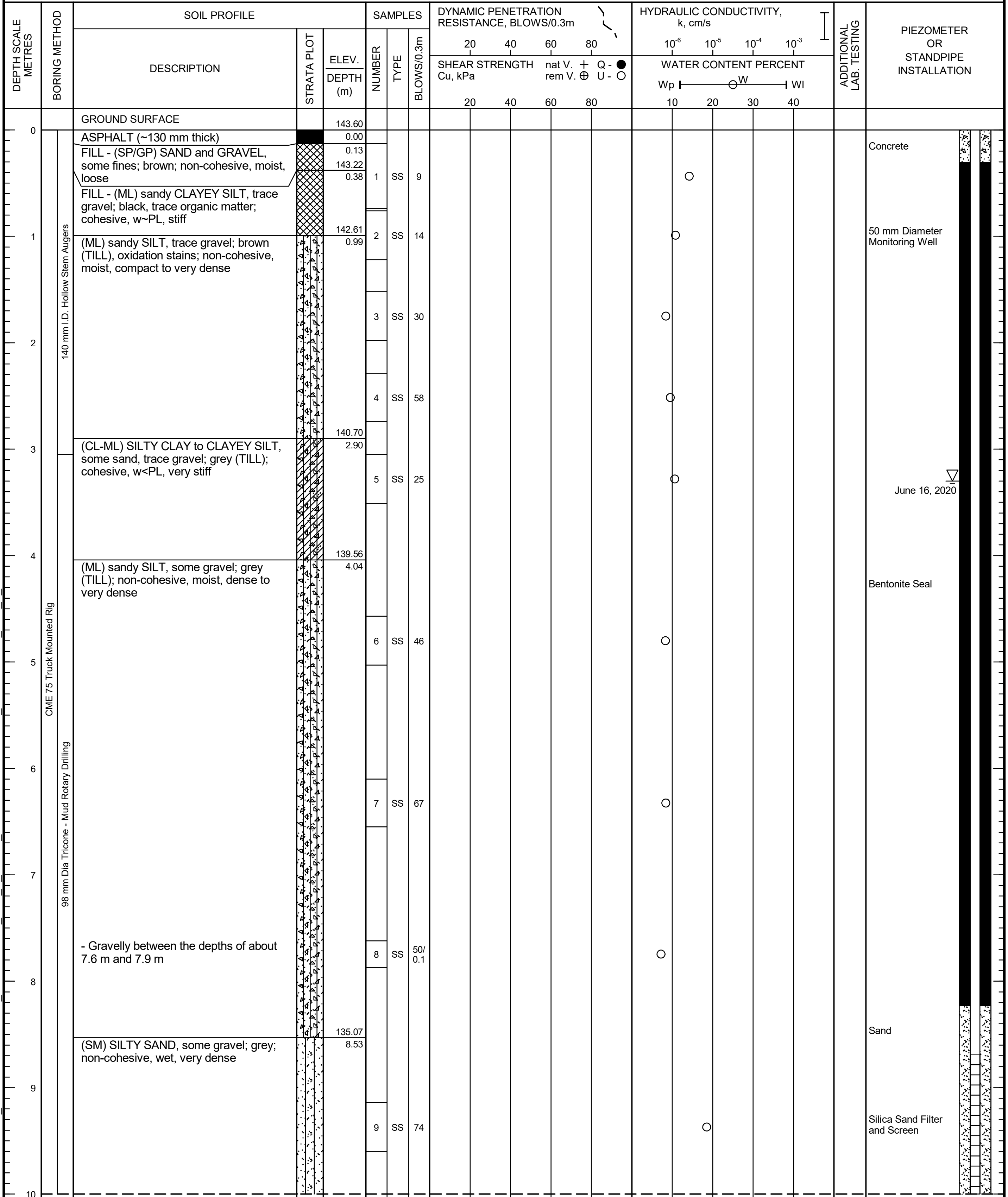

DEPTH SCALE

1 : 50

GOLDER

LOGGED: AD/SS

CHECKED: RA

PROJECT: 19129918 (1000)
LOCATION: See Figure 2

RECORD OF BOREHOLE: BH20-4

BORING DATE: March 25, 2020

SHEET 2 OF 2
DATUM: Geodetic

SPT/DCPT HAMMER: MASS, 63kg; DROP, 760mm

HAMMER TYPE: AUTOMATIC

BORING METHOD: CME 75 Truck Mounted Rig; 98 mm Dia Tricone - Mud Rotary Drilling

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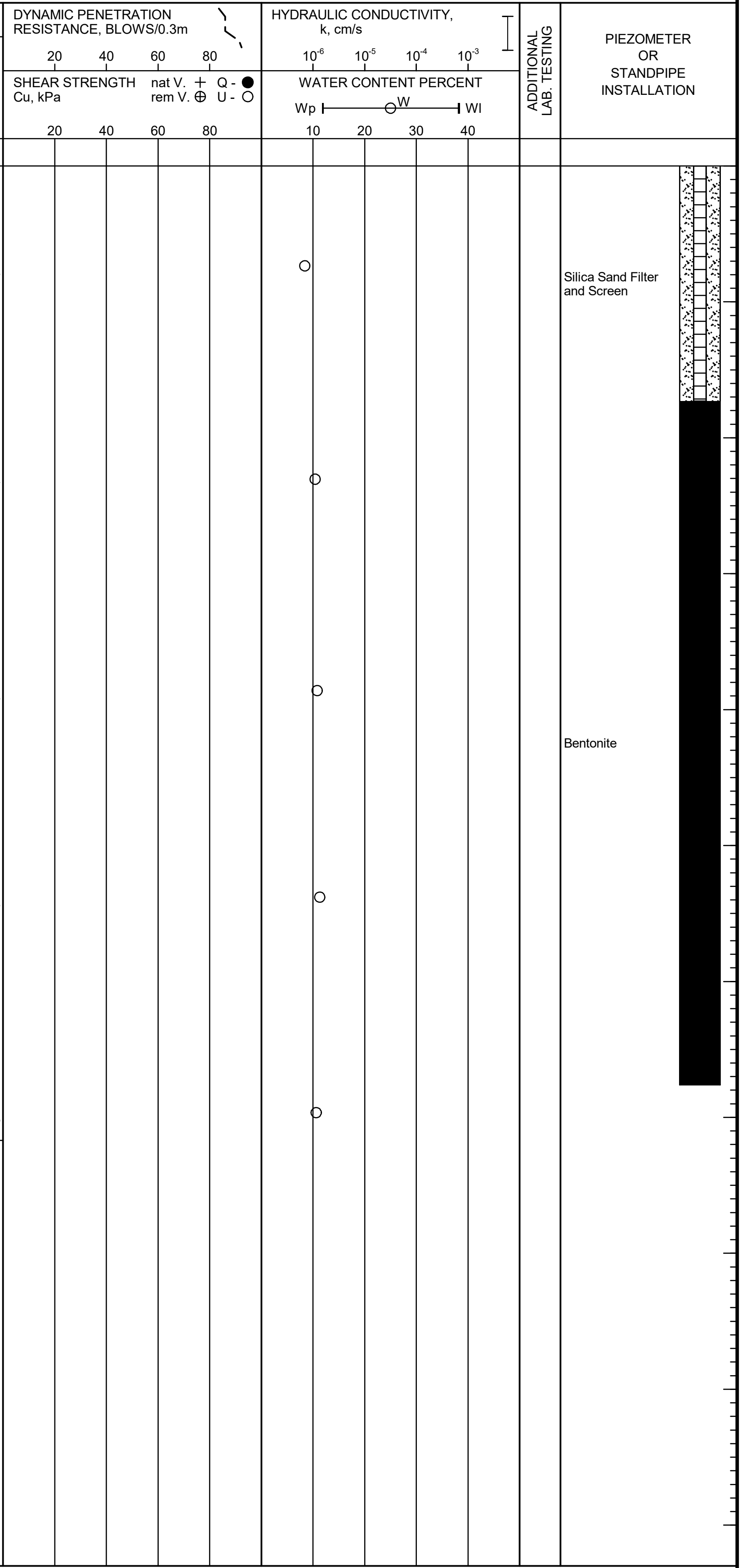
DEPTH SCALE METRES	SOIL PROFILE DESCRIPTION	ELEV. DEPTH (m)	SAMPLES NUMBER	TYPE	BLOWS/0.3m
10		133.47			
	(ML) sandy SILT, some gravel; grey (TILL); non-cohesive, moist to wet, very dense	10.13	10	SS	50/ 0.13
11		132.09			
	(CL-ML) SILTY CLAY to CLAYEY SILT, trace to some sand, trace gravel; grey (TILL); cohesive, w<PL, hard	11.51	11	SS	50/ 0.07
			12	SS	50/ 0.13
			13	SS	50/ 0.13
			14	SS	98/ 0.25
17		126.43			
	END OF BOREHOLE	17.17			

NOTE:

1. Groundwater level measured in monitoring well as follows:

Date	Depth(m)	Elev. (m)
13/05/2020	3.3	140.3
21/05/2020	3.3	140.3
05/06/2020	3.3	140.3
16/06/2020	3.3	140.3



DEPTH SCALE
1 : 50

GOLDER

LOGGED: AD/SS
CHECKED: RA

PROJECT: 19129918 (1000)
LOCATION: See Figure 2

RECORD OF BOREHOLE: BH20-5

BORING DATE: March 26, 2020

SHEET 1 OF 2
DATUM: Geodetic

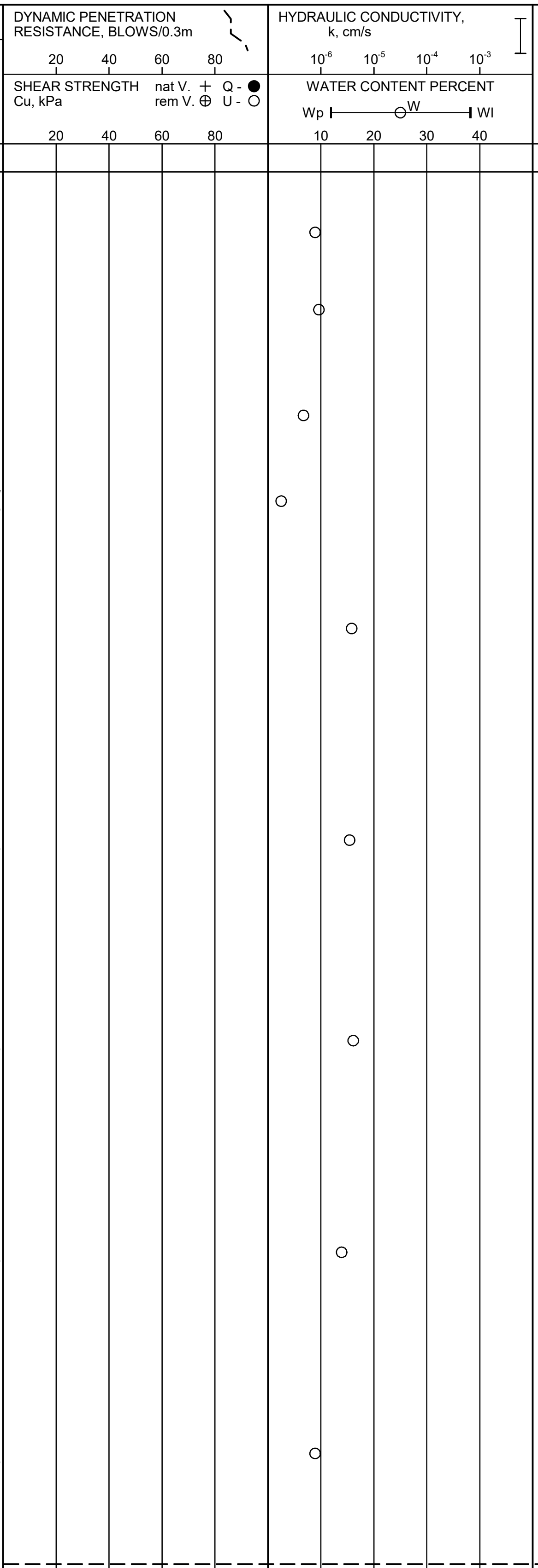
SPT/DCPT HAMMER: MASS, 63kg; DROP, 760mm

HAMMER TYPE: AUTOMATIC

BORING METHOD: 140 mm I.D. Hollow Stem Augers (0 to about 3 m); CME 75 Truck Mounted Rig; 98 mm Dia Tricone - Mud Rotary Drilling

SOIL PROFILE DESCRIPTION	ELEV. DEPTH (m)
GROUND SURFACE	144.60
ASPHALT (~130 mm thick)	0.00
FILL - (SP/GP) SAND and GRAVEL, some fines; brown; non-cohesive, moist, compact	0.13
(ML) sandy SILT, trace to some gravel; brown (TILL), oxidation stains, non-cohesive, moist, compact to very dense - Boulders encountered between the depths of about 2.2 m and 2.3 m	144.27 0.33
(SM/ML) SILTY SAND to sandy SILT, trace to some gravel; brown to grey; non-cohesive, moist to wet, dense to very dense - Grey at a depth of about 7.0 m - Gravelly seam between the depths of about 7.6 m and 7.8 m	141.86 2.74
(CL-ML) SILTY CLAY to CLAYEY SILT, trace to some sand, trace gravel; grey (TILL); cohesive, w<PL, hard	136.07 8.53

SAMPLES NUMBER	TYPE	BLOWS/0.3m	ADDITIONAL LAB. TESTING
1	SS	23	
2	SS	31	
3	SS	61	
4	SS	100/ 0.15	
5	SS	48	
6	SS	89/ 0.28	
7	SS	50/ 0.13	
8	SS	50/ 0.13	M
9	SS	50/ 0.13	



PIEZOMETER OR STANDPIPE INSTALLATION
Concrete
50 mm Diameter Monitoring Well
June 16, 2020
Bentonite Seal

DEPTH SCALE METRES: 0 1 2 3 4 5 6 7 8 9 10

CONTINUED NEXT PAGE

DEPTH SCALE
1 : 50

GOLDER

LOGGED: AD/SS
CHECKED: RA

PROJECT: 19129918 (1000)
LOCATION: See Figure 2

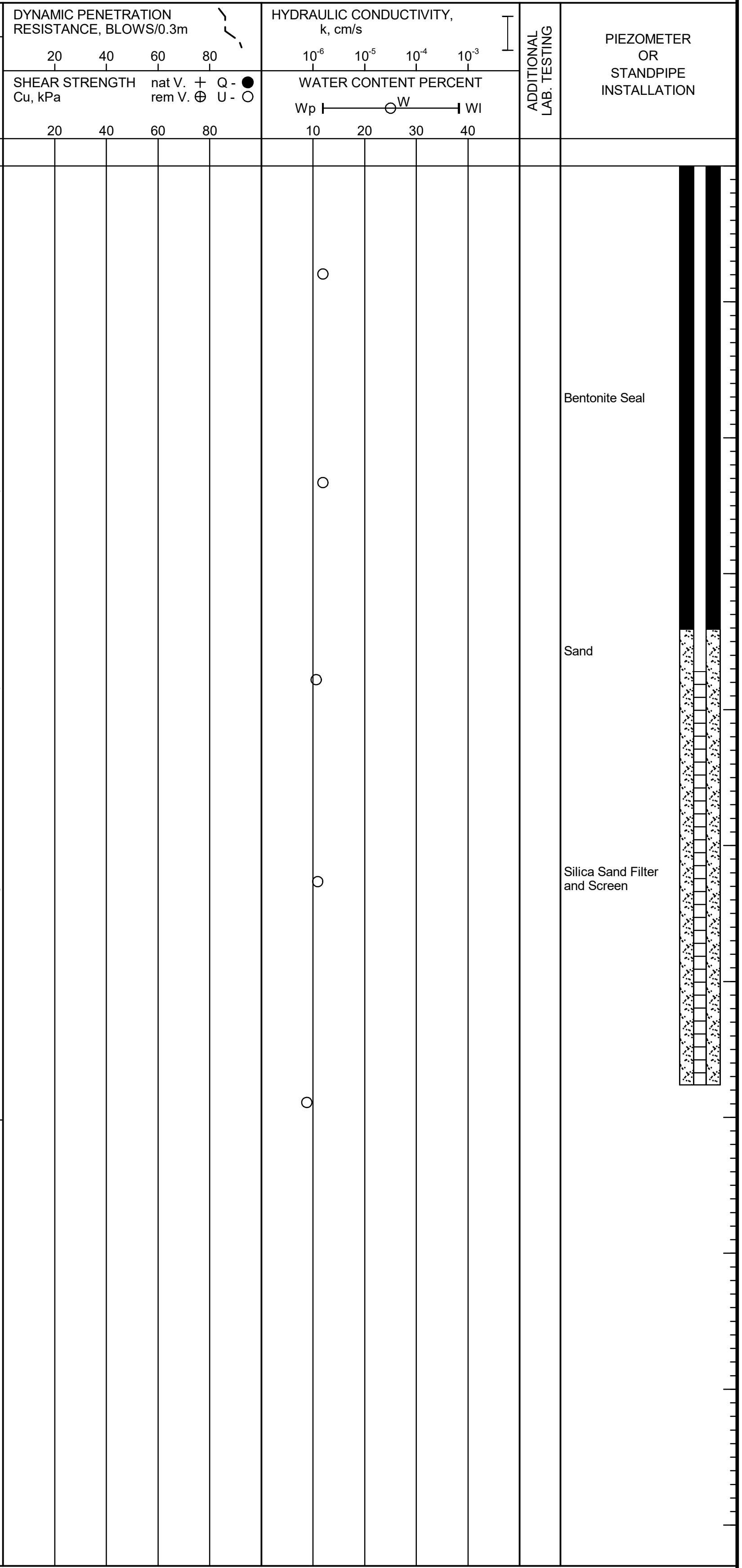
RECORD OF BOREHOLE: BH20-5

SHEET 2 OF 2
DATUM: Geodetic
BORING DATE: March 26, 2020

SPT/DCPT HAMMER: MASS, 63kg; DROP, 760mm
HAMMER TYPE: AUTOMATIC

--- CONTINUED FROM PREVIOUS PAGE ---

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE DESCRIPTION	ELEV. DEPTH (m)	SAMPLES NUMBER	TYPE	BLOWS/0.3m
10	CME 75 Truck Mounted Rig 98 mm Dia Tricone - Mud Rotary Drilling	(CL-ML) SILTY CLAY to CLAYEY SILT, trace to some sand, trace gravel; grey (TILL); cohesive, w<PL, hard				
				10	SS	50/ 0.1
11						
12				11	SS	50/ 0.13
13						
				12	SS	50/ 0.13
14						
15				13	SS	50/ 0.05
16						
17			127.58 17.02	14	SS	50/ 0.1
		END OF BOREHOLE				
18						
19						
20						



END OF BOREHOLE

NOTE:

1. Groundwater level measured in monitoring well as follows:

Date	Depth(m)	Elev. (m)
13/05/2020	3.6	141.0
21/05/2020	3.5	141.1
05/06/2020	3.6	141.0
16/06/2020	3.6	141.0

DEPTH SCALE
1 : 50

LOGGED: AD/SS
CHECKED: RA

PROJECT: 19129918 (1000)

RECORD OF BOREHOLE: BH22-1 PMT

SHEET 1 OF 2

LOCATION: See Figure 2

BORING DATE: March 19, 2020

DATUM: Geodetic

SPT/DCPT HAMMER: MASS, 63kg; DROP, 760mm

HAMMER TYPE: AUTOMATIC

DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m: 20 40 60 80

SHEAR STRENGTH Cu, kPa: nat V. + Q - ● rem V. ⊕ U - ○ : 20 40 60 80

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

WATER CONTENT PERCENT: Wp ⊢—○W—⊣ Wl : 10 20 30 40

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE DESCRIPTION	ELEV. DEPTH (m)	SAMPLES NUMBER	TYPE	BLOWS/0.3m	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		GROUND SURFACE	142.90					
0	CME 75 Truck Mounted Rig 140 mm Solid Stem Augers	ASPHALT (~130 mm thick)	0.00					
		FILL - (SP/GP) SAND and GRAVEL, some fines; brown; non-cohesive, moist	0.13					
		(CL) SILTY CLAY, some sand, trace gravel; brown (TILL); oxidation stains; cohesive, w<PL, very stiff	142.47 0.43					
1		(ML) sandy SILT, trace gravel; brown to grey (TILL); non-cohesive, moist, dense to very dense - Becomes grey at a depth of about 3.3 m	141.53 1.37					
4		(CL-ML) SILTY CLAY to CLAYEY SILT, trace sand, trace gravel; grey (TILL); cohesive, w<PL, hard	138.96 3.94					
5		(ML) sandy SILT, trace gravel; grey (TILL); non-cohesive, moist, very dense	137.34 5.56	1	PMT			
8				2	PMT			
		(CL-ML) SILTY CLAY to CLAYEY SILT, trace sand, trace gravel; grey (TILL); cohesive, w<PL, hard	134.37 8.53					
10			132.90					

CONTINUED NEXT PAGE

DEPTH SCALE
1 : 50

LOGGED: AD/SS
CHECKED: RA

PROJECT: 19129918 (1000)

LOCATION: See Figure 2

RECORD OF BOREHOLE: BH22-1 PMT

BORING DATE: March 19, 2020

SHEET 2 OF 2

DATUM: Geodetic

SPT/DCPT HAMMER: MASS, 63kg; DROP, 760mm

HAMMER TYPE: AUTOMATIC

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	ELEV. DEPTH (m)	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: BLOWS/0.3m
		--- CONTINUED FROM PREVIOUS PAGE ---				
10	CME 75 Truck Mounted Rig 140 mm Solid Stem Augers	(SM) SILTY SAND, some gravel; grey; non-cohesive, moist, very dense	10.00			
11		(CL-ML) SILTY CLAY to CLAYEY SILT, some sand, some gravel; grey (TILL); cohesive, w<PL, hard	132.16 10.74	3	PMT	
12		(ML) sandy SILT, some gravel; grey (TILL); non-cohesive, moist, very dense	131.39 11.51			
13		(CL-ML) SILTY CLAY to CLAYEY SILT, trace to some sand, trace gravel; grey (TILL); cohesive, w<PL, hard	129.92 12.98			
14				4	PMT	
15						
16						
17		END OF BOREHOLE	125.93 16.97			
18						
19						
20						

DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m: 20 40 60 80

SHEAR STRENGTH Cu, kPa: nat V. + Q - ● rem V. ⊕ U - ○ : 20 40 60 80

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

WATER CONTENT PERCENT: Wp ⊢—○W—⊣ Wl : 10 20 30 40

ADDITIONAL LAB. TESTING

PIEZOMETER OR STANDPIPE INSTALLATION

DEPTH SCALE

1 : 50

LOGGED: AD/SS

CHECKED: RA

PROJECT: 19129918 (1000)

RECORD OF BOREHOLE: BH22-3 PMT

SHEET 1 OF 2

LOCATION: See Figure 2

BORING DATE: March 26, 2020

DATUM: Geodetic

SPT/DCPT HAMMER: MASS, 63kg; DROP, 760mm

HAMMER TYPE: AUTOMATIC

BORING METHOD: CME 75 Truck Mounted Rig; 140 mm I.D. Hollow Stem Augers (0 to about 3.05 m); 98 mm Dia Tricone - Mud Rotary Drilling (about 3.05 m to 10 m)

DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m: 20 40 60 80

SHEAR STRENGTH Cu, kPa: nat V. + Q - ● rem V. ⊕ U - ○ : 20 40 60 80

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

WATER CONTENT PERCENT: Wp ├──○W──┤ Wl : 10 20 30 40

ADDITIONAL LAB. TESTING

PIEZOMETER OR STANDPIPE INSTALLATION

DEPTH SCALE METRES	SOIL PROFILE DESCRIPTION	ELEV. DEPTH (m)	SAMPLES NUMBER	TYPE	BLOWS/0.3m
	GROUND SURFACE	144.60			
0	ASPHALT (~130 mm thick)	0.00			
	FILL - (SP/GP) SAND and GRAVEL, some fines; brown; non-cohesive, moist, compact	0.13			
	(ML) sandy SILT, trace to some gravel; brown (TILL), oxidation stains, non-cohesive, moist, compact to very dense	144.27 0.33			
2	- Boulders encountered between the depths of about 2.2 m and 2.3 m				
	(SM/ML) SILTY SAND to sandy SILT, trace to some gravel; brown to grey; non-cohesive, moist to wet, dense to very dense	141.86 2.74			
6			1	PMT	
7	- Grey at a depth of about 7.0 m				
7.6	- Gravelly seam between the depths of about 7.6 m and 7.8 m				
	(CL-ML) SILTY CLAY to CLAYEY SILT, trace to some sand, trace gravel; grey (TILL); cohesive, w<PL, hard	136.07 8.53			
9			2	PMT	
10					

CONTINUED NEXT PAGE

DEPTH SCALE
1 : 50

WSP GOLDER

LOGGED: AD/SS
CHECKED: RA

PROJECT: 19129918 (1000)

LOCATION: See Figure 2

RECORD OF BOREHOLE: BH22-3 PMT

BORING DATE: March 26, 2020

SHEET 2 OF 2

DATUM: Geodetic

SPT/DCPT HAMMER: MASS, 63kg; DROP, 760mm

HAMMER TYPE: AUTOMATIC

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	SAMPLES NUMBER	SAMPLES TYPE	BLOWS/0.3m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20 40 60 80); SHEAR STRENGTH Cu, kPa nat V. + Q - ● rem V. ⊕ U - ○ (20 40 60 80)	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-6} 10^{-5} 10^{-4} 10^{-3}); WATER CONTENT PERCENT Wp ⊢—○W—⊣ Wl (10 20 30 40)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		--- *CONTINUED FROM PREVIOUS PAGE* ---									
10	CME 75 Truck Mounted Rig 98 mm Dia Tricone - Mud Rotary Drilling	(CL-ML) SILTY CLAY to CLAYEY SILT, trace to some sand, trace gravel; grey (TILL); cohesive, w<PL, hard									
11											
12											
					3	PMT					
13											
14											
15											
					4	PMT					
16											
17				127.58 17.02							
		END OF BOREHOLE									
18											
19											
20											

DEPTH SCALE

1 : 50

LOGGED: AD/SS

CHECKED: RA

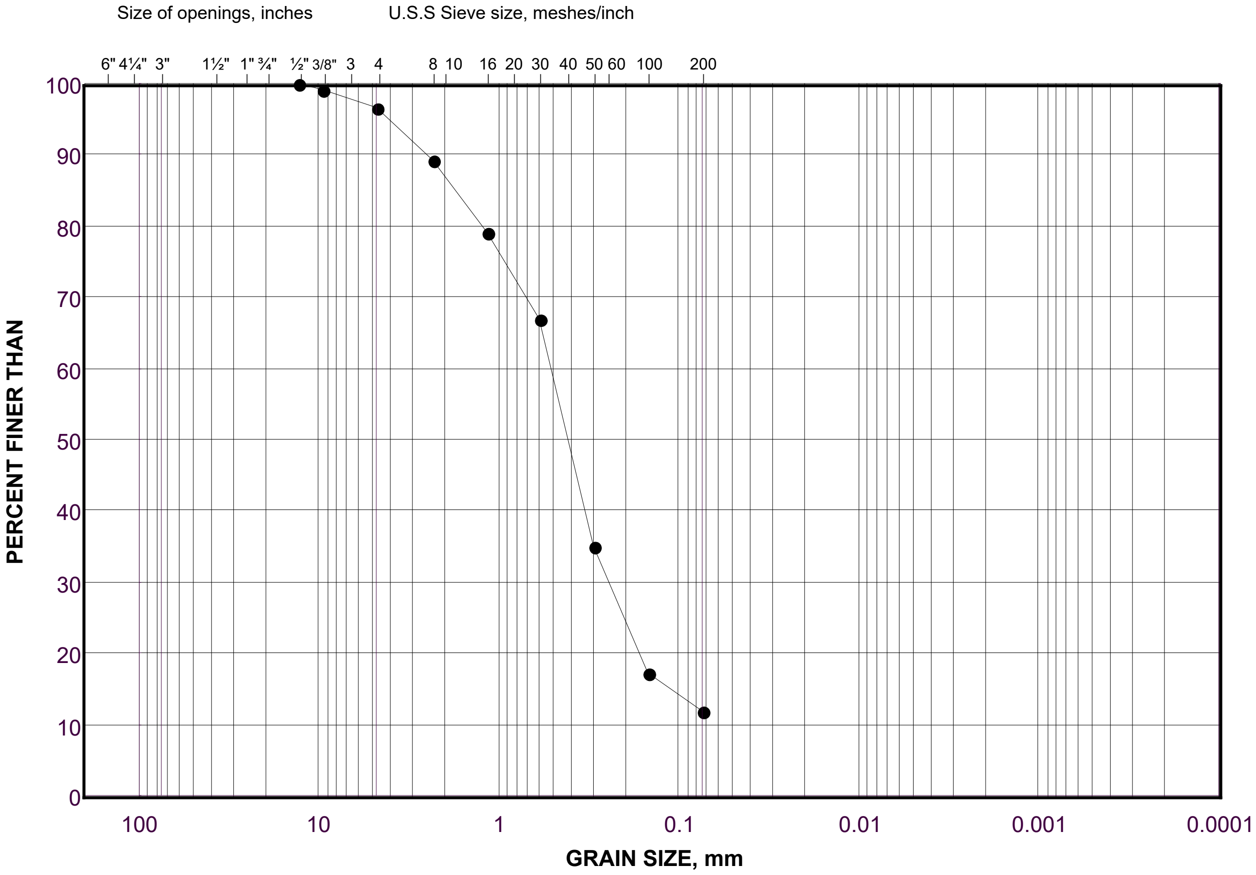
APPENDIX D

Results of Geotechnical Laboratory Testing

GRAIN SIZE DISTRIBUTION

(SM) SILTY SAND

FIGURE D1



COBBLE	COARSE	FINE	COARSE	MEDIUM	FINE	SILT AND CLAY SIZES
SIZE	**GRAVEL SIZE**		**SAND SIZE**			**FINE GRAINED**

LEGEND

SYMBOL	BOREHOLE	SAMPLE	DEPTH(m)
●	BH 20-2	7	6.1 - 6.6

Project Number: 19129918

Checked By: RA

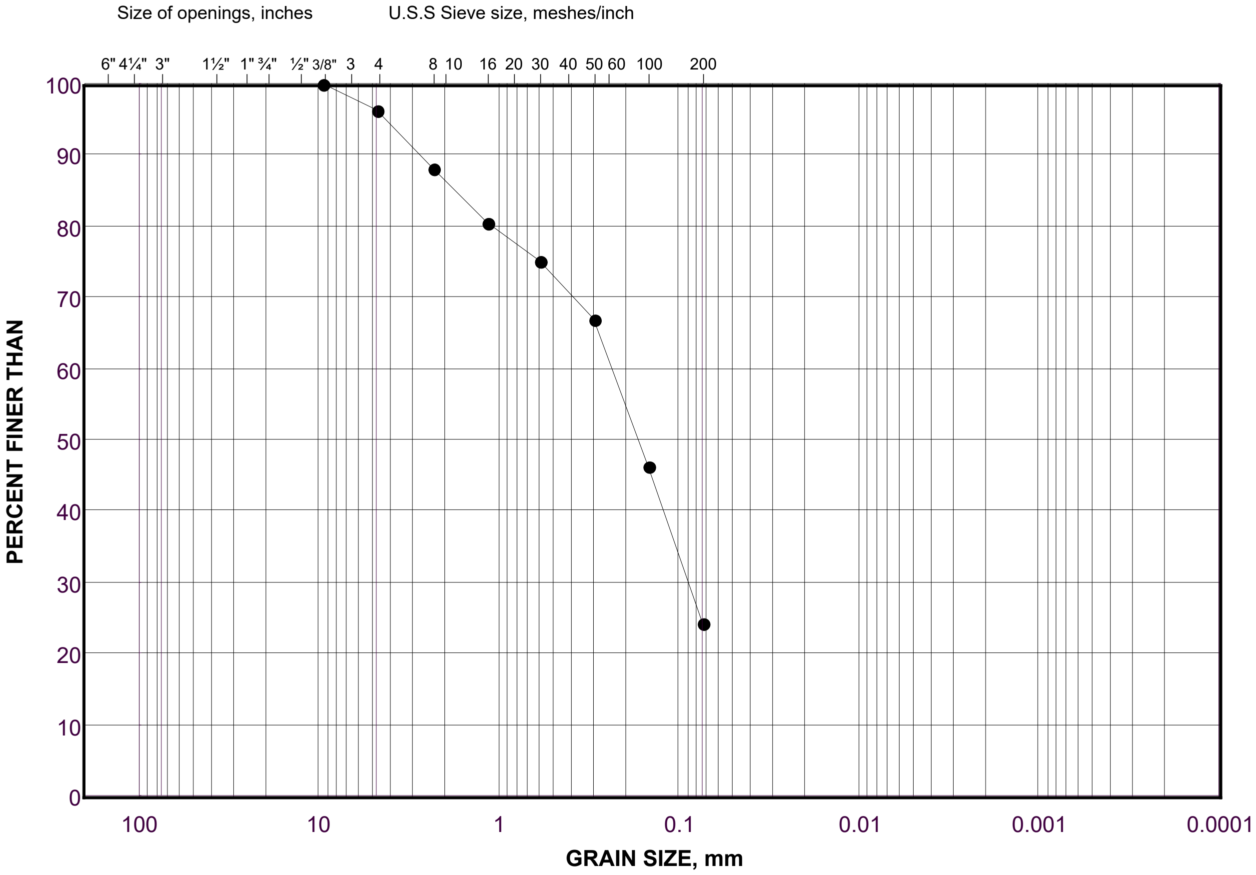
Golder Associates

Date: 18-Jun-20

GRAIN SIZE DISTRIBUTION

(SM) SILTY SAND

FIGURE D2



COBBLE	COARSE	FINE	COARSE	MEDIUM	FINE	SILT AND CLAY SIZES
SIZE	**GRAVEL SIZE**		**SAND SIZE**			**FINE GRAINED**

LEGEND

SYMBOL	BOREHOLE	SAMPLE	DEPTH(m)
●	BH 20-5	8	7.6 - 7.9

Project Number: 19129918

Checked By: RA

Golder Associates

Date: 18-Jun-20

APPENDIX E

PMT Testing

In-Depth
Geotechnical Inc.

In-Situ Pressuremeter Testing
895 Lawrence Avenue, Toronto
Boring Nos. BH22-1 and BH22-3
Revised on December 7th, 2022

Project No. IDG 220705

Prepared for:
Mr. Alexander Dziedzic, B.Eng., E.I.T.
Golder Associated Ltd.
215 Shields Court
Markham, Ontario
L3R 8V2

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Table of Contents

1. Introduction

In-Depth Geotechnical Inc. was retained by Golder associates Ltd. to conduct Pressuremeter testing in relation to their Geotechnical Investigation for the site located at the 895 Lawrence Avenue, in Toronto, Ontario.

This report presents the results of pressuremeter testing (PMT) carried out at two borehole locations with the purpose of evaluating specific parameters related to a) shear strength; and b) deformation properties of the encountered soils.

This report includes data obtained by use of a pre-bored pressuremeter system. Inferred characteristics of the data are also presented including initial contact pressure, limit pressure, secant deformation modulus values during loading, unloading and reloading cycles, and yield pressure if and when justified by the data. Multiple methods are available for interpretation of this data to estimate engineering properties of soils but such methods are not discussed or included in this report except for the characteristics of the data plots as described above.

2. Field Testing Procedures

Pressuremeter testing was performed at two boreholes, on the above-mentioned site.

Details of tested boring are:

Borehole	Number of Tests	Ground Elevation (masl)	Water Elevation (masl)	Maximum Depth (m)
BH22-1-PMT	4	N/A	N/A	15.0
BH22-3-PMT	4	N/A	N/A	16.0

Field work was completed on September 19 and 20, 2022. Drilling procedures were undertaken by Altech Drilling Contractor. The boreholes were advanced using mud rotary drilling technique with a truck-mounted Diedrich D120 drill rig. These borings were drilled for PMT testing as well as SPT testing and sampling.

Hollow-stem- continuous flight augers were installed to a depth of about 3.0 m below the ground surface to prevent soil collapse on the upper part of the boring (collar).

The test sections of the boring were drilled with a tricone bit or a drag bit. The bit was advanced using continuous circulation of drilling mud to flush soil cuttings, producing a controlled diameter hole for the pressuremeter probe. A positive water head was kept inside the surface casing throughout drilling and in-situ testing procedures. In general, the drilling fluid remained at the top of casing.

Pre-boring pressuremeter testing was completed using a TEXAM unit. The testing procedure was in general accordance with Procedure B, volume-controlled loading, as outlined in the ASTM D 4719-00 Standard Test Method for Pre-bored Pressuremeter Testing of Soils. The testing equipment was calibrated for pressure and volume losses as indicated in the above-mentioned standard. The Records of Calibration for the PMT probes utilized in this job are attached on Appendix Three. The control unit was de-aired prior to every test. Also, checks were completed to ensure that the probe, tubing, and control unit assembly were fully saturated, and that the probe membrane was leakage-free at high pressures. Two readings were taken for each volume step, namely for time delays of 15, and 30 seconds.

As per Golder instructions, test procedures also included completion of up to two unload-reload cycles per test, wherever possible.

3. Pressuremeter Test Results

3.1 PMT test parameters

Pressuremeter test data is presented in Appendix One, and the summary of test results are illustrated in Table Nos. 1a and 1b, below.

Based on pressuremeter test data, we have included subsoil profiles for the tested borings, plotting the distributions of the interpreted PMT parameters. These profiles are shown in the following pages.

3.2 PMT-Inferred soil parameters

A general guideline to interpret and infer soil properties based on available PMT test data is attached to Appendix Two This guideline suggests accepted current procedures to estimate or infer shear strength, deformation properties, and other related soil parameters. These inferred properties are summarized in Table Nos. 2a and 2b, below.

It is recognized that the values of in-situ total horizontal stresses, σ_{h0}, presented in this report correspond to best possible estimates. These estimates were obtained using the *corrected pressure* versus *1/Volume* method, and are used in this report to infer values of the at-rest stress ratio k_0. The following subsurface soil conditions were assumed to apply:

- Ground Surface and Ground Water elevations: as indicated on the Table Nos. 2a and 2b, below
- Average wet and saturated unit weights: $\gamma_{wet} = 21$ kN/m^3 and $\gamma_{sat} = 22$ kN/m^3
- Total horizontal stresses taken as direct values of p_0 (PMT test results).

It is considered that stresses within the soil mass are defined by geostatic conditions, that is to say:

1. No surcharges are applied on the surface (structural loads from existing buildings nearby are negligible),
2. Static groundwater conditions (no seepage occurs),
3. Surface topography is horizontal (no slopes or excavations), and
4. Total vertical stresses are defined by the *wet* (unsaturated soils) and *saturated* (submerged soils) unit weights, γ_{wet} and γ_{sat}, respectively.

Using the *Pressiorama* and the associated *Pressiorama Cyclique Charts* inferred values of Young's Moduli (E_Y), Classification Index (I_c), and drained friction angle (ϕ') are also shown in Table Nos. 2a and 2b.

TABLE No. 1a Summary of Pressuremeter Test Results

Boring No. BH 22-1-PMT

Test No.	Surface Elevation (m): 100.00 (assumed)		Contact Pressure	PMT Modulus	Unload - Reload Cycles								Yield Pressure	Net Limit Pressure		
					$E_{Unload\ 1}$	$E_{Reload\ 1}$	Stresses			Strains $\Delta R/R_0$						
	Depth	Elevation	p_0	E_{PMT}			Point 1	Point 2	Point 3	Point 1	Point 2	Point 3	p_y	p^*_L	E_{PMT} / p^*_L	p^*_L / p_y
	[m]	[m]	[kPa]	[MPa]	[MPa]	[MPa]	[kPa]	[kPa]	[kPa]	[%]	[%]	[%]	[kPa]	[kPa]		
1	5.84	94.2	77	64.0	421.1	250.8	2045.2	960.8	2127.8	18.1	17.7	18.6	640	7288	8.8	11.4
					810.2	332.8	3008.0	1487.4	3002.3	20.5	20.2	20.9				
2	8.33	91.7	112	45.1	188.4	89.4	1100.0	467.6	1040.6	15.8	15.2	16.2	870	5771	7.8	6.6
					345.6	172.0	1767.6	814.2	1761.7	18.2	17.8	18.6				
3	11.43	88.6	160	285.1	770.6	436.8	3112.0	1483.5	3303.7	9.0	8.7	9.4	2257	8676	32.9	3.8
4	14.48	85.5	181	113.5	292.7	157.5	2221.9	1250.6	2252.9	7.3	6.8	7.8	1135	5096	22.3	4.5
					307.3	150.5	3108.3	2136.5	3098.5	9.9	9.4	10.4				

Table No. 2a PMT-Inferred Parameters Boring No. BH 22-1-PMT

PMT	z	z_w	Hydrostatic	Total Stresses		Effective Stresses		**Stress Ratio**	**Young's Modulus**		**Shear Strength**		**Classification Index**
									α	E_Y	Undrained	Drained	
Test	depth	water	Pressure	Vertical	Horizontal	Vertical	Horizontal		Menard's Parameter		Cohesive Behavior	Cohesionless Behavior	I_c
								k_0			c_u	ϕ'	
No.	[m]	[m]	[kPa]	[kPa]	[kPa]	[kPa]	[kPa]			[MPa]	[kPa]	[degrees]	
1	5.84	0.84	8	123	77	115	69	**0.60**	0.27	236	524	44	3.40
2	8.33	3.33	33	178	112	146	79	**0.54**	0.30	151	440	40	3.16
3	11.43	6.43	63	246	160	183	97	**0.53**	0.60	472	597	37	2.99
4	14.48	9.48	93	314	181	221	88	**0.40**	0.59	194	401	33	2.75

Notes

1. Ground surface elevation (m) Assumed 100.00 Water elevation (m) 95.00 Water depth (m) Assumed 5.00

2. Wet unit weight of soil 21.0 [kN/m^3] Saturated unit weight of soil 22.0 [kN/m^3]

3. Observations on Shear Strength Parameters (SSP):

SSP are considered either for Undrained Conditions (Short Term) or Drained Conditions (Long Term). These two conditions are mutually exclusive.

Undrained Conditions imply cohesion is c_u , and $\phi = 0$. ***Drained Conditions*** imply negligible cohesion or $c'=0$, and $\phi = \phi'$

Based on the Classification Index I_C (Soil Behavior Type), the suggested values of the SSP are highlighted in green (Thick box border)

4. The Classification Index parameter, I_C, is indicative of the soil type of behavior. It does not exactly relate to the Soil Classification types as those obtained via Grain-Size Distribution analyses. I_C varies from 1.0 to 4.5, from soft clays (cohesive) to dense coarse sands (frictional), correspondingly.

TABLE No. 1b Summary of Pressuremeter Test Results

Boring No. BH 22-3-PMT

Test No.	Surface Elevation (m): 100.00 (assumed)		Contact Pressure	PMT Modulus	Unload - Reload Cycles								Yield Pressure	Net Limit Pressure		
					$E_{Unload\ 1}$	$E_{Reload\ 1}$	Stresses			Strains $\Delta R/R_0$						
	Depth	Elevation	p_0	E_{PMT}			Point 1	Point 2	Point 3	Point 1	Point 2	Point 3	p_y	p^*_L	E_{PMT} / p^*_L	p^*_L / p_y
	[m]	[m]	[kPa]	[MPa]	[MPa]	[MPa]	[kPa]	[kPa]	[kPa]	[%]	[%]	[%]	[kPa]	[kPa]		
1	6.55	93.5	91	61.0	307.1	193.2	1634.2	644.7	1722.7	8.4	7.9	8.8	1286	5286	11.5	4.1
					500.0	252.8	2447.0	1155.2	2481.7	11.0	10.6	11.4				
2	9.80	90.2	131	213.2	3782.0	1291.6	4130.0	1626.5	4479.5	7.8	7.7	8.2	3100	12798	16.7	4.1
3	12.85	87.2	171	165.1	711.1	418.8	2924.9	1354.4	3118.6	9.0	8.7	9.4	2220	8580	19.2	3.9
					1390.7	382.1	4489.1	2494.3	4404.8	11.4	11.2	11.9				
4	16.00	84.0	241	149.2	319.2	198.8	2410.8	1382.5	2514.8	7.3	6.8	7.7	1869	5512	27.1	2.9
					404.0	194..3	3356.2	2200.4	3360.4	9.8	9.4	10.3				

Table No. 2b PMT-Inferred Parameters Boring No. BH 22-3-PMT

PMT Test No.	z depth [m]	z_w water [m]	Hydrostatic Pressure [kPa]	Total Stresses		Effective Stresses		Stress Ratio k_0	Young's Modulus		Shear Strength		Classification Index I_c
				Vertical [kPa]	Horizontal [kPa]	Vertical [kPa]	Horizontal [kPa]		α Menard's Parameter	E_Y [MPa]	Undrained Cohesive Behavior c_u [kPa]	Drained Cohesionless Behavior ϕ' [degrees]	
1	6.55	1.55	15	139	91	124	76	**0.61**	0.35	174	412	40	3.15
2	9.80	4.80	47	211	131	164	84	**0.51**	0.37	575	799	43	3.33
3	12.85	7.85	77	278	171	201	94	**0.47**	0.47	351	592	38	3.02
4	16.00	11.00	108	347	241	239	133	**0.56**	0.68	219	425	31	2.63

Notes

1. Ground surface elevation (m) Assumed 100.00 Water elevation (m) 95.00 Water depth (m) Assumed 5.00

2. Wet unit weight of soil 21.0 [kN/m^3] Saturated unit weight of soil 22.0 [kN/m^3]

3. Observations on Shear Strength Parameters (SSP):

SSP are considered either for Undrained Conditions (Short Term) or Drained Conditions (Long Term). These two conditions are mutually exclusive.

Undrained Conditions imply cohesion is c_u , and $\phi = 0$. ***Drained Conditions*** imply negligible cohesion or $c'=0$, and $\phi = \phi'$

Based on the Classification Index I_C (Soil Behavior Type), the suggested values of the SSP are highlighted in green (Thick box border)

4. The Classification Index parameter, I_C, is indicative of the soil type of behavior. It does not exactly relate to the Soil Classification types as those obtained via Grain-Size Distribution analyses. I_C varies from 1.0 to 4.5, from soft clays (cohesive) to dense coarse sands (frictional), correspondingly.

4. Closure

The subsoils data presented in this report is based on in-situ PMT testing and interpretation procedures. It should be noted that soil conditions may vary within the site and interpreted data may not be entirely representative of conditions at locations away from the tested borings. Therefore, care should be exercised when extrapolating or inferring subsoil conditions away from the borehole location.

We trust that the present report fulfills your requirements. Should you have any question, please feel free to contact the undersigned.

Sincerely,

In-Depth Geotechnical Inc.

LICENSED PROFESSIONAL ENGINEER
G. SEDRAN
December 7th, 2022
PROVINCE OF ONTARIO

Gabriel Sedran, P.Eng., Ph.D.
President

Appendix One

Pressuremeter Results - Data

BH22-1-PMT	pages 1 to 4
BH22-3-PMT	pages 5 to 8

Field Test Data (uncorrected)

Volume [cm³]	Pressure [bar] 15 sec	Pressure [bar] 30 sec
2	0.16	0.16
40	0.25	0.25
80	0.32	0.32
120	0.41	0.40
160	0.48	0.47
200	0.62	0.61
240	0.78	0.76
280	1.01	0.97
320	1.34	1.32
360	1.69	1.66
400	2.12	2.07
440	2.65	2.57
480	3.35	3.24
520	4.19	4.07
560	5.26	5.11
600	6.77	6.57
640	8.84	8.59
680	11.48	11.12
720	14.22	13.83
760	17.58	17.11
800	20.91	20.36
790	14.54	14.59
780	11.40	11.50
770	9.40	9.51
780	13.93	13.90
790	16.82	16.69
800	19.15	18.88
840	24.00	23.50
880	27.38	26.78
920	30.70	30.01
910	22.00	22.08
900	17.69	17.79
890	14.70	14.80
900	20.82	20.74
910	25.08	24.88
920	28.20	27.93
960	32.27	31.98
1000	35.57	35.27
1040	38.45	38.14
1080	40.87	40.54
1120	43.04	42.72

Corrected Test data

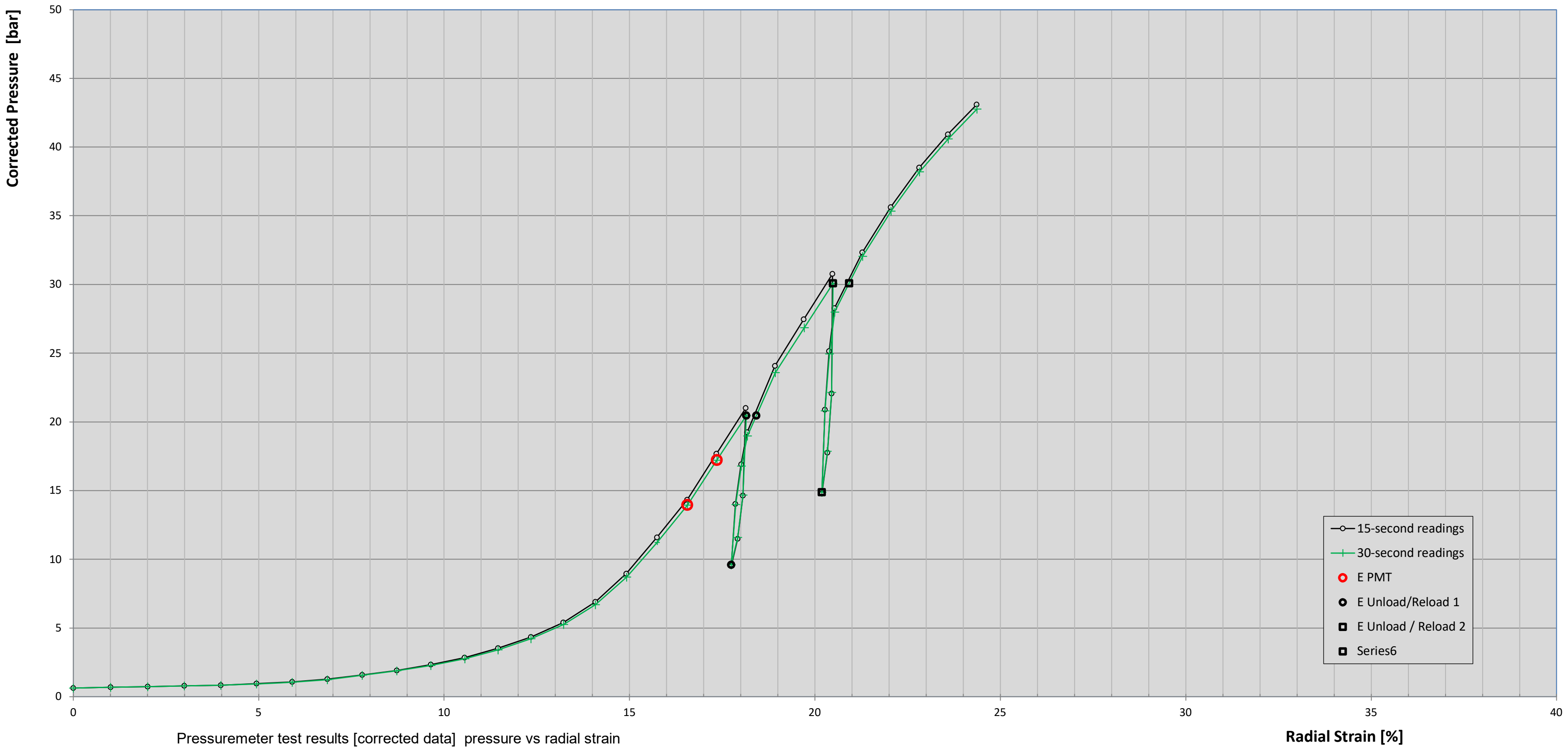
15-second readings			30-second readings		
Pressure [bar]	Volume [cm³]	Δr/r₀ [%]	Pressure [bar]	Volume [cm³]	Δr/r₀ [%]
0.64	2	0.00	0.64	2	0.00
0.70	39.7	1.00	0.70	39.7	1.00
0.74	79.7	2.00	0.74	79.7	2.00
0.80	119.6	2.99	0.79	119.6	2.99
0.84	159.5	3.97	0.83	159.5	3.97
0.95	199.4	4.94	0.94	199.4	4.94
1.08	239.2	5.90	1.06	239.2	5.90
1.29	279.0	6.85	1.25	279.0	6.85
1.59	318.6	7.79	1.57	318.6	7.79
1.92	358.2	8.72	1.89	358.3	8.72
2.33	397.8	9.64	2.28	397.9	9.64
2.85	437.3	10.55	2.77	437.3	10.56
3.53	476.5	11.45	3.42	476.6	11.46
4.35	515.7	12.34	4.23	515.8	12.34
5.41	554.5	13.22	5.26	554.7	13.22
6.90	593.0	14.08	6.70	593.2	14.08
8.96	630.8	14.92	8.71	631.1	14.92
11.60	668.1	15.74	11.24	668.5	15.75
14.33	705.3	16.55	13.94	705.7	16.56
17.68	741.8	17.34	17.21	742.3	17.35
21.00	778.3	18.13	20.45	778.9	18.15
14.63	774.9	18.06	14.68	774.9	18.06
11.50	768.2	17.91	11.60	768.1	17.91
9.50	760.3	17.74	9.61	760.1	17.74
14.03	765.6	17.86	14.00	765.6	17.86
16.91	772.6	18.01	16.78	772.7	18.01
19.24	780.1	18.17	18.97	780.4	18.18
24.08	815.1	18.92	23.58	815.6	18.93
27.46	851.6	19.70	26.86	852.2	19.71
30.77	888.2	20.47	30.08	888.9	20.49
22.07	887.2	20.45	22.15	887.1	20.45
17.76	881.7	20.34	17.86	881.6	20.33
14.77	874.8	20.19	14.87	874.7	20.19
20.89	878.4	20.27	20.81	878.5	20.27
25.15	884.0	20.38	24.95	884.2	20.39
28.27	890.8	20.53	28.00	891.0	20.53
32.34	926.5	21.28	32.05	926.8	21.29
35.63	963.1	22.04	35.33	963.4	22.05
38.51	1000.1	22.81	38.20	1000.4	22.82
40.92	1037.6	23.58	40.59	1038.0	23.59
43.09	1075.4	24.36	42.77	1075.7	24.37

Creep

Volume [cm³]	Δp 30-15 [bar]
2	0.00
39.7	0.00
79.7	0.00
119.6	0.01
159.5	0.01
199.4	0.01
239.2	0.02
279.0	0.04
318.6	0.02
358.3	0.03
397.9	0.05
437.3	0.08
476.6	0.11
515.8	0.12
554.7	0.15
593.2	0.20
631.1	0.25
668.5	0.36
705.7	0.39
742.3	0.47
778.9	0.55
815.6	0.50
852.2	0.60
888.9	0.69
926.8	0.29
963.4	0.30
1000.4	0.31
1038.0	0.33
1075.7	0.32

Auxiliary Data

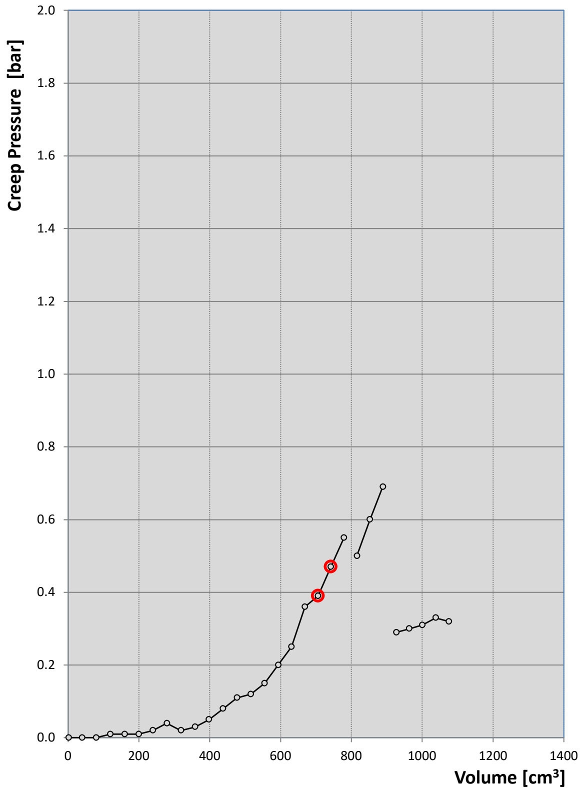
30 sec	
Pressure [bar]	1 / V
0.64	0.54524
0.70	0.02516
0.74	0.01255
0.79	0.00836
0.83	0.00627
0.94	0.00502
1.06	0.00418
1.25	0.00358
1.57	0.00314
1.89	0.00279
2.28	0.00251
2.77	0.00229
3.42	0.00210
4.23	0.00194
5.26	0.00180
6.70	0.00169
8.71	0.00158
11.24	0.00150
13.94	0.00142
17.21	0.00135
20.45	0.00128
14.68	0.00129
11.60	0.00130
9.61	0.00132
14.00	0.00131
16.78	0.00129
18.97	0.00128
23.58	0.00123
26.86	0.00117
30.08	0.00113
22.15	0.00113
17.86	0.00113
14.87	0.00114
20.81	0.00114
24.95	0.00113
28.00	0.00112
32.05	0.00108
35.33	0.00104
38.20	0.00100
40.59	0.00096
42.77	0.00093



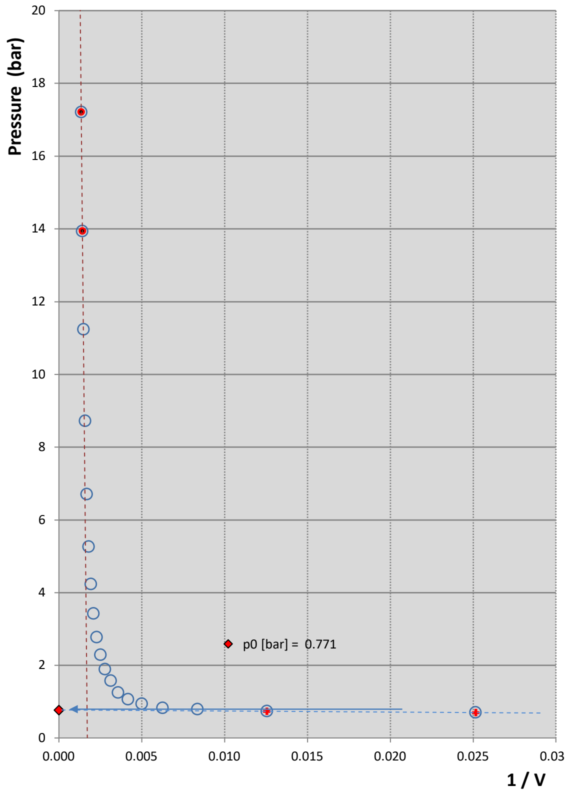
Pressuremeter test results [corrected data] pressure vs radial strain

Interpreted PMT Test Results

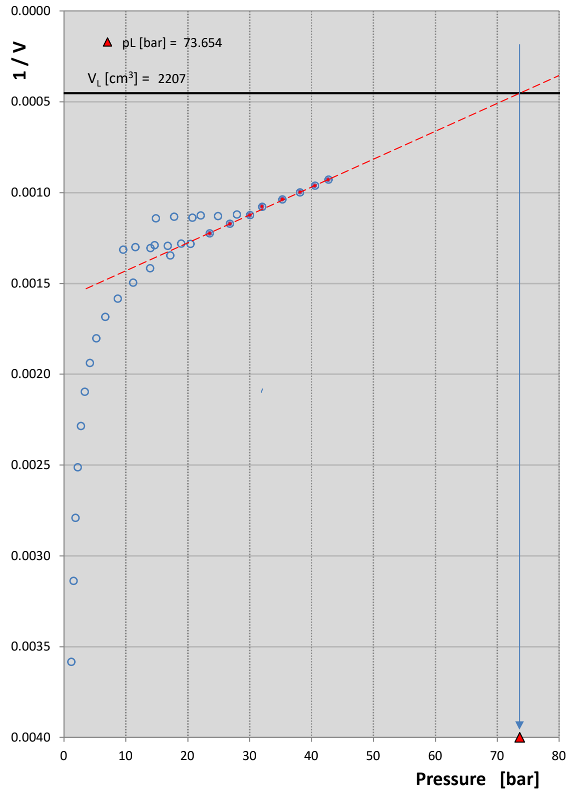
[30-second readings]			volume [cm³]	radial strain [%]	strain range [%]
p_0	0.77	[bar]	119.6	3.0	
p_L	73.65	[bar]			
p^*_L	72.88	[bar]			
p_Y	17.21	[bar]	742	17.4	
E_{PMT}	640	[bar]	706	16.6	{16.6 - 17.4 %}
E_{PMT} / p^*_L	8.8				
$E_{Unload\ 1}$	4211	[bar]	760	17.7	
$E_{Reload\ 1}$	2508	[bar]			
$E_{Unload\ 2}$	8102	[bar]	875	20.2	
$E_{Reload\ 2}$	3328	[bar]			



Pressure difference from 15 to 30 sec. readings Δp [15-30 sec]



Determination of total contact pressure p_0



Determination of Limit Pressure p_L

Pressuremeter Equipment: TEXAM Model	Probe Designation : NX Probe (76 mm OD)	Drilling Method: Mud Rotary Drilling Drilling Bit: Tricone Bit	Test Date: September 20, 2022
Volume-controlled test as per ASTM D4719 Method B	Probe No.: E 497 Calibration Record No.: 1	Time elapsed from hole drilling to testing ~ 5 minutes	Test Depth [m]: 5.84 (center of the probe)
Volume increments: 40 cm³ Maximum Volume: 1400 cm³ Maximum Pressure: 100 bar	Tubing Length: 180 [ft] Probe Lenght: 0.46 [m] Probe Initial Volume: 1968 cm³	Engineer: Gabriel Sedran, P.Eng., Ph.D. Operator: Scott A. Hall	Drilling Company: Altech Drilling

Project:	**895 Lawrence Ave., Toronto**	**PMT TEST No.:**	**1**
Client:	Golder Associates	**Borehole No.:**	**BH 22-1**
In-Depth Geotechnical Project No.:	IDG 220705		

In-Depth
Geotechnical Inc.

Field Test Data (uncorrected)

Volume [cm³]	Pressure [bar] 15 sec	Pressure [bar] 30 sec
2	0.25	0.25
40	0.31	0.30
80	0.40	0.40
120	0.49	0.48
160	0.58	0.56
200	0.70	0.68
240	0.86	0.84
280	1.08	1.06
320	1.28	1.24
360	1.49	1.47
400	1.84	1.77
440	2.29	2.16
480	2.80	2.65
520	3.49	3.28
560	4.69	4.28
600	6.44	5.86
640	9.16	8.33
680	11.62	10.64
670	7.31	7.22
660	5.40	5.42
650	4.26	4.31
660	6.38	6.23
670	7.71	7.29
680	8.51	8.14
720	12.92	11.96
760	15.66	14.67
800	18.76	17.34
790	12.41	12.32
780	9.68	9.71
770	7.72	7.80
780	11.46	11.19
790	13.60	13.12
800	15.32	14.75
840	20.87	19.82
880	24.35	23.37
920	26.94	25.98
960	28.75	27.83
1000	30.34	29.40

Corrected Test data

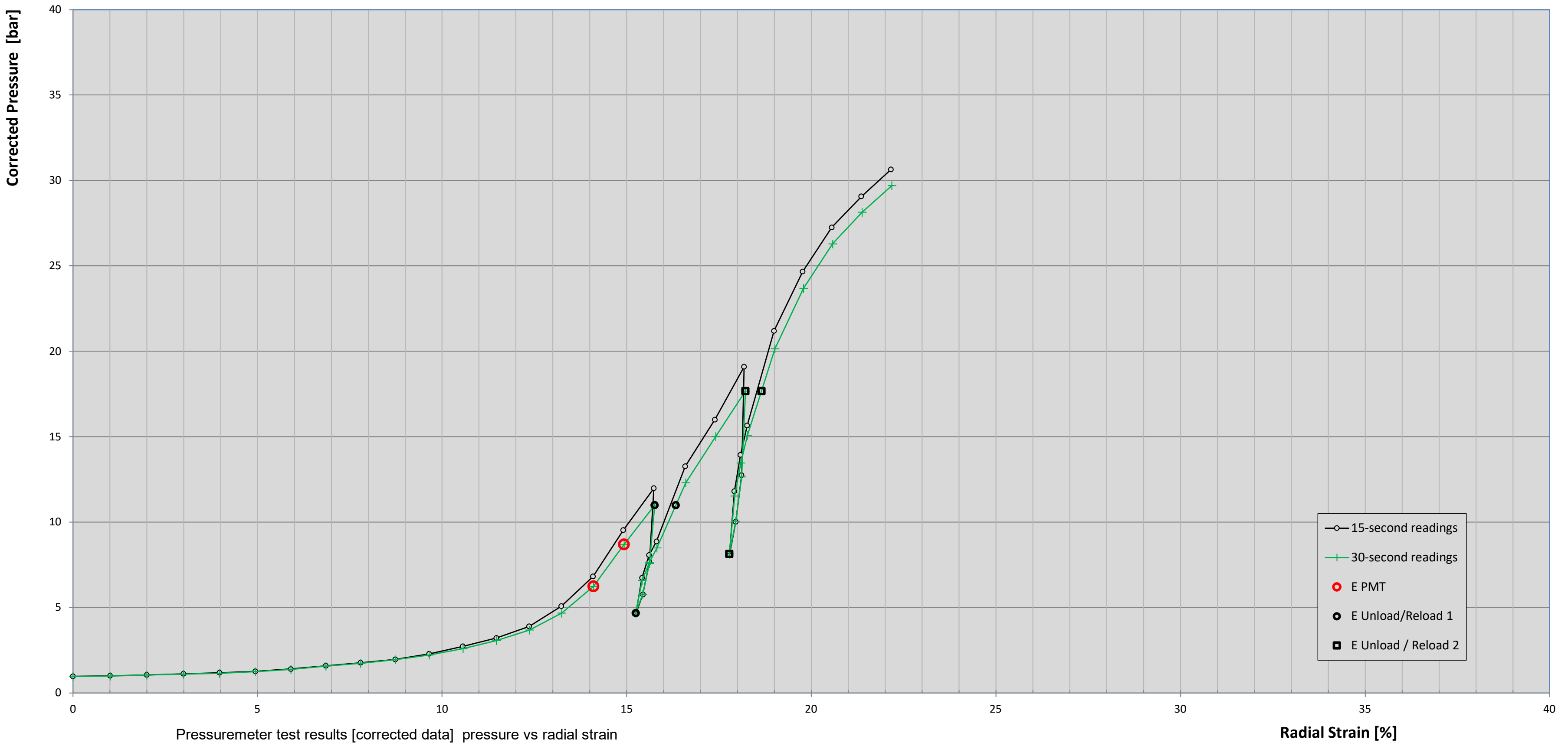
15-second readings Pressure [bar]	15-second readings Volume [cm³]	15-second readings $\Delta r/r_0$ [%]	30-second readings Pressure [bar]	30-second readings Volume [cm³]	30-second readings $\Delta r/r_0$ [%]
0.97	2	0.00	0.97	2	0.00
1.00	39.7	1.00	0.99	39.7	1.00
1.06	79.6	2.00	1.06	79.6	2.00
1.12	119.5	2.99	1.11	119.5	2.99
1.18	159.4	3.97	1.16	159.4	3.97
1.28	199.3	4.94	1.26	199.3	4.94
1.41	239.1	5.90	1.39	239.1	5.90
1.60	278.9	6.85	1.58	278.9	6.85
1.78	318.7	7.79	1.74	318.7	7.79
1.97	358.5	8.73	1.95	358.5	8.73
2.30	398.1	9.65	2.23	398.2	9.65
2.73	437.6	10.56	2.60	437.8	10.57
3.22	477.1	11.47	3.07	477.3	11.47
3.90	516.4	12.36	3.69	516.6	12.36
5.08	555.1	13.23	4.67	555.6	13.24
6.82	593.3	14.08	6.24	593.9	14.10
9.53	630.5	14.91	8.70	631.4	14.93
11.98	667.9	15.73	11.00	669.0	15.76
7.67	662.4	15.61	7.58	662.5	15.62
5.76	654.4	15.44	5.78	654.4	15.44
4.63	645.6	15.24	4.68	645.5	15.24
6.74	653.4	15.41	6.59	653.5	15.42
8.07	662.0	15.60	7.65	662.4	15.61
8.87	671.2	15.81	8.50	671.6	15.81
13.27	706.6	16.58	12.31	707.6	16.60
16.00	743.8	17.39	15.01	744.8	17.41
19.10	780.5	18.18	17.68	782.0	18.21
12.75	777.1	18.11	12.66	777.2	18.11
10.02	770.0	17.95	10.05	769.9	17.95
8.06	762.0	17.78	8.14	761.9	17.78
11.80	768.1	17.91	11.53	768.4	17.92
13.94	775.9	18.08	13.46	776.4	18.09
15.66	784.1	18.26	15.09	784.7	18.27
21.20	818.4	18.99	20.15	819.4	19.01
24.67	854.7	19.77	23.69	855.8	19.79
27.25	892.1	20.55	26.29	893.1	20.58
29.06	930.2	21.36	28.14	931.1	21.38
30.65	968.5	22.16	29.71	969.5	22.18

Creep

Volume [cm³]	Δp 30-15 [bar]
2	0.00
39.7	0.01
79.6	0.00
119.5	0.01
159.4	0.02
199.3	0.02
239.1	0.02
278.9	0.02
318.7	0.04
358.5	0.02
398.2	0.07
437.8	0.13
477.3	0.15
516.6	0.21
555.6	0.41
593.9	0.58
631.4	0.83
669.0	0.98
707.6	0.96
744.8	0.99
782.0	1.42
819.4	1.05
855.8	0.98
893.1	0.96
931.1	0.92
969.5	0.94

Auxiliary Data

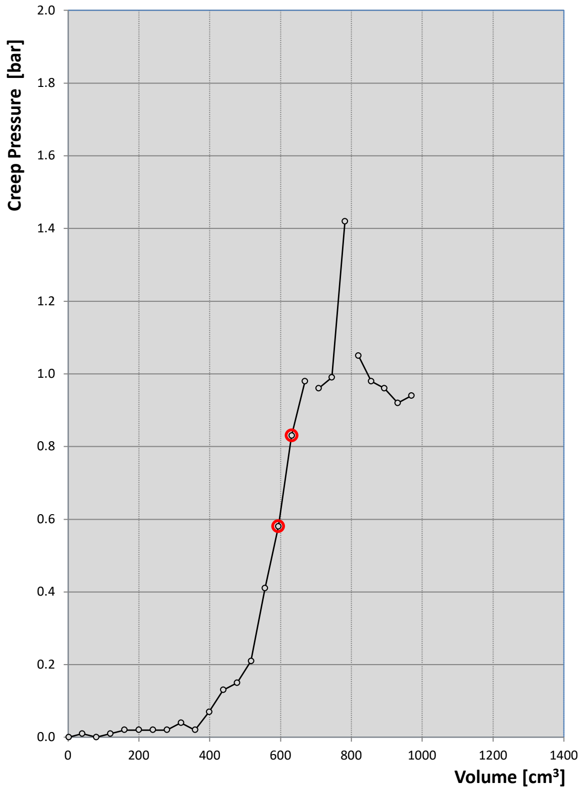
30 sec Pressure [bar]	30 sec 1 / V
0.97	0.57447
0.99	0.02520
1.06	0.01257
1.11	0.00837
1.16	0.00627
1.26	0.00502
1.39	0.00418
1.58	0.00359
1.74	0.00314
1.95	0.00279
2.23	0.00251
2.60	0.00228
3.07	0.00210
3.69	0.00194
4.67	0.00180
6.24	0.00168
8.70	0.00158
11.00	0.00149
7.58	0.00151
5.78	0.00153
4.68	0.00155
6.59	0.00153
7.65	0.00151
8.50	0.00149
12.31	0.00141
15.01	0.00134
17.68	0.00128
12.66	0.00129
10.05	0.00130
8.14	0.00131
11.53	0.00130
13.46	0.00129
15.09	0.00127
20.15	0.00122
23.69	0.00117
26.29	0.00112
28.14	0.00107
29.71	0.00103



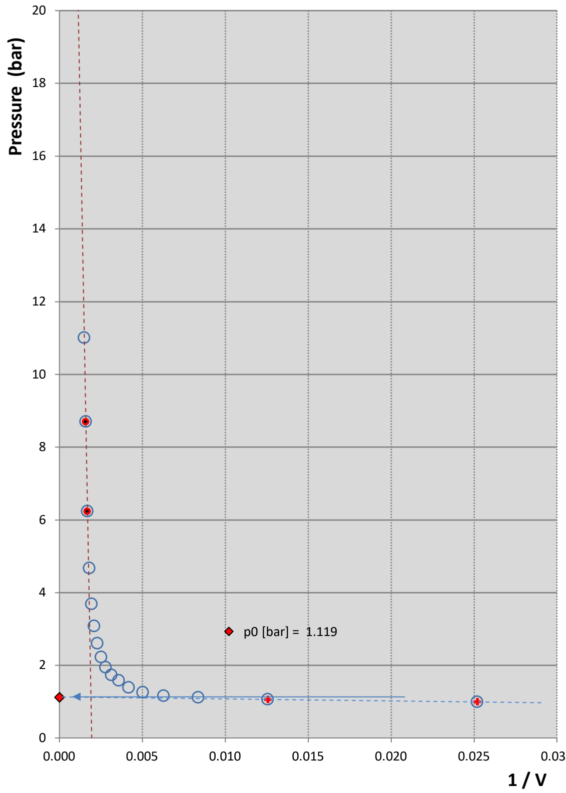
Pressuremeter test results [corrected data] pressure vs radial strain

Interpreted PMT Test Results

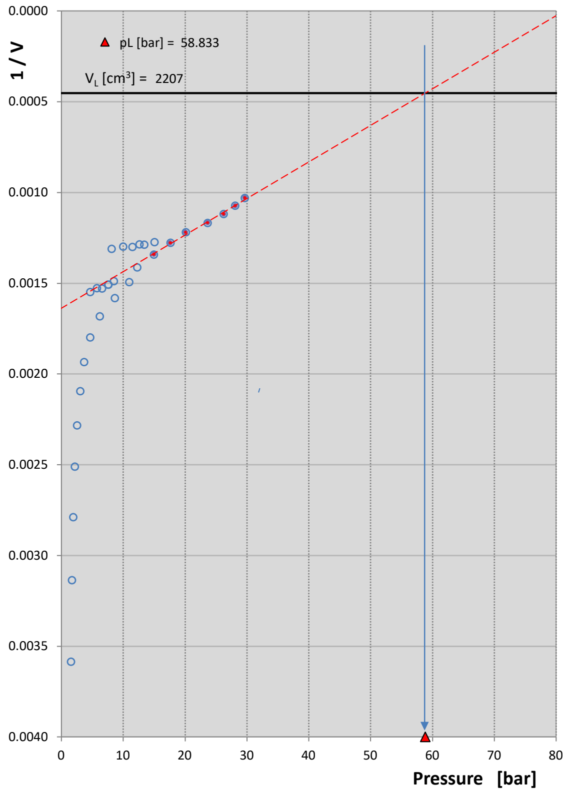
[30-second readings]			volume [cm³]	radial strain [%]	strain range [%]
p_0	1.12	[bar]	119.5	3.0	
p_L	58.83	[bar]			
p^*_L	57.71	[bar]			
p_Y	8.70	[bar]	631	14.9	
E_{PMT}	451	[bar]	594	14.1	{14.1 - 14.9 %}
E_{PMT} / p^*_L	7.8				
$E_{Unload\ 1}$	1884	[bar]	646	15.2	
$E_{Reload\ 1}$	894	[bar]			
$E_{Unload\ 2}$	3456	[bar]	762	17.8	
$E_{Reload\ 2}$	1720	[bar]			



Pressure difference from 15 to 30 sec. readings $\Delta p_{[15\text{-}30\ sec]}$



Determination of total contact pressure p_0



Determination of Limit Pressure p_L

Pressuremeter Equipment: TEXAM Model		
Volume-controlled test as per ASTM D4719 Method B		
Volume increments:	40	cm³
Maximum Volume:	1400	cm³
Maximum Pressure:	100	bar

Probe Designation :	NX Probe (76 mm OD)	
Probe No.:	E 497	
Calibration Record No.:	1	
Tubing Length:	180	[ft]
Probe Lenght:	0.46	[m]
Probe Initial Volume:	1968	cm³

Drilling Method: Mud Rotary Drilling
Drilling Bit: Tricone Bit
Time elapsed from hole drilling to testing ~ 5 minutes
Engineer: Gabriel Sedran, P.Eng., Ph.D.
Operator: Scott A. Hall

Test Date: September 20, 2022
Test Depth [m]: 8.33 (center of the probe)
Drilling Company: Altech Drilling

Project: **895 Lawrence Ave., Toronto**
Client: Golder Associates
In-Depth Geotechnical Project No.: IDG 220705

PMT TEST No.: 2
Borehole No.: BH 22-1

Field Test Data (uncorrected)		
Volume	Pressure [bar]	
[cm³]	15 sec	30 sec
2	0.34	0.34
40	0.50	0.47
80	0.60	0.58
120	0.80	0.77
160	1.09	1.06
200	1.65	1.61
240	2.65	2.55
280	4.84	4.65
320	9.40	9.18
360	22.22	21.79
400	31.02	30.36
390	23.09	23.06
380	17.93	18.00
370	13.94	14.06
380	20.26	20.13
390	24.92	24.54
400	28.75	28.41
440	37.00	36.16
480	42.37	41.20

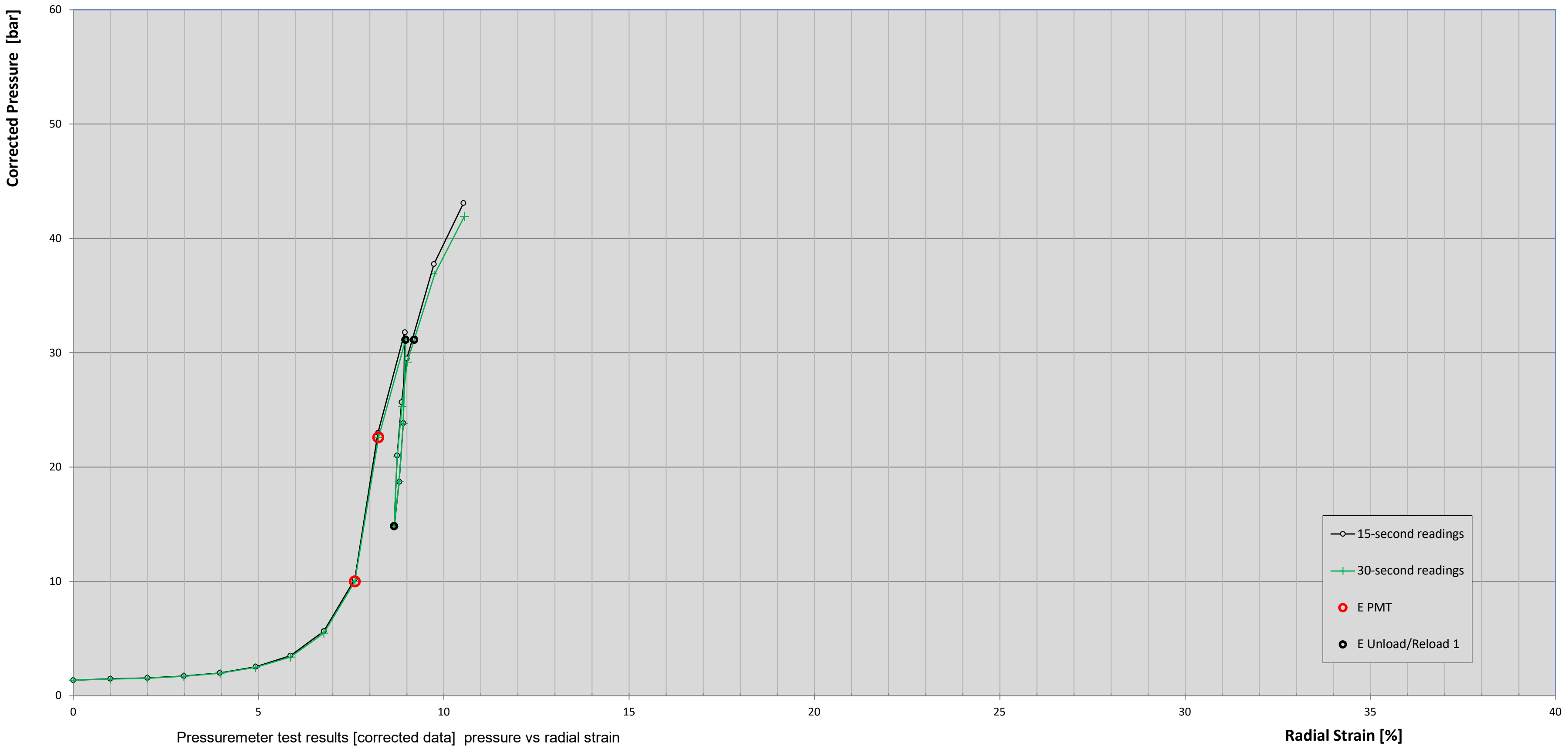
Corrected Test data					
15-second readings			30-second readings		
Pressure [bar]	Volume [cm³]	$\Delta r/r_0$ [%]	Pressure [bar]	Volume [cm³]	$\Delta r/r_0$ [%]
1.37	2	0.00	1.37	2	0.00
1.50	39.5	1.00	1.47	39.5	1.00
1.57	79.4	2.00	1.55	79.4	2.00
1.74	119.2	2.98	1.71	119.2	2.98
2.00	158.9	3.96	1.97	158.9	3.96
2.53	198.3	4.92	2.49	198.3	4.92
3.50	237.3	5.86	3.40	237.4	5.86
5.66	275.0	6.76	5.47	275.2	6.76
10.20	310.3	7.60	9.98	310.5	7.60
23.00	337.0	8.22	22.57	337.4	8.23
31.78	367.8	8.95	31.12	368.5	8.96
23.85	366.1	8.91	23.82	366.1	8.91
18.70	361.4	8.80	18.77	361.3	8.79
14.71	355.5	8.66	14.83	355.4	8.66
21.03	359.0	8.74	20.90	359.1	8.74
25.68	364.2	8.86	25.30	364.5	8.87
29.51	370.2	9.00	29.17	370.5	9.01
37.74	401.6	9.73	36.90	402.5	9.75
43.10	436.1	10.53	41.93	437.3	10.55

Creep	
Volume [cm³]	Δp_{30-15} [bar]
2	0.00
39.5	0.03
79.4	0.02
119.2	0.03
158.9	0.03
198.3	0.04
237.4	0.10
275.2	0.19
310.5	0.22
337.4	0.43
368.5	0.66
402.5	0.84
437.3	1.17

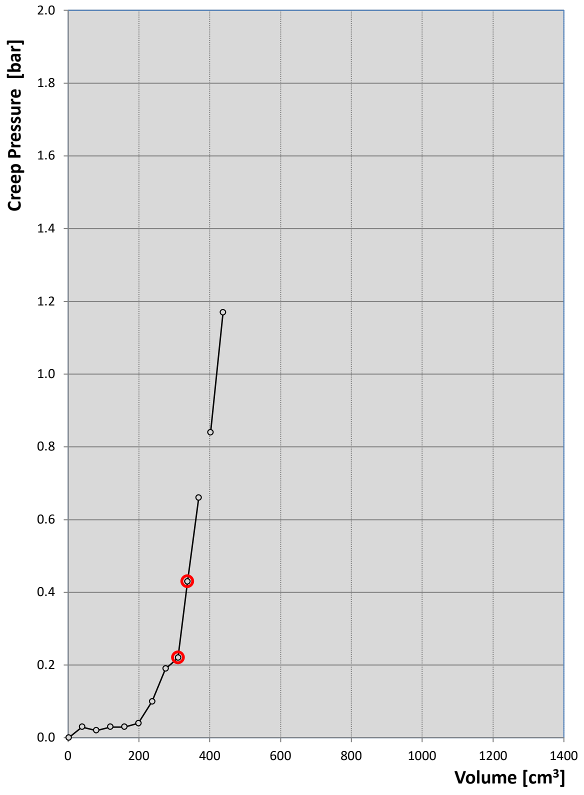
Auxiliary Data	
30 sec	
Pressure [bar]	1 / V
1.37	0.60702
1.47	0.02531
1.55	0.01259
1.71	0.00839
1.97	0.00629
2.49	0.00504
3.40	0.00421
5.47	0.00363
9.98	0.00322
22.57	0.00296
31.12	0.00271
23.82	0.00273
18.77	0.00277
14.83	0.00281
20.90	0.00278
25.30	0.00274
29.17	0.00270
36.90	0.00248
41.93	0.00229

Interpreted PMT Test Results

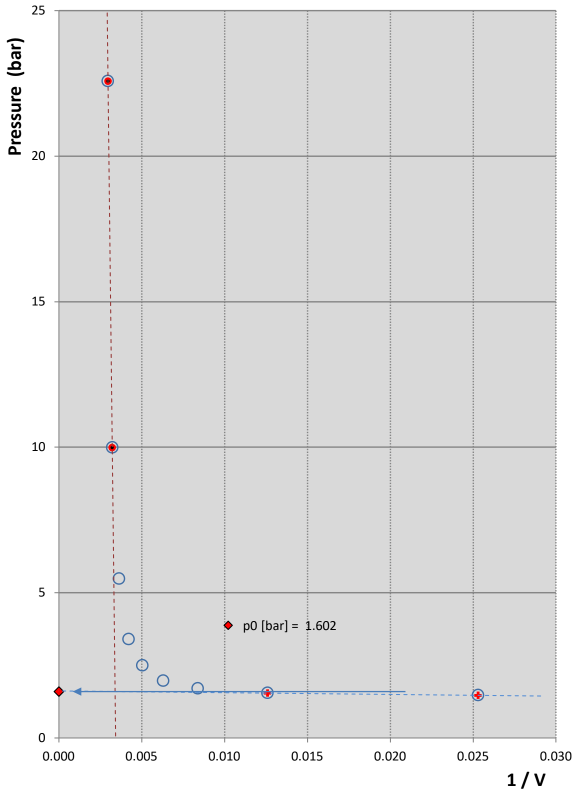
[30-second readings]			volume [cm³]	radial strain [%]	strain range [%]
p_0	1.60	[bar]	119.2	3.0	
p_L	88.36	[bar]			
p^*_L	86.76	[bar]			
p_Y	22.57	[bar]	337	8.2	
E_{PMT}	2851	[bar]	310	7.6	{7.6 - 8.2 %}
E_{PMT} / p^*_L	32.9				
$E_{Unload\ 1}$	7706	[bar]	355	8.7	
$E_{Reload\ 1}$	4368	[bar]			



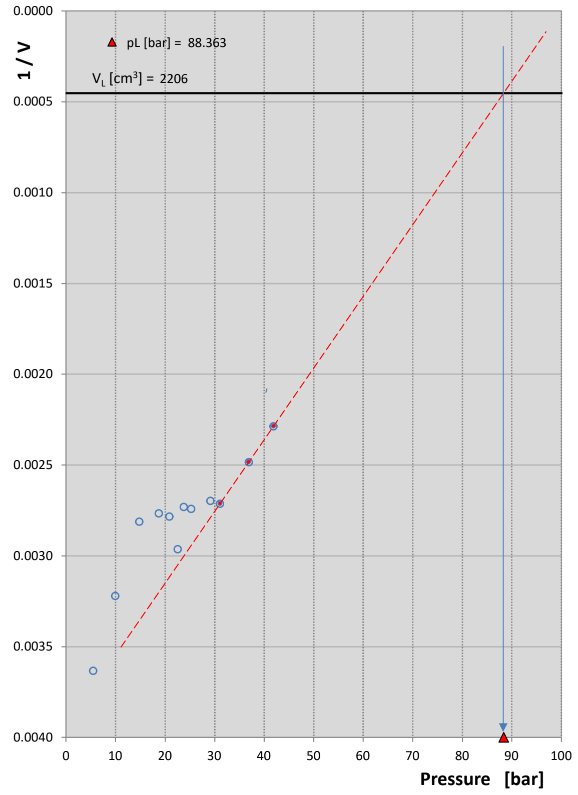
Pressuremeter test results [corrected data] pressure vs radial strain



Pressure difference from 15 to 30 sec. readings $\Delta p_{[15\text{-}30\ sec]}$



Determination of total contact pressure p_0



Determination of Limit Pressure p_L

Pressuremeter Equipment: TEXAM Model
Volume-controlled test as per ASTM D4719 Method B
Volume increments: 40 cm³
Maximum Volume: 1400 cm³
Maximum Pressure: 100 bar

Probe Designation : NX Probe (76 mm OD)
Probe No.: E 497
Calibration Record No.: 1
Tubing Length: 180 [ft]
Probe Lenght: 0.46 [m]
Probe Initial Volume: 1968 cm³

Drilling Method: Mud Rotary Drilling
Drilling Bit: Drag Bit
Time elapsed from hole drilling to testing ~ 5 minutes
Engineer: Gabriel Sedran, P.Eng., Ph.D.
Operator: Scott A. Hall

Test Date: September 20, 2022
Test Depth [m]: 11.43 (center of the probe)
Drilling Company: Altech Drilling

Project: **895 Lawrence Ave., Toronto**
Client: Golder Associates
In-Depth Geotechnical Project No.: IDG 220705

PMT TEST No.: 3
Borehole No.: BH 22-1

In-Depth Geotechnical Inc.

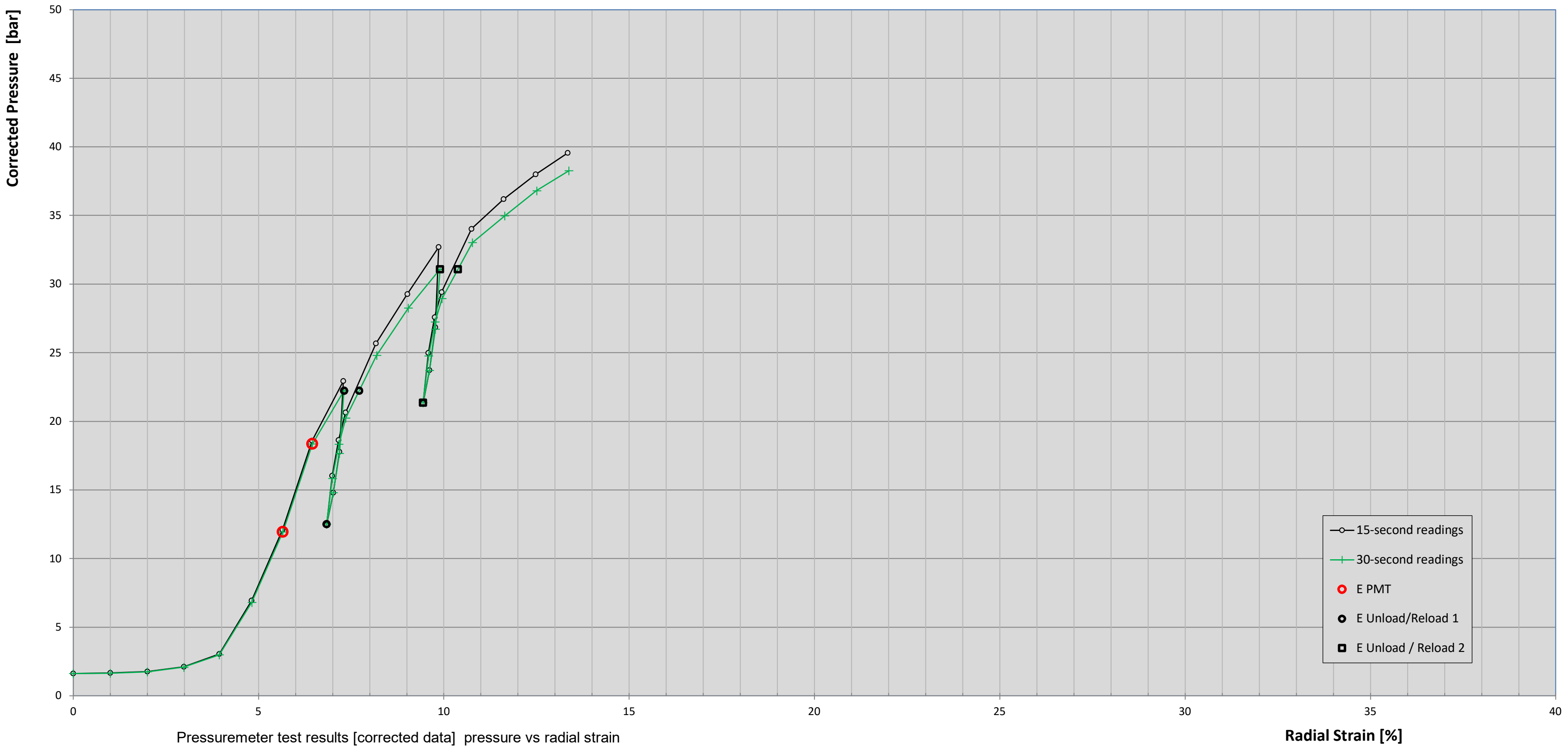
Field Test Data (uncorrected)		
Volume [cm³]	Pressure [bar] 15 sec	30 sec
2	0.30	0.30
40	0.37	0.36
80	0.51	0.49
120	0.88	0.85
160	1.84	1.79
200	5.77	5.63
240	10.96	10.78
280	17.47	17.23
320	21.83	21.12
310	16.67	16.55
300	13.69	13.70
290	11.34	11.39
300	14.93	14.73
310	17.54	17.23
320	19.55	19.15
360	24.59	23.73
400	28.21	27.20
440	31.65	30.04
430	25.81	25.66
420	22.67	22.66
410	20.26	20.31
420	23.94	23.72
430	26.54	26.19
440	28.36	27.90
480	33.00	32.00
520	35.18	33.96
560	37.00	35.81
600	38.58	37.28

Corrected Test data					
15-second readings			30-second readings		
Pressure [bar]	Volume [cm³]	$\Delta r/r_0$ [%]	Pressure [bar]	Volume [cm³]	$\Delta r/r_0$ [%]
1.63	2	0.00	1.63	2	0.00
1.67	39.6	1.00	1.66	39.6	1.00
1.77	79.5	2.00	1.75	79.5	2.00
2.11	119.1	2.98	2.08	119.1	2.98
3.05	158.1	3.94	3.00	158.1	3.94
6.95	194.0	4.81	6.81	194.2	4.82
12.11	228.6	5.65	11.93	228.8	5.65
18.59	261.9	6.45	18.35	262.1	6.45
22.93	297.4	7.29	22.22	298.1	7.31
17.77	292.7	7.18	17.65	292.8	7.18
14.80	285.8	7.02	14.81	285.8	7.02
12.46	278.2	6.84	12.51	278.2	6.84
16.04	284.5	6.99	15.84	284.7	6.99
18.64	291.8	7.16	18.33	292.1	7.17
20.65	299.7	7.35	20.25	300.1	7.36
25.67	334.5	8.17	24.81	335.4	8.19
29.27	370.7	9.01	28.26	371.8	9.04
32.69	407.2	9.86	31.08	408.8	9.90
26.86	403.2	9.77	26.71	403.4	9.77
23.72	396.5	9.61	23.71	396.5	9.61
21.31	389.0	9.44	21.36	388.9	9.44
24.99	395.2	9.58	24.77	395.4	9.59
27.59	402.5	9.75	27.24	402.8	9.76
29.40	410.6	9.94	28.94	411.1	9.95
34.03	445.8	10.75	33.03	446.8	10.77
36.19	483.5	11.61	34.97	484.8	11.64
37.99	521.6	12.48	36.80	522.9	12.50
39.56	560.0	13.34	38.26	561.3	13.37

Creep	
Volume [cm³]	Δp_{30-15} [bar]
2	0.00
39.6	0.01
79.5	0.02
119.1	0.03
158.1	0.05
194.2	0.14
228.8	0.18
262.1	0.24
298.1	0.71
335.4	0.86
371.8	1.01
408.8	1.61
446.8	1.00
484.8	1.22
522.9	1.19
561.3	1.30

Auxiliary Data	
30 sec	
Pressure [bar]	1 / V
1.63	0.59211
1.66	0.02524
1.75	0.01258
2.08	0.00840
3.00	0.00632
6.81	0.00515
11.93	0.00437
18.35	0.00381
22.22	0.00335
17.65	0.00341
14.81	0.00350
12.51	0.00359
15.84	0.00351
18.33	0.00342
20.25	0.00333
24.81	0.00298
28.26	0.00269
31.08	0.00245
26.71	0.00248
23.71	0.00252
21.36	0.00257
24.77	0.00253
27.24	0.00248
28.94	0.00243
33.03	0.00224
34.97	0.00206
36.80	0.00191
38.26	0.00178

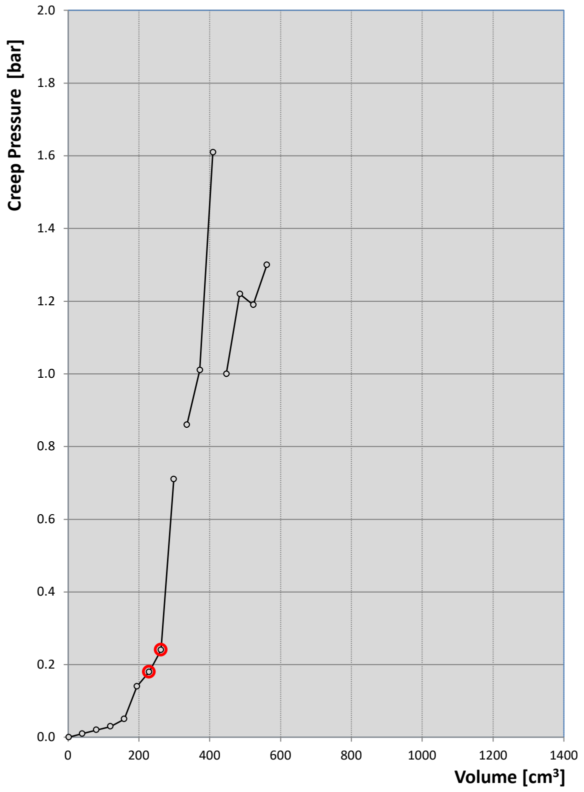
GOLDER



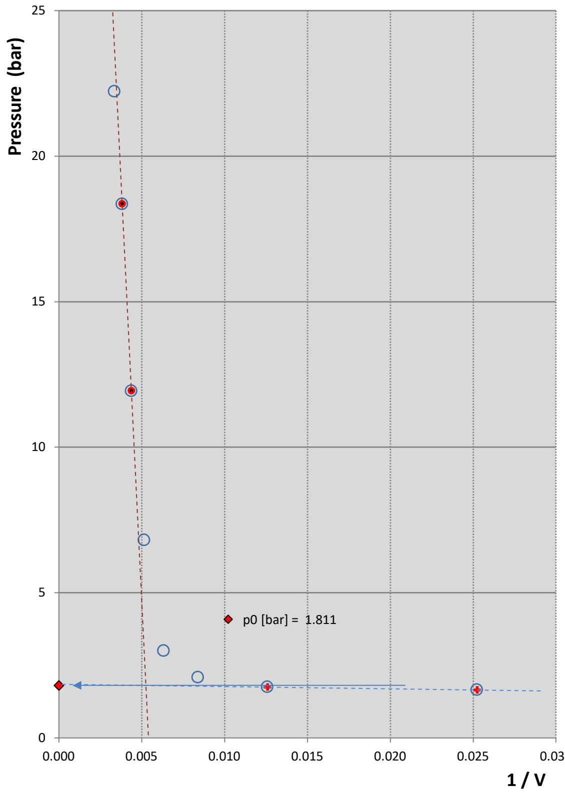
Pressuremeter test results [corrected data] pressure vs radial strain

Interpreted PMT Test Results

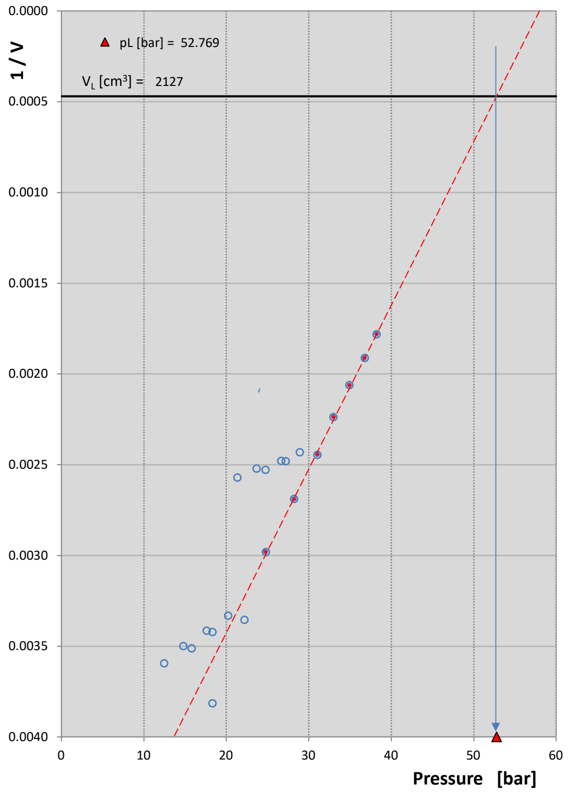
[30-second readings]			volume [cm³]	radial strain [%]	strain range [%]
p_0	1.81	[bar]	79.5	2.0	
p_L	52.77	[bar]			
p^*_L	50.96	[bar]			
p_Y	18.35	[bar]	262	6.5	
E_{PMT}	1135	[bar]	229	5.7	{5.7 - 6.5 %}
E_{PMT} / p^*_L	22.3				
$E_{Unload\ 1}$	2927	[bar]	278	6.8	
$E_{Reload\ 1}$	1575	[bar]			
$E_{Unload\ 2}$	3073	[bar]	389	9.4	
$E_{Reload\ 2}$	1505	[bar]			



Pressure difference from 15 to 30 sec. readings $\Delta p_{[15\text{-}30\ sec]}$



Determination of total contact pressure p_0



Determination of Limit Pressure p_L

Pressuremeter Equipment: TEXAM Model
Volume-controlled test as per ASTM D4719
Method B
Volume increments: 40 cm³
Maximum Volume: 1400 cm³
Maximum Pressure: 100 bar

Probe Designation : NX Probe (76 mm OD)
Probe No.: E 497
Calibration Record No.: 1
Tubing Length: 180 [ft]
Probe Lenght: 0.46 [m]
Probe Initial Volume: 1968 cm³

Drilling Method: Mud Rotary Drilling
Drilling Bit: Tricone Bit
Time elapsed from hole drilling to testing
~ 5 minutes
Engineer: Gabriel Sedran, P.Eng., Ph.D.
Operator: Scott A. Hall

Test Date: September 20, 2022
Test Depth [m]: 14.48 (center of the probe)
Drilling Company: Altech Drilling

Project: **895 Lawrence Ave., Toronto**
Client: Golder Associates
In-Depth Geotechnical Project No.: IDG 220705

PMT TEST No.: 4
Borehole No.: BH 22-1

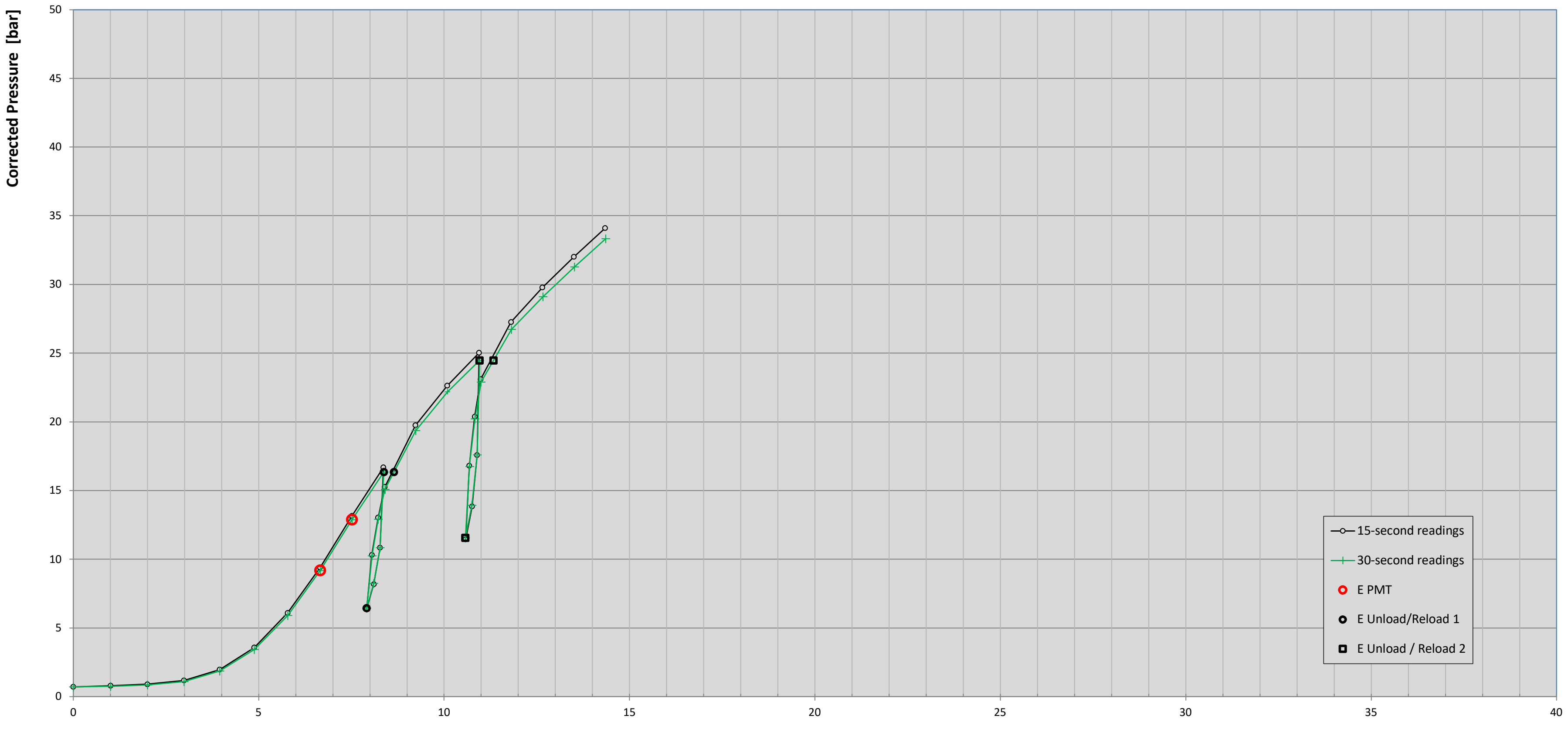
In-Depth
Geotechnical Inc.

Field Test Data (uncorrected)		
Volume	**Pressure** [bar]	
[cm^3]	15 sec	30 sec
2	0.16	0.16
40	0.27	0.23
80	0.42	0.36
120	0.72	0.65
160	1.55	1.45
200	3.17	3.03
240	5.72	5.53
280	9.06	8.84
320	12.83	12.54
360	16.39	16.04
350	10.53	10.54
340	7.88	7.93
330	6.07	6.13
340	10.00	9.94
350	12.73	12.61
360	14.96	14.78
400	19.46	19.09
440	22.36	21.92
480	24.78	24.22
470	17.33	17.35
460	13.59	13.67
450	11.19	11.29
460	16.56	16.50
470	20.12	19.96
480	22.86	22.65
520	27.03	26.50
560	29.55	28.88
600	31.80	31.08
640	33.90	33.13

Corrected Test data					
15-second readings			30-second readings		
Pressure [bar]	**Volume** [cm^3]	**$\Delta r/r_0$** [%]	**Pressure** [bar]	**Volume** [cm^3]	**$\Delta r/r_0$** [%]
0.71	2	0.00	0.71	2	0.00
0.79	39.7	1.00	0.75	39.8	1.01
0.91	79.6	2.00	0.85	79.6	2.00
1.18	119.3	2.99	1.11	119.3	2.99
1.98	158.4	3.95	1.88	158.5	3.95
3.57	196.7	4.88	3.43	196.9	4.88
6.09	234.1	5.78	5.90	234.3	5.79
9.41	270.6	6.65	9.19	270.8	6.66
13.15	306.7	7.51	12.86	307.0	7.52
16.69	343.0	8.37	16.34	343.4	8.37
10.84	339.1	8.27	10.85	339.1	8.27
8.19	331.8	8.10	8.24	331.8	8.10
6.39	323.7	7.91	6.45	323.6	7.91
10.31	329.6	8.05	10.25	329.7	8.05
13.04	336.8	8.22	12.92	336.9	8.22
15.26	344.5	8.40	15.08	344.7	8.40
19.74	379.8	9.23	19.37	380.2	9.23
22.63	416.8	10.08	22.19	417.3	10.09
25.03	454.3	10.94	24.47	454.9	10.96
17.58	452.0	10.89	17.60	452.0	10.89
13.85	445.9	10.75	13.93	445.8	10.75
11.45	438.4	10.58	11.55	438.3	10.58
16.82	442.8	10.68	16.76	442.9	10.68
20.37	449.1	10.83	20.21	449.3	10.83
23.11	456.3	10.99	22.90	456.5	11.00
27.26	492.0	11.80	26.73	492.5	11.82
29.77	529.4	12.65	29.10	530.0	12.67
32.00	567.0	13.50	31.28	567.8	13.51
34.09	604.8	14.34	33.32	605.6	14.36

Creep	
Volume [cm^3]	Δp_{30-15} [bar]
2	0.00
39.8	0.04
79.6	0.06
119.3	0.07
158.5	0.10
196.9	0.14
234.3	0.19
270.8	0.22
307.0	0.29
343.4	0.35
380.2	0.37
417.3	0.44
454.9	0.56
492.5	0.53
530.0	0.67
567.8	0.72
605.6	0.77

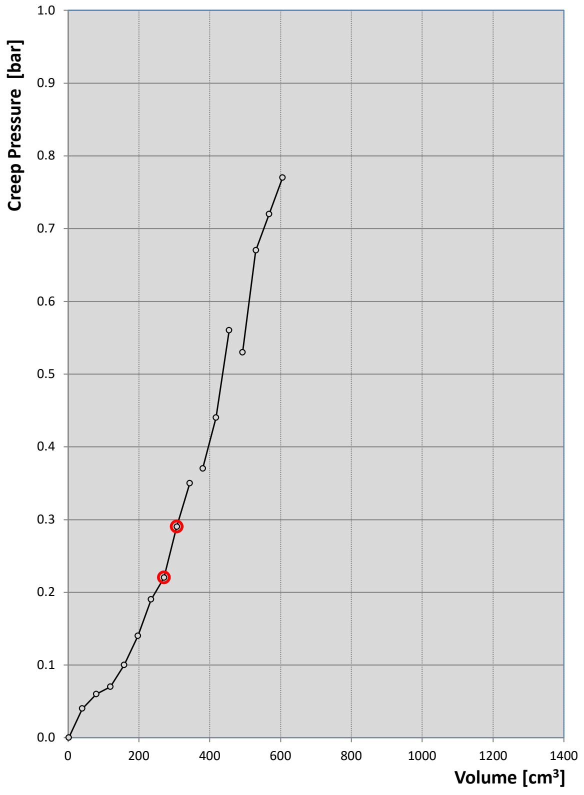
Auxiliary Data	
30 sec	
Pressure [bar]	1 / V
0.71	0.54524
0.75	0.02515
0.85	0.01256
1.11	0.00838
1.88	0.00631
3.43	0.00508
5.90	0.00427
9.19	0.00369
12.86	0.00326
16.34	0.00291
10.85	0.00295
8.24	0.00301
6.45	0.00309
10.25	0.00303
12.92	0.00297
15.08	0.00290
19.37	0.00263
22.19	0.00240
24.47	0.00220
17.60	0.00221
13.93	0.00224
11.55	0.00228
16.76	0.00226
20.21	0.00223
22.90	0.00219
26.73	0.00203
29.10	0.00189
31.28	0.00176
33.32	0.00165



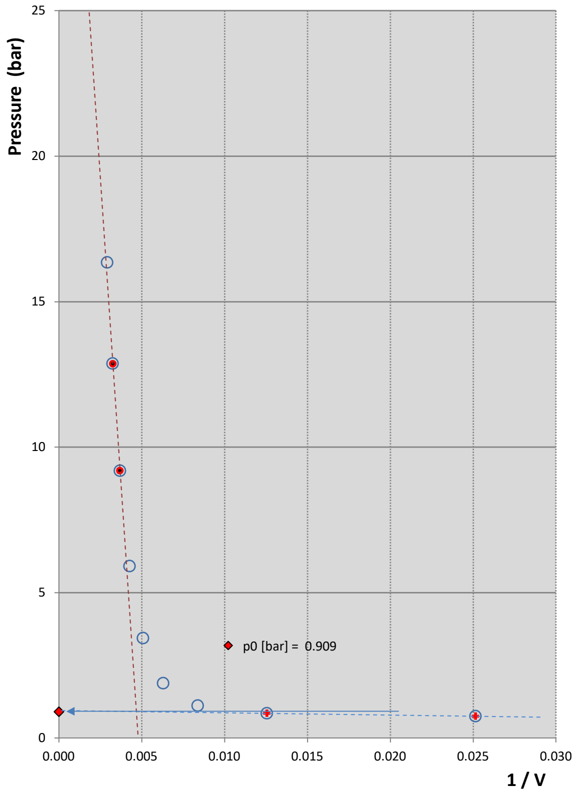
Pressuremeter test results [corrected data] pressure vs radial strain

Interpreted PMT Test Results

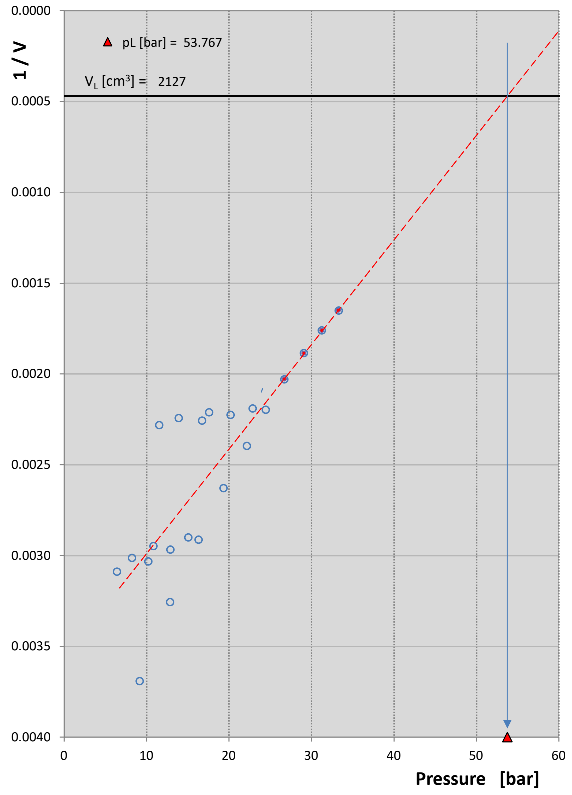
[30-second readings]			volume [cm^3]	radial strain [%]	strain range [%]
p_0	0.91	[bar]	79.6	2.0	
p_L	53.77	[bar]			
p^*_L	52.86	[bar]			
p_Y	12.86	[bar]	307	7.5	
E_{PMT}	610	[bar]	271	6.7	{6.7 - 7.5 %}
E_{PMT} / p^*_L	11.5				
$E_{Unload\ 1}$	3071	[bar]	324	7.9	
$E_{Reload\ 1}$	1932	[bar]			
$E_{Unload\ 2}$	5000	[bar]	438	10.6	
$E_{Reload\ 2}$	2528	[bar]			



Pressure difference from 15 to 30 sec. readings $\Delta p_{[15\text{-}30\ sec]}$



Determination of total contact pressure p_0



Determination of Limit Pressure p_L

Pressuremeter Equipment: TEXAM Model
Volume-controlled test as per ASTM D4719
Method B
Volume increments: 40 cm³
Maximum Volume: 1400 cm³
Maximum Pressure: 100 bar

Probe Designation : NX Probe (76 mm OD)
Probe No.: E 497
Calibration Record No.: 1
Tubing Length: 180 [ft]
Probe Lenght: 0.46 [m]
Probe Initial Volume: 1968 cm³

Drilling Method: Mud Rotary Drilling
Drilling Bit: Tricone Bit
Time elapsed from hole drilling to testing
~ 5 minutes
Engineer: Gabriel Sedran, P.Eng., Ph.D.
Operator: Scott A. Hall

Test Date: September 19, 2022
Test Depth [m]: 6.55 (center of the probe)
Drilling Company: Altech Drilling

Project: **895 Lawrence Ave., Toronto**
Client: Golder Associates
In-Depth Geotechnical Project No.: IDG 220705

PMT TEST No.: 1
Borehole No.: BH 22-3

In-Depth
Geotechnical Inc.

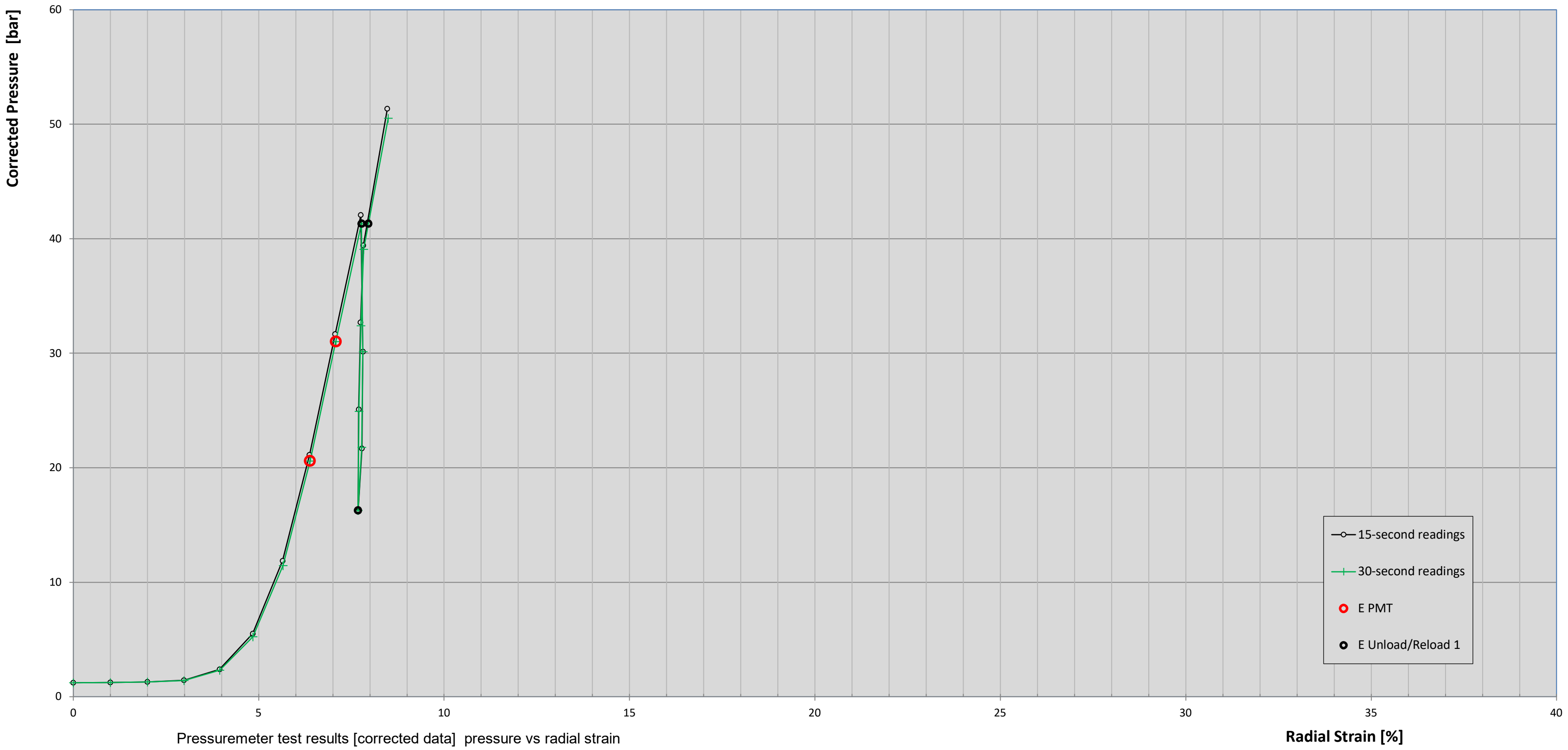
GOLDER

Field Test Data (uncorrected)		
Volume [cm³]	Pressure [bar] 15 sec	Pressure [bar] 30 sec
2	0.35	0.35
40	0.42	0.41
80	0.50	0.48
120	0.67	0.65
160	1.64	1.56
200	4.78	4.53
240	11.17	10.77
280	20.46	19.91
320	31.02	30.36
360	41.44	40.68
350	29.50	29.50
340	21.04	21.14
330	15.51	15.63
340	24.45	24.30
350	32.06	31.77
360	38.78	38.45
400	50.75	49.92

Corrected Test data					
15-second readings			30-second readings		
Pressure [bar]	Volume [cm³]	$\Delta r/r_0$ [%]	Pressure [bar]	Volume [cm³]	$\Delta r/r_0$ [%]
1.22	2	0.00	1.22	2	0.00
1.26	39.6	1.00	1.25	39.6	1.00
1.31	79.5	2.00	1.29	79.5	2.00
1.45	119.3	2.99	1.43	119.3	2.99
2.39	158.3	3.94	2.31	158.4	3.95
5.50	195.0	4.84	5.25	195.3	4.85
11.86	228.4	5.64	11.46	228.8	5.65
21.12	258.8	6.37	20.57	259.4	6.39
31.66	287.8	7.06	31.00	288.5	7.08
42.06	317.0	7.75	41.30	317.8	7.77
30.13	319.4	7.81	30.13	319.4	7.81
21.67	318.2	7.78	21.77	318.1	7.78
16.15	313.9	7.68	16.27	313.8	7.68
25.08	314.6	7.70	24.93	314.8	7.70
32.69	316.8	7.75	32.40	317.1	7.76
39.40	319.8	7.82	39.07	320.1	7.83
51.35	347.4	8.47	50.52	348.2	8.49

Creep	
Volume [cm³]	Δp_{30-15} [bar]
2	0.00
39.6	0.01
79.5	0.02
119.3	0.02
158.4	0.08
195.3	0.25
228.8	0.40
259.4	0.55
288.5	0.66
317.8	0.76
348.2	0.83

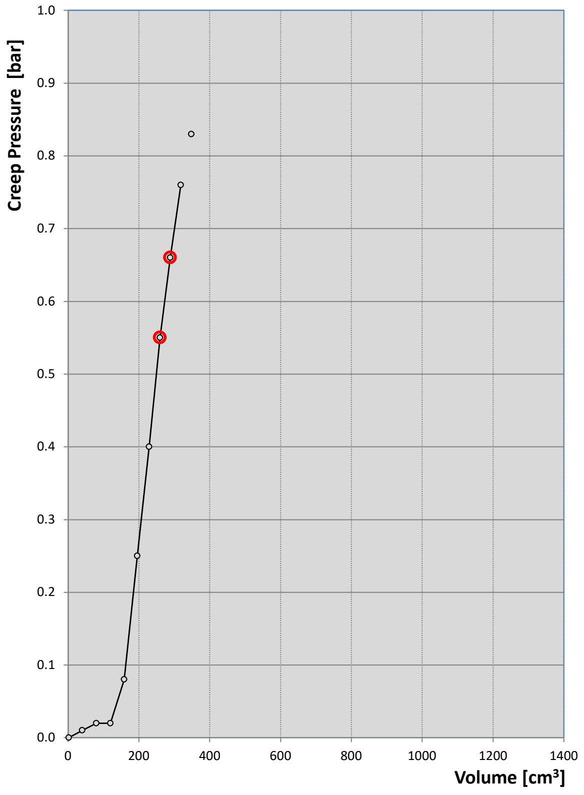
Auxiliary Data	
30 sec	
Pressure [bar]	1 / V
1.22	0.61087
1.25	0.02527
1.29	0.01258
1.43	0.00838
2.31	0.00631
5.25	0.00512
11.46	0.00437
20.57	0.00386
31.00	0.00347
41.30	0.00315
30.13	0.00313
21.77	0.00314
16.27	0.00319
24.93	0.00318
32.40	0.00315
39.07	0.00312
50.52	0.00287



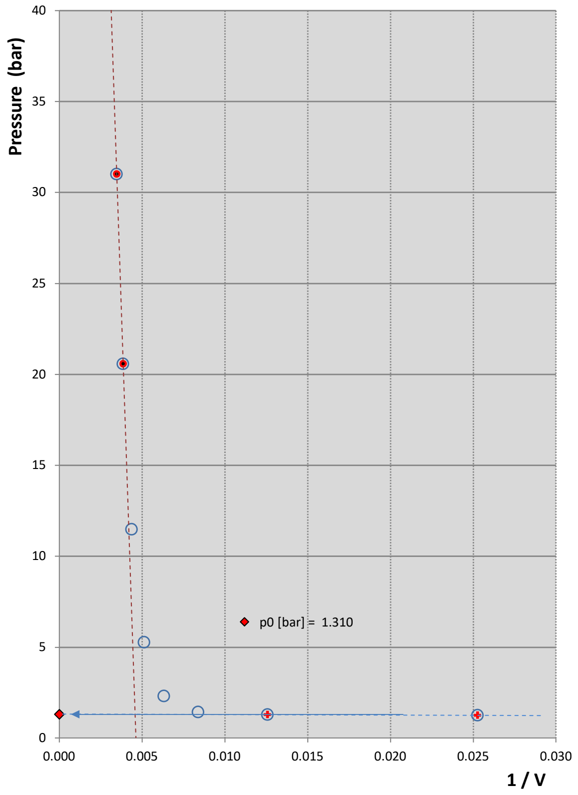
Pressuremeter test results [corrected data] pressure vs radial strain

Interpreted PMT Test Results

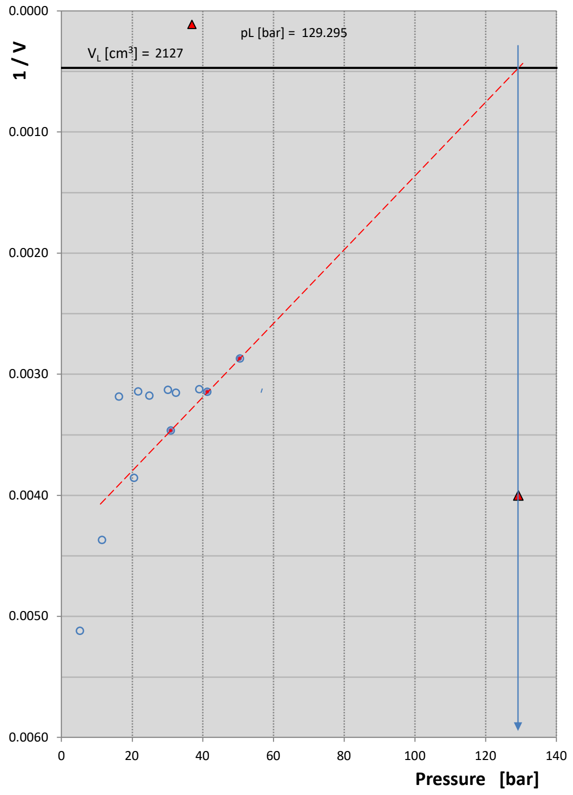
[30-second readings]			volume [cm³]	radial strain [%]	strain range [%]
p_0	1.31	[bar]	79.5	2.0	
p_L	129.30	[bar]			
p^*_L	127.98	[bar]			
p_Y	31.00	[bar]	289	7.1	
E_{PMT}	2132	[bar]	259	6.4	{6.4 - 7.1 %}
E_{PMT} / p^*_L	16.7				
$E_{Unload\ 1}$	37820	[bar]	314	7.7	
$E_{Reload\ 1}$	12916	[bar]			



Pressure difference from 15 to 30 sec. readings $\Delta p_{[15\text{-}30\ sec]}$



Determination of total contact pressure p_0



Determination of Limit Pressure p_L

Pressuremeter Equipment: TEXAM Model	Probe Designation : NX Probe (76 mm OD)	Drilling Method: Mud Rotary Drilling Drilling Bit: Tricone Bit	Test Date: September 19, 2022	**Project:** **895 Lawrence Ave., Toronto**	**PMT TEST No.: 2**
Volume-controlled test as per ASTM D4719 Method B	Probe No.: E 497 Calibration Record No.: 1	Time elapsed from hole drilling to testing ~ 5 minutes	Test Depth [m]: 9.80 (center of the probe)	Client: Golder Associates	
Volume increments: 40 cm³ Maximum Volume: 1400 cm³ Maximum Pressure: 100 bar	Tubing Length: 180 [ft] Probe Lenght: 0.46 [m] Probe Initial Volume: 1968 cm³	Engineer: Gabriel Sedran, P.Eng., Ph.D. Operator: Scott A. Hall	Drilling Company: Altech Drilling	In-Depth Geotechnical Project No.: IDG 220705	**Borehole No.: BH 22-3**

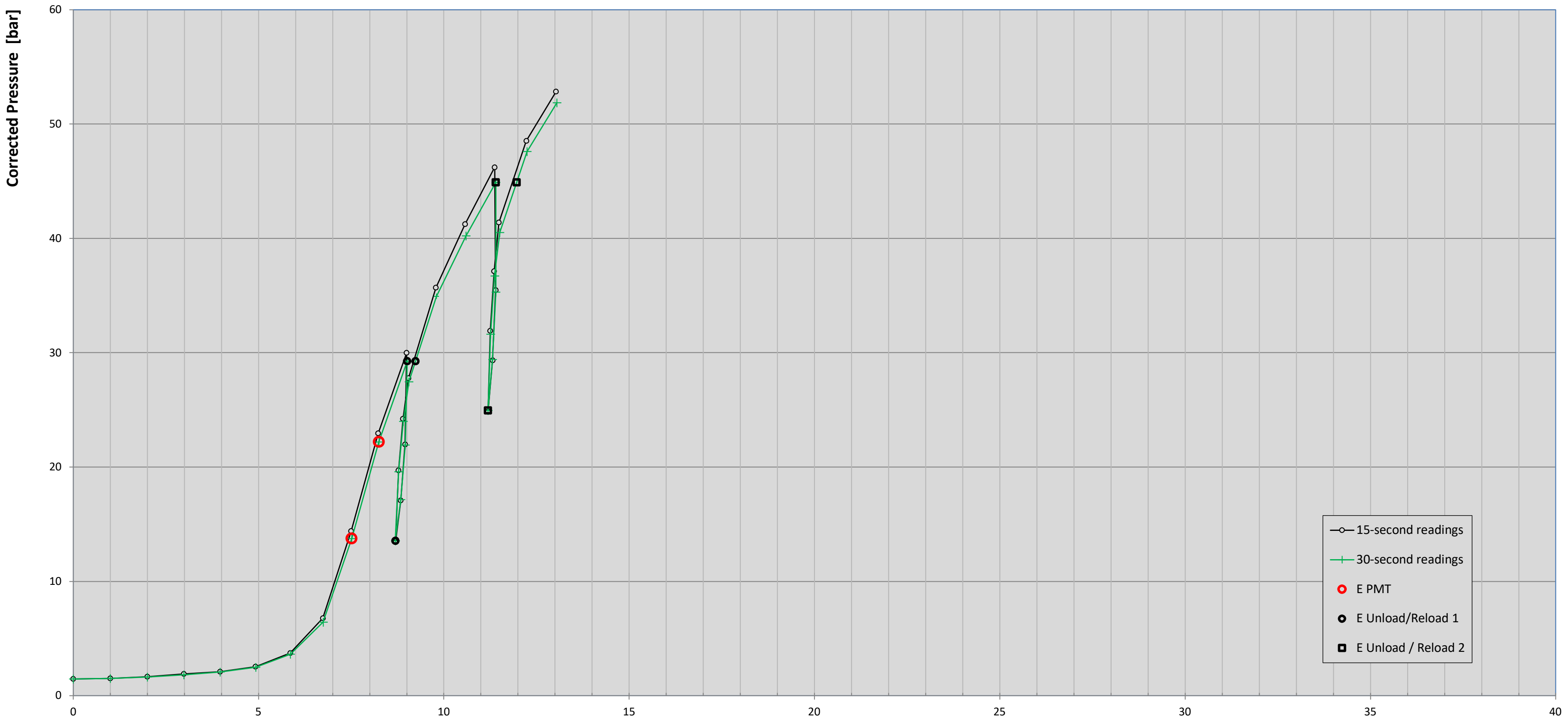
In-Depth Geotechnical Inc.

Field Test Data (uncorrected)		
Volume	Pressure [bar]	
[cm^3]	15 sec	30 sec
2	0.30	0.30
40	0.38	0.37
80	0.55	0.52
120	0.83	0.76
160	1.06	1.02
200	1.53	1.46
240	2.75	2.64
280	5.82	5.48
320	13.45	12.80
360	22.03	21.28
400	29.08	28.35
390	21.08	21.02
380	16.16	16.23
370	12.51	12.63
380	18.80	18.68
390	23.31	23.09
400	26.88	26.55
440	34.80	34.04
480	40.38	39.34
520	45.36	44.04
510	34.60	34.44
500	28.46	28.54
490	23.98	24.08
500	31.06	30.76
510	36.26	35.84
520	40.52	39.65
560	47.68	46.76
600	52.00	51.03

Corrected Test data					
15-second readings			30-second readings		
Pressure [bar]	Volume [cm^3]	$\Delta r/r_0$ [%]	Pressure [bar]	Volume [cm^3]	$\Delta r/r_0$ [%]
1.47	2	0.00	1.47	2	0.00
1.52	39.6	1.00	1.51	39.6	1.00
1.66	79.4	2.00	1.63	79.5	2.00
1.91	119.1	2.98	1.84	119.2	2.98
2.11	158.9	3.96	2.07	158.9	3.96
2.55	198.4	4.92	2.48	198.5	4.92
3.74	237.1	5.85	3.63	237.3	5.86
6.78	274.0	6.73	6.44	274.3	6.74
14.39	306.1	7.50	13.74	306.7	7.51
22.95	337.2	8.23	22.20	337.9	8.25
29.98	369.8	8.99	29.25	370.6	9.01
21.98	368.1	8.95	21.92	368.2	8.96
17.07	363.2	8.84	17.14	363.2	8.84
13.42	357.0	8.69	13.54	356.9	8.69
19.71	360.5	8.78	19.59	360.6	8.78
24.21	365.8	8.90	23.99	366.1	8.91
27.78	372.1	9.05	27.45	372.5	9.05
35.68	403.9	9.78	34.92	404.7	9.80
41.25	438.1	10.57	40.21	439.2	10.60
46.21	473.0	11.37	44.89	474.3	11.40
35.46	474.1	11.40	35.30	474.3	11.40
29.32	470.5	11.31	29.40	470.4	11.31
24.84	465.1	11.19	24.94	465.0	11.19
31.92	467.8	11.25	31.62	468.1	11.26
37.12	472.4	11.36	36.70	472.8	11.37
41.37	478.0	11.49	40.50	478.9	11.51
48.52	510.6	12.23	47.60	511.5	12.25
52.82	546.1	13.03	51.85	547.1	13.05

Creep	
Volume [cm^3]	Δp_{30-15} [bar]
2	0.00
39.6	0.01
79.5	0.03
119.2	0.07
158.9	0.04
198.5	0.07
237.3	0.11
274.3	0.34
306.7	0.65
337.9	0.75
370.6	0.73
404.7	0.76
439.2	1.04
474.3	1.32
511.5	0.92
547.1	0.97

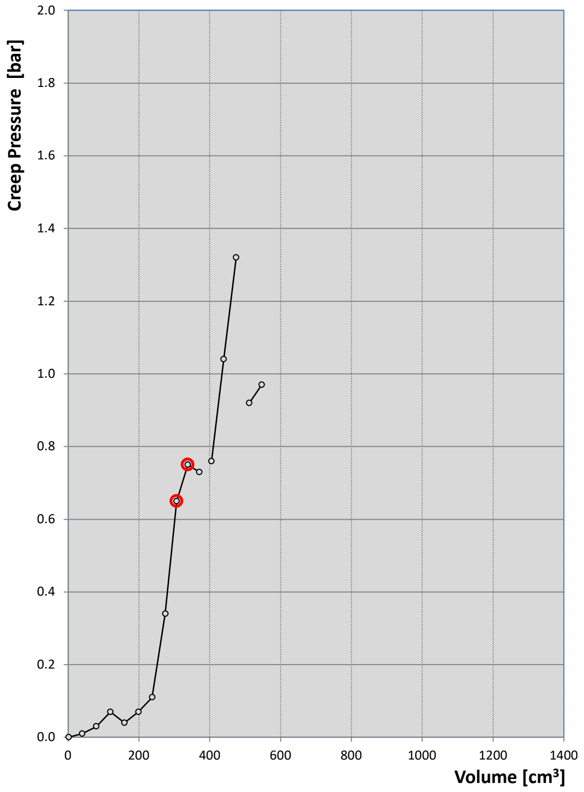
Auxiliary Data	
30 sec	
Pressure [bar]	1 / V
1.47	0.59211
1.51	0.02524
1.63	0.01258
1.84	0.00839
2.07	0.00629
2.48	0.00504
3.63	0.00421
6.44	0.00365
13.74	0.00326
22.20	0.00296
29.25	0.00270
21.92	0.00272
17.14	0.00275
13.54	0.00280
19.59	0.00277
23.99	0.00273
27.45	0.00268
34.92	0.00247
40.21	0.00228
44.89	0.00211
35.30	0.00211
29.40	0.00213
24.94	0.00215
31.62	0.00214
36.70	0.00211
40.50	0.00209
47.60	0.00196
51.85	0.00183



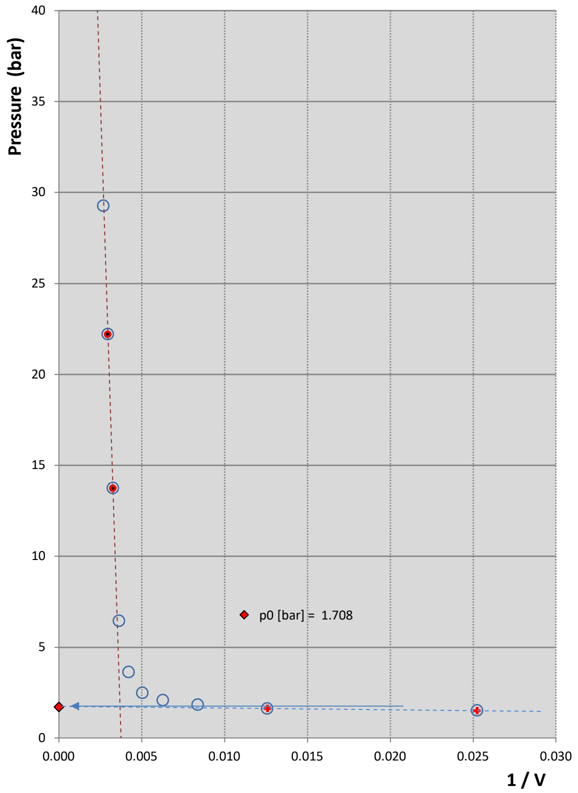
Pressuremeter test results [corrected data] pressure vs radial strain

Interpreted PMT Test Results

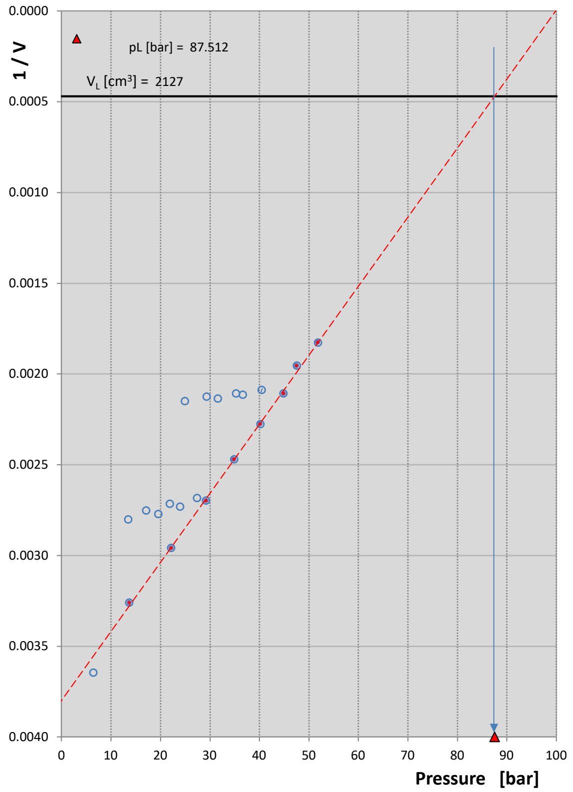
[30-second readings]			volume [cm^3]	radial strain [%]	strain range [%]
p_0	1.71	[bar]	79.5	2.0	
p_L	87.51	[bar]			
p^*_L	85.80	[bar]			
p_Y	22.20	[bar]	338	8.2	
E_{PMT}	1651	[bar]	307	7.5	{7.5 - 8.2 %}
E_{PMT} / p^*_L	19.2				
$E_{Unload\ 1}$	7111	[bar]	357	8.7	
$E_{Reload\ 1}$	4188	[bar]			
$E_{Unload\ 2}$	13907	[bar]	465	11.2	
$E_{Reload\ 2}$	3821	[bar]			



Pressure difference from 15 to 30 sec. readings $\Delta p_{[15\text{-}30\ sec]}$



Determination of total contact pressure p_0



Determination of Limit Pressure p_L

Pressuremeter Equipment: TEXAM Model
Volume-controlled test as per ASTM D4719 Method B

Volume increments:	40	cm³
Maximum Volume:	1400	cm³
Maximum Pressure:	100	bar

Probe Designation : NX Probe (76 mm OD)

Probe No.:	E 497	
Calibration Record No.:	1	
Tubing Length:	180	[ft]
Probe Lenght:	0.46	[m]
Probe Initial Volume:	1968	cm³

Drilling Method: Mud Rotary Drilling
Drilling Bit: Tricone Bit
Time elapsed from hole drilling to testing ~ 5 minutes
Engineer: Gabriel Sedran, P.Eng., Ph.D.
Operator: Scott A. Hall

Test Date: September 19, 2022
Test Depth [m]: 12.85 (center of the probe)
Drilling Company: Altech Drilling

Project: **895 Lawrence Ave., Toronto**
Client: Golder Associates
In-Depth Geotechnical Project No.: IDG 220705

PMT TEST No.: 3
Borehole No.: BH 22-3

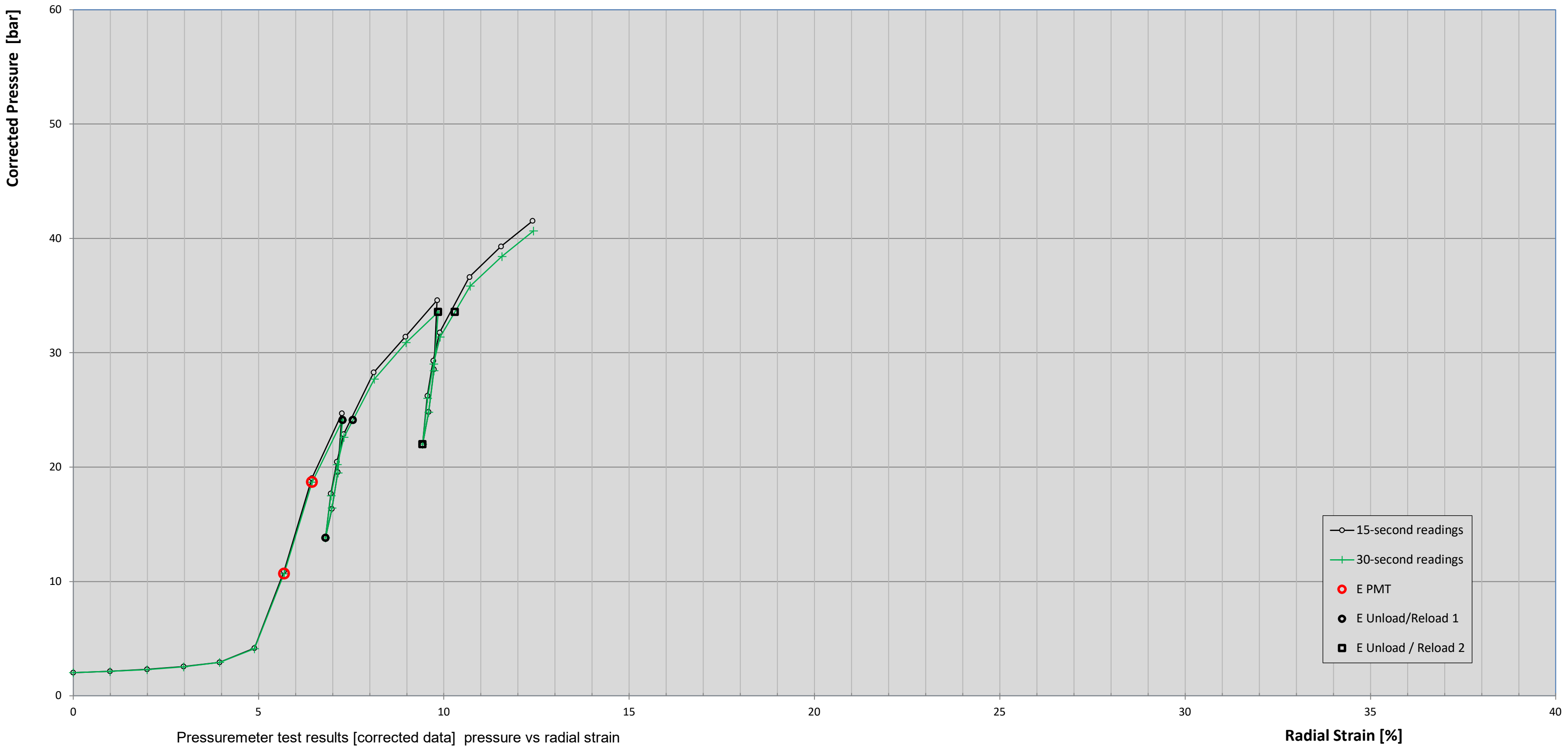
In-Depth Geotechnical Inc.

Field Test Data (uncorrected)		
Volume	Pressure [bar]	
[cm³]	15 sec	30 sec
2	0.56	0.56
40	0.70	0.69
80	0.91	0.89
120	1.19	1.16
160	1.58	1.56
200	2.84	2.79
240	9.60	9.37
280	17.76	17.42
320	23.45	22.86
310	18.30	18.24
300	15.09	15.16
290	12.57	12.56
300	16.42	16.24
310	19.22	18.96
320	21.63	21.36
360	27.05	26.46
400	30.20	29.68
440	33.39	32.37
430	27.35	27.22
420	23.62	23.60
410	20.75	20.80
420	25.04	24.82
430	28.10	27.82
440	30.57	30.18
480	35.44	34.66
520	38.14	37.24
560	40.38	39.50

Corrected Test data					
15-second readings			30-second readings		
Pressure [bar]	Volume [cm³]	$\Delta r/r_0$ [%]	Pressure [bar]	Volume [cm³]	$\Delta r/r_0$ [%]
2.04	1	0.00	2.04	1	0.00
2.15	39.3	0.99	2.14	39.3	0.99
2.32	79.1	1.99	2.30	79.1	1.99
2.57	118.8	2.97	2.54	118.8	2.97
2.94	158.4	3.95	2.92	158.4	3.95
4.17	197.1	4.89	4.12	197.1	4.89
10.90	230.0	5.68	10.67	230.3	5.69
19.03	261.6	6.44	18.69	261.9	6.45
24.70	295.7	7.25	24.11	296.3	7.26
19.55	291.0	7.14	19.49	291.1	7.14
16.35	284.4	6.98	16.42	284.3	6.98
13.84	277.0	6.81	13.83	277.0	6.81
17.68	283.0	6.95	17.50	283.2	6.95
20.47	290.1	7.12	20.21	290.3	7.12
22.88	297.6	7.30	22.61	297.8	7.30
28.28	331.9	8.11	27.69	332.6	8.12
31.41	368.7	8.97	30.89	369.2	8.98
34.58	405.4	9.82	33.56	406.4	9.84
28.55	401.6	9.73	28.42	401.8	9.74
24.82	395.5	9.59	24.80	395.5	9.59
21.95	388.5	9.43	22.00	388.4	9.43
26.24	394.0	9.56	26.02	394.3	9.56
29.30	400.9	9.71	29.02	401.1	9.72
31.76	408.3	9.89	31.37	408.7	9.90
36.62	443.2	10.69	35.84	444.1	10.71
39.30	480.4	11.54	38.40	481.4	11.56
41.52	518.1	12.40	40.64	519.0	12.42

Creep	
Volume [cm³]	Δp_{30-15} [bar]
1	0.00
39.3	0.01
79.1	0.02
118.8	0.03
158.4	0.02
197.1	0.05
230.3	0.23
261.9	0.34
296.3	0.59
332.6	0.59
369.2	0.52
406.4	1.02
444.1	0.78
481.4	0.90
519.0	0.88

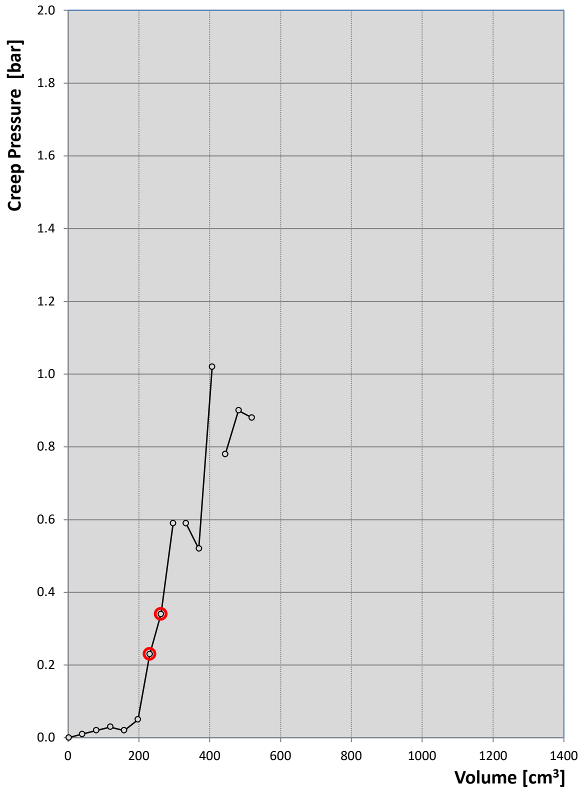
Auxiliary Data	
30 sec	
Pressure [bar]	1 / V
2.04	0.70461
2.14	0.02546
2.30	0.01265
2.54	0.00842
2.92	0.00631
4.12	0.00507
10.67	0.00434
18.69	0.00382
24.11	0.00338
19.49	0.00344
16.42	0.00352
13.83	0.00361
17.50	0.00353
20.21	0.00344
22.61	0.00336
27.69	0.00301
30.89	0.00271
33.56	0.00246
28.42	0.00249
24.80	0.00253
22.00	0.00257
26.02	0.00254
29.02	0.00249
31.37	0.00245
35.84	0.00225
38.40	0.00208
40.64	0.00193



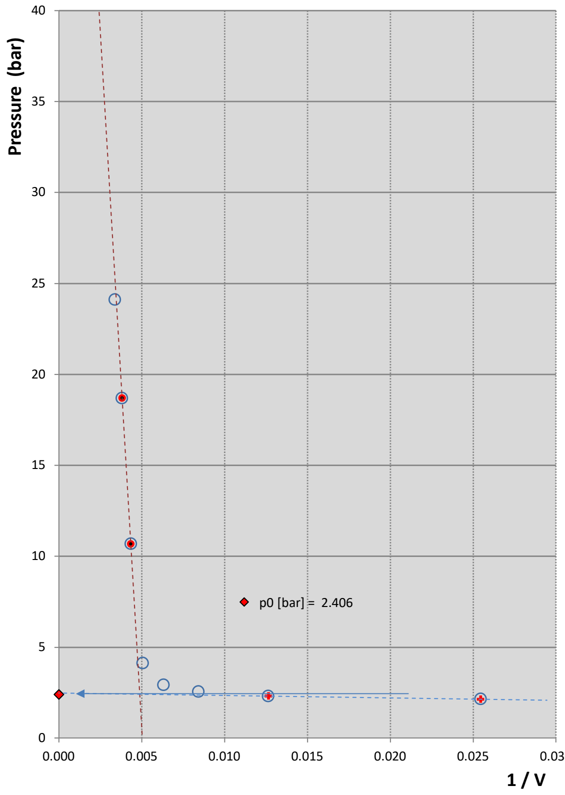
Pressuremeter test results [corrected data] pressure vs radial strain

Interpreted PMT Test Results

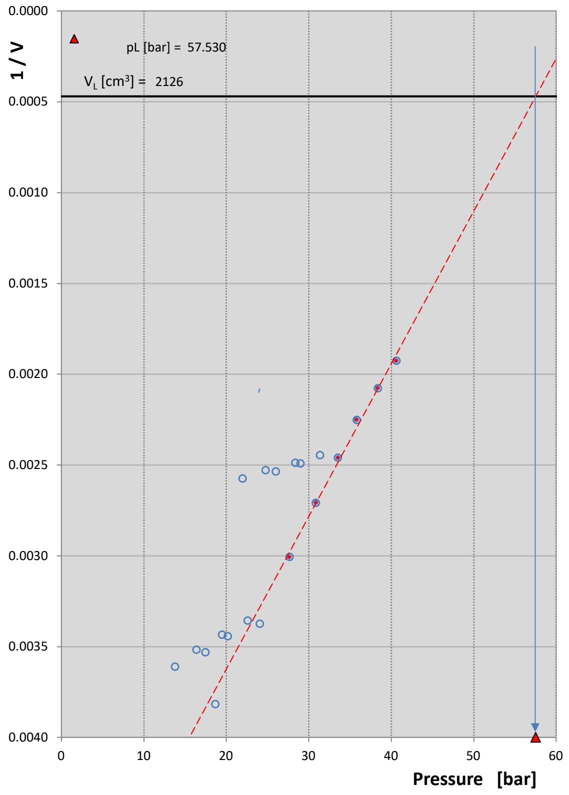
[30-second readings]			volume [cm³]	radial strain [%]	strain range [%]
p_0	2.41	[bar]	79.1	2.0	
p_L	57.53	[bar]			
p^*_L	55.12	[bar]			
p_Y	18.69	[bar]	262	6.4	
E_{PMT}	1492	[bar]	230	5.7	{5.7 - 6.4 %}
E_{PMT} / p^*_L	27.1				
$E_{Unload\ 1}$	3192	[bar]	277	6.8	
$E_{Reload\ 1}$	1988	[bar]			
$E_{Unload\ 2}$	4040	[bar]	388	9.4	
$E_{Reload\ 2}$	1943	[bar]			



Pressure difference from 15 to 30 sec. readings $\Delta p_{[15-30\ sec]}$



Determination of total contact pressure p_0



Determination of Limit Pressure p_L

Pressuremeter Equipment: TEXAM Model	Probe Designation : NX Probe (76 mm OD)	Drilling Method: Mud Rotary Drilling Drilling Bit: Tricone Bit	Test Date: September 19, 2022
Volume-controlled test as per ASTM D4719 Method B	Probe No.: E 497 Calibration Record No.: 1	Time elapsed from hole drilling to testing ~ 5 minutes	Test Depth [m]: 16.00 (center of the probe)
Volume increments: 40 cm³ Maximum Volume: 1400 cm³ Maximum Pressure: 100 bar	Tubing Length: 180 [ft] Probe Lenght: 0.46 [m] Probe Initial Volume: 1968 cm³	Engineer: Gabriel Sedran, P.Eng., Ph.D. Operator: Scott A. Hall	Drilling Company: Altech Drilling

Project: **895 Lawrence Ave., Toronto**

Client: Golder Associates

In-Depth Geotechnical Project No.: IDG 220705

PMT TEST No.: 4

Borehole No.: BH 22-3

Appendix Two

Pressuremeter Data Interpretation

Interpretation of Pressuremeter Test Results

Prebored pressuremeter test results are expressed in terms of applied pressure versus radial strain. Both pressure and strain measurements must be corrected for pressure and volume loses using the corresponding probe and system calibration curves.

The typical pressure versus radial strain curve features up to four distinctive portions which characterize the stress-strain behaviour of the soil, namely:

a) The linear pseudo-elastic stress-strain portion of the deformation curve;
b) The departure from linear elastic conditions starting at the yield pressure p_y;
c) The unload-reload portion of the test (usually two cycles are performed); and
d) The development of soil failure, which is represented by the net limit pressure p^*_L.

Based on these test features the following soil parameters are determined or estimated:

1. Contact Pressure p_o:

When using the prebored TEXAM unit, the initial contact pressure is taken as the pressure at the intersection of the two lines representing the pseudo elastic and the initial expansion portions of the pressure vs. 1/V plot, as shown in the PMT data sheets, in Appendix One.

2. Pressuremeter modulus E_{PMT}:

The pressuremeter modulus is represented by the slope of the pressure versus radial strain curve along its linear portion, and may be calculated as follows:

$$E_{PMT} = (1+\upsilon)(p_2 - p_1)\frac{\left(1+\left(\frac{\Delta R}{R_o}\right)_2\right)^2 + \left(1+\left(\frac{\Delta R}{R_o}\right)_1\right)^2}{\left(1+\left(\frac{\Delta R}{R_o}\right)_2\right)^2 - \left(1+\left(\frac{\Delta R}{R_o}\right)_1\right)^2}$$

where the sub-indices 1 and 2 indicate the beginning and the end of the linear portion of the curve, respectively. These two points are shown in pressuremeter curves with two red oversized circles. For the self-boring probe, the linear portion of the stress-strain response occurs between the very first data point (zero volume increase) and the subsequent two or three data points.

In this determination a value of the Poisson's ratio, typically $\nu = 0.33$ for most soils, must be assumed. For saturated clays a value of $\nu = 0.45$ is suggested.

3. **Yield Pressure p_y:**

The yield pressure indicates the end of the linear pseudo-elastic deformations and the onset of plasticity. This yield pressure is useful in indicating beyond which pressure significant creep deformations may occur.

4. **Unload-Reload Moduli E_{Unload} and E_{Reload}**

The unload and reload moduli are represented by the slope of the unload-reload loop, and they may be used to determine elastic soil deformations upon unloading or reloading conditions such as those typically encountered during excavations.

5. **Net Limit Pressure p^*_L:**

The net limit pressure is a measure of the strength of the soil (either under undrained conditions for cohesive soils, or drained conditions for non-cohesive soils). This parameter is defined as the pressure reached when the soil cavity has been extended to twice its original soil cavity volume V_c (minus the initial total contact pressure p_o).

The limit pressure is not always attained during testing. In such cases, the value of p_L is inferred by plotting pressure versus 1/V for the plastic phase of the deformations. This method of inferring p_L, known as the "upside down curve" method, is described in "*The Pressuremeter and Foundation Engineering*" textbook, by F. Baguelin, J.F. Jezequel, and D.H. Shields, published in 1978 by Trans Tech Publications, Section: Methods of extrapolating pressuremeter curves to p_L. See also ASTM D4719-00, Section 10.6.

It should be noted that radial strains are calculated from the volume of fluid (typically tap water) injected into the probe. In this regard, the radial strains shown in the results are related to the probe expansion, not the cavity's expansion. The cavity initial volume, V_c, is calculate by adding the probe initial volume, V_0, to the volume of water injected into the probe at the initial contact pressure p_0.

6. Some Additional PMT-based Parameters

In addition, two useful ratios, (E_{PMT} / p^*_L) and (p^*_L / p_y), may be used as a general guideline for soil identification, as follows:

for sands $7 < E_{PMT} / p^*_L < 12$

for clays $12 < E_{PMT} / p^*_L$

Many PMT tests completed in the glacial tills present in the geology of the Golden Shoe area (Ontario) registered much higher values than those listed above. In many cases, values for E_{PMT} / p^*_L in excess of 30 have been recorded.

The E_{PMT} / p^*_L value is known as the *mechanical ratio*, and it indicates whether a soil mass behaves in a ductile (high value) or brittle (low value) manner after yield stresses have been reached. This ration It is the PMT equivalent of the soil mechanic's Rigidity Index, e.g., G/σ_{max}.

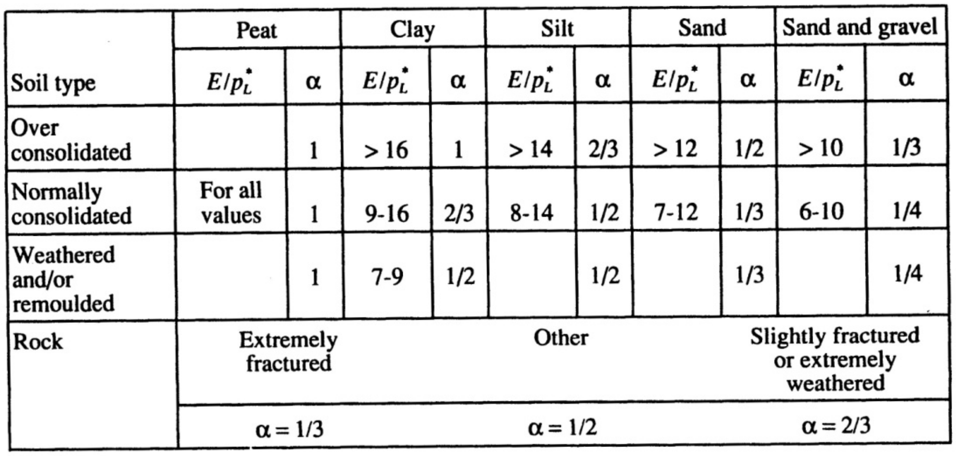
Inferred Soil Parameters

7. Young's Modulus E_Y

The Pressuremeter modulus E_{PMT} corresponds to large strains, namely for radial strains in the 2 to 5 % range, and it is therefore considered to be a relatively low value of the elastic modulus. In practice, the Young's modulus E can be inferred from Pressuremeter testing using the empirical Menard α factor:

$$E_Y = E_{PMT} / \alpha$$

Typical values of the Menard α factor are suggested in the following Table:



Soil type	Peat		Clay		Silt		Sand		Sand and gravel	
	E/p_L^*	α	E/p_L^*	α	E/p_L^*	α	E/p_L^*	α	E/p_L^*	α
Over consolidated		1	> 16	1	> 14	2/3	> 12	1/2	> 10	1/3
Normally consolidated	For all values	1	9-16	2/3	8-14	1/2	7-12	1/3	6-10	1/4
Weathered and/or remoulded		1	7-9	1/2		1/2		1/3		1/4
Rock	Extremely fractured				Other				Slightly fractured or extremely weathered	
	α = 1/3				α = 1/2				α = 2/3	

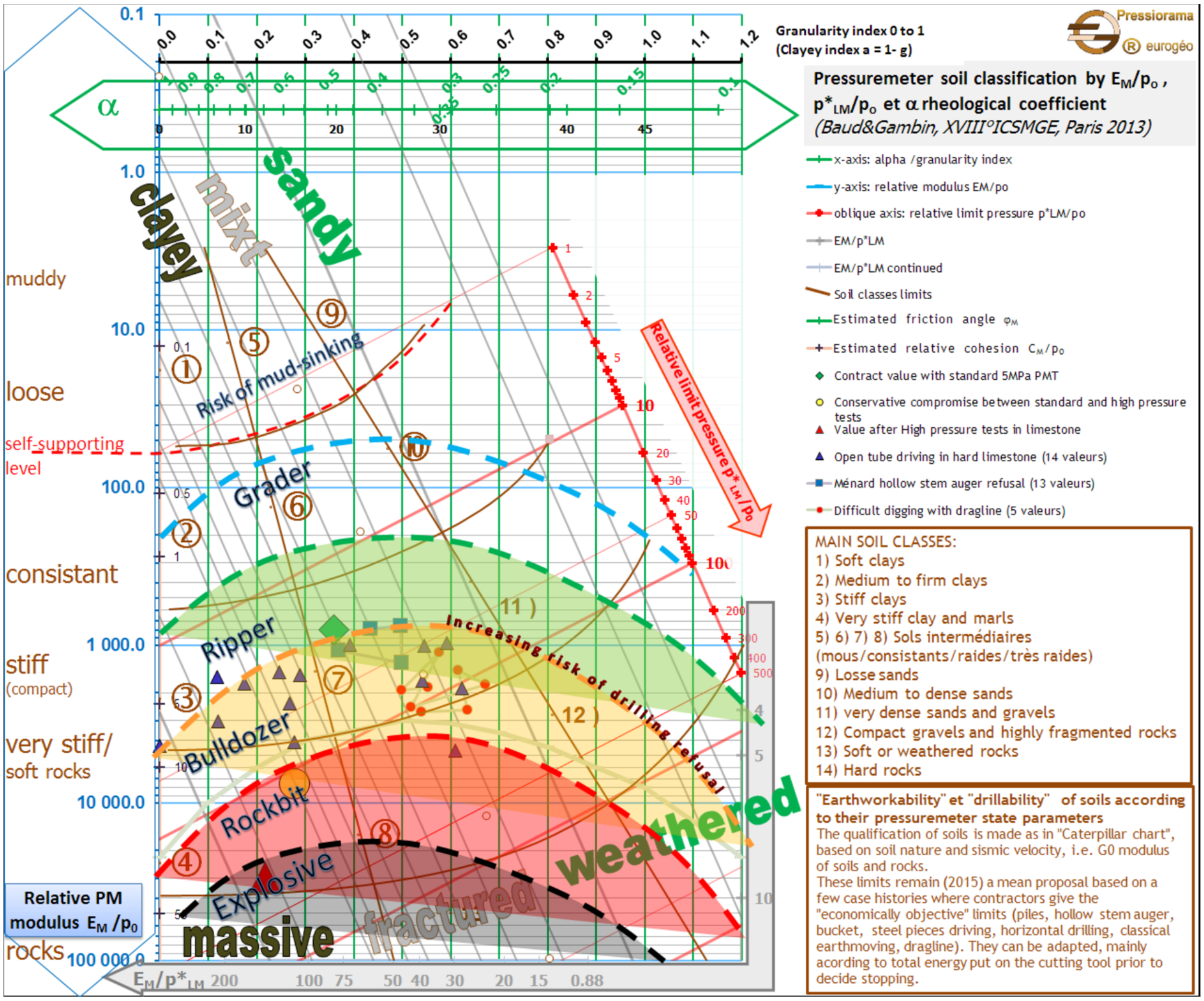
(from 'The Pressuremeter', J.L. Briaud. Balkema, 1992)

Alternatively, better-defined values of the Menard α parameter can be obtained using the following expression, as introduced by J.P. Baud

$$\alpha = \frac{\left(E_{PMT}/P_L^*\right)^{1/n}}{k_E\left(\frac{P_L^*}{p_0}\right)^{m/n}}$$

With $n = 2$; $m = 0.5$; and $k_E = 3.5$.

This expression is based on empirical correlations and may also be visualized in the Pressiorama Chart illustrated in the next page:



Pressuremeter soil classification by E_M/p_o, p^*_{LM}/p_o et α rheological coefficient
(Baud&Gambin, XVIII°ICSMGE, Paris 2013)

- x-axis: alpha / granularity index
- y-axis: relative modulus EM/po
- oblique axis: relative limit pressure p*LM/po
- EM/p*LM
- EM/p*LM continued
- Soil classes limits
- Estimated friction angle φ_M
- Estimated relative cohesion C_M/p_o
- Contract value with standard 5MPa PMT
- Conservative compromise between standard and high pressure tests
- Value after High pressure tests in limestone
- Open tube driving in hard limestone (14 valeurs)
- Ménard hollow stem auger refusal (13 valeurs)
- Difficult digging with dragline (5 valeurs)

MAIN SOIL CLASSES:
1) Soft clays
2) Medium to firm clays
3) Stiff clays
4) Very stiff clay and marls
5) 6) 7) 8) Sols intermédiaires (mous/consistants/raides/très raides)
9) Losse sands
10) Medium to dense sands
11) very dense sands and gravels
12) Compact gravels and highly fragmented rocks
13) Soft or weathered rocks
14) Hard rocks

"Earthworkability" et "drillability" of soils according to their pressuremeter state parameters
The qualification of soils is made as in "Caterpillar chart", based on soil nature and sismic velocity, i.e. G0 modulus of soils and rocks.
These limits remain (2015) a mean proposal based on a few case histories where contractors give the "economically objective" limits (piles, hollow stem auger, bucket, steel pieces driving, horizontal drilling, classical earthmoving, dragline). They can be adapted, mainly acording to total energy put on the cutting tool prior to decide stopping.

Baud J.P., and Gambin M. 2013. *"Détermination du coefficient rhéologique α de Ménard dans le diagramme Pressiorama"*. Proceedings of the 18th International Conference on Soil Mechanics and Geotechnical Engineering. Paris, 2013, Parallel Session ISP 6, International Symposium on the Pressuremeter.

8. Undrained Shear Strength for Cohesive Soil Materials

The undrained shear strength of cohesive soils, c_u or S_u, may be estimated as:

$$\frac{S_u}{p_a} = 0.21\left(\frac{p_L^*}{p_a}\right)^{0.75}$$

where p_a represents a reference pressure (i.e., atmospheric pressure = 100 kPa), after J.L. Briaud ('The Pressuremeter', Balkema, 1992).

9. Drained Friction Angle for Cohesionless Soil Materials

The drained friction angle of cohesionless soils (for *c'* = 0) may be estimated using the empirical correlations illustrated in the graph shown below. This approach is outlined by Baguelin et.al., in *"The Pressuremeter and Foundation Engineering"* (F. Baguelin; J.F. Jézéquel; and D.H. Shields. TransTech Publications. 1978), and it requires some knowledge on the state or conditions of the cohesionless material. This approach only provides a likely range of friction angles for recorded values of the limit pressure.

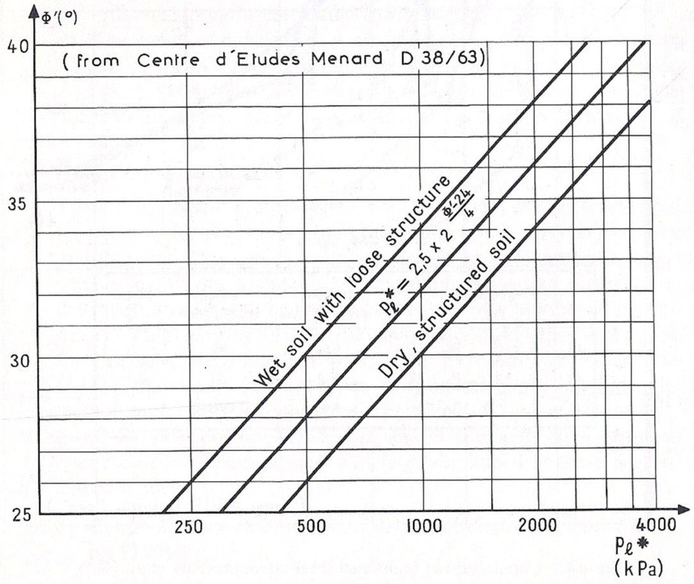
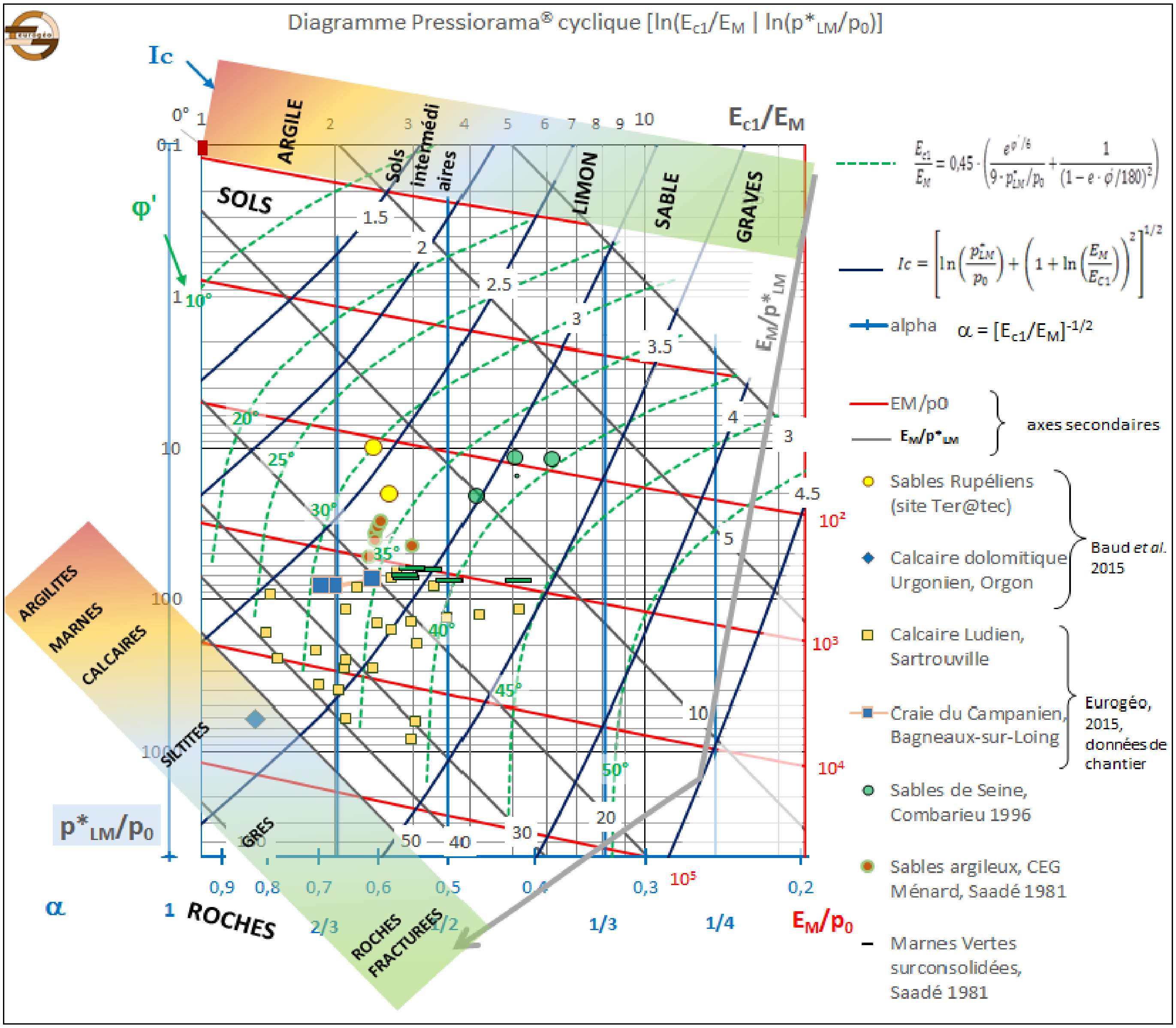


Fig. 6-86: MÉNARD's graph to determine Φ' from p_1^*.

Also alternatively, values of the drained friction angle ϕ' can be inferred using the modified Pressiorama Chart (*Pressiorama Cyclique, in French*) as introduced by Baud.



$$\frac{E_{c1}}{E_M} = 0{,}45 \cdot \left(\frac{e^{\varphi'/6}}{9 \cdot p^*_{LM}/p_0} + \frac{1}{(1 - e \cdot \varphi/180)^2} \right)$$

$$Ic = \left[\ln\left(\frac{p^*_{LM}}{p_0}\right) + \left(1 + \ln\left(\frac{E_M}{E_{C1}}\right)\right)^2 \right]^{1/2}$$

Figure 3. Diagramme Pressiorama® cyclique [ln(E$_{c1}$/E$_M$ | ln(p*$_{LM}$/p$_0$)].

The values of ϕ' plotted in the modified Pressiorama Chart are calculated with the following expression:

$$\phi' = 5.5\ ln\left(\frac{9}{\alpha^2}\ \frac{P_L^*}{p_0}\right)$$

with values of α calculated/inferred from the modified Pressiorama Chart.

Where this expression provides values of effective friction angle greater than a 45^o, a maximum value of 45^o should be assumed.

This expression was presented by J.P. Baud, in his publication *"Apport de L'Essai Cyclique a la Classification Pressiométrique des Sols et des Roches",* Journées Nationales de Geotechnique et de Géologie de l'Ingénieur, Nancy, 2016.

Shear strength parameters suggested in Table No. 3, are based on the guidelines provided by the *Pressiorama* and *Cyclique Pressiorama* charts. It should be noted that these guidelines are subject to changes, or improvements, as the correlations between pressuremeter parameters E_M, p'_L, and p_0 are being adjusted by ever increasing amount of field data. As such, care should be used when using these suggested parameters.

10. Soil Classification Index

Based on PMT testing procedures, soil behavior may be characterized as cohesive or frictional (cohesionless). Using the modified Pressiorama Chart, a Soil Classification Index, namely I_c, can be inferred with the following expression:

$$I_c = \left[\left(1 + log\left({P_L^*}/{p_0}\right)\right)^2 + \left(1 - log(\alpha)\right)^2\right]^{½}$$

A minimum value of 1 would correspond to a cohesive soil, near its state of liquefaction. Whereas, a value of 4.5 would correspond to coarse gravel materials. A value of I_c = 2.7 would apply to a material which behaves mechanically as part frictional (drained for long-term loading conditions) and part cohesive (undrained for the short-term loading conditions). In general, Soil Type Behaviors corresponding to values of the Classification Index I_C are listed as:

1.0 to 1.5	Clays
1.5 to 2.5	Clay-Silt mixes
2.5 to 3.0	Silts
3.0 to 3.5	Sands
3.5 to 4.0	Gravels, and
4.0 to 4.5	Weathered Rocks

Appendix Three

Calibration Data

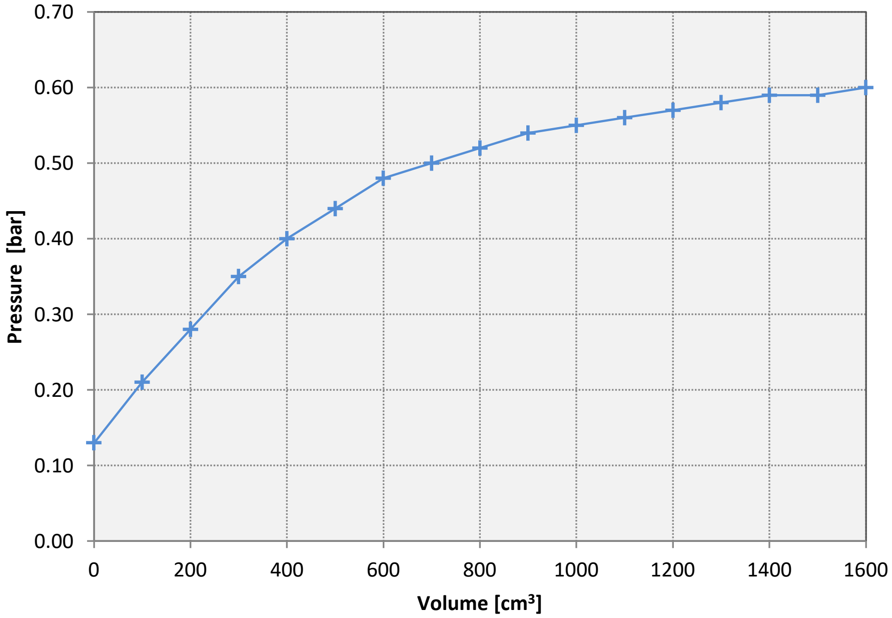
Calibration Date:	September 8, 2022
Probe Designation:	E 497
Calibration Record No.:	I
Length of Tubing:	180 feet
Calibrated by:	S.H.

In-Depth
Geotechnical Inc.

Membrane stiffness calibration

Pressure [bar]	Volume cm³
0.13	0
0.21	100
0.28	200
0.35	300
0.40	400
0.44	500
0.48	600
0.50	700
0.52	800
0.54	900
0.55	1000
0.56	1100
0.57	1200
0.58	1300
0.59	1400
0.59	1500
0.60	1600

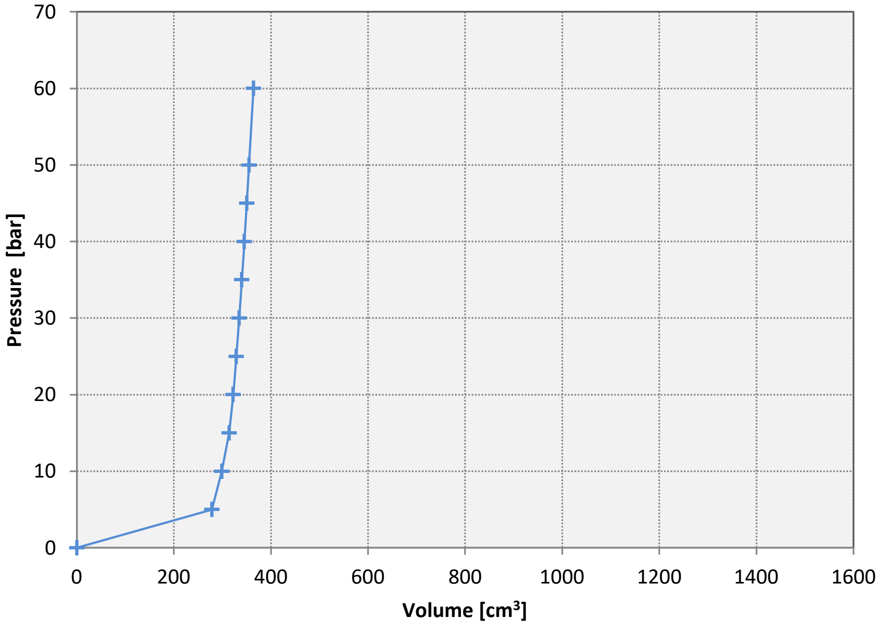
Membrane Stiffness (Air Calibration)



Volume calibration

Pressure [bar]	Volume cm³
0	0.0
5	278.6
10	299.0
15	314.2
20	322.3
25	328.9
30	334.7
35	340.1
40	345.3
45	350.3
50	355.0
60	364.0
Reload Cal. Data	
25	334.7
50	355.5

System Stiffness (Compliance Calibration)



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