Terraprobe
Consulting Geotechnical & Environmental Engineering
Construction Materials Inspection & Testing

GEOTECHNICAL INVESTIGATION
PROPOSED SMVS TEMPLE
6939 KING STREET
CALEDON, ONTARIO

Prepared for: Swaminarayan Mandir Vasna Sanstha Canada (SMVS)
114 Toryork Drive
Toronto, Ontario
M9L 1X6

Attention: Mr. Rasik Patel

©Terraprobe Inc.
File No. 1-20-0222-02
Issued: December 21, 2021

Distribution

1 Electronic Copy	-	Swaminarayan Mandir Vasna Sanstha Canada
1 Copy	-	Terraprobe Inc., Brampton

Terraprobe Inc.

Greater Toronto	Hamilton – Niagara	Central Ontario	Northern Ontario
11 Indell Lane	903 Barton Street, Unit 22	220 Bayview Drive, Unit 25	1012 Kelly Lake Rd., Unit 1
Brampton, Ontario L6T 3Y3	**Stoney Creek**, Ontario L8E 5P5	**Barrie**, Ontario L4N 4Y8	**Sudbury**, Ontario P3E 5P4
(905) 796-2650 Fax: 796-2250	(905) 643-7560 Fax: 643-7559	(705) 739-8355 Fax: 739-8369	(705) 670-0460 Fax: 670-0558
brampton@terraprobe.ca	stoneycreek@terraprobe.ca	barrie@terraprobe.ca	sudbury@terraprobe.ca

www.terraprobe.ca

TABLE OF CONTENTS

1 INTRODUCTION....1

2 SITE AND PROJECT DESCRIPTIONS....1

3 INVESTIGATION PROCEDURE....2

4 SUBSURFACE CONDITIONS....3

4.1 Topsoil....3
4.2 Earth Fill....3
4.3 Glacial Till....3
4.4 Sand....4
4.5 Geotechnical Laboratory Test Results....4
4.6 Ground Water....5

5 DISCUSSIONS AND RECOMMENDATIONS....6

5.1 Foundation....6
5.1.1 Foundations on Native Soil....6
5.1.2 Foundations on Engineered Fill....7
5.1.3 Foundation Installation....8
5.2 Earth Pressure Design Parameters....8
5.3 Earthquake Design Parameters....10
5.4 Slab-on-Grade....10
5.5 Pavement....12
5.5.1 Pavement Design....12
5.5.2 Drainage....12
5.5.3 General Pavement Recommendations....13
5.5.4 Subgrade Preparation....13
5.6 Storm Water Management Pond....13
5.6.1 Pond Base and Slope....13
5.6.2 Earth Berm and Pond Slope Surface Treatment....14
5.6.3 Operational Considerations....16
5.7 Pipe Bedding and Cover/Embedment....17
5.8 Excavations and Ground Water Control....18
5.8.1 Regulatory Requirements....19
5.9 Backfill....20
5.10 Quality Control....21

6 LIMITATIONS AND RISK....21

6.1 Procedures....21
6.2 Changes in Site and Scope....22

ENCLOSURES

Figures

Figure 1	Site Location Plan
Figure 2A	Borehole Location Plan (Existing Condition)
Figure 2B	Borehole Location Plan (Proposed Condition)
Figure 3	Typical Reinforced Wall Details for Structures on Engineered Fill

Appendices

Appendix A	Borehole Logs, 2020 and 2021
Appendix B	Geotechnical Laboratory Test Results
Appendix C	Engineered Fill Earthworks Specifications

1 INTRODUCTION

Terraprobe Inc. (Terraprobe) was retained by Swaminarayan Mandir Vasna Sanstha (SMVS) Canada to conduct a supplementary geotechnical investigation for the proposed development located at 6939 King Street in the Town of Caledon, Ontario.

Terraprobe previously carried out a geotechnical and hydrological investigation (File: 1-20-0222-01, dated November 27, 2020 and File: 1-20-0222-46, dated November 26, 2020) on the north portion of subject site based on the original design drawings, which included one-storey structure with no basement. Subsequent to these investigations, the new design drawing was provided to Terraprobe which indicated the new proposed building location, and included a Storm Water Management (SWM) facility and a sanitary disposal bed at south portions of subject site. Therefore, the current supplementary geotechnical investigation was conducted to meet the new project design requirements.

This report encompasses the results of the previous and current geotechnical investigations conducted for the proposed development to determine the prevailing subsurface soil and ground water conditions, and based on this information, provides geotechnical engineering recommendations for the design of foundations, slab-on-grade, earth pressure and seismic design parameters, pavement design and bedding/embedment and cover. Geotechnical comments are also included on pertinent construction aspects, excavation, bedding/embedment, backfill and ground water control.

Terraprobe has also conducted a Supplementary Hydrogeological Study for the property based on new design drawings, the finding of which are reported under separate cover.

2 SITE AND PROJECT DESCRIPTIONS

The site is located at the southwest quadrant of the intersection of King Street and Centreville Creek Road, in the Town of Caledon, Ontario. The property currently consists of a parallelogram-shaped parcel of agricultural land with a residential unit at north-west portion of the site and covers an area of approximately 60,590 m^2 (15 acres). The general location of the site is presented on Figure 1.

It is proposed to develop the site to include a religious temple with at-grade parking lots, a storm water management facility and a sanitary disposal bed. It is understood that the proposed temple will be a one-story slab-on-grade structure with no basement.

The following design drawings were provided to Terraprobe and reviewed in the preparation of this report,

- *Drawing No. A1, Site Plan,* dated November 5, 2020, prepared by Battaglia Architect Inc.
- *Drawing No. C702, Preliminary Servicing Plan,* dated: December 23, 2020, prepared by Crozier Consulting Engineers.

3 INVESTIGATION PROCEDURE

The previous field investigation was conducted on July 14 and September 21, 2020, and consisted of drilling and sampling a total of twelve (12) boreholes, extending to about 1.8 to 8.1 m depth below grade. The current field investigation was conducted on November 11 and 12, 2021, and consisted of drilling and sampling a total of seven (7) boreholes, extending to about 5.0 to 6.6 m depth below grade. The approximate locations of the boreholes are shown on the enclosed Borehole Location Plan (Figure 2A – Existing Conditions and Figure 2B – Proposed Conditions).

The boreholes were drilled by a specialist drilling contractor using track-mounted drill rig power auger. The borings were advanced using continuous flight solid stem augers, and were sampled at 0.75 m and 1.5 m intervals with a conventional 50 mm diameter split barrel samplers when the Standard Penetration Test (SPT) was carried out (ASTM D1586). The field work (drilling, sampling and testing) was observed and recorded by a member of our field engineering staff, who logged the borings and examined the samples as they were obtained.

All samples obtained during the investigation were sealed into clean plastic jars, and transported to our geotechnical testing laboratory for detailed inspection and testing. All borehole samples were examined (tactile) in detail by a geotechnical engineer, and classified according to visual and index properties. Laboratory tests consisted of water content determination on all samples; and a Sieve and Hydrometer analysis on eight (8) selected native soil samples (Borehole 1, Sample 3; Borehole 3, Sample 4; Borehole 5, Sample 3; Borehole 8, Sample 2; Borehole 11, Sample 2; Borehole 103, Sample 3; Borehole 104, Sample 2; and Borehole 104, Sample 6). The measured natural water contents of individual samples and the results of the Sieve and Hydrometer analysis are plotted on the enclosed Borehole Logs at respective sampling depths. The results of Sieve and Hydrometer analysis are also summarized in Section 4.5 of this report, and appended.

Water levels were measured in open boreholes upon completion of drilling. Monitoring wells comprising 50 mm diameter PVC pipes were installed in selected boreholes (Boreholes 101, 103, 104, 106 and 107) to facilitate ground water monitoring. The PVC tubing was fitted with a bentonite clay seal as shown on the accompanying Borehole Logs. Water levels in the monitoring wells were measured during subsequent site visits. The results of ground water monitoring are presented in Section 4.6 of this report.

The borehole ground surface elevations were surveyed by Terraprobe using a Trimble R10 GNSS System. The Trimble R10 system uses the Global Navigation Satellite System and the Can-Net reference system to determine target location and elevation. The Trimble R10 system is reported to have an accuracy of up to 10 mm horizontally and up to 30 mm vertically.

It should be noted that the elevations provided on the Borehole Logs are approximate only, for the purpose of relating soil stratigraphy and should not be used or relied on for other purposes.

4 SUBSURFACE CONDITIONS

The specific soil conditions encountered at each borehole location are described in greater detail on the Borehole Logs, with a summary of the general subsurface soil conditions outlined below. This summary is intended to correlate this data to assist in the interpretation of the subsurface conditions encountered at the site.

It should be noted that the subsurface conditions are confirmed at the borehole locations only, and may vary between and beyond the borehole locations. The boundaries between the various strata as shown on the logs are based on non-continuous sampling. These boundaries represent an inferred transition between the various strata, rather than a precise plane of geologic change.

4.1 Topsoil

A topsoil layer was encountered at the ground surface in Boreholes 2 to 10 and 101 to 107. The thickness ranged from 100 to 300 mm. The topsoil was dark brown in colour and consisted of matrix of silt and sand.

The topsoil surficial layer thicknesses provided in the report were obtained at individual borehole locations, as measured through the collar of the open borehole or as inferred from non-continuous sampling. Thickness may vary between and beyond borehole locations.

4.2 Earth Fill

An earth fill zone, consisting of clayey silt with varying amounts of sand and trace amounts of gravel and organics was encountered at the ground surface in Boreholes 1, 11 and 12 and beneath the topsoil layer in Boreholes 3, 4, 6, 9, 10 and 101 to 105, and extended to about 0.6 to 1.2 m depth below existing grade.

Standard Penetration Test (SPT) results (N-values) obtained from the earth fill zone ranged from 5 to 21 blows per 300 mm of penetration, indicating a firm to very stiff consistency. The in-situ moisture contents of the earth fill samples ranged from 10 to 22 percent by mass, indicating a moist condition.

4.3 Glacial Till

Silt and clay to clayey silt till deposit, with varying amounts of sand (trace sand to sandy) and trace amounts of gravel was encountered beneath the earth fill zone in Boreholes 1, 3, 4, 6, and 9 to 12, 101, 102, 103, 104, and 105, and beneath the topsoil layer in Boreholes 2, 5, 7, 8 106 and 107. This zone extended to the full depths of the investigation ranging from 2.0 m to 8.1 m below grade. The upper zone of the glacial till deposit extending up to 0.6 m depth below grade was weathered and disturbed in Boreholes 2, 5, 6, 7, 106 and 107. The composition of the weathered and disturbed soil is generally similar to that of underlying undisturbed soil but included trace amounts of organic matter and topsoil.

The result of Standard Penetration Test (N-values) obtained from the undisturbed silt and clay to clayey silt till deposits ranged from 11 to 51 blows per 300 mm of penetration, indicating a stiff to hard consistency (typically very stiff to hard). The in-situ moisture contents of the silt and clay to clayey silt glacial till samples ranged from 9 to 22 percent by mass, indicating a moist condition.

It should be noted that the glacial till deposit may contain larger size particles (cobbles and boulders) that are not specifically identified in the boreholes. The size and distribution of such obstructions cannot be predicted with borings, because the borehole sampler size is insufficient to secure representative samples for the particles of this size.

4.4 Sand

A layer of sand deposit with some clay and silt was encountered sandwiched between the glacial till zone in Boreholes 103. This layer was encountered at depth of about 2.3 m below grade and extended to the depth of about 3.0 m below grade.

The result of Standard Penetration Test (N-value) obtained from the sand zone was 39 blows per 300 mm of penetration, indicating a dense relative density. The in-situ moisture content of the sand soil sample was 14 percent by mass, indicating a moist condition.

4.5 Geotechnical Laboratory Test Results

The geotechnical laboratory testing consisted of natural water content determination for all samples, while Sieve and Hydrometer analysis were conducted on selected soil samples. The test results are plotted on the enclosed Borehole Logs at respective sampling depths.

The results (graphs) of the Sieve and Hydrometer (grain size) analyses are appended and a summary of these results is presented as follows:

Borehole No. Sample No.	Sampling Depth below Grade (m)	Percentage (by mass)				Descriptions (MIT System)
		Gravel	Sand	Silt	Clay	
Borehole 1, Sample 3	1.8	2	14	48	36	SILT AND CLAY TILL some sand, trace gravel
Borehole 3, Sample 4	2.5	1	16	43	40	SILT AND CLAY TILL some sand, trace gravel
Borehole 5, Sample 3	1.8	0	13	40	47	CLAY AND SILT TILL some sand
Borehole 8, Sample 2	1.0	4	11	42	43	CLAY AND SILT TILL some sand, trace gravel
Borehole 11, Sample 2	1.1	6	13	41	40	SILT AND CLAY TILL some sand, trace gravel

Borehole No. Sample No.	Sampling Depth below Grade (m)	Percentage (by mass)				Descriptions (MIT System)
		Gravel	Sand	Silt	Clay	
Borehole 103, Sample 3	1.8	1	16	49	34	CLAYEY SILT TILL some sand, trace gravel
Borehole 104, Sample 2	1.0	2	24	48	26	CLAYEY SILT TILL sandy, trace gravel
Borehole 104, Sample 6	4.8	1	18	51	30	CLAYEY SILT TILL some sand, trace gravel

4.6 Ground Water

Observations pertaining to the depth of water level and caving were made in the open boreholes immediately after completion of drilling, and are noted on the enclosed Borehole Logs. Monitoring wells were installed in Boreholes 1, 3, 5, 101, 103, 104, 106 and 107 to facilitate ground water level monitoring and the purpose of supplementary hydrogeological study. The ground water level measurements in the monitoring wells were measured during the subsequent site visits and are noted on the enclosed Borehole Logs. A summary of these observations is provided as follows,

Borehole No.	Depth of Boring below Grade (m)	Depth to Cave below Grade (m)	Water Level Depth/Elevation at the Time of Drilling (m)	Water Level Depth/Elevation in Monitoring Wells (m)		
				Nov 19, 2021	Dec 1, 2021	Dec 13, 2021
Borehole 1	8.1	5.8	Dry	2.4/264.4	2.6/264.2	2.90/263.9
Borehole 3	8.1	Open	Dry	2.6/263.7	2.6/263.7	2.6/263.7
Borehole 5	8.1	Open	Dry	4.2/262.2	4.2/262.2	4.3/262.1
Borehole 101	6.6	Open	Dry	1.8/265.3	0.7/266.4	0.7/266.4
Borehole 103	6.6	Open	6.0/260.6	0.7/265.9	0.6/266.0	0.4/266.2
Borehole 104	6.6	Open	Dry	Dry	5.9/260.4	5.7/260.5
Borehole 106	6.6	Open	Dry	2.9/262.4	1.7/263.5	1.3/263.9
Borehole 107	6.6	Open	5.8/259.8	2.8/262.8	2.8/262.8	2.5/263.1

The water levels noted above may fluctuate seasonally depending upon the amount of precipitation and surface runoff.

5 DISCUSSIONS AND RECOMMENDATIONS

The following discussion and recommendations are based on the factual data obtained from this investigation and are intended for the use of the owner and the design engineer. Contractors bidding or providing services on this project should review the factual data and determine their own conclusions regarding construction methods and scheduling.

This report is provided on the basis of these terms of reference and on the assumption that the design features relevant to the geotechnical analyses will be in accordance with applicable codes, standards and guidelines of practice. If there are any changes to the site development features or is any additional information relevant to the interpretations made of the subsurface information with respect to the geotechnical analyses or other recommendations, then Terraprobe should be retained to review the implications of these changes with respect to the contents of this report.

5.1 Foundation

Boreholes 3, 6, 101, 102 and 103 advanced within the proposed building footprint typically encountered the topsoil at the ground surface underlain by the earth fill zone extending to depths ranging from 0.8 m below grade (Elev. 265.5 to 266.3 m), which was underlain by undisturbed silt and clay to clayey silt till deposit, extending to the full depth of the investigation in each borehole.

Based on the Site Plan prepared by Battaglia Architect Inc., the finished ground floor elevation for the temple would ranges from Elev. 267.531 to 270.788 m.

The existing topsoil, weathered/disturbed soils and earth fill soils are unsuitable for the support of proposed building foundations. All foundations must be supported on the underlying competent undisturbed native soils and engineered fill.

5.1.1 Foundations on Native Soil

The undisturbed silt and clay to clayey silt till deposit is considered suitable to support the proposed building foundations. A maximum net geotechnical reaction of 250 kPa (Serviceability Limit States, SLS) and a maximum factored geotechnical resistance of 375 kPa (Ultimate Limit States, ULS) may be used for design of conventional spread footing foundations (for vertical and concentric loads) supported on the underlying competent undisturbed silt and clay to clayey silt till deposit of very stiff to hard consistency.

The minimum width of the continuous strip footings must be 450 mm and the minimum footing area for column must be 0.9×0.9 m^2 regardless of loading considerations, in conjunction with the above recommended geotechnical resistance. The geotechnical resistance(s) as recommended allow for up to 25 mm of total settlement. This settlement will occur as load is applied and is linear elastic and non-recoverable. Differential settlement is a function of spacing, loading and foundation size.

5.1.2 Foundations on Engineered Fill

The site grades will be raised in some areas of the building footprint. Where site grades are required to be raised, consideration should be given to the construction of engineered fill which may also support building foundations at normal depths, if needed.

The engineered fill refers to earth fill designed and constructed with a full-time inspection and testing to support the building foundations without excessive settlement. Construction of engineered fill should only be conducted under the full-time engineering guidance and supervision.

Prior to the placement of the engineered fill, it is recommended that the topsoil, weathered /disturbed native soils be stripped from beneath and beyond the proposed building footprints (a minimum of 2 m beyond), and that the subgrade be proof rolled. Any soft or wet areas that deflect excessively during the proof roll should be sub-excavated and replaced with suitably compacted clean earth fill placed in maximum 150 mm thick lifts. It should be noted that localized subgrade stabilization measures may be required, based on proof roll assessment. The selection and sorting of the existing earth fill or weathered/disturbed native soil materials present on the site should be conducted under the supervision of a geotechnical engineer. These materials may be utilized as engineered fill, provided these soils are not too wet to achieve specified compaction and do not contain excessive organic inclusion. The moisture content of the engineered fill material must be within 2 percent of its optimum moisture content.

The engineered fill should consist of clean earth fill or imported granular materials (OPSS.MUNI 1010) and should be placed in maximum 150 mm thick lifts and compacted to a minimum of 98 percent Standard Proctor Maximum Dry Density (SPMDD). The engineered fill should extend for a distance of at least 2 m beyond the building footprint as measured at the founding level and should extend downwards from this point at a 1 to 1 (horizontal to vertical) slope, to the approved subgrade. In addition, the engineered fill should extend at least 0.6 m above the proposed foundation elevation. This is to ensure that the foundations are placed on the engineered fill both in plan and elevation. The engineered fill must be provided with a minimum of 1.2 m of earth cover or equivalent insulation to provide adequate frost protection.

The placement and inspection of the engineered fill must be conducted under the full-time supervision of a qualified geotechnical engineer. Provided the engineered fill is placed and compacted as indicated above, a maximum net allowable geotechnical reaction of 150 kPa at SLS and factored geotechnical resistance of 225 kPa at ULS may be utilized for the design of conventional spread footing foundations supported on engineered fill. Site grading plan should be reviewed by Terraprobe to better assess the suitability and requirements for engineered fill.

In case of footings supported on engineered fill, the minimum width for the conventional spread strip footing must be 600 mm, and the minimum size of the individual column footing must be 1,000 mm×1,000 mm, regardless of loading considerations.

It should be noted that for buildings placed on engineered fill, nominal reinforcing steel is recommended in the foundation walls. The reinforcing steel should consist of two (2) continuous 15 M bars at the top of the foundation wall and two (2) continuous 15 M bars at the bottom (Figure 3). A draft copy of "Engineered Fill Earthworks Specifications" is enclosed in the appendix section of this report for reference.

5.1.3 Foundation Installation

Prior to pouring concrete for the footings, the footing subgrade must be cleaned of all deleterious materials such as softened, disturbed or caved materials, as well as any standing water. If construction proceeds during freezing weather conditions, adequate temporary frost protection for the footing bases and concrete must be provided. As per the Ontario Building Code (2012), the foundation excavations must be inspected and approved (by Terraprobe) to ensure the bearing capacities stated below are applicable. If incompetent soils are encountered at the proposed bearing depths during foundation excavation or due to inadequate dewatering, sub-excavation to competent soil subgrade is required under the direction of the geotechnical engineer.

The isolated footings must be supported entirely either on the competent native soils or engineered fill and cannot be supported partially on engineered fill and partially on native soils.

For the continuous spread footings to be located in the transition zone (from engineered fill to native soils or vice versa), reinforcement in foundations in addition to the reinforcement in the foundation walls (see Figure 3) will be required extending to a minimum of 3 m on each side of the transition line.

All exterior foundations and foundations in unheated areas must be provided with a minimum soil cover of 1.2 m or equivalent insulation for frost protection. All footings must be designed and constructed to bear at least 0.3 m into the undisturbed native soil/engineered fill stratum.

It is noted that the native soils tend to weather rapidly and deteriorate on exposure to the atmosphere or surface water. Hence, foundation bases which remain open for an extended period of time should be protected by a skim coat of lean concrete.

5.2 Earth Pressure Design Parameters

Walls or bracings subject to unbalanced earth pressures must be designed to resist a pressure that can be calculated based on the following equation:

$$P = K [\gamma (h-h_w) + \gamma' h_w + q] + \gamma_w h_w$$

Where: P = the horizontal pressure (kPa)
K = the earth pressure coefficient

h = the depth below the ground surface (m)
h_w = the depth below the ground water level (m)
γ = the bulk unit weight of soil (kN/m^3)
γ_w = the bulk unit weight of water (9.8 kN/m^3)
γ' = the submerged unit weight of the exterior soil, (γ_{sat} - γ_w)
q = the complete surcharge loading (kPa)

Where the wall backfill can be drained effectively to eliminate hydrostatic pressures on the wall, this equation can be simplified to:

$$P = K[\gamma h + q]$$

This equation assumes that free-draining granular backfill is used and positive drainage is provided to ensure that there is no hydrostatic pressure acting in conjunction with the earth pressure.

Resistance to sliding of retaining structures is developed by friction between the base of the footing and the soil. This friction **(R)** depends on the normal load on the soil contact (**N**) and the frictional resistance of the soil (**tan ϕ**) expressed as **R = N tan ϕ**. The factored geotechnical resistance at ULS is **0.8 R**.
Passive earth pressure resistance is generally not considered as a resisting force against sliding for conventional retaining structure design because a structure must deflect significantly to develop the full passive resistance.

The average values for use in the design of structures subject to unbalanced earth pressures at this site are tabulated as follow:

Parameter	Definition	Units
ϕ	angle of internal friction	degrees
γ	bulk unit weight of soil	kN/ m^3
K_a	active earth pressure coefficient (Rankine)	dimensionless
K_o	at-rest earth pressure coefficient (Rankine)	dimensionless
K_p	passive earth pressure coefficient (Rankine)	dimensionless

Stratum/Parameter	Φ (degree)	γ (kN/m^3)	K_a	K_o	K_p
Weathered/Disturbed Soil/Earth Fill	28	19.0	0.36	0.53	2.77
Undisturbed Silt and Clay to Clayey Silt Till	32	21.0	0.31	0.47	3.25

The above values of the earth pressure coefficients are for the horizontal backfill grade behind the wall. The earth pressure coefficients for inclined grade will vary based on the inclination of the retained ground surface.

5.3 Earthquake Design Parameters

The Ontario Building Code (OBC) stipulates the methodology for earthquake design analysis. The determination of the type of analysis is predicated on the importance of the structure, the spectral response acceleration and the site classification.

Under Ontario Regulation 88/19, the ministry amended Ontario's Building Code (O. Reg 332/12) to further harmonize Ontario's Building Code with the 2015 National Codes. These changes will help reduce red tape for businesses and remove barriers to interprovincial trade throughout the country. The amendments are based on code change proposals the ministry consulted in 2016 and 2017. The majority of the amendments came into effect on January 1, 2020, which includes structural sufficiency of buildings to withstand external forces and improve resilience.

Seismic hazard is defined in the Ontario Building Code by uniform hazard spectra (UHS) at spectral coordinates of 0.2s, 0.5s, 1.0s and 2.0s 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 (vs), Standard Penetration Test (SPT) resistance, and undrained shear strength (s_u) in the top 30 meters of the site stratigraphy below the foundation level, as set out in the Ontario Building Code. 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 soils). The site class is then used to obtain peak ground acceleration (PGA), peak ground velocity (PGV) site coefficients F_a and F_v, respectively, used to modify the UHS to account for the effects of site-specific soil conditions.

Based on the above, it is recommended that the site designation for seismic analysis be **Site Class C**, as per the Ontario Building Code. It should be noted that the above site seismic designation is estimated on the basis of rational analysis of the undrained shear strength information obtained from the borehole advanced at the site only up to about 8.1 m depth below grade. Consideration may be given to conducting a site-specific Multichannel Analysis of Surface Waves (MASW) at this site to confirm the average shear wave velocity in the top 30 metres of the site stratigraphy.

The values of the site coefficient for design spectral acceleration at period T, F(T), and of similar coefficients F(PGA) and F(PGV) shall conform to Tables 4.1.8.4.B. to 4.1.8.4.I. using linear interpolation for intermediate values of PGA.

5.4 Slab-on-Grade

Conventional lightly loaded concrete floor slab should be placed on at least 150 mm of granular base (OPSS.MUNI 1004 19 mm clear stone) compacted to a dense state by vibration. The weathered/disturbed native soil may remain to support the slab-on-grade provided they are approved by the geotechnical engineer at the time of construction. Any subgrade area containing excessive amounts of deleterious materials must be sub-excavated. The subgrade must be assessed by a geotechnical engineer or its representative, prior to placement of the granular base. Any soft or wet subgrade areas identified, should be locally sub-excavated and backfilled with clean earth fill compacted to a minimum of 98 percent Standard Proctor Maximum Dry Density (SPMDD). Based on the borehole information, selection and sorting of the weathered/disturbed native materials will be required.

Suitable geotextile (for instance OPSS.MUNI 1860 Class II non-woven geotextile) needs to be placed to separate granular base course from the subgrade to prevent migration of soil fines where the silt/sand subgrade soils are encountered.

The following subgrade parameters are recommended for the design of slab-on-grade supported on the undisturbed glacial deposit, engineered fill material or compacted earth fill compacted to 98 percent of SPMDD:

K_s = 40,000 kPa/m (undisturbed native glacial till)
K_s = 20,000 kPa/m (engineered fill)
K_s = 18,000 kPa/m (compacted earth fill)

Provided the finish floor level of the slab-on-grade building is at least 200 mm above the outside design grade, and the site is graded to promote drainage away from the building; subfloor drainage provisions are not required.

Regardless of the approach to slab construction, the floor slabs that are to have bonded floor finish (such as tiles with adhesives) should be provided with a capillary moisture break and a vapour barrier. The floor manufacturers have specific requirements for moisture and vapour barrier, therefore, the floor designer/ architect must ensure that a provision of appropriate moisture and vapour barrier conforming to specific floor finish product requirements is incorporated in the project specifications. Adequate testing must be carried out to ensure acceptable levels of moisture and relative humidity in the concrete slab prior to the installation of floor finish. Studies indicate that a provision of 200 mm thick 19 mm Clear Stone base (OPSS.MUNI 1004) under the slab helps provide a good capillary moisture break provided the granular base is positively drained. However, this provision does not provide protection against moisture vapour migration and/or replace the floor manufacturers' specific requirement(s) for a moisture and vapour barrier.

The under-slab vapour retarder specifications, selection and installation shall conform to ASTM E1745 and ASTM E1643. The moisture vapour measurement tests shall conform to RH: ASTM F2170, RH: ASTM F2420 and Calcium Chloride: ASTM F1869. The Surface Applied Moisture Vapour Barrier system shall meet the guidelines established in ASTM F3010-13.

The soils at this site are susceptible to frost effects which would have the potential to deform hard landscaping material adjacent to the building. It is likely that the buildings may have flush entrances, therefore care must be taken in detailing the exterior slabs/sidewalks by providing insulation/drainage

/non-frost susceptible backfill to maintain the flush threshold during freezing weather conditions. Alternatively, a frost slab construction may be employed at these locations.

5.5 Pavement

Based on the preliminary design information, a parking lot would be constructed in the eastern portion of the project site. It is understood that the proposed parking lot will be mainly subjected to passenger car traffic, with occasional commercial vehicle traffic, for instance fire truck, garbage truck, delivery truck, etc.

5.5.1 Pavement Design

The asphalt pavement design for parking lot and fire route/driveway is provided in the following table:

Pavement Structural Layers	Parking Lot	Fire Route and Driveway
HMA Surface Course, OPSS.MUNI 1150 HL 3	40 mm	40 mm
HMA Binder Course, OPSS.MUNI 1150 HL 8	50 mm	65 mm
Granular Base Course, OPSS.MUNI 1010 Granular A	150 mm	150 mm
Granular Subbase Course, OPSS.MUNI 1010 Granular B Type I	300 mm	400 mm
Total Thickness	540 mm	655 mm

5.5.2 Drainage

Control of water is an important factor in achieving a good pavement life. Therefore, we recommend that provisions be made to drain the new pavement subgrade and its granular layers. Drainage can be achieved by installing catchbasin(s) and a storm sewer system to collect surface runoff and, this system can also be used for subsurface drainage by installing subdrains that are designed to drain into the catchbasins. The subgrade must be free of depressions and sloped at a grade of 3 percent to provide positive drainages.

Continuous pavement subdrains (designed to drain into catchbasins) should be provided along both sides of the driveway curblines. Two lengths of subdrain (each minimum 3 m long) should also be installed at each catchbasin at the parking lot area. All sub-drain arrangements should comply with *OPSD 216.021 Subdrain Pipe, Connection and Outlet, Urban*.

5.5.3 General Pavement Recommendations

HL 3 and HL 8 hot mix asphalt mixes should be designed, produced and placed in conformance with OPSS 1150 and OPSS 310 requirements and pertinent Town's standards.

Granular base and subbase materials should meet the requirements of OPSS MUNI 1010. Granular materials should be compacted to 100 percent SPMDD at ±2 percent of the OMC.

PG 58-28, conforming to OPSS MUNI 1101 is recommended in the HMA surface and binder courses.

Tack coat SS-1 should be applied between hot mix asphalt binder course and surface course.

5.5.4 Subgrade Preparation

All topsoil, organics, soft/loose soils should be stripped from the subgrade areas. The exposed subgrade is expected to consist of silt and clay to clayey silt glacial till deposit or the earth fill materials and these soils will be weakened by construction traffic when wet; especially if site work is carried out during the periods of wet weather. An adequate granular working surface would be likely required in order to minimize subgrade disturbance and protect its integrity in wet periods.

Immediately prior to placing the granular subbase, the exposed subgrade should be proof rolled with a heavy rubber-tired vehicle (such as a loaded gravel truck). The subgrade should be inspected for signs of rutting, distress and displacement. Areas displaying signs of rutting, distress and displacement should be recompacted and retested or, these materials should be locally excavated and replaced with well-compacted clean approved fill material.

The fill material may consist of either granular material or local inorganic soils provided that its moisture content is within ±2 percent of OMC. Fill material should be placed and compacted in accordance with OPSS.MUNI 501 and the subgrade should be compacted to 98 percent of SPMDD. The final subgrade surface should be sloped at least 3 percent to provide positive drainage.

5.6 Storm Water Management Pond

A storm water management (SWM) pond will be constructed in the southwest portion of the site. The preliminary Servicing Plan prepared by Crozier Consulting Engineers indicated that the top elevation of the SWM pond would be set at Elev. 265.45 m while the bottom elevations of the SWM pond would be set at Elev. 265.45 m and Elev. 263.95 m.

5.6.1 Pond Base and Slope

Boreholes 104 and 105 advanced within the proposed pond footprint encountered a surficial layer of topsoil underlain by weathered/disturbed soil extending to 0.8 m depth below grade (Elev. 265.4 m and

264.4 m), which was underlain by undisturbed native silt and clay to clayey silt glacial till deposit extending to the full depth of investigation.

The results of the grain size distribution test indicate that the till deposit comprises 1 and 2 percent gravel, 24 and 18 percent sand, 48 and 51 percent silt and 26 and 30 percent clay size particles. The estimated permeability of the glacial till deposit (based on the grain size distribution) is on the order of 10^{-6} cm/sec. For design purpose, an average infiltration rate of 12 mm/hour can be assumed.

The pond base and sides are expected to comprise low permeability glacial till soil and therefore, a clay liner may not be required.

It is recommended that the pond slopes and base must be inspected by a geotechnical engineer to assess the exposed subgrade soil conditions to identify presence of any relatively permeable weathered/disturbed soils, and silt or sand layers/pockets typically found within the till deposit, to provide recommendations for possible modification to the geotechnical design of the pond. These modifications may include local sub-excavation of the relatively permeable soil zone(s) and backfilling with approved low permeability clayey soils.

Based on the subsurface conditions encountered in the borehole, the recommended stable slope inclinations for the pond side slope is 3 horizontal to 1 vertical (or flatter) and back slopes matches the existing grades. There is no permanent water pond anticipated. It must be noted that regulatory agencies may have specific requirements with respect to pond slope design in addition to the slope considerations noted above.

5.6.2 Earth Berm and Pond Slope Surface Treatment

The final pond design grade may require an earth-berm. The earth fill materials used for the berm construction must include a minimum of 15 percent clay (finer than 0.002 mm) and 35 percent silt sized (finer than 0.075 mm, i.e., passing No. 200 sieve) particles. This material must not include particles greater than 100 mm dimension, greater than 15 percent of the material larger than 4.75 mm size (No. 4 sieve), and greater than 5 percent organic content by weight, as well as visible roots, stumps and topsoil. The clayey silt till deposit at this project site could be used for the pond berm construction. The earth fill materials should be placed in lifts not exceeding 150 mm and be compacted to a minimum of 95 percent of the SPMDD. The materials shall be placed and compacted at a water content of between 1½ percent dry and 2½ percent wet of the optimum moisture content. In order to achieve required compaction of the berm fill soils at the edges, consideration should be given to over-build the berm (minimum 1.5 m beyond the design slope surface) and cut neatly to the final design slope configuration.

The subgrade area beneath berm fill and pond base should be stripped to remove all organics, topsoil and vegetation. The exposed subgrade should be proof-rolled and inspected by a qualified geotechnical engineer to confirm the founding soil conditions. Any loose, soft or otherwise deleterious materials must be removed to their full extent and replaced with compacted earth fill (as specified) under the direction of a qualified geotechnical engineer. Similarly, pockets/areas of sand/silt soils must be identified, sub-excavated and replaced with compacted and approved low permeability earth fill soils as specified above. The subgrade should be compacted to at least 95 percent SPMDD prior to the berm fill placement.

The final slope surface and all bare or exposed areas (where applicable) should be provided with suitable ground cover or erosion protection. The slope surface should be provided with a thin layer of topsoil (minimum 100 mm thick) and should be hydro-seeded with a grass mixture and mulch. If seeded, during the first 2 to 3 years, the surface cover of topsoil and seeding may require periodic maintenance until the vegetation becomes well established. It is recommended that erosion netting be staked on the outside slope (where applicable) for erosion protection (and inside slope which is above the water level).

It is understood that the inside slopes of the SWM pond will likely be vegetated with aquatic vegetation species. It should be noted that periodic fluctuations in the pond water level will make inside slopes susceptible to minor sheet and rill erosion over extended periods of exposure if these slopes remain bare and without vegetation. Occasional maintenance and repair of the inside bare pond slopes (and removal of accumulated sediment in the base) will be required. A lining of the pond inside slopes would reduce the amount of maintenance. This lining may consist of rip-rap or local field stones.

The emergency spillway must be provided with a significant erosion resistant lining consisting of either rip-rap, gabion mattresses, buried and staked Geoweb and/or Duramat Concrete Units (or equivalent). The lining at least should extend from the design high water level to over the berm and down to the berm/pond slope toe. It is recommended that any piping or trenching in the area of the pond should be provided with seepage cut-off collars (clay plugs, concrete plugs, or other barriers) to protect against water seepage through the pipe bedding and backfill.

In case the relatively permeable zones (sandy silt to silty sand) are encountered in the pond slope and base, these zones should be sub-excavated and replaced with approved low permeability soils as specified above. The backfill soil should consist of a natural soil material (such as clay or clayey silt). Primary considerations for the design of the clay backfill will be low permeability, protection from frost damage, desiccation, and burrowing animals. The clay backfill should be a minimum of 1.0 m thick. The backfill soils must consist of low permeability materials (clayey silt or clay) in order to perform adequately and to provide a barrier to potential seepage. As noted before, the backfill material must include a minimum of 15 percent clay (finer than 0.002 mm) and 35 percent silt sized (finer than 0.075 mm, i.e., passing No. 200 sieve) particles. The backfill material must not include particles greater than 100 mm dimension, greater than 15 percent of the material larger than 4.8 mm sizes (No. 4 sieve), and greater than 5 percent organic content by weight, as well as visible roots, stumps and topsoil.

It is required to ensure that the berm soils and backfill materials for the permeable zones (if encountered in the base and sides of the pond) are compacted to a homogenous mass, and does not remain as distinct "clods" or "clumps". The backfill should be constructed in thin lifts (not exceeding 150 mm thick) and heavily compacted to a minimum of 95 percent SPMDD. The soil should not contain any frozen material should the construction proceeds under winter conditions (ideally not recommended). Also, adequate protection against frost penetration must be provided, as required (e.g. straw bales, tarping, heating).

The delineation of the permeable soil zones, sub-excavation and backfill/replacement must be conducted under the full time supervision of a qualified geotechnical engineer.

It is recognized that a broad range of soil materials may be suitable for the low permeability backfill material (i.e., will meet the specifications noted above). It is recommended that contractors bidding on the project provide the results of testing, to indicate the following:

- The location (source) of the clay material
- Verification of the uniformity of the material
- Demonstration that sufficient material is available for the project
- Laboratory testing to demonstrate that material meets the minimum specifications noted above.

The berm construction must be conducted under the full time supervision of a qualified geotechnical engineer. Periodic on-site samples should be collected and tested to ensure that the material placed conforms to the project specification.

5.6.3 Operational Considerations

The following general considerations are recommended with respect to the long-term operation and maintenance of the pond:

- A minimum operating freeboard of 0.3 m should be maintained between the high water level and the pond rim. Overtopping of the pond, as a result of overfilling or flooding, would result in severe damage and possible breaching or failure of the earth berm, spillway and the downstream slope. A provision of an overflow conveyance route/spillway is recommended to prevent pond overtopping.
- The flat surface (maintenance/access road) at the top of the pond/berm must be a minimum of 3.0 m wide to facilitate adequate compaction and to accommodate service vehicles for maintenance.
- The pond should be carefully inspected each season for including but not limited to the following:
    - ► General condition of various pond components to identify areas of erosion, settlement, slump or deterioration.

- Inspection of pond base and slope surface for discontinuities or holes as a result of burrowing animals, vandalism, settlement, or the like.
- Removal of unwanted vegetation (tree, seedlings and the like) from within the footprint of the pond area.

Any damaged or deteriorated areas must be repaired regularly.

It must be noted that regulatory agencies stipulate pond slope inclinations and other requirements for storm water management pond design. These specifications may have requirements above and beyond the geotechnical recommendations provided in this report, and must be followed.

5.7 Pipe Bedding and Cover/Embedment

The design details and invert elevations of the underground utilities were not available at the time of preparation of this report. The following sections provide preliminary geotechnical engineering information for the design of underground services with relatively shallow inverts. Trench excavation should be carried out in accordance with the *Occupational Health and Safety Act (OHSA) and Regulations for Construction Projects* (O.Reg. 213/91 with recent amendments) (refer to Section 5.8 for details), while trench bedding, backfilling and compaction should be carried out in accordance with OPSD 802 series/or OPSS.MUNI 401 and the Town’s standards as appropriate.

The undisturbed silt and clay to clayey till deposit will be suitable for support of buried services that are properly bedded. Where disturbance of the trench base has occurred, due to ground water seepage, or construction traffic, the disturbed soils should be sub-excavated and replaced with suitably compacted granular material. Any accumulation of water at the base of the excavation and any soft/loose soils should be removed prior to placement of the pipe bedding/embankment. Placement of the pipe bedding/embedment must be done in dry condition.

Rigid pipes should be installed in conformance with the OPSD 802.030 or OPSD 802.031 requirements, while flexible pipes should be installed in conformance with the OPSD 802.010 requirements. The recommended bedding and embedment materials should be OPSS.MUNI 1010 Granular A or 19 mm crusher run limestone. The cover materials for rigid pipes should be OPSS.MUNI 1010 Granular B with 100 percent passing 26.5 mm sieve.

Further detail information on bedding/embedment and cover materials can be provided following availability of detailed design drawings.

The bedding, embedment and cover materials should be placed in layers not exceeding 200 mm in thickness and compacted to a minimum of 95 percent SPMDD or vibrated into a dense state in the case of clear stone type bedding.

5.8 Excavations and Ground Water Control

The boreholes data indicate that the weathered/disturbed materials and undisturbed native soils would be encountered in the excavations. Excavations must be carried out in accordance with the *Occupational Health and Safety Act and Regulations for Construction Projects*. These regulations designate four (4) broad classifications of soils to stipulate appropriate measures for excavation safety.

TYPE 1 SOIL

a. is hard, very dense and only able to be penetrated with difficulty by a small sharp object;
b. has a low natural moisture content and a high degree of internal strength;
c. has no signs of water seepage; and
d. can be excavated only by mechanical equipment.

TYPE 2 SOIL

a. is very stiff, dense and can be penetrated with moderate difficulty by a small sharp object;
b. has a low to medium natural moisture content and a medium degree of internal strength; and
c. has a damp appearance after it is excavated.

TYPE 3 SOIL

a. is stiff to firm and compact to loose in consistency or is previously-excavated soil;
b. exhibits signs of surface cracking;
c. exhibits signs of water seepage;
d. if it is dry, may run easily into a well-defined conical pile; and
e. has a low degree of internal strength

TYPE 4 SOIL

a. is soft to very soft and very loose in consistency, very sensitive and upon disturbance is significantly reduced in natural strength;
b. runs easily or flows, unless it is completely supported before excavating procedures;
c. has almost no internal strength;
d. is wet or muddy; and
e. exerts substantial fluid pressure on its supporting system.

The earth fill and weathered/disturbed soil would be classified as Type 3 Soil while the native glacial till deposits would be classified as Types 2 Soil above and Type 3 Soil below prevailing ground water level under these regulations.

Where workmen must enter excavations advanced deeper than 1.2 m, the trench walls should be suitably sloped and/or braced in accordance with the Occupational Health and Safety Act and Regulations for Construction Projects. The regulation stipulates the steepest slopes of excavation by soil type as follows:

Soil Type	Base of Slope	Steepest Slope Inclination
1	within 1.2 metres of bottom of trench	1 horizontal to 1 vertical
2	within 1.2 metres of bottom of trench	1 horizontal to 1 vertical
3	from bottom of trench	1 horizontal to 1 vertical
4	from bottom of trench	3 horizontal to 1 vertical

Minimum support system requirements for steeper excavations are stipulated in the Occupational Health and Safety Act and Regulations for Construction Projects, and include provisions for timbering, shoring and moveable trench boxes.

It should be noted that the glacial till deposit may contain larger particles (cobbles and boulders) that are not specifically identified in the Borehole Logs. The size and distribution of such obstructions cannot be predicted with borings, because the borehole sampler size is insufficient to secure representative samples of the particles of this size. Provision should be made in excavation contracts to allocate risks associated with time spent and equipment utilized to remove or penetrate such obstructions when encountered.

The ground water levels measured on November 19 and December 1, 2021 in the monitoring wells (installed in Boreholes 101, 103, 104, 106 and 107) indicated that the water levels ranged from 0.6 to 5.9 m depth below grade.

The site is underlain by relatively low permeability glacial till deposits that should preclude significant amounts of free-flowing ground water seepage into the excavation in the short-term. Therefore, significant ground water seepage is not expected for the relatively shallow excavation, and active dewatering (by well points etc.) would not be required. However, perched ground water seepage may be encountered during the excavations primarily emanating from the fill materials and silt/sand lenses typically found in the glacial till deposit due to its mode of deposition. The perched ground water seepage should diminish slowly and can be controlled by continuous pumping from a conventional sump and pump arrangement at the base of the excavation. For excavations extending to depths greater than 0.3 m below the prevailing water table, it will be necessary to lower the ground water level below the excavation base, prior to, and maintain during the subsurface construction.

5.8.1 Regulatory Requirements

The volume of water entering the excavation will be based on both ground water infiltration and precipitation events. Based on recent regulation changes within O.Reg. 63/16, the following dewatering limits and requirements are as follows:

- Construction Dewatering less than 50,000 L/day: The takings of both ground water and storm water **does not require** a Construction Dewatering Assessment Report (CDAR) and **does not require** a Permit to Take Water (PTTW) from the Ministry of the Environment and Climate Change (MOECC).
- Construction Dewatering greater than 50,000 L/day and less than 400,000 L/day: The taking of ground water and/or storm water **requires** a Construction Dewatering Assessment Report (CDAR) and **does not** require a Permit to Take Water (PTTW) from the Ministry of the Environment and Climate Change (MOECC).

- Construction Dewatering greater than 400,000 L/day: The taking of ground water and/or storm water **requires** a Construction Dewatering Assessment Report (CDAR) and **requires** a Permit to Take Water (PTTW) from the Ministry of the Environment and Climate Change (MOECC).

If it is expected that greater than 50,000 L/day of water will be pumped, a CDAR and/or a PTTW should be obtained as soon as possible in advance of construction to avoid possible delays. Depending on the construction methodology for the site servicing (trench boxes or open cut, and length of trench) and the time of year (high versus low ground water levels), there is the possibility that water taking of greater than 50,000 L/day may occur at this site.

A CDAR takes up to 1 month to complete if monitoring wells are already installed on site. Once the CDAR is completed, it is uploaded to the Environmental Activity and Sector Registry (EASR), which registers the construction dewatering with the MOECC without the need for a permit. If the results of the CDAR indicate that greater than 400,000 L/day will be pumped, a PTTW application must be submitted to the MOECC. A PTTW application can take up to an additional 3 months for the MOECC to process upon completion of the CDAR. Note that Environmental Compliance Assessments, Impact Study Reports and applicable municipal, provincial and conservation authority approvals (completed by others) will be required as part of the CDAR.

5.9 Backfill

The native soils are considered suitable for backfill provided the moisture content of these soils is within 3% of the Optimum Moisture Content (OMC). It should be noted that there may be wet zones within the subsurface soils (particularly soils excavated from below the prevailing water level) which could be too wet to compact. Any soil material with 3% or higher in-situ moisture content than its OMC, could be put aside to dry or be tilled to reduce the moisture content so that it can be effectively compacted. Alternatively, materials of higher moisture content could be wasted and replaced with imported material which can be readily compacted.

In settlement sensitive areas, the backfill should consist of clean earth and should be placed in lifts of 150 mm thickness or less, and heavily compacted to a minimum of 95% SPMDD at a water content close to optimum (within 2%). The upper 1.2 m of the pavement subgrade must be compacted to a minimum of 98% SPMDD.

It should be noted that the soils encountered on the site are generally not free draining, and will be difficult to handle and compact should they become wetter as a result of inclement weather or seepage. Hence, it can be expected that the earthworks will be difficult and may incur additional costs if carried out during wet periods (i.e. spring and fall) of the year.

5.10 Quality Control

Excavations on this site must be shored to preserve the integrity of the surrounding properties and structures. The Ontario Building Code 2012 stipulates that engineering review of the subsurface conditions is required on a continuous basis during the installation of earth retaining structures. Terraprobe should be retained to provide this review, which is an integral part of the geotechnical design function as it relates to the shoring design considerations. Terraprobe can provide detailed shoring design services for the project, if requested. All foundations must be monitored by the geotechnical engineer on a continuous basis as they are constructed. The on-site review of the condition of the foundation soil as the foundations are constructed is an integral part of the geotechnical design function and is required by Section 4.2.2.2 of the Ontario Building Code 2012. If Terraprobe is not retained to carry out foundation evaluations during construction, then Terraprobe accepts no responsibility for the performance or non-performance of the foundations, even if they are ostensibly constructed in accordance with the conceptual design advice provided in this report.

Concrete for this structure will be specified in accordance with the requirements of CAN3 - CSA A23.1. Terraprobe maintains a CSA certified concrete laboratory and can provide concrete sampling and testing services for the project as necessary.

The requirements for fill placement on this project should be stipulated relative to SPMDD, as determined by ASTM D698. In-situ determinations of density during fill placement by Procedure Method B of ASTM D2922 are recommended to demonstrate that the contractor is achieving the specified soil density. Terraprobe is a CNSC licensed operator of appropriate nuclear density gauges for this work and can provide sampling and testing services for the project as necessary.

Terraprobe can provide thorough in house resources, quality control services for Building Envelope, Roofing and Structural Steel in accordance with CSA W178, as necessary, for the Structural and Architectural quality control requirements of the project. Terraprobe is certified by the Canadian Welding Bureau under W178.1-1996.

6 LIMITATIONS AND RISK

6.1 Procedures

This investigation has been carried out using investigation techniques and engineering analysis methods consistent with those ordinarily exercised by Terraprobe and other engineering practitioners, working under similar conditions and subject to the time, financial and physical constraints applicable to this project. The discussions and recommendations that have been presented are based on the factual data obtained by Terraprobe.

It must be recognized that there are special risks whenever engineering or related disciplines are applied to identify subsurface conditions. Even a comprehensive sampling and testing programme implemented in accordance with the most stringent level of care may fail to detect certain conditions. Terraprobe has assumed for the purposes of providing design parameters and advice, that the conditions that exist between sampling points are similar to those found at the sample locations. The conditions that Terraprobe has interpreted to exist between sampling points can differ from those that actually exist.

It may not be possible to drill a sufficient number of boreholes or sample and report them in a way that would provide all the subsurface information that could affect construction costs, techniques, equipment and scheduling. Contractors bidding on or undertaking work on the project should be directed to draw their own conclusions as to how the subsurface conditions may affect them, based on their own investigations and their own interpretations of the factual investigation results, cognizant of the risks implicit in the subsurface investigation activities so that they may draw their own conclusions as to how the subsurface conditions may affect them.

6.2 Changes in Site and Scope

It must also be recognized that the passage of time, natural occurrences, and direct or indirect human intervention at or near the site have the potential to alter subsurface conditions. Groundwater levels are particularly susceptible to seasonal fluctuations.

The discussion and recommendations are based on the factual data obtained from this investigation made at the site by Terraprobe and are intended for use by the owner and its retained designers in the design phase of the project. If there are changes to the project scope and development features, the interpretations made of the subsurface information, the geotechnical design parameters and comments relating to constructability issues and quality control may not be relevant or complete for the revised project. Terraprobe should be retained to review the implications of such changes with respect to the contents of this report.

This report was prepared for the express use of SMVS Canada and their retained design consultants and is not for use by others. This report is copyright of Terraprobe Inc. and no part of this report may be reproduced by any means, in any form, without the prior written permission of Terraprobe Inc. and SMVS Canada who are the authorized users.

It is recognized that the regulatory agencies in their capacities as the planning and building authorities under Provincial statues, will make use of and rely upon this report, cognizant of the limitations thereof, both expressed and implied.

We trust the foregoing information is sufficient for your present requirements. If you have any questions, or if we can be of further assistance, please do not hesitate to contact us.

Yours truly,

Terraprobe Inc.

Rattan Singh

LICENSED PROFESSIONAL ENGINEER
L. ZHANG
100108585
2022-05-12
PROVINCE OF ONTARIO

Rattan Singh, M.Eng., EIT
Engineer In Training

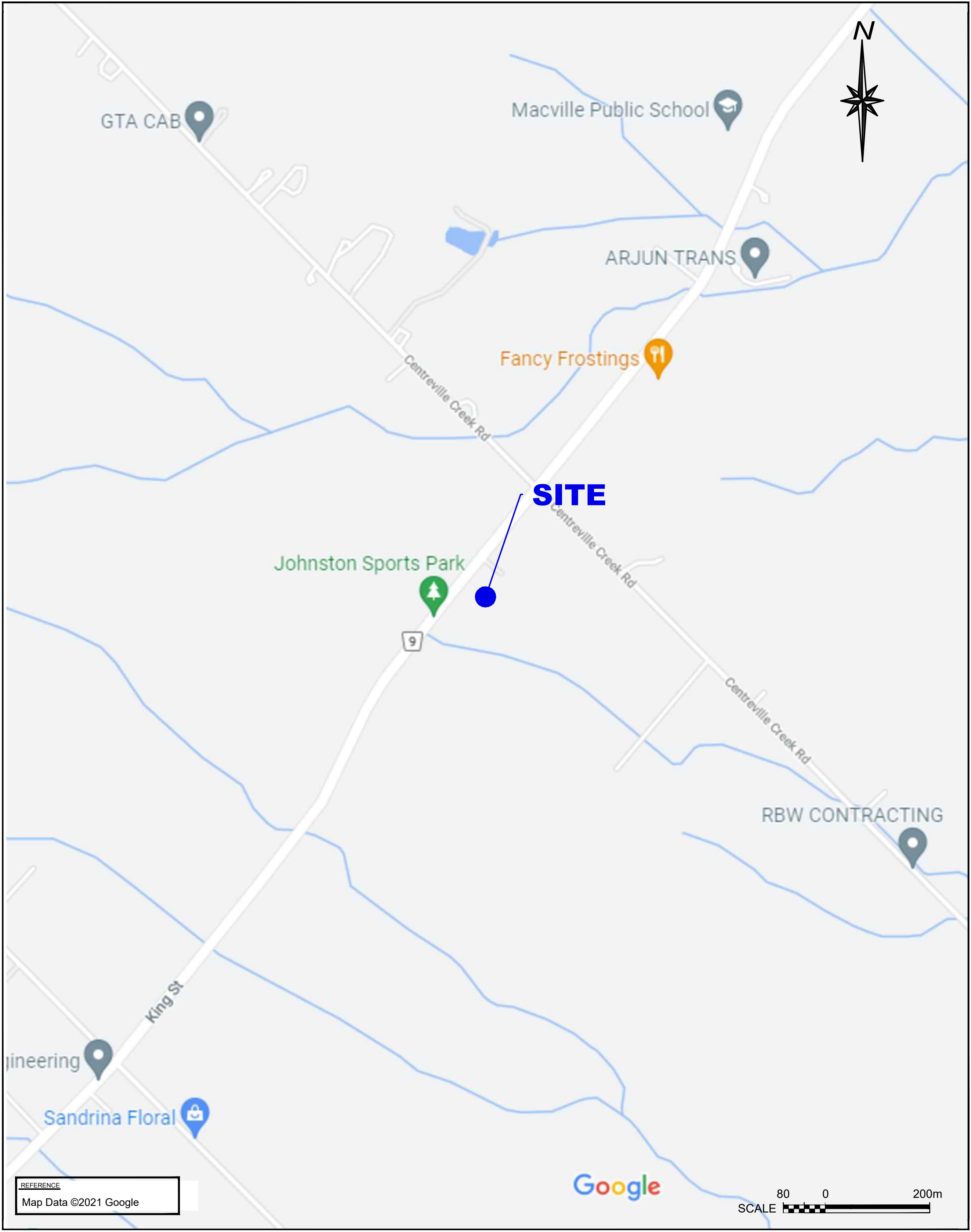
Seth Zhang, P. Eng., M.Eng., M.Sc.
Associate

ENCLOSURES

TERRAPROBE INC.

FIGURES

TERRAPROBE INC.



Terraprobe

11 Indell Lane, Brampton, Ontario, L6T 3Y3
Tel: (905) 796-2650 Fax: (905) 796-2250

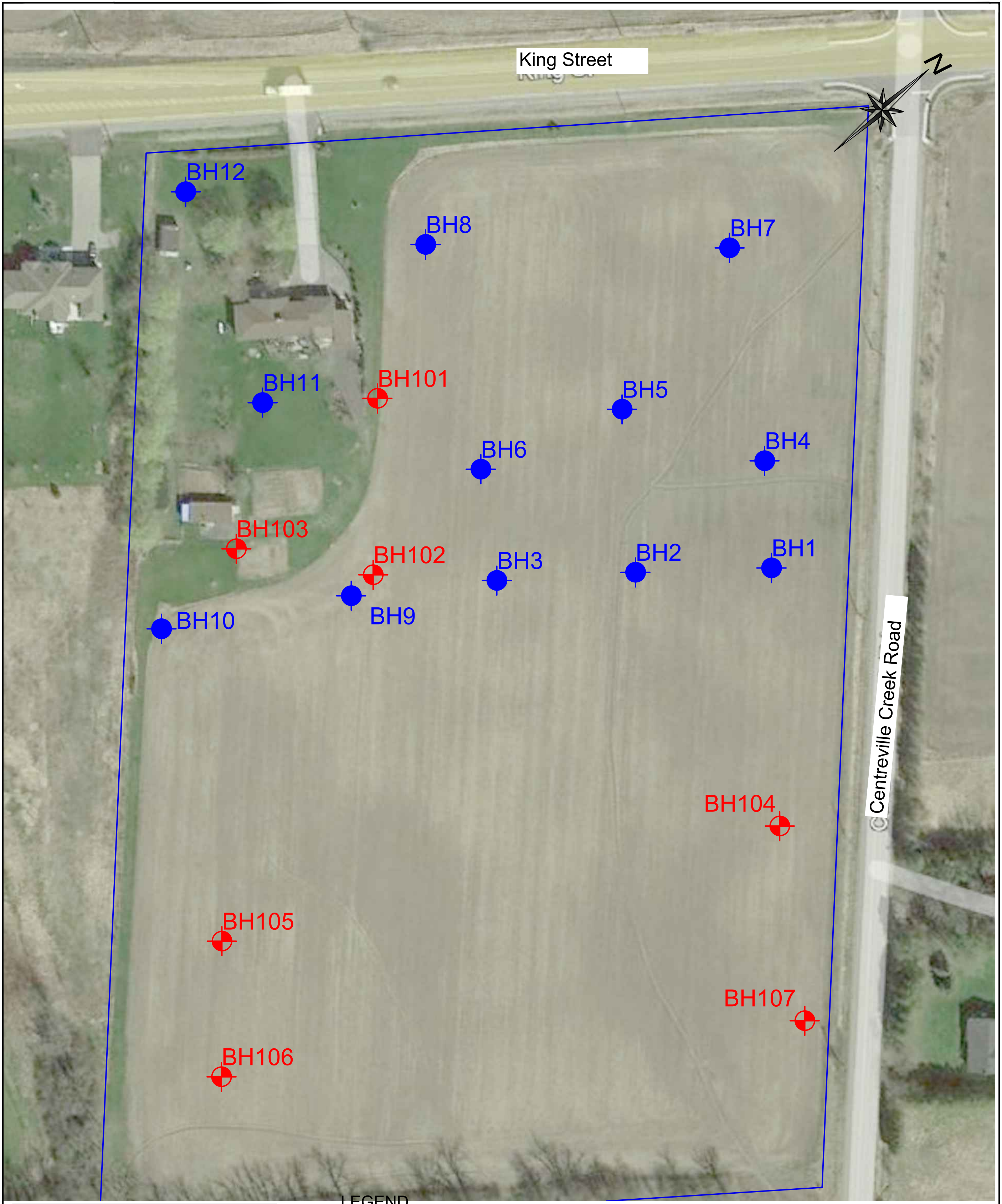
Title:

SITE LOCATION PLAN

File. No.: 1-20-222-02

FIGURE : 1

Z:\1-Projects\2020\1-20-0222 - 6939 King Street, Caledon\02-Supplementary Geotechnical Investigation\A. Dwgs, Logs\AutoCAD\1-20-0222-02Site.dwg,
12/7/2021 12:18:31 PM, DWG To PDF.pc3, 1:27



REFERENCE

Image ©2021 Google Earth

LEGEND

🟥 Approximate Borehole Location (2021)

● Approximate Borehole Location (2020)

SCALE 16 0 40m

Terraprobe

11 Indell Lane, Brampton, Ontario, L6T 3Y3
Tel: (905) 796-2650 Fax: (905) 796-2250

Title:

BOREHOLE LOCATION PLAN

Existing Condition

File. No.: 1-20-0222-02

FIGURE : 2A

\\10.70.216.35\tss\1-Project Files\2020\1-20-0222 - 6939 King Street, Caledon\02-Supplementary Geotechnical Investigation\A. Dwgs, Logs\AutoCAD\1-20-0222-02 BH Locations 2021-12-22.dwg,
DWG To PDF.pc3, Kamal, Kamal

REFERENCE

Title: Preliminary Servicing Plan
Project No.: 1990-5787
Dwg. No.: C702 Date: Dec 23, 2020
By: Crozier Consulting Engineers

LEGEND

⊕ Approximate Borehole Location (2021)
● Approximate Borehole Location (2020)

16 0 40m
SCALE

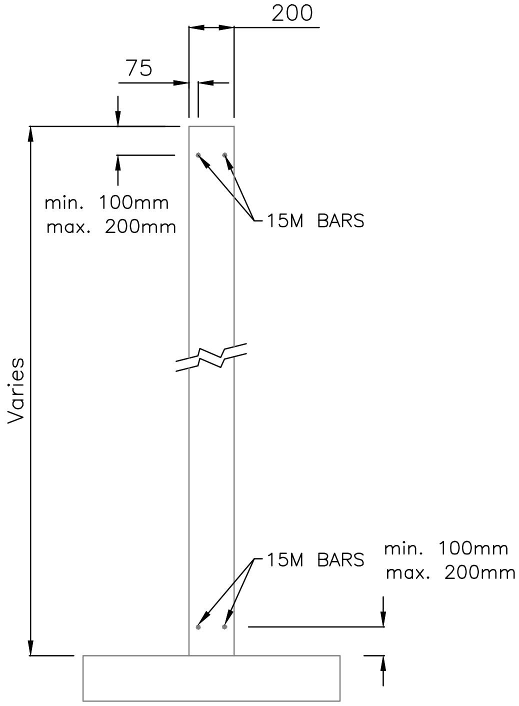
Terraprobe
11 Indell Lane, Brampton, Ontario, L6T 3Y3
Tel: (905) 796-2650 Fax: (905) 796-2250

Title:
BOREHOLE LOCATION PLAN
Proposed Condition

File No.: 1-20-0222-02

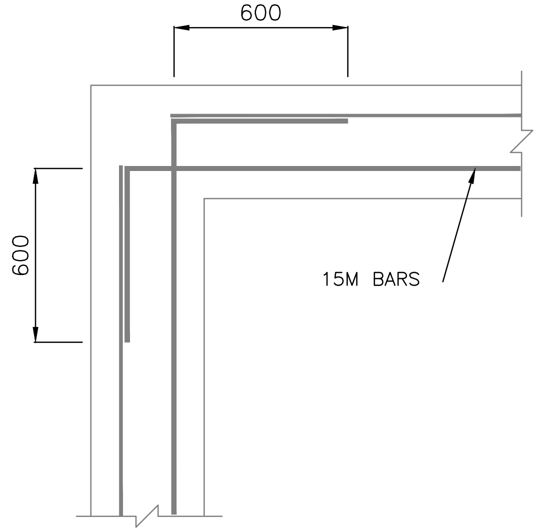
FIGURE :
2B

\\10.70.216.35\ts\1-Project Files\2020\1-20-0222 - 6939 King Street, Caledon\02-Supplementary Geotechnical Investigation\A. Dwgs, Logs\AutoCAD\1-20-0222-02 BH Locations 2021-12-22.dwg.
DWG To PDF.pc3, Kamal, Kamal



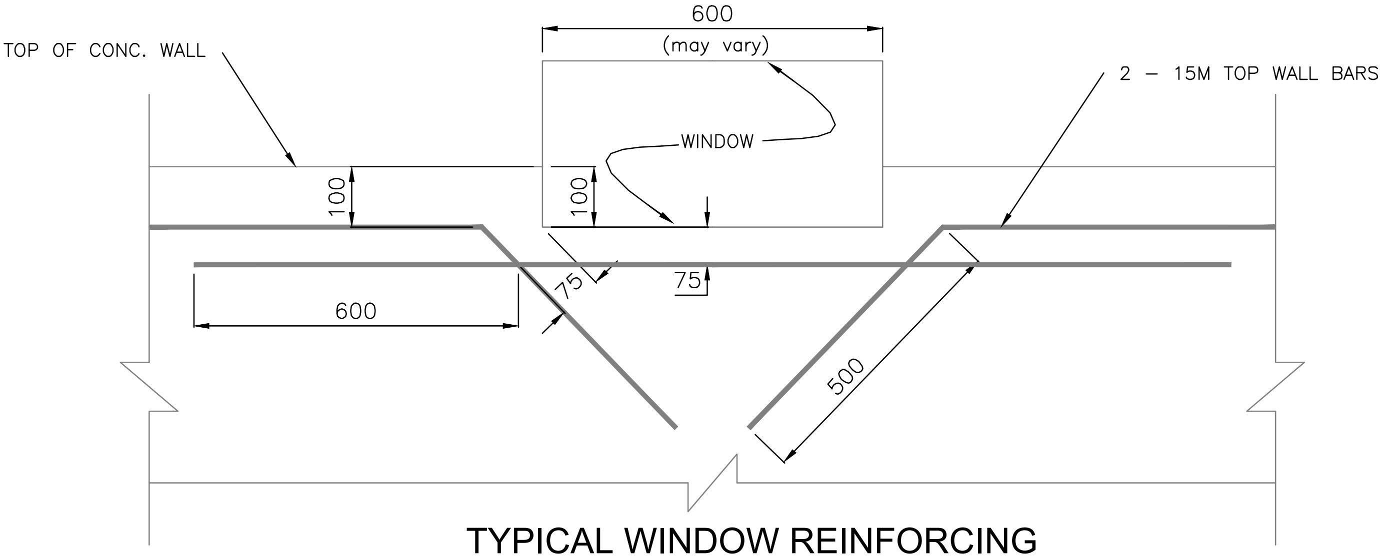
TYPICAL REINFORCED WALL

NOT TO SCALE



TYPICAL SPLICING AT CORNERS

NOT TO SCALE



TYPICAL WINDOW REINFORCING

NOT TO SCALE

NOTES:

1. Reinforcing steel C.S.A. G30.18–09 Grade 400
2. Concrete min. 28 day strength 20MPa (3000psi)
3. Base of all footing excavations to be inspected and approved prior to placing formwork.
4. All dimensions are in mm.

Terraprobe

11 Indell Lane, Brampton, Ontario, L6T 3Y3
Tel: (905) 796-2650 Fax: (905) 796-2250

Title:

TYPICAL FOUNDATION WALL DETAILS FOR
STRUCTURES ON ENGINEERED FILL

APPENDIX A

TERRAPROBE INC.

Terraprobe

ABBREVIATIONS AND TERMINOLOGY

SAMPLING METHODS

AS	auger sample
CORE	cored sample
DP	direct push
FV	field vane
GS	grab sample
SS	split spoon
ST	shelby tube
WS	wash sample

PENETRATION RESISTANCE

Standard Penetration Test (SPT) resistance ('N' values) is defined as the number of blows by a hammer weighing 63.6 kg (140 lb.) falling freely for a distance of 0.76 m (30 in.) required to advance a standard 50 mm (2 in.) diameter split spoon sampler for a distance of 0.3 m (12 in.).

Dynamic Cone Test (DCT) resistance is defined as the number of blows by a hammer weighing 63.6 kg (140 lb.) falling freely for a distance of 0.76 m (30 in.) required to advance a conical steel point of 50 mm (2 in.) diameter and with 60° sides on 'A' size drill rods for a distance of 0.3 m (12 in.)."

COHESIONLESS SOILS

Compactness	'N' value
very loose	< 4
loose	4 – 10
compact	10 – 30
dense	30 – 50
very dense	> 50

COHESIVE SOILS

Consistency	'N' value	Undrained Shear Strength (kPa)
very soft	< 2	< 12
soft	2 – 4	12 – 25
firm	4 – 8	25 – 50
stiff	8 – 15	50 – 100
very stiff	15 – 30	100 – 200
hard	> 30	> 200

COMPOSITION

Term (e.g)	% by weight
trace silt	< 10
some silt	10 – 20
silty	20 – 35
sand *and* silt	> 35

TESTS AND SYMBOLS

MH	mechanical sieve and hydrometer analysis
w, w_c	water content
w_L, LL	liquid limit
w_P, PL	plastic limit
I_P, PI	plasticity index
k	coefficient of permeability
γ	soil unit weight, bulk
G_s	specific gravity
φ'	internal friction angle
c'	effective cohesion
c_u	undrained shear strength

▽	Unstabilized water level
▼	1st water level measurement
▼	2nd water level measurement
▼	Most recent water level measurement
3.0 +	Undrained shear strength from field vane (with sensitivity)
C_c	compression index
c_v	coefficient of consolidation
m_v	coefficient of compressibility
e	void ratio

FIELD MOISTURE DESCRIPTIONS

Damp	refers to a soil sample that does not exhibit any observable pore water from field/hand inspection.
Moist	refers to a soil sample that exhibits evidence of existing pore water (e.g. sample feels cool, cohesive soil is at or close to plastic limit) but does not have visible pore water
Wet	refers to a soil sample that has visible pore water

Terraprobe

LOG OF BOREHOLE 101

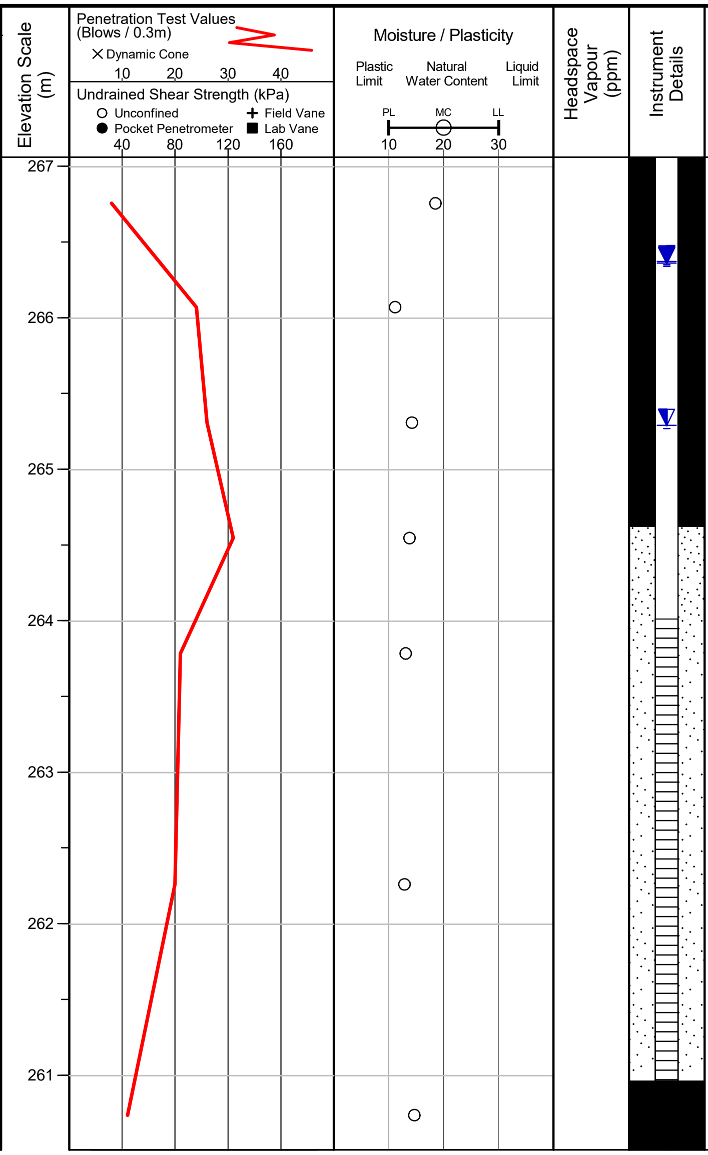
Project No. : 1-20-0222-02
Date started : November 11, 2021
Sheet No. : 1 of 1

Client : Swaminarayan Mandir Vasna Sanstha Canada
Project : 6939 King Street
Location : Caledon, Ontario

Originated by : SS
Compiled by : RS
Checked by : AR

Position : E: 597102, N: 4855671 (UTM 17T)
Rig type : Track-mounted
Elevation Datum : Geodetic
Drilling Method : Solid stem augers

Depth Scale (m)	Elev Depth (m)	SOIL PROFILE Description	SAMPLES Number	Type	SPT 'N' Value
0	267.1	**GROUND SURFACE**			
	266.9 0.2	150mm **TOPSOIL**			
		FILL, clayey silt, some sand, trace gravel, stiff, dark brown, moist	1	SS	8
1	266.3 0.8	**SILT AND CLAY to CLAYEY SILT**, trace to some sand, trace gravel, stiff to hard, brown, moist (GLACIAL TILL)	2	SS	24
2			3	SS	26
3			4	SS	31
			5	SS	21
4					
5		...grey below	6	SS	20
6			7	SS	11
	260.5 6.6	**END OF BOREHOLE**			



Lab Data and Comments
GRAIN SIZE DISTRIBUTION (%) (MIT)
GR SA SI CL

Borehole was dry and open upon completion of drilling.

50 mm dia. monitoring well installed.

WATER LEVEL READINGS

Date	Water Depth (m)	Elevation (m)
Nov 19, 2021	1.8	265.3
Dec 1, 2021	0.7	266.4
Dec 13, 2021	0.7	266.4

file: 1-20-0222-02 bh logs.gpj

LOG OF BOREHOLE 102

Project No. : 1-20-0222-02
Date started : November 11, 2021
Sheet No. : 1 of 1

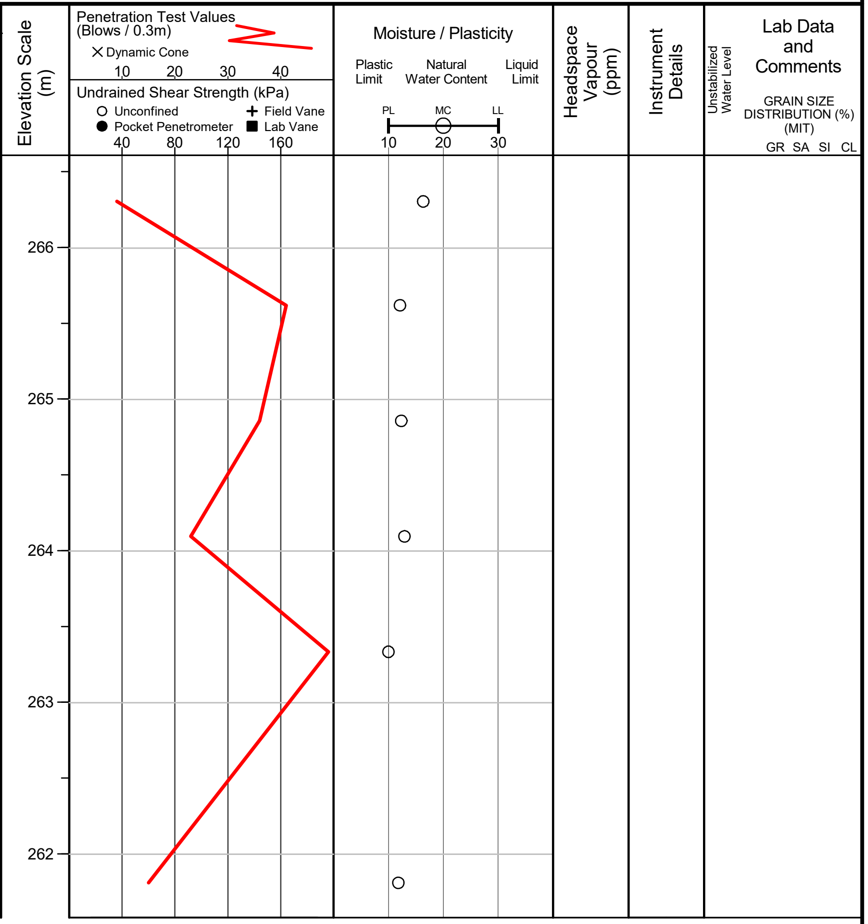
Client : Swaminarayan Mandir Vasna Sanstha Canada
Project : 6939 King Street
Location : Caledon, Ontario

Originated by : SS
Compiled by : RS
Checked by : AR

Position : E: 597140, N: 4855646 (UTM 17T)
Rig type : Track-mounted

Elevation Datum : Geodetic
Drilling Method : Solid stem augers

Depth Scale (m)	Elev Depth (m)	SOIL PROFILE Description	Graphic Log	SAMPLES Number	SAMPLES Type	SAMPLES SPT 'N' Value
0	**266.6**	**GROUND SURFACE**				
	266.4	140mm **TOPSOIL**				
	0.2	**FILL**, clayey silt, some sand, trace gravel, stiff, brown, moist		1	SS	9
	265.8					
1	0.8	**SILT AND CLAY to CLAYEY SILT**, trace to some sand, trace gravel, very stiff to hard, brown, moist (GLACIAL TILL)		2	SS	41
2				3	SS	36
				4	SS	23
3				5	SS	49
4						
		...grey		6	SS	15
5	261.6 5.0					



END OF BOREHOLE

Borehole was dry and open upon completion of drilling.

Terraprobe

LOG OF BOREHOLE 103

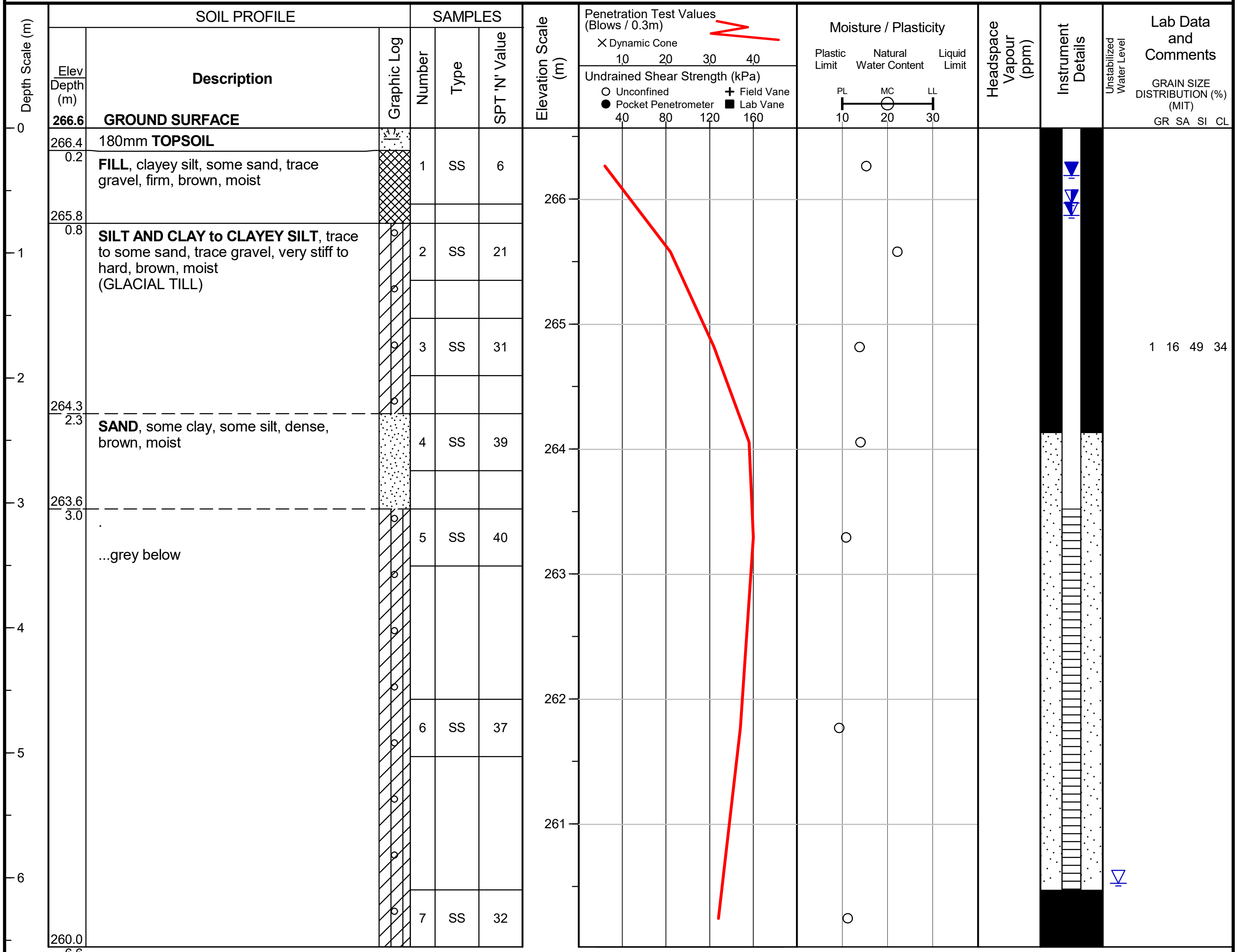
Project No. : 1-20-0222-02
Client : Swaminarayan Mandir Vasna Sanstha Canada
Originated by : SS

Date started : November 11, 2021
Project : 6939 King Street
Compiled by : RS

Sheet No. : 1 of 1
Location : Caledon, Ontario
Checked by : AR

Position : E: 597105, N: 4855618 (UTM 17T)
Elevation Datum : Geodetic

Rig type : Track-mounted
Drilling Method : Solid stem augers



Elev Depth (m)	Description	Number	Type	SPT 'N' Value	Lab Data and Comments GRAIN SIZE DISTRIBUTION (%) (MIT) GR SA SI CL
266.6	**GROUND SURFACE**				
266.4	180mm **TOPSOIL**				
0.2	**FILL**, clayey silt, some sand, trace gravel, firm, brown, moist	1	SS	6	
265.8 0.8	**SILT AND CLAY to CLAYEY SILT**, trace to some sand, trace gravel, very stiff to hard, brown, moist (GLACIAL TILL)	2	SS	21	
		3	SS	31	1 16 49 34
264.3 2.3	**SAND**, some clay, some silt, dense, brown, moist	4	SS	39	
263.6 3.0	. ...grey below	5	SS	40	
		6	SS	37	
		7	SS	32	
260.0 6.6					

END OF BOREHOLE

Unstabilized water level measured at 6.0 m below ground surface; borehole was open upon completion of drilling.

50 mm dia. monitoring well installed.

WATER LEVEL READINGS

Date	Water Depth (m)	Elevation (m)
Nov 19, 2021	0.7	265.9
Dec 1, 2021	0.6	266.0
Dec 13, 2021	0.4	266.2

file: 1-20-0222-02 bh logs.gpj

Terraprobe

LOG OF BOREHOLE 104

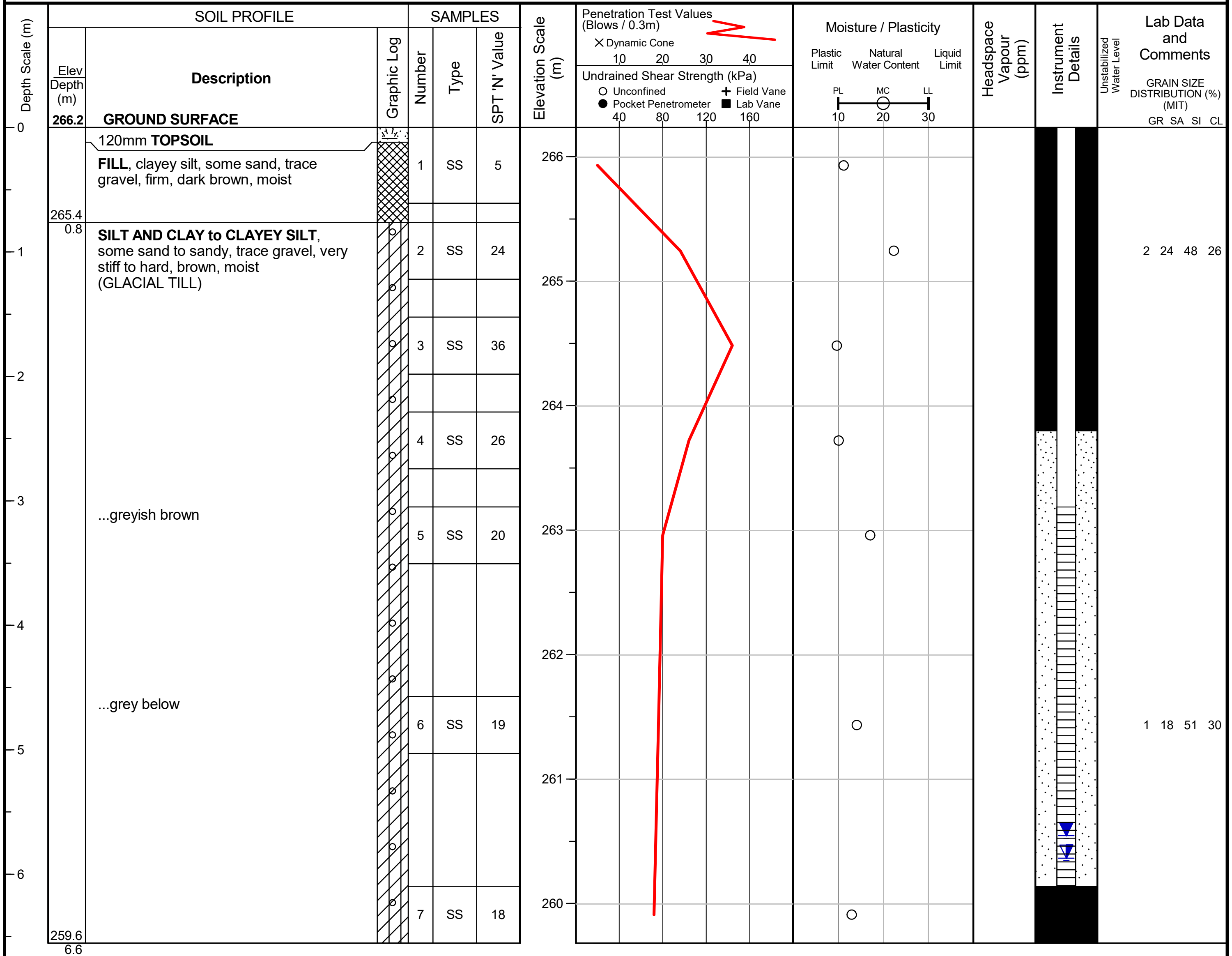
Project No. : 1-20-0222-02
Date started : November 12, 2021
Sheet No. : 1 of 1

Client : Swaminarayan Mandir Vasna Sanstha Canada
Project : 6939 King Street
Location : Caledon, Ontario

Originated by : SS
Compiled by : RS
Checked by : AR

Position : E: 597253, N: 4855671 (UTM 17T)
Rig type : Track-mounted

Elevation Datum : Geodetic
Drilling Method : Solid stem augers



Elev Depth (m)	Description
266.2	**GROUND SURFACE**
	120mm **TOPSOIL**
	FILL, clayey silt, some sand, trace gravel, firm, dark brown, moist
265.4 0.8	**SILT AND CLAY to CLAYEY SILT**, some sand to sandy, trace gravel, very stiff to hard, brown, moist (GLACIAL TILL) ...greyish brown ...grey below
259.6 6.6	**END OF BOREHOLE**

Number	Type	SPT 'N' Value	GR	SA	SI	CL
1	SS	5				
2	SS	24	2	24	48	26
3	SS	36				
4	SS	26				
5	SS	20				
6	SS	19	1	18	51	30
7	SS	18				

Borehole was dry and open upon completion of drilling.

50 mm dia. monitoring well installed.

WATER LEVEL READINGS

Date	Water Depth (m)	Elevation (m)
Nov 19, 2021	dry	n/a
Dec 1, 2021	5.9	260.4
Dec 13, 2021	5.7	260.5

Terraprobe

LOG OF BOREHOLE 105

Project No. : 1-20-0222-02
Date started : November 11, 2021
Sheet No. : 1 of 1

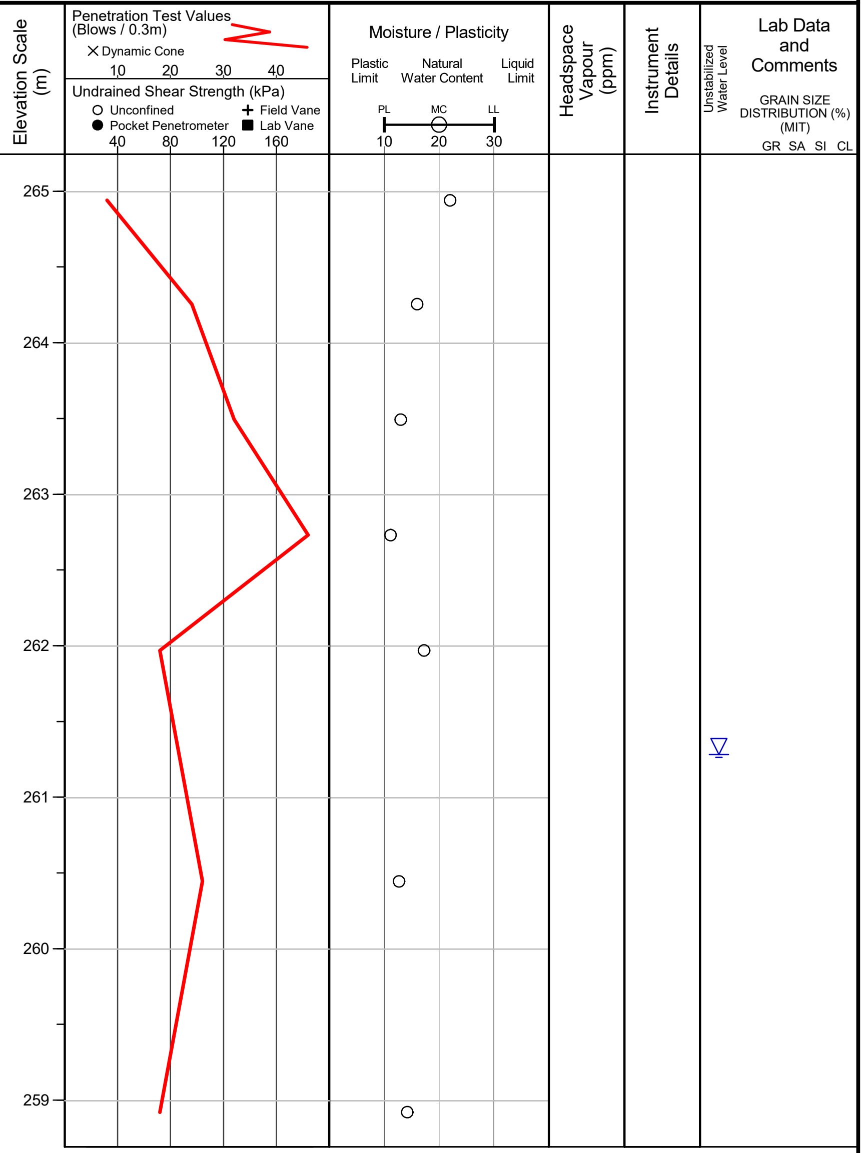
Client : Swaminarayan Mandir Vasna Sanstha Canada
Project : 6939 King Street
Location : Caledon, Ontario

Originated by : SS
Compiled by : RS
Checked by : AR

Position : E: 597183, N: 4855542 (UTM 17T)
Rig type : Track-mounted

Elevation Datum : Geodetic
Drilling Method : Solid stem augers

Depth Scale (m)	Elev Depth (m)	Description	Graphic Log	Number	Type	SPT 'N' Value
0	**265.2**	**GROUND SURFACE**				
	265.0	190mm **TOPSOIL**				
	0.2	**FILL**, clayey silt, some sand, trace gravel, firm, dark brown, moist		1	SS	8
	264.4 0.8	**SILT AND CLAY to CLAYEY SILT**, trace to some sand, trace gravel, very stiff to hard, brown, moist (GLACIAL TILL)		2	SS	24
1						
				3	SS	32
2						
				4	SS	46
3		...grey below				
				5	SS	18
4						
				6	SS	26
5						
6				7	SS	18
	258.6 6.6					



END OF BOREHOLE

Unstabilized water level measured at 4.0 m below ground surface; borehole was open upon completion of drilling.

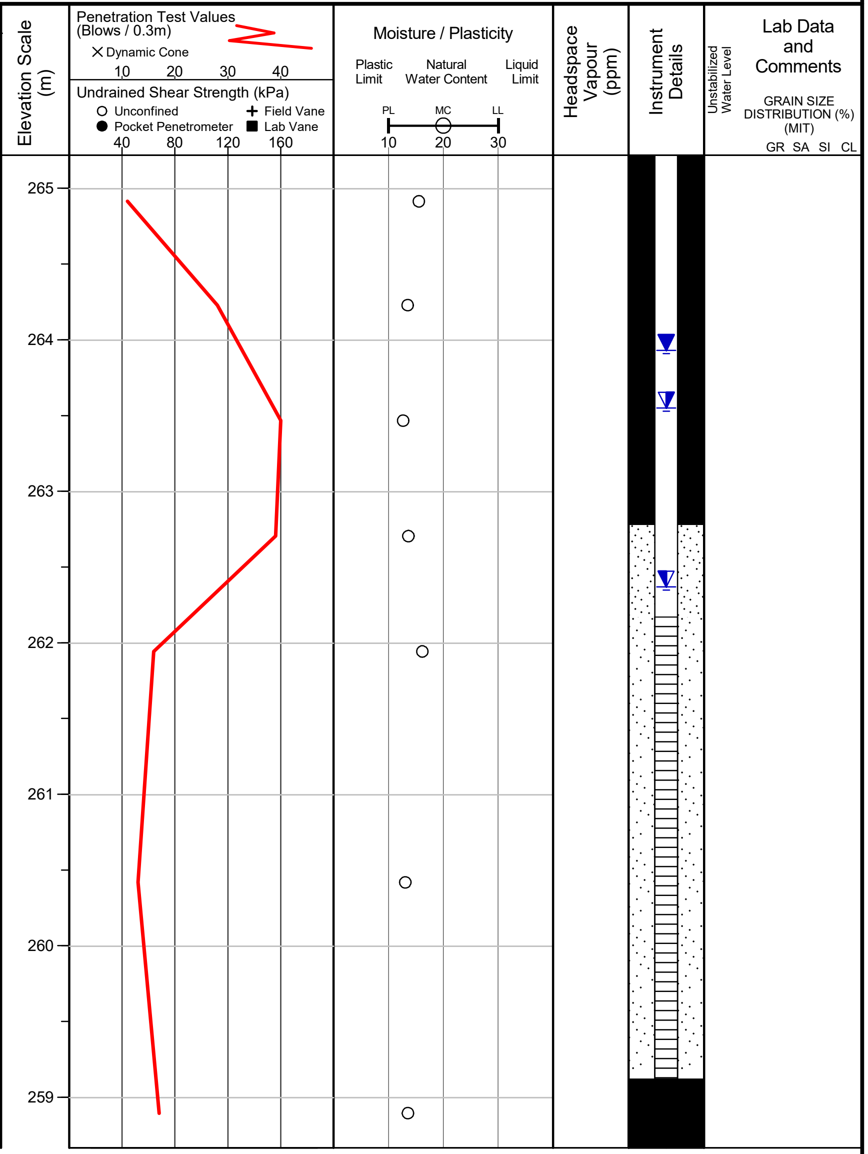
file: 1-20-0222-02 bh logs.gpj

LOG OF BOREHOLE 106

Project No. : 1-20-0222-02
Client : Swaminarayan Mandir Vasna Sanstha Canada
Originated by : SS
Date started : November 12, 2021
Project : 6939 King Street
Compiled by : RS
Sheet No. : 1 of 1
Location : Caledon, Ontario
Checked by : AR

Position : E: 597215, N: 4855511 (UTM 17T)
Elevation Datum : Geodetic
Rig type : Track-mounted
Drilling Method : Solid stem augers

Elev / Depth (m)	SOIL PROFILE Description	SAMPLES Number	Type	SPT 'N' Value
265.2 / 0	**GROUND SURFACE**			
	110mm **TOPSOIL**			
	(WEATHERED/DISTURBED)	1	SS	11
264.6 / 0.6	**SILT AND CLAY to CLAYEY SILT**, trace to some sand, trace gravel, stiff to hard, brown, moist (GLACIAL TILL)	2	SS	28
		3	SS	40
		4	SS	39
		5	SS	16
	...grey below	6	SS	13
258.6 / 6.6		7	SS	17



END OF BOREHOLE

Borehole was dry and open upon completion of drilling.

50 mm dia. monitoring well installed.

WATER LEVEL READINGS

Date	Water Depth (m)	Elevation (m)
Nov 19, 2021	2.9	262.4
Dec 1, 2021	1.7	263.5
Dec 13, 2021	1.3	263.9

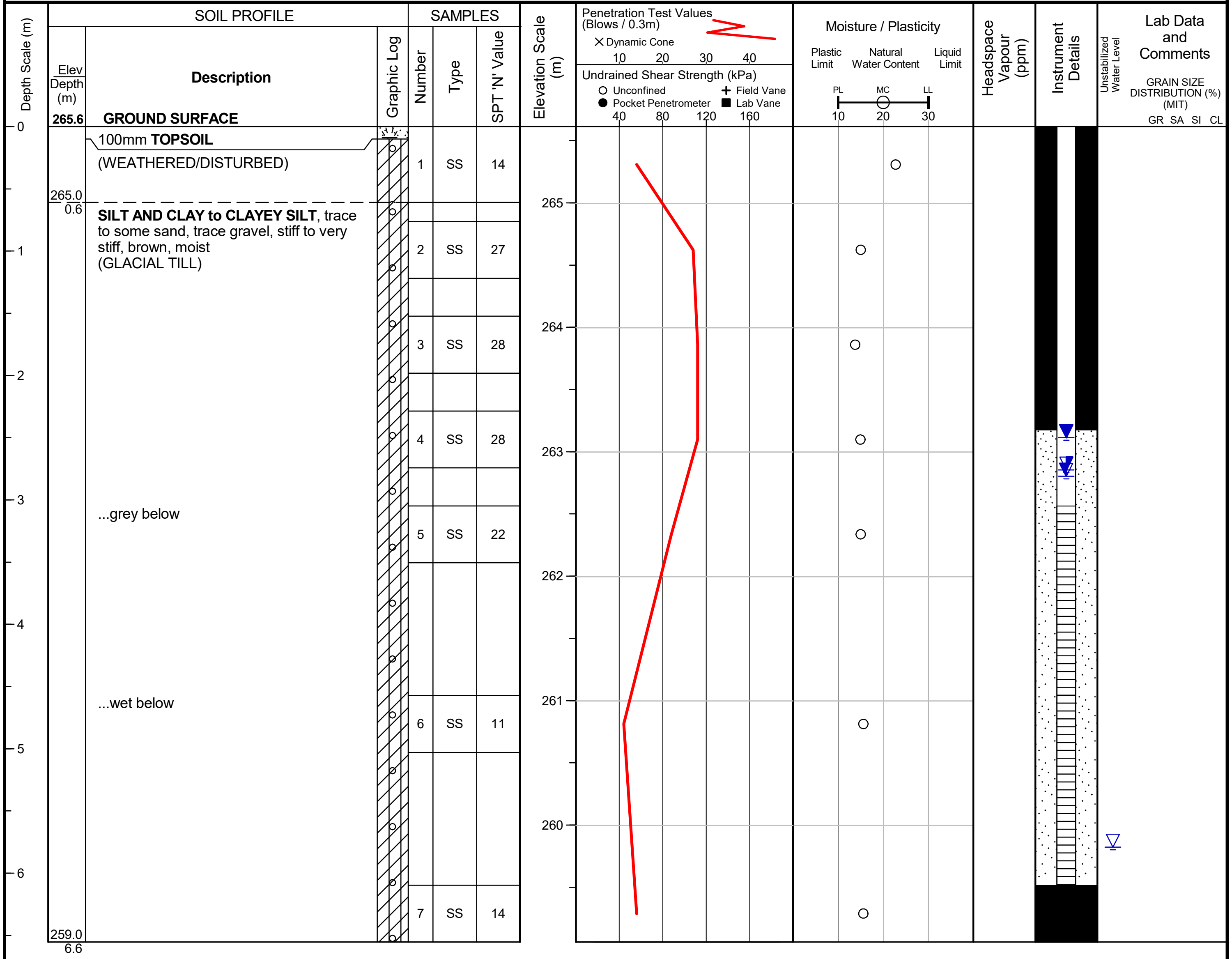
file: 1-20-0222-02 bh logs.gpj

Terraprobe

LOG OF BOREHOLE 107

Project No. : 1-20-0222-02	Client : Swaminarayan Mandir Vasna Sanstha Canada	Originated by : SS
Date started : November 12, 2021	Project : 6939 King Street	Compiled by : RS
Sheet No. : 1 of 1	Location : Caledon, Ontario	Checked by : AR

Position : E: 597308, N: 4855648 (UTM 17T)
Rig type : Track-mounted
Elevation Datum : Geodetic
Drilling Method : Solid stem augers



Elev Depth (m)	Description
265.6	GROUND SURFACE
	100mm **TOPSOIL** (WEATHERED/DISTURBED)
265.0 0.6	**SILT AND CLAY to CLAYEY SILT**, trace to some sand, trace gravel, stiff to very stiff, brown, moist (GLACIAL TILL) ...grey below ...wet below
259.0 6.6	

Number	Type	SPT 'N' Value
1	SS	14
2	SS	27
3	SS	28
4	SS	28
5	SS	22
6	SS	11
7	SS	14

END OF BOREHOLE

Unstabilized water level measured at 5.8 m below ground surface; borehole was open upon completion of drilling.

50 mm dia. monitoring well installed.

WATER LEVEL READINGS

Date	Water Depth (m)	Elevation (m)
Nov 19, 2021	2.8	262.8
Dec 1, 2021	2.8	262.9
Dec 13, 2021	2.5	263.1

Terraprobe

LOG OF BOREHOLE 1

Project No. : 1-20-0222-01
Date started : July 14, 2020
Sheet No. : 1 of 1

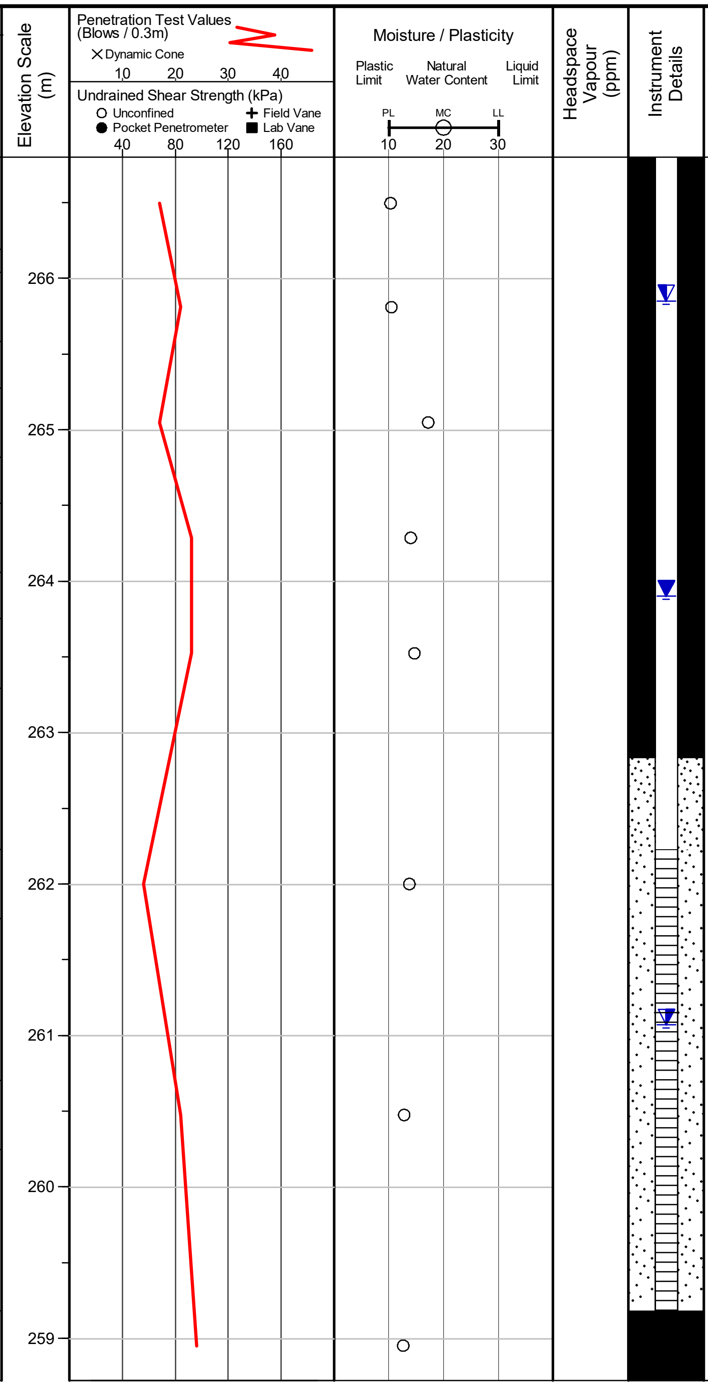
Client : Swaminarayan Mandir Vasna Sansthan Canada
Project : 6939 King Street
Location : Caledon, Ontario

Originated by : Saif
Compiled by : CM
Checked by : SZ

Position : E: 597212, N: 4855726 (UTM 17T)
Rig type : Deidric 60, track-mounted
Elevation Datum : Geodetic
Drilling Method : Solid stem augers

Elev Depth (m)	SOIL PROFILE Description	SAMPLES Number	Type	SPT 'N' Value	Lab Data and Comments GRAIN SIZE DISTRIBUTION (%) (MIT) GR SA SI CL
266.8	**GROUND SURFACE**				
	FILL, clayey silt, trace sand, trace gravel, trace wood chips, very stiff, brown, moist	1	SS	17	
		2	SS	21	
265.6 1.2	**SILT AND CLAY to CLAYEY SILT**, trace to some sand, trace gravel, stiff to very stiff, brown, moist (GLACIAL TILL)	3	SS	17	2 14 48 36
		4	SS	23	
		5	SS	23	
	...grey below	6	SS	14	
		7	SS	21	
	...rock fragments	8	SS	24	
258.7 8.1					

Depth Scale (m): 0, 1, 2, 3, 4, 5, 6, 7, 8



END OF BOREHOLE

Borehole was dry and caved to 5.8 m below ground surface upon completion of drilling.

50 mm dia. monitoring well installed.

WATER LEVEL READINGS

Date	Water Depth (m)	Elevation (m)
Oct 5, 2020	1.0	265.9
Oct 13, 2020	5.7	261.1
Oct 20, 2020	5.0	261.8
Nov 10, 2021	2.4	264.4
Dec 1, 2021	2.6	264.2
Dec 13, 2021	2.9	263.9

Terraprobe

LOG OF BOREHOLE 2

Project No. : 1-20-0222-01
Client : Swaminarayan Mandir Vasna Sansthan Canada
Originated by : SM

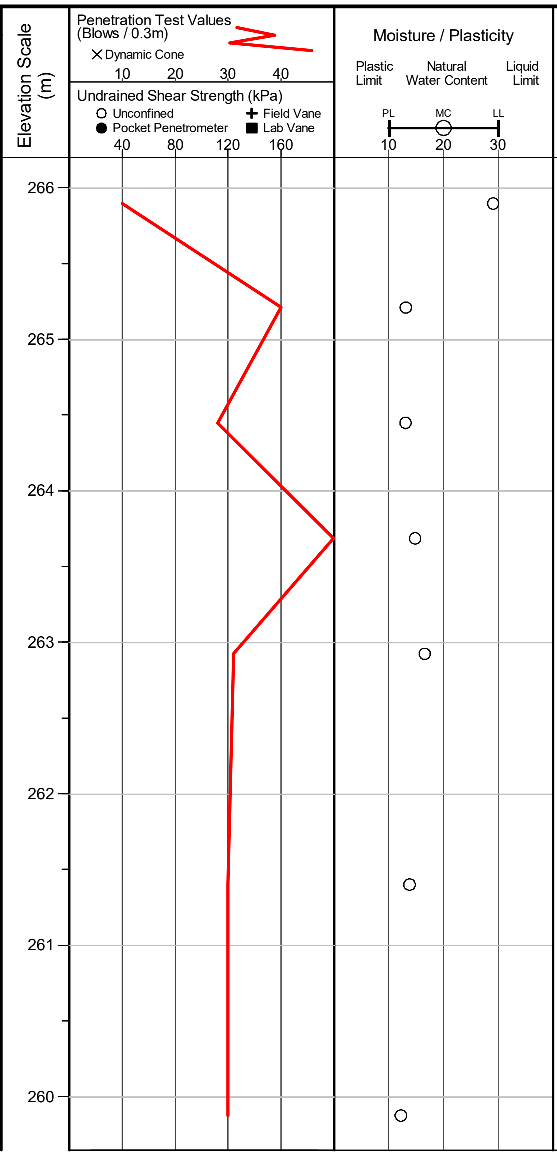
Date started : September 21, 2020
Project : 6939 King Street
Compiled by : CM

Sheet No. : 1 of 1
Location : Caledon, Ontario
Checked by : SZ

Position : E: 597188, N: 4855697 (UTM 17T)
Elevation Datum : Geodetic

Rig type : Track-mounted
Drilling Method : Solid stem augers

Elev / Depth (m)	SOIL PROFILE Description	SAMPLES Number	Type	SPT 'N' Value
266.2	**GROUND SURFACE**			
265.9 0.3	300mm **TOPSOIL**	1	SS	10
265.4 0.8	(WEATHERED/DISTURBED)			
	SILT AND CLAY to CLAYEY SILT, trace to some sand, trace gravel, very stiff to hard, brown, moist (GLACIAL TILL)	2	SS	40
		3	SS	28
		4	SS	51
		5	SS	31
	...grey below	6	SS	30
259.6 6.6		7	SS	30



Headspace Vapour (ppm) | Instrument Details | Unstabilized Water Level | Lab Data and Comments GRAIN SIZE DISTRIBUTION (%) (MIT) GR SA SI CL

Depth Scale (m): 0 1 2 3 4 5 6

END OF BOREHOLE

Borehole was dry and caved to 5.5 m below ground surface upon completion of drilling.

file: 1-20-0222-01 bh logs.gpj

Terraprobe

LOG OF BOREHOLE 3

Project No. : 1-20-0222-01
Date started : September 21, 2020
Sheet No. : 1 of 1

Client : Swaminarayan Mandir Vasna Sansthan Canada
Project : 6939 King Street
Location : Caledon, Ontario

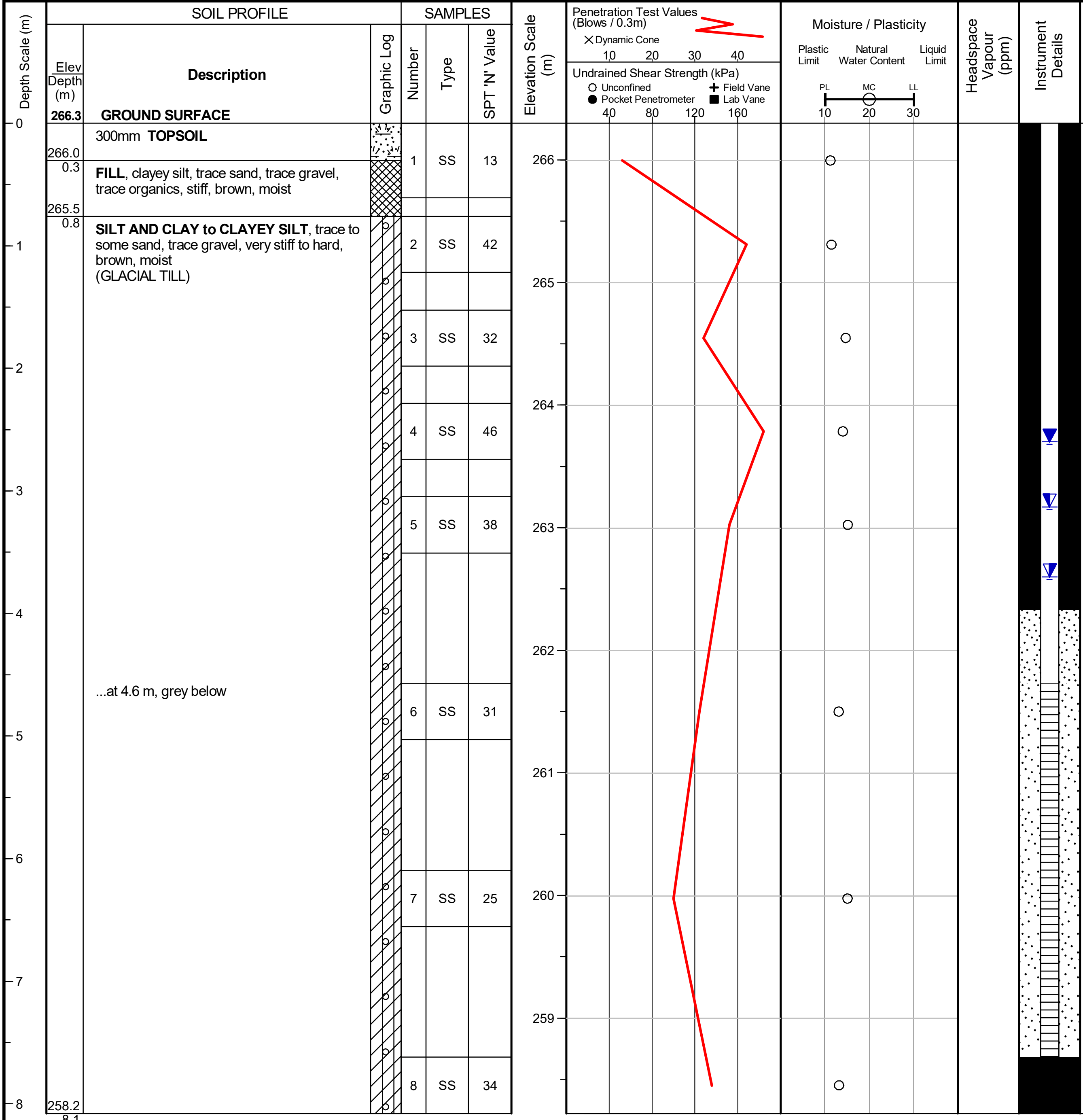
Originated by : SM
Compiled by : CM
Checked by : SZ

Position : E: 597164, N: 4855667 (UTM 17T)
Rig type : Track-mounted

Elevation Datum : Geodetic
Drilling Method : Solid stem augers

Elev Depth (m)	Description
266.3	**GROUND SURFACE**
	300mm **TOPSOIL**
266.0 0.3	**FILL**, clayey silt, trace sand, trace gravel, trace organics, stiff, brown, moist
265.5 0.8	**SILT AND CLAY to CLAYEY SILT**, trace to some sand, trace gravel, very stiff to hard, brown, moist (GLACIAL TILL)
	...at 4.6 m, grey below
258.2 8.1	**END OF BOREHOLE**

Number	Type	SPT 'N' Value	Lab Data and Comments GRAIN SIZE DISTRIBUTION (%) (MIT) GR SA SI CL
1	SS	13	
2	SS	42	
3	SS	32	
4	SS	46	1 16 43 40
5	SS	38	
6	SS	31	
7	SS	25	
8	SS	34	



END OF BOREHOLE

Borehole was dry and open upon completion of drilling.

50 mm dia. monitoring well installed.

WATER LEVEL READINGS

Date	Water Depth (m)	Elevation (m)
Oct 5, 2020	3.1	263.2
Oct 13, 2020	3.7	262.6
Oct 20, 2020	2.3	264.0
Nov 10, 2021	2.6	263.7
Dec 1, 2021	2.6	263.7
Dec 13, 2021	2.6	263.7

Terraprobe

LOG OF BOREHOLE 4

Project No. : 1-20-0222-01
Date started : September 21, 2020
Sheet No. : 1 of 1

Client : Swaminarayan Mandir Vasna Sansthan Canada
Project : 6939 King Street
Location : Caledon, Ontario

Originated by : SM
Compiled by : CM
Checked by : SZ

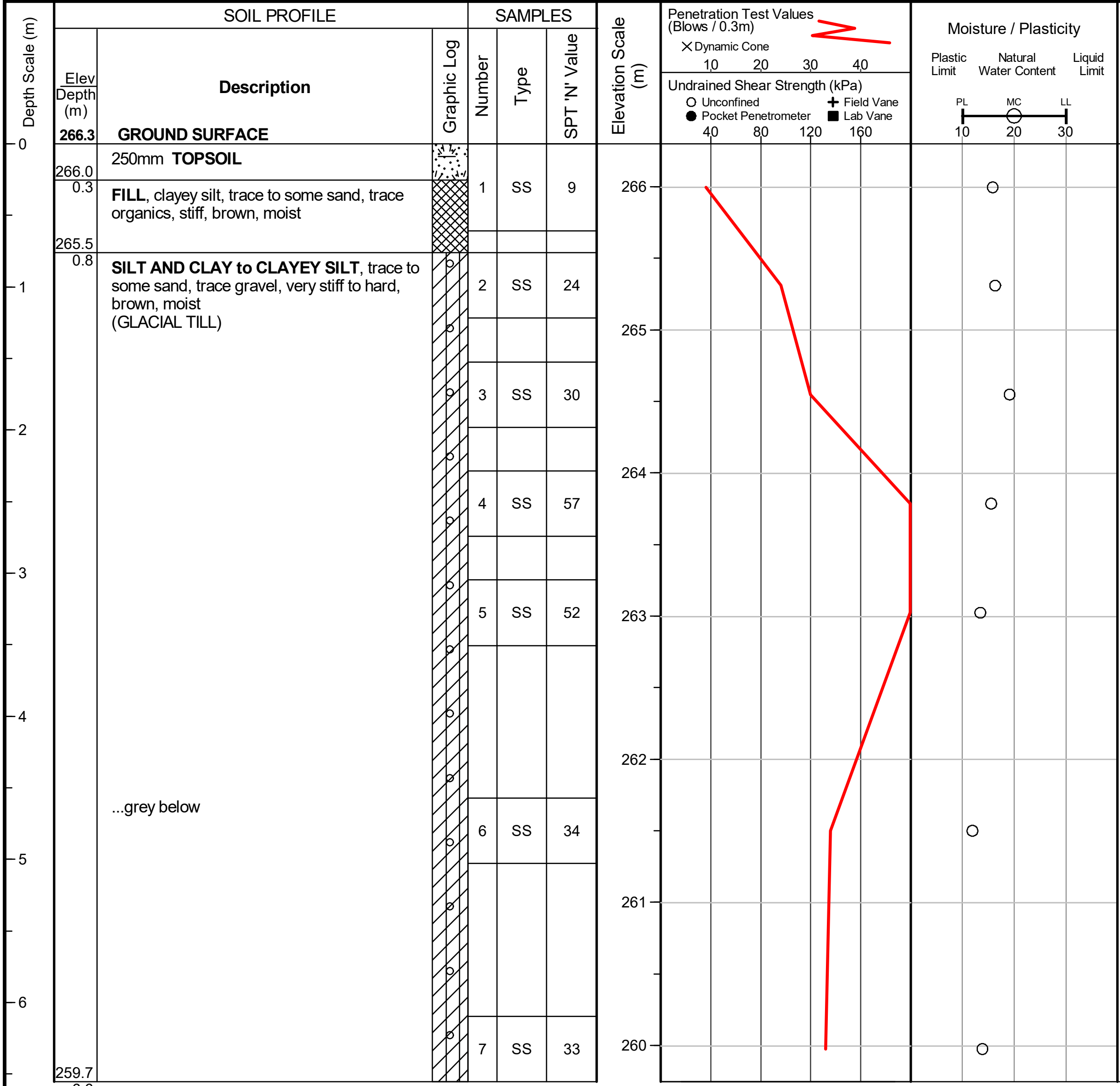
Position : E: 597189, N: 4855745 (UTM 17T)
Rig type : Track-mounted
Elevation Datum : Geodetic
Drilling Method : Solid stem augers

SOIL PROFILE

Elev Depth (m)	Description
266.3	**GROUND SURFACE**
	250mm **TOPSOIL**
266.0 0.3	**FILL**, clayey silt, trace to some sand, trace organics, stiff, brown, moist
265.5 0.8	**SILT AND CLAY to CLAYEY SILT**, trace to some sand, trace gravel, very stiff to hard, brown, moist (GLACIAL TILL) ...grey below
259.7 6.6	**END OF BOREHOLE**

SAMPLES

Number	Type	SPT 'N' Value
1	SS	9
2	SS	24
3	SS	30
4	SS	57
5	SS	52
6	SS	34
7	SS	33



Headspace Vapour (ppm)

Instrument Details

Unstabilized Water Level

Lab Data and Comments

GRAIN SIZE DISTRIBUTION (%) (MIT)

GR SA SI CL

Borehole was dry and open upon completion of drilling.

Terraprobe

LOG OF BOREHOLE 5

Project No. : 1-20-0222-01
Date started : September 21, 2020
Sheet No. : 1 of 1

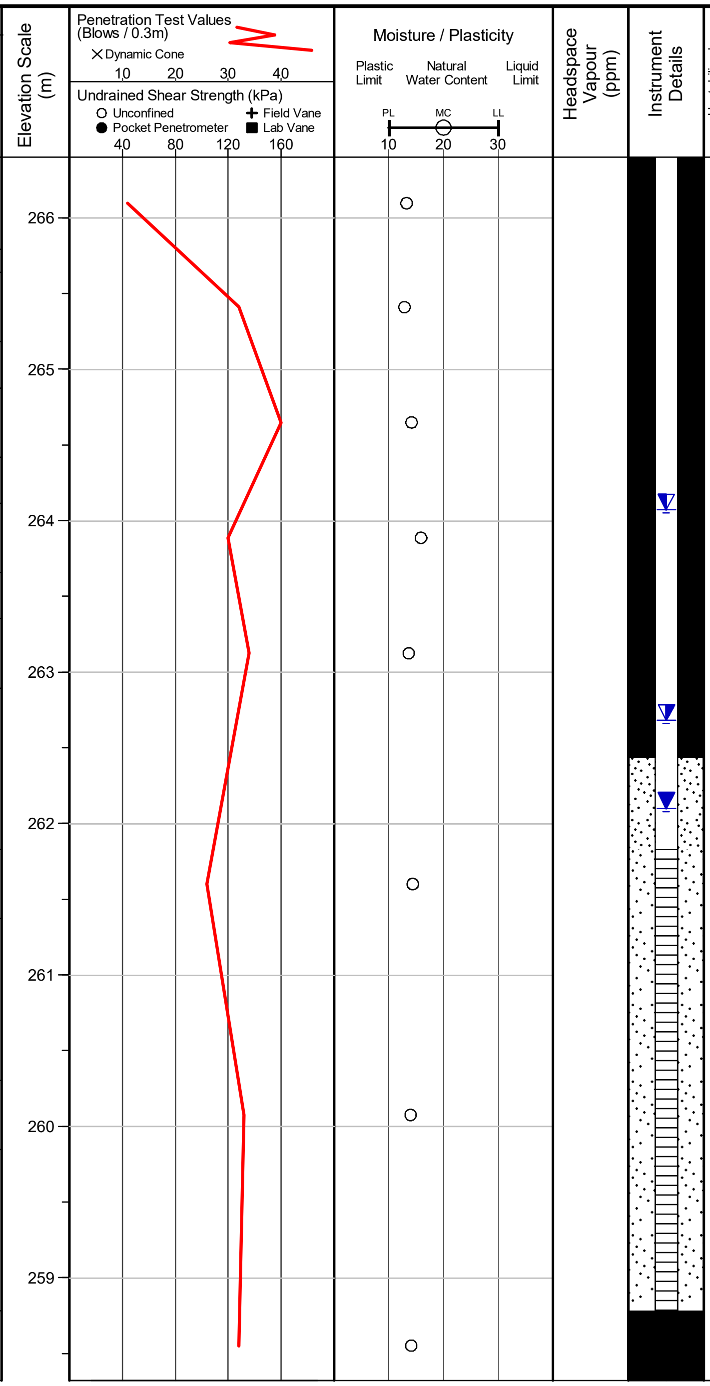
Client : Swaminarayan Mandir Vasna Sansthan Canada
Project : 6939 King Street
Location : Caledon, Ontario

Originated by : SM
Compiled by : CM
Checked by : SZ

Position : E: 597152, N: 4855725 (UTM 17T)
Rig type : Track-mounted
Elevation Datum : Geodetic
Drilling Method : Solid stem augers

Elev Depth (m)	Description
266.4	**GROUND SURFACE**
266.1 0.3	300mm **TOPSOIL**
265.8 0.6	(WEATHERED/DISTURBED)
	SILT AND CLAY to CLAYEY SILT, trace to some sand, trace gravel, very stiff to hard, brown, moist (GLACIAL TILL)
	...grey below
258.3 8.1	

Number	Type	SPT 'N' Value	GR	SA	SI	CL
1	SS	11				
2	SS	32				
3	SS	40	0	13	40	47
4	SS	30				
5	SS	34				
6	SS	26				
7	SS	33				
8	SS	32				



END OF BOREHOLE

Borehole was dry and open upon completion of drilling.

50 mm dia. monitoring well installed.

WATER LEVEL READINGS

Date	Water Depth (m)	Elevation (m)
Oct 5, 2020	2.3	264.1
Oct 13, 2020	3.7	262.7
Oct 20, 2020	2.1	264.3
Nov 10, 2021	4.2	262.2
Dec 1, 2021	4.2	262.2
Dec 13, 2021	4.3	262.1

file: 1-20-0222-01 bh logs.gpj

Terraprobe

LOG OF BOREHOLE 6

Project No. : 1-20-0222-01
Date started : September 21, 2020
Sheet No. : 1 of 1

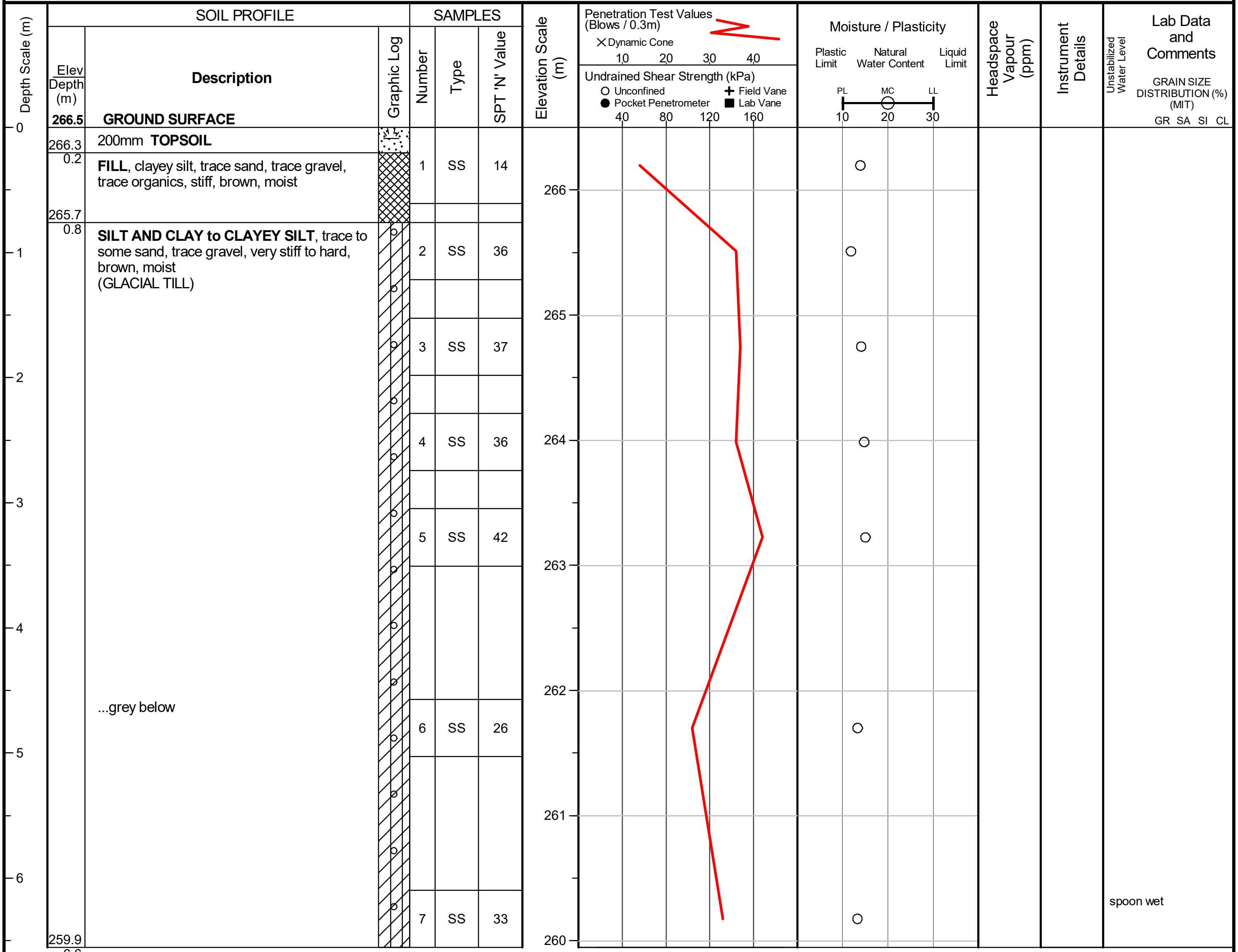
Client : Swaminarayan Mandir Vasna Sansthan Canada
Project : 6939 King Street
Location : Caledon, Ontario

Originated by : SM
Compiled by : CM
Checked by : SZ

Position : E: 597138, N: 4855685 (UTM 17T)
Rig type : Track-mounted
Elevation Datum : Geodetic
Drilling Method : Solid stem augers

Elev Depth (m)	SOIL PROFILE Description	SAMPLES Number	Type	SPT 'N' Value	Lab Data and Comments
266.5	**GROUND SURFACE**				
	200mm **TOPSOIL**				
266.3 0.2	**FILL**, clayey silt, trace sand, trace gravel, trace organics, stiff, brown, moist	1	SS	14	
265.7 0.8	**SILT AND CLAY to CLAYEY SILT**, trace to some sand, trace gravel, very stiff to hard, brown, moist (GLACIAL TILL)	2	SS	36	
		3	SS	37	
		4	SS	36	
		5	SS	42	
	...grey below	6	SS	26	
		7	SS	33	spoon wet
259.9 6.6	**END OF BOREHOLE**				

Borehole was dry and caved to 5.8 m below ground surface upon completion of drilling.



Terraprobe

LOG OF BOREHOLE 7

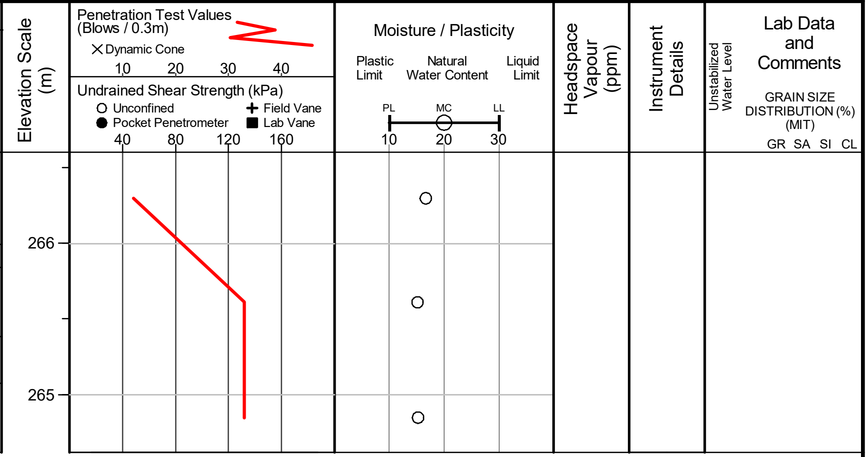
Project No. : 1-20-0222-01
Date started : September 21, 2020
Sheet No. : 1 of 1

Client : Swaminarayan Mandir Vasna Sansthan Canada
Project : 6939 King Street
Location : Caledon, Ontario

Originated by : SM
Compiled by : CM
Checked by : SZ

Position : E: 597139, N: 4855778 (UTM 17T)
Rig type : Track-mounted
Elevation Datum : Geodetic
Drilling Method : Solid stem augers

Depth Scale (m)	Elev Depth (m)	SOIL PROFILE Description	Graphic Log	SAMPLES Number	Type	SPT 'N' Value
0	**266.6**	**GROUND SURFACE**				
	266.3 0.3	300mm **TOPSOIL**		1	SS	12
	266.0 0.6	(WEATHERED/DISTURBED)				
1		**SILT AND CLAY to CLAYEY SILT**, trace to some sand, trace gravel, hard, brown, moist (GLACIAL TILL)		2	SS	33
				3	SS	33
	264.6 2.0					



END OF BOREHOLE

Borehole was dry and open upon completion of drilling.

Terraprobe

LOG OF BOREHOLE 8

Project No. : 1-20-0222-01
Date started : September 21, 2020
Sheet No. : 1 of 1

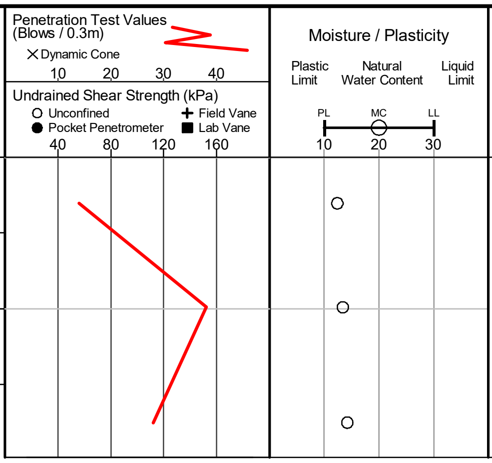
Client : Swaminarayan Mandir Vasna Sansthan Canada
Project : 6939 King Street
Location : Caledon, Ontario

Originated by : SM
Compiled by : CM
Checked by : SZ

Position : E: 597081, N: 4855716 (UTM 17T)
Rig type : Track-mounted

Elevation Datum : Geodetic
Drilling Method : Solid stem augers

Depth Scale (m)	Elev Depth (m)	SOIL PROFILE Description	Graphic Log	SAMPLES Number	Type	SPT 'N' Value	Elevation Scale (m)	Headspace Vapour (ppm)	Instrument Details	Unstabilized Water Level	Lab Data and Comments GRAIN SIZE DISTRIBUTION (%) (MIT) GR SA SI CL
0	**267.0**	**GROUND SURFACE**					267				
	266.7 0.3	300mm **TOPSOIL**		1	SS	14					
	266.4 0.6	(WEATHERED/DISTURBED)									
1		**SILT AND CLAY to CLAYEY SILT**, trace to some sand, trace gravel, very stiff to hard, brown, moist (GLACIAL TILL)		2	SS	38	266				4 11 42 43
	265.0 2.0			3	SS	28					



END OF BOREHOLE

Borehole was dry and open upon completion of drilling.

LOG OF BOREHOLE 9

Project No. : 1-20-0222-01
Date started : September 21, 2020
Sheet No. : 1 of 1

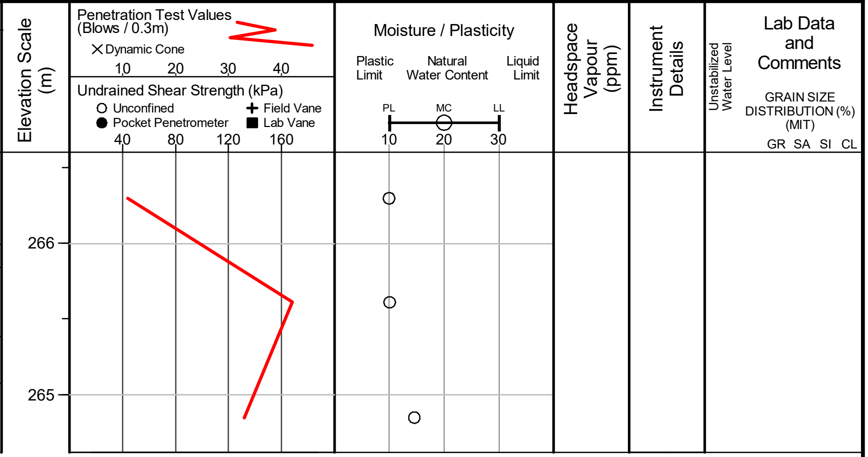
Client : Swaminarayan Mandir Vasna Sansthan Canada
Project : 6939 King Street
Location : Caledon, Ontario

Originated by : SM
Compiled by : CM
Checked by : SZ

Position : E: 597140, N: 4855634 (UTM 17T)
Rig type : Track-mounted

Elevation Datum : Geodetic
Drilling Method : Solid stem augers

Depth Scale (m)	Elev Depth (m)	SOIL PROFILE Description	Graphic Log	SAMPLES Number	Type	SPT 'N' Value
0	**266.6**	**GROUND SURFACE**				
	266.3 0.3	300mm **TOPSOIL**		1	SS	11
	265.8 0.8	**FILL**, clayey silt, trace sand, trace gravel, trace organics, stiff, brown, moist				
1	264.6 2.0	**SILT AND CLAY to CLAYEY SILT**, trace to some sand, trace gravel, hard, brown, moist (GLACIAL TILL) ...rock fragments		2 3	SS SS	42 33



END OF BOREHOLE

Borehole was dry and open upon completion of drilling.

Terraprobe

LOG OF BOREHOLE 10

Project No. : 1-20-0222-01
Client : Swaminarayan Mandir Vasna Sansthan Canada
Originated by : SM

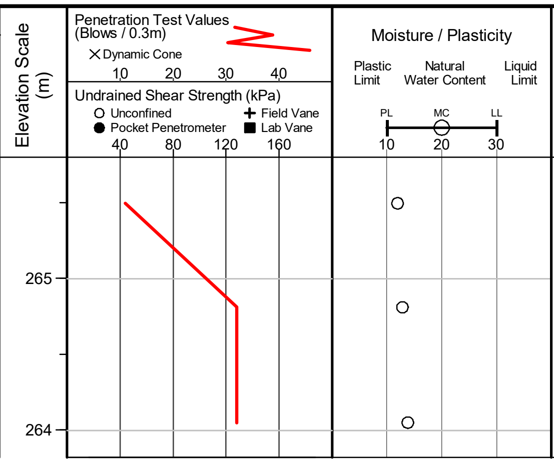
Date started : September 21, 2020
Project : 6939 King Street
Compiled by : CM

Sheet No. : 1 of 1
Location : Caledon, Ontario
Checked by : SZ

Position : E: 597111, N: 4855589 (UTM 17T)
Elevation Datum : Geodetic

Rig type : Track-mounted
Drilling Method : Solid stem augers

Depth Scale (m)	SOIL PROFILE Elev Depth (m)	Description	Graphic Log	SAMPLES Number	Type	SPT 'N' Value
0	**265.8**	**GROUND SURFACE**				
	265.5 0.3	250mm **TOPSOIL**				
	265.0 0.8	**FILL**, clayey silt, trace sand, trace gravel, stiff, brown, moist		1	SS	11
1	263.8 2.0	**SILT AND CLAY to CLAYEY SILT**, trace to some sand, trace gravel, hard, brown, moist (GLACIAL TILL)		2	SS	32
				3	SS	32



Headspace Vapour (ppm)	Instrument Details	Unstabilized Water Level	Lab Data and Comments GRAIN SIZE DISTRIBUTION (%) (MIT) GR SA SI CL

END OF BOREHOLE

Borehole was dry and open upon completion of drilling.

file: 1-20-0222-01 bh logs.gpj

LOG OF BOREHOLE 11

Project No. : 1-20-0222-01
Date started : July 14, 2020
Sheet No. : 1 of 1

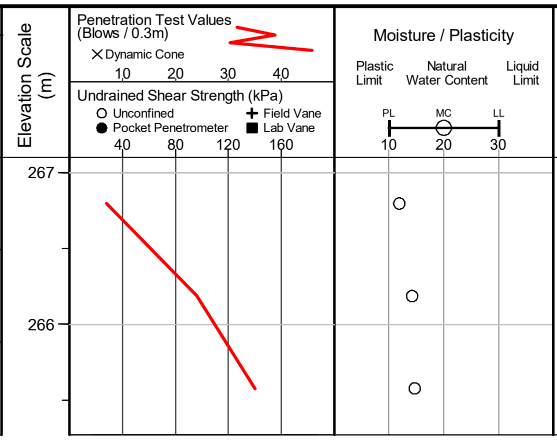
Client : Swaminarayan Mandir Vasna Sansthan Canada
Project : 6939 King Street
Location : Caledon, Ontario

Originated by : Saif
Compiled by : CM
Checked by : SZ

Position : E: 597083, N: 4855653 (UTM 17T)
Rig type : Deidric 60, track-mounted

Elevation Datum : Geodetic
Drilling Method : Continuous sampling

Depth Scale (m)	Elev Depth (m)	SOIL PROFILE Description	Graphic Log	SAMPLES Number	Type	SPT 'N' Value	Headspace Vapour (ppm)	Instrument Details	Unstabilized Water Level	Lab Data and Comments GRAIN SIZE DISTRIBUTION (%) (MIT) GR SA SI CL
0	**267.1**	**GROUND SURFACE**								
		FILL, clayey silt, sandy, trace gravel, firm, brown, moist	▩	1	SS	7				
	266.5 0.6	**SILT AND CLAY to CLAYEY SILT**, trace to some sand, trace gravel, very stiff to hard, brown, moist (GLACIAL TILL)	▨	2	SS	24				6 13 41 40
1				3	SS	35				
	265.3 1.8									



END OF BOREHOLE

Borehole was dry and open upon completion of drilling.

Terraprobe

LOG OF BOREHOLE 12

Project No. : 1-20-0222-01
Date started : July 14, 2020
Sheet No. : 1 of 1

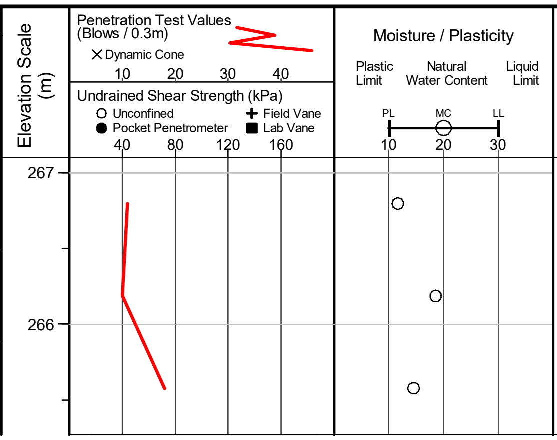
Client : Swaminarayan Mandir Vasna Sansthan Canada
Project : 6939 King Street
Location : Caledon, Ontario

Originated by : Saif
Compiled by : CM
Checked by : SZ

Position : E: 597025, N: 4855676 (UTM 17T)
Rig type : Deidric 60, track-mounted

Elevation Datum : Geodetic
Drilling Method : Continuous sampling

Depth Scale (m)	Elev Depth (m)	SOIL PROFILE Description	Graphic Log	SAMPLES Number	Type	SPT 'N' Value
0	267.1	**GROUND SURFACE**				
		FILL, clayey silt, trace sand, trace gravel, trace organics, trace top soil inclusions, stiff, brown, moist		1	SS	11
				2	SS	10
1	265.9 1.2	**SILT AND CLAY**, trace sand, trace gravel, very stiff, brown, moist (GLACIAL TILL)		3	SS	18
	265.3 1.8	**END OF BOREHOLE**				



Headspace Vapour (ppm)

Instrument Details

Unstabilized Water Level

Lab Data and Comments

GRAIN SIZE DISTRIBUTION (%) (MIT)

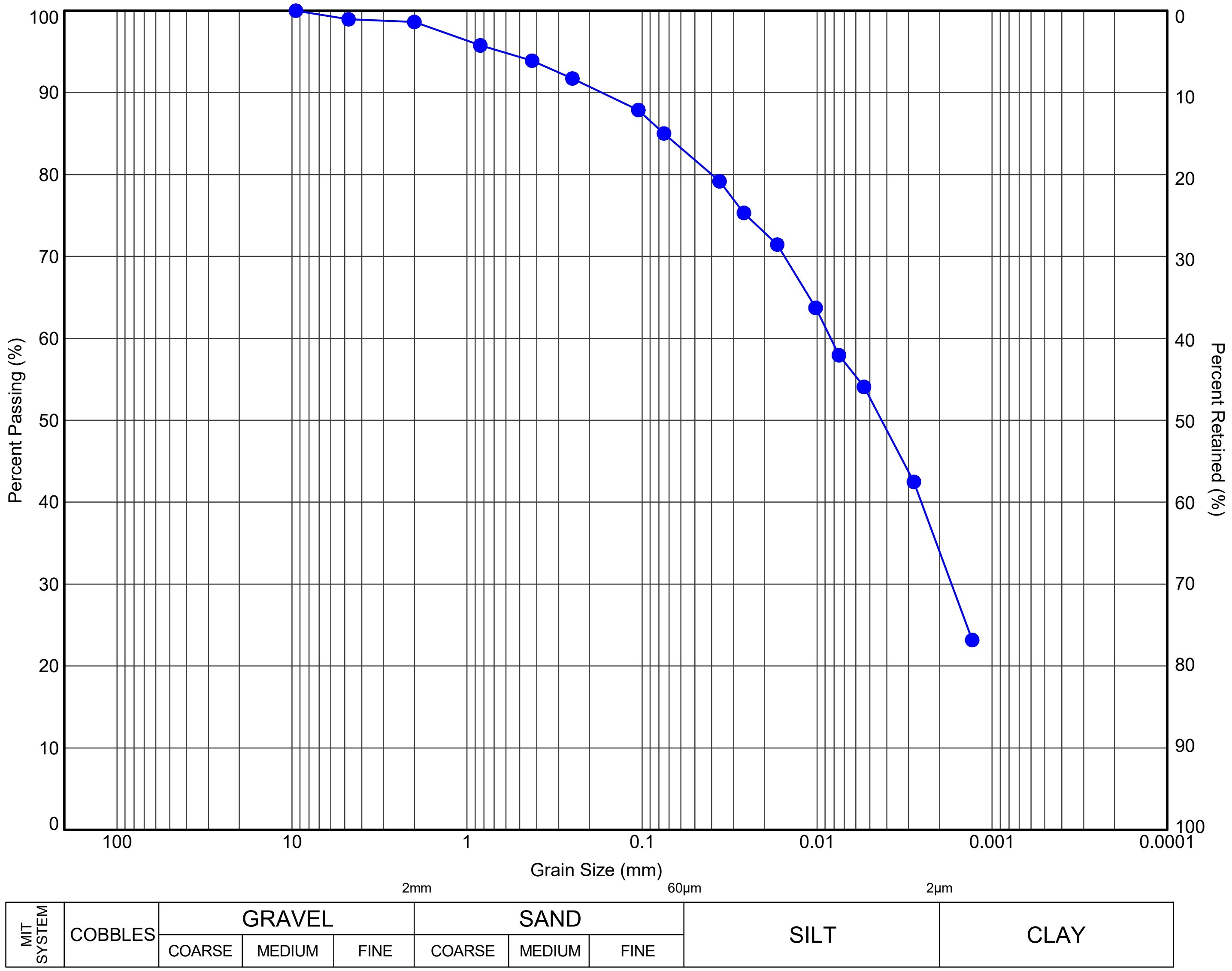
GR SA SI CL

Borehole was dry and open upon completion of drilling.

file: 1-20-0222-01 bh logs.gpj

APPENDIX B

TERRAPROBE INC.



					MIT SYSTEM				
	Hole ID	Sample	Depth (m)	Elev. (m)	Gravel (%)	Sand (%)	Silt (%)	Clay (%)	*(Fines, %)*
●	**103**	SS3	1.8	264.8	1	16	49	34	

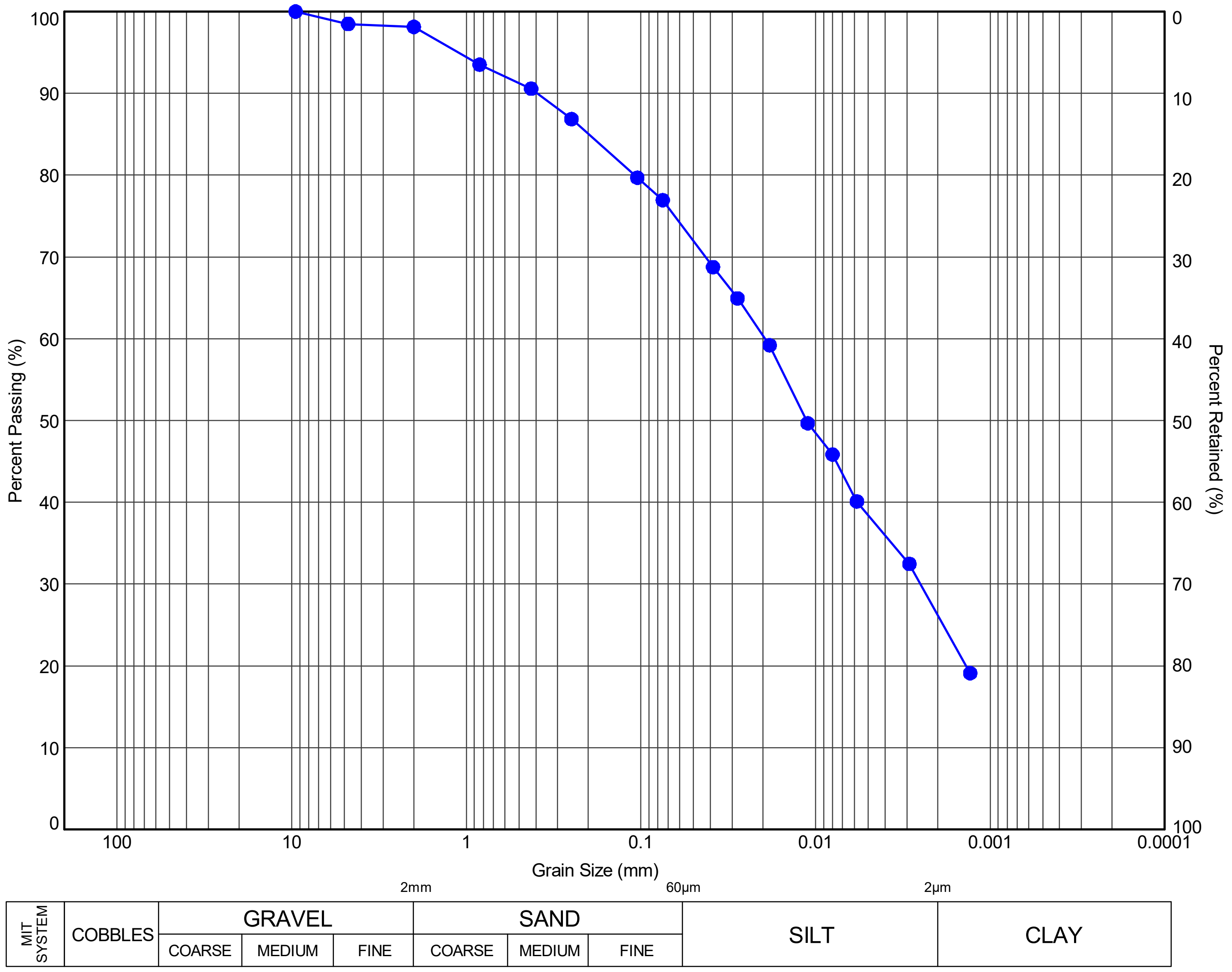
Terraprobe

11 Indell Lane, Brampton Ontario L6T 3Y3
(905) 796-2650

Title:

GRAIN SIZE DISTRIBUTION
CLAYEY SILT, SOME SAND, TRACE GRAVEL

File No.: **1-20-0222-02**



MIT SYSTEM

	Hole ID	Sample	Depth (m)	Elev. (m)	Gravel (%)	Sand (%)	Silt (%)	Clay (%)	*(Fines, %)*
●	**104**	SS2	1.0	265.2	2	24	48	26	

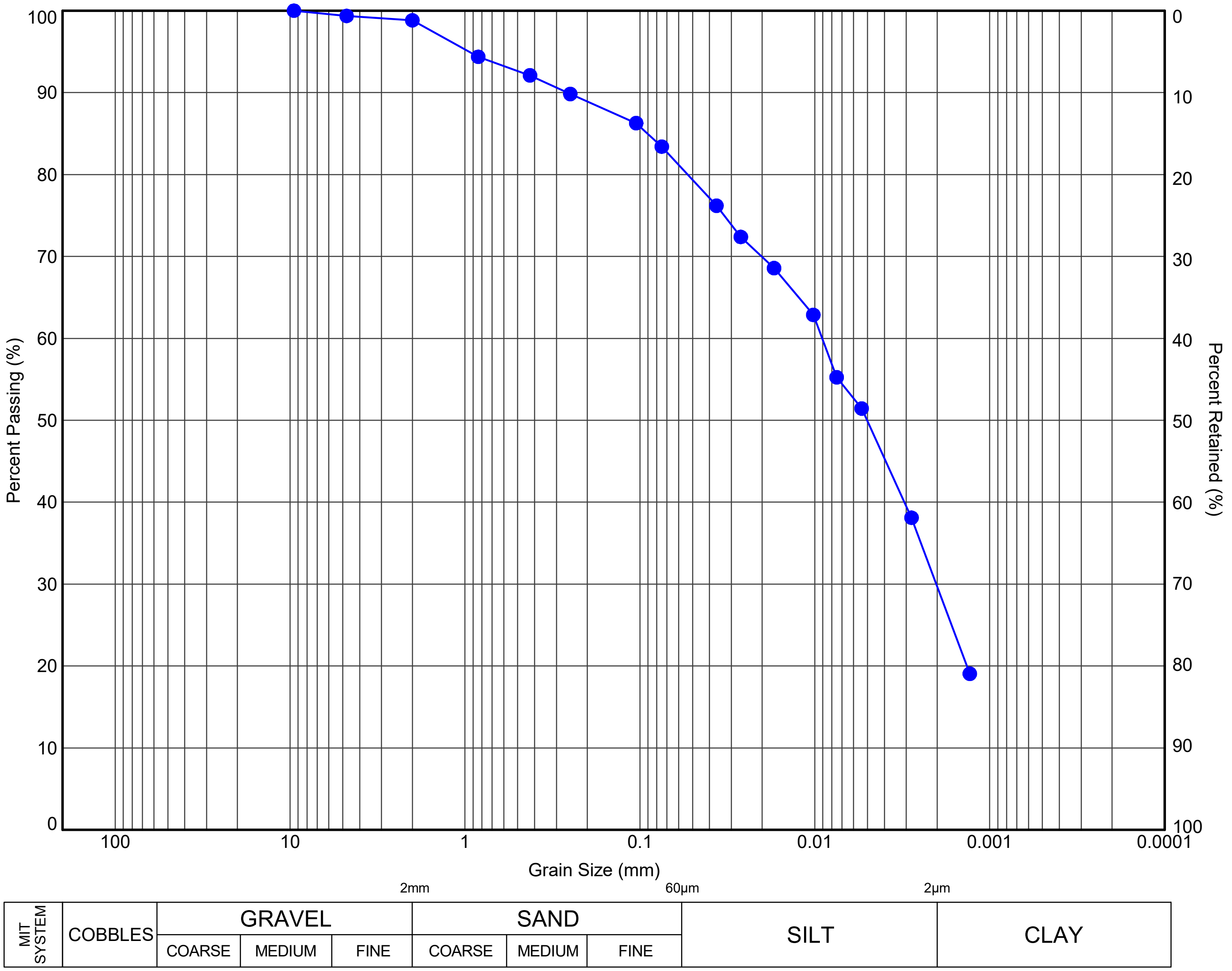
Terraprobe

11 Indell Lane, Brampton Ontario L6T 3Y3
(905) 796-2650

Title:

GRAIN SIZE DISTRIBUTION
CLAYEY SILT, SANDY, TRACE GRAVEL

File No.: **1-20-0222-02**



MIT SYSTEM

	Hole ID	Sample	Depth (m)	Elev. (m)	Gravel (%)	Sand (%)	Silt (%)	Clay (%)	*(Fines, %)*
●	**104**	SS6	4.8	261.4	1	18	51	30	

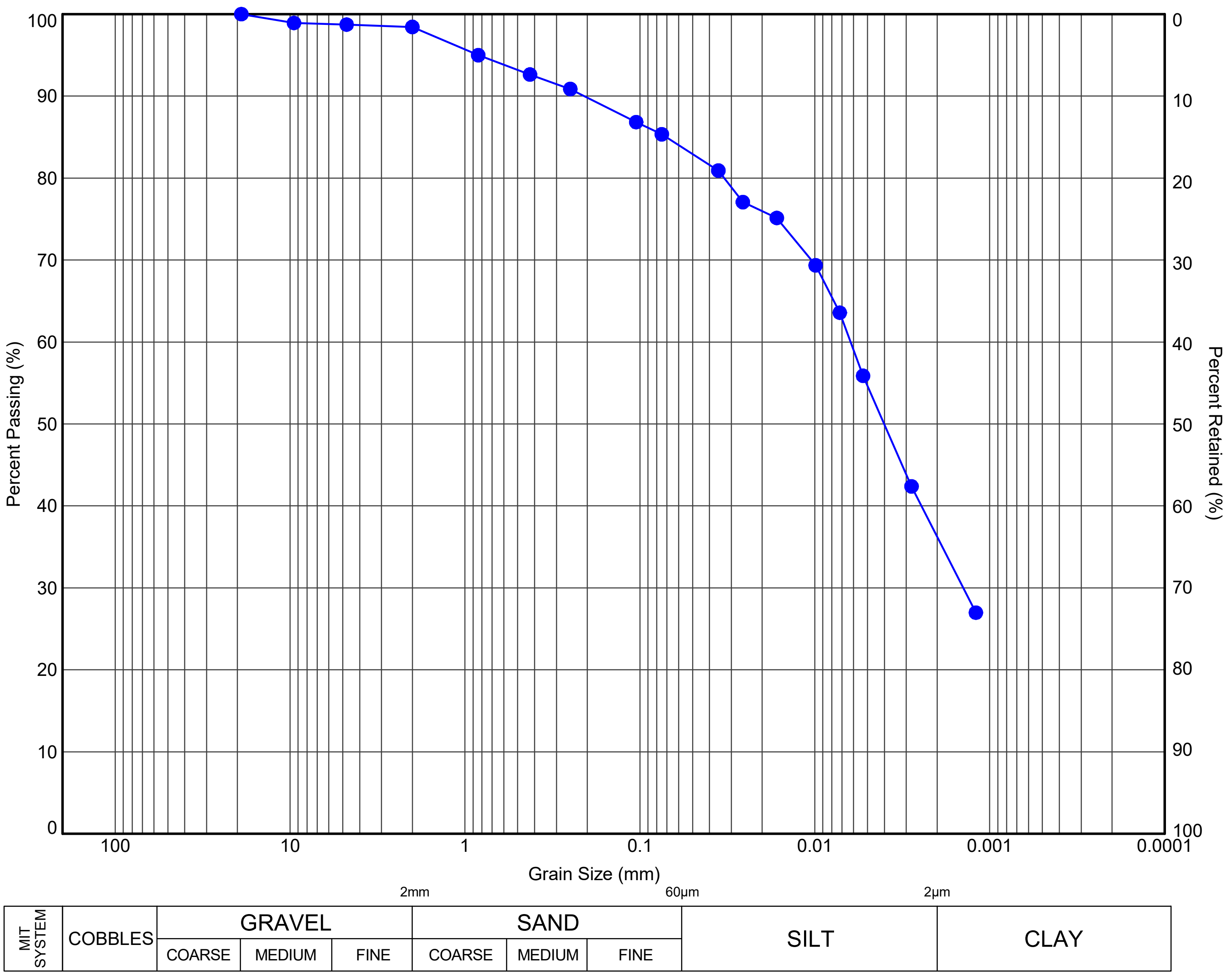
Terraprobe

11 Indell Lane, Brampton Ontario L6T 3Y3
(905) 796-2650

Title:

GRAIN SIZE DISTRIBUTION
CLAYEY SILT, SOME SAND, TRACE GRAVEL

File No.: **1-20-0222-02**



					MIT SYSTEM				
	Hole ID	Sample	Depth (m)	Elev. (m)	Gravel (%)	Sand (%)	Silt (%)	Clay (%)	*(Fines, %)*
●	**1**	SS3	1.8	265.0	2	14	48	36	

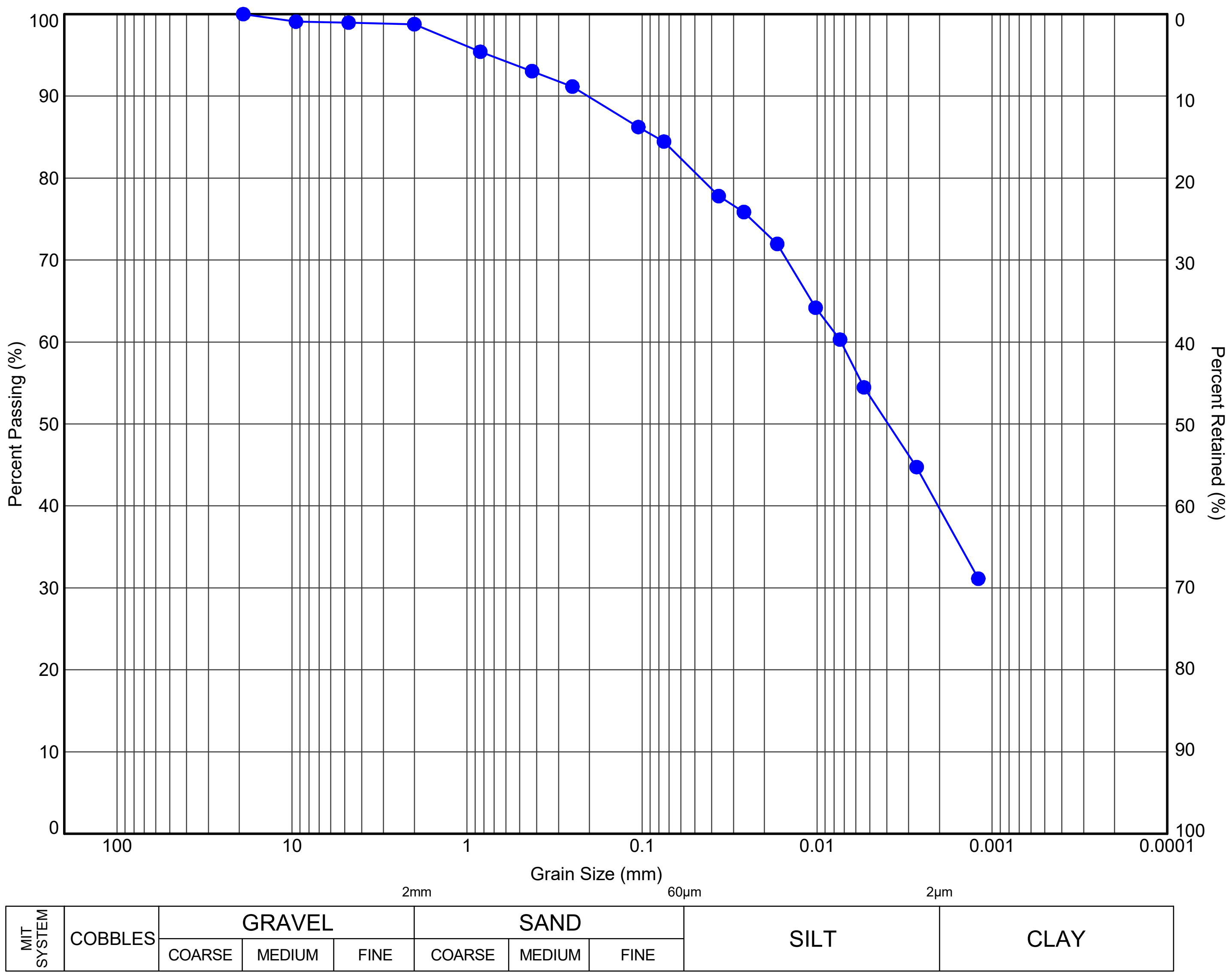
Terraprobe

11 Indell Lane, Brampton Ontario L6T 3Y3
(905) 796-2650

Title:

GRAIN SIZE DISTRIBUTION
SILT AND CLAY, SOME SAND, TRACE GRAVEL

File No.: **1-20-0222-01**



MIT SYSTEM

	Hole ID	Sample	Depth (m)	Elev. (m)	Gravel (%)	Sand (%)	Silt (%)	Clay (%)	*(Fines, %)*
●	**3**	SS4	2.5	263.8	1	16	43	40	

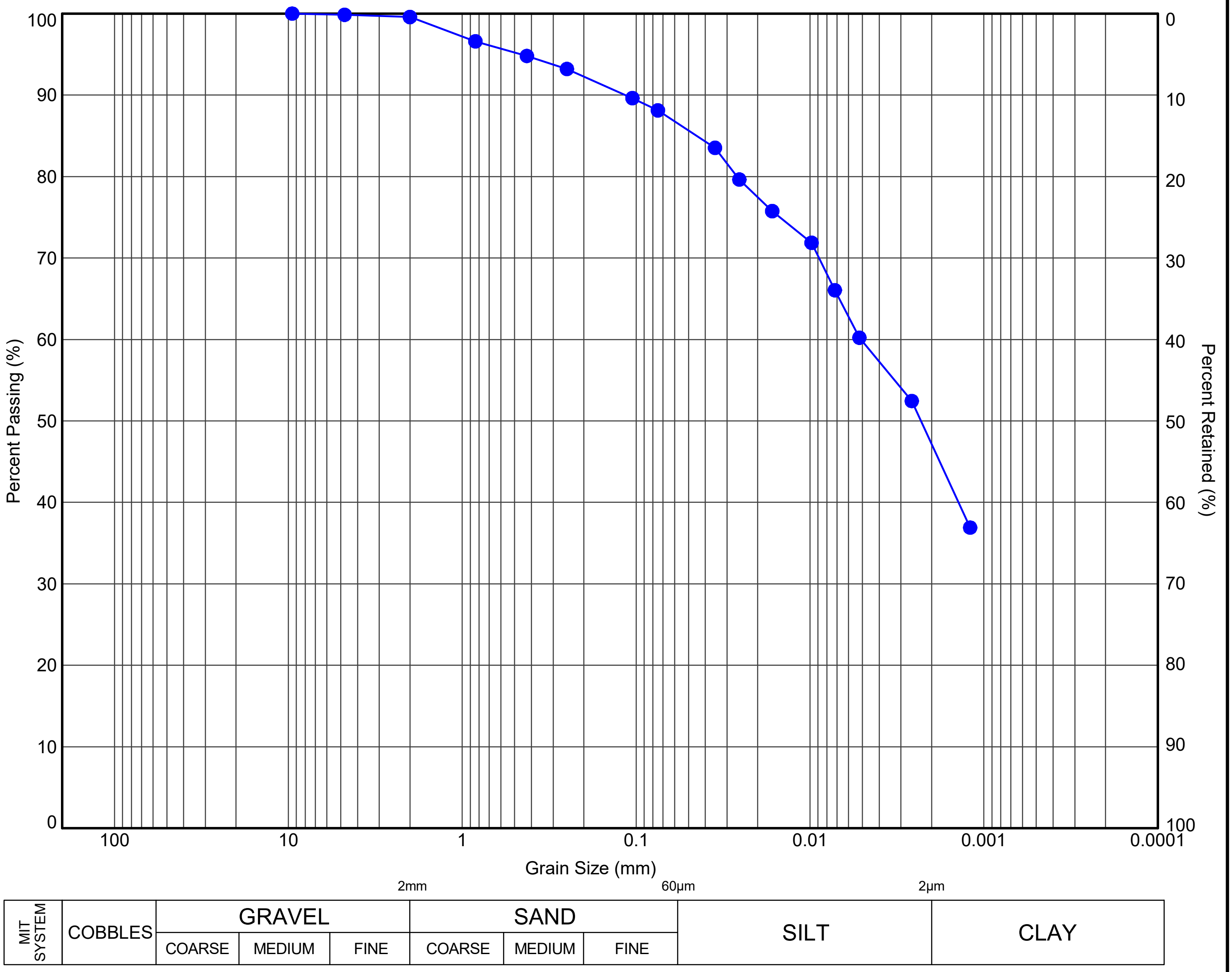
Terraprobe

11 Indell Lane, Brampton Ontario L6T 3Y3
(905) 796-2650

Title:

GRAIN SIZE DISTRIBUTION
SILT AND CLAY, SOME SAND, TRACE GRAVEL

File No.: **1-20-0222-01**



MIT SYSTEM

	Hole ID	Sample	Depth (m)	Elev. (m)	Gravel (%)	Sand (%)	Silt (%)	Clay (%)	*(Fines, %)*
●	**5**	SS3	1.8	264.6	0	13	40	47	

Terraprobe

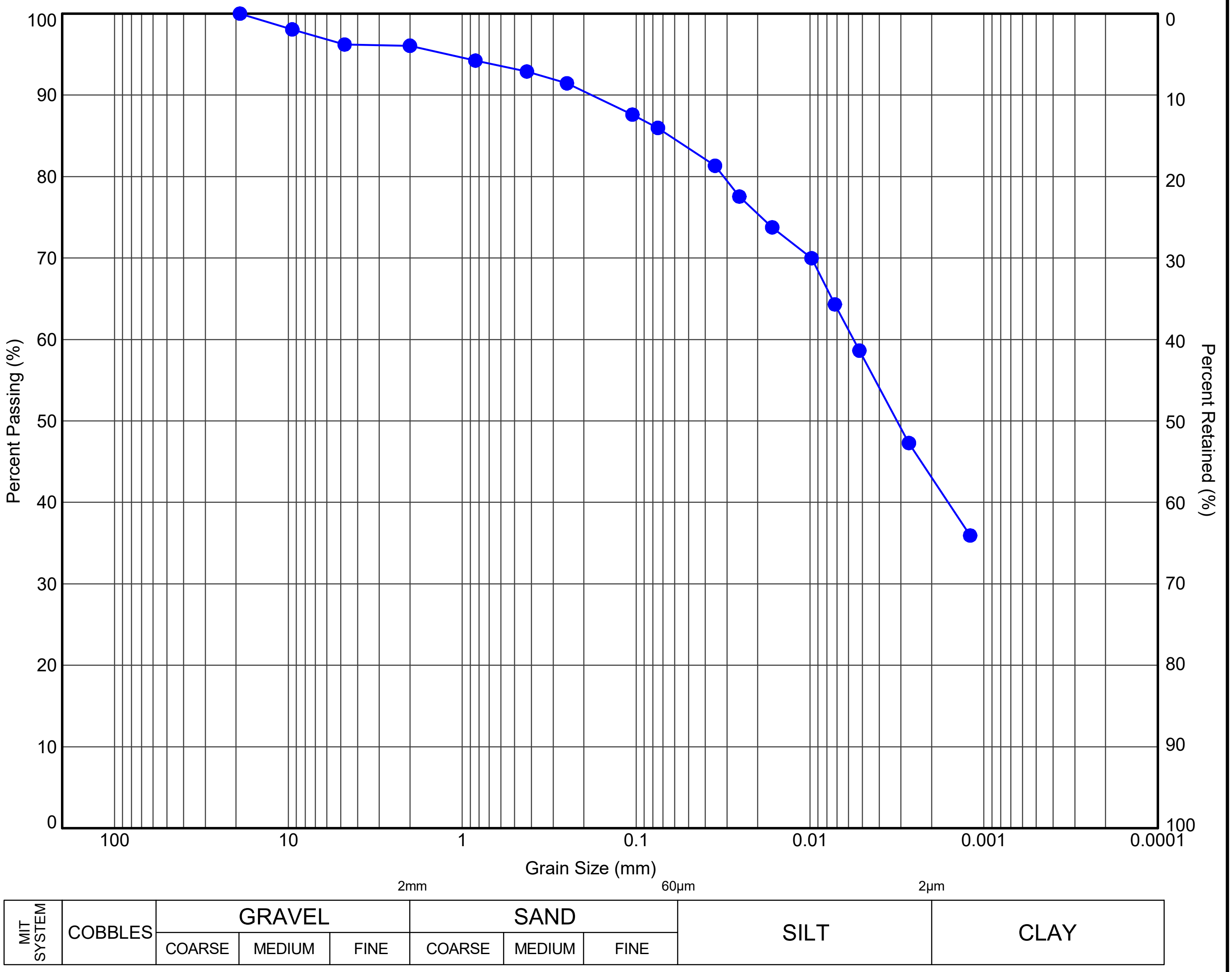
11 Indell Lane, Brampton Ontario L6T 3Y3
(905) 796-2650

Title:

GRAIN SIZE DISTRIBUTION
CLAY AND SILT, SOME SAND

File No.:

1-20-0222-01



	Hole ID	Sample	Depth (m)	Elev. (m)	MIT SYSTEM Gravel (%)	Sand (%)	Silt (%)	Clay (%)	*(Fines, %)*
●	**8**	SS2	1.0	266.0	4	11	42	43	

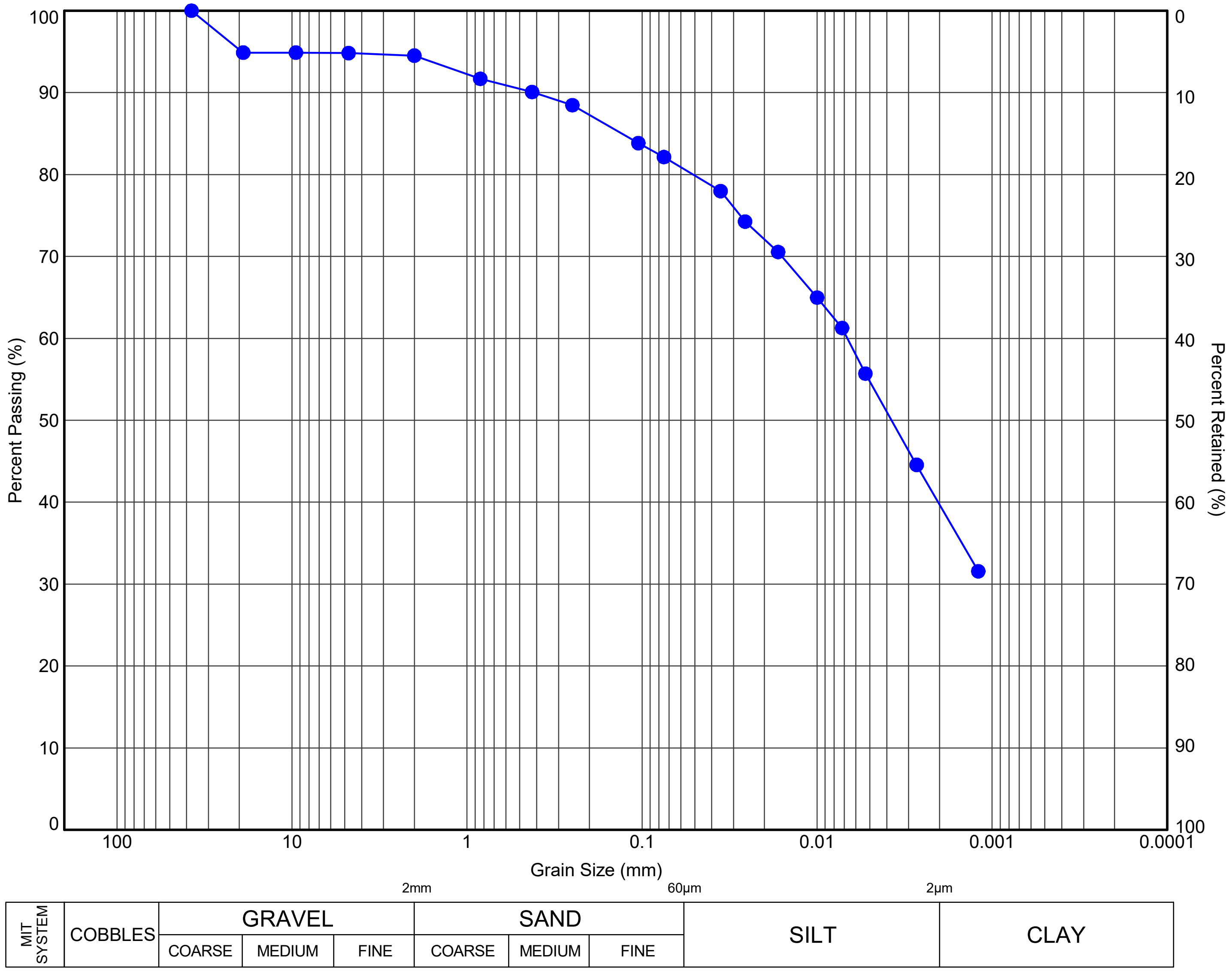
Terraprobe

11 Indell Lane, Brampton Ontario L6T 3Y3
(905) 796-2650

Title:

GRAIN SIZE DISTRIBUTION
CLAY AND SILT, SOME SAND, TRACE GRAVEL

File No.: **1-20-0222-01**



MIT SYSTEM

	Hole ID	Sample	Depth (m)	Elev. (m)	Gravel (%)	Sand (%)	Silt (%)	Clay (%)	*(Fines, %)*
●	**11**	SS2	0.9	266.2	6	13	41	40	

Terraprobe

11 Indell Lane, Brampton Ontario L6T 3Y3
(905) 796-2650

Title:

GRAIN SIZE DISTRIBUTION
SILT AND CLAY, SOME SAND, TRACE GRAVEL

File No.: **1-20-0222-01**

APPENDIX C

TERRAPROBE INC.

PART 1 GENERAL

1.01 Description

Engineered Fill refers to earth fill (earthworks) designed and constructed with engineering inspection and testing, so as to be capable of supporting structure foundations and slabs without excessive settlement. Poured concrete foundation walls must be provided with nominal reinforcing steel to provide stiffening of the foundation walls and to protect against excessive crack formation within the foundation walls.

Preparation for Engineered Fill and Engineered Fill operations must only be conducted under full time inspection and testing by the Geotechnical Engineer, in order to ensure adequate compaction and fill quality.

The work for the construction of Engineered Fill, is shown on the Design Drawings prepared by the Design Civil Engineer and as described by these specifications. The work included in this section includes the following:

a) Stripping of the existing topsoil, fill layer, and weathered/disturbed soil as needed from the ground surface below all areas to be covered with Engineered Fill,

b) Excavation of Test Holes into the subgrade to investigate the suitability of subsurface conditions for support of the Engineered Fill and determine if any prior existing fill materials are present,

c) Proof-rolling or visual inspection (as directed by the geotechnical engineer) of the subgrade below areas to be covered with Engineered Fill, to detect the presence and extent of unstable ground conditions,

d) Excavation and removal of unstable subgrade materials or other approved stabilization measures, if required prior to the placement of Engineered Fill,

e) Surveying of ground elevations prior to placing Engineered Fill,

f) Supply, placement, and compaction of approved clean earth as specified herein, with full time inspection and testing,

g) Surveying of ground elevations on completion of Engineered Fill placement,

h) Providing and maintaining survey layout of areas to receive Engineered Fill, and monitoring of ground elevations throughout the construction of Engineered Fill.

1.02 The Project Parties

A) The term Contractor shall refer to the individual or firm who will be carrying out the earthworks related to preparation and construction of Engineered Fill.

B) The term Geotechnical Engineer shall refer to the individual or firm who will be carrying out the full time inspection and testing of the earthworks related to preparation and construction of Engineered Fill.

C) The term Design Civil Engineer shall refer to the individual or firm who will be carrying out the Site Grading Design (pre-grading), the determination of Design Foundation Grades for the structures on the site, and the choice of lots and site areas to receive Engineered Fill.

PART 2 MATERIALS

2.01 Definitions

A) Topsoil Layer is the surface layer of naturally organic soil typically found at the ground surface and with thickness on the order of 25 to 250 mm thick.

B) Earth fill is soil material which has been placed by man-made effort and has not been deposited by nature over a long period of time.

C) Weathered/disturbed soil is natural or native soil that has been disrupted by weathering processes such as frost damage.

D) Subgrade soil is the “in situ” (in place) natural or native soil beneath any earth fill and/or weathered/disturbed soil and/or topsoil layer(s).

E) Engineered Fill soils must consist of clean earth materials (not excessively wet), free of organics and topsoil, free of deleterious materials such as building rubble, wood, plant materials, placed in thin lifts not exceeding 150 mm in thickness. Cohesionless soils such as sand or gravel, are the easiest to handle and compact.

F) All values stated in metric units shall be considered as accurate.

PART 3 ENGINEERED FILL DESIGN

3.01 Design Foundation Pressure

A) Engineered Fill can be expected to experience post-construction settlement on the order of 1 percent of the depth of the Engineered Fill. The time period over which most of this settlement typically occurs, depends on the composition of the Engineered Fill as follows (after initial placement);

a) Sand or gravel soil;	several days,
b) Silt soil;	several weeks,
c) Clay or clayey soil;	several months.

The placement of Engineered Fill might also result in post-construction settlement of the underlying natural soil.

The timing of foundation construction must take into account the post-construction settlement of the Engineered Fill and the foundation soil.

B) Unless otherwise stated, the Engineered Fill is to be placed over the entire lot or site area.

C) The Engineered Fill is to extend up to 1 m above the highest level of required foundation support. Typically this can be within 1 m of the design final grades. Additional common fill can be placed over the Engineered Fill to provide protection against environmental factors such as wind, frost, precipitation, and the like.

E) A geotechnical reaction at SLS of 150 kPa for 25 mm of settlement is typically recommended for the Engineered Fill, unless it consists of glaciolacustrine silt and clay in which case a lower design foundation pressure will need to be determined on a site specific basis. Foundations shall have minimum widths of 0.6 m for continuous strip footings, and minimum dimensions of 1 m for column footings.

F) At the foundation level, sufficient Engineered Fill shall be constructed to ensure that it extends at least 1.0 m laterally beyond the edge of any foundations, and that it extends outward within an area defined by a 1 to 1 line downward from the edge of any Engineered Fill.

G) Foundations placed on the Engineered Fill must be provided with nominal reinforcing steel for protection against excessive minor cracking. The reinforcing steel must consist of 2-15M bars continuous at the top of the foundation wall, and 2-15M bars continuous at the bottom of the foundation walls.

H) At the time of foundation construction, foundation excavations must be reviewed by the Geotechnical Engineer to confirm suitable bearing capacity of the Engineered Fill. The Geotechnical Engineer must inspect the foundation subgrade immediately after excavation, and must inspect the foundation subgrade immediately prior to placement of concrete for footings. The Geotechnical Engineer must also inspect the placement of reinforcing steel in the foundation walls. Written approval must be obtained from the Geotechnical Engineer prior to,

a) placement of footing concrete, and

b) placement of foundation wall concrete.

PART 4 CONSTRUCTION

4.01 Survey Layout

A) The survey layout shall be carried out and maintained throughout the construction of Engineered Fill activities. A suitable layout stake shall be placed at the corners of the start and finish of every block or work area to receive Engineered Fill.

B) At least two temporary survey elevation benchmarks shall be provided for every work area to receive Engineered Fill, to assist in monitoring the level of the Engineered Fill as it is constructed.

C) The ground elevations of the subgrade approved for receiving Engineered Fill shall be surveyed and recorded on a regular grid pattern. Engineered Fill shall not be placed on any work area without the written approval of the Geotechnical Engineer.

D) The ground elevations of the Engineered Fill on each work area shall be surveyed and recorded on a regular grid pattern at the end of each day during the placement of Engineered Fill.

E) On completion of Engineered Fill construction, the final ground elevations shall be surveyed and recorded on a regular grid pattern.

4.02 Topsoil Stripping

A) The Geotechnical Engineer must observe the stripping of topsoil from the areas proposed for Engineered Fill, from start to finish.

B) Topsoil must be stripped from the entire building site area. The Geotechnical Engineer must photograph the work areas which have had the earth fill suitably stripped.

4.03 Test Holes Into Subgrade

A) After the topsoil has been stripped, the exposed subgrade must be investigated for the presence of weak zones or deleterious material, which may be unsuitable for the support of Engineered Fill.

B) Exploratory test holes must be dug using a small backhoe, on a suitable pattern to obtain a representative indication of the entire site area.

C) The Geotechnical Engineer must observe the digging and backfilling of the test holes; must log the test hole stratigraphy; must obtain soil samples at maximum depth intervals of 0.3m; and must photograph each dug test hole.

D) If the test holes discover any old buried fill or deleterious materials, it must be excavated and removed from the lot area down to undisturbed, stable native soil.

E) All test holes must be properly backfilled and compacted in loose lifts of maximum 150 mm thickness to at least 98 percent Standard Proctor Maximum Dry Density (SPMDD), at the optimum water content plus or minus 2 percent. The Geotechnical Engineer must observe the backfilling and compaction of the test holes.

4.04 Subgrade Proof-rolling

A) Prior to placing any Engineered Fill, the exposed subgrade must be proof-rolled with a static smooth-drum roller and the Geotechnical Engineer must observe the proof-rolling.

B) Cohesive soil will be disrupted by proof-rolling. Competency must be determined by a geotechnical engineer by cutting and inspecting the soil.

C) If unstable subgrade conditions are encountered, the unstable subgrade must be sub-excavated. If wet site conditions exist during filling, stabilization with granular materials may be required.

4.05 Engineered Fill Placement

A) Engineered fill must not be placed without the approval of the Geotechnical Engineer. Prior to placing any Engineered Fill, the existing fill must be removed down to native soil subgrade, the subgrade must be investigated for old buried fill or deleterious material, the subgrade must be proof-rolled, and the subgrade elevations must be surveyed.

B) Prior to the placement of Engineered Fill, the source or borrow area for the Engineered Fill must be evaluated for its suitability. Some of the existing site fill that is removed prior to placement of Engineered Fill may be sorted and reused as Engineered Fill, but must first be approved by the Geotechnical Engineer. Samples of the proposed fill material must be obtained by the Geotechnical Engineer and tested in the geotechnical laboratory for Standard Proctor Maximum Dry Density, prior to approval of the material for use as Engineered Fill. The Engineered Fill must be free of organics and other deleterious material (wood, building debris, rubble, cobbles, boulders, and the like).

C) The Engineered Fill must be placed in maximum loose lift thicknesses of 150 mm. Each lift of Engineered Fill must be compacted with a heavy roller, to at least 98 percent Standard Proctor Maximum Dry Density (SPMDD), at the optimum water content plus or minus 2 percent.

D) Field density tests must be taken by the Geotechnical Engineer, on each lift of Engineered Fill, on each lot area. Any Engineered Fill which is tested and found to not meet the specifications, shall be either removed or, reworked and retested.

E) Engineered fill must not be placed during the period of the year when cold weather occurs, i.e., when there are freezing ambient temperatures during the daytime and overnight.