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Soil Engineers Ltd.
CONSULTING ENGINEERS
GEOTECHNICAL • ENVIRONMENTAL • HYDROGEOLOGICAL • BUILDING SCIENCE
90 WEST BEAVER CREEK ROAD, SUITE 100, RICHMOND HILL, ONTARIO L4B 1E7 · TEL: (416) 754-8515 · FAX: (905) 881-8335

BARRIE	MISSISSAUGA	OSHAWA	NEWMARKET	GRAVENHURST	HAMILTON
TEL: (705) 721-7863	TEL: (905) 542-7605	TEL: (905) 440-2040	TEL: (905) 853-0647	TEL: (705) 684-4242	TEL: (905) 777-7956
FAX: (705) 721-7864	FAX: (905) 542-2769	FAX: (905) 725-1315	FAX: (905) 881-8335	FAX: (705) 684-8522	FAX: (905) 542-2769

A REPORT TO
CARRINGWOOD HOMES

A GEOTECHNICAL INVESTIGATION FOR PROPOSED RESIDENTIAL DEVELOPMENT

HUNSDEN SIDEROAD

TOWN OF CALEDON

REFERENCE NO. 2202-S079

APRIL 2022

DISTRIBUTION

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1.0 INTRODUCTION

In accordance with written authorization dated February 17, 2022 from Mr. Robert Fernicola, President of Woodbridge Crossing Ltd., on behalf of Carringwood Homes, a geotechnical investigation was conducted on a parcel of land on the south side of Hunsden Sideroad, approximately 350 m east of Mount Pleasant Road in the Town of Caledon, for a proposed Residential Development.

The purpose of the investigation was to reveal the subsurface conditions and determine the engineering properties of the disclosed soils. The geotechnical findings and resulting recommendations are presented in this Report.

2.0 SITE AND PROJECT DESCRIPTION

The Town of Caledon is situated on Peel-Markham till plain where the drift dominates the soil stratigraphy. In places, lacustrine sand, silt, clay and drift which have been reworked by the water action of Peel Ponding (glacial lake) have modified the drift stratigraphy.

The property, approximately 20 hectares in area, consists of a residential lot fronting Hundsden Sideroad, farm field and a wood lot. The grading within the property is relatively flat, generally descends towards Hunsden Sideroad.

At the time of the report preparation, detailed design for the proposed development is not available, however, it is understood that the property will be developed into a residential subdivision with a block reserved for a stormwater management facility.

3.0 FIELD WORK

The field work, consisting of six (6) sampled boreholes extending to a depth of 6.6 to 9.6 m from the prevailing ground surface, was performed on March 9 and 10, 2022, at the locations shown on the Borehole and Monitoring Well Location Plan, Drawing No. 1.

The boreholes were advanced at intervals to the sampling depths by a track-mounted, continuous-flight power-auger machine equipped for soil sampling. Standard Penetration Tests, using the procedures described on the enclosed “List of Abbreviations and Terms”, were performed at the sampling depths. The results are recorded as the Standard Penetration Resistance (or ‘N’ values) of the subsoil. The relative density of the non-cohesive strata and the consistency of the cohesive strata are inferred from the ‘N’ values. Split-spoon samples were recovered for soil classification and laboratory testing.

Monitoring wells, 50 mm in diameter, were installed at all borehole locations to facilitate a a hydrogeological assessment by others. The depth and details of wells are shown on the corresponding Borehole Logs.

The fieldwork was supervised and the findings were recorded by a Geotechnical Technician. The ground elevation at each borehole location was obtained using a hand-held Global Navigation Satellite System (GNSS) equipment.

4.0 **SUBSURFACE CONDITIONS**

The boreholes were completed in the farm field. The investigation has disclosed that beneath the topsoil, the site is generally underlain by a deposit of silt, with strata of sand in places.

Detailed descriptions of the subsurface conditions are presented on the Borehole Logs, comprising Figures 1 to 6, inclusive. The revealed stratigraphy is plotted on the Subsurface Profile, Drawing No. 2. The engineering properties of the disclosed soils are discussed herein.

4.1 **Topsoil** (All Boreholes)

The revealed topsoil is 15 cm to 30 cm in thickness. Thicker topsoil layer may be contacted in areas beyond the borehole locations, especially near the treed or low-lying areas.

4.2 **Silt** (All Boreholes)

A silt deposit was contacted throughout the property, with sand deposit either above or beneath the silt. It consists of some sand to being sandy, with a trace of gravel. Grain size analyses were performed on three representative samples of the silt; the result is illustrated on Figure 7.

The recorded ‘N’ values of the silt ranges from 5 to 64 blows per 30 cm of penetration, indicating that the deposit is loose to very dense in relative density. The loose condition is generally restricted to the weathered zone, extending to a depth of up to 1.2 m from grade.

The silt is generally moist, as disclosed by the natural water content values ranging from 10% to 25%. The silt deposit is wet in Boreholes 5 and 6, likely derived from perched groundwater. The engineering properties of the silt deposit are presented below:

- High frost susceptibility and high soil adfreezing potential.
- High water erodibility. In excavation, the fine particles are susceptible to migration through small openings under seepage pressure.
- Relatively low permeability, with estimated permeability of 10^{-4} to 10^{-5} cm/sec, or percolation time of 12 to 20 min/cm.
- In excavation, the silt will run with water seepage and boil under a piezometric head of 0.3 m.
- Poor pavement-supportive material, with an estimated CBR value of 3% to 7%.
- Moderate corrosivity to buried metal, with an estimated electrical resistivity of 5000 ohm·cm.

4.3 **Sand** (Boreholes 1, 4 and 6)

The sand was encountered in Boreholes 1, 4 and 6. It is fine-grained to well-graded, with a variable amount of silt and gravel. Grain size analysis was performed on two representative samples of the sand. The results are plotted on Figures 8 and 9.

The obtained 'N' values ranges from 12 to 76 blows per 30 cm of penetration, indicating the sand is compact to very dense in relative density. The moisture contents of the sand ranges from 1% to 16%, indicating dry to very moist condition. The high-water content value is likely due to the higher silt content in the sand, as sample examination indicates that the sand is generally in a dry to moist condition.

The engineering properties of the sand deposit are listed below:

- Moderate to moderately high frost susceptibility.
- High water erodibility, it is susceptible to migration through small opening under seepage pressure.
- Pervious to relatively pervious, with an estimated coefficient of permeability and percolation times of 10^{-2} to 10^{-4} cm/sec and 4 to 12 min/cm, respectively.
- In excavation, the sand will slough to its angle of repose, run with water seepage and boil under a piezometric head of 0.4 m.
- Fair pavement-supportive material, with an estimated CBR value of 8%.
- Low to moderately low corrosivity to buried metal, with an estimated electrical resistivity of 5000 to 6000 ohm·cm.

4.4 Compaction Characteristics of the Revealed Soils

The obtainable degree of compaction is primarily dependent on the soil moisture and, to a lesser extent, on the type of compactor used and the effort applied. As a general guide, the typical water content values of the revealed soils for Standard Proctor compaction are presented in Table 1.

Table 1 - Estimated Water Content for Compaction of On-Site Material

Soil Type	Determined Natural Water Content (%)	Water Content (%) for Standard Proctor Compaction	
		100% (optimum)	Range for 95% or +
Sand	1 to 16 (median 6)	10	7 to 13
Silt	10 to 25 (median 19)	12	8 to 15

The above values show that the in-situ soils are either too dry or too wet for 95% or + Standard Proctor compaction. The weathered soils near the ground surface and portions of the sand and silt are on the wet side of the optimum or too wet and will require aeration prior to compaction. Aeration can be achieved by spreading the wet soil thinly on the ground in the dry and warm weather. The weathered soil must also be screened, segregated the topsoil and organics, before aeration for reuse as structural backfill.

When compacting the tills on the dry side of the optimum, the compactive energy will frequently bridge over the chunks in the soil and be transmitted laterally into the soil mantle. Therefore, the lifts must be limited to 20 cm or less (before compaction).

5.0 GROUNDWATER CONDITION

All boreholes remained dry upon completion of the fieldwork. Water seepage was encountered in Boreholes 1, 5 and 6, at a depth of 9.1 m, 1.4 m and 3.0 m from grade, respectively, or El. 300.1 to 286.9 m.

Groundwater yield, if encountered, from the silt and sand will likely, be moderate to appreciable. Perched groundwater may occur at shallow depths during wet seasons.

6.0 DISCUSSION AND RECOMMENDATIONS

The investigation revealed that beneath the topsoil, the site is underlain by a loose to very dense, generally compact silt deposit. In places, compact to very dense sand was also contacted. The upper zone of the soil, extending to 1.2 m from grade, is generally weathered.

All boreholes remained dry and upon completion of borehole drilling with groundwater seepage detected in 3 of the boreholes. During wet seasons, perched groundwater may occur at shallow depths and will be subject to seasonal fluctuation. If encountered, the groundwater yield from the silt and sand will be moderate appreciable. Additional water level in the monitoring wells will be recorded by others.

The conceptual site plan indicates that the site will be developed into a residential subdivision provided with municipal road. The lots will be serviced privately with individual septic systems for sewage. The geotechnical findings warranting special consideration for the proposed project are presented below:

1. The topsoil must be removed for site development. It can only be re-used for landscaping in designated areas only.
2. The site can be re-graded with an engineered fill for development. The weathered soils must be sub-excavated, sorted free of topsoil and organics before reuse for engineered fill or structural backfill.
3. The engineered fill and sound native soils are suitable for supporting the proposed structures, underground services and road pavement.
4. The footing subgrade must be inspected by a geotechnical engineer or a senior geotechnical technician to assess its suitability for supporting the structures at the designed bearing pressures.
5. Backfill of any trenches and house foundation should consist of on-site excavated material, free of organics, or imported granular material or inorganic earth fill.
6. If the proposed stormwater management pond is a retention pond, an impermeable clay liner must be provided.

The recommendations appropriate for the project described in Section 2.0 are presented herein. One must be aware that the subsurface conditions may vary between boreholes. Should any subsurface variance become apparent during construction, a geotechnical engineer must be consulted to determine whether the following recommendations require revision.

6.1 Site Preparation

The site can be re-graded with an engineered fill for development. The requirements for the engineered fill are presented below:

1. The topsoil must be removed; any disturbed soils and weathered soils must be subexcavated and further assessed of their suitability for engineered fill.

2. The native soil subgrade must be inspected and proof-rolled prior to any fill placement.
3. Inorganic soils must be used for the fill, and they must be uniformly compacted in lifts 20 cm thick to 98% or + of the maximum Standard Proctor dry density (SPDD) up to the proposed finished grade. The soil moisture must be properly controlled near the optimum. If the foundations are to be built soon after the fill placement, the densification process for the engineered fill must be increased to 100% SPDD.
4. If the engineered fill is compacted with the moisture content on the wet side of the optimum, the underground services and pavement construction should not begin until the pore pressure within the fill mantle has completely dissipated. This must be further assessed at the time of the engineered fill construction.
5. If imported fill is to be used, it should be inorganic soils, free of any deleterious material with environmental issue (contamination). Any potential imported earth fill from off-site must be reviewed for geotechnical and environmental quality by the appropriate personnel as authorized by the developer or agency, before it is hauled to the site.
6. The engineered fill must not be placed during the period where freezing ambient temperatures occur either persistently or intermittently. This is to ensure that the fill is free of frozen soils, ice and snow.
7. The fill operation must be fully supervised and monitored by a technician under the direction of a geotechnical engineer.
8. The engineered fill envelope and finished elevations must be clearly and accurately defined in the field, and they must be precisely documented.
9. Foundations founded on engineered fill must be reinforced in the footings and in the upper section of the foundation walls. It should be designed by a structural engineer to properly distribute the stress induced by the abrupt differential settlement (about 20 mm) in engineered fill.
10. Any excavation carried out in certified engineered fill must be reported to the geotechnical consultant who supervised the fill placement in order to document the locations of excavation and/or to supervise reinstatement of the excavated areas to engineered fill status. If construction on the engineered fill does not commence within a period of 2 years from the date of certification, the condition of the engineered fill must be assessed for re-certification.
11. The footing and underground services subgrade must be inspected by the geotechnical consulting firm that supervised the engineered fill placement. This is to ensure that the foundations and service pipes are placed within the engineered fill envelope, and the integrity of the fill has not been compromised by interim construction, environmental degradation and/or disturbance by the footing excavation.

6.2 Foundations

The proposed structures can be supported on conventional spread and strip footings, founded on the undisturbed native soil below the weathered soils, or on engineered fill. The recommended soil bearing pressures for the design of conventional footings are provided:

- Maximum Bearing Pressure at Serviceability Limit State (SLS) = 150 kPa
- Factored Bearing Pressure at Ultimate Limit State (ULS) = 240 kPa

The total and differential settlements of structures designing for the bearing pressure at SLS are estimated within 25 mm and 20 mm, respectively.

The foundation subgrade should be inspected by the geotechnical engineer or a senior geotechnical technician to ensure that the revealed conditions are compatible with the foundation design requirements.

Foundations exposed to weathering or in unheated areas should have at least 1.4 m of earth cover for protection against frost action.

If groundwater seepage is encountered in excavation, the foundation must be poured immediately after subgrade inspection or the subgrade should be protected by a mud-slab of lean concrete immediately after exposure. This will prevent construction disturbance and costly rectification of the bearing subsoil.

The building foundations should meet the requirements specified in the latest Ontario Building Code and the structures should be designed to resist an earthquake force using Site Classification ‘D’ (stiff soil).

6.3 Basement Structures

The basement structure should be provided with a drainage system (Drawing No. 3) at the wall base and damp-proofing of the perimeter walls. The subdrains should be encased in a fabric filter to protect them against blockage by silting.

The perimeter walls should be designed to sustain a lateral earth pressure calculated using the soil parameters stated in Section 6.10. Any applicable surcharge loads adjacent to the basement must also be considered in the wall design.

The basement floor subgrade should consist of sound native soil or well compacted inorganic earth fill. The floor slab should be constructed on a granular base, at least 15 cm thick, consisting of 19-mm Crusher-Run Clearstone, or equivalent.

The exterior gradient beside the basement structure must be graded to direct runoff away from the structures.

6.4 Garages and Driveways

The on-site soils are mostly frost susceptible and the ground will be subject to frost heaving during cold weather.

The driveway at the entrance to the garage must be backfilled with non-frost-susceptible granular material, with a frost taper at a slope flatter than 1 vertical:1 horizontal. In areas where frost susceptible material is present beneath the garage floor slab, the subgrade should be insulated with 50-mm Styrofoam, or its thermal equivalent.

6.5 Underground Services

The underground services should be founded on sound native soil or properly compacted inorganic earth fill. Where incompetent or weathered soil is encountered, it should be subexcavated and replaced with the bedding material, compacted to at least 98% SPDD.

A Class ‘B’ bedding is recommended for the underground services construction. It should consist of compacted 19-mm Crusher-Run Limestone, or equivalent, as approved by a geotechnical engineer.

A soil cover of at least two times the diameter of the pipe should be in place at all times after pipe installation, to prevent pipe floatation when the trench is deluged with water derived from precipitation.

6.6 Backfilling in Trenches and Excavated Areas

The backfill in service trenches should be compacted to at least 98% SPDD, particularly in the zone within 1.0 m below the pavement. The material should be compacted with the water content at 2% to 3% drier than the optimum.

Selected on site inorganic soils are suitable for use as trench backfill. Wet soils will require aeration prior to its use as structural backfill.

In normal construction practice, the problem areas of pavement settlement largely occur adjacent to manholes, services crossings, foundation walls and columns, it is recommended that a sand backfill should be used.

The narrow trenches for services crossings should be cut at 1 vertical:2 horizontal so that the backfill in the trenches can be effectively compacted. Otherwise, soil arching in the trenches will prevent achievement of the proper compaction. In confined areas where the desired slope cannot be achieved or the operation of a proper kneading-type roller cannot be facilitated, imported sand fill, which can be appropriately compacted by using a smaller vibratory compactor, must be used.

One must be aware of the possible consequences during trench backfilling and exercise caution as described below:

- To backfill a trench, one must be aware that future settlement is to be expected, unless the sides is flattened to 2 Horizontal (H):1 vertical (V), and the lifts of the fill and its moisture content are stringently controlled; i.e., lifts should be no more than 20 cm (or less if the backfilling conditions dictate) and uniformly compacted to achieve at least 98% SPDD, with the moisture content on the wet side of the optimum.
- It is often difficult to achieve uniform compaction of the backfill in the lower vertical section of a trench which is an open cut or is stabilized by a trench box, particularly in the sector close to the trench walls or the sides of the box. These sectors must be backfilled with sand and the compaction must be carried out diligently prior to the placement of the backfill above this sector, i.e., in the upper sloped trench section. This measure is necessary in order to prevent consolidation of inadvertent voids and loose backfill which will compromise the compaction of the backfill in the upper section.
- In areas where groundwater movement is expected in the pipe bedding or trench backfill mantle, anti-seepage collars (OPSS 802.095) should be provided.
- When construction is carried out in freezing weather, frozen soil layers may inadvertently be mixed with the structural trench backfill. Should the in situ soils have a water content on the dry side of the optimum, it would be impossible to wet the soils due to the freezing condition, rendering difficulties in obtaining uniform and proper compaction. Furthermore, the freezing condition will prevent wetting of the backfill or when it is required, such as when the trench box is removed. The above will invariably cause backfill settlement in the next few years.
- In areas where the underground services construction is carried out during winter months, prolonged exposure of the trench walls will result in frost heave within the soil mantle of the walls. This may result in some settlement as the frost recedes, and repair costs will be incurred prior to final surfacing of the new pavement.

6.7 Septic System

For normal in-ground septic tile bed construction, the limitations are that the bottom of the absorption trenches, or the surface of a filter medium be located a minimum of 0.5 m above the highest groundwater level, and 0.9 m above rock or soils with a percolation time exceeding 50 min/cm. The soil in the treatment zone should possess acceptable effluent absorption properties expressed in a percolation time of between 1 min/cm and 50 min/cm.

As shown in the soil report, the predominant *in situ* soils consist of silt and sand which are relatively pervious and suitable for in-ground septic tile bed construction.

The estimated percolation time (‘T’) for the design of the septic tile bed is presented in Section 4.2 and 4.3 of this report. A detailed design of the septic tile bed system can be obtained from the 1997 Ontario Building Code, published by the Ontario Ministry of Municipal Affairs and Housing.

In order to enhance an efficient bed operation, the following requirements should be incorporated in the septic tile bed construction:

1. Grading of the surrounding areas should be such that it directs surface runoff away from the tile bed area.
2. The bed should be located in an unshaded area.
3. The fissured pattern of the underlying soil should not be disturbed, as this would reduce its capacity for in-ground effluent absorption.
4. In the low areas, the septic tile bed should be elevated so that surface runoff will not pond.

6.8 Pavement Design

The pavement design for local road meeting the Town of Caledon standards is presented in Table 2.

Table 2 - Pavement Design

Course	Thickness (mm)	Specifications
Asphalt Surface	40	OPSS HL3
Asphalt Binder	80	OPSS HL-8
Granular Base	150	20-mm Crusher-Run Limestone
Granular Sub-base	300	50-mm Crusher-Run Limestone

In preparation of pavement subgrade, all topsoil and compressible material should be removed. The final subgrade must be proof-rolled using a heavy roller or loaded dump truck. Any soft spot identified must be rectified by subexcavation and replacing with selected dry inorganic material. The subgrade within 1.0 m below the underside of the granular sub-base must be compacted to at least 98% SPDD, with the water content at 2% to 3% drier than its optimum.

All the granular bases should be compacted in 150 to 200 mm lifts to 100% SPDD.

The pavement subgrade will suffer a strength regression if water is allowed to saturate the mantle. The following measures should, therefore, be incorporated in the construction procedures and road design:

- The subgrade should be properly crowned and smooth-rolled to allow interim precipitation to be properly drained prior to pavement construction.
- Lot areas adjacent to the roads should be properly graded to prevent ponding of large amounts of water. Otherwise, the water will seep into the subgrade mantle and induce a regression of the subgrade strength, with costly consequences for the pavement construction.

The roadside ditches should be at least 1.5 m below the crown of the finished pavement, and the sides should be graded to 2.5H:1V or flatter for stability.

In order to prevent rainwash erosion, the sides must be sodded. The wet perimeter of the open ditches should be protected against flow erosion by using the measures given in Table 3.

Table 3 - Protection Against Flow Erosion

Drainage Flow (m/sec)	**Protective Measures Against Flow Erosion**
0.6 or less	Not Required
0.6 to 1.5	Sodded Gutter
1.5 to 2.1	Cobbled Gutter
2.1 to 4.5	30 cm Paving Stone
4.5 +	Gabion Mat on Geotextile Backing

6.9 **Stormwater Management Facility** (Borehole 6)

A stormwater management facility is proposed in the vicinity of Borehole 6. Based on the borehole findings, the subsoil consists of silt overlying sand. Due to the relatively previous nature of the sand and silt, a clay liner will be necessary if the facility is to consist of a retention pond. The liner thickness will depend on the invert of the facilities and the groundwater conditions in the vicinity. The thickness of the liner must be further assessed once the stormwater management design is available.

The side slopes of the stormwater management facility should be maintained at a stable slope not steeper than 3H to 1V above the wet perimeter, and flatter than 4H to 1V below the wet perimeter. The final slopes must be vegetated and/or sodded to prevent runoff erosion.

If an earth berm is to be constructed in the retention facility, topsoil and badly weathered soils must be removed and the subgrade must be proof-rolled. The berm should consist of inorganic clayey soils, compacted to 98% SPDD. The final surface of the berm should be graded and vegetated properly as recommended above.

The foundation of control structures should extend into the sound native soils below the frost depth or scouring depth, whichever is greater. A Maximum Allowable Soil Pressure (SLS) of 150 kPa and a Factored Ultimate Soil Bearing Pressure (ULS) of 240 kPa are recommended for the design of control structures.

6.10 **Soil Parameters**

The recommended soil parameters for the project design are given in Table 4.

Table 4 - Soil Parameters

Unit Weight and Bulk Factor	**Bulk Unit Weight γ (kN/m^3)**	**Estimated Bulk Factor**	
		Loose	**Compacted**
Silt	21.0	1.25	1.00
Sand	20.0	1.25	1.00
Lateral Earth Pressure Coefficients	**Active K_a**	**At Rest K_0**	**Passive K_p**
Silt	0.33	0.43	3.00
Sand	0.30	0.46	3.39

Table 4 - Soil Parameters (Cont'd)

Coefficients of Friction	
Between Concrete and Granular Base	0.50
Between Concrete and Sound Native Soils	0.35
Maximum Allowable Soil Pressure (SLS) For Thrust Block Design	
Engineered Fill and Sound Native Soils	75 kPa

6.11 Excavation

Excavation should be carried out in accordance with Ontario Regulation 213/91. The types of soils are classified in Table 5.

Table 5 - Classification of Soils for Excavation

Material	Type
Weathered soils, drained Sand and Silt	3
Wet Sand and Silt	4

In open excavation, the sides of excavation may suffer localized sloughing or side collapse; therefore, a stable backing slope or excavation protection will be required for stability.

Continuous groundwater is not anticipated within the depth of the investigation. Any excavation extending into the wet sand and silt, if any, will require extensive dewatering from closely spaced sump wells or well points.

Prospective contractors may be asked to assess the subsurface conditions by digging test pits to the intended depth of trench excavation. These test pits should be allowed to remain open for a few hours to assess the trenching conditions and the dewatering scheme for excavation.

7.0 LIMITATIONS OF REPORT

This report was prepared by Soil Engineers Ltd. for the account of Carringwood Homes and for review by the designated consultants, contractors, financial institutions, and government agencies. The material in the report reflects the judgment of Kelvin Hung, P.Eng., and Bernard Lee, P.Eng., in light of the information available to it at the time of preparation.

Use of the report is subject to the conditions and limitations of the contractual agreement. Any use which a Third Party makes of this report, and/or any reliance on decisions to be made based on it is the responsibility of such Third Parties. Soil Engineers Ltd. accepts no responsibility for damages, if any, suffered by any Third Party as a result of decisions made or actions based on this report.

SOIL ENGINEERS LTD.

LICENSED PROFESSIONAL ENGINEER
04/05/2022
K. W. K. HUNG
100124295
KH
PROVINCE OF ONTARIO

Kelvin Hung, P.Eng.

LICENSED PROFESSIONAL ENGINEER
Apr 5, 2022
B. P. Y. LEE
100104568
PROVINCE OF ONTARIO

Bernard Lee, P.Eng.
KH/BL:dd

LIST OF ABBREVIATIONS AND DESCRIPTION OF TERMS

The abbreviations and terms commonly employed on the borehole logs and figures, and in the text of the report, are as follows:

SAMPLE TYPES

AS	Auger sample
CS	Chunk sample
DO	Drive open (split spoon)
DS	Denison type sample
FS	Foil sample
RC	Rock core (with size and percentage recovery)
ST	Slotted tube
TO	Thin-walled, open
TP	Thin-walled, piston
WS	Wash sample

PENETRATION RESISTANCE

Dynamic Cone Penetration Resistance:

A continuous profile showing the number of blows for each foot of penetration of a 2-inch diameter, 90° point cone driven by a 140-pound hammer falling 30 inches.

Plotted as '—●—'

Standard Penetration Resistance or 'N' Value:

The number of blows of a 140-pound hammer falling 30 inches required to advance a 2-inch O.D. drive open sampler one foot into undisturbed soil.

Plotted as '○'

WH	Sampler advanced by static weight
PH	Sampler advanced by hydraulic pressure
PM	Sampler advanced by manual pressure
NP	No penetration

SOIL DESCRIPTION

Cohesionless Soils:

'N' (blows/ft)	Relative Density
0 to 4	very loose
4 to 10	loose
10 to 30	compact
30 to 50	dense
over 50	very dense

Cohesive Soils:

Undrained Shear Strength (ksf)	'N' (blows/ft)	Consistency
less than 0.25	0 to 2	very soft
0.25 to 0.50	2 to 4	soft
0.50 to 1.0	4 to 8	firm
1.0 to 2.0	8 to 16	stiff
2.0 to 4.0	16 to 32	very stiff
over 4.0	over 32	hard

Method of Determination of Undrained Shear Strength of Cohesive Soils:

x 0.0 Field vane test in borehole; the number denotes the sensitivity to remoulding

△ Laboratory vane test

☐ Compression test in laboratory

For a saturated cohesive soil, the undrained shear strength is taken as one half of the undrained compressive strength

METRIC CONVERSION FACTORS

1 ft = 0.3048 metres
1lb = 0.454 kg
1 inch = 25.4 mm
1ksf = 47.88 kPa

JOB NO.: 2202-S079

LOG OF BOREHOLE NO.: 1

FIGURE NO.: 1

PROJECT DESCRIPTION: Proposed Residential Development

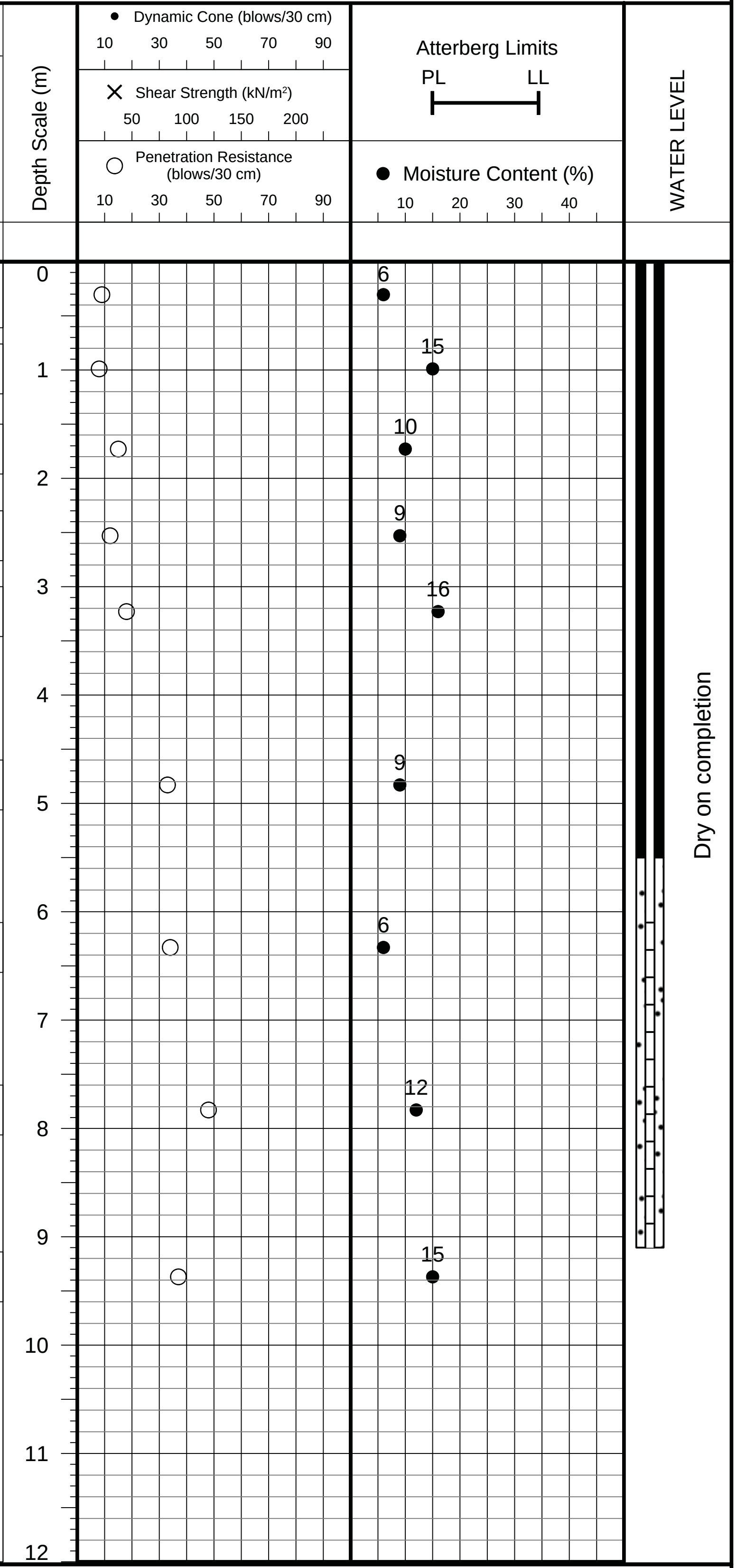
METHOD OF BORING: Flight-Auger

PROJECT LOCATION: Hunsden Sideroad, Town of Caledon (Bolton)

DRILLING DATE: March 9, 2022

El. (m) Depth (m)	SOIL DESCRIPTION
296.0	Ground Surface
0.0	15 cm TOPSOIL Brown, loose SAND fine grained, some silt weathered
294.6 1.4	Brown, compact to dense SAND well-graded, gravelly some silt to silty occ. silt layers
288.9 7.1	Brown, dense SILT some sand to sandy, a trace of fine gravel occ. sand seams water seepage at 9.1 m
286.4 9.6	END OF BOREHOLE Installed 51 mm Ø monitoring well to 9.1 m completed with 3.0 m screen Sand backfill from 5.5 to 9.1 m Bentonite seal from 0.0 m to 5.5 m Provided with a monument steel casing.

SAMPLES		
Number	Type	N-Value
1	DO	9
2	DO	8
3	DO	15
4	DO	12
5	DO	18
6	DO	33
7	DO	34
8	DO	48
9	DO	37



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JOB NO.: 2202-S079

LOG OF BOREHOLE NO.: 2

FIGURE NO.: 2

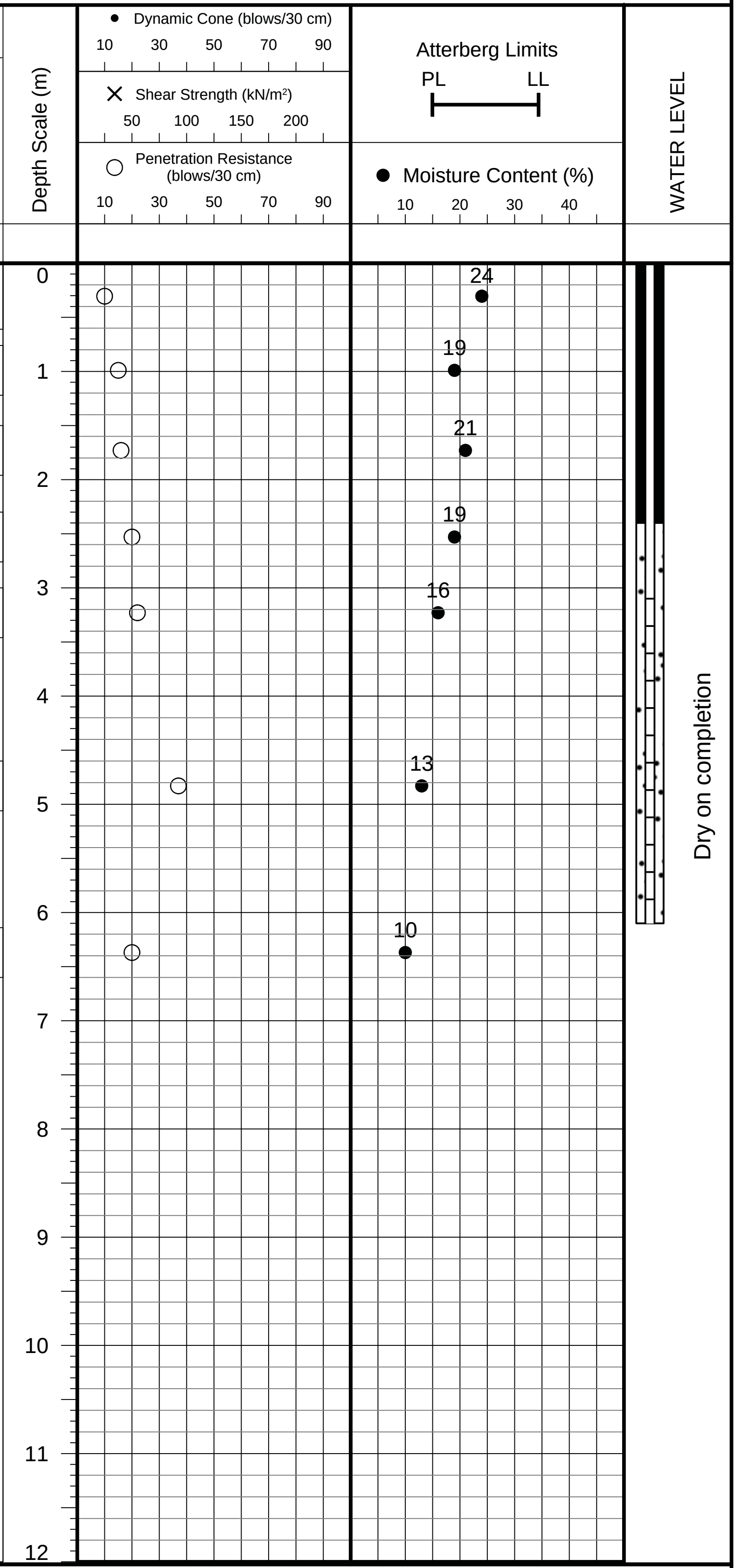
PROJECT DESCRIPTION: Proposed Residential Development

METHOD OF BORING: Flight-Auger

PROJECT LOCATION: Hunsden Sideroad, Town of Caledon (Bolton)

DRILLING DATE: March 10, 2022

El. (m) Depth (m)	SOIL DESCRIPTION	SAMPLES		
		Number	Type	N-Value
295.9	Ground Surface			
0.0	18 cm TOPSOIL Brown, compact to dense	1	DO	10
	weathered	2	DO	15
		3	DO	16
	SILT	4	DO	20
		5	DO	22
	some sand to sandy	6	DO	37
		7	DO	20
289.3 6.6	END OF BOREHOLE Installed 51 mm Ø monitoring well to 6.1 m completed with 3.0 m screen Sand backfill from 2.4 to 6.1 m Bentonite seal from 0.0 m to 2.4 m Provided with a monument steel casing.			



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Page: 1 of 1

JOB NO.: 2202-S079

LOG OF BOREHOLE NO.: 3

FIGURE NO.: 3

PROJECT DESCRIPTION: Proposed Residential Development

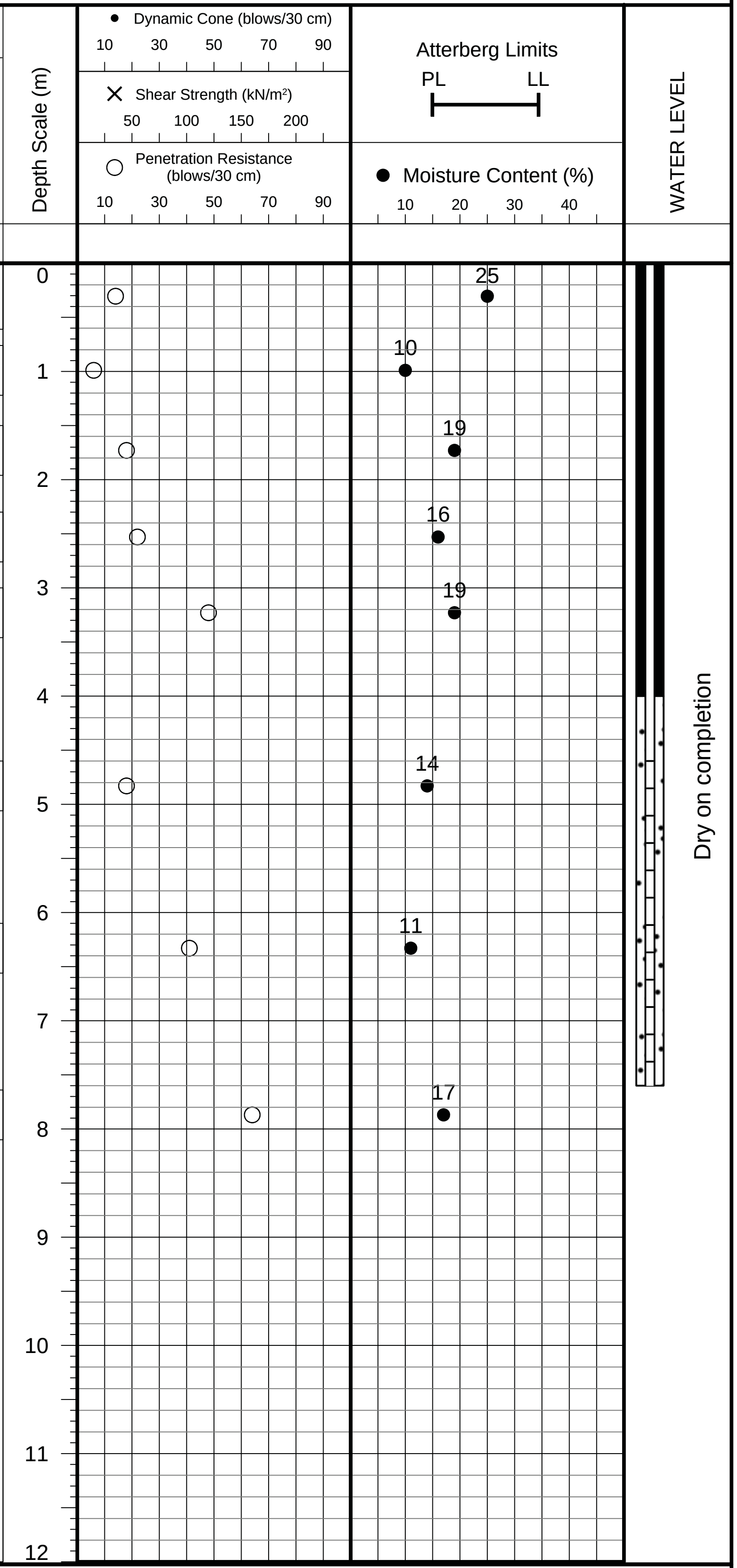
METHOD OF BORING: Flight-Auger

PROJECT LOCATION: Hunsden Sideroad, Town of Caledon (Bolton)

DRILLING DATE: March 9, 2022

El. (m) Depth (m)	SOIL DESCRIPTION	SAMPLES Number	SAMPLES Type	SAMPLES N-Value
298.2	Ground Surface			
0.0	23 cm TOPSOIL Brown, loose to very dense	1	DO	14
	weathered	2	DO	6
		3	DO	18
	SILT	4	DO	22
		5	DO	48
	some sand to sandy a trace of fine gravel below 7.6 m	6	DO	18
		7	DO	41
290.1 8.1		8	DO	64
	END OF BOREHOLE			

Installed 51 mm Ø monitoring well to 7.6 m
completed with 3.0 m screen
Sand backfill from 4.0 to 7.6 m
Bentonite seal from 0.0 m to 4.0 m
Provided with a monument steel casing.



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JOB NO.: 2202-S079

LOG OF BOREHOLE NO.: 4

FIGURE NO.: 4

PROJECT DESCRIPTION: Proposed Residential Development

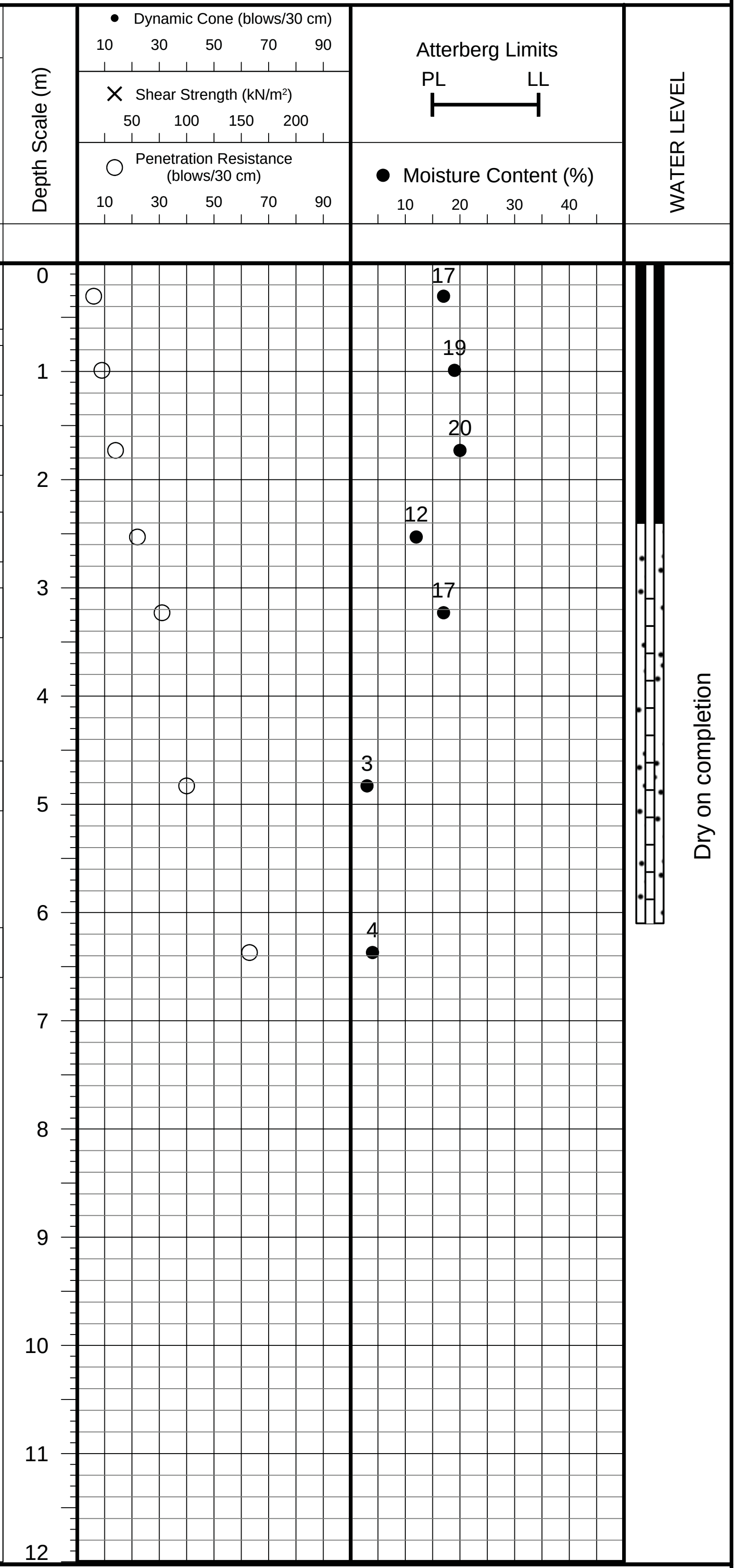
METHOD OF BORING: Flight-Auger

PROJECT LOCATION: Hunsden Sideroad, Town of Caledon (Bolton)

DRILLING DATE: March 10, 2022

El. (m) Depth (m)	SOIL DESCRIPTION	SAMPLES Number	Type	N-Value
293.2	Ground Surface			
0.0	30 cm TOPSOIL			
	Brown, loose to very dense	1	DO	6
	weathered	2	DO	9
	SILT	3	DO	14
	some sand to sandy	4	DO	22
		5	DO	31
289.2 4.0	Brown, dense to very dense			
	SAND	6	DO	40
	fine grained some silt			
		7	DO	63
286.6 6.6	END OF BOREHOLE			

Installed 51 mm Ø monitoring well to 6.1 m
completed with 3.0 m screen
Sand backfill from 2.4 to 6.1 m
Bentonite seal from 0.0 m to 2.4 m
Provided with a monument steel casing.



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JOB NO.: 2202-S079

LOG OF BOREHOLE NO.: 5

FIGURE NO.: 5

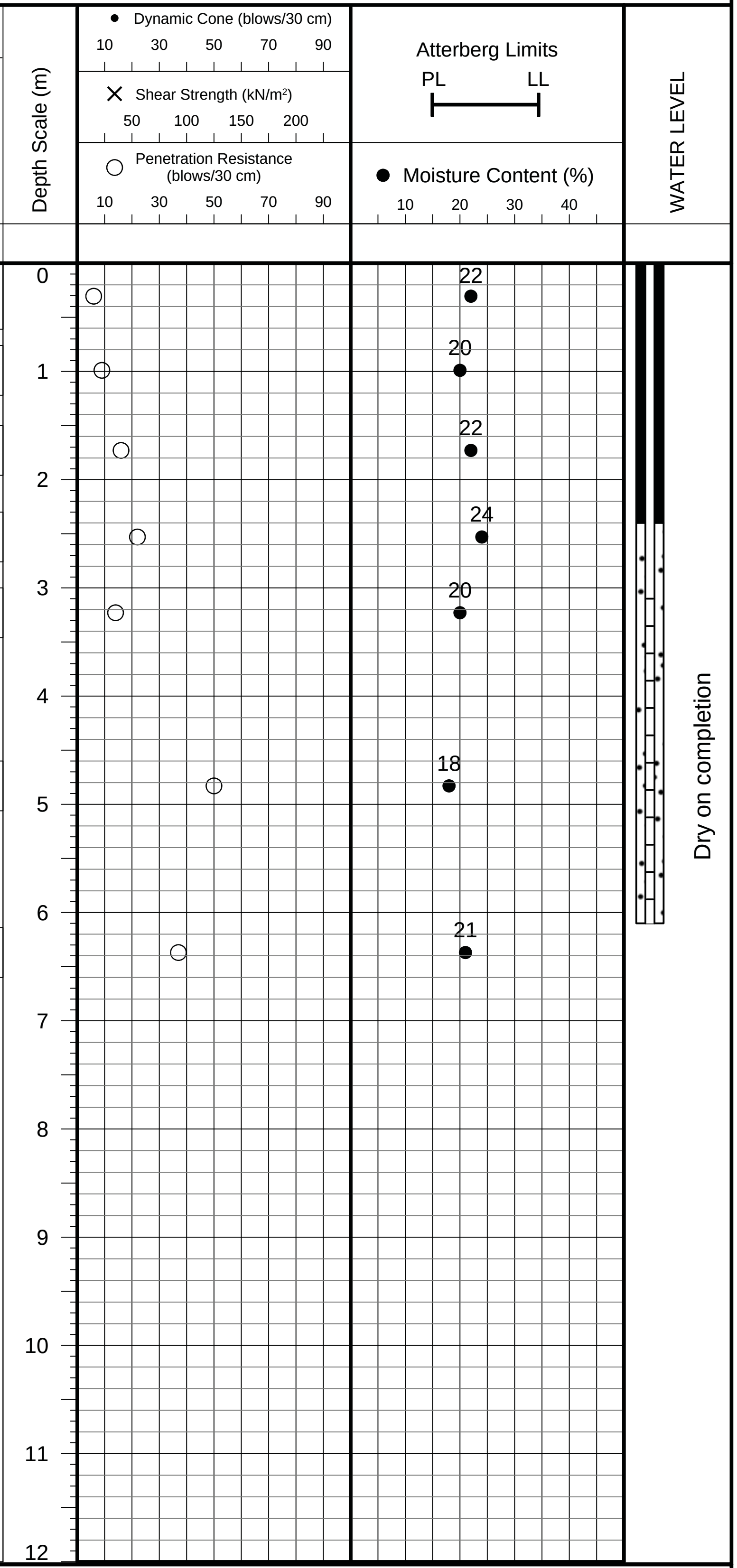
PROJECT DESCRIPTION: Proposed Residential Development

METHOD OF BORING: Flight-Auger

PROJECT LOCATION: Hunsden Sideroad, Town of Caledon (Bolton)

DRILLING DATE: March 10, 2022

El. (m) Depth (m)	SOIL DESCRIPTION	SAMPLES Number	Type	N-Value
301.5 0.0	Ground Surface 23 cm TOPSOIL Brown, loose to very dense weathered SILT some sand to sandy occ. clay layers seepages below 1.4 m	1	DO	6
		2	DO	9
		3	DO	16
		4	DO	22
		5	DO	14
		6	DO	50
		7	DO	37
294.9 6.6	END OF BOREHOLE Installed 51 mm Ø monitoring well to 6.1 m completed with 3.0 m screen Sand backfill from 2.4 to 6.1 m Bentonite seal from 0.0 m to 2.4 m Provided with a monument steel casing.			



JOB NO.: 2202-S079

LOG OF BOREHOLE NO.: 6

FIGURE NO.: 6

PROJECT DESCRIPTION: Proposed Residential Development

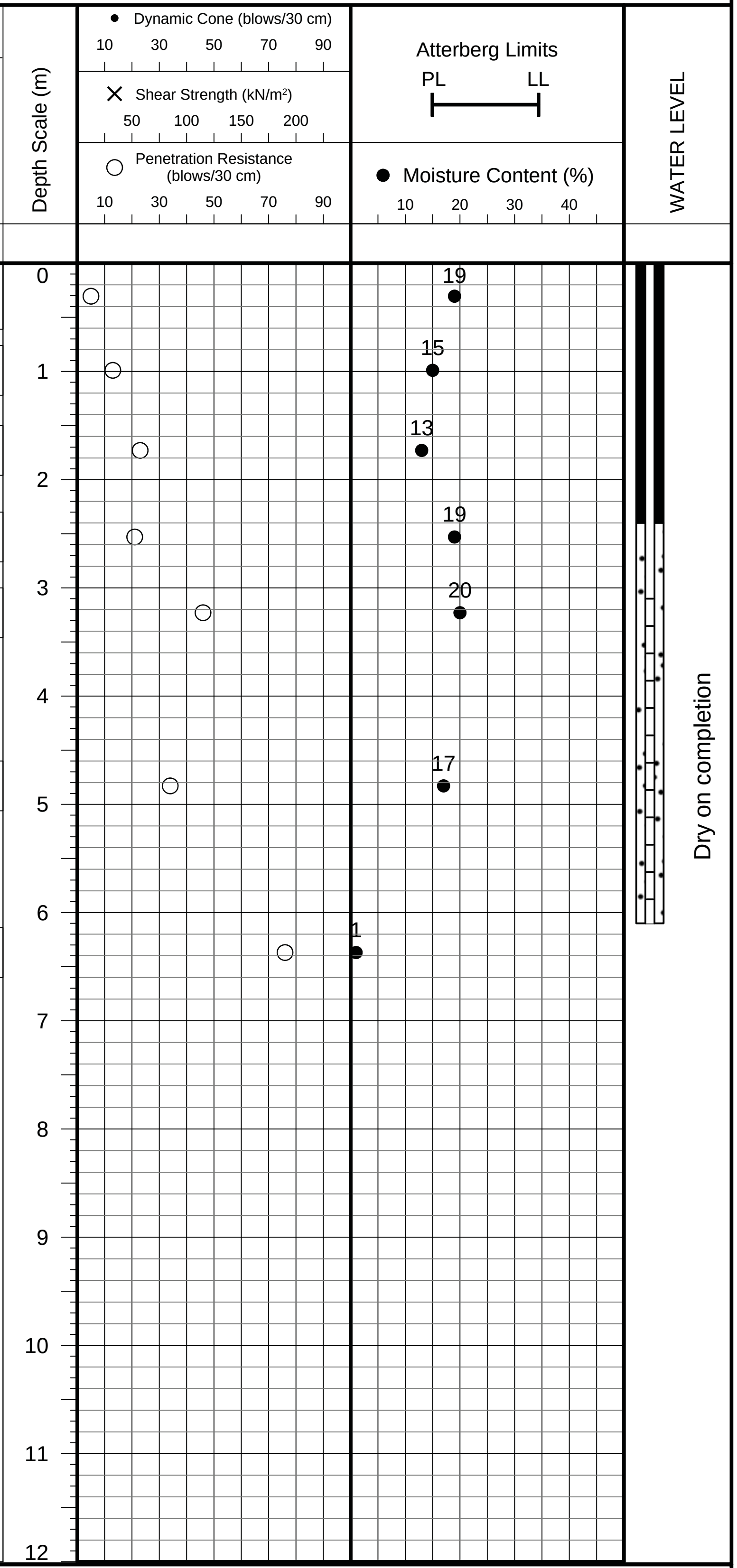
METHOD OF BORING: Flight-Auger

PROJECT LOCATION: Hunsden Sideroad, Town of Caledon (Bolton)

DRILLING DATE: March 10, 2022

El. (m) Depth (m)	SOIL DESCRIPTION	SAMPLES Number	Type	N-Value
294.4	Ground Surface			
0.0	23 cm TOPSOIL Brown, loose to very dense	1	DO	5
	weathered	2	DO	13
		3	DO	23
	SILT	4	DO	21
		5	DO	46
	some sand to sandy occ. clay layers seepage at 3.0 m			
		6	DO	34
288.8 5.6	Brown, very dense SAND fine grained some silt	7	DO	76
287.8 6.6	END OF BOREHOLE			

Installed 51 mm Ø monitoring well to 6.1 m
completed with 3.0 m screen
Sand backfill from 2.4 to 6.1 m
Bentonite seal from 0.0 m to 2.4 m
Provided with a monument steel casing.



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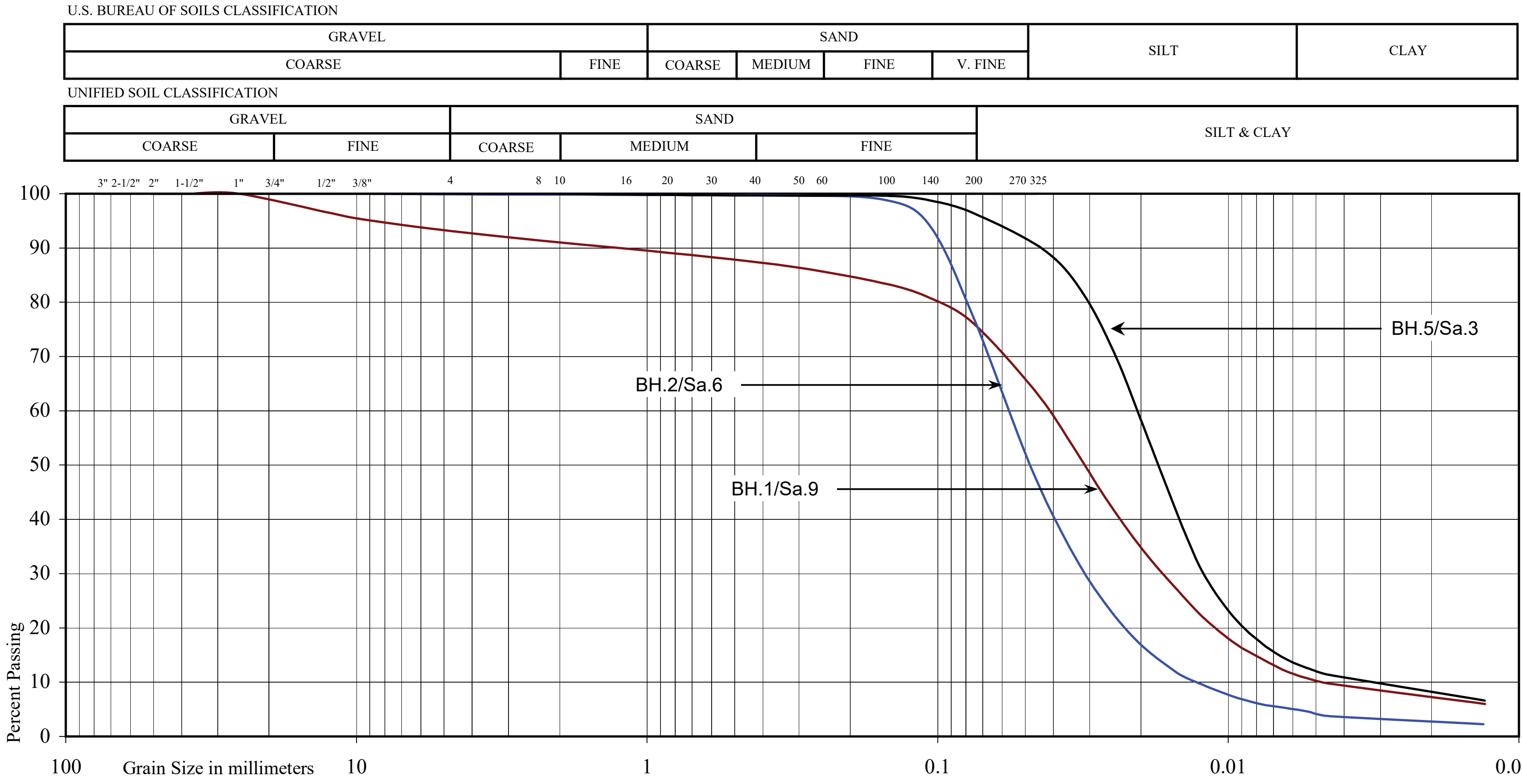
GRAIN SIZE DISTRIBUTION

Reference No: 0310-S142



Project: Proposed Residential Development

Location: Hunsden Sideroad, Town of Caledon (Bolton)

Borehole No:	1	2	5
Sample No:	9	6	3
Depth (m):	1.0	4.8	1.8
Elevation (m):	295.0	291.1	299.7

BH./Sa.	1/9	2/6	5/3
Liquid Limit (%) =	-	-	-
Plastic Limit (%) =	-	-	-
Plasticity Index (%) =	-	-	-
Moisture Content (%) =	15	13	22
Estimated Permeability (cm./sec.) =	10^{-5}	10^{-4}	10^{-5}

Classification of Sample [& Group Symbol]: SILT

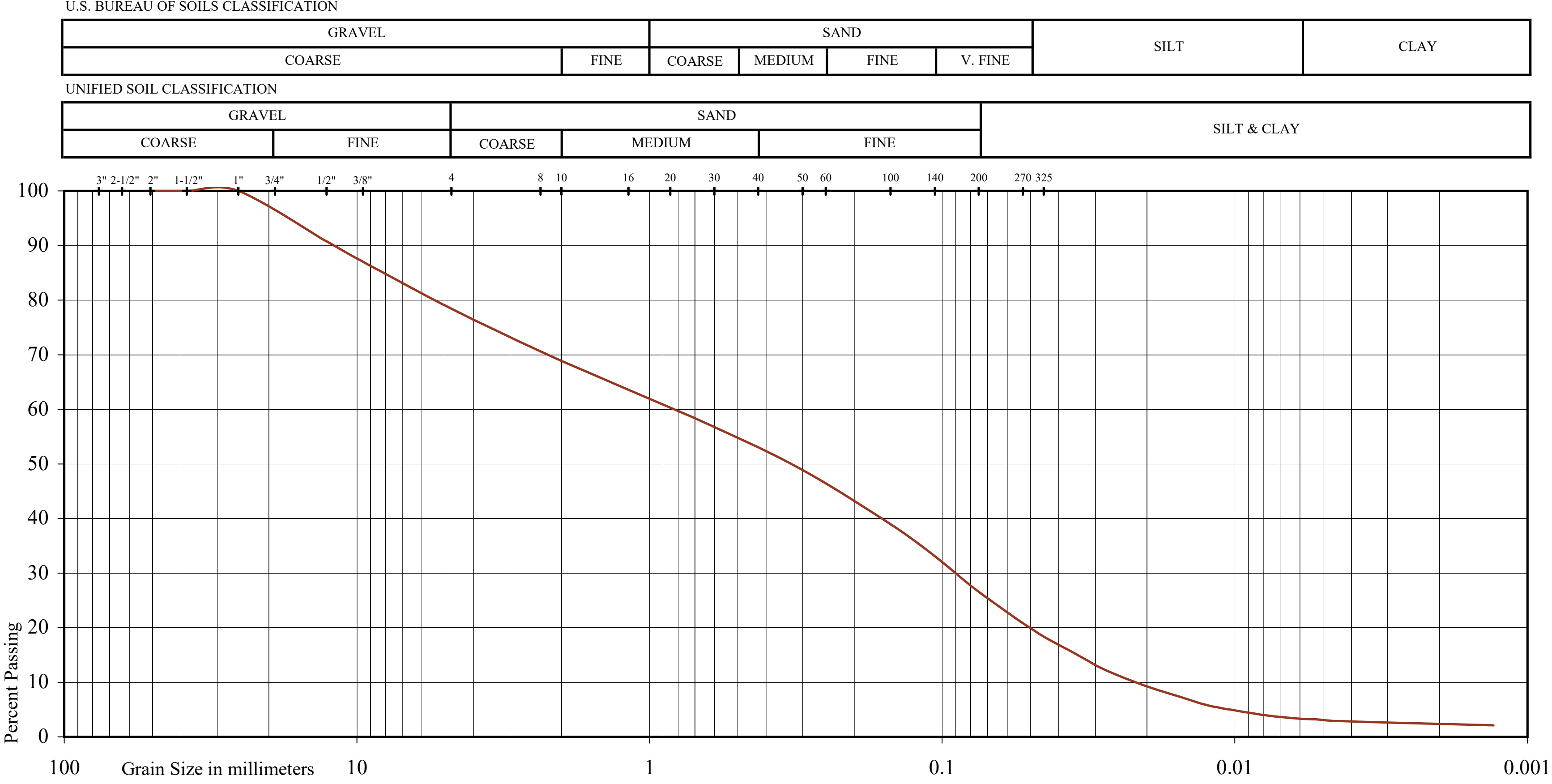
some sand to sandy, a trace of fine gravel

Figure: 7

Soil Engineers Ltd.

GRAIN SIZE DISTRIBUTION

Reference No: 2202-S079



Project: Proposed Residential Development

Location: Hunsden Sideroad, Town of Caledon (Bolton)

Liquid Limit (%) = -

Plastic Limit (%) = -

Plasticity Index (%) = -

Borehole No: 1

Sample No: 5

Moisture Content (%) = 16

Depth (m): 3.2

Estimated Permeability

Elevation (m): 292.8

(cm./sec.) = 10^{-4}

Classification of Sample [& Group Symbol]: SAND

well-graded, gravelly, some silt to silty

Figure: 8

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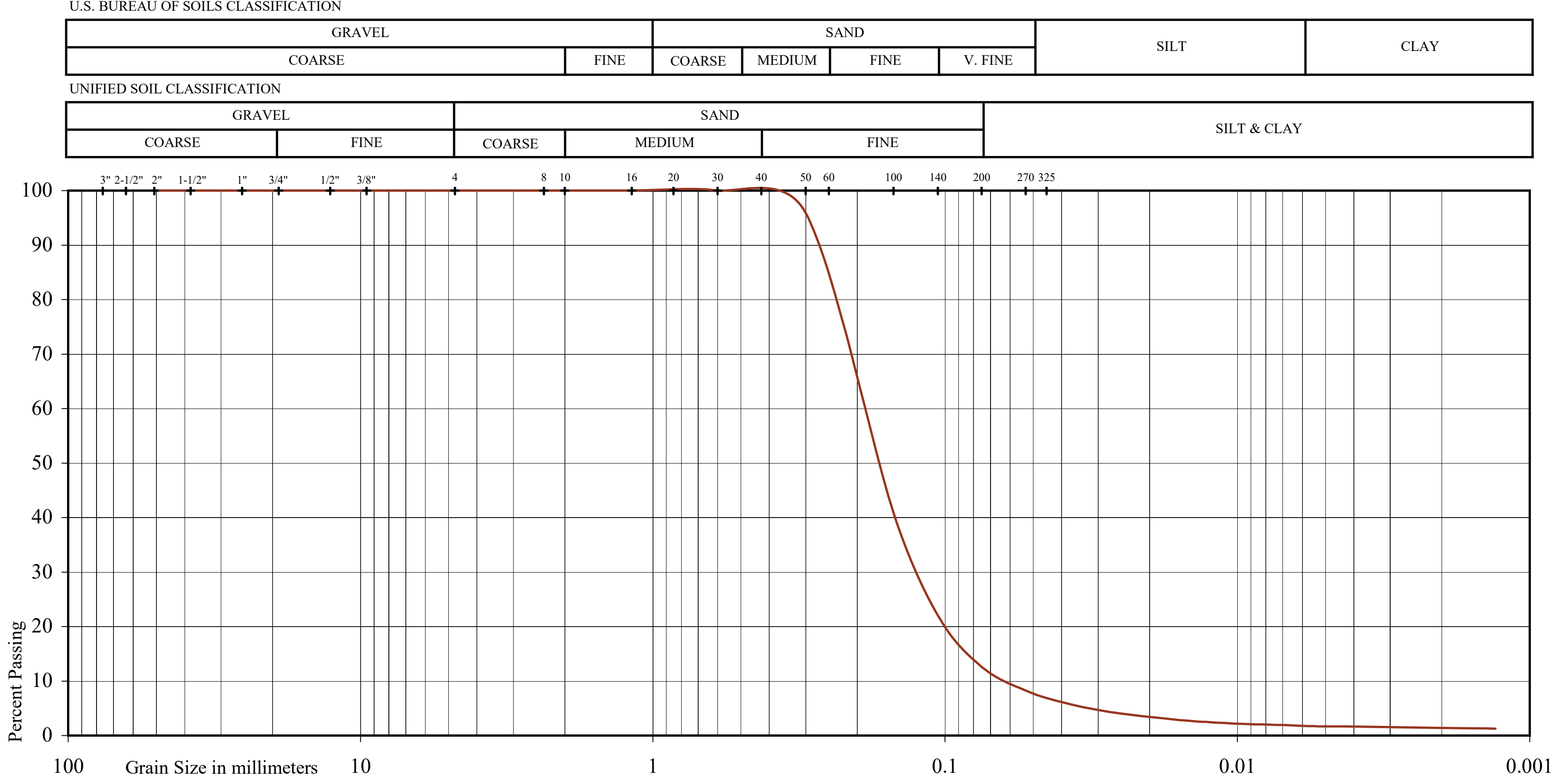
GRAIN SIZE DISTRIBUTION

Reference No: 2202-S079



Project: Proposed Residential Development

Location: Hunsden Sideroad, Town of Caledon (Bolton)

Borehole No: 4

Sample No: 6

Depth (m): 4.8

Elevation (m): 288.4

Liquid Limit (%) = -

Plastic Limit (%) = -

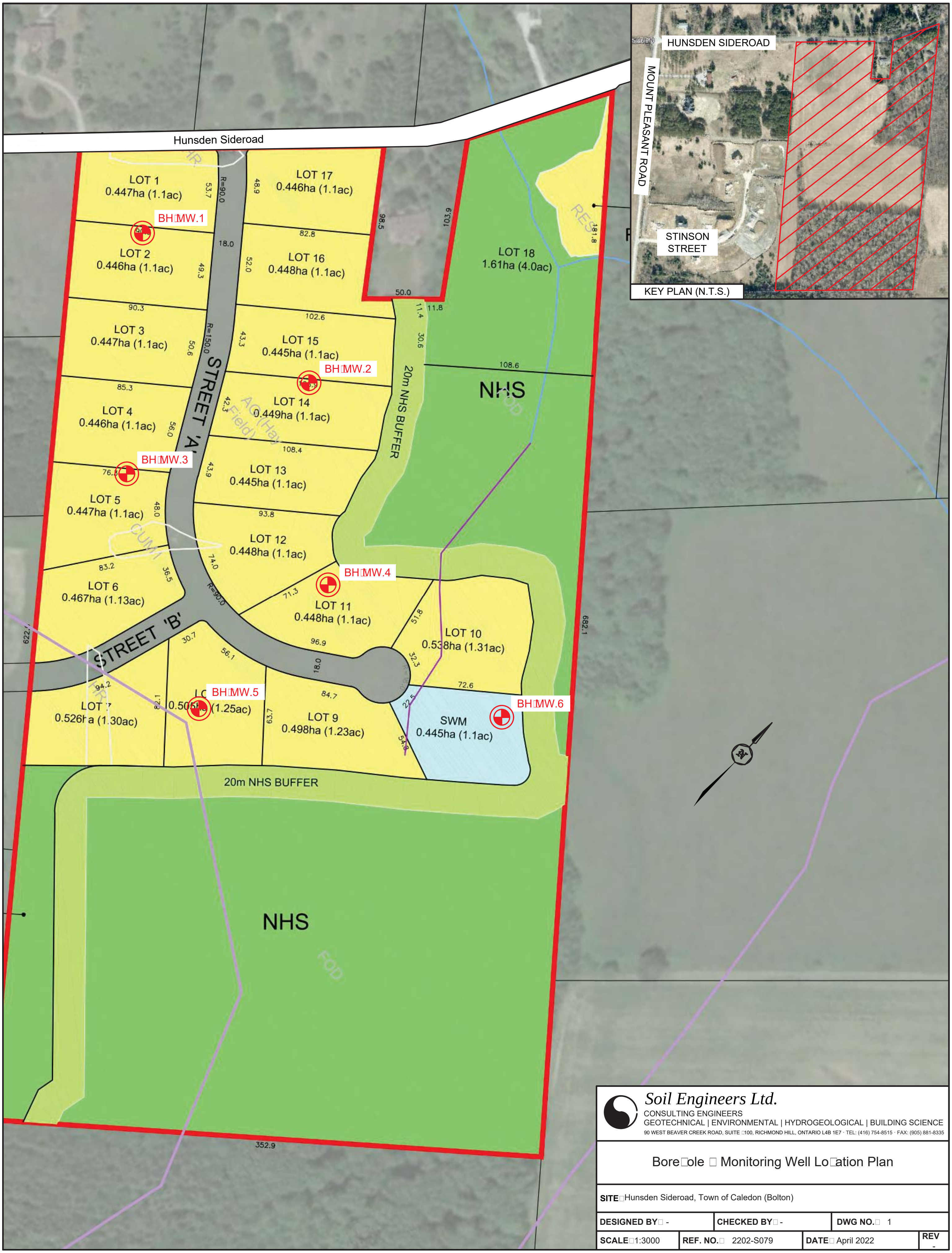
Plasticity Index (%) = -

Moisture Content (%) = 3

Estimated Permeability (cm./sec.) = 10^{-2}

Classification of Sample [& Group Symbol]: SAND
fine-grained, some silt

Figure: 9



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90 WEST BEAVER CREEK ROAD, SUITE □100, RICHMOND HILL, ONTARIO L4B 1E7 · TEL: (416) 754-8515 · FAX: (905) 881-8335

Borehole □ Monitoring Well Location Plan

SITE□Hunsden Sideroad, Town of Caledon (Bolton)

DESIGNED BY□ -	**CHECKED BY**□ -	**DWG NO.**□ 1

SCALE□1:3000	**REF. NO.**□ 2202-S079	**DATE**□ April 2022	**REV** -

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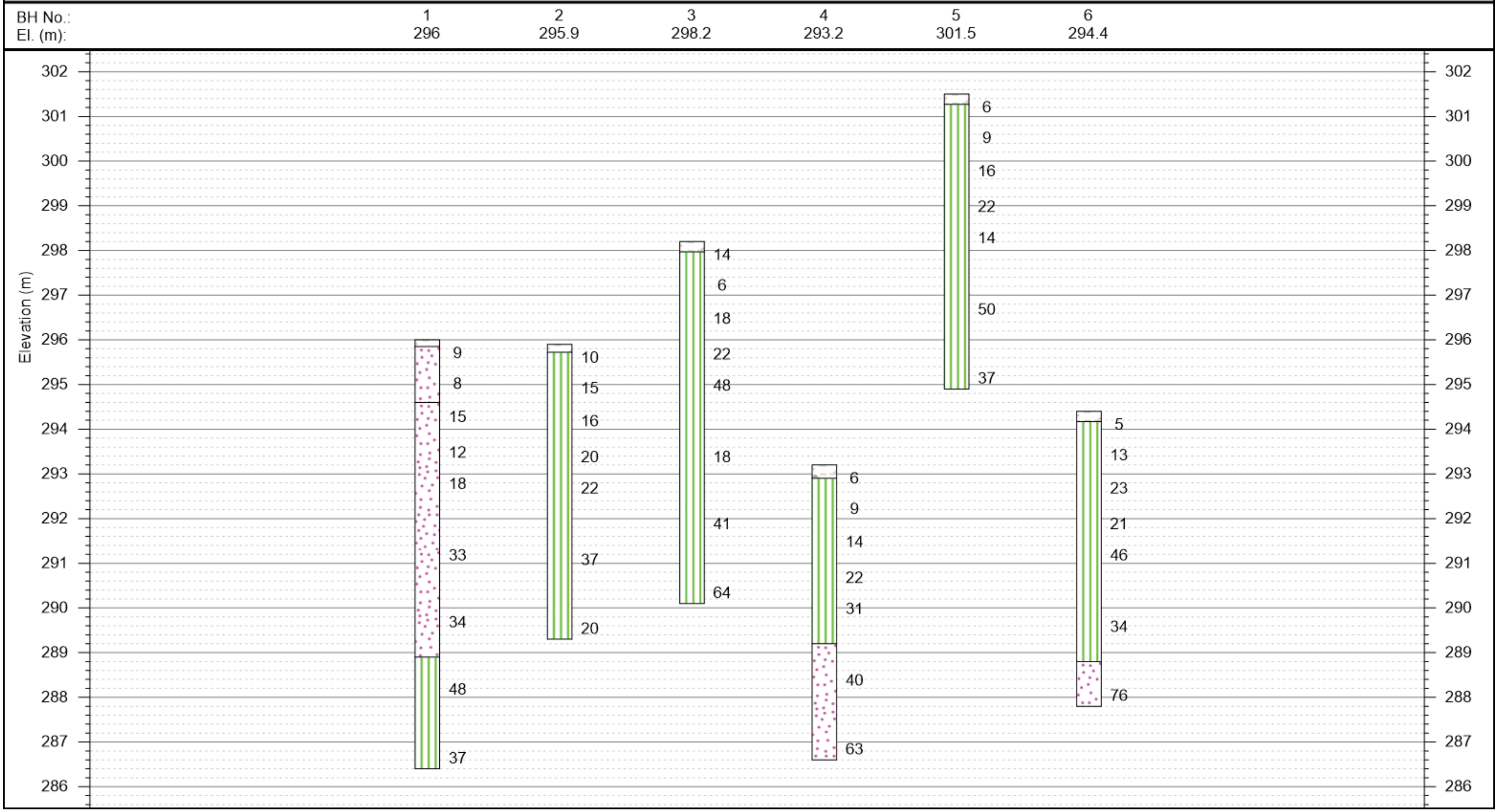
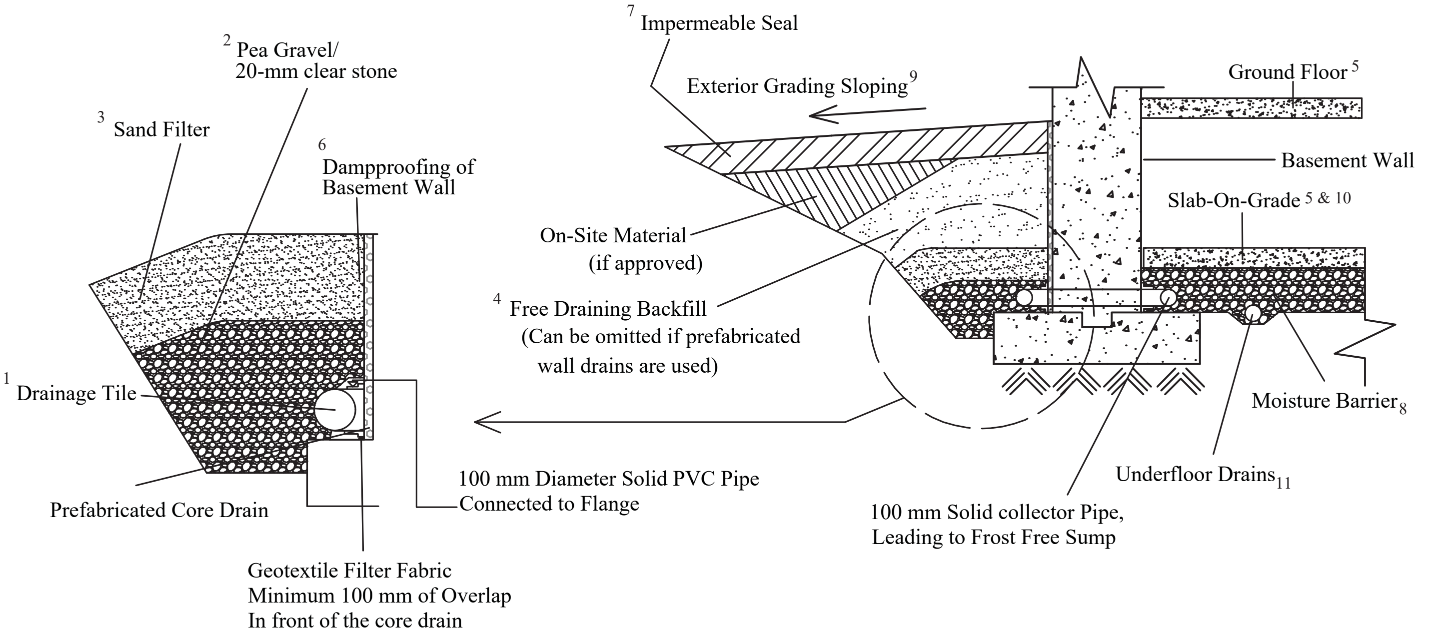
SUBSURFACE PROFILE
DRAWING NO. 2
SCALE: AS SHOWN

JOB NO.:	2202-S079
REPORT DATE:	April 2022
PROJECT DESCRIPTION:	Proposed Residential Development
PROJECT LOCATION:	Hunsden Sideroad, Town of Caledon (Bolton)

LEGEND

▤ TOPSOIL ▨ SAND ▥ SILT





NOTES:

1. **Drainage tile**: consists of 100 mm (4") diameter weeping tile or equivalent perforated pipe leading to a positive sump or outlet. Invert to be at minimum of 150 mm (6") below underside of basement floor slab.

2. **Pea gravel**: at 150 mm (6") on the top and sides of drain. If drain is not placed on concrete footing, provide 100 mm (4") of pea gravel below drain. The pea gravel may be replaced by 19 mm clear stone provided that the drain is covered by a porous geotextile membrane of Terrafix 270R or equivalent.

3. **Filter material**: consists of C.S.A. fine concrete aggregate. A minimum of 300 mm (12") on the top and sides of gravel. This may be replaced by an approved porous geotextile membrane of Terrafix 270R or equivalent.

4. **Free-draining backfill**: OPSS Granular 'B' or equivalent, compacted to 95% to 98% (maximum) Standard Proctor dry density. Do not compact closer than 1.8 m (6') from wall with heavy equipment. This may be replaced by on-site material if prefabricated wall drains (Miradrain) extending from the finished grade to the bottom of the basement wall are used.

5. **Do not backfill** until the wall is supported by the basement floor slab and ground floor framing, or adquate bracing.

6. **Dampproofing** of the basement wall is required before backfilling

7. **Impermeable backfill seal** of compacted clay, clayey silt or equivalent. If the original soil in the vicinity is a free-draining sand, the seal may be omitted.

8. **Moisture barrier**: 19-mm clear stone or compacted OPSS Granular 'A', or equivalent. The thickness of this layer should be 150 mm (6") minimum.

9. **Exterior Grade**: slope away from basement wall on all the sides of the building.

10. **Slab-On-Grade** should not be structurally connected to walls or foundations.

11. **Underfloor drains*** should be placed in parallel rows at 6 to 8 m (20'-25') centre, on 100 mm (4") of pea gravel with 150 mm (6") of pea gravel on top and sides. The invert should be at least 300 mm (12") below the underside of the floor slab. The drains should be connected to positive sumps or outlets. Do not connect the underfloor drains to the perimeter drains.

*Underfloor drains can be deleted where not required.

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Details of Perimeter Drainage System

SITE Hunsden Sideroad, Town of Caledon (Bolton)

DESIGNED BY K.L. **CHECKED BY** B.S. **DWG NO.** 3

SCALE N.T.S. **REF. NO.** 2202-S079 **DATE** April 2022 **REV** -