

GEOTECHNICAL ENGINEERING REPORT

PREPARED FOR:
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ATTENTION:
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**Britannia Road and Bronte Street
South | Milton, Ontario**

Grounded Engineering Inc.
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1 Introduction

Shearling Heights Estates Ltd has retained Grounded Engineering Inc. to provide geotechnical engineering design advice for their proposed “Shearling Heights” development on the northeast corner lot at the intersection of Britannia Road and Bronte Street South, in Milton, Ontario.

The proposed project includes constructing 13 double-car garage townhouse buildings with residential basements in the northern, central, and southeastern portions of the site, and a 7-storey midrise structure with one underground parking level on the southwestern portion of the site. The townhouse basements are at approximately Elev. 186.9 to 185.6± m (approximately 2.2± m below final grade) based on provided grading plans. The southwest underground parking structure (P1) is set at about Elev. 183.66 m.

A revision history of this geotechnical report for this site is as follows:

- Original (March 1, 2021), included geotechnical engineering for townhouse blocks with residential basements, and townhouse blocks and multiple mid-rise buildings set on top of a P2 underground parking structure
- Revision 1 (May 12, 2021), included clarifications for townhouse descriptions and updated architectural drawing references.
- Revision 2 (February 8, 2022), referenced updated architectural drawings with adjusted tower heights.
- Revision 3 (February 29, 2024), referenced updated architectural drawings with modified basement elevations.
- Revision 4 (March 14, 2024), referenced updated architectural drawings for application consistency purposes.
- Revision 5 (October 30, 2025), referenced updated architectural drawings with modified basement elevations.
- Revision 6 (current, February 4, 2026), referenced updated architectural drawings with a P1 underground parking structure.
- **Revision 7 (current, February 24, 2026)** of this report includes references to updated architectural drawings minor site plan changes.

Grounded has been provided with the following drawings to assist in the understanding of the scope of work:

- Site Survey, prepared by R-PE Surveying (June 11, 2020).
- Updated Site Survey, prepared by R-PE Surveying (Received October 22, 2024).
- Architectural Drawings, “Trinity Point-Shearling Heights”; Project 2268.24, dated February 13, 2026, prepared by Graziani + Corazza Architects.
- Architectural Drawings, “Typ. 6 Unit Blk.”; Project No. 25-11, dated September 12, 2025 (Preliminary), prepared by Ian Robertson Design.
- Site Grading Plan, “Main Sail Estates Subdivision Major Node”; Project No. 2017 - 4568, received January 21, 2026, prepared by Schaeffers Consulting Engineers.



Grounded's subsurface investigation of the site to date includes fourteen (14) boreholes (Boreholes 101 to 114) which were advanced from January 4th to 11th, 2021.

Based on the borehole findings, geotechnical engineering advice for the proposed development is provided for foundations, seismic site classification, earth pressure design, slab on grade design, basement drainage, and pavement design. Construction considerations including excavation, groundwater control, and geostructural engineering design advice are also provided.

Grounded Engineering must conduct the on-site evaluation of founding subgrade as foundation and slab construction proceeds. This is a vital and essential part of the geotechnical engineering function and must not be grouped together with other "third-party inspection services". Grounded will not accept responsibility for foundation performance if Grounded is not retained to carry out all the foundation evaluations during construction.

2 Ground Conditions

The borehole results are detailed on the attached borehole logs. Our assessment of the relevant stratigraphic units is intended to highlight the strata as they relate to geotechnical engineering. The ground conditions reported here will vary between and beyond the borehole locations.

The stratigraphic boundary lines shown on the borehole logs are assessed from non-continuous samples supplemented by drilling observations. These stratigraphic boundary lines represent transitions between soil types and should be regarded as approximate and gradual. They are not exact points of stratigraphic change.

Elevations are measured relative to geodetic datum (NAD83). Aquafor Beech Ltd. was retained to survey the elevations of temporary benchmarks relative to geodetic datum, and the temporary benchmarks were used in surveying borehole elevations. The horizontal coordinates are provided relative to the Universal Transverse Mercator (UTM) geographic coordinate system.

2.1 Soil Stratigraphy

The following stratigraphic summary is based on the results of the boreholes and the geotechnical laboratory testing.

A subsurface profile showing stratigraphy and engineering units is appended.

"Existing grade" and "grade" refers to the site grade elevation at the time of our borehole investigation (January 2021). Since completion of the borehole investigation, stockpiles from the site have been removed; the new site grades were documented in the updated site survey by R-PE Surveying.



2.1.1 Earth Fill

Stockpiles of fill were noted across the site during the time of our investigation (January 2021). At existing grade, all boreholes observed a layer of earth fill that extends to depths of 1.5 to 4.6 m below grade (Elev. 189.6 to 184.0 m). The earth fill varies in composition but generally consists of clayey silt and sandy silt with trace gravel. It contains trace rootlets, wood fragments, asphalt, and rock fragments. The earth fill is typically dark brown to dark brown with black, and moist.

Due to the variation and inconsistent placement of the earth fill material, the consistency/relative density of the earth fill varies but is on average firm/loose.

2.1.2 Clayey Silt Till

Underlying the fill materials, boreholes encountered a native clayey silt glacial till at depths of 1.5 to 4.6 m below grade (Elev. 189.6 to 184.0 m) and extending to depths of 7.6 to 10.7 m below grade (Elev. 178.9 to 176.7 m). Boreholes 101, 102, and 110 observed weathering in this deposit at a depth of 2.3 m below grade (Elev. 187.3 to 185.7 m) and extending to depths of 3.0 to 3.8 m below grade (Elev. 185.0 to 184.2 m). The clayey silt till generally consists of some sand, trace gravel, and trace rock fragments. The weathered layers are generally blackish grey to dark brown with black, and moist. The unweathered till is generally reddish brown and moist.

Standard Penetration Test (SPT) results (N-Values) measured in the clayey silt till range from 6 to 37 blows per 300 mm of penetration ("bpf"). In general, the clayey silt till is stiff to very stiff above Elev. 181± m, and only stiff to firm below Elev. 181± m.

2.1.3 Sandy Silt Till

Underlying the clayey silt till, boreholes encountered a dense to very dense sandy silt glacial till (the "sandy silt till" unit) at depths of 7.6 to 10.7 m below grade (Elev. 178.9 to 176.7 m). The sandy silt till consists of trace clay, trace gravel, and trace rock fragments. It is typically reddish brown and moist. In Boreholes 104 and 106, the sandy silt till transitions to a silty sand glacial till at depths of 10.7 and 12.2 m below grade (Elev. 177.3 and 176.8 m). The silty sand till consists of trace to some gravel and trace clay. It is reddish grey and wet. The sandy silt to silty sand till extended beyond the depth of investigation (Elev. 176 to 172± m).

Standard Penetration Test (SPT) results (N-Values) measured in this unit range from 23 to more than 50 blows per 300 mm of penetration ("bpf"), indicating a relative density ranging from compact to very dense (on average, very dense).

2.2 Groundwater

Monitoring wells were installed in Boreholes 101 to 103, 107, 108, 112, and 114, and stabilized groundwater levels were measured in each of the monitoring wells after the completion of drilling.

A detailed table of monitoring well observation data is appended.



Groundwater levels fluctuate with time depending on the amount of precipitation and surface runoff, and may be influenced by known or unknown dewatering activities at nearby sites.

The design groundwater table for engineering purposes is at Elev. 184.8± m. Please note:

- Boreholes 102 and 103 were screened within the earth fill and are therefore not considered when determining the design groundwater table.
- The higher water level measured in Borehole 107 in 2021 was unstabilized.

The groundwater table is in all the native soil units. The clayey silt till deposit has a low permeability and will yield only minor seepage in the long-term. There is also infiltrated stormwater perched in the earth fill, which is flowing down towards the groundwater table.

2.3 Frost Heave Susceptibility of Soils

Frost heave occurs in a) frost-susceptible soils, when there is b) a source of water (e.g., the groundwater table or stormwater infiltration) and c) those soils with a source of water are exposed to freezing temperatures.

Frost susceptibility in soils refers to the tendency of soils to grow ice lenses and heave during freezing. This tendency varies between soil types, with fine-grained soils with low cohesion and high capillarity generally having the highest susceptibility.

The U.S. Army Corps of Engineers (USACE) provides a classification system¹ relating soil types to different levels of frost susceptibility. The Canadian Foundation Engineering Manual (“CFEM”) 5th Edition adopts and updates this frost design screening criteria approach (see table below). Frost-susceptible soils are classified in groups, F1 to F4, generally coinciding with increasing order of susceptibility. Soil in the latter groups tend to have higher rates of frost heave and lower strength after freeze-thaw cycles.

¹ U.S. Army Corps of Engineers. April 1984. Pavement Criteria for Seasonal Frost Conditions. Engineer Manual No. 1110-3-138.



CFEM 5th Ed. Table 14.1, Frost Design Soil Classification adapted from USACE

Frost Group	Soil Type	Percentage Finer than 0.02 mm, by Weight	Typical USCS ² Soil Types
F1	Gravelly soils	3-10	GW, GP, GM, GW-GM, GP-GM
F2	Gravelly soils	10-20	GM, GW-GM, GP-GM
	Sands	3-15	SW, SP, SM, SW-SM, SP-SM
F3	Gravelly soils	> 20	GM-GC
	Sands, except very fine silty sands	> 15	SM, SC
	Clays, PI > 12	-	CL, CH
	All silts	-	ML, MH
F4	Very fine silty sands	> 15	SM
	Clays, PI < 12	-	CL, CL-ML
	Varved clays and other fined-grained, banded sediments	-	CL and ML; CL, ML, and SM; CL, CH, ML, and SM

The table above is interpreted by Grounded as follows:

- All soils in these groups are frost-susceptible to some degree per the USACE.
- Non-frost susceptible groups are not listed.
- Within each group, the soil's frost susceptibility can vary from very low to very high, though this has never been quantitatively standardized.
- Soils in the F4 groups are especially susceptible to frost.

The site soils are classified by their Frost Group (level of frost susceptibility) according to their grain size data and USCS classification.

Stratum	Percentage Finer than 0.02 mm, by Weight	USCS Symbol	Frost Group
Earth Fill	Est. 55% or higher	CL*	F3/F4
Clayey Silt Till	55 to 70%	CL	F3/F4

* inferred

2.4 For the purposes, Corrosivity and Sulphate Attack

Five (5) soil samples were submitted for corrosivity testing parameters (pH, Resistivity, Electrical Conductivity, Redox Potential, Sulphate, Sulphide and Chloride). The Certificate of Analyses and interpretation sheet is appended.

The soil samples were analysed for soluble sulphate concentration and compared to the Canadian Standard CAN3/CSA A23.1-M94 Table 3, *Additional Requirements for Concrete*

² ASTM D2487-17



Subjected to Sulphate Attack. Corrosivity parameters are also used for assessing soil corrosivity applicable to cast iron alloys, according to the 10-point soil evaluation procedure described in the American Water Work Association (AWWA) C-105-18 standard³.

The analytical results only provide an indication of the potential for corrosion. The results of this analysis are in reference to only the soil samples collected from specific locations, and soil chemistry may vary between and beyond the locations of the analysed samples. In summary:

- 4 of the 5 samples have negligible sulphate concentrations.
- *The soluble sulphate content of sample BH113-SS6 indicates a potential for sulphate attack in the vicinity of Borehole 113. The Class of Exposure is S-2 in this location.*
- 3 of the 5 samples scored more than 10 points and corrosion protective measures are therefore recommended for cast iron alloys.

3 Geotechnical Engineering Recommendations

Based on the factual data summarized above, we are providing the following geotechnical engineering design recommendations. Contractors must review the factual data while bidding or scoping services for this project and must provide their own opinion as to means, methods, and schedule.

This report assumes 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 there is any additional information relevant to the interpretations made of the subsurface information with respect to the geotechnical analyses or other recommendations, then Grounded should be retained to review the implications of these changes with respect to the contents of this report.

3.1 Foundation Design Parameters

The proposed project includes constructing 13 double-car garage townhouse buildings with basements in the northern, central, and southeastern portions of the site, and a 7-storey midrise structure with one underground parking level on the southwestern portion of the site. The townhouse basements are at approximately Elev. 186.9 to 185.6± m (approximately 2.2± m below grade) based on provided grading plans. The underground parking structure (P1) is set at about Elev. 183.66 m.

The following foundation options have been considered in our analysis.

- Townhouses: Shallow conventional spread footings on native soil or engineered fill
- Midrise Structure with P1:

³ ANSI/AWWA C105/A21.5-18, Appendix A



- Conventional spread footings
- Raft foundation on cohesive till

3.1.1 General Foundation Recommendations

Grounded should be retained by the Owner to review the structural engineering drawings prior to issue or construction, to ensure that the recommendations in this report have been appropriately implemented.

Footings stepped from one elevation to another should be offset at a slope not steeper than 7 vertical to 10 horizontal. This requirement exists to avoid undermining adjacent footings at the higher elevation.

When exposed to ambient environmental temperatures in this area, the design earth cover for frost protection of foundations and grade beams is 1.2 metres. This also applies to unheated structures up to 1 level below grade.

The founding subgrade must be cleaned of all unacceptable materials and approved by Grounded prior to pouring concrete for the footings. Such unacceptable materials may include disturbed or caved soils, ponded water, or similar as indicated by Grounded during founding subgrade inspection.

Per Section 2.3, the conditions that create frost heave (high groundwater table, highly frost-susceptible soils, and freezing temperatures) exist at this site. Foundation subgrades must be protected against frost damage. If protection from frost is not provided during winter months, frost damage will result in a loss of soil strength and bearing capacity. During the winter, adequate temporary frost protection for the footing bases and concrete must be provided if construction proceeds during freezing weather conditions.

3.1.2 Townhouse Foundations

The earth fill soils are considered unsuitable for the support of the proposed townhouse foundations. Foundations may be made on native soil or engineered fill. Footings resting on ground improved soils are also feasible.

3.1.2.1 Spread Footings on Native Soils

Conventional spread footings (formed and cast in place, or as drilled piles) can be made to bear on the undisturbed native stiff to very stiff clayey silt till. Elevations of this till in the borehole locations around the proposed townhouses area are tabulated below. Conventional spread footings made to bear on this soil may be designed using a maximum factored geotechnical resistance at ULS of 250 kPa. The net geotechnical reaction at SLS is 150 kPa, for an estimated total settlement of 25 mm.



	BH101	BH102	BH103	BH104	BH105	BH106	BH107	BH108	BH110	BH111	BH114
Approx. Basement FFEs near Borehole (m)	186.8 (BLG. 1)	186.0 (BLG. 4)	185.7 (BLG. 5)	186.6 (BLG. 3 and 6)	186.2 (BLG. 7)	186.8 (BLG. 2)	186.7 (BLG. 8 and 9)	185.4 (BLG. 10)	186.1 (BLG. 11)	185.4 (BLG. 12)	185.8 (BLG. 13)
Elevation of Top of Clayey Silt Till (m)	185.7	185.7	185.3	184.4	185.4	184.2	187.3	185.9	184.8	186.2	185.0
Depth of Clayey Silt Till below FFE (m)	1.1	0.3	0.4	2.2	0.8	2.6	n/a (Above)	n/a (Above)	1.3	n/a (Above)	0.8

The townhouse basement FFEs vary between Elev. 186.8 and 185.4± m. Understanding that footings must be a minimum 0.5 m below FFE for bearing capacity purposes, subexcavation of the earth fill materials is anticipated in several locations, as shown in the table above.

The capacities provided above are based on individual spread footing foundations that are 1 to 3 m wide, spaced one footing width apart, and embedded a minimum of 0.5 m below FFE. These minimum requirements apply in conjunction with the above recommended geotechnical resistance regardless of loading considerations. The geotechnical reaction at SLS refers to an estimated settlement which for practical purposes is linear and non-recoverable. Differential settlement is related to column spacing, column loads, and footing sizes.

3.1.2.2 Spread Footings on Engineered Fill

Where there are deeper existing fills present (e.g. Boreholes 104 and 106, and possibly other areas between and beyond the boreholes), another option is for the proposed townhomes to be supported by conventional spread footing foundations resting on an engineered fill pad. An engineered fill specification is appended. It fully describes the engineered fill requirements for this site including site preparation, materials, lateral extents, placement, inspections, typical reinforcing steel requirements, notes on construction, and certification. Engineered fill would require the removal of all existing fill in the areas of the Boreholes 104, 106, and possibly other areas between and beyond the boreholes, and replacement with the engineered fill pad designed to take structural loads.

So long as the engineered fill is placed and compacted as indicated per the specification (including full-time inspection), spread footings resting on engineered fill constructed using common earth fill may be designed using a net geotechnical reaction of 150 kPa at SLS (for an estimated total settlement of 25 mm) and a factored geotechnical resistance of 225 kPa at ULS. These footings must be placed at least 0.6 m into the engineered fill strata.

Footings for buildings closest to the P1 structure (e.g., Buildings 2, 8, and 9) may need to be stepped down per the recommendations in Section 3.1.1. Some of these footings will be made to bear on native soil (see section above for capacities). Any single grid line should be supported fully on either engineered fill or on native soils.

For footings supported on engineered fill, the minimum width for conventional strip footings must be 0.6 m, and the minimum width of individual spread footings must be 1 m. The maximum widths



are 1.2 and 3.0 m respectively. These requirements apply in conjunction with the above recommended geotechnical resistance regardless of loading considerations. The geotechnical reaction at SLS refers to a settlement which for practical purposes is linear and non-recoverable. Differential settlement is related to column spacing, column loads, and footing sizes.

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 this settlement occurs depends on the composition of the engineered fill as follows (after initial placement):

- Sand or gravel soil – several days
- Silt soil – several weeks
- Clay or clayey soil – several months

The timing of foundation construction must consider the post-construction settlement of the engineered fill.

3.1.3 Midrise Structure and P1 Foundations

3.1.3.1 Spread Footings on Clayey Silt Till

Conventional spread footings for the proposed P1 structure may bear on the clayey silt till approximately 1 m below FFE. These foundation capacities are limited by a weaker compressible layer of firm to stiff clayey silt at around Elev. 181± m (e.g. Boreholes 109, 112, 113).

Conventional spread footings made to bear on stiff to hard clayey silt till at approximate Elev. 182.7± m (i.e., about 1 m below FFE) may be designed using a maximum factored geotechnical resistance at ULS of 400 kPa. The net geotechnical reaction at SLS is 275 kPa, for an estimated total settlement of 25 mm.

These capacities are likely sufficient for support of the portion of the P1 structure that is not supporting the proposed 7-storey building (structural engineer to confirm). They may also be feasible for the support of a 7-storey midrise building.

The capacities for spread footings on the stiff to hard clayey silt till at approximately Elev. 182.7± m are provided based on individual spread footing foundations that are a minimum 1 to maximum 3 m wide, spaced one footing width apart, and embedded no lower than Elev. 182± m with a minimum of 0.7 m below FFE. These minimum requirements apply in conjunction with the above recommended geotechnical resistance regardless of loading considerations. The geotechnical reaction at SLS refers to an estimated settlement which for practical purposes is linear and non-recoverable. Differential settlement is related to column spacing, column loads, and footing sizes.

The SLS capacity is estimated using conventional assumptions on footing uniformity and spacing, and is applicable for a first round of foundation design. In reality, a detailed spread footing plan includes many different footing sizes, spacings, and depths. Footings will influence each other if they are spaced closer than 1 footing width apart, which is almost always needed in



structural foundation design. As such, the initial SLS capacity is conservative as it anticipates these complexities.

To remove the standard simplifying assumptions and provide a more realistic estimate of footing settlement, Grounded should be retained by the Owner to numerically model the estimated settlement of the detailed foundation design acting as a whole. Once an initial foundation plan is completed by the structural engineer and provided to us, Grounded will model the footing pressures, sizes, and spacings to estimate the settlement at each individual footing location. These estimated settlements are then sent back to the structural engineer to assess the total and differential settlements of the entire foundation system acting as a whole, and whether or not they are within tolerable limits. The structural design is then modified as required.

3.1.3.2 Raft Foundation

As requested by the structural engineer, a 17 x 60 m raft underlying the tower is considered in the bearing capacity discussion below. Raft slabs for a podium structure will be subjected to much less load, and will not govern design.

Considering a lowest P1 FFE of about 183.66± m, it is assumed that a raft would be founded around 2 m lower (Elev. 181.66± m), on undisturbed very stiff to hard clayey silt till but just above the weaker stiff to firm till.

The preliminary raft design parameters assume a uniform load at the base of the raft. In reality, raft loads are non-uniform; they are typically highest at the core and lowest at the perimeter. The preliminary parameters below are provided as the initial step in determining raft feasibility (a structural task). The detailed design process is described below.

Bulk excavation to underside of raft elevation (Elev. 181.66 m) will induce a reduction in effective stress of 90 kPa, which is the unload stress. Utilizing preliminary soil stiffness parameters, analysis of a uniformly loaded raft foundation shows that a uniform total applied SLS bearing pressure of 120 kPa (incorporating a 0.9 factor as per the CFEM 5th edition) at the base of the raft will generate an estimated 25± mm of settlement. Similarly, a uniform geotechnical reaction at SLS of 190 kPa will generate an estimated 50± mm of settlement.

The modulus of subgrade reaction for design of a raft slab is a function of the size of the raft, the applied load, and whether loading is within the recompression range or the virgin range. On the basis of our preliminary stiffness parameters and the assumption of uniform raft loading, the preliminary modulus of subgrade reaction appropriate for 17 x 60 m raft design at this site is about 2,700 kPa/m for loads over 90 kPa SLS.

The maximum factored geotechnical resistance at ULS of this 17 x 60 m raft foundation is 250 kPa. Raft foundation design is typically governed by service load criteria.

Detailed raft design is an iterative process between the structural and the geotechnical engineer. Once a draft structural design is completed by the structural engineer, the resulting non-uniform raft pressure distribution is provided to us (typically as a contour plot of SLS pressures). Grounded



then models that non-uniform pressure distribution to more accurately estimate the settlement at each point under the raft. The resulting estimated settlement distribution is then sent back to the structural engineer to assess the total and differential settlements under the raft, as well as lateral impacts on adjacent footings and structures. The structural design is then modified as required.

During construction, the subgrade at founding elevation should be cut neat, inspected, and immediately protected by a mud slab (lean concrete) to provide a working surface. The subsurface must not be proofrolled as this activity would further weaken these soils. The raft slab is then constructed on top of the mud slab. Prior to pouring the mud mat and foundation, the foundation subgrade must be cleaned of all deleterious materials such as softened, disturbed or caved materials, or standing water. If construction proceeds during freezing weather conditions, adequate temporary frost protection for the raft foundation base and concrete must be provided.

Differential settlement is related to real non-uniform raft load distribution and must be assessed as part of the detailed design process. Impacts to adjacent structures caused by settlement within the raft's lateral zone of influence will also need to be reviewed by the structural engineer.

It is assumed that this basement will be designed as a drained structure. Tiedowns to resist buoyancy are not required in this case.

3.2 Seismic Site Designation

The Ontario Building Code (2024) stipulates the methodology for earthquake load and effects analysis and design, as set out in Subsection 4.1.8. The determination of the type of analysis is predicated on the importance of the structure, the spectral response acceleration, and the site classification.

The site designation, X , is determined using the average shear wave velocity, V_{s30} , calculated from in situ measurements of shear wave velocity, in accordance with ground profiles provided in Table 4.1.8.4.-A. For all other ground profiles, the site designation is X_V , where V is the value of V_{s30} . At sites where V_{s30} is not available, the site designation is X_S , where S is the Site Class as determined from rational analysis of average undrained shear strength (s_u) or energy-corrected average standard penetration resistance (SPT N-values) in accordance with Table 4.1.8.4.-B.

The structural commentaries to the NBC 2020, on which the OBC 2024 are based, have been recently released. Based on the structural commentaries, site designation must be evaluated in the top 30 m of site stratigraphy.

At this site, the boreholes observe generally stiff to very stiff cohesive till overlying very dense sandy silt till. The stratigraphy in the upper 15 m, projected to 30m has an average SPT-N value between 15 and 50 bpf. Based on this information, the site designation for seismic analysis is X_b , per Table 4.1.8.4.-B of the Ontario Building Code (2024).



We have determined the site designation based on rational analysis of energy-corrected average standard penetration resistance (SPT N-values) with assumed N-values for the stratigraphy beyond the investigation depth. The National Building Code 2020 (and the OBC 2024) provides the option of calculating the seismic hazard (i.e. spectral acceleration) directly from average V_{s30} measurement. Consideration should be given to conducting site-specific shear wave testing (Multichannel Analysis of Surface Waves (MASW) testing or downhole shear wave testing) as part of a future scope of work, to determine the average shear wave velocity in the 30 metres of stratigraphy (V_{s30}). Shear wave testing will result in the least conservative seismic site designation.

3.3 Earth Pressure Design Parameters

At this site, the design parameters for structures subject to unbalanced earth pressures such as basement walls and retaining walls are shown in the table below.

Stratigraphic Unit	γ	ϕ	K_a	K_o	K_p
Compact Granular Fill Granular 'B' (OPSS.MUNI 1010)	21	32	0.31	0.47	3.26
Existing Earth Fill	18	29	0.35	0.52	2.88
Clayey Silt Till Above Elev. 181± m	22	32	0.31	0.47	3.26
Clayey Silt Till Below Elev. 181± m	22	29	0.35	0.52	2.88
Sandy Silt Till	22	36	0.26	0.41	3.85

- γ = soil bulk unit weight (kN/m³)
- ϕ = internal friction angle (degrees)
- 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)

These earth pressure parameters assume that grade is horizontal behind the retaining structure. If retained grade is inclined, these parameters do not apply and must be re-evaluated.

The following equation can be used to calculate the unbalanced earth pressure imposed on walls:

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

- P = horizontal pressure (kPa) at depth h
- h = the depth at which P is calculated (m)
- K = earth pressure coefficient
- h_w = height of groundwater (m) above depth h
- γ = soil bulk unit weight (kN/m³)
- γ' = submerged soil unit weight ($\gamma - 9.8$ kN/m³)
- q = total surcharge load (kPa)

If the wall backfill is drained such that hydrostatic pressures on the wall are effectively eliminated, this equation simplifies to:



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

Where walls are made directly against shoring, prefabricated composite drainage panel covering the blind side of the wall is used to provide drainage. Water from the composite drainage panel is collected and discharged through the basement wall in solid ports directly to the sumps. This is discussed in Section 3.5.

The possible effects of frost on retaining earth structures must be considered. In frost-susceptible soils, pressures induced by freezing pore water are basically irresistible. Insulation typically addresses this issue. Alternatively, non-frost-susceptible backfill may be specified.

Foundation resistance to sliding is proportional to the friction between the subgrade and the base of the footing. The factored geotechnical resistance to friction (R_f) at ULS provided in the following equation:

$$R_f = \Phi N \tan \varphi$$

R_f	=	frictional resistance (kN)
Φ	=	reduction factor per CFEM 5 th Ed. (0.8 for cohesionless soils or rock; 0.6 for cohesive soils)
N	=	normal load at base of footing (kN)
φ	=	internal friction angle (see table above)

3.4 Slab on Grade Design Parameters

The slab-on-grade parameters provided here apply to a conventional slab on grade and drained basement approach only. Raft foundation design parameters are provided in Section 3.1.

Townhouse basement slabs on grade will be made on earth fill or undisturbed native soils based on the borehole findings in 2021. The existing earth fill, if not removed and replaced with engineered fill, must be proof rolled under the observation of Grounded. Any areas of excess deflection or observed deleterious materials must be removed and replaced with Granular B (OPSS 1010) compacted in thin lifts to 98% SPMDD.

Per Section 2.3, the conditions that create frost heave (high groundwater table, highly frost-susceptible soils, and freezing temperatures) exist at this site. These soils must be protected against frost damage which would result in a loss of soil strength and bearing capacity. At this site, any slabs on grade exposed to frost (prolonged freezing temperatures) must be finished, heated, and/or adequately protected from frost before the onset of prolonged freezing temperatures, to prevent slab cracking caused by frost damage.

It is expected that the P1 structure will be exposed to frost heave conditions. If it is unheated, the slab on grade would be exposed to frost damage on a yearly basis. To mitigate this risk, two options are available:

1. A raft foundation extending below frost penetration depth can be used to support the P1 structure.



2. The frost-susceptible soils within frost penetration depth (1.2 m below P1 FFE) can be sub-excavated and replaced with non-frost susceptible granular fill that is adequately drained.

At the proposed lowest P1 elevation, the undisturbed native soils will provide adequate subgrade for the support of a conventional slab on grade.

Engineered fill, native soils, or proof rolled and compacted existing fill at this site will provide adequate subgrade for the support of a conventional slab on grade. The moduli of subgrade reaction for slab-on-grade design are as follows for the given subgrades:

- Existing earth fill or engineered fill, compacted: 10,000 kPa/m
- Undisturbed native soils: 20,000 kPa/m

For the townhouses, the slab on grade must be provided with a drainage layer and capillary moisture break, which is achieved by forming the slab on a minimum 200 mm thick layer of 19 mm clear stone (OPSS.MUNI 1004) vibrated to a dense state.

A permanent drainage system including subfloor drains is required (see section below). In this case, the slab on grade must be provided with a drainage layer and capillary moisture break, which is achieved by forming the slab on a minimum 300 mm thick layer of 19 mm clear stone (OPSS.MUNI 1004) vibrated to a dense state. In the case of the townhome basements, the clear stone layer can be 200 mm thick.

Given the nature of the native soils at this site, recompaction or proof rolling of the **undisturbed native subgrade** will weaken these materials. These activities should be specifically prohibited when preparing native subgrade. The subgrade should be cut neat and inspected by Grounded prior to placement of the capillary moisture break and construction of the slab. Disturbed or otherwise unacceptable material (as determined by Grounded) must be subexcavated and replaced with Granular B (OPSS.MUNI 1010) compacted to a minimum of 98% SPMD. The slab on grade should not be placed on frozen subgrade, to prevent excessive settlement of the slab as the subgrade thaws. Areas of frozen subgrade should be removed during subgrade preparation.

3.5 Long-Term Groundwater and Seepage Control

To limit seepage to the extent practicable, exterior grades adjacent to foundation walls should be sloped at a minimum 2 percent gradient away from the wall for 1.2 m minimum.

For a conventional drained basement approach, perimeter and subfloor drainage systems are required. Subfloor drainage collects and removes the seepage that infiltrates under the floor. Perimeter drainage collects and removes seepage that infiltrates at the foundation walls. Perimeter drainage must be collected and conveyed directly to the building sumps, and not discharged into the subfloor drainage system, the granular layer, or beneath the floor slab.

Subfloor drainage pipes are to be spaced at an average 6 m (measured on-centres).



The basement walls are to be fully drained to eliminate hydrostatic pressure. How the drainage system is installed depends on whether the basement wall is made in an open cut or over a shored excavation face. Where drained basement walls are made directly against shoring, prefabricated composite drainage panel covering the blind side of the wall is used to provide drainage. Seepage from the composite drainage panel is collected and discharged through the basement wall in solid ports directly to the sumps.

In an open cut excavation, basement wall drainage is installed directly against the basement wall from the open cut side. Perimeter foundation drains made in this application comprise perforated pipe (minimum 100 mm diameter) surrounded by a granular filter of OPSS.MUNI HL-8 Coarse Aggregate providing a minimum 300 mm of cover over the drain pipe.

Although the basement will be made as a drained structure, the relative humidity at the interface between the foundation wall and the soil/shoring system will still be 100%. A layer of waterproofing placed between the drainage layer and the foundation wall is recommended to protect interior finishes and reinforcing steel from moisture. The building science engineer should confirm this and can provide further advice, as well as specifications for waterproofing products.

Typical basement drainage details are appended.

The perimeter and subfloor drainage systems are critical structural elements since they eliminate hydrostatic pressure from acting on the basement walls and floor slab. The sumps that ensure the performance of these systems must have a duplexed pump arrangement providing 100% redundancy, and they must be on emergency power. The sumps should be sized by the mechanical engineer to adequately accommodate the estimated volume of water seepage.

The permanent dewatering requirements are provided in Grounded's Hydrogeological Report (File No. 20-294).

If any water is to be discharged to the storm or sanitary sewers, the Region of Halton will require a Permit to Discharge in the short term, and a Discharge Agreement in the long-term.

For the townhouses, the perimeter drainage system should be connected directly to the municipal storm system if possible, or else discharged at grade away from the townhouses. Flow must not be directed into the drainage layer.

3.6 Site Servicing

All services must have at least 1.2 metres of earth cover or equivalent insulation for frost protection.

Where site services are not installed below the basement levels of the proposed development, the following recommendations apply.



3.6.1 Bedding

The soil subgrade encountered within the proposed site servicing trenches on site may consist of either earth fill or native soil. If earth fill is encountered, the subgrade must be compacted in place to a minimum 98% SPMDD. The trench base must be inspected for obvious loose, wet, or disturbed material. Any unsuitable material must be subexcavated and replaced with imported fill compacted to 98% SPMDD.

Bedding material below the groundwater table must consist of well graded granular fill such as Granular A (OPSS.MUNI 1010). Clear stone is specifically prohibited below the groundwater table. The bedding material must be compacted to a minimum 95% SPMDD.

Where trenches are above the groundwater table, bedding material may consist of 19 mm clear stone (OPSS.MUNI 1004) or similar, vibrated to a dense state. Where the bedding material consists of clear stone, the bedding must be separated from the subgrade with a non-woven geotextile.

3.6.2 Backfill

Excavated earth fill and native soils on site will constitute adequate backfill material if the soil meets the backfill specifications:

- Any deleterious material in the earth fill is removed prior to reuse as backfill.
- Backfill materials are not frozen.
- The moisture content is within 2% of optimum, or moisture conditioned to within 2% of optimum.
- The backfill must be compacted to a minimum 98% SPMDD.

4 Pavement Engineering Recommendations

4.1 Underground Parking Structure

It is expected that some of the pavements will be placed on top of the reinforced concrete parking structure and not on soil subgrade. In this case, the pavements resting on parking structure should consist of the following:

Component	Compaction Requirement	Pavement on Concrete Parking Structure Minimum Component Thickness
Asphalt Top Lift HL-3 (OPSS.MUNI 1150), and PG 58-28 (OPSS.MUNI 1101)	OPSS.MUNI 310	40 mm
Asphalt Base Course HL-8 (OPSS.MUNI 1150), and PG 58-28 (OPSS.MUNI 1101)	OPSS.MUNI 310	50 mm



Component	Compaction Requirement	Pavement on Concrete Parking Structure Minimum Component Thickness
Granular Base Course Granular A (OPSS.MUNI 1010)	100% Standard Proctor Maximum Dry Density (ASTM-D698)	150 mm
Total Thickness		240 mm

A waterproof membrane will be required between the asphalt and concrete parking structure deck. For pavements placed on top of the underground parking structure, all drainage, waterproofing, and protection considerations for these areas must be designed separately and in conjunction with the civil engineering design of the underground parking structure. Wherever they have to connect to the adjacent roadways or driveways, those adjacent pavement profiles will be different and so taper transitions and run-outs must be designed for the connections.

4.2 Asphalt Pavement

The following design pertains to asphaltic concrete pavements ('pavement') where the pavement will **rest on soil subgrade** as described above.

The following Ontario Provincial Standards Specifications (OPSS.MUNI) apply to the pavement construction and material requirements:

- OPSS.MUNI 310 - Hot Mix Asphalt
- OPSS.MUNI 501 - Compacting
- OPSS.MUNI 1010 - Aggregates – Base, Subbase, Select Subgrade, and Backfill Material
- OPSS.MUNI 1101 - Performance Graded Asphalt Cement
- OPSS.MUNI 1150 - Hot Mix Asphalt

The pavement construction and material should also follow the relevant city specifications, as applicable.

The City may eventually assume the roads. The municipality has its own minimum pavement design requirements which will have to be followed for the making of any of the pavement surfaces that will eventually become a municipal responsibility.

4.2.1 Pavement Subgrade Preparation

The subgrade must be adequately prepared prior to pavement construction.

Topsoil and existing wet or organic rich earth fill soils are considered unsuitable for the pavement subgrade. These materials must be stripped down to acceptable subgrade prior to pavement construction.



Existing earth fill, if cleared of organic rich or wet soils, and native subgrade will provide adequate subgrade for the support of the pavement. The subgrade must be proof-rolled and inspected under the supervision of Grounded for obvious loose or disturbed soils or where there is deleterious materials or moisture. These areas can either be recompacted in place and retested or replaced with Granular B in lifts 150 mm thick or less, and compacted to a minimum of 98% SPMDD.

The subgrade for all pavement structures shall be frost tapered at a 3H to 1V slope to match with existing pavement structures, to reduce differential settlements due to frost heave.

4.2.2 Asphalt Pavement Design

Minimum and performance asphaltic concrete pavement designs are outlined in the tables below.

The following **basic pavement design** will last for 8 to 10 years before significant maintenance is required, depending on the traffic volume.

Basic Pavement Structure	Compaction Requirement	Car Parking Minimum Component Thickness	Bus/Truck Traffic Minimum Component Thickness
Asphalt Top Lift HL-3 (OPSS.MUNI 1150), and PG 58-28 (OPSS.MUNI 1101)	OPSS.MUNI 310	65 mm	40 mm
Asphalt Base Course HL-8 (OPSS.MUNI 1150), and PG 58-28 (OPSS.MUNI 1101)	OPSS.MUNI 310	N/A	50 mm
Granular Base Course 19 mm diameter crusher run limestone or Granular A (OPSS.MUNI 1010)	100% Standard Proctor Maximum Dry Density (ASTM-D698)	150 mm	150 mm
Granular Subbase Course 50 mm diameter crusher run limestone or Granular B Type II (OPSS.MUNI 1010)	98% Standard Proctor Maximum Dry Density (ASTM-D698)	300 mm	400 mm
Total Thickness		515 mm	640 mm

The following **performance pavement design** will last approximately twice as long before significant maintenance is required. The performance pavement design considers that the top layer of asphalt will be damaged over time, and therefore, will contribute less to the structural strength of the asphalt.



Performance Pavement Structure	Compaction Requirement	Car Parking Minimum Component Thickness	Bus/Truck Traffic Minimum Component Thickness
Asphalt Top Lift HL-3 (OPSS.MUNI 1150), and PG 58-28 (OPSS.MUNI 1101)	OPSS.MUNI 310	40 mm	40 mm
Asphalt Base Course HL-8 (OPSS.MUNI 1150), and PG 58-28 (OPSS.MUNI 1101)	OPSS.MUNI 310	50 mm	80 mm
Granular Base Course 19 mm diameter crusher run limestone or Granular A (OPSS.MUNI 1010)	100% Standard Proctor Maximum Dry Density (ASTM-D698)	150 mm	150 mm
Granular Subbase Course 50 mm diameter crusher run limestone or Granular B Type II (OPSS.MUNI 1010)	98% Standard Proctor Maximum Dry Density (ASTM-D698)	400 mm	500 mm
Total Thickness		640 mm	770 mm

4.2.3 Susceptibility to Frost Damage

As established on the Site Grading Plan by Schaeffers, the elevations of the top of proposed pavements range from Elev. 189± to 187.5± m.

The most effective ways of dealing with potential frost heave are to construct a good subsurface drainage system, and to stay well above the groundwater table. Per Section 2.3, there are frost-susceptible soils at this site, but the groundwater table will be below frost penetration depth during pavement construction, mitigating frost heave potential of the pavements. Subgrade must be protected from frost per the recommendations in the Site Work section below. Pavements must be adequately drained (section below) to mitigate frost damage risk.

4.2.4 Pavement Drainage

Adequate drainage of the pavement subgrade is required. Prior to paving, the subgrade should be free of any depressions and sloped at a minimum grade of 2% to provide positive drainage. Perforated plastic subdrains (100 mm diameter) should be designed to collect subgrade water and positively outlet it at the catch basins. Typical pavement drainage details are appended.

Controlling surface water is important in keeping pavements in good maintenance. Grading adjacent pavement areas must be designed so that water is not allowed to pond adjacent to the outside edges of the pavement or curb.



5 Considerations for Construction

5.1 Excavations

Excavations must be carried out in accordance with the *Occupational Health and Safety Act – Regulation 213/91 – Construction Projects (Part III - Excavations, Section 222 through 242)*. These regulations designate four (4) broad classifications of soils to stipulate appropriate measures for excavation safety. For practical purposes:

- The earth fill is a Type 3 soil
- The clayey silt till is a Type 2 soil
- The sandy silt and silty sand tills are Type 4 soils, or Type 3 soils if dewatered

In accordance with the regulation's requirements, the soil must be suitably sloped and/or braced where workers must enter a trench or excavation deeper than 1.2 m. Safe excavation slopes (of no more than 3 m in height) by soil type are stipulated as follows, per Section 234:

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 Sections 235 through 239 and 241 of the Act and Regulations and include provisions for timbering, shoring and moveable trench boxes. Any excavation slopes greater than 3 m in height should be checked by Grounded for global stability issues.

Larger obstructions (e.g. buried concrete debris, other obstructions) not directly observed in the boreholes are likely present in the earth fill. Similarly, larger inclusions (e.g. cobbles and boulders) may be encountered in the native soils. The size and distribution of these obstructions cannot be predicted with boreholes, as the split spoon sampler is not large enough to capture particles of this size. Provision must be made in excavation contracts to allocate risks associated with the time spent and equipment utilized to remove or penetrate such obstructions when encountered.

Excess soil is governed by Ontario Regulation 406/19: On-Site and Excess Soil Management (ESM). The Project Leader (typically the owner) may be required to file a notice in the excess soil registry and a Qualified Person (within the meaning of O.Reg. 153/04) may be required to prepare the associated planning documents and/or develop and implement a tracking system in accordance with the Soil Rules, to track each load of excess soil during its transportation and deposit before removing excess soil from the project area.



5.2 Short Term Groundwater Control

Considerations pertaining to groundwater discharge quantities and quality are discussed in Grounded's hydrogeological report for the site, under separate cover.

The groundwater table at Elev. 184.8± m is above the bulk excavation level for P1 and near bulk excavation level for the townhouse structures. The groundwater table is present in the clayey silt till deposit which has a low permeability and will yield only minor seepage in the long-term. There is also infiltrated stormwater perched in the earth fill, which is flowing down towards the groundwater table.

Seepage into excavations above Elev. 181.6 m may be allowed to drain into the excavation and then controlled by a conventional sump pump arrangement. Nevertheless, delays in excavation will occur as the seepage is controlled and these delays should be anticipated in the construction schedule.

If excavations (or drill holes for soldier piles, see below) below Elev. 181.6 m are required, there is a risk for basal instability due to the piezometric (groundwater pressure) head in the lower sandy silt till. It will therefore be necessary to depressurize the lower sandy silt till prior to these excavations. The lower wet sandy silt till must be depressurized to preserve the in-situ integrity of the native soils. If the lower sandy silt till is not depressurized prior to excavation below Elev. 181.6 m, the native soils will become disturbed by basal heave or the ingress of groundwater, rendering the advice provided for undisturbed subgrade conditions inapplicable. In this case, a professional dewatering contractor should be consulted to review the subsurface conditions and to design a site-specific dewatering system. It is the dewatering contractor's responsibility to assess the factual data and to provide recommendations on dewatering system requirements.

The Region of Halton will require Discharge Agreements in the short and long-terms, if any water is to be discharged to the storm or sanitary sewers. It should be noted that securing a permit to take water on a permanent basis may not be supported by regulatory agencies.

5.3 Earth-Retention Shoring Systems

No excavation shall extend below the foundations of existing adjacent structures without adequate alternative support being provided.

Excavation zone of influence guidelines are appended. If shoring is preferred over open cut excavations, or is required for any reason, the following advice is recommended.

5.3.1 Lateral Earth Pressure Distribution

If the shoring is supported with a single level of earth anchor or bracing, a triangular earth pressure distribution like that used for the basement wall design is appropriate.



Where multiple rows of lateral supports are used to support the shoring walls, research has shown that a distributed pressure diagram more realistically approximates the earth pressure on a shoring system of this type, when restrained by pre-tensioned anchors. A multi-level supported shoring system can be designed based on an earth pressure distribution with a maximum pressure defined by:

$$P = 0.8 K[\gamma H + q] + \gamma_w h_w$$

- P = maximum horizontal pressure (kPa)
- K = earth pressure coefficient (see Section 3.3)
- H = total depth of the excavation (m)
- h_w = height of groundwater (m) above the base of excavation
- γ = soil bulk unit weight (kN/m³)
- q = total surcharge loading (kPa)

Where shoring walls are drained to effectively eliminate hydrostatic pressure on the shoring system (e.g. pile and lagging walls), h_w is equal to zero.

In cohesive soils, the multi-level lateral earth pressure distribution is trapezoidal, uniformly increasing from zero to the maximum pressure defined in the equation above over the top and bottom quarter (H/4) of the shoring.

5.3.2 Soldier Pile Toe Embedment

Soldier pile toes will be made in the undisturbed clayey silt till. Soldier pile toes resist horizontal movement due to the passive earth pressure acting on the toe below the base of excavation.

There are zones of soil in the subgrade that are wet, cohesionless, and permeable. Augered holes for piles made into these soils will be prone to caving and blowback. To prevent groundwater issues (groundwater inflow, caving and blowback into the drill holes, disturbance to placed concrete, etc.) during drilling and installation, construction methods such as utilizing temporary liners, pre-advancing liners deeper than the augered holes, mud/slurry/polymer drilling techniques, tremie pour concrete, or other methods as deemed necessary by the shoring contractor are required. Concrete for shoring piles and fillers must be placed by tremie method wherever there is more than 300 mm of water or fluid at the base of the drill hole.

The piezometric head in the lower sandy silt till could cause basal heave and groundwater inflow for any drill holes advanced below Elev. 181.6 m. To protect drill holes against basal disturbance caused by the inflow of groundwater, and to prevent loss of ground, it will be necessary at this site to control the bases of any drill holes below Elev. 181.6 m. This may include dewatering to below the drill hole depths prior to installation, or the use of drilling muds (slurry, polymer, etc.), pre-advancing casing, or other techniques as deemed necessary by the shoring contractor.



5.3.3 Lateral Bracing Elements

The shoring system at this site will require lateral bracing. If feasible, the shoring system should be supported by pre-stressed soil anchors (tiebacks) extending into the subgrade of the adjacent properties. To limit the movement of the shoring system as much as is practically possible, tiebacks are installed and stressed as excavation proceeds. The use of tiebacks through adjacent properties requires the consent (through encroachment agreements) of the adjacent property owners.

It is expected that post-grouted anchors in tension can be designed using the following maximum factored geotechnical resistances at ULS within the specified strata:

- In the clayey silt till, up to 50 to 80 kN/m of adhered anchor length (at a nominal borehole diameter of 150 mm). Considerations for the potential creep over time of post-grouted anchors made in the lower firm clayey silt till (to Elev. 179± m) is required during shoring design.
- In the very dense sandy silt till, up to 80 to 100 kN/m of adhered anchor length (at a nominal borehole diameter of 150 mm)

These capacities are provided assuming that a site-specific tension load test is performed, implying a resistance factor of 0.6.

Production tiebacks require a minimum 3 m socket length.

At least one prototype anchor per tieback level must be performance-tested to 200% of the design load to demonstrate the anchor capacity and validate design assumptions. For temporary applications, the performance test anchor may be used as a production anchor.

Every production anchor must be proof tested to 133% of design load, and then locked in at 100% of design load.

The very stiff to hard till below the proposed FFE is suitable for the placement of raker foundations. Raker footings established on the till at an inclination of 45 degrees can be designed for a maximum factored geotechnical resistance at ULS of 200 kPa.

5.4 Site Work

To better protect wet undisturbed subgrade, excavations exposing wet soils must be cut neat, inspected, and then immediately protected with a skim coat of concrete (i.e. a mud mat). Wet sands are susceptible to degradation and disturbance due to even mild site work, frost, weather, or a combination thereof.

The effects of work on site can greatly impact soil integrity. Care must be taken to prevent this damage. Site work carried out during periods of inclement weather may result in the subgrade becoming disturbed, unless a granular working mat is placed to preserve the subgrade soils in



their undisturbed condition. Subgrade preparation activities should not be conducted in wet weather and the project must be scheduled accordingly.

If site work causes disturbance to the subgrade, removal of the disturbed soils and the use of granular fill material for site restoration or underfloor fill will be required at additional cost to the project.

It is construction activity itself that often imparts the most severe loading conditions on the subgrade. Special provisions such as end dumping and forward spreading of earth and aggregate fills, restricted construction lanes, and half-loads during placement of the granular base and other work may be required, especially if construction is carried out during unfavourable weather.

Adequate temporary frost protection for the founding subgrade must be provided if construction proceeds in freezing weather conditions. The subgrade at this site is susceptible to frost damage. The slab on grade should not be placed on frozen subgrade, to prevent excess settlement of the slab as the subgrade thaws. Areas of frozen subgrade should be removed during subgrade preparation. Depending on the project context, consideration should be given to frost effects (heaving, softening, etc.) on exposed subgrade surfaces.

5.5 Engineering Review

By issuing this report, Grounded Engineering has assumed the role of Geotechnical Engineer of Record for this site. Grounded should be retained to review the structural engineering drawings prior to issue or construction to ensure that the recommendations in this report have been appropriately implemented.

All foundation installations must be reviewed in the field by Grounded, the Geotechnical Engineer of Record, as they are constructed. The on-site review of foundation installations and the condition of the founding subgrade as the foundations are constructed is as much a part of the geotechnical engineering design function as the design itself; it is also required by Section 4.2.2.3. of the 2024 Ontario Building Code. If Grounded is not retained to carry out foundation engineering field review during construction, then Grounded accepts no responsibility for the performance or non-performance of the foundations, even if they are constructed in general conformance with the engineering design advice contained in this report.

House foundations designed under Part 9 of the Building Code are approved by local building inspectors. Prior to placing concrete for foundations of dwellings, the foundation areas must be cleaned of all deleterious materials such as topsoil, fill, and softened, disturbed, or caved materials, as well as any standing water.

Strict procedures must be maintained during construction to maintain the integrity of the subgrade to the extent possible. The design advice in this report is based on an assessment of the subgrade support capabilities as indicated by the boreholes. These conditions may vary across the site depending on the final design grades and therefore, the preparation of the



subgrade should be monitored by Grounded at the time of construction to confirm material quality, and thickness.

A visual pre-construction survey of adjacent lands and buildings is recommended to be completed prior to the start of any construction. This documents the baseline condition and can prevent unwarranted damage claims. Any shoring system, regardless of the execution and design, has the potential for movement. Small changes in stress or soil volume can cause cracking in adjacent buildings.

6 Limitations and Restrictions

Grounded should be retained by the Owner to review the structural and geotechnical engineering drawings prior to issue or construction to ensure that the recommendations in this report have been appropriately implemented.

6.1 Investigation Procedures

The geotechnical engineering analysis and advice provided are based on the factual borehole information observed and recorded by Grounded. The investigation methodology and engineering analysis methods used to carry out this scope of work are consistent with conventional standard practice by Grounded as well as other geotechnical consultants, working under similar conditions and constraints (time, financial and physical).

Borehole drilling services were provided to Grounded by a specialist professional contractor. The drilling was observed and recorded by Grounded's field supervisor on a full-time basis. Drilling was conducted using conventional drilling rigs equipped with hollow stem augers. As drilling proceeded, groundwater observations were made in the boreholes. Based on examination of recovered borehole samples, our field supervisor made a record of borehole and drilling observations. The field samples were secured in air-tight clean jars and bags and taken to the Grounded soil laboratory where they were each logged and reviewed by the geotechnical engineering team and the senior reviewer.

The Split-Barrel Method technique (ASTM D1586) was used to obtain the soils samples. The sampling was conducted at conventional intervals and not continuously. As such, stratigraphic interpolation between samples is required and stratigraphic boundary lines do not represent exact depths of geological change. They should be taken as gradual transition zones between soil or rock types.

A carefully conducted, fully comprehensive investigation and sampling scope of work carried out under the most stringent level of oversight may still fail to detect certain ground conditions. As such, users of this report must be aware of the risks inherent in using engineered field investigations to observe and record subsurface conditions. As a necessary requirement of working with discrete test locations, Grounded has assumed that the conditions between test



locations are the same as the test locations themselves, for the purposes of providing geotechnical engineering advice.

It is not possible to design a field investigation with enough test locations that would provide complete subsurface information, nor is it possible to provide geotechnical engineering advice that completely identifies or quantifies every element that could affect construction, scheduling, or tendering. Contractors undertaking work based on this report (in whole or in part) must make their own determination of how they may be affected by the subsurface conditions, based on their own analysis of the factual information provided and based on their own means and methods. Contractors using this report must be aware of the risks implicit in using factual information at discrete test locations to infer subsurface conditions across the site and are directed to conduct their own investigations as needed.

6.2 Site and Scope Changes

Natural occurrences, the passage of time, local construction, and other human activity all have the potential to directly or indirectly alter the subsurface conditions at or near the project site. Contractual obligations related to groundwater or stormwater control, disturbed soils, frost protection, etc. must be considered with attention and care as they relate this potential site alteration.

The geotechnical engineering advice provided in this report is based on the factual observations made from the site investigations as reported. It is intended for use by the owner and their retained design team. If there are changes to the features of the development or to the scope, the interpreted subsurface information, geotechnical engineering design parameters, advice, and discussion on construction considerations may not be relevant or complete for the project. Grounded should be retained to review the implications of such changes with respect to the contents of this report.

6.3 Report Use

The authorized users of this report are Shearling Heights Estates Ltd and their design team, for whom this report has been prepared. Grounded Engineering Inc. maintains the copyright and ownership of this document. Reproduction of this report in any format or medium requires explicit prior authorization from Grounded Engineering Inc.

The Town of Milton or Region of Halton may also make use of and rely upon this report, subject to the limitations as stated.



7 Closure

If the design team has any questions regarding the discussion and advice provided, please do not hesitate to have them contact our office. We trust that this report meets your requirements at present.

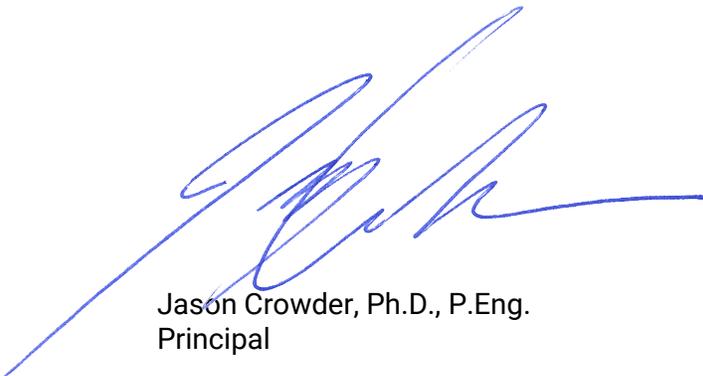
For and on behalf of our team,



Matthew Garcia, P.Eng.
Project Engineer



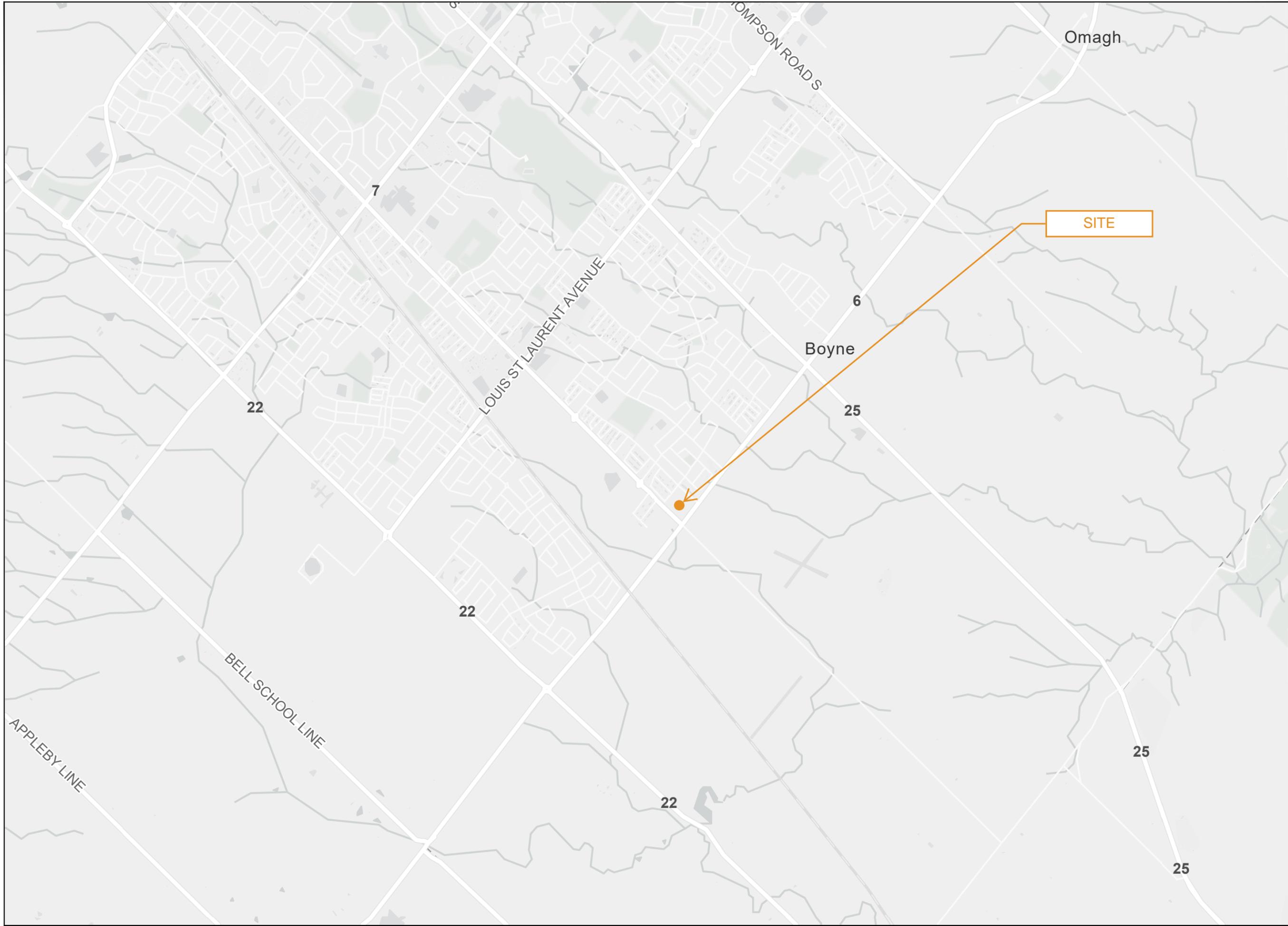
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FIGURES





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LEGEND

● APPROXIMATE SITE LOCATION

Note

Reference

ArcGIS, 2024

Project

**BRITANNIA ROAD AND
BRONTE STREET SOUTH,
MILTON, ONTARIO**

Figure Title

KEY PLAN

North



Date

FEBRUARY 2026

Scale

N.T.S.

Job No

20-294

Figure No

FIGURE 1



GROUND
ENGINEERING

49 MOBILE DRIVE, TORONTO, ONT., M4A 1H5
www.groundedeng.ca

LEGEND

— APPROXIMATE PROPERTY BOUNDARY

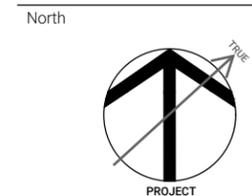
⊕ ⊗ MONITORING WELL/BOREHOLE BY GROUND

Note
Overlaid on Site Plan architectural drawing.

Reference
Architectural Drawings, "Trinity Point-Shearing Heights"; Project 2268.24, dated February 13, 2026 (Draft for SPA), prepared by Graziani + Corazza Architects.

Project
BRITANNIA ROAD AND BRONTE STREET SOUTH, MILTON, ONTARIO

Figure Title
BOREHOLE LOCATION PLAN PROPOSED CONDITIONS (SITE PLAN)

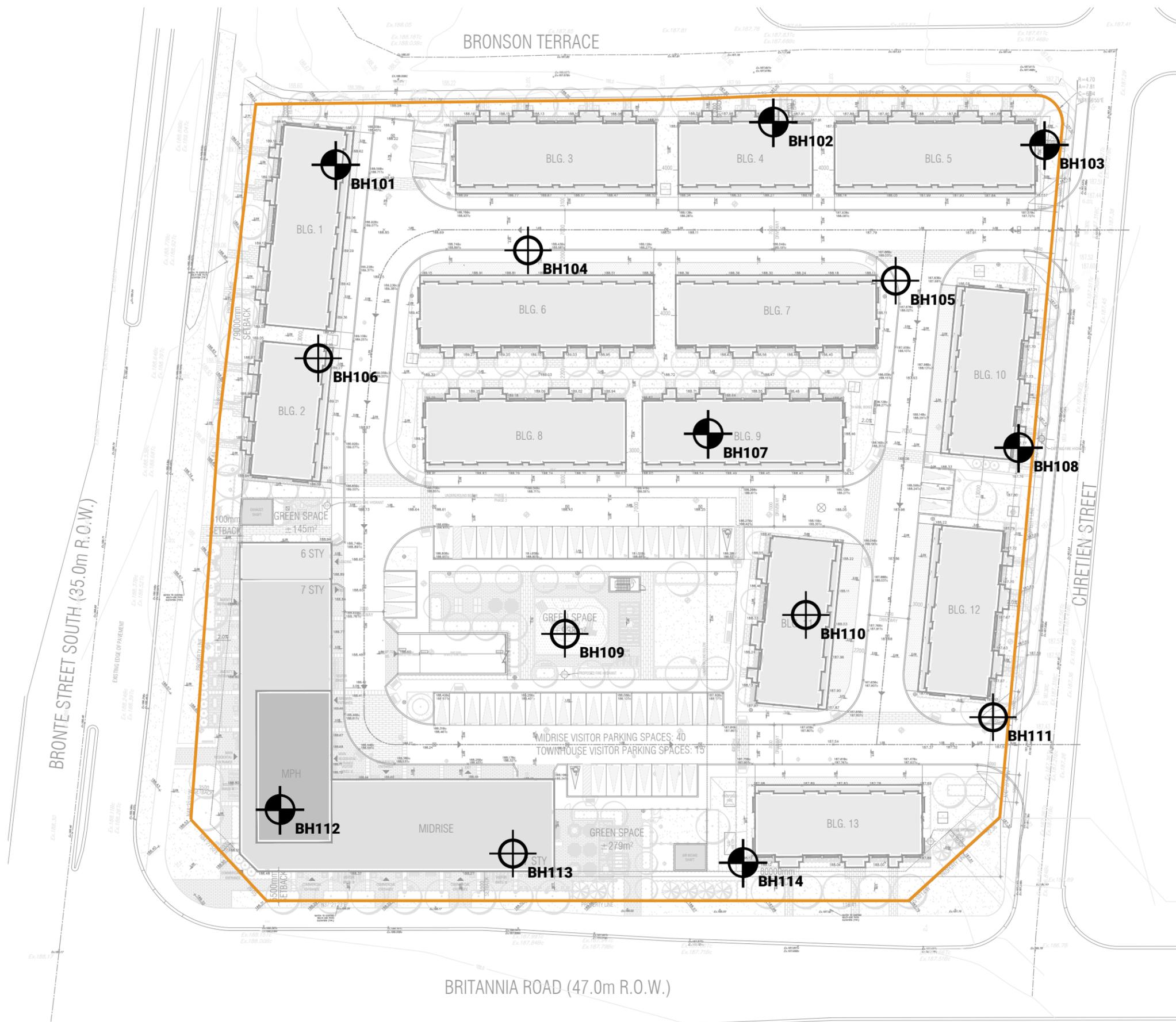


Date
FEBRUARY 2026

Scale
AS INDICATED

Job No
20-294

Figure No
FIGURE 2A





GROUND
ENGINEERING

49 MOBILE DRIVE, TORONTO, ONT., M4A 1H5
www.groundedeng.ca

LEGEND

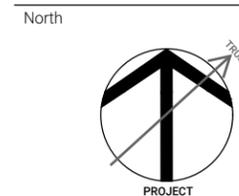
- APPROXIMATE PROPERTY BOUNDARY
- ⊕ MONITORING WELL/BOREHOLE BY GROUNDED
- ⋯ APPROXIMATE EXTENT OF MIDRISE ABOVE

Note
Overlaid on P1 architectural drawing.
Excludes unfinished townhouse
basements.

Reference
Architectural Drawings, "Trinity
Point-Shearing Heights"; Project 2268.24,
dated February 13, 2026 (Draft for SPA),
prepared by Graziani + Corazza Architects.

Project
**BRITANNIA ROAD AND
BRONTE STREET SOUTH,
MILTON, ONTARIO**

Figure Title
**BOREHOLE LOCATION PLAN
PROPOSED CONDITIONS
(P1)**



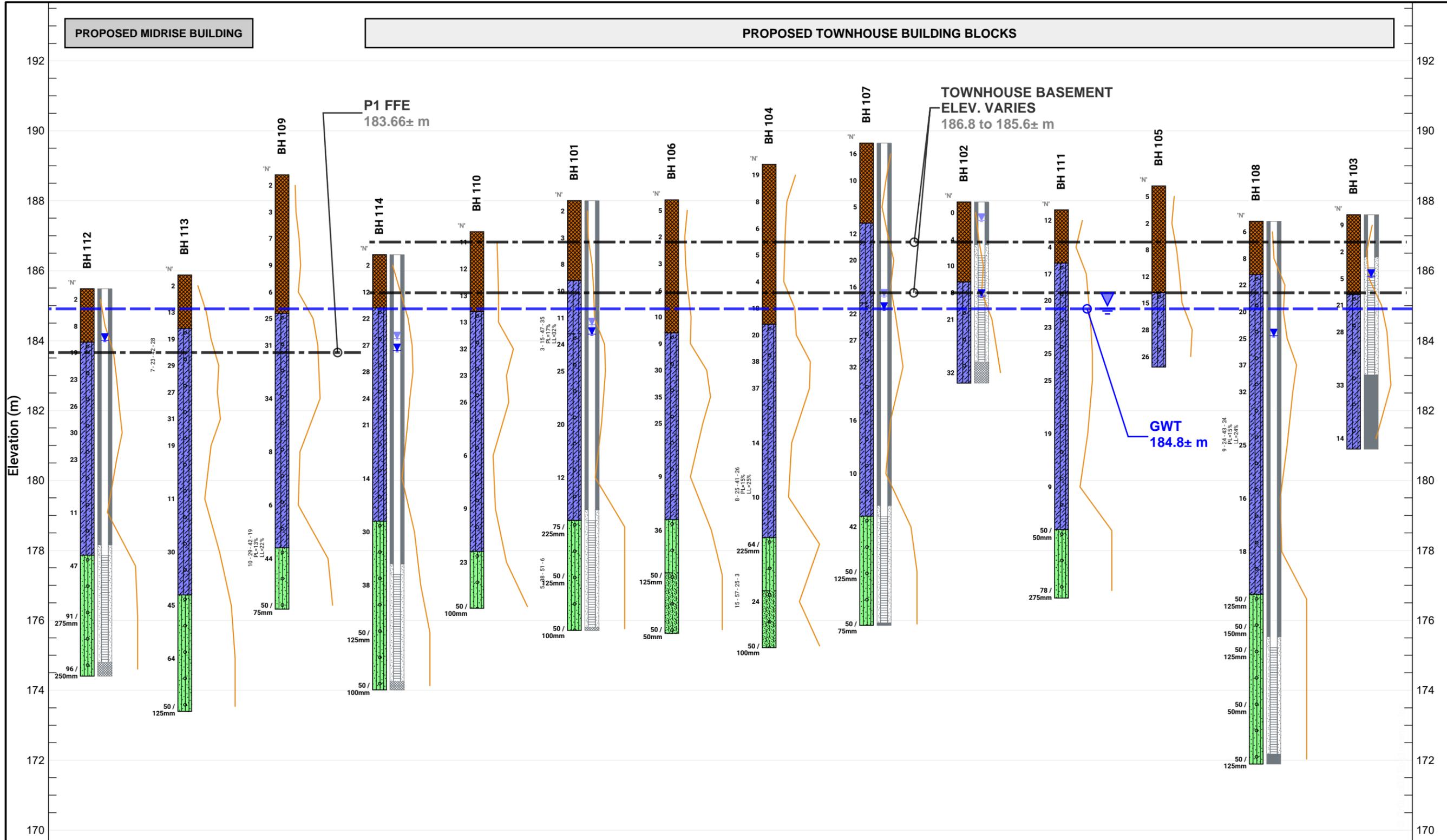
Date
FEBRUARY 2026

Scale
AS INDICATED

Job No
20-294

Figure No
FIGURE 2B





LEGEND

- FILL
- GRAVELS (gravel to gravelly sand)
- SILT TO SAND (not till)
- COHESIONLESS TILLS
- COHESIVE SOILS (clayey silt to clay, incl. tills)
- DISTURBED/REWORKED/ORGANIC

BH 101 BOREHOLES BY GROUNDED
T-BH7 BOREHOLES BY OTHERS

- water level, unstabilized
- water level, stabilized (latest)
- water level, stabilized (highest)

Project
BRITANNIA RD AND BRONTE ST S, MILTON ON

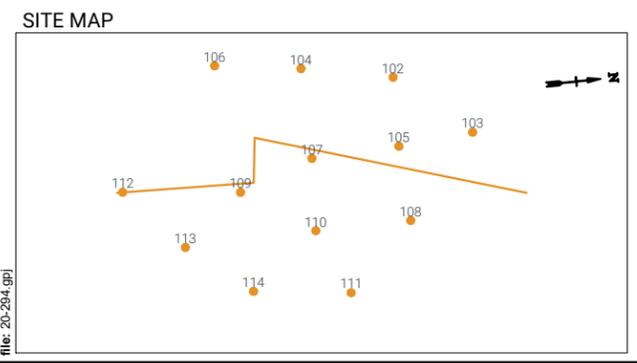
Figure Title
SUBSURFACE PROFILE

Date
FEBRUARY 2026

Scale
AS INDICATED

Job No
20-294

Figure No
FIGURE 3



Boreholes Equally Spaced

BOREHOLE STRATIGRAPHY LEGEND

- Fill
- Clayey Silt
- Clayey Silt Till
- Silty Sand Till
- Sandy Silt Till

TABLES



**TABLE 1:
GROUNDWATER LEVEL MONITORING SUMMARY
BRITANNIA RD AND BRONTE ST S, MILTON, ON**



Well ID	Ground Surface Elev. (masl)	Well Screen Interval		Soil Strata	Grounded Engineering																Minimum Elev. (Lowest)		Maximum Elev. (Highest)		Seasonal Fluctuation (±m)	Number of Monitoring Events
		(mbgs)	(masl)		Jan. 12, 2021		Jan. 29, 2021		Mar. 02, 2021		Mar. 28, 2021		Apr. 18, 2021		Feb. 16, 2024		Jan. 20, 2025		July 21, 2025		(mbgs)	(masl)	(mbgs)	(masl)		
					(mbgs)	(masl)	(mbgs)	(masl)	(mbgs)	(masl)	(mbgs)	(masl)	(mbgs)	(masl)	(mbgs)	(masl)	(mbgs)	(masl)	(mbgs)	(masl)						
BH101	188.0	9.1 - 12.2	178.9 - 175.8	Sandy Silt Till	3.7	184.3	3.7	184.3	3.8	184.2	3.7	184.3	3.6	184.4	3.6	184.4	3.9	184.1	NA	-	3.9	184.1	3.6	184.4	0.2	7
BH102	188.0	1.5 - 4.6	186.5 - 183.4	Clayey Silt Till / Fill	dry	dry	dry	dry	dry	dry	4.1	183.9	4.0	184.0	0.6	187.4	0.6	187.4	2.7	185.3	4.1	183.9	0.6	187.4	3.5	8
BH103	187.6	1.5 - 4.6	186.1 - 183.0	Clayey Silt Till / Fill	dry	dry	4.2	183.4	3.1	184.5	2.9	184.7	2.9	184.7	2.1	185.5	1.9	185.7	1.8	185.9	4.2	183.4	1.8	185.9	2.4	8
BH107	189.6	10.7 - 13.7	178.9 - 175.9	Sandy Silt Till	4.4*	185.2*	5.4	184.2	5.5	184.1	5.5	184.1	5.4	184.2	5.4	184.3	4.8	184.8	NA	-	5.5	184.1	4.8	184.8	0.7	7
BH108	187.4	12.2 - 15.2	175.2 - 172.2	Sandy Silt Till	3.4	184.0	3.5	183.9	3.6	183.8	3.6	183.8	3.5	183.9	3.3	184.1	NA	-	NA	-	3.6	183.8	3.4	184.0	0.2	6
BH112	185.5	7.6 - 10.7	177.9 - 174.8	Sandy Silt Till	1.8	183.7	1.6	183.9	1.7	183.8	1.6	183.9	1.6	183.9	1.5	184.0	NA	-	NA	-	1.8	183.7	1.6	183.9	0.2	6
BH114	186.5	9.1 - 12.2	177.4 - 174.3	Sandy Silt Till	7.6	178.9	2.6	183.9	2.7	183.8	2.6	183.9	2.6	184.0	2.4	184.1	2.4	184.1	2.8	183.7	7.6	178.9	2.4	184.1	5.2	8

mbgs = metres below existing ground surface

masl = metres above sea level

* = unstabilized groundwater level

NA = not available, unable to access monitoring well

APPENDIX A



SAMPLING/TESTING METHODS

SS: split spoon sample
 AS: auger sample
 GS: grab sample
 FV: shear vane
 DP: direct push
 PMT: pressuremeter test
 ST: shelby tube
 CORE: soil coring
 RUN: rock coring

SYMBOLS & ABBREVIATIONS

MC: moisture content
 LL: liquid limit
 PL: plastic limit
 NP: non-plastic
 γ : soil unit weight (bulk)
 G_s : specific gravity
 S_u : undrained shear strength
 unstabalized water level
 water level measurement
 highest water level measurement

ENVIRONMENTAL SAMPLES

M&I: metals and inorganic parameters
 PAH: polycyclic aromatic hydrocarbon
 PCB: polychlorinated biphenyl
 VOC: volatile organic compound
 PHC: petroleum hydrocarbon
 BTEX: benzene, toluene, ethylbenzene and xylene
 PPM: parts per million

FIELD MOISTURE (based on tactile inspection)

DRY: no observable pore water
MOIST: inferred pore water, not observable (i.e. grey, cool, etc.)
WET: visible pore water

COHESIONLESS

Relative Density	N-Value
Very Loose	<4
Loose	4 - 10
Compact	10 - 30
Dense	30 - 50
Very Dense	>50

COHESIVE

Consistency	N-Value	Su (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	% by weight
trace silt	<10
some silt	10 - 20
silty	20 - 35
sand and silt	>35

ASTM STANDARDS

ASTM D1586 Standard Penetration Test (SPT)

Driving a 51 mm O.D. split-barrel sampler ("split spoon") into soil with a 63.5 kg weight free falling 760 mm. The blows required to drive the split spoon 300 mm ("bpf") after an initial penetration of 150 mm is referred to as the N-Value.

ASTM D3441 Cone Penetration Test (CPT)

Pushing an internal still rod with a outer hollow rod ("sleeve") tipped with a cone with an apex angle of 60° and a cross-sectional area of 1000 mm² into soil. The resistance is measured in the sleeve and at the tip to determine the skin friction and the tip resistance.

ASTM D2573 Field Vane Test (FVT)

Pushing a four blade vane into soil and rotating it from the surface to determine the torque required to shear a cylindrical surface with the vane. The torque is converted to the shear strength of the soil using a limit equilibrium analysis.

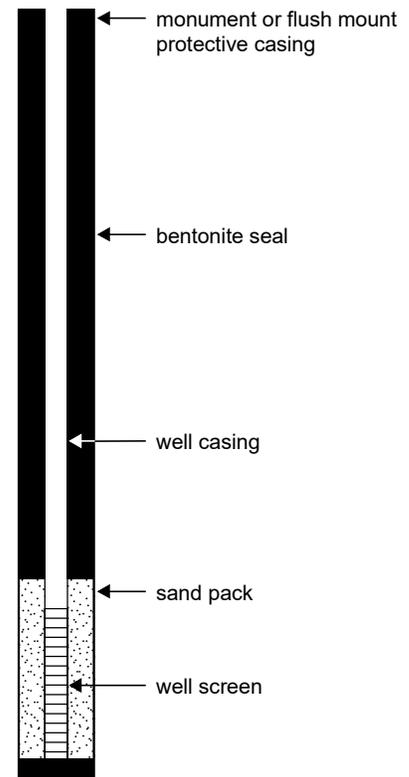
ASTM D1587 Shelby Tubes (ST)

Pushing a thin-walled metal tube into the in-situ soil at the bottom of a borehole, removing the tube and sealing the ends to prevent soil movement or changes in moisture content for the purposes of extracting a relatively undisturbed sample.

ASTM D4719 Pressuremeter Test (PMT)

Place an inflatable cylindrical probe into a pre-drilled hole and expanding it while measuring the change in volume and pressure in the probe. It is inflated under either equal pressure increments or equal volume increments. This provides the stress-strain response of the soil.

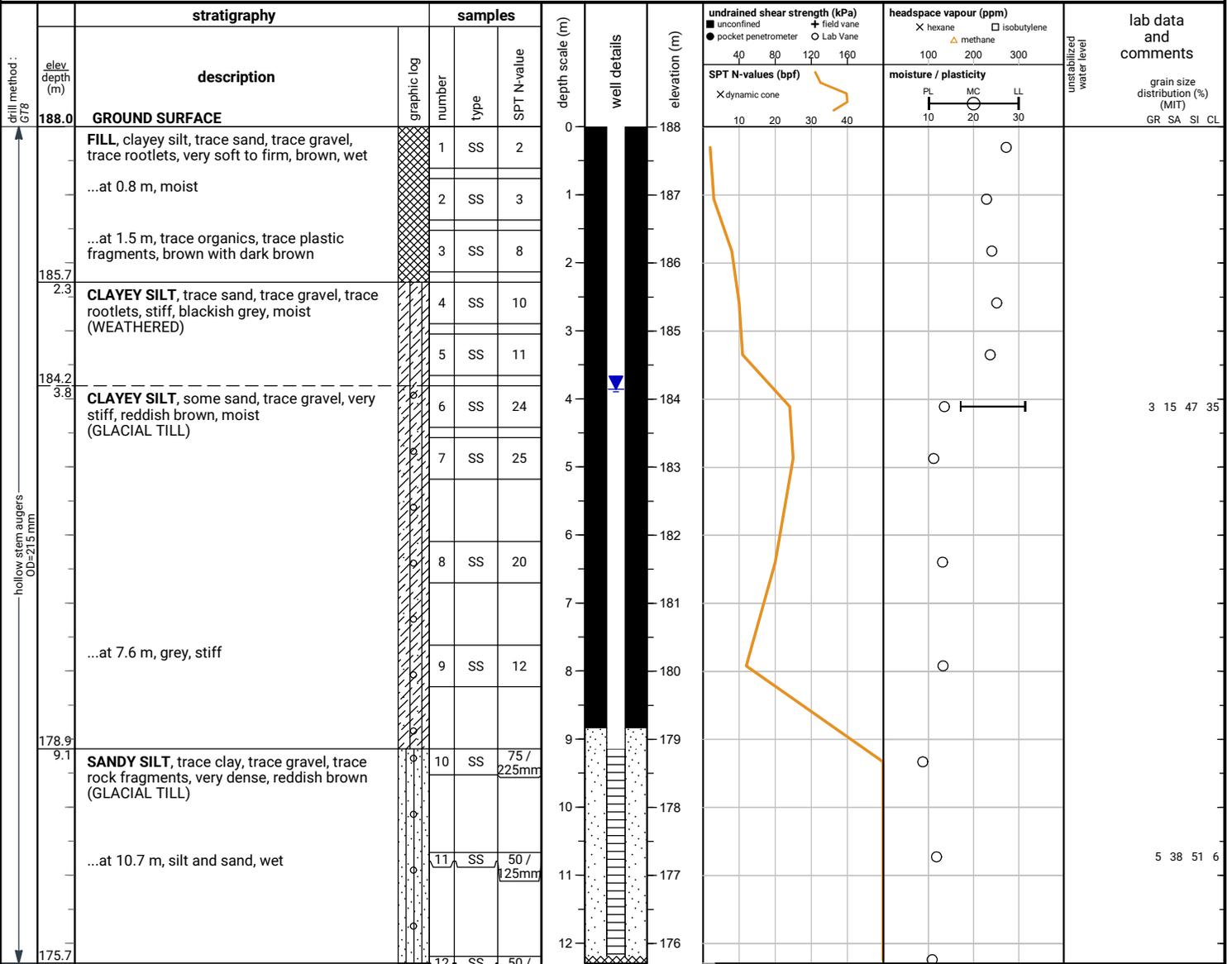
WELL LEGEND



File No. : 20-294

Project : Britannia Rd and Bronte St S, Milton, ON

Client : Trinity Point



END OF BOREHOLE

Borehole was dry upon completion of drilling.

50 mm dia. monitoring well installed.

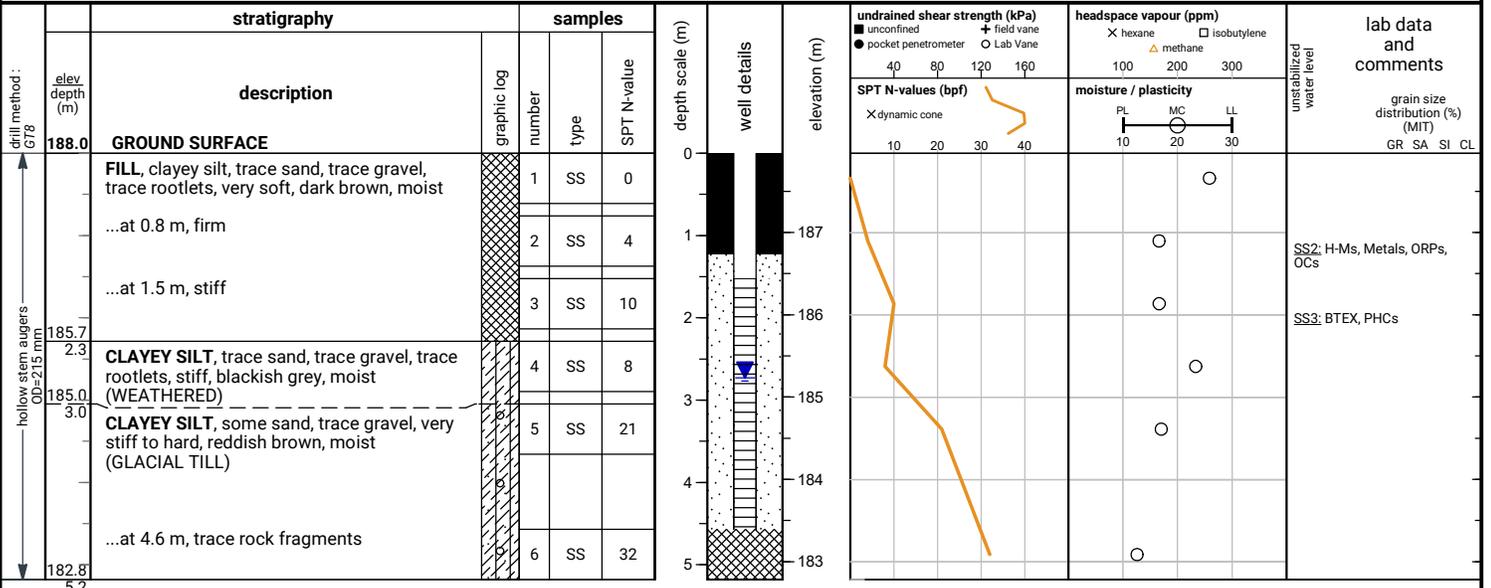
GROUNDWATER LEVELS

date	depth (m)	elevation (m)
Jan 12, 2021	3.7	184.3
Jan 29, 2021	3.7	184.3
Mar 2, 2021	3.8	184.2
Mar 28, 2021	3.7	184.3
Apr 18, 2021	3.6	184.4
Feb 16, 2024	3.6	184.4
Jan 20, 2025	3.9	184.1

File No. : 20-294

Project : Britannia Rd and Bronte St S, Milton, ON

Client : Trinity Point



END OF BOREHOLE

Borehole was dry upon completion of drilling.

50 mm dia. monitoring well installed.

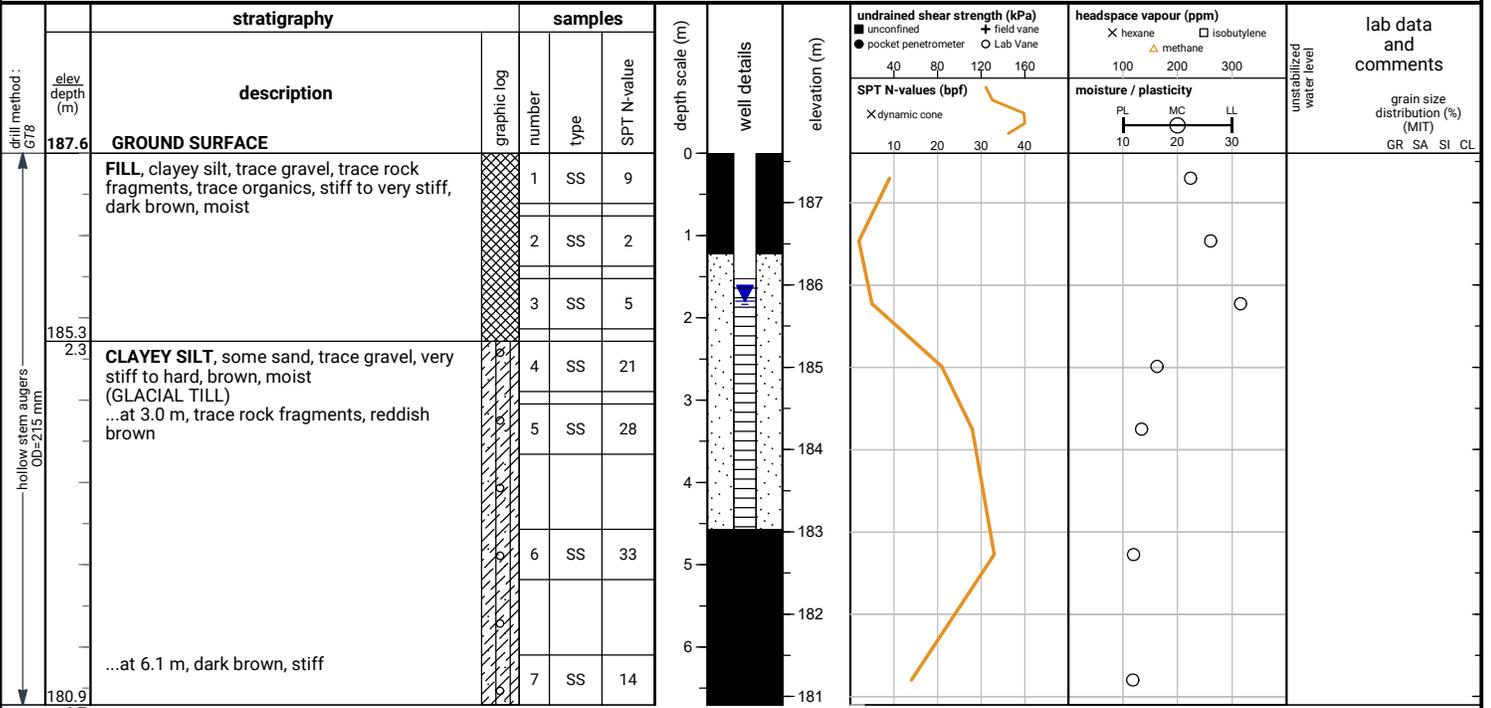
GROUNDWATER LEVELS

date	depth (m)	elevation (m)
Jan 12, 2021	dry	n/a
Jan 29, 2021	dry	n/a
Mar 2, 2021	dry	n/a
Mar 28, 2021	4.1	183.9
Apr 18, 2021	4.0	184.0
Feb 16, 2024	0.6	187.4
Jan 20, 2025	0.6	187.4
Jul 21, 2025	2.7	185.3

File No. : 20-294

Project : Britannia Rd and Bronte St S, Milton, ON

Client : Trinity Point



END OF BOREHOLE

Borehole was dry upon completion of drilling.

50 mm dia. monitoring well installed.

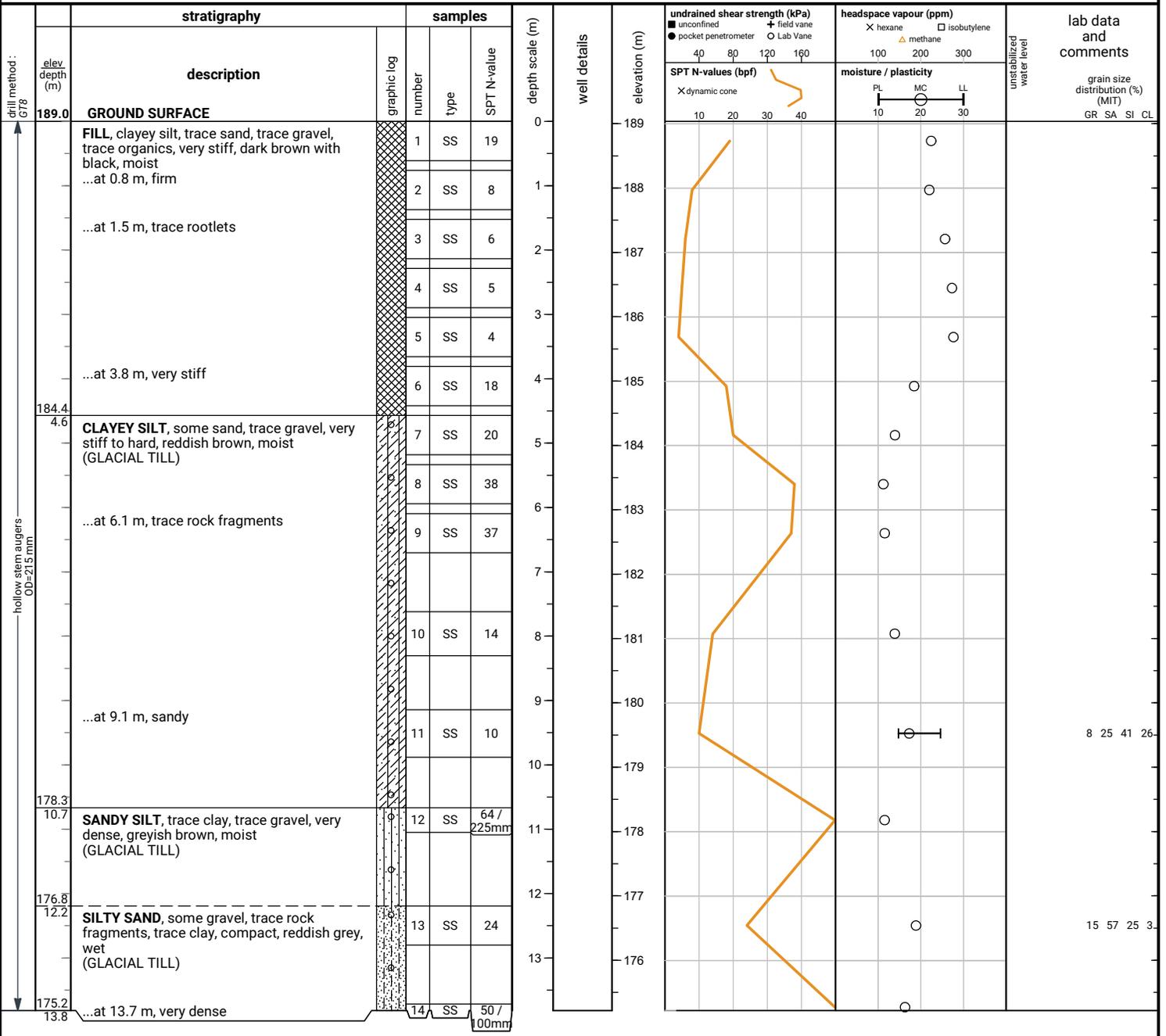
GROUNDWATER LEVELS

date	depth (m)	elevation (m)
Jan 12, 2021	dry	n/a
Jan 29, 2021	4.2	183.4
Mar 2, 2021	3.1	184.5
Mar 28, 2021	2.9	184.7
Apr 18, 2021	2.9	184.7
Feb 16, 2024	2.1	185.5
Jan 20, 2025	1.9	185.7
Jul 21, 2025	1.8	185.8

File No. : 20-294

Project : Britannia Rd and Bronte St S, Milton, ON

Client : Trinity Point



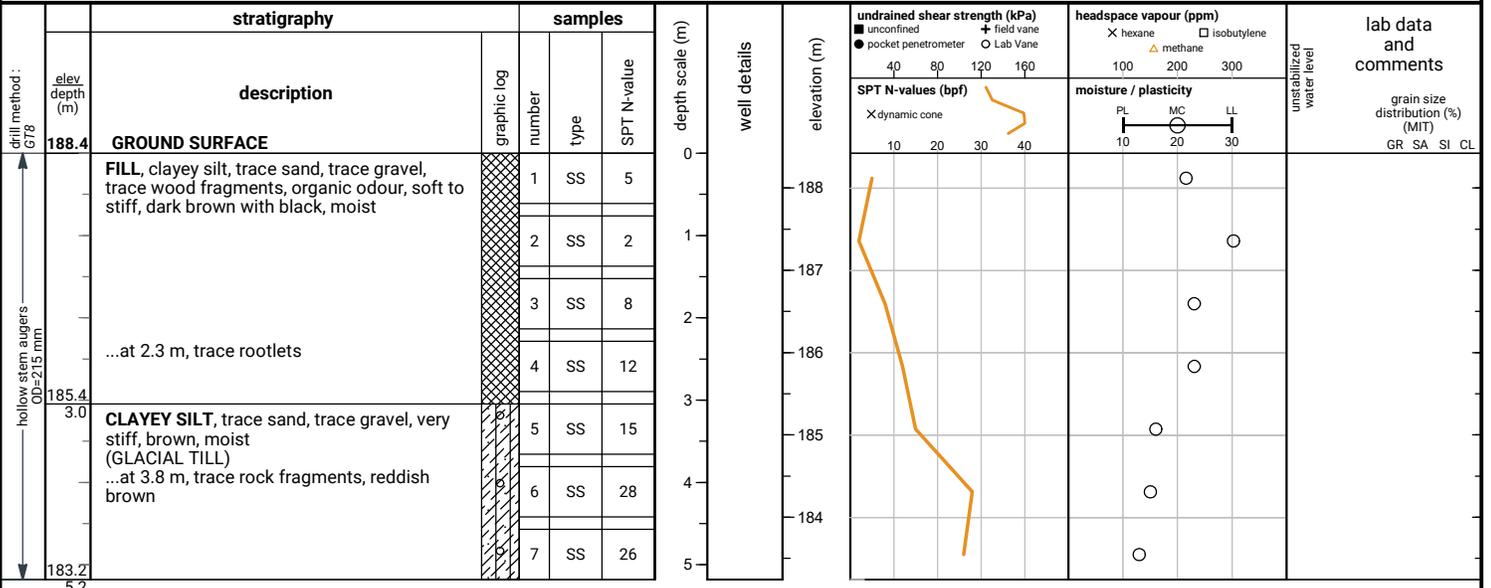
END OF BOREHOLE

Borehole was dry upon completion of drilling.

File No. : 20-294

Project : Britannia Rd and Bronte St S, Milton, ON

Client : Trinity Point



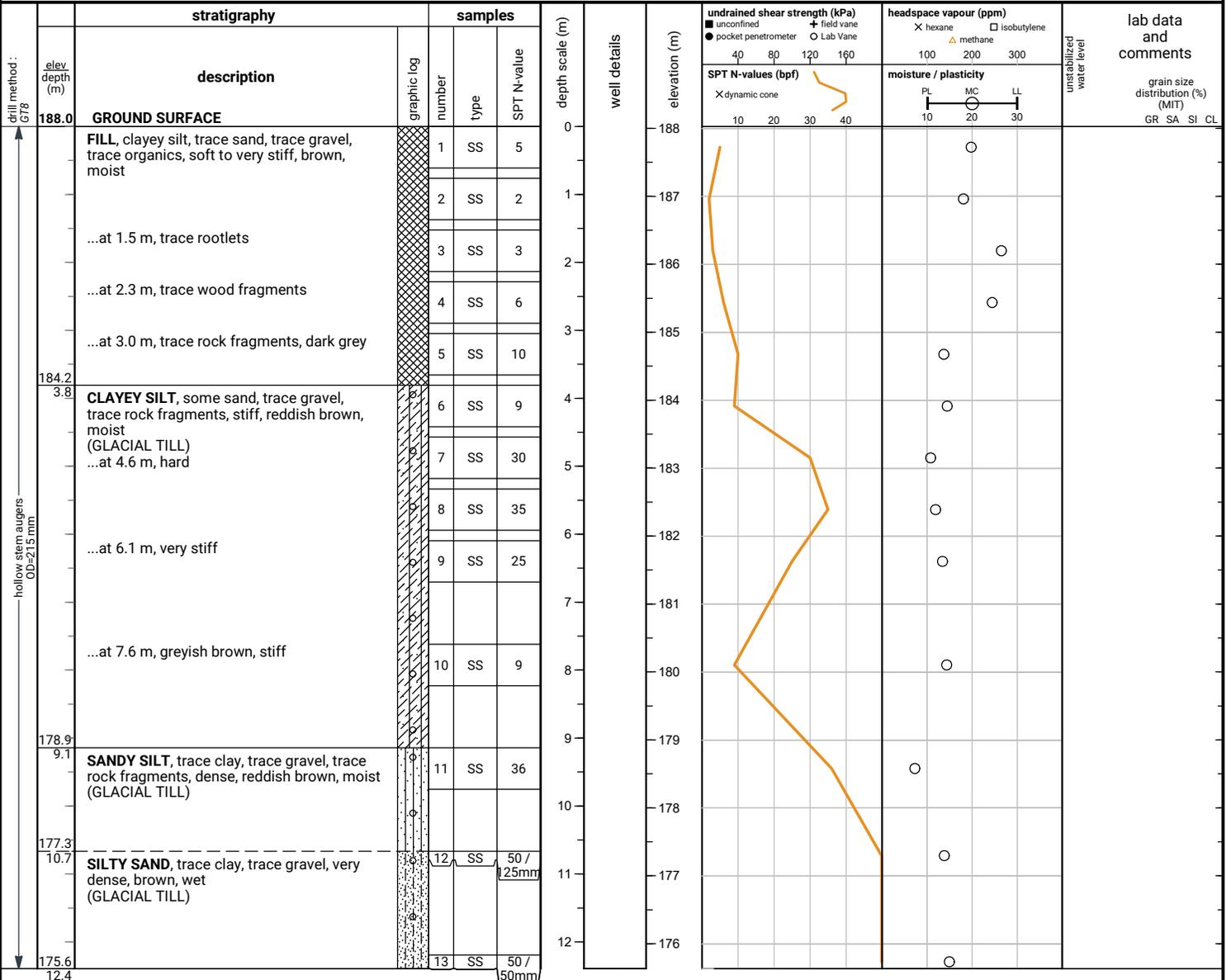
END OF BOREHOLE

Borehole was dry upon completion of drilling.

File No. : 20-294

Project : Britannia Rd and Bronte St S, Milton, ON

Client : Trinity Point



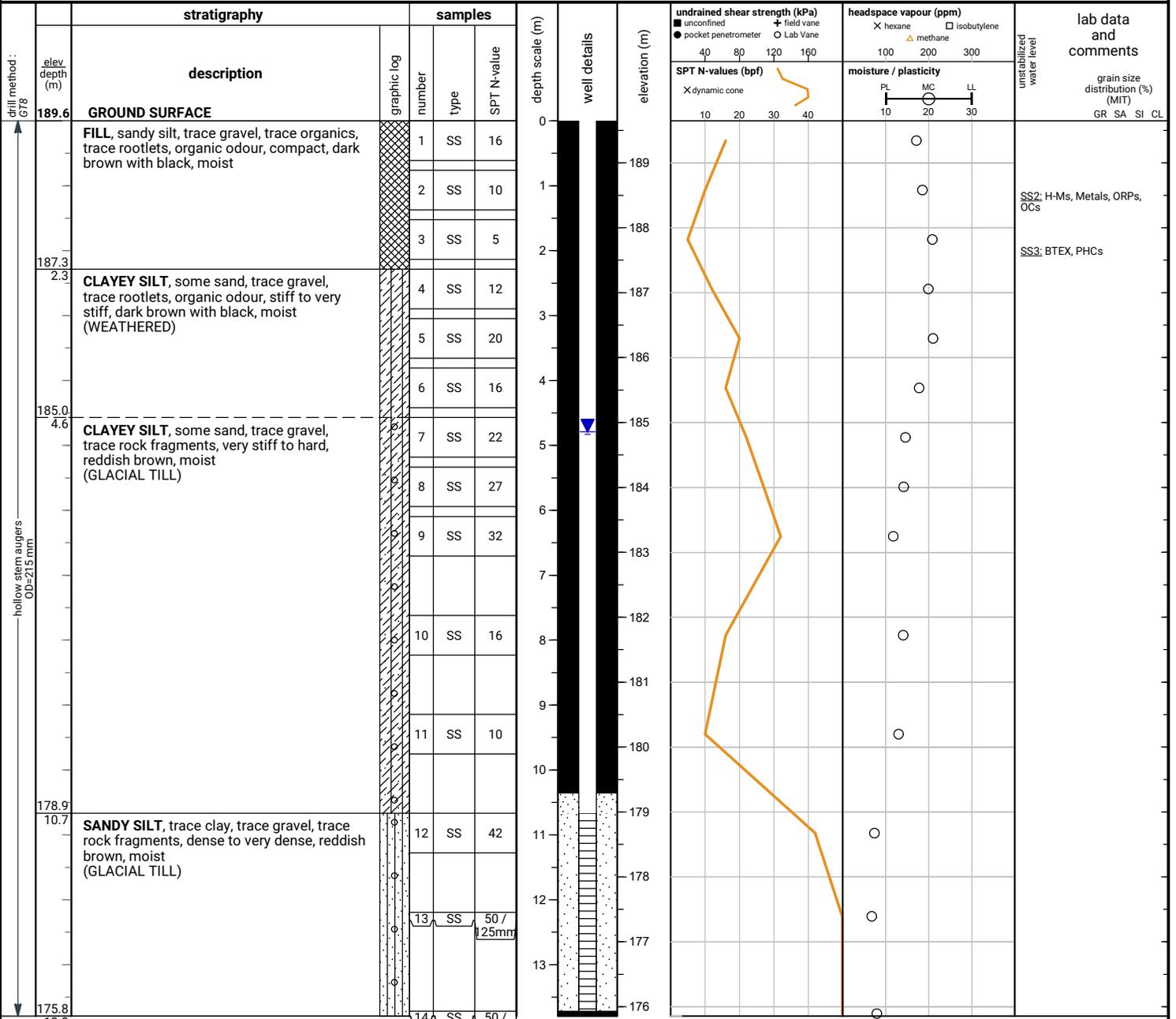
END OF BOREHOLE

Borehole was dry upon completion of drilling.

File No. : 20-294

Project : Britannia Rd and Bronte St S, Milton, ON

Client : Trinity Point



END OF BOREHOLE

Borehole was dry upon completion of drilling.

50 mm dia. monitoring well installed.

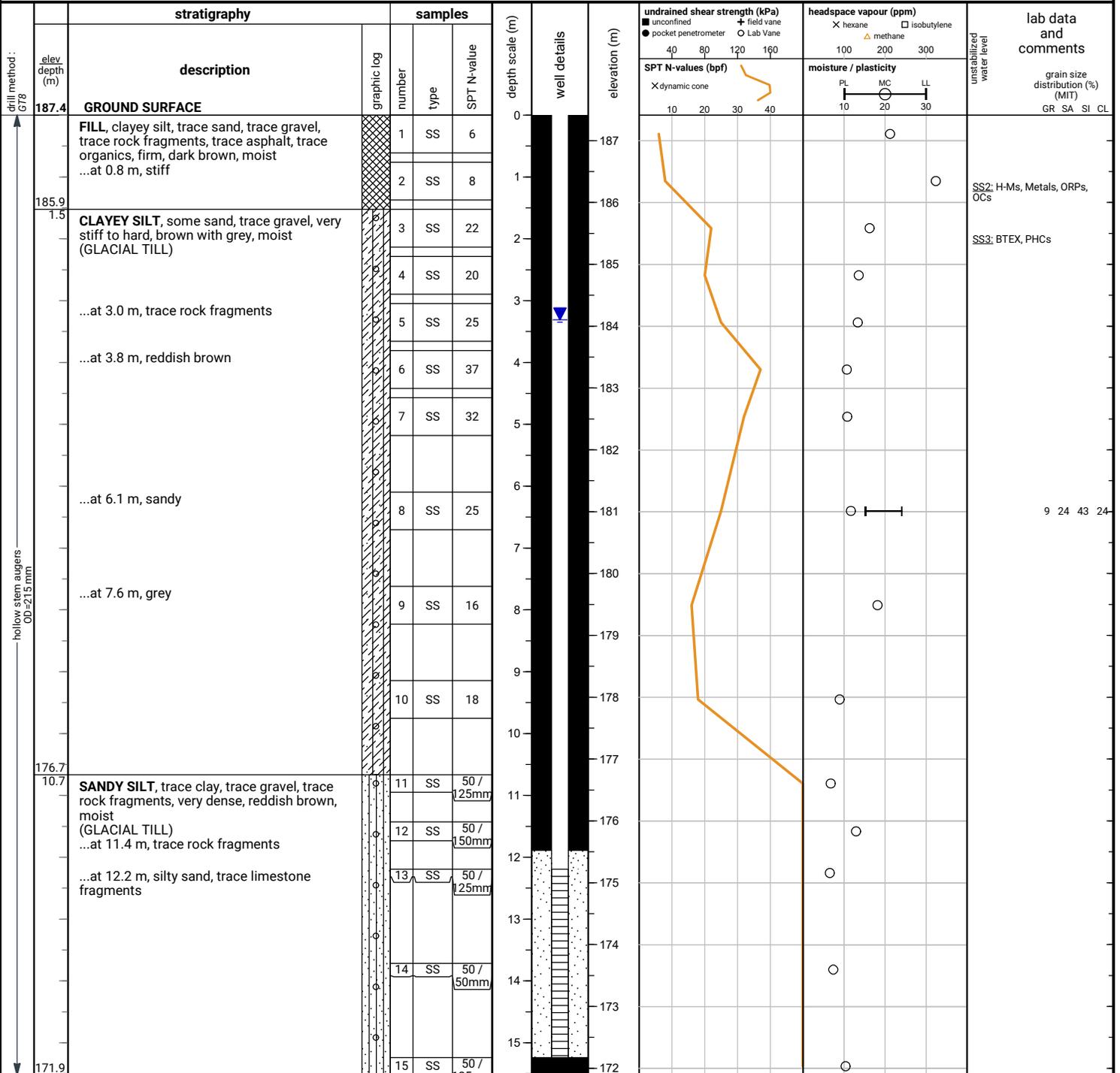
GROUNDWATER LEVELS

date	depth (m)	elevation (m)
Jan 12, 2021	4.4	185.2
Jan 29, 2021	5.4	184.2
Mar 2, 2021	5.5	184.1
Mar 28, 2021	5.5	184.1
Apr 18, 2021	5.4	184.2
Feb 16, 2024	5.4	184.2
Jan 20, 2025	4.8	184.8

File No. : 20-294

Project : Britannia Rd and Bronte St S, Milton, ON

Client : Trinity Point



END OF BOREHOLE

Borehole was dry upon completion of drilling.

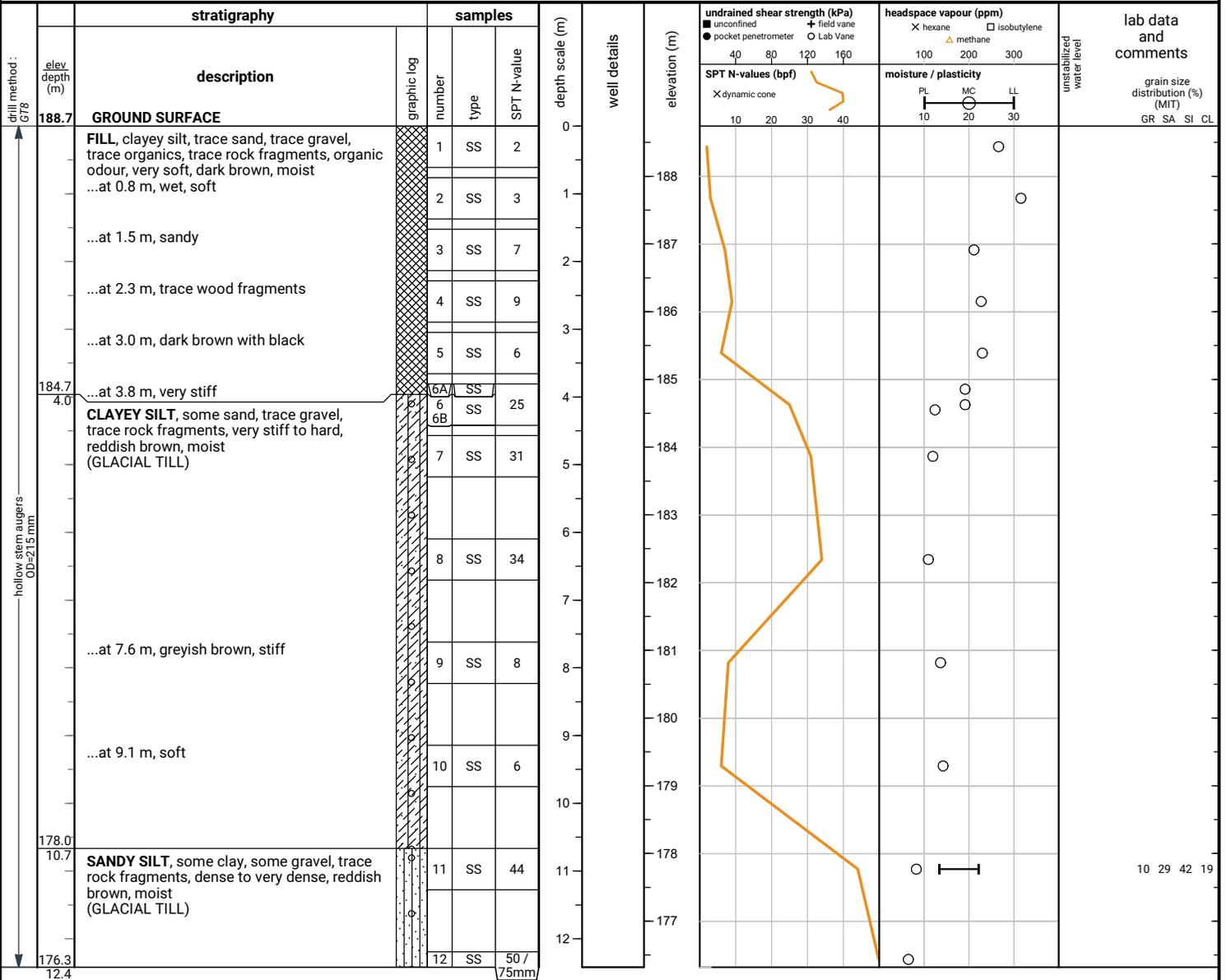
GROUNDWATER LEVELS

date	depth (m)	elevation (m)
Jan 12, 2021	3.4	184.0
Jan 29, 2021	3.5	183.9
Mar 2, 2021	3.6	183.8
Mar 28, 2021	3.6	183.8
Apr 18, 2021	3.5	183.9
Feb 16, 2024	3.3	184.1

File No. : 20-294

Project : Britannia Rd and Bronte St S, Milton, ON

Client : Trinity Point



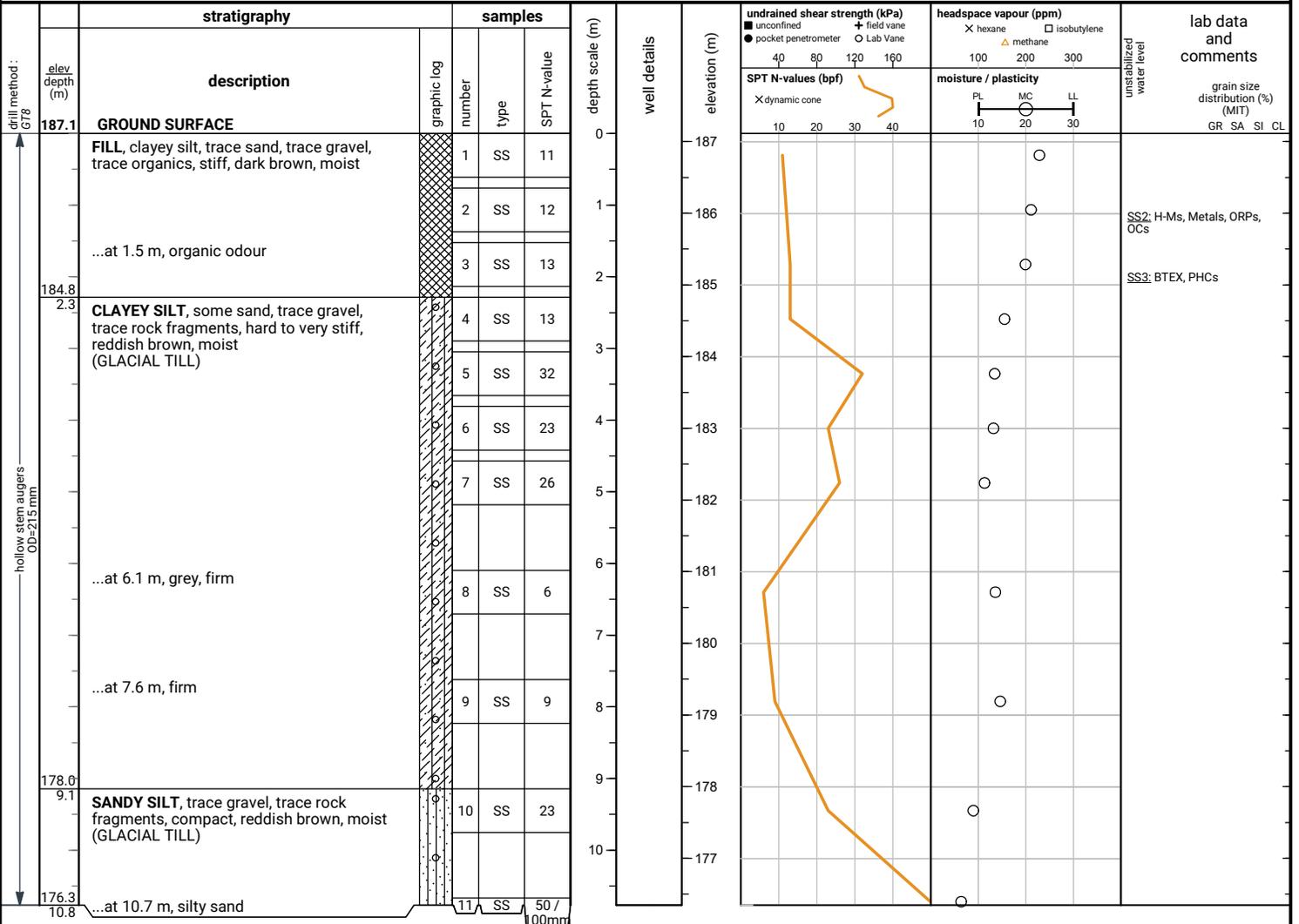
END OF BOREHOLE

Borehole was dry upon completion of drilling.

File No. : 20-294

Project : Britannia Rd and Bronte St S, Milton, ON

Client : Trinity Point



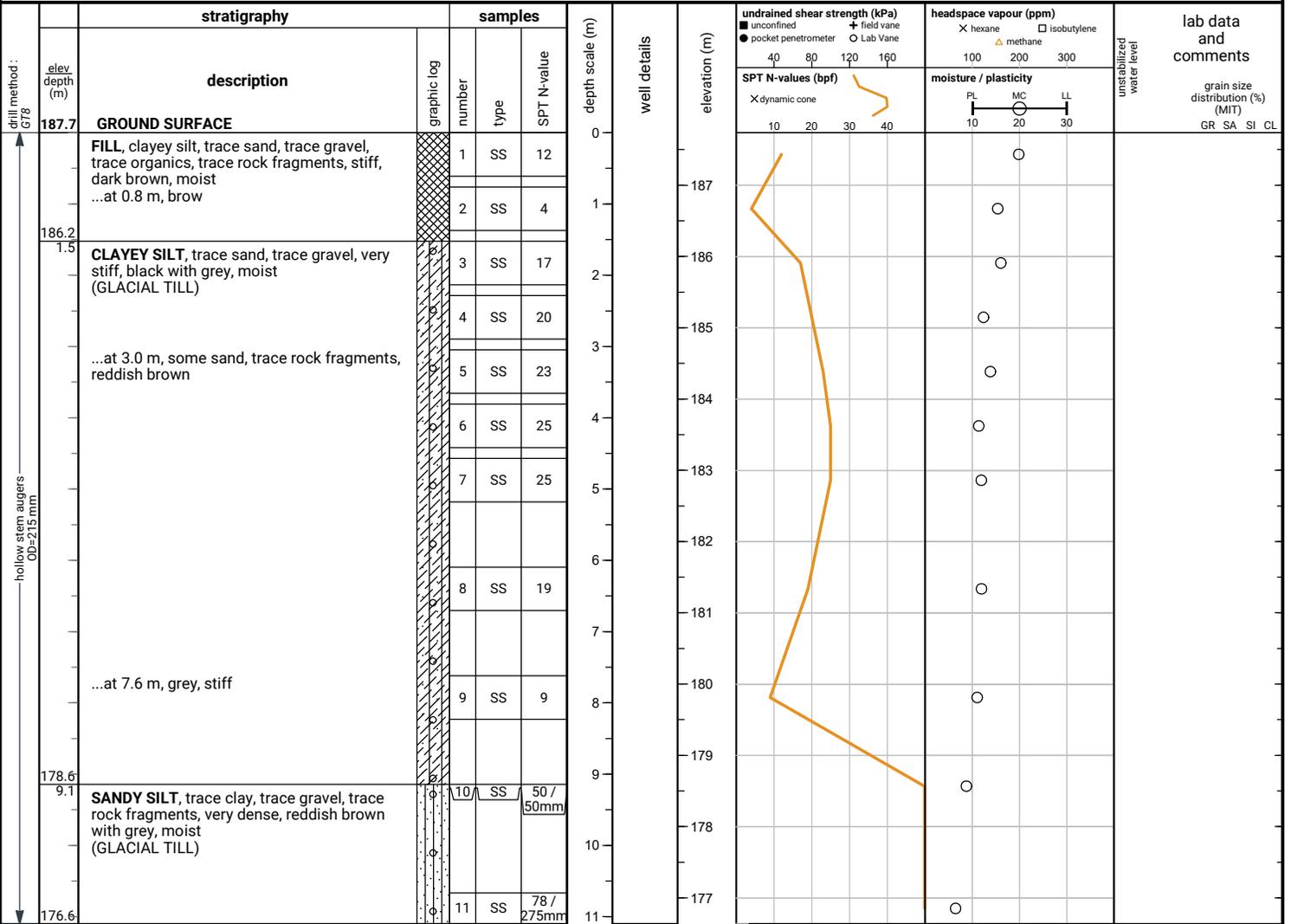
END OF BOREHOLE

Borehole was dry upon completion of drilling.

File No. : 20-294

Project : Britannia Rd and Bronte St S, Milton, ON

Client : Trinity Point



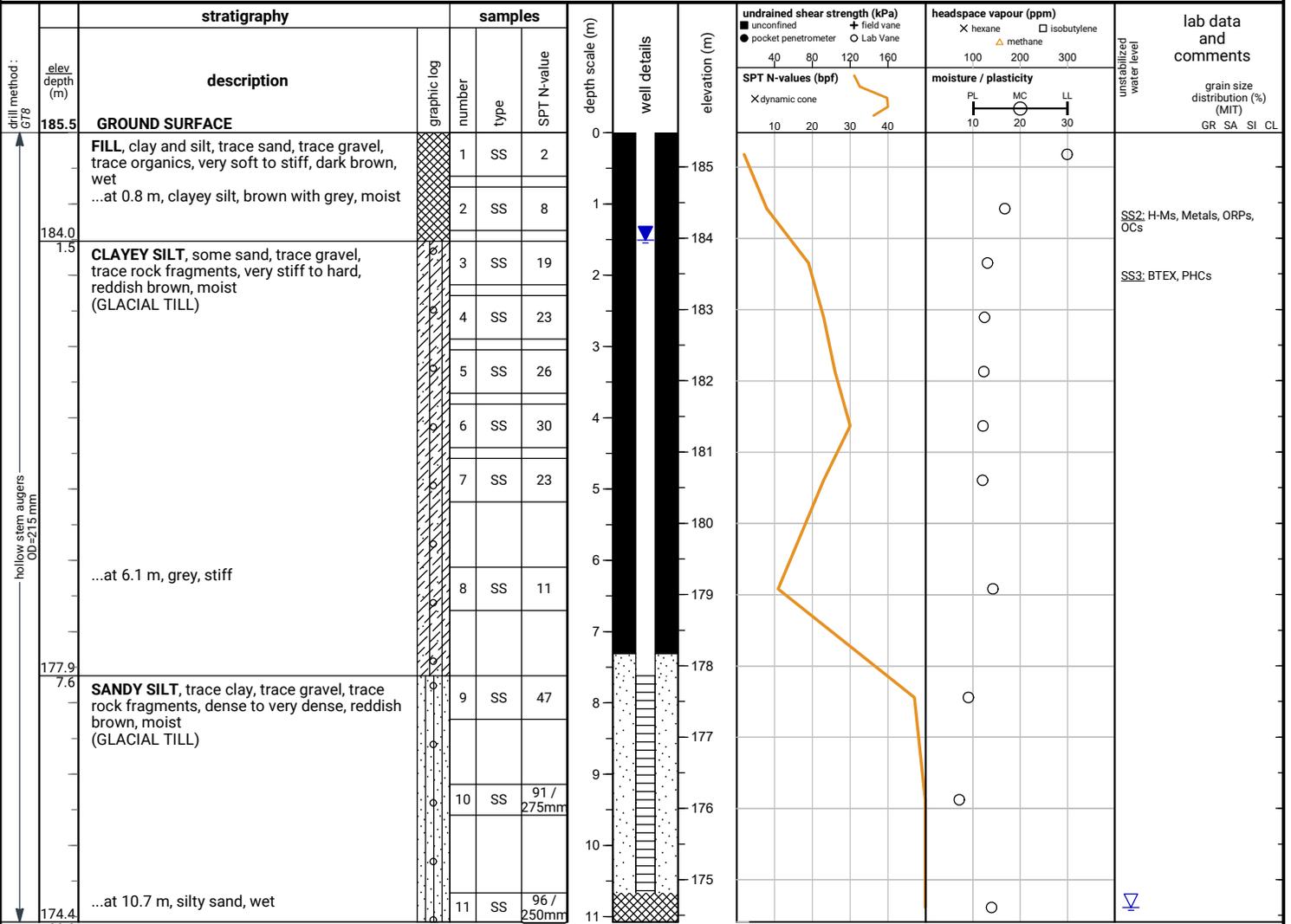
END OF BOREHOLE

Borehole was dry upon completion of drilling.

File No. : 20-294

Project : Britannia Rd and Bronte St S, Milton, ON

Client : Trinity Point



END OF BOREHOLE

Unstabilized water level measured at 10.9 m below ground surface upon completion of drilling.

50 mm dia. monitoring well installed.

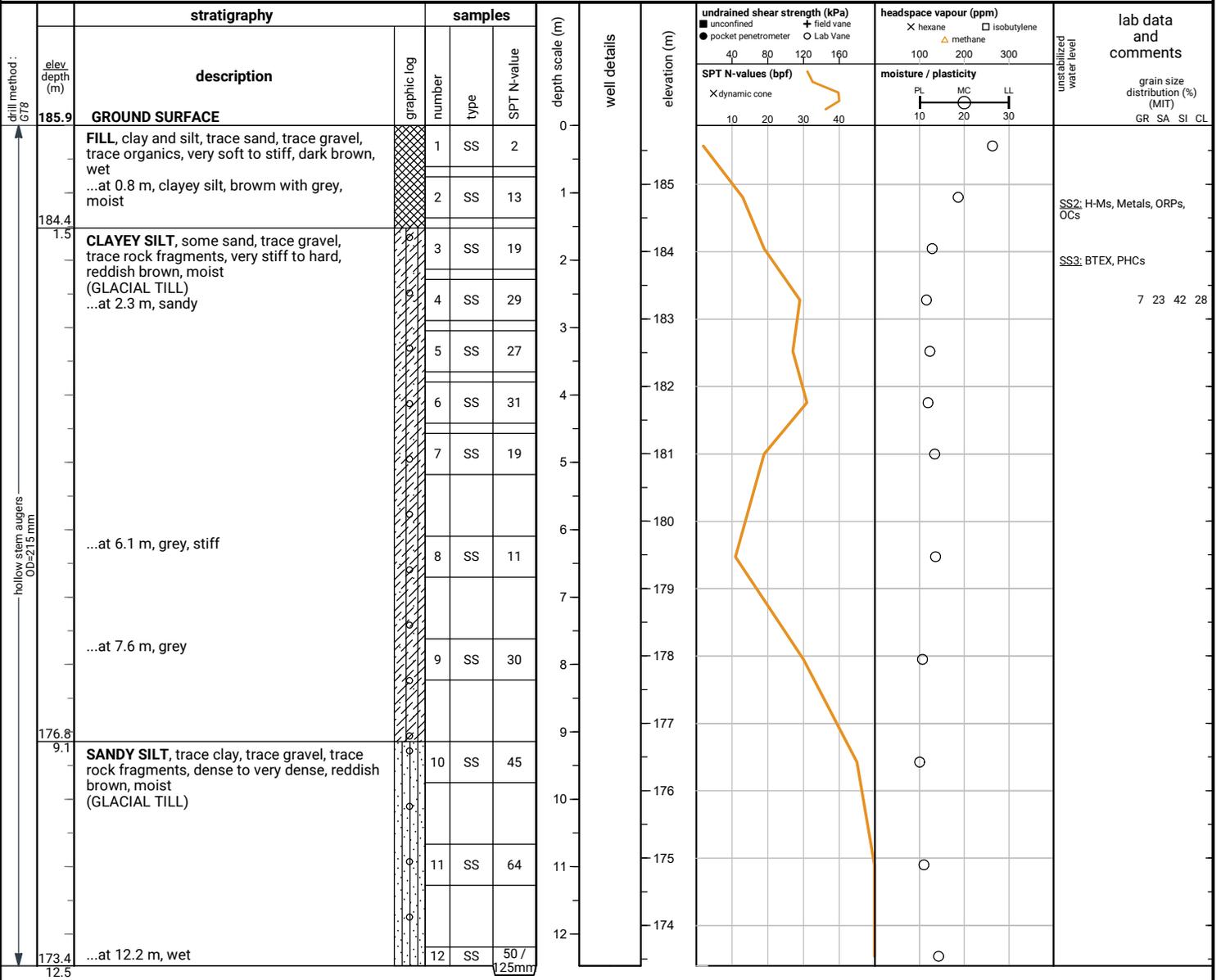
GROUNDWATER LEVELS

date	depth (m)	elevation (m)
Jan 12, 2021	1.8	183.7
Jan 29, 2021	1.6	183.9
Mar 2, 2021	1.7	183.8
Mar 28, 2021	1.6	183.9
Apr 18, 2021	1.6	183.9
Feb 16, 2024	1.5	184.0

File No. : 20-294

Project : Britannia Rd and Bronte St S, Milton, ON

Client : Trinity Point



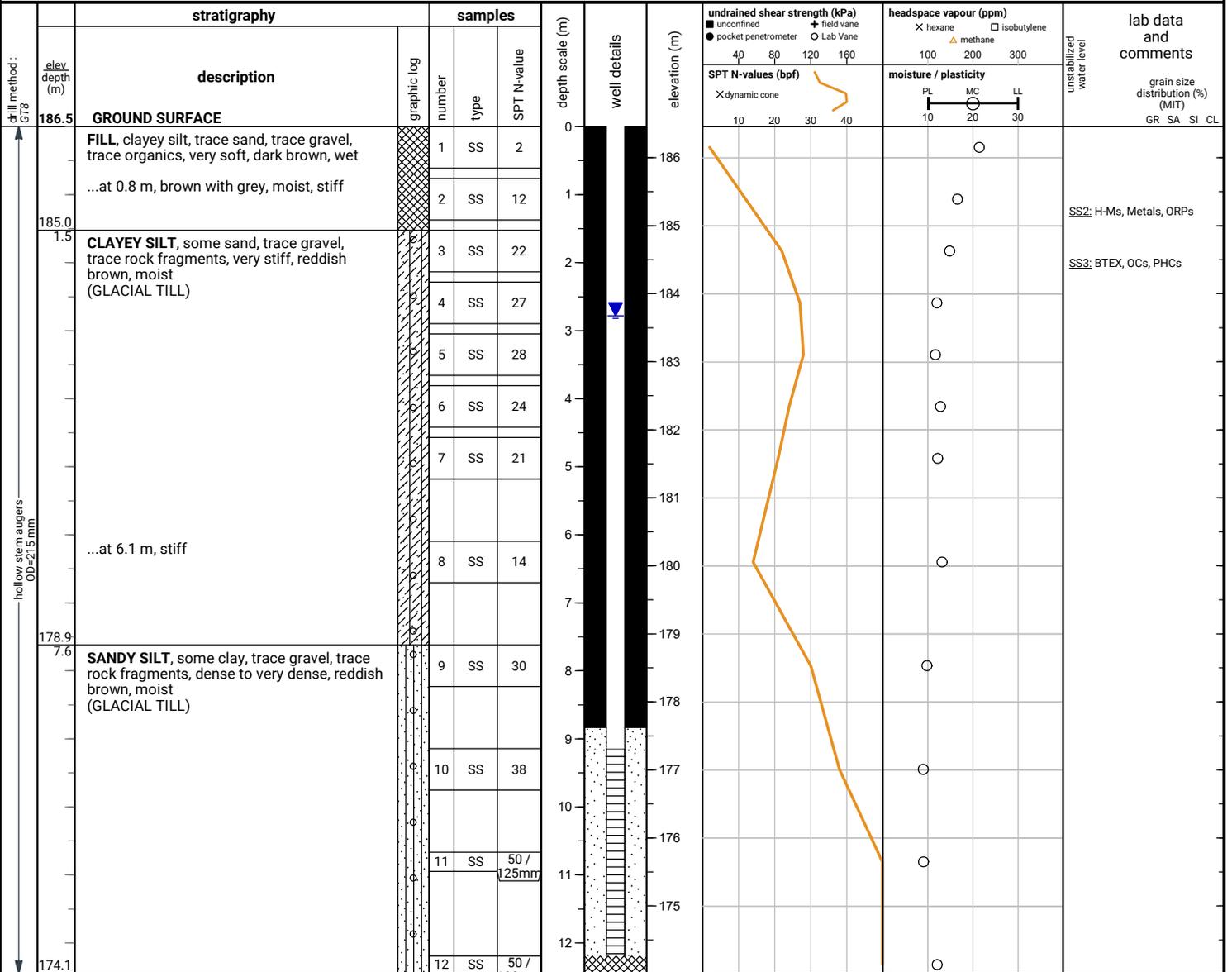
END OF BOREHOLE

Borehole was dry upon completion of drilling.

File No. : 20-294

Project : Britannia Rd and Bronte St S, Milton, ON

Client : Trinity Point



END OF BOREHOLE

Borehole was dry upon completion of drilling.

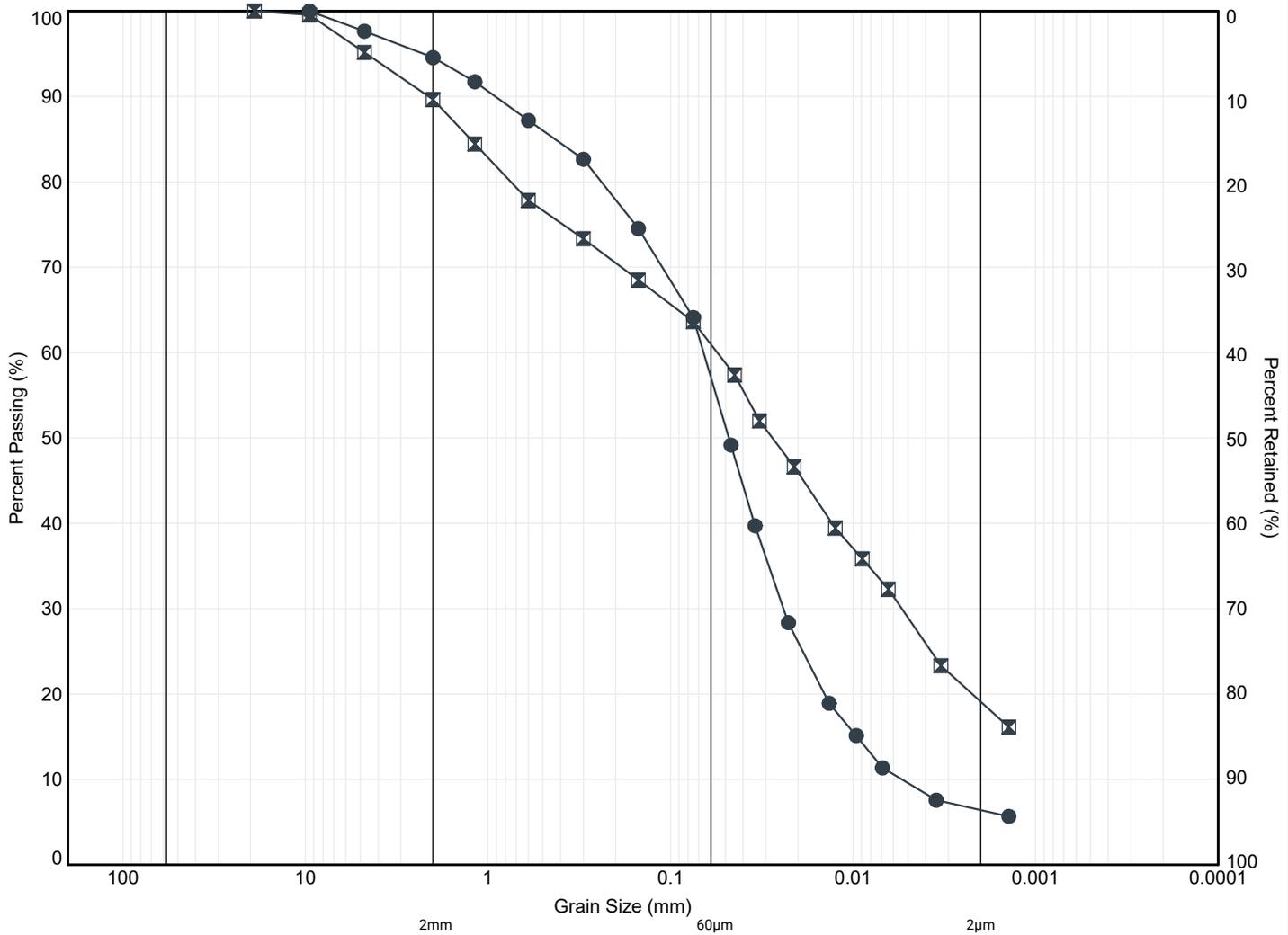
50 mm dia. monitoring well installed.

GROUNDWATER LEVELS

date	depth (m)	elevation (m)
Jan 12, 2021	7.6	178.9
Jan 29, 2021	2.6	183.9
Mar 2, 2021	2.7	183.8
Mar 28, 2021	2.6	183.9
Apr 18, 2021	2.6	183.9
Feb 16, 2024	2.4	184.1
Jan 20, 2025	2.4	184.1
Jul 21, 2025	2.8	183.7

APPENDIX B





MIT SYSTEM	COBBLES	GRAVEL			SAND			SILT	CLAY
		COARSE	MEDIUM	FINE	COARSE	MEDIUM	FINE		

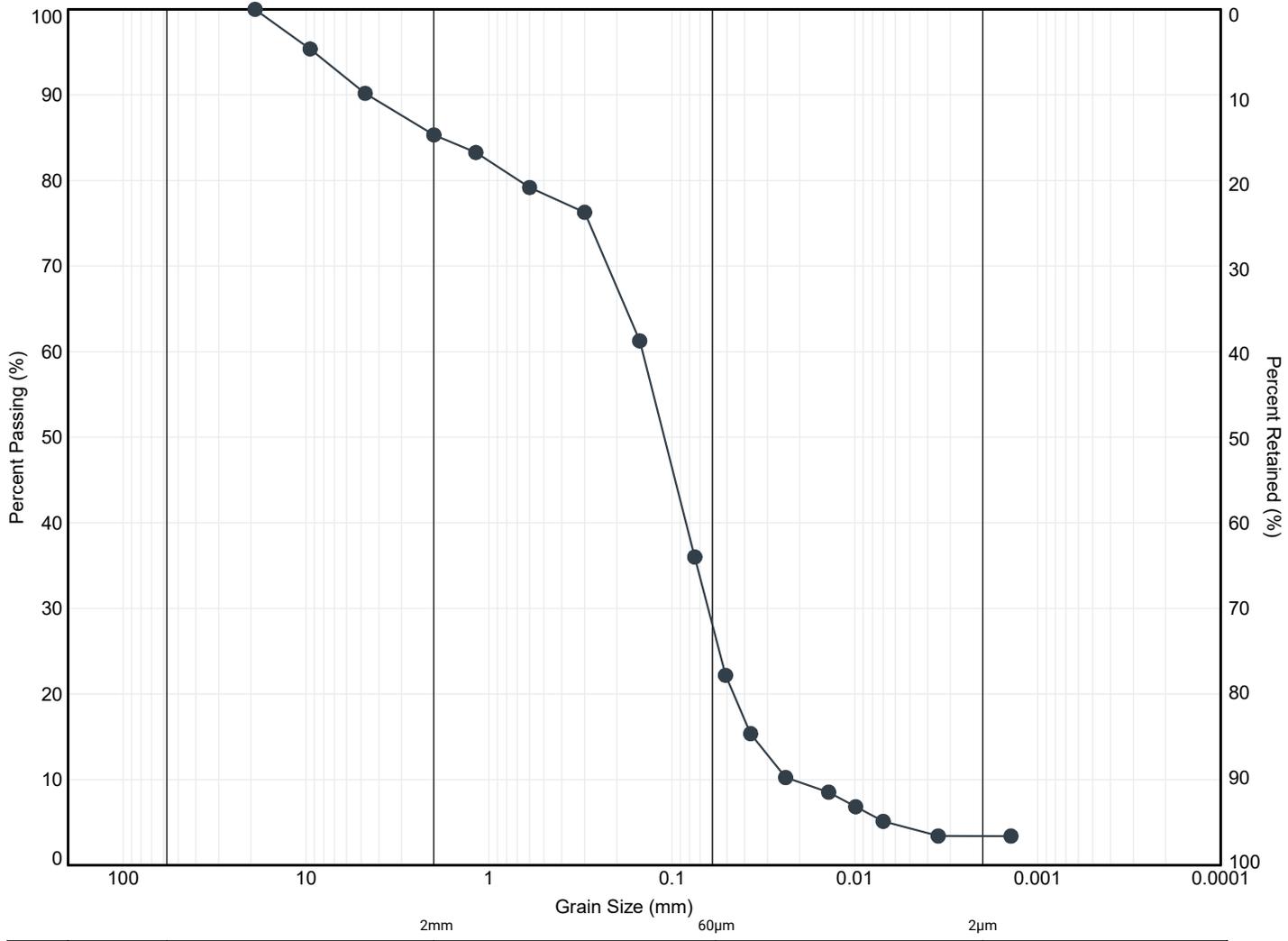
MIT SYSTEM

Borehole	Sample	Depth (m)	Elev. (m)	Gravel (%)	Sand (%)	Silt (%)	Clay (%)
● 101	SS11	10.7	177.3	5	38	51	6
☒ 109	SS11	11.0	177.8	10	29	42	19



Title: **GRAIN SIZE DISTRIBUTION SANDY SILT**

File No.: **20-294**



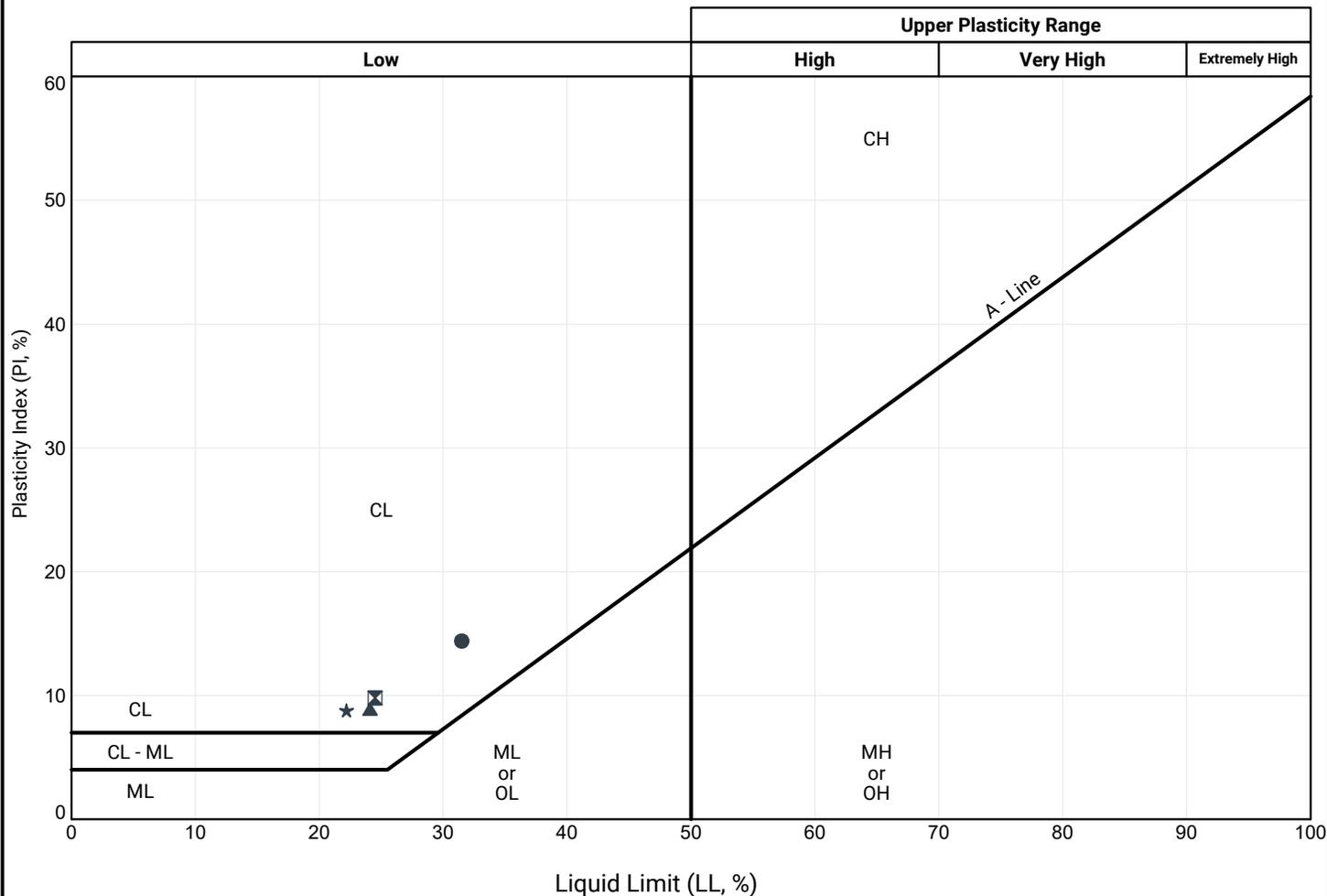
MIT SYSTEM	COBBLES	GRAVEL			SAND			SILT	CLAY
		COARSE	MEDIUM	FINE	COARSE	MEDIUM	FINE		

MIT SYSTEM								
Borehole	Sample	Depth (m)	Elev. (m)	Gravel (%)	Sand (%)	Silt (%)	Clay (%)	
● 104	SS13	12.5	176.5	15	57	25	3	



Title: **GRAIN SIZE DISTRIBUTION SILTY SAND**

File No.: **20-294**



Borehole	Sample	Depth (m)	Elev. (m)	LL (%)	PL (%)	PI (%)
● 101	SS6	4.1	183.9	32	17	15
⊠ 104	SS11	9.5	179.5	25	15	9
▲ 108	SS8	6.4	181.0	24	15	9
★ 109	SS11	11.0	177.8	22	13	9



APPENDIX C



CORROSIVITY (BVL)



BV Labs Job Number: C110991
Report Date: 2021/01/22

Grounded Engineering Inc.
Client Project #: 20-294
Site Location: BRITANNIA RD & BRONTE ST S, MILTON

Sampler Initials: KS

SOIL CORROSIVITY PACKAGE (SOIL)

Bureau Veritas ID			OPN366	OPN367	OPN368	OPN369	OPN370
Sampling Date			2021/01/08 14:00	2021/01/06 14:00	2021/01/05 16:00	2021/01/11 13:30	2021/01/08 14:00
COC Number			806784-04-01	806784-04-01	806784-04-01	806784-04-01	806784-04-01
	UNITS	RDL	BH101-SS5	BH109-SS7	BH111-SS5	BH112-SS6	BH113-SS6
Calculated Parameters							
Resistivity	ohm-cm		2400	1200	2900	1100	430
CONVENTIONALS							
Redox Potential	mV	N/A	218	226	208	211	205
Inorganics							
Soluble (20:1) Chloride (Cl-)	ug/g	20	51	<20	<20	52	23
Conductivity	umho/cm	2	411	847	342	935	2340
Available (CaCl2) pH	pH		7.1	7.72	7.6	7.75	7.7
Soluble (20:1) Sulphate (SO4)	ug/g	20	<20	750	200	880	3200
Sulphide	mg/kg	0.5	2.2 (1)	3.2 (1)	2.0 (1)	2.5 (2)	1.7 (1)
Physical Testing							
Moisture-Subcontracted	%	0.3	21	13	16	13	11

RDL = Reportable Detection Limit
N/A = Not Applicable

INTERPRETATION

AWWA C-105 Standard

% Moisture

pH

Is pH bet 6.5-7.5 ?

Is Redox Potential < 100 mv?

Are Sulphides present ?

If above three conditions are met, pH is assigned 3 points

pH - Score

Redox Potential

Resistivity

Acid Volatile Sulphides

	Points	Points	Points	Points	Points
% Moisture	1	2	2	2	2
Is pH bet 6.5-7.5 ?	YES	NO	NO	NO	NO
Is Redox Potential < 100 mv?	NO	NO	NO	NO	NO
Are Sulphides present ?	NO	NO	NO	NO	NO
pH - Score	0	0	0	0	0
Redox Potential	0	0	0	0	0
Resistivity	2	10	1	10	10
Acid Volatile Sulphides	0	0	0	0	0
TOTAL SCORE (AWWA C-105)	3	12	3	12	12

Sample

Corrosion Protection Recommended?

Anions and Nutrients (Soil)

Sulphate

CLASS OF EXPOSURE

	BH101-SS5	BH109-SS7	BH111-SS5	BH112-SS6	BH113-SS6
Corrosion Protection Recommended?	No	YES	No	YES	YES
Sulphate %	Not Detected	0.08%	0.02%	0.09%	0.32%
CLASS OF EXPOSURE	Negligible	Negligible	Negligible	Negligible	Severe (S-2)



Your Project #: 20-294
 Your C.O.C. #: 806784-04-02, 806784-04-01

Attention: Matthew Garcia

Grounded Engineering Inc.
 12 Banigan Drive
 Toronto, ON
 CANADA M4H 1E9

Report Date: 2021/01/22
 Report #: R6490447
 Version: 1 - Final

CERTIFICATE OF ANALYSIS

BV LABS JOB #: C110991

Received: 2021/01/14, 14:35

Sample Matrix: Soil
 # Samples Received: 5

Analyses	Quantity	Date	Date	Laboratory Method	Analytical Method
		Extracted	Analyzed		
Chloride (20:1 extract)	5	2021/01/18	2021/01/19	CAM SOP-00463	SM 23 4500-CI E m
Conductivity	5	2021/01/18	2021/01/18	CAM SOP-00414	OMOE E3530 v1 m
Moisture (Subcontracted) (1, 3)	5	N/A	2021/01/19	AB SOP-00002	CCME PHC-CWS m
Sulphide in Soil (1)	5	N/A	2021/01/20	AB SOP-00080	EPA9030B/SM4500S2-DF
pH CaCl2 EXTRACT	5	2021/01/18	2021/01/18	CAM SOP-00413	EPA 9045 D m
Resistivity of Soil	5	2021/01/14	2021/01/18	CAM SOP-00414	SM 23 2510 m
Sulphate (20:1 Extract)	5	2021/01/18	2021/01/19	CAM SOP-00464	EPA 375.4 m
Redox Potential (2, 4)	5	N/A	N/A		

Remarks:

Bureau Veritas Laboratories are accredited to ISO/IEC 17025 for specific parameters on scopes of accreditation. Unless otherwise noted, procedures used by BV Labs are based upon recognized Provincial, Federal or US method compendia such as CCME, MELCC, EPA, APHA.

All work recorded herein has been done in accordance with procedures and practices ordinarily exercised by professionals in BV Labs profession using accepted testing methodologies, quality assurance and quality control procedures (except where otherwise agreed by the client and BV Labs in writing). All data is in statistical control and has met quality control and method performance criteria unless otherwise noted. All method blanks are reported; unless indicated otherwise, associated sample data are not blank corrected. Where applicable, unless otherwise noted, Measurement Uncertainty has not been accounted for when stating conformity to the referenced standard.

BV Labs liability is limited to the actual cost of the requested analyses, unless otherwise agreed in writing. There is no other warranty expressed or implied. BV Labs has been retained to provide analysis of samples provided by the Client using the testing methodology referenced in this report. Interpretation and use of test results are the sole responsibility of the Client and are not within the scope of services provided by BV Labs, unless otherwise agreed in writing. BV Labs is not responsible for the accuracy or any data impacts, that result from the information provided by the customer or their agent.

Solid sample results, except biota, are based on dry weight unless otherwise indicated. Organic analyses are not recovery corrected except for isotope dilution methods.

Results relate to samples tested. When sampling is not conducted by BV Labs, results relate to the supplied samples tested.

This Certificate shall not be reproduced except in full, without the written approval of the laboratory.

Reference Method suffix "m" indicates test methods incorporate validated modifications from specific reference methods to improve performance.

* RPDs calculated using raw data. The rounding of final results may result in the apparent difference.

- (1) This test was performed by BVLabs Calgary via Mississauga
- (2) This test was performed by Sub from Campo to Env. Testing Canada (Eurofins)
- (3) Offsite analysis requires that subcontracted moisture be reported.
- (4) Oxidation-Reduction Potential (ORP) values are determined using a Ag/AgCl reference electrode.



Your Project #: 20-294
Your C.O.C. #: 806784-04-02, 806784-04-01

Attention: Matthew Garcia

Grounded Engineering Inc.
12 Banigan Drive
Toronto, ON
CANADA M4H 1E9

Report Date: 2021/01/22
Report #: R6490447
Version: 1 - Final

CERTIFICATE OF ANALYSIS

BV LABS JOB #: C110991

Received: 2021/01/14, 14:35

Encryption Key

Marijane Cruz
Senior Project Manager
22 Jan 2021 17:11:57

Please direct all questions regarding this Certificate of Analysis to your Project Manager.
Marijane Cruz, Senior Project Manager
Email: Marijane.Cruz@bureauveritas.com
Phone# (905)817-5756

=====
BV Labs has procedures in place to guard against improper use of the electronic signature and have the required "signatories", as per ISO/IEC 17025, signing the reports. For Service Group specific validation please refer to the Validation Signature Page.



SOIL CORROSIVITY PACKAGE (SOIL)

BV Labs ID		OPN366			OPN366			OPN367		
Sampling Date		2021/01/08 14:00			2021/01/08 14:00			2021/01/06 14:00		
COC Number		806784-04-01			806784-04-01			806784-04-01		
	UNITS	BH101-SS5	RDL	QC Batch	BH101-SS5 Lab-Dup	RDL	QC Batch	BH109-SS7	RDL	QC Batch
Calculated Parameters										
Resistivity	ohm-cm	2400		7150396				1200		7150396
Inorganics										
Soluble (20:1) Chloride (Cl-)	ug/g	51	20	7155233				<20	20	7155233
Conductivity	umho/cm	411	2	7154919				847	2	7154919
Available (CaCl2) pH	pH	7.10		7154956				7.72		7154956
Soluble (20:1) Sulphate (SO4)	ug/g	<20	20	7155208				780	40	7155208
Sulphide	mg/kg	2.2 (1)	0.5	7162050	1.5	0.5	7162050	3.2 (1)	0.5	7162050
Physical Testing										
Moisture-Subcontracted	%	21	0.30	7158093				13	0.30	7158093
<p>RDL = Reportable Detection Limit QC Batch = Quality Control Batch Lab-Dup = Laboratory Initiated Duplicate (1) Sample contained greater than 10% headspace at time of extraction. Sample extracted past method-specified hold time. Analyzed past method specified hold time</p>										



BUREAU
VERITAS

BV Labs Job #: C110991
Report Date: 2021/01/22

Grounded Engineering Inc.
Client Project #: 20-294
Sampler Initials: KS

SOIL CORROSIVITY PACKAGE (SOIL)

BV Labs ID		OPN368		OPN369		OPN369			
Sampling Date		2021/01/05 16:00		2021/01/11 13:30		2021/01/11 13:30			
COC Number		806784-04-01		806784-04-01		806784-04-01			
	UNITS	BH111-SS5	RDL	BH112-SS6	RDL	QC Batch	BH112-SS6 Lab-Dup	RDL	QC Batch
Calculated Parameters									
Resistivity	ohm-cm	2900		1100		7150396			
Inorganics									
Soluble (20:1) Chloride (Cl-)	ug/g	<20	20	52	20	7155233			
Conductivity	umho/cm	342	2	935	2	7154919	953	2	7154919
Available (CaCl2) pH	pH	7.60		7.75		7154956			
Soluble (20:1) Sulphate (SO4)	ug/g	200	20	880	40	7155208			
Sulphide	mg/kg	2.0 (1)	0.5	2.5 (2)	0.5	7162050			
Physical Testing									
Moisture-Subcontracted	%	16	0.30	13	0.30	7158093			
RDL = Reportable Detection Limit QC Batch = Quality Control Batch Lab-Dup = Laboratory Initiated Duplicate (1) Sample contained greater than 10% headspace at time of extraction. Sample extracted past method-specified hold time. Analyzed past method specified hold time (2) Sample contained greater than 10% headspace at time of extraction.									



SOIL CORROSIVITY PACKAGE (SOIL)

BV Labs ID		OPN370		
Sampling Date		2021/01/08 14:00		
COC Number		806784-04-01		
	UNITS	BH113-SS6	RDL	QC Batch
Calculated Parameters				
Resistivity	ohm-cm	430		7150396
Inorganics				
Soluble (20:1) Chloride (Cl-)	ug/g	23	20	7155233
Conductivity	umho/cm	2340	2	7154919
Available (CaCl2) pH	pH	7.70		7154956
Soluble (20:1) Sulphate (SO4)	ug/g	3200	200	7155208
Sulphide	mg/kg	1.7 (1)	0.5	7162050
Physical Testing				
Moisture-Subcontracted	%	11	0.30	7158093
RDL = Reportable Detection Limit QC Batch = Quality Control Batch (1) Sample contained greater than 10% headspace at time of extraction. Sample extracted past method-specified hold time. Analyzed past method specified hold time				



BUREAU
VERITAS

BV Labs Job #: C110991
Report Date: 2021/01/22

Grounded Engineering Inc.
Client Project #: 20-294
Sampler Initials: KS

TEST SUMMARY

BV Labs ID: OPN366
Sample ID: BH101-SS5
Matrix: Soil

Collected: 2021/01/08
Shipped:
Received: 2021/01/14

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (20:1 extract)	KONE/EC	7155233	2021/01/18	2021/01/19	Deonarine Ramnarine
Conductivity	AT	7154919	2021/01/18	2021/01/18	Tarunpreet Kaur
Moisture (Subcontracted)	BAL	7158093	N/A	2021/01/19	Sneha Bashyal
Sulphide in Soil	SPEC	7162050	N/A	2021/01/20	Marjolen Busslinger
pH CaCl2 EXTRACT	AT	7154956	2021/01/18	2021/01/18	Neil Dassanayake
Resistivity of Soil		7150396	2021/01/18	2021/01/18	Automated Statchk
Sulphate (20:1 Extract)	KONE/EC	7155208	2021/01/18	2021/01/19	Deonarine Ramnarine
Redox Potential	COND	7164624	2021/01/22		Marijane Cruz

BV Labs ID: OPN366 Dup
Sample ID: BH101-SS5
Matrix: Soil

Collected: 2021/01/08
Shipped:
Received: 2021/01/14

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Sulphide in Soil	SPEC	7162050	N/A	2021/01/20	Marjolen Busslinger

BV Labs ID: OPN367
Sample ID: BH109-SS7
Matrix: Soil

Collected: 2021/01/06
Shipped:
Received: 2021/01/14

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (20:1 extract)	KONE/EC	7155233	2021/01/18	2021/01/19	Deonarine Ramnarine
Conductivity	AT	7154919	2021/01/18	2021/01/18	Tarunpreet Kaur
Moisture (Subcontracted)	BAL	7158093	N/A	2021/01/19	Sneha Bashyal
Sulphide in Soil	SPEC	7162050	N/A	2021/01/20	Marjolen Busslinger
pH CaCl2 EXTRACT	AT	7154956	2021/01/18	2021/01/18	Neil Dassanayake
Resistivity of Soil		7150396	2021/01/18	2021/01/18	Automated Statchk
Sulphate (20:1 Extract)	KONE/EC	7155208	2021/01/18	2021/01/19	Deonarine Ramnarine
Redox Potential	COND	7164624	2021/01/22		Marijane Cruz

BV Labs ID: OPN368
Sample ID: BH111-SS5
Matrix: Soil

Collected: 2021/01/05
Shipped:
Received: 2021/01/14

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (20:1 extract)	KONE/EC	7155233	2021/01/18	2021/01/19	Deonarine Ramnarine
Conductivity	AT	7154919	2021/01/18	2021/01/18	Tarunpreet Kaur
Moisture (Subcontracted)	BAL	7158093	N/A	2021/01/19	Sneha Bashyal
Sulphide in Soil	SPEC	7162050	N/A	2021/01/20	Marjolen Busslinger
pH CaCl2 EXTRACT	AT	7154956	2021/01/18	2021/01/18	Neil Dassanayake
Resistivity of Soil		7150396	2021/01/18	2021/01/18	Automated Statchk
Sulphate (20:1 Extract)	KONE/EC	7155208	2021/01/18	2021/01/19	Deonarine Ramnarine
Redox Potential	COND	7164624	2021/01/22		Marijane Cruz



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BV Labs Job #: C110991
Report Date: 2021/01/22

Grounded Engineering Inc.
Client Project #: 20-294
Sampler Initials: KS

TEST SUMMARY

BV Labs ID: OPN369
Sample ID: BH112-SS6
Matrix: Soil

Collected: 2021/01/11
Shipped:
Received: 2021/01/14

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (20:1 extract)	KONE/EC	7155233	2021/01/18	2021/01/19	Deonarine Ramnarine
Conductivity	AT	7154919	2021/01/18	2021/01/18	Tarunpreet Kaur
Moisture (Subcontracted)	BAL	7158093	N/A	2021/01/19	Sneha Bashyal
Sulphide in Soil	SPEC	7162050	N/A	2021/01/20	Marjolen Busslinger
pH CaCl2 EXTRACT	AT	7154956	2021/01/18	2021/01/18	Neil Dassanayake
Resistivity of Soil		7150396	2021/01/18	2021/01/18	Automated Statchk
Sulphate (20:1 Extract)	KONE/EC	7155208	2021/01/18	2021/01/19	Deonarine Ramnarine
Redox Potential	COND	7164624	2021/01/22		Marijane Cruz

BV Labs ID: OPN369 Dup
Sample ID: BH112-SS6
Matrix: Soil

Collected: 2021/01/11
Shipped:
Received: 2021/01/14

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Conductivity	AT	7154919	2021/01/18	2021/01/18	Tarunpreet Kaur

BV Labs ID: OPN370
Sample ID: BH113-SS6
Matrix: Soil

Collected: 2021/01/08
Shipped:
Received: 2021/01/14

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (20:1 extract)	KONE/EC	7155233	2021/01/18	2021/01/19	Deonarine Ramnarine
Conductivity	AT	7154919	2021/01/18	2021/01/18	Tarunpreet Kaur
Moisture (Subcontracted)	BAL	7158093	N/A	2021/01/19	Sneha Bashyal
Sulphide in Soil	SPEC	7162050	N/A	2021/01/20	Marjolen Busslinger
pH CaCl2 EXTRACT	AT	7154956	2021/01/18	2021/01/18	Neil Dassanayake
Resistivity of Soil		7150396	2021/01/18	2021/01/18	Automated Statchk
Sulphate (20:1 Extract)	KONE/EC	7155208	2021/01/18	2021/01/19	Deonarine Ramnarine
Redox Potential	COND	7164624	2021/01/22		Marijane Cruz



BUREAU
VERITAS

BV Labs Job #: C110991
Report Date: 2021/01/22

Grounded Engineering Inc.
Client Project #: 20-294
Sampler Initials: KS

GENERAL COMMENTS

Results relate only to the items tested.



BUREAU
VERITAS

BV Labs Job #: C110991
Report Date: 2021/01/22

QUALITY ASSURANCE REPORT

Grounded Engineering Inc.
Client Project #: 20-294
Sampler Initials: KS

QC Batch	Parameter	Date	Matrix Spike		SPIKED BLANK		Method Blank		RPD	
			% Recovery	QC Limits	% Recovery	QC Limits	Value	UNITS	Value (%)	QC Limits
7154919	Conductivity	2021/01/18			102	90 - 110	<2	umho/cm	2.0	10
7154956	Available (CaCl2) pH	2021/01/18			100	97 - 103			0.056	N/A
7155208	Soluble (20:1) Sulphate (SO4)	2021/01/19	NC	70 - 130	104	70 - 130	<20	ug/g	5.5	35
7155233	Soluble (20:1) Chloride (Cl-)	2021/01/19	NC	70 - 130	106	70 - 130	<20	ug/g	6.1	35
7158093	Moisture-Subcontracted	2021/01/19					<0.30	%		
7162050	Sulphide	2021/01/20							NC	30

N/A = Not Applicable

Duplicate: Paired analysis of a separate portion of the same sample. Used to evaluate the variance in the measurement.

Matrix Spike: A sample to which a known amount of the analyte of interest has been added. Used to evaluate sample matrix interference.

Spiked Blank: A blank matrix sample to which a known amount of the analyte, usually from a second source, has been added. Used to evaluate method accuracy.

Method Blank: A blank matrix containing all reagents used in the analytical procedure. Used to identify laboratory contamination.

NC (Matrix Spike): The recovery in the matrix spike was not calculated. The relative difference between the concentration in the parent sample and the spike amount was too small to permit a reliable recovery calculation (matrix spike concentration was less than the native sample concentration)

NC (Duplicate RPD): The duplicate RPD was not calculated. The concentration in the sample and/or duplicate was too low to permit a reliable RPD calculation (absolute difference <= 2x RDL).



BUREAU
VERITAS

BV Labs Job #: C110991
Report Date: 2021/01/22

Grounded Engineering Inc.
Client Project #: 20-294
Sampler Initials: KS

VALIDATION SIGNATURE PAGE

The analytical data and all QC contained in this report were reviewed and validated by the following individual(s).

Harry (Peng) Liang, Senior Analyst

Veronica Falk, B.Sc., P.Chem., QP, Scientific Specialist, Organics

Ewa Pranjic, M.Sc., C.Chem, Scientific Specialist

Marijane Cruz, Senior Project Manager

BV Labs has procedures in place to guard against improper use of the electronic signature and have the required "signatories", as per ISO/IEC 17025, signing the reports. For Service Group specific validation please refer to the Validation Signature Page.



Bureau Veritas Laboratories
6740 Campobello Road, Mississauga, Ontario Canada L5N 2L8 Tel: (905) 817-5700 Toll-free 800-563-6266 Fax: (905) 817-5777 www.bvlabs.com

14-Jan-21 14:35

Marijane Cruz

C110991

KSE ENV-883
COC #:



C#805784-04-01

ly:
Bottle Order #:
805784
Project Manager:
Marijane Cruz

INVOICE TO:
Company Name: #36876 Grounded Engineering Inc.
Attention: Jeremy Bobro, Matthew Garcia
Address: 12 Banigan Drive
Toronto ON M4H 1E9
Tel: (647) 264-7953 Fax: 7950
Email: jbobro@groundedeng.ca

REPORT TO:
Company Name: Grounded Engineering
Attention: Jeremy Bobro, Matthew Garcia
Address: 12 Banigan Dr.
Toronto ON M4H 1E9
Tel: (647) 264-7953 Fax: 7950
Email: jbobro@groundedeng.ca

PROJECT INFORMATION:
Quotation #: C04975
P.O. #:
Project: 20-287 20-294
Project Name:
Site #:
Sampled By:

MOE REGULATED DRINKING WATER OR WATER INTENDED FOR HUMAN CONSUMPTION MUST BE SUBMITTED ON THE BV LABS DRINKING WATER CHAIN OF CUSTODY

Regulation 153 (2011)	Other Regulations	Special Instructions
<input type="checkbox"/> Table 1 <input type="checkbox"/> Res/Park <input type="checkbox"/> Medium/Fine <input type="checkbox"/> Table 2 <input type="checkbox"/> Ind/Comm <input type="checkbox"/> Coarse <input type="checkbox"/> Table 3 <input type="checkbox"/> Agri/Other <input type="checkbox"/> For RSC <input type="checkbox"/> Table _____	<input type="checkbox"/> CCME <input type="checkbox"/> Sanitary Sewer Bylaw <input type="checkbox"/> Reg 558 <input type="checkbox"/> Storm Sewer Bylaw <input type="checkbox"/> MISA <input type="checkbox"/> Municipality _____ <input type="checkbox"/> PWQO <input type="checkbox"/> Reg 406 Table _____ <input type="checkbox"/> Other _____	

ANALYSIS REQUESTED (PLEASE BE SPECIFIC)

Field Filtered (please circle):
Metals / Hg / Cr / VI

O Reg 153 PHCs, BTEX/F1-F4 (Soil)
 O Reg 153 PCBs (Soil)
 O Reg 153 VOCs by HS (Soil)
 O Reg 558 TCLP Benzotoluene
 O Reg 558 TCLP Inorganics Package
 O Reg 558 TCLP Leachate Preparation
 O Reg 558 TCLP PCBs
 O Reg 558 TCLP VOCs by HS

Turnaround Time (TAT) Required:
Please provide advance notice for rush projects

Regular (Standard) TAT:
(will be applied if Rush TAT is not specified):
Standard TAT = 5-7 Working days for most tests.
Please note: Standard TAT for certain tests such as BOD and Dioxins/Furans are > 5 days - contact your Project Manager for details.

Job Specific Rush TAT (if applies to entire submission)
Date Required: _____ Time Required: _____
Rush Confirmation Number: _____ (call lab for #)

Sample Barcode Label	Sample (Location) Identification	Date Sampled	Time Sampled	Matrix	Field Filtered (please circle): Metals / Hg / Cr / VI	O Reg 153 PHCs, BTEX/F1-F4 (Soil)	O Reg 153 PCBs (Soil)	O Reg 153 VOCs by HS (Soil)	O Reg 558 TCLP Benzotoluene	O Reg 558 TCLP Inorganics Package	O Reg 558 TCLP Leachate Preparation	O Reg 558 TCLP PCBs	O Reg 558 TCLP VOCs by HS	# of Bottles	Comments
1	BH 101-SS5	21/01/08	14:00	Soil	X									1	TCLP analyses are
2	BH 109-SS7	21/01/06	14:00		X									1	MCE, VOC, PCB, BWP
3	BH 111-SS5	21/01/05	16:00		X									1	
4	BH 112-SS6	21/01/11	13:30		X									1	
5	BH 113-SS6	21/01/08	14:00		X									1	
6	ICEP 21/01/11 15:30						X							3	
7															
8															
9															
10															

* RELINQUISHED BY: (Signature/Print) Kishan Sunderaligan	Date: (YY/MM/DD) 21/01/11	Time 14:00	RECEIVED BY: (Signature/Print) M. G. V. S. R. N. S. M. R.	Date: (YY/MM/DD) 2021/01/14	Time 14:35	# jars used and not submitted	Laboratory Use Only No 100	Time Sensitive	Temperature (°C) on Recept 0.816	Custody Seal Present Intact	Yes No	White: BV Labs Yellow: Client
---	------------------------------	---------------	--	--------------------------------	---------------	-------------------------------	-------------------------------	----------------	-------------------------------------	-----------------------------------	-----------	----------------------------------

* UNLESS OTHERWISE AGREED TO IN WRITING, WORK SUBMITTED ON THIS CHAIN OF CUSTODY IS SUBJECT TO BV LABS' STANDARD TERMS AND CONDITIONS. SIGNING OF THIS CHAIN OF CUSTODY DOCUMENT IS ACKNOWLEDGMENT AND ACCEPTANCE OF OUR TERMS WHICH ARE AVAILABLE FOR VIEWING AT WWW.BVLABS.COM/TERMS-AND-CONDITIONS.

** SAMPLE CONTAINER, PRESERVATION, HOLD TIME AND PACKAGE INFORMATION CAN BE VIEWED AT WWW.BVLABS.COM/RESOURCES/CHAIN-OF-CUSTODY-FORMS.

SAMPLES MUST BE KEPT COOL (< 10° C) FROM TIME OF SAMPLING UNTIL DELIVERY TO BV LABS.

Client: Bureau Veritas Canada (2019) Inc
6740 Campobello Road
Mississauga, ON
L5N 2L8
Attention: Ms. Marijane Cruz
PO#:
Invoice to: Bureau Veritas Canada (2019) Inc

Report Number: 1946466
Date Submitted: 2021-01-18
Date Reported: 2021-01-22
Project: C110991
COC #: 869156

Page 1 of 3

Dear Marijane Cruz:

Please find attached the analytical results for your samples. If you have any questions regarding this report, please do not hesitate to call (613-727-5692).

Report Comments:



Addrine Thomas
2021.01.22
15:47:18 -05'00'

APPROVAL:

Addrine Thomas, Inorganics Supervisor

All analysis is completed at Eurofins Environment Testing Canada Inc. (Ottawa, Ontario) unless otherwise indicated.

Eurofins Environment Testing Canada Inc. (Ottawa, Ontario) is accredited by CALA, Canadian Association for Laboratory Accreditation to ISO/IEC 17025 for tests which appear on the scope of accreditation. The scope is available at: <http://www.cala.ca/scopes/2602.pdf>.

Eurofins Environment Testing Canada Inc. (Ottawa, Ontario) is licensed by the Ontario Ministry of the Environment, Conservation, and Parks (MECP) for specific tests in drinking water (license #2318). A copy of the license is available upon request.

Eurofins Environment Testing Canada Inc. (Ottawa, Ontario) is accredited by the Ontario Ministry of Agriculture, Food, and Rural Affairs for specific tests in agricultural soils.

Please note: Field data, where presented on the report, has been provided by the client and is presented for informational purposes only. Guideline values listed on this report are provided for ease of use (informational purposes) only. Eurofins recommends consulting the official provincial or federal guideline as required. Unless otherwise stated, measurement uncertainty is not taken into account when determining guideline or regulatory exceedances.

Certificate of Analysis

Client: Bureau Veritas Canada (2019) Inc
 6740 Campobello Road
 Mississauga, ON
 L5N 2L8
 Attention: Ms. Marijane Cruz
 PO#:
 Invoice to: Bureau Veritas Canada (2019) Inc

Report Number: 1946466
 Date Submitted: 2021-01-18
 Date Reported: 2021-01-22
 Project: C110991
 COC #: 869156

Group	Analyte	MRL	Units	Guideline	Lab I.D. Sample Matrix Sample Type Sampling Date Sample I.D.			
Redox Potential	REDOX Potential		mV		1538580 Soil 2021-01-08 OPN366-BH101-SS5	1538581 Soil 2021-01-06 OPN367-BH109-SS7	1538582 Soil 2021-01-05 OPN368-BH111-SS5	1538583 Soil 2021-01-11 OPN369-BH112-SS6
					218	226	208	211

Group	Analyte	MRL	Units	Guideline	Lab I.D. Sample Matrix Sample Type Sampling Date Sample I.D.
Redox Potential	REDOX Potential		mV		1538584 Soil 2021-01-08 OPN370-BH113-SS6
					205

Guideline = *** = Guideline Exceedence**

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

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

Client: Bureau Veritas Canada (2019) Inc
 6740 Campobello Road
 Mississauga, ON
 L5N 2L8
 Attention: Ms. Marijane Cruz
 PO#:
 Invoice to: Bureau Veritas Canada (2019) Inc

Report Number: 1946466
 Date Submitted: 2021-01-18
 Date Reported: 2021-01-22
 Project: C110991
 COC #: 869156

QC Summary

Analyte	Blank	QC % Rec	QC Limits
Run No 395420 Analysis/Extraction Date 2021-01-22 Analyst R_R Method C SM2580B			
REDOX Potential	273 mV	101	

Guideline = * = **Guideline Exceedence**

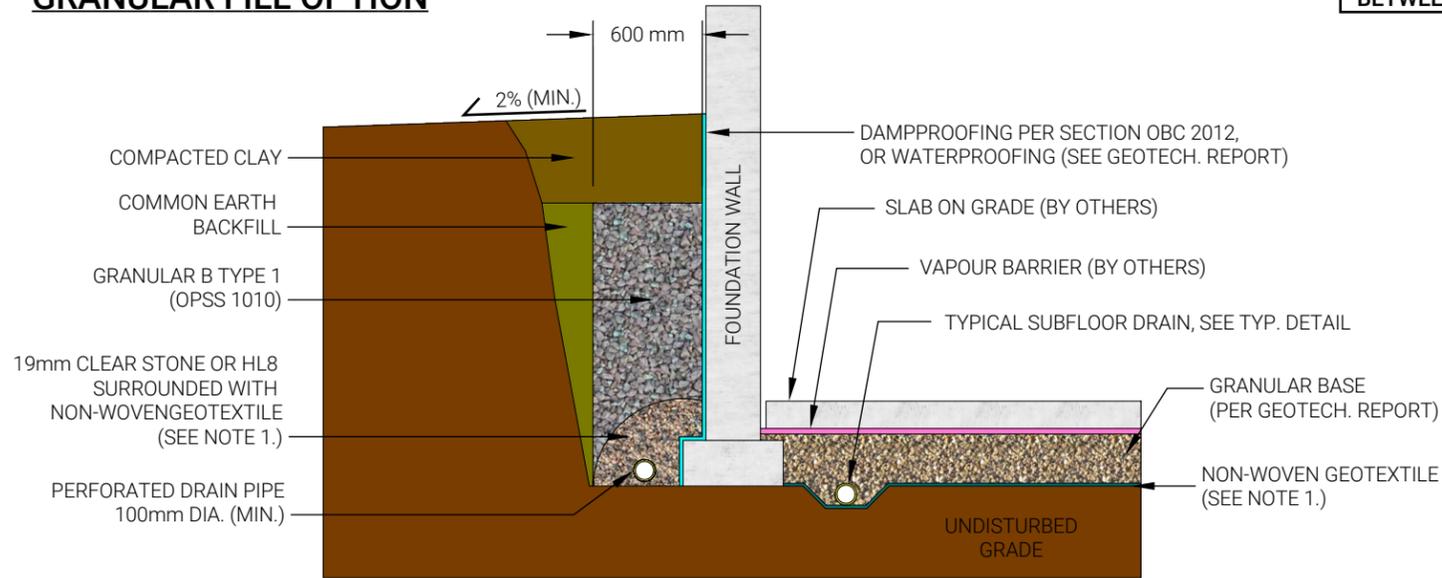
Results relate only to the parameters tested on the samples submitted.
 Methods references and/or additional QA/QC information available on request.

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

APPENDIX D

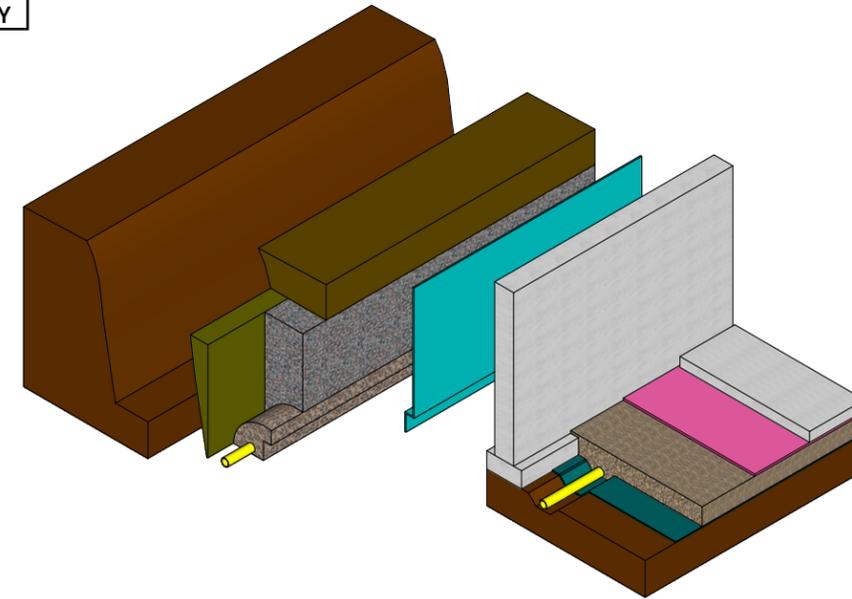


GRANULAR FILL OPTION



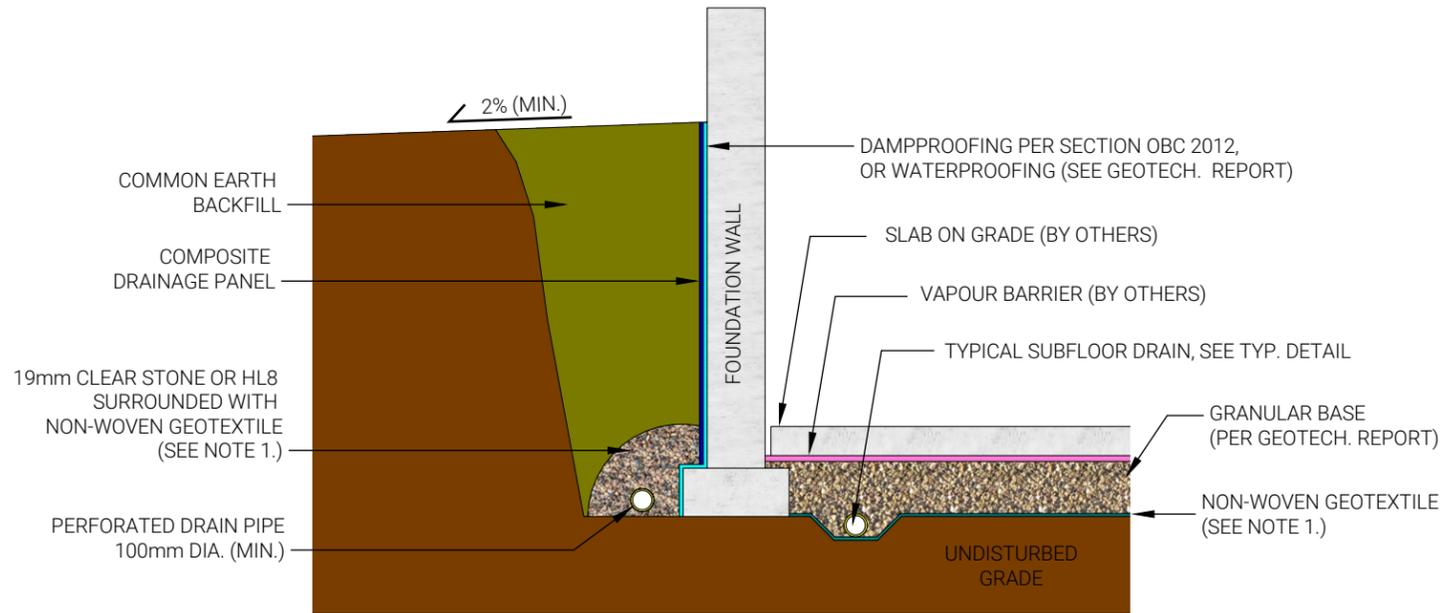
SECTIONAL VIEW

OBJECTS ARE COLOR-CODED BETWEEN TWO VIEWS FOR CLARITY

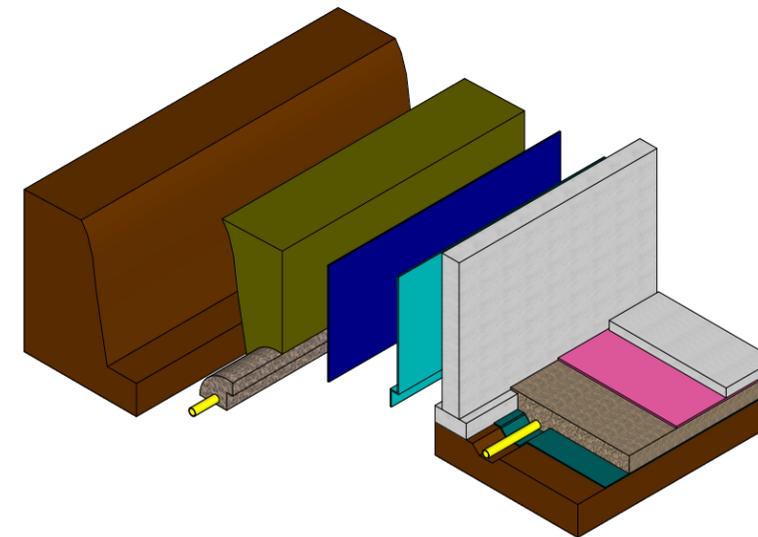


ISOMETRIC VIEW

GEO-COMPOSITE DRAINAGE PANEL OPTION



SECTIONAL VIEW

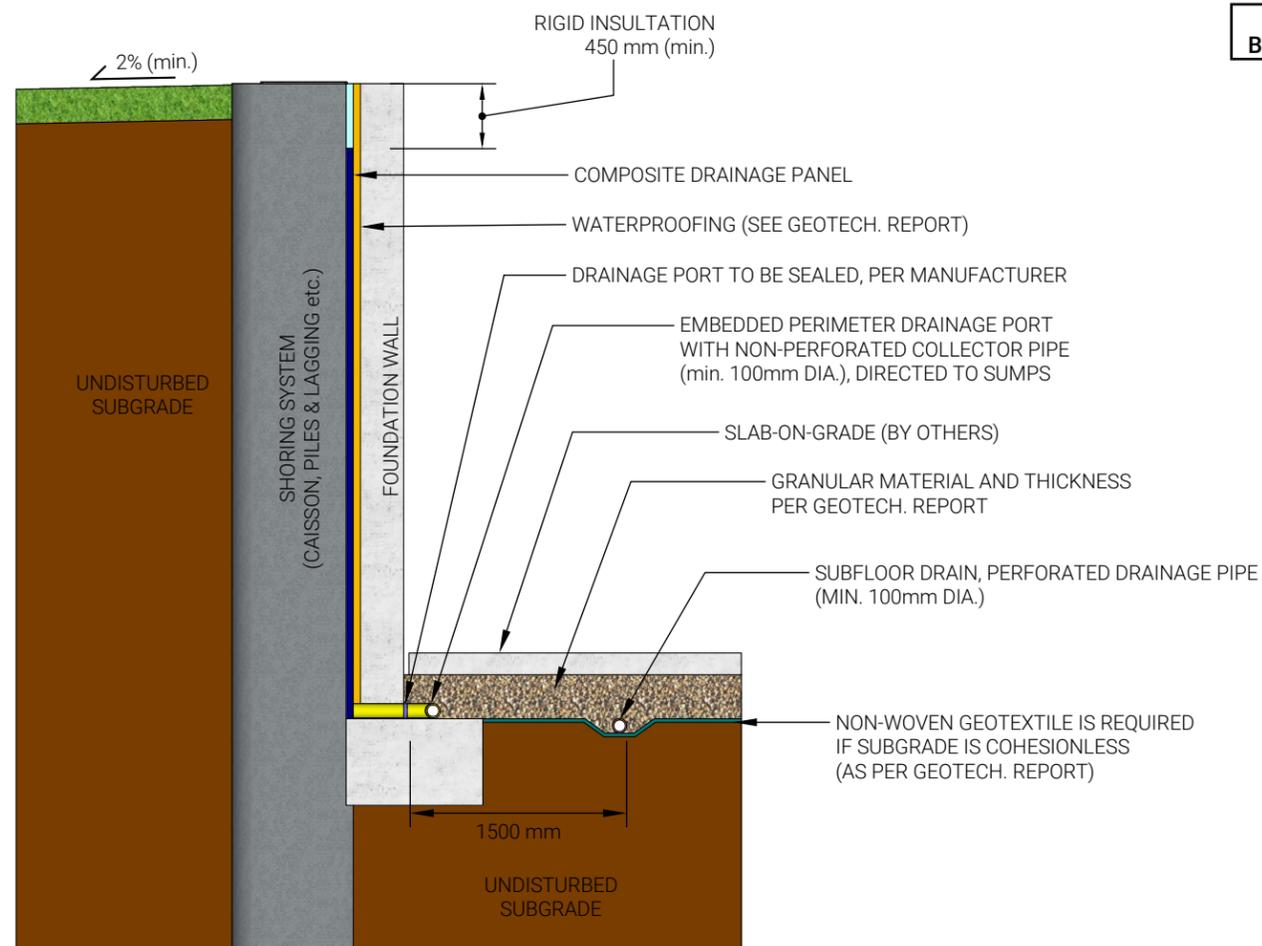


ISOMETRIC VIEW

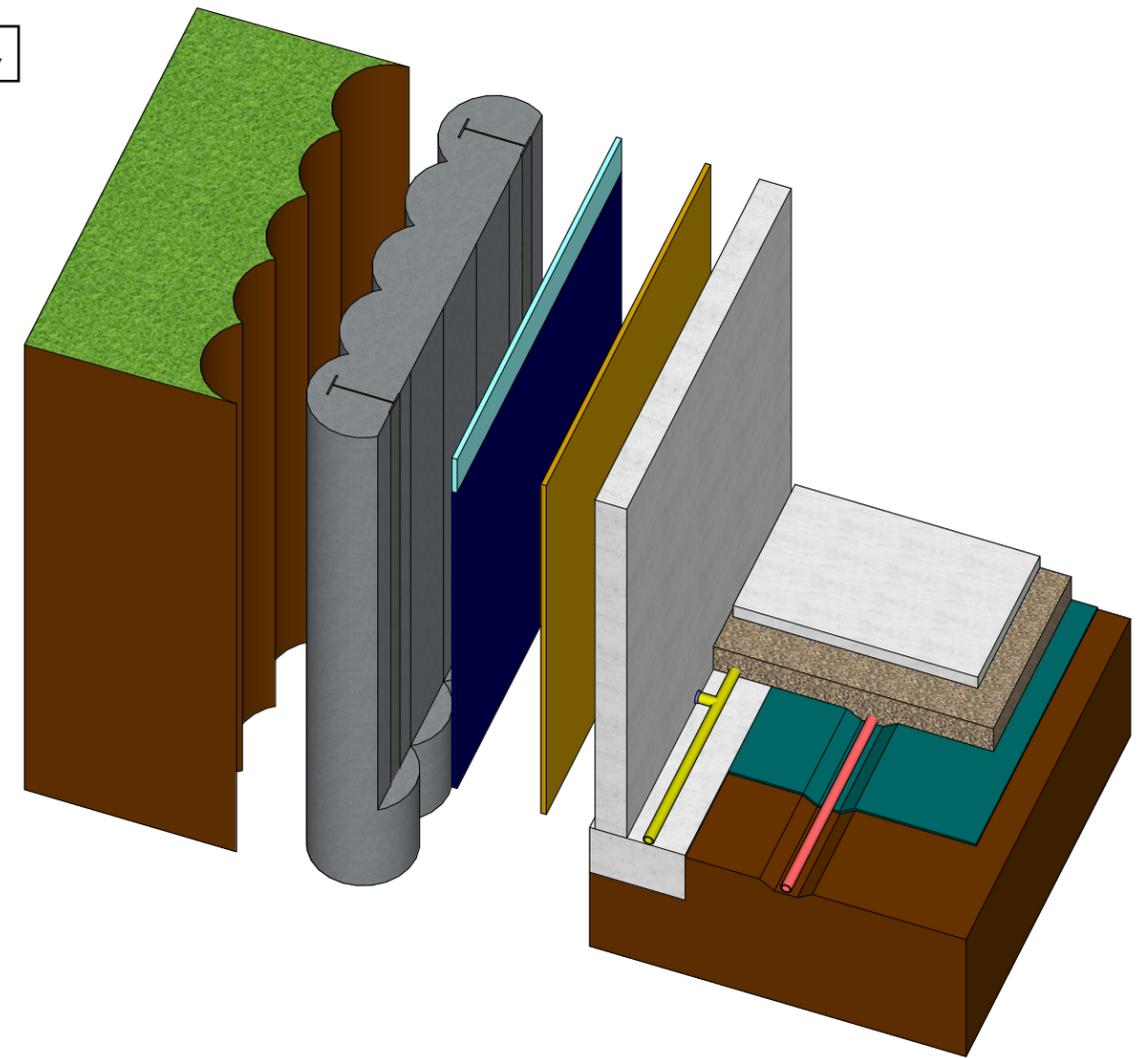
NOTES

1. A NON-WOVEN GEOTEXTILE WITH AN APPARENT OPENING SIZE OF < 0.250mm AND A TEAR RESISTANCE OF > 200 N.

Title



OBJECTS ARE COLOR-CODED BETWEEN TWO VIEWS FOR CLARITY



SECTIONAL VIEW

ISOMETRIC VIEW

SUBFLOOR DRAINAGE SYSTEM

1. THE SUBFLOOR DRAINS SHOULD BE SET IN PARALLEL ROWS, IN ONE DIRECTION, AND SPACED AS PER THE GEOTECHNICAL REPORT.
2. THE INVERT OF THE PIPES SHOULD BE A MINIMUM OF 300mm BELOW THE UNDERSIDE OF THE SLAB-ON-GRADE.
3. A CAPILLARY MOISTURE BARRIER (I.E. DRAINAGE LAYER) CONSISTING OF A MINIMUM 200 mm LAYER OF CLEAR STONE (OPSS MUNI 1004) COMPACTED TO A DENSE STATE (OR AS PER THE GEOTECHNICAL REPORT). WHERE VEHICULAR TRAFFIC IS REQUIRED, THE UPPER 50 mm OF THE CAPILLARY MOISTURE BARRIER MAY BE REPLACED WITH GRANULAR A (OPSS MUNI 1010) COMPACTED TO A MINIMUM 98% SPMDD.
4. A NON-WOVEN GEOTEXTILE MUST SEPARATE THE SUBGRADE FROM THE SUBFLOOR DRAINAGE LAYER IF THE SUBGRADE IS COHESIONLESS. THE NON-WOVEN GEOTEXTILE MAY CONSIST OF TERRAFIX 360R OR AN APPROVED EQUIVALENT.

PERIMETER DRAINAGE SYSTEM

1. FOR A DISTANCE OF 1.2m FROM THE BUILDING, THE GROUND SURFACE SHOULD HAVE A MINIMUM 2% GRADE.
2. PREFABRICATED COMPOSITE DRAINAGE PANEL (CONTINUOUS COVER, AS PER MANUFACTURER'S REQUIREMENTS) IS RECOMMENDED BETWEEN THE BASEMENT WALL AND RIGID SHORING WALL. THE DRAINAGE PANEL MAY CONSIST OF MIRADRAIN 6000 OR AN APPROVED EQUIVALENT.
3. PERIMETER DRAINAGE IS TO BE COLLECTED IN NON-PERFORATED PIPES AND CONVEYED DIRECTLY TO THE BUILDING SUMPS.
4. PERIMETER DRAINAGE PORTS SHOULD BE SPACED A MAXIMUM 3m ON-CENTRE. EACH PORT SHOULD HAVE A MINIMUM CROSS-SECTIONAL AREA OF 1500 mm².

GENERAL NOTES

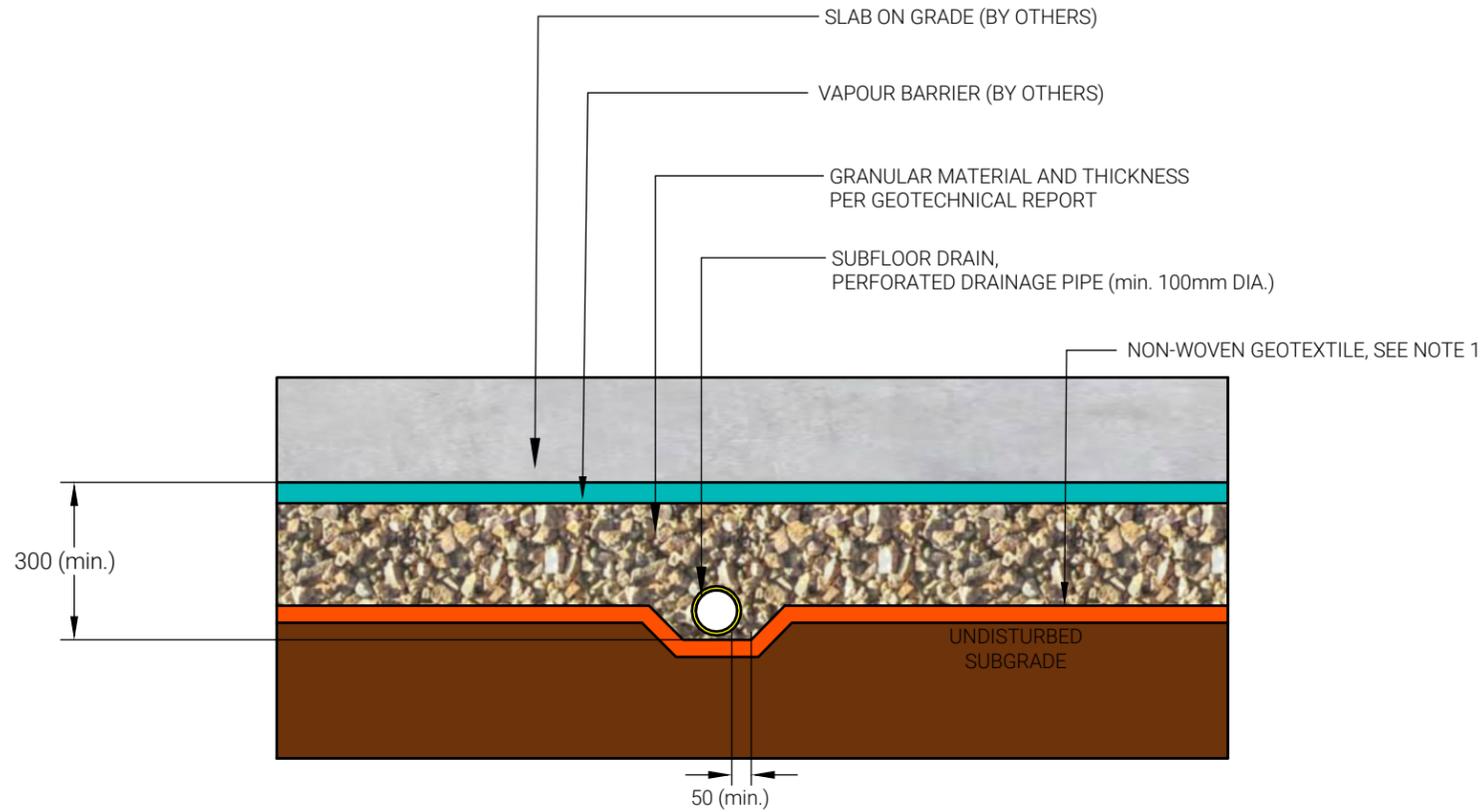
1. THERE SHOULD BE NO STRUCTURAL CONNECTION BETWEEN THE SLAB-ON-GRADE AND THE FOUNDATION WALL OR FOOTING.
2. THERE SHOULD BE NO CONNECTION BETWEEN THE SUBFLOOR AND PERIMETER DRAINAGE SYSTEMS.
3. THIS IS ONLY A TYPICAL BASEMENT DRAINAGE DETAIL. THE GEOTECHNICAL REPORT SHOULD BE CONSULTED FOR SITE SPECIFIC RECOMMENDATIONS.
4. THE FINAL BASEMENT DRAINAGE DESIGN SHOULD BE REVIEWED BY THE GEOTECHNICAL ENGINEER TO CONFIRM THE DESIGN IS ACCEPTABLE.

Title

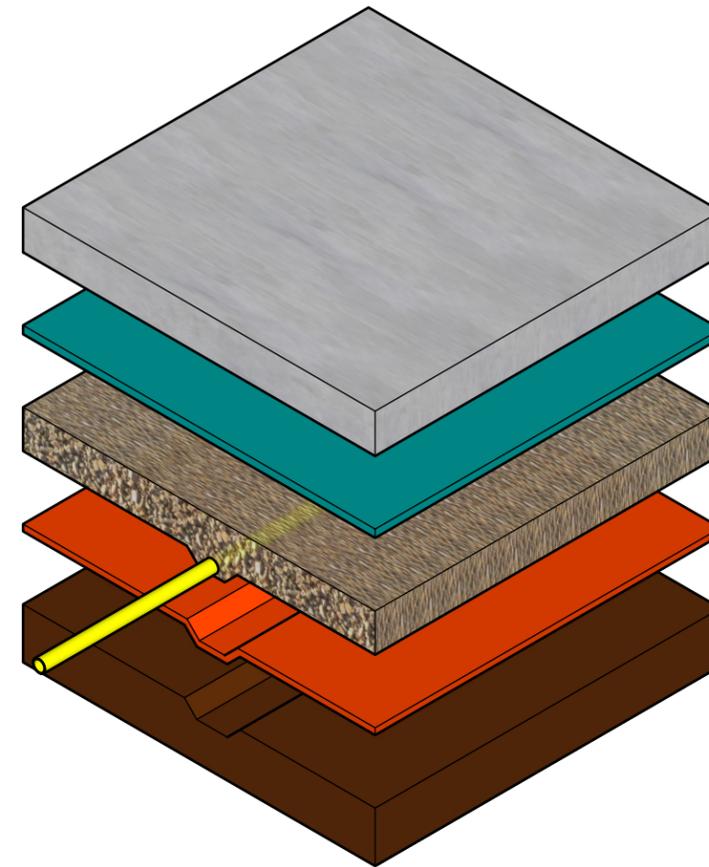


BASEMENT DRAINAGE SHORING SYSTEM TYPICAL DETAILS

OBJECTS ARE COLOR-CODED
BETWEEN TWO VIEWS FOR CLARITY



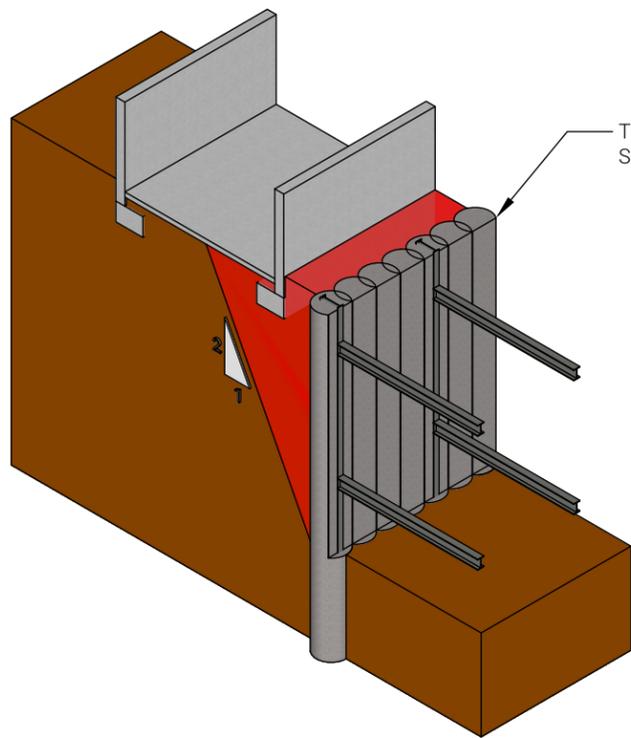
SECTIONAL VIEW



ISOMETRIC VIEW

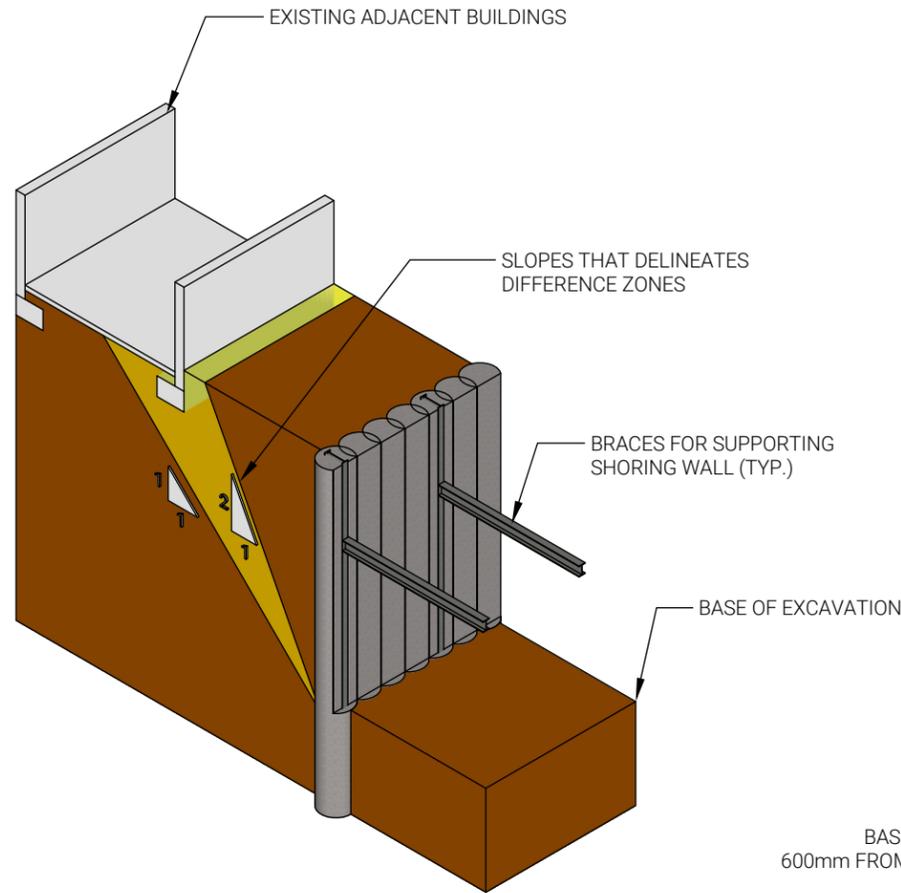
NOTES

1. WHEN THE SUBGRADE CONSISTS OF COHESIONLESS SOIL, IT MUST BE SEPARATED FROM THE SUBFLOOR DRAINAGE LAYER USING A NON-WOVEN GEOTEXTILE (WITH AN APPARENT OPENING SIZE OF $< 0.250\text{mm}$ AND A TEAR RESISTANCE OF $> 200\text{ N}$).
2. TYPICAL SCHEMATIC ONLY. MUST BE READ IN CONJUNCTION WITH GEOTECHNICAL REPORT.



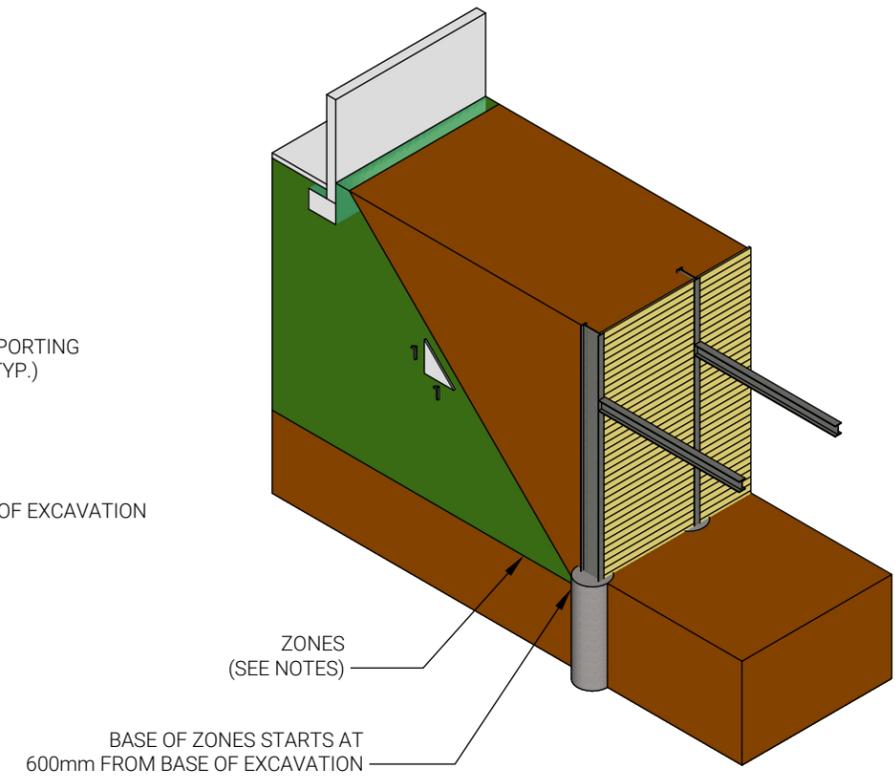
ZONE A (RED)

FOUNDATIONS WITHIN THIS ZONE OFTEN REQUIRE UNDERPINNING OR SHORING SYSTEM. HORIZONTAL AND VERTICAL PRESSURES ON EXCAVATION WALL OF NON-UNDERPINNED FOUNDATION MUST BE CONSIDERED



ZONE B (YELLOW)

FOUNDATIONS WITHIN THIS ZONE OFTEN DO NOT REQUIRE UNDERPINNING BUT MAY REQUIRE SHORING SYSTEM. HORIZONTAL AND VERTICAL PRESSURES ON EXCAVATION WALL OF NON-UNDERPINNED FOUNDATION MUST BE CONSIDERED



ZONE C (GREEN)

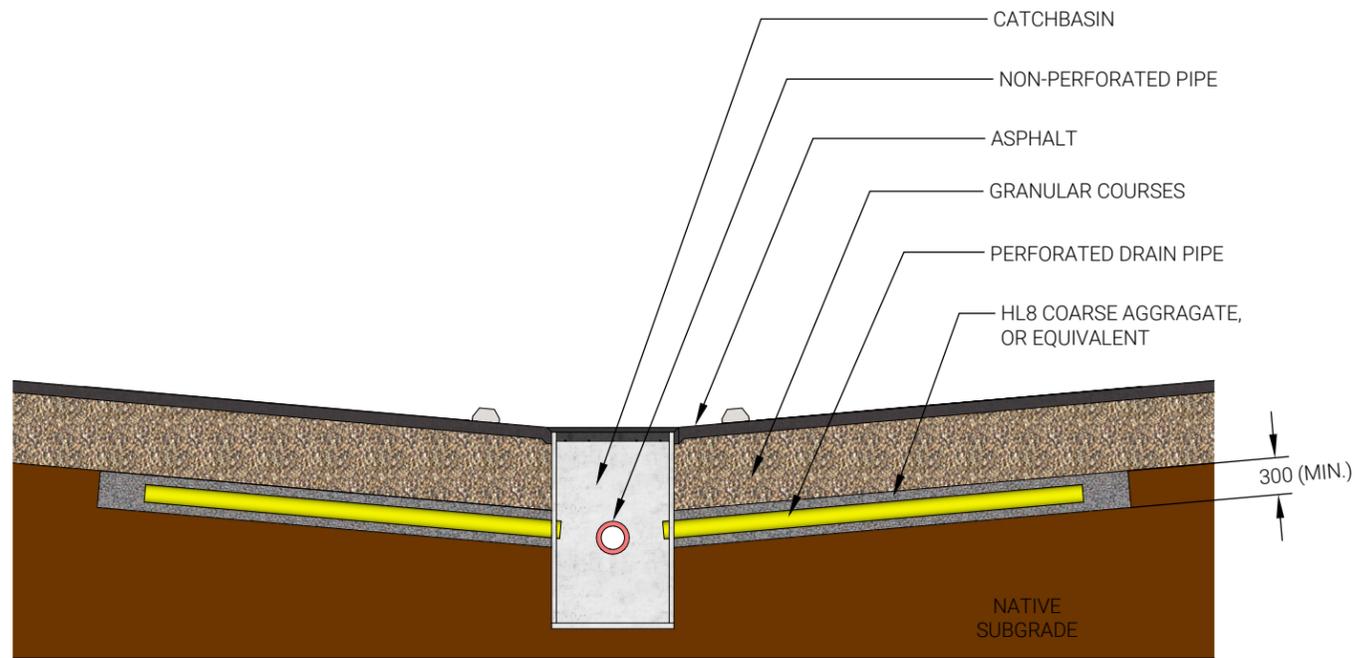
FOUNDATIONS WITHIN THIS ZONE USUALLY DO NOT REQUIRE UNDERPINNING OR SHORING SYSTEM

NOTES:

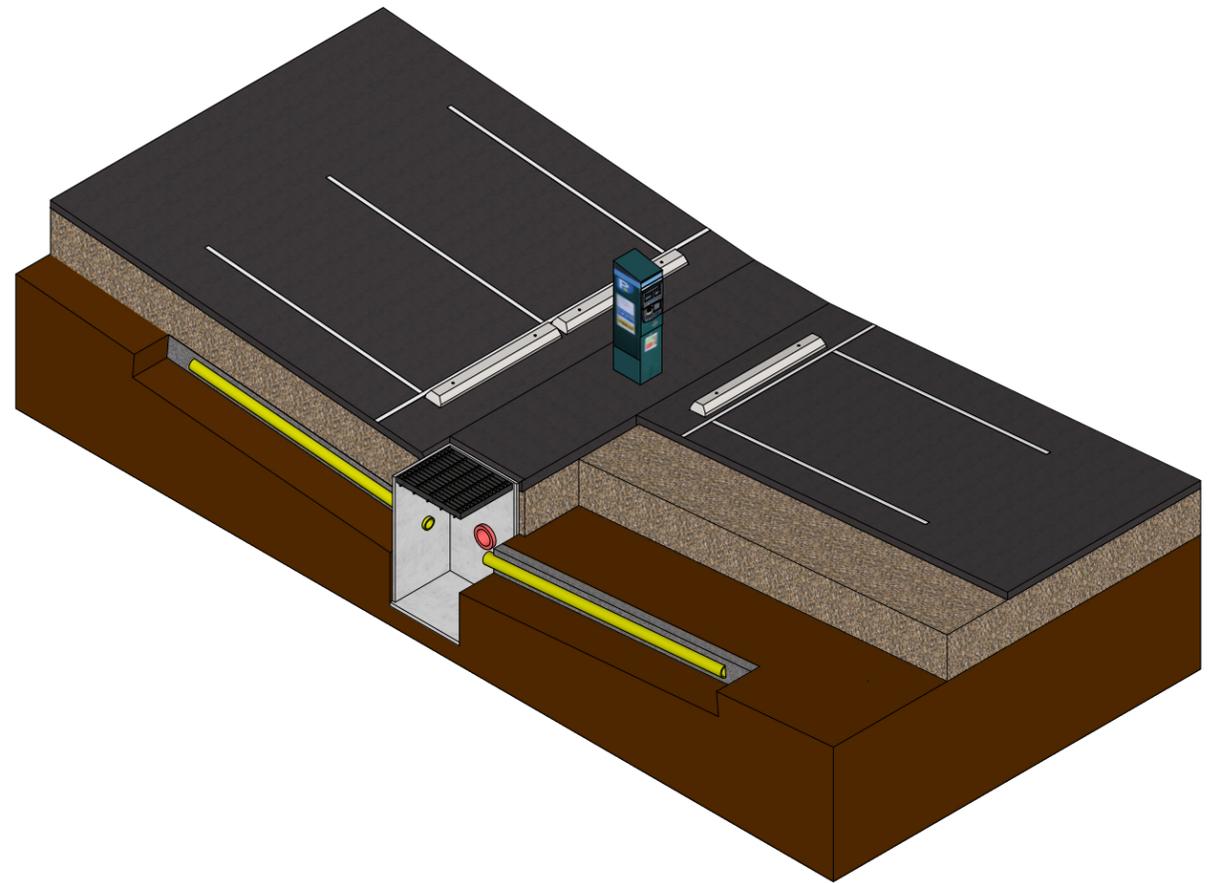
1. USER'S GUIDE - NBC 2005 STRUCTURAL COMMENTARIES (PART 4 OF DIVISION B) - COMMENTARY K.

Title

OBJECTS ARE COLOR-CODED
BETWEEN TWO VIEWS FOR CLARITY



SECTIONAL VIEW



ISOMETRIC

APPENDIX E



1 GENERAL

These specifications are suitable for use as a technical specification only, relating to the engineering aspects as discussed in Grounded's corresponding geotechnical report for the site. If this technical specification is to be used as a tender document, the geotechnical report and this technical specification must be read in conjunction with the relevant supporting tender documents, prepared by others.

This specification must be read in conjunction with Grounded's geotechnical report for the site. Wherever there is conflicting advice, Grounded's geotechnical report for the site governs.

1.1 Description

Engineered Fill refers to earthworks (earth fill) designed and constructed with engineering inspection and testing to support foundations at SLS loads for a design net geotechnical reaction.

Site preparation for Engineered Fill operations must only be conducted under the full time inspection and testing of a Third Party Testing Agency (Testing Engineer), with review by the Geotechnical Engineer, in order to ensure adequate compaction and fill quality.

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.

The Engineered Fill to be constructed 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:

1. Topsoil stripping from the ground surface below all Engineered Fill areas,
2. Test pit excavating into the subgrade to a) investigate subgrade suitability for the support of Engineered Fill and b) observe and document any prior existing fill materials,
3. Proof-rolling of the subgrade below all Engineered Fill areas, to detect the presence and extent of unstable ground conditions,
4. Excavating and removing unstable/unacceptable subgrade materials, or the implementation of other approved subgrade stabilization measures (as required) prior to the placement of Engineered Fill,
5. Surveying of ground elevations prior to placing Engineered Fill,
6. Supply, placement, and compaction of approved clean earth as specified herein, with full time inspection and testing,
7. Surveying of ground elevations on completion of Engineered Fill placement,
8. Providing and maintaining survey layout of the Engineered Fill areas, and monitoring of ground elevations throughout the construction of Engineered Fill.

1.2 The Project Parties

1. 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.
2. The term Testing 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.

3. The term Geotechnical Engineer shall refer to Grounded Engineering.
4. 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.

2 MATERIALS

2.1 Definitions

1. Topsoil is the layer of naturally organic soil typically found at the ground surface and commonly in the range of about 100 to 300 mm thick.
2. Earth Fill is soil material which has been placed by humans and has not been deposited by nature over a long period of time.
3. Subgrade Soil is the “in situ” (in place) native soil beneath any earth fill and/or topsoil layer(s).
4. Disturbed Soil is soil material which was originally deposited naturally but has since been disturbed or reworked in place, usually by agriculture activities. Disturbed Soil may or may not be suitable Subgrade Soil; see our Geotechnical Report.
5. Weathered Soil is soil material which is naturally deposited but weathered in place due to its exposure to the elements. Weathered Soil may or may not be suitable Subgrade Soil; see our Geotechnical Report.
6. 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. It is placed in thin lifts of no more than 150 mm in thickness. Cohesionless soils such as sand or gravel are the easiest to place and compact.
7. All values stated in metric units shall be considered as accurate.

3 ENGINEERED FILL DESIGN

3.1 Design Foundation Pressure

1. 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 (after initial placement) over which this settlement typically occurs depends on the composition of the Engineered Fill as follows:
 - 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 natural soil.

The timing of foundation construction must consider the post-construction settlement of the Engineered Fill and the foundation soil.

2. Unless otherwise stated, the Engineered Fill is to be placed over the entire lot area or site area.
3. Engineered Fill is to extend up to at least 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.

4. An allowable design foundation pressure (net geotechnical reaction at SLS for 25 mm of settlement) of 150 kPa 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 0.8 m for continuous strip footings, and minimum dimensions of 1 m for column footings.
5. 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.
6. Foundations placed on the Engineered Fill must be provided with nominal reinforcing steel for stiffening of basement foundation walls and 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.
7. 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.

4 CONSTRUCTION

4.1 Survey Layout

1. 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.
2. 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. Benchmark positions may need to be reviewed by Grounded if consolidation settlement is expected to influence their elevations.
3. 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 Testing Engineer.
4. 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.
5. On completion of Engineered Fill construction, the final ground elevations shall be surveyed and recorded on a regular grid pattern.

4.2 Topsoil Stripping

1. The Geotechnical Engineer must observe the stripping of topsoil from the areas proposed for Engineered Fill, from start to finish.
2. Topsoil must be stripped from the entire building site area. The Geotechnical Engineer must photograph the work areas which have been suitably stripped.

4.3 Test Holes Into Subgrade

1. After topsoil has been stripped, the exposed subgrade must be investigated for the presence of old buried fill or deleterious material, which may be unsuitable (as determined by the Testing Engineer or the Geotechnical Engineer) for the support of Engineered Fill.
2. Exploratory test pits must be dug using a small backhoe, on a suitable pattern, to observe an appropriate representation of the entire site area.
3. The Testing Engineer or Geotechnical Engineer must observe the digging and backfilling of the test pits; must log the test pit stratigraphy; must obtain soil samples at maximum depth intervals of 0.3m; and must photograph each dug test pit.
4. If the test pits discover any old buried fill or deleterious materials, it must be excavated and removed from the Engineering Fill area down to undisturbed, stable native soil.
5. All test pits must be properly backfilled and compacted in thin lifts (max. 150mm thickness) to at least 98 percent Standard Proctor Maximum Dry Density (SPMDD), at the optimum water content plus or minus 2 percent. The Testing Engineer or Geotechnical Engineer must observe the backfilling and compaction of the test pits.

4.4 Subgrade Proof-rolling

1. Prior to placing any Engineered Fill, the exposed subgrade must be proofrolled under the observation of the Testing Engineer.
2. 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.

4.5 Engineered Fill Placement

1. Engineered fill must not be placed without the approval of the Testing Engineer. Prior to placing any Engineered Fill, the topsoil must be stripped, 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.
2. Prior to the placement of Engineered Fill, the source or borrow area for the Engineered Fill must be evaluated for its suitability both geotechnically and environmentally. Samples of the proposed fill material must be obtained and tested by the Testing Engineer. The samples must be tested in a geotechnical laboratory for Standard Proctor Maximum Dry Density. Samples must also be tested per the requirements of Ontario Regulation 406/19, prior to approval of the material for use as Engineered Fill. The results of the lab testing must be approved by the Geotechnical Engineer and the results of the environmental testing must be approved by the site Qualified Person, prior to import.
3. 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.
4. Field density tests must be taken by the Testing 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.
5. 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.

4.6 Certification

1. The Testing Engineer shall provide written summaries of the compaction and lab testing to the Geotechnical Engineer on a frequency of not less than every two weeks.
2. Upon Completion of the Engineered Fill placement the Testing Engineer will provide certification to the Geotechnical Engineer of General Compliance with this specification.
3. Upon receipt of the certification from the Testing Engineer, the Geotechnical Engineer will provide the owner with a Certificate of Engineered Fill