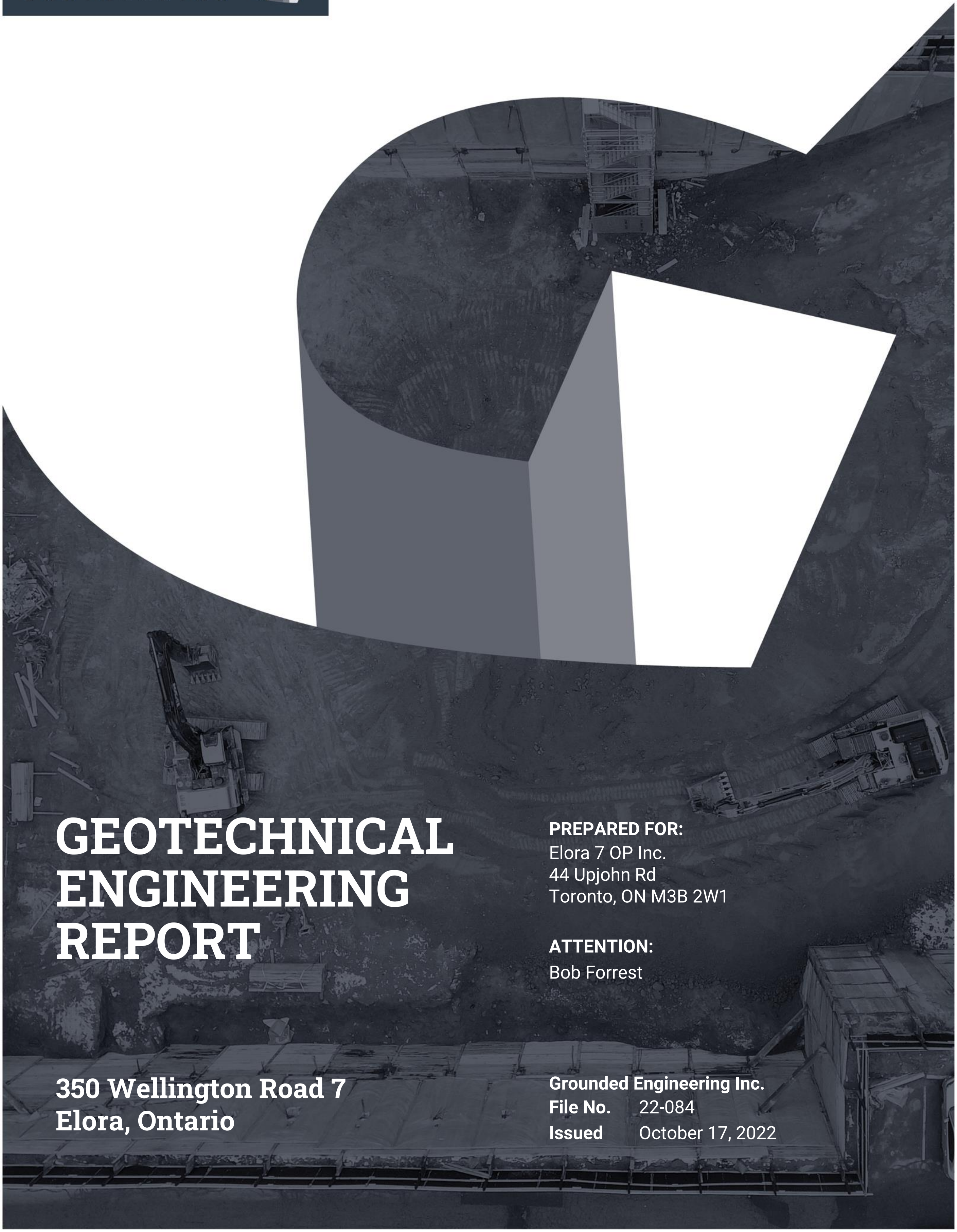

GEOTECHNICAL ENGINEERING REPORT

PREPARED FOR:
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Grounded Engineering Inc.
File No. 22-084
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1 Introduction

Elora 7 OP Inc. has retained Grounded Engineering Inc. (“Grounded”) to provide preliminary geotechnical engineering design advice for their proposed development at 350 Wellington Road 7, in Elora, Ontario.

The proposed project includes constructing townhomes with up to one basement level with associated infrastructure including services and pavements. The Finished Floor Elevation will vary across the site.

Grounded has been provided with the following reports and drawings to assist in our geotechnical scope of work:

- We Merchandise Space Inc. and Forrest Group Inc., “Version 3.3 Concept Site Plan, 350 Wellington Rd #7 Elora ON”; Project 3287, dated October 14, 2022

Grounded’s subsurface investigation of the site to date includes thirteen (13) boreholes (Boreholes 1 to 13) which were advanced from May 9 to 16th, 2022.

Based on the borehole findings, preliminary geotechnical engineering advice for the proposed development is provided for foundations, seismic site classification, earth pressure design, slab on grade design, basement drainage. 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.

This preliminary geotechnical engineering report is appropriate for due diligence and planning purposes only. Additional boreholes, wells, and a detailed geotechnical engineering report will be required for detailed design. This scope of work is appropriate for due diligence and OPA/ZBA application purposes. It is noted that a detailed engineering (including the advancement of additional boreholes/wells) will be required for detailed design for 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 (CGVD2010). The horizontal coordinates are provided relative to the Universal Transverse Mercator (UTM NAD83) geographic coordinate system.

2.1 Soil Stratigraphy

The following soil stratigraphy summary is based on the borehole results and the geotechnical laboratory testing.

A subsurface profile showing stratigraphy and engineering units is appended.

2.1.1 Surficial and Disturbed Soil

All the boreholes encountered 225 to 760 mm of topsoil at ground surface.

All boreholes except Borehole 7 and 12 encountered disturbed soils underlying the topsoil. These disturbed soils appear to be either regraded native soils, or soils disturbed by the ingress of storm water / farming activities. The disturbed soils extend to depths of 0.8 to 3.0 m below grade (Elev. 398.3 to 405.7 m). The disturbed soils comprise sands and silts with trace to some clay and trace gravel. Trace organics and trace rootlets were occasionally encountered within the disturbed soils. The disturbed soils are generally moist transitioning to wet below 0.8 m. The disturbed soils are light brown to dark brown. Standard Penetration Test (SPT) results (N-Values) measured in the disturbed soils range from 2 to 8 blows per 300 mm of penetration (“bpf”), indicating a relative density ranging from very loose to loose.

2.1.2 Upper Glacial Till

Underlying the topsoil or disturbed soils, Boreholes 9, 12, and 13 encountered a cohesionless glacial till deposit comprising sandy silt with trace to some clay and trace gravel. The upper glacial till was encountered at 0.8 to 2.3 m depth below grade (Elev. 398.3 to 399.4 m), extending to 1.5 to 5.0 m depth below grade (Elev. 399.4 to 395.5 m). The upper glacial till is light brown to brown and wet. SPT N-values measured in this unit range from 5 to 11 bpf indicating a loose to compact relative density.

2.1.3 Sands

Underlying the topsoil, disturbed soils, or upper glacial till, a sand deposit was encountered in all boreholes except Borehole 13 at a 0.8 to 3.0 m depth (Elev. 397.6 to 405.7 m) extending to 4.6 to 12.2 m (Elev. 394.5 to 396.6 m). Boreholes 1, 2, and 6 were terminated in the sands unit (Elev. 396.1 to 399.0 m). The sands deposit comprises silt, some sand to sand, some silt with trace clay and gravel. The sands are light brown to brown and moist to wet. SPT N-values measured in this unit range from 5 to 33 bpf.

2.1.4 Lower Glacial Till

Underlying the upper glacial till or the sands, a lower glacial till was encountered in all boreholes (except Boreholes 1, 2, and 6) at 4.6 to 12.2 m below existing grade (Elev. 394.5 to 396.6 m) and extends past the depth of the investigation (Elev. 391.2 m). The lower glacial till comprises sand and silt to clayey silt with trace gravel. The lower glacial till is generally grey and moist. SPT N-values measured in this unit range from 19 to 66 bpf, with a very stiff to hard consistency, or is compact to very dense.

2.2 Groundwater

The boreholes were cased by hollow stem augers on completion, and cave measurement was not practical. Drill fluid was added to the hollow stem augers in some boreholes, therefore depth to groundwater was not always measured. Monitoring wells were installed in select boreholes, and stabilized groundwater levels were measured in each of the monitoring wells one week after the completion of drilling.

The groundwater observations are shown on the Borehole Logs and are summarized as follows.

Table 2.1: Groundwater observations

Borehole No.	**Depth of borehole (m)**	**Upon completion of drilling Unstabilized water level (m)**	**Strata Screened**	**Water Level in Well, Depth/Elev. (m)**		
				May 17, 2022	**May 27, 2022**	**June 3, 2022**
1	9.8	n/a	No monitoring well installed.			
2	8.2	2.7	Sands	1.9 / 402.4	1.9 / 402.4	2.0 / 402.3
3	8.2	dry	Sands and Lower Glacial Till	1.3 / 400.7	0.8 / 401.2	0.8 / 401.2
4	8.2	2.1	Lower Glacial Till	3.0 / 398.2	3.0 / 398.2	3.0 / 398.2
5	12.8	n/a	Sands	3.7 / 403.2	3.7 / 403.2	3.7 / 403.2
6	8.2	2.1	No monitoring well installed.			
7	9.0	2.1	No monitoring well installed.			
8	9.8	8.2	No monitoring well installed.			
9	8.2	6.4	Lower Glacial Till	2.6 / 398.0	2.7 / 397.9	2.8 / 397.8
10	14.3	n/a	Sands and Lower Glacial Till	3.7 / 403.0	3.7 / 403.0	3.7 / 403.0
11	9.8	5.8	No monitoring well installed.			
12	8.2	2.1	Sands and Lower Glacial Till	0.8 / 400.1	0.8 / 400.1	0.8 / 400.1

Borehole No.	Depth of borehole (m)	Upon completion of drilling Unstabilized water level (m)	Strata Screened	Water Level in Well, Depth/Elev. (m)		
				May 17, 2022	May 27, 2022	June 3, 2022
13	8.2	dry	Upper and Lower Glacial Till	2.6 / 397.9	2.6 / 397.9	2.8 / 397.7

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. 403.2 m at the north end (Borehole 5) of the site decreasing to Elev. 397.7 m (Borehole 13) at the south end of the site. There is also perched water in the disturbed soils which is flowing down towards the groundwater table.

Grounded has prepared a hydrogeological report for this site (File No. 22-084).

2.3 Proctor Testing

Consideration is being given to reuse the disturbed soils as backfill. To determine the soil's suitability for reuse, representative samples from the site were collected and submitted for proctor testing (ASTM D698, Method A).

On June 3, 2022, a representative of Grounded collected six (6) samples across the site. The proctor samples were comprised of smaller grab samples, obtained via shovel. The samples were collected from the disturbed soil beneath the organic rich topsoil layer, extending up to 1.0 m depth below grade.

The results of the proctor tests are enclosed with this letter and summarized in the table below.

Table 2.2: Proctor Test Results

Sample ID	Maximum Dry Density (kN/m^3)	Optimum Moisture Content (%)	In Situ Moisture Content (%)	Sample Description (MIT)
P1	17.3	15.1	16.8	Sandy Silt, trace gravel
P2	18.4	12.2	15.8	Silty Sand, trace gravel
P3	17.6	15.6	17.2	Silty Sand, trace gravel
P4	17.8	14.7	17.9	Silty Sand, trace gravel
P5	18.1	13.0	17.4	Silty Sand, trace gravel
P6	17.2	14.8	21.7	Silty Sand, trace gravel

To reuse these soils as backfill, it is required that they be compacted within 2 percent of optimum moisture. On this basis, the disturbed soils on site will require moisture conditioning, which could involve spreading and drying or blending with dryer soils.

Once conditioned, these materials can be used anywhere on the site that requires engineered fill if placed in accordance with our engineered fill specification.

2.4 Frost Heave Susceptibility of Soils

A soil's susceptibility to frost heave is related to the percentage of silt and very fine sand in the soil, as frost heave impacts fine-grained soils with low cohesion and high capillarity. The site soils are classified for susceptibility to frost heave according to their grain size distributions on this basis. Geotechnical laboratory results for this site are appended. Per the Second Edition of the Pavement Design and Rehabilitation Manual by the Ministry of Transportation in Ontario, the following table summarizes the relationship between grain size and frost heave susceptibility:

Table 2.3: Relationship Between Grain Size and Frost Susceptibility (MTO)

Grain Size Percentage between 5 and 75 µm	Susceptibility to Frost Heaving
0 to 40%	Low
40 to 55%	Moderate
55 to 100%	High

Per the grain size data measured in the site soils, frost heave susceptibility is summarized accordingly:

Table 2.4: Summary of Susceptibility to Frost Heave

Stratum	Grain Size Percentage between 5 and 75 µm	Susceptibility to Frost Heaving
Disturbed Soils	Est. 40 to 55%	Moderate
Upper Glacial Till	Est. 40 to 55%	Moderate
Sands	Est. 0 to 55%	Low to Moderate
Lower Glacial Till	Est. 40 to 100%	Moderate to High

3 Preliminary 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.

Based on the factual data summarized above, preliminary geotechnical engineering recommendations are provided. These preliminary recommendations are for due diligence purposes only. They must be supplemented and confirmed by additional boreholes, wells, and a detailed geotechnical engineering report at the detailed design stage.

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 Site Grading

The existing topsoil and other deleterious materials is not geotechnically suitable and must be removed. Topsoil may be re-used in landscaped areas that are not sensitive to settlement or wasted off-site.

It is recommended that all areas of grade raise be placed as engineered fill to ensure full-time quality control of the placed fill. Engineered fill is required for building areas where fill is required to provide structural support for foundations.

Engineered fill shall comprise earth fill that is inorganic, clean, and geotechnically suitable soil sourced from the site or imported.

The disturbed soils (see Sec. 2.1.1) in their current condition are also unsuitable and must be removed beneath the proposed development. These soils must be subexcavated down to the native subgrade. Where the native subgrade was encountered in each of the boreholes is summarized below.

Table 3.1: Summary of Depth/Elevation to Native Soil

Borehole No.	Depth to native soil subgrade (m)	Elevation of native soil subgrade (m)
1	3.0	404.2
2	1.5	402.8
3	2.3	399.7
4	2.3	398.9
5	1.5	405.4
6	1.5	405.7
7	0.8	402.1
8	2.3	398.7
9	2.3	398.3

Borehole No.	Depth to native soil subgrade (m)	Elevation of native soil subgrade (m)
10	1.5	405.2
11	0.8	402.9
12	0.8	400.1
13	1.5	399.0

Representative soil samples were be collected from the disturbed soils on site and tested using the Standard Proctor Maximum Dry Density (SPMDD) method to determine the optimum moisture content and maximum dry density prior to placement and compact as engineered fill. Additional samples from proposed fill material should be tested using the SPMDD method. Moisture content measurements made on disturbed soil samples from the boreholes range from 10 to 27% (on average, 17%). They occasionally contain trace organics. The disturbed soils are suitable for re-use as engineered fill if it is sorted or blended to remove any excess organics, moisture, or other deleterious materials.

Some zones of excavation of the disturbed materials will be required below the recorded groundwater table. In these areas groundwater control may be required for excavation and placement of engineered fill. This could likely be accomplished using perimeter trenches and sumps with pumps.

The proposed subgrade must be cut neat and must be inspected by Grounded to identify any voids, organics, or soft, wet, or weak zones. Any identified areas must be sub-excavated to a competent subgrade. Engineered fill must be made to bear on inspector-approved undisturbed native soil.

All fill must be placed in loose lifts of 150 mm and compacted to a minimum of 98% SPMDD at a moisture content within 2% of optimum and be free of deleterious materials, cobbles/boulders greater than 150 mm in diameter, topsoil, and other organics. Engineered fill must be placed under the full-time supervision of a Geotechnical Engineer, who shall perform frequent in situ density measurements to ensure the uniformity and adequacy of the compaction effort.

Prior to the arrival of imported soil materials, they must be test per the requirements of O.Reg 406/19 and approved by the Environmental QP for the site.

Embedded cobbles and boulders were not directly observed in the boreholes but may be present in all soil units at the site.

Engineered fill may not be readily compacted in small volumes, such as trenches or in areas adjacent to foundations or catch basins. For areas of limited extent, compactable aggregate-source backfills like Granular B (OPSS.MUNI 1010) are recommended for post-construction grade integrity. All new fill shall be compacted to a minimum of 98% SPMDD.

Frost susceptible soils within 1.6 m of finished grades in unheated areas (e.g. pavements) could potentially cause pavements to heave or crack next to other structures (e.g. curbs, catchbasins, etc.). The degree of heaving is unknown. If frost susceptibility is to be considered in design (to be determined by the Owner based on their own pavement performance criteria), all soil placed within 1.6 m of finished grades must be classified to have a low susceptibility to frost heaving, as defined in Section 2.5 above.

Where engineered fill pads tie into existing grades, the engineered fill should extend for a distance of at least 2 m beyond the proposed structure footprints in every direction as measured at the founding level and should extend downwards from this point at no steeper than 1 to 1 (horizontal to vertical) slope to the adjacent ground level.

For the expected heights of engineered fill to be placed, post-construction settlements of the engineered fill itself (i.e. due to self-weight) can be expected to be around 1% of the height of soil placed, depending on the composition of the engineered fill. If the engineered fill is composed of sand or aggregate materials, then post-construction settlements of the engineered fill will be around 0.5% or less and will occur within a week or two. If the engineered fill is sourced from the existing disturbed soils or glacial till from the site similar fine grained soils, it will take several weeks for the majority of post-construction settlement due to self-weight to occur. Post-construction settlement of the underlying sand and till soils should be complete within an estimated 4-6 weeks after completion of engineered fill placement.

3.2 Foundation Design Parameters

The existing topsoil and disturbed soils are not suitable to support the proposed structural foundations.

The design groundwater table for engineering purposes is at Elev. 403.2 m (Borehole 5) at the north end of the site decreasing to Elev. 397.7 m (Borehole 13) at the south end of the site. To minimize groundwater control during construction, bases of footings should be 1± m above the design groundwater table. In the middle of the site (Boreholes 2, 3, 7, 8, 11, 12), the groundwater table is within 0.8 m of the existing ground surface. If basements are proposed in the middle of the site, grade raises are required so that bases of footings are constructed 1± m above the groundwater table.

When exposed to ambient environmental temperatures in the Elora Area, the design earth cover for frost protection of foundations and grade beams is 1.6 metres.

Footings stepped from one elevation to another should be offset at a slope not steeper than 7 vertical to 10 horizontal.

For footings supported on engineered fill or native soil, the minimum width for conventional strip footings must be 600 mm, and the minimum size of individual spread footings must be 800 mm x 800 mm. These minimum 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.

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. During the winter, adequate temporary frost protection for the footing bases and concrete must be provided if construction proceeds during freezing weather conditions.

3.2.1 Spread Footings on Engineered Fill

Structures may be supported on conventional spread footing foundations resting on engineered fill. An engineered fill specification is appended and discussed in Section 3.1.

So long as the engineered fill is placed and compacted as indicated per the specification, spread footings resting on engineered fill may be designed for 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.

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 (common earth fill) – several months

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

Soils at the base of the foundation excavation shall not exceed a maximum particle size of 75 mm. Backfill shall not exceed a maximum particle size of 75 mm in foundation excavations exceeding 1 m in depth. If cobbles and boulders exceeding this maximum particle size are encountered, they will be deemed unsuitable and must be subexcavated and replaced with suitable material.

3.2.2 Spread Footings on Native Soil

In areas where the sub-excavation is less than 1 m from the proposed basement FFE (around Boreholes 5, 6, and 10), the footings may be made on undisturbed native soils. Conventional spread footings made to bear on the native soils may be designed using a maximum factored geotechnical resistance at ULS of 300 kPa. The net geotechnical reaction at SLS 150 kPa, for an estimated total settlement of 25 mm.

3.2.3 Helical Piles

Helical piles may be designed to carry new structural load. Since helical pile installations require little to no excavation, they are a suitable option where the groundwater table is within 1± m of the ground surface. Helical piles can be installed with minimal ground disturbance and minimal excess soil cuttings.

Contractors specializing in helical pile design and installation can provide detailed information on installation methodology, detailed design, product quality, and certification. EBS Geostructural is one local specialist contractor that provides design-build services for Chance helical piles.

At this site, helical piles can be installed to bear into either the very stiff to hard lower glacial till, in order to obtain adequate resistance to support the new loads. The depth/elevation of the lower glacial till encountered across the site is summarized in the table below.

Table 3.2: Summary of Depth/Elevation to Lower Glacial Till

Borehole No.	Depth to lower glacial till (m)	Elevation of lower glacial till (m)
1	Not encountered*	Not encountered*
2	Not encountered*	Not encountered*
3	6.1	395.9
4	4.6	396.6
5	10.7	396.2
6	Not encountered*	Not encountered*
7	7.6	395.3
8	6.1	394.9
9	4.9	395.7
10	12.2	394.5
11	9.1	394.6
12	6.1	394.8
13	5.0	395.5

*boreholes terminated in the sand unit above the lower glacial till

Following helical pile installation, a pile cap or grade beam is constructed to transfer the building loads onto the underlying competent soils through the helical piles. The design earth cover (or equivalent insulation) for frost protection of grade beams exposed to ambient environmental temperatures is 1.6 metres for this location.

There are several helical pile products available. Helical pile detailed design will ultimately depend upon the loading considerations and the ground conditions. The project geotechnical information should be provided to a specialist design/build contractor to assess the feasibility of this foundation system and to determine probable helical pile refusal/installation depths, and capacities.

The actual installation depth of each helical pile is determined on site during installation based on depth and torque measurements made during installation, and the load support requirements. The load carrying capacity of each helical pile is confirmed by the helical pile contractor based on the torque measurements and a full-scale performance test of a prototype/production pile. Occasionally, field torque measurements indicate that helical piles must be advanced deeper than originally designed. Provision must be made in helical pile contracts to allocate and quantify risks associated with any extra time and materials utilized to achieve the required field torque readings.

The presence of debris/obstructions within fill materials or larger sized cobbles or boulders in native soil (although not specifically encountered in the borehole) could impede helical pile installation. Refer to the borehole logs for detailed subsurface information. Provision must be made in helical pile contracts to allocate risks associated with the time spent and equipment utilized to remove or work around such obstructions when encountered.

3.3 Earthquake Design Parameters

The Ontario Building Code stipulates the methodology for earthquake design analysis, as set out in Subsection 4.1.8.7. The determination of the type of analysis is predicated on the importance of the structure, the spectral response acceleration, and the site classification.

The parameters for determination of Site Classification for Seismic Site Response are set out in Table 4.1.8.4A of the Ontario Building Code. The classification is based on the determination of the average shear wave velocity in the top 30 metres of the site stratigraphy, where shear wave velocity (v_s) measurements have been taken. Alternatively, the classification is estimated from the rational analysis of undrained shear strength (s_u) or penetration resistance (N-values) according to the OBC and National Building Code of Canada.

Below the nominal founding elevations, the boreholes observe loose to compact soils. The upper soils have an average N value of 10 overlying the lower glacial till with approximate undrained shear strength of 150 kPa. Based on this information, the site designation for seismic analysis is **Class D**, per Table 4.1.8.4.A of the Ontario Building Code. Tables 4.1.8.4.B and 4.1.8.4.C. of the same code provide the applicable acceleration- and velocity-based site coefficients.

3.4 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.

Table 3.3: Earth Pressure Design Parameters

Stratigraphic Unit	γ	φ	K_a	K_o	K_p
Compact Granular Fill Granular ‘B’ (OPSS.MUNI 1010)	21	32	0.31	0.47	3.25
Disturbed soils	19	29	0.35	0.52	2.88
Upper Glacial Till and Sands	19	30	0.33	0.50	3.00
Lower Glacial Till	21	32	0.31	0.47	3.25

γ = soil bulk unit weight (kN/m^3)
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/m^3)
γ' = submerged soil unit weight (γ - 9.8 kN/m^3)
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 3.6.

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 soil 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 Canadian Foundation Engineering Manual (CFEM) Ed. 4 (0.8)
N = normal load at base of footing (kN)
φ = internal friction angle (see table above)

3.5 Slab on Grade Design Parameters

The proposed townhomes will be constructed with up to one basement level with a subgrade of engineered fill. Some townhomes may rest at grade, with no basement.

Where there is a basement structure, they may be made as a conventional drained structure, a permanent drainage system including subfloor drains is required (see Section 3.6). 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 200 mm thick layer of 19 mm clear stone (OPSS.MUNI 1004) vibrated to a dense state.

A conventional slab on grade would be made on an engineered fill pad. An engineered fill specification is appended and discussed in Section 3.1. Unacceptable material (as determined by Grounded) must be subexcavated and replaced with Granular B (OPSS.MUNI 1010) compacted to a minimum of 98% SPMDD. The modulus of subgrade reaction appropriate for design of the slab on grade resting on engineered fill soils is 22,000 kPa/m.

3.6 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 conventional slab-on-grade structures with no basement, perimeter drainage is not needed where the finished floor is 200 mm higher than exterior grade. Drainage of the subgrade is required where doors are flush to grade or in areas where the finished floor is less than 200 mm higher than grade. This is to prevent impaired door function during winter months.

For a conventional drained basement approach, perimeter and subfloor drainage systems are required for the underground structure. Subfloor drainage collects and removes the seepage that infiltrates under the floor. Perimeter drainage collects and removes seepage that infiltrates at the foundation walls. If subdrain elevation conflicts with top of footing elevation, footings should be lowered as necessary.

The walls of the substructure are to be fully drained to eliminate hydrostatic pressure. 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.

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 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. 22-084).

3.7 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.

3.7.1 Bedding

The soil subgrade encountered within utility trenches on site may consist of either disturbed soil or native soil. If disturbed soil 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.

It is recommended that trenches stay 1± m above the groundwater table.

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.

3.7.2 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.
- 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 Design Advice

4.1 Pavement Engineering Recommendations

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

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 or Region 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. If this is the case, the relevant specifications should be reviewed in detail.

4.1.1 Pavement Subgrade Preparation

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 disturbed soils, 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.

4.1.2 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**

The existing native soils have a moderate susceptibility to frost heave, and pavement on these materials must be designed accordingly.

4.1.3 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 and disturbed soils are Type 3 soils
- The wet sands are Type 4 soils, or Type 3 soils if dewatered
- The glacial tills are Type 2 soils

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:

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 238 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 an/or disturbed 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.

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 design groundwater table for engineering purposes is at Elev. 403.2 m at the north end of the site decreasing to Elev. 397.7 m at the south end of the site. The groundwater table is approximately 3± m below existing grade at the north and south ends of the site. However, in the middle of the site (Borehole 2, 3, 7, 8, 11, 12) the groundwater table is within 1± m of the existing ground surface. There is also perched water in the disturbed soils which is flowing down towards the groundwater table.

The sands will produce free flowing water below the groundwater table. Therefore, it is recommended that all excavations remain 1± m above the design groundwater table. Where excavations are 1± m above the design groundwater table, there is still infiltrated stormwater in the upper stratigraphy. It is expected that infiltrated stormwater, if encountered, will be of limited extent. Infiltrated stormwater may be allowed to drain into the excavation and then pumped out. In open excavations, it is anticipated that seepage volumes will be limited to the extent that temporary pumping will sufficiently control any groundwater seepage. Regardless, excavation delays will occur as seepage (however limited) is controlled. These delays should be anticipated in the construction schedule.

It may not be possible to keep excavations 1± m above the design groundwater table in the middle of the site (around Boreholes 2, 3, 7, 8, 11, 12). Dewatering to lower the groundwater table will be required to facilitate construction as well as to maintain the integrity of the subgrade for engineered fill placement. This could likely be accomplished using perimeter trenches and sumps with pumps. Dewatering will take some time to accomplish prior to the start of excavation. Failure to dewater prior to excavation will result in unrecoverable disturbance of the subgrade, which will render advice provided for undisturbed subgrade conditions inapplicable.

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.

5.3 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 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.

5.4 Engineering Review

By issuing this preliminary 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 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 4.2.2.2 of the 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.

The long-term performance of a slab on grade is highly dependent upon the subgrade support and drainage conditions. 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 and the compaction of all fill should be monitored by Grounded at the time of construction to confirm material quality, thickness, and to ensure adequate compaction.

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 to review the structural engineering drawings prior to issue or construction to ensure that the recommendations in this report have been appropriately implemented.

This preliminary geotechnical engineering study is intended for due diligence purposes only. At detailed design, additional site-specific boreholes, groundwater monitoring wells, and updated detailed geotechnical engineering advice are required. Once completed, the future detailed geotechnical engineering report by Grounded Engineering would then supersede this preliminary report.

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.

This report provides preliminary geotechnical engineering advice intended for use by the owner and their retained design team for due diligence only. These preliminary interpretations, design parameters, advice, and discussion on construction considerations are not complete. A detailed site-specific geotechnical investigation must be conducted by Grounded during detailed design to confirm and update the preliminary recommendations provided here.

6.3 Report Use

The authorized users of this report are Elora 7 OP Inc. 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 local municipal/regional governing bodies 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,

GROUNDED
ENGINEERING

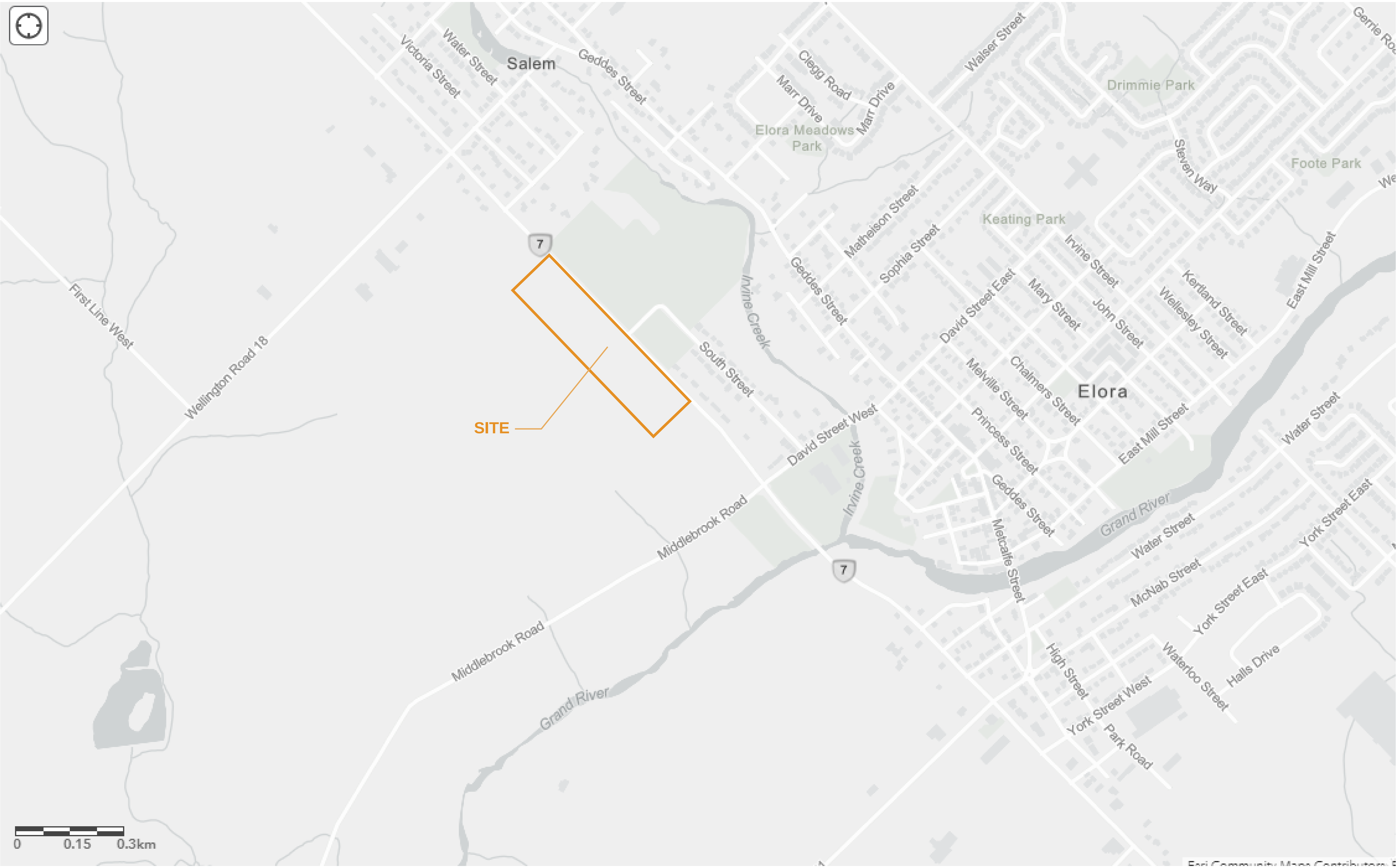
LICENSED PROFESSIONAL ENGINEER
J. J. HUNTER
100513420
17/10/2022
PROVINCE OF ONTARIO

LICENSED PROFESSIONAL ENGINEER
J. J. CROWDER
100077148
17/10/2022
PROVINCE OF ONTARIO

Jory Hunter, B.Sc.(Eng.), P.Eng.
Project Engineer

Jason Crowder, Ph.D., P.Eng.
Principal

FIGURES



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LEGEND

— APPROXIMATE PROPERTY BOUNDARY

Note

Reference

ArcGIS Map

Project

350 WELLINGTON ROAD 7
ELORA, ONTARIO

Figure Title

SITE LOCATION PLAN

North

TRUE
PROJECT

Date

MAY 2022

Scale

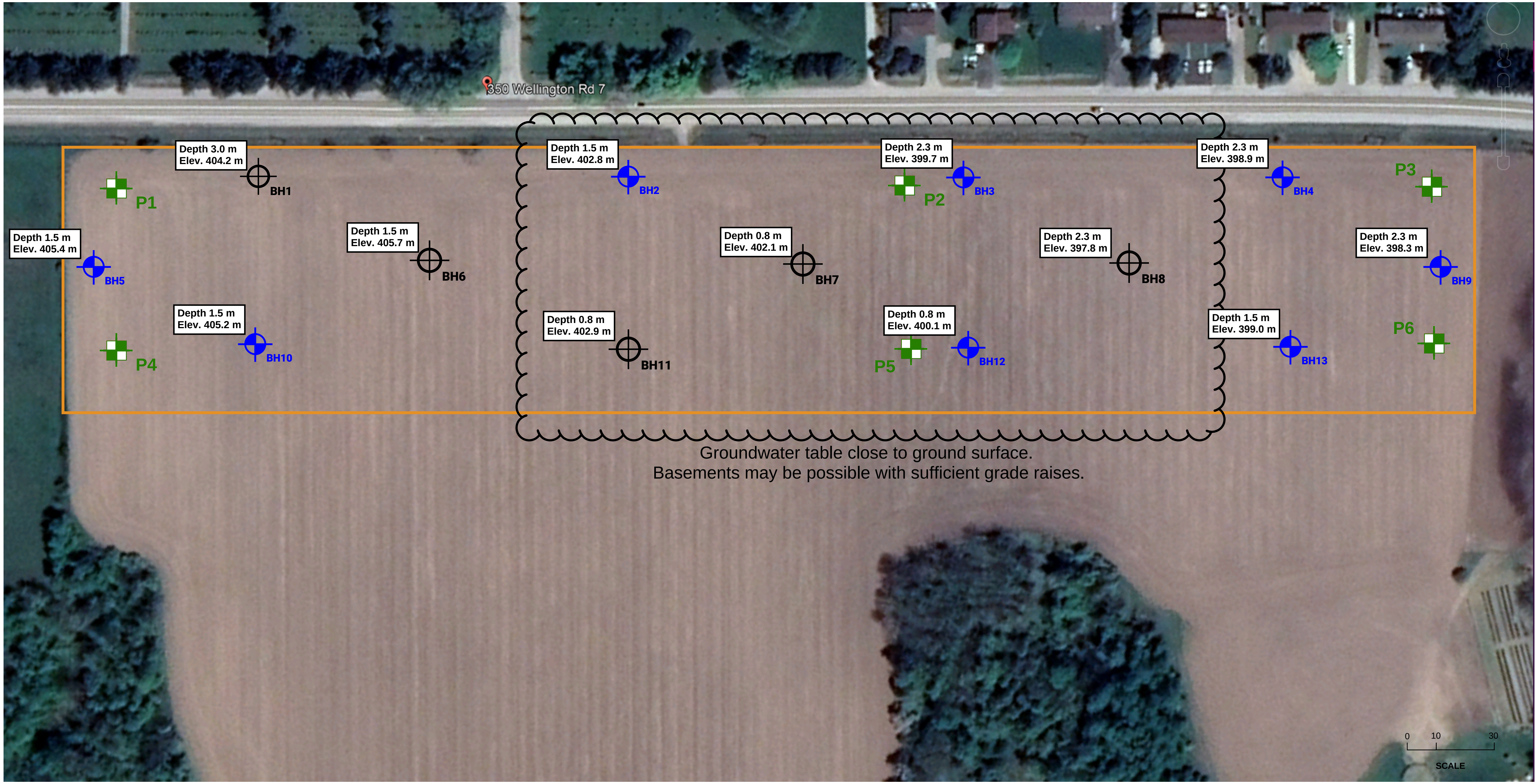
AS INDICATED

Job No

22-084

Figure No

FIGURE 1



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LEGEND

—	APPROXIMATE PROPERTY BOUNDARY
⊕	BH **WITH** MONITORING WELL
⊕	BH
✚	APPROXIMATE PROCTOR TEST LOCATION
Depth 2.3 m Elev. 398.3 m	DEPTH/ELEVATION OF SOIL TO BE SUBEXCAVATED (TOP OF NATIVE SOILS)

Note

Reference

Google Earth

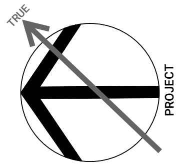
Project

350 WELLINGTON ROAD 7
ELORA, ONTARIO

Figure Title

BOREHOLE LOCATION PLAN

North



Date

MAY 2022

Scale

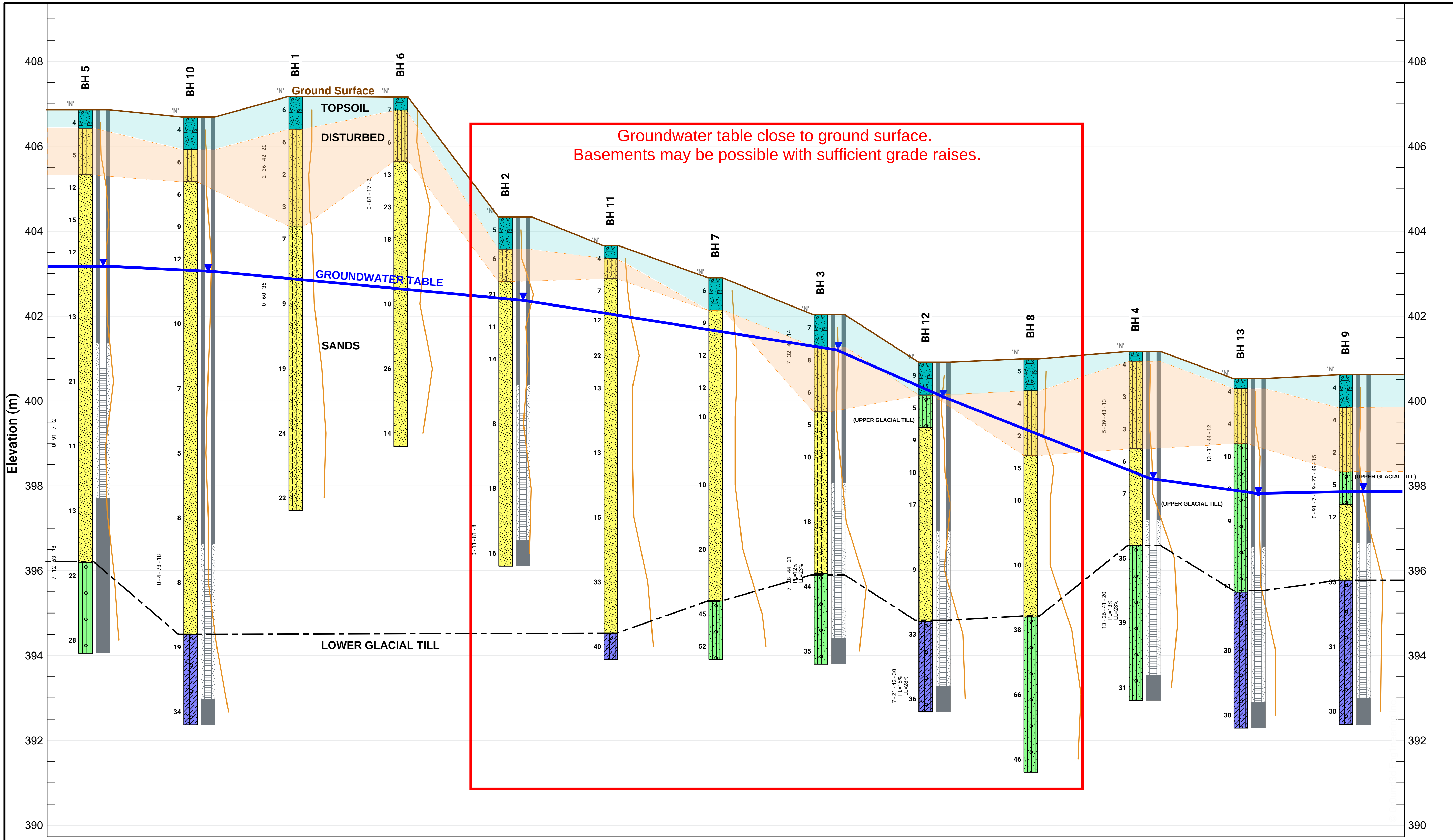
AS INDICATED

Job No

22-084

Figure No

FIGURE 2

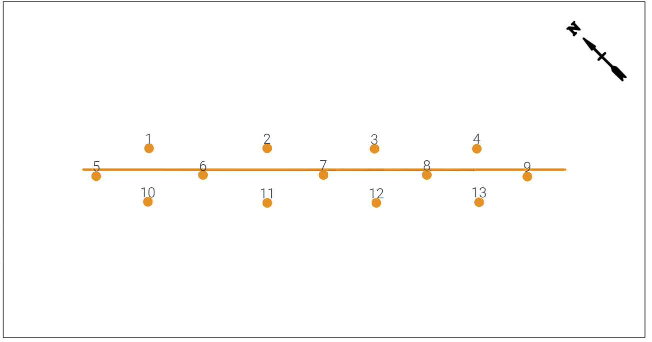


Groundwater table close to ground surface.
Basements may be possible with sufficient grade raises.

Boreholes Equally Spaced

SITE MAP

Alignment: PROFILE



file: 22-084 gint.gpj

BOREHOLE STRATIGRAPHY LEGEND

- Topsoil
- Sandy Silt
- Clayey Silt Till
- Silt and Sand
- Sandy Silt Till
- Silty Sand
- Silty Till
- Sand
- Sand and Silt

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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

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

Project
350 WELLINGTON ROAD 7
ELORA, ON

Figure Title
SUBSURFACE PROFILE

Date
JUNE 2022

Scale
AS INDICATED

Job No
22-084

Figure No
FIGURE x

APPENDIX A

BOREHOLE LOG TERMINOLOGY

GROUNDED ENGINEERING

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

▽ unstabilized water level

▼ 1st water level measurement

▼ 2nd water level measurement most recent

▼ 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

COMPOSITION

Term	% by weight
trace silt	<10
some silt	10 - 20
silt***y***	20 - 35
sand ***and*** silt	>35

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

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.

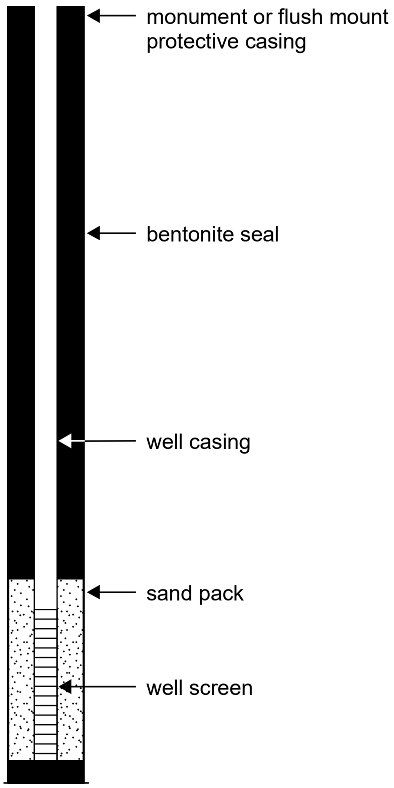
ASTM D3441 Cone Penetration Test (CPT)
Pushing an internal still rod with a outer hollow rod ("sleeve") tipped with a cone with an apex angle of 60° and a cross-sectional area of 1000 mm^2 into soil. The resistance is measured in the sleeve and at the tip to determine the skin friction and the tip resistance.

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



Date Started : May 16, 2022
Position : E: 544825, N: 4837273 (UTM 17T)
Elev. Datum : Geodetic

BOREHOLE LOG 1

File No. : 22-084
Project : 350 Wellington Road 7, Elora, ON
Client : Elora 7 OP Inc.

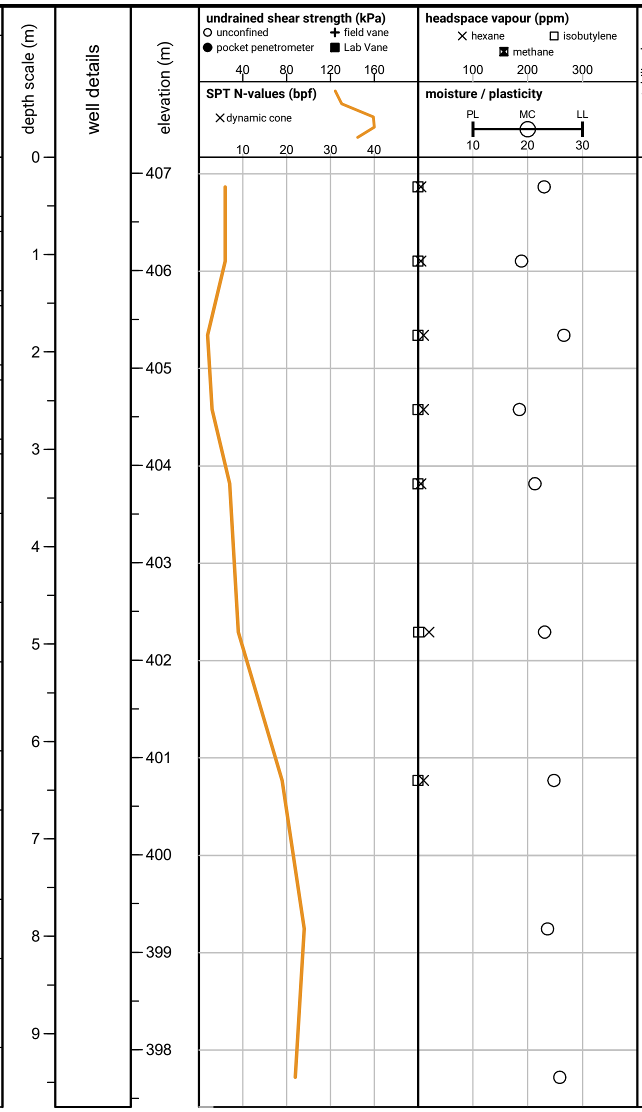
drill method : CME 55

hollow stem augers OD=215 mm

elev depth (m)	description
407.2	**GROUND SURFACE**
	760mm **TOPSOIL**
406.4 0.8	**SILT AND SAND**, some clay, trace gravel, loose to very loose, brown, moist (DISTURBED) ...at 1.5 m, wet ...at 2.3 m, silty sand
404.2 3.0	**SILTY SAND**, trace clay, loose, light brown, moist to wet ...at 4.6 m, sand and silt, wet ...at 6.1 m, compact
397.4 9.8	**END OF BOREHOLE**

Borehole was filled with drill water upon completion of drilling.

number	type	SPT N-value	lab data and comments: grain size distribution (%) (MIT) GR SA SI CL
1	SS	6	
2	SS	6	
3	SS	2	2 36 42 20
4	SS	3	
5	SS	7	
6	SS	9	0 60 36 4
7	SS	19	
8	SS	24	
9	SS	22	



Date Started : May 9, 2022
Position : E: 544929, N: 4837169 (UTM 17T)
Elev. Datum : Geodetic

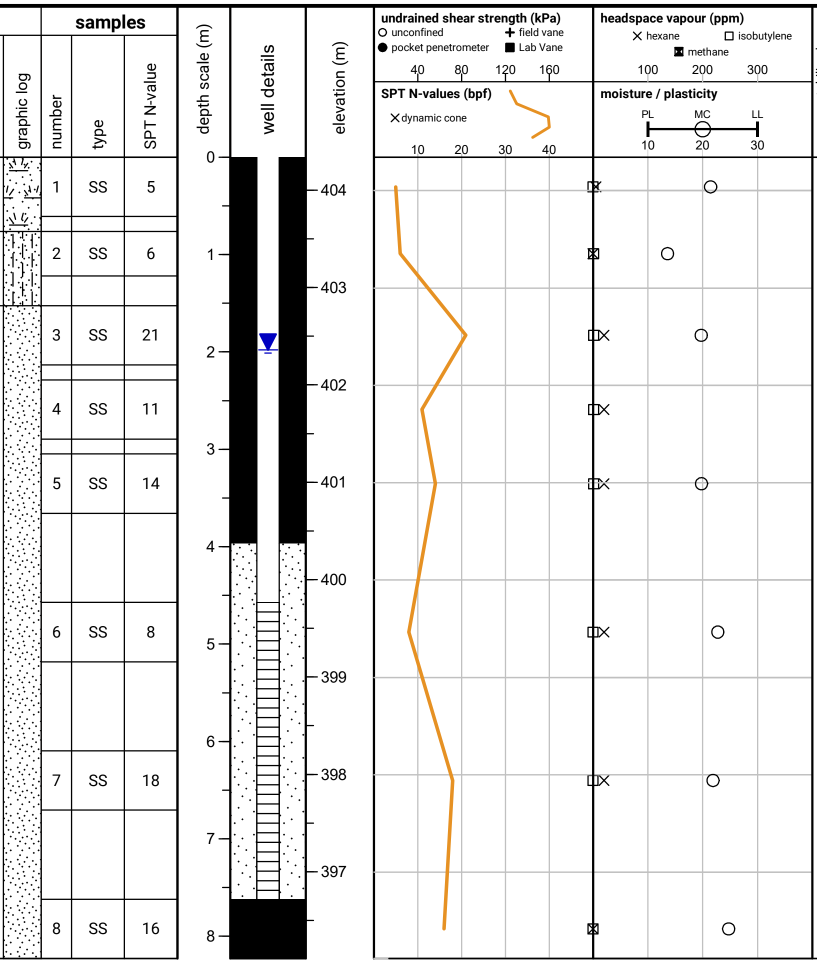
BOREHOLE LOG 2

File No. : 22-084 **Project** : 350 Wellington Road 7, Elora, ON **Client** : Elora 7 OP Inc.

drill method : CME 55

hollow stem augers OD=215 mm

elev depth (m)	stratigraphy description	samples number	type	SPT N-value	lab data and comments
404.3	**GROUND SURFACE**				
	760mm **TOPSOIL**	1	SS	5	
403.5 0.8	**SILTY SAND**, trace clay, loose, brown, moist (DISTURBED)	2	SS	6	SS2: PAHs
402.8 1.5	**SAND**, some silt, trace clay, compact, light brown, wet	3	SS	21	SS3: BTEX, PHCs, VOCs, Pesticides
	...at 2.3 m, silty	4	SS	11	SS4: H-Ms, Metals, ORPs, PCBs, PHCs
		5	SS	14	
	...at 4.6 m, some silt, loose	6	SS	8	
	...at 6.1 m, compact	7	SS	18	**6.1m:** blowback after drilling to 20', unable to remove drill bit from HSA. Removed augers & re-drilled with water to advance SS7: H-Ms, Metals, ORPs, PHCs, VOCs
	...at 7.6 m, silt, some sand	8	SS	16	grain size distribution (%) (MIT) GR SA SI CL: 0 11 81 8
396.1 8.2					



END OF BOREHOLE

Unstabilized water level measured at 2.7 m below ground surface upon completion of drilling.

50 mm dia. monitoring well installed.
No. 10 screen

GROUNDWATER LEVELS

date	depth (m)	elevation (m)
May 17, 2022	1.9	402.4
May 27, 2022	1.9	402.4
Jun 3, 2022	2.0	402.3

Tech : DI | **PM** : JN/JH | **Rev** : JH

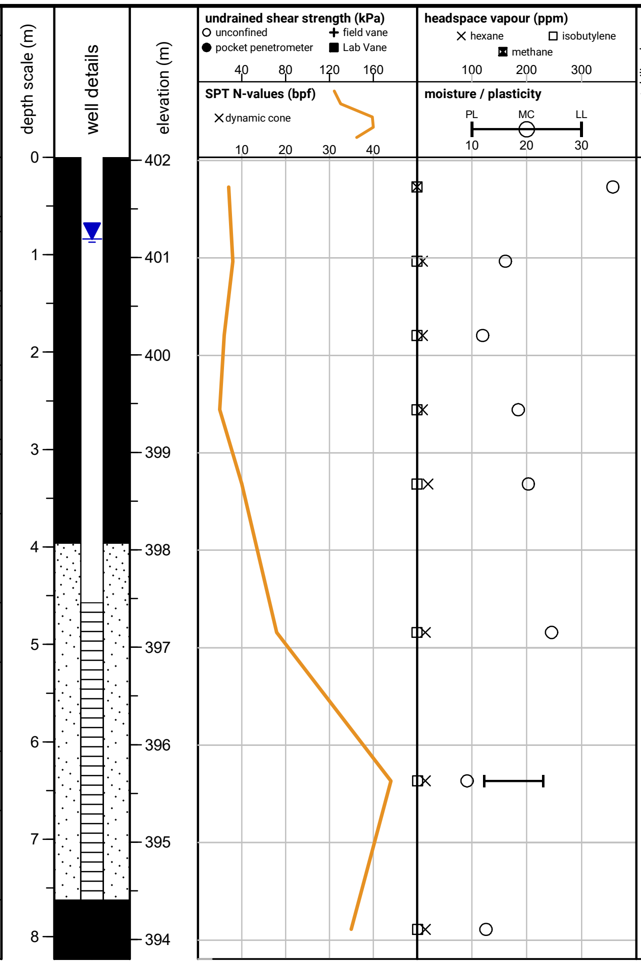
Date Started : May 10, 2022
Position : E: 545023, N: 4837074 (UTM 17T)
Elev. Datum : Geodetic

BOREHOLE LOG 3

File No. : 22-084 **Project** : 350 Wellington Road 7, Elora, ON **Client** : Elora 7 OP Inc.

drill method : CME 55
hollow stem augers OD=215 mm

elev depth (m)	stratigraphy description	sample number	type	SPT N-value	lab data and comments (grain size distribution (%) (MIT) GR SA SI CL)
402.0	**GROUND SURFACE**				
	760mm **TOPSOIL**	1	SS	7	
401.2 0.8	**SANDY SILT**, some clay, trace gravel, trace organics, loose, brown, wet (DISTURBED)	2	SS	8	7 32 47 14 SS2: H-Ms, Metals, ORPs, OCs
	...at 1.5 m, brown	3	SS	6	SS3: PAHs, PCBs
399.7 2.3	**SILTY SAND**, trace clay, trace gravel, loose, brown, wet	4	SS	5	
		5	SS	10	SS5: BTEX, PHCs, VOCs
	...at 4.6 m, sand and silt, compact	6	SS	18	SS6: H-Ms, Metals, ORPs, PAHs
395.9 6.1	**SANDY SILT**, some clay, trace gravel, hard, grey, moist (GLACIAL TILL)	7	SS	44	7 28 44 21 SS7: BTEX, PHCs, VOCs
		8	SS	35	
393.8 8.2	**END OF BOREHOLE**				



Borehole was dry upon completion of drilling.

50 mm dia. monitoring well installed.
No. 10 screen

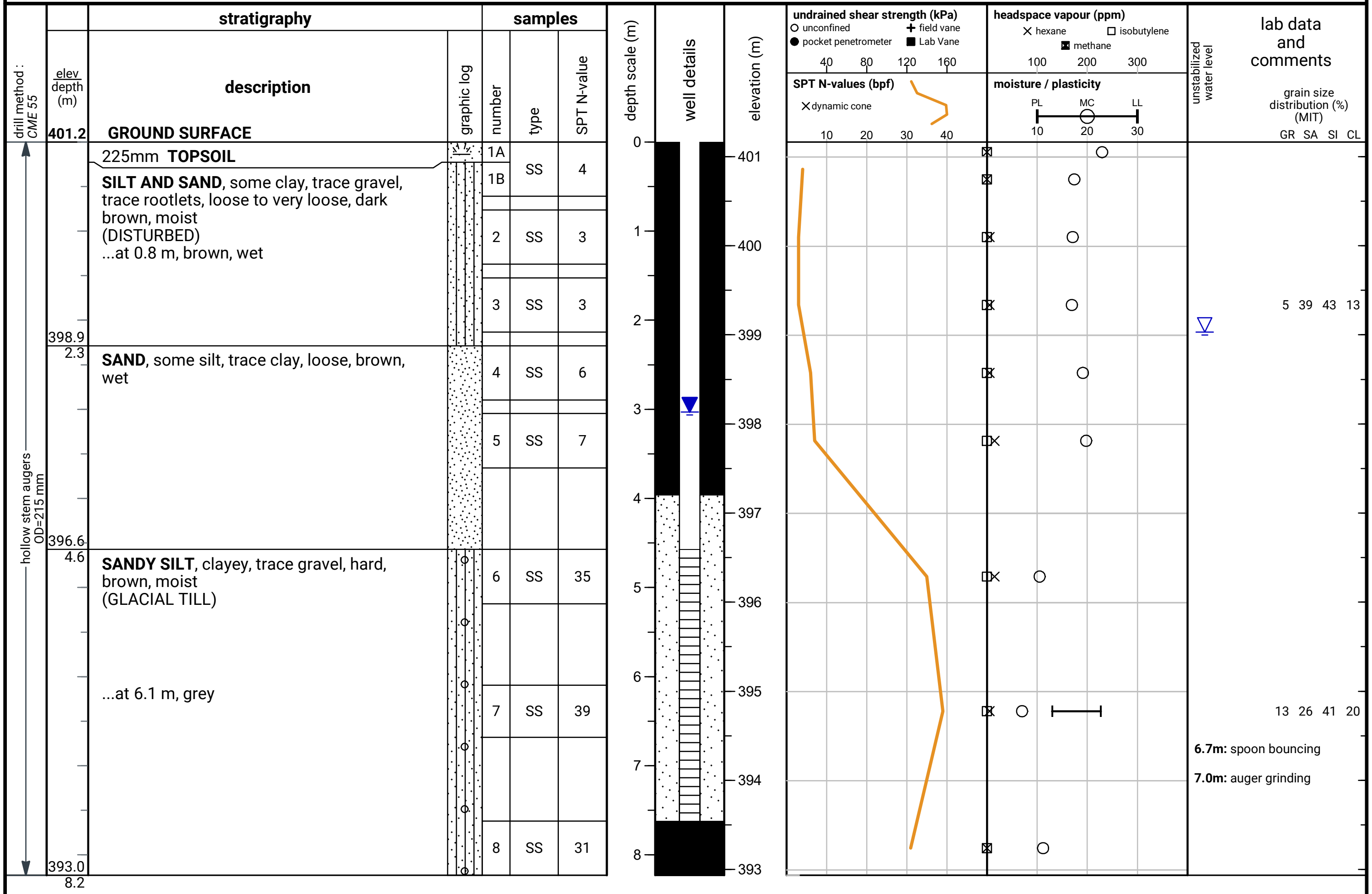
GROUNDWATER LEVELS

date	depth (m)	elevation (m)
May 17, 2022	1.3	400.7
May 27, 2022	0.8	401.2
Jun 3, 2022	0.8	401.2

Date Started : May 12, 2022
Position : E: 545113, N: 4836984 (UTM 17T)
Elev. Datum : Geodetic

BOREHOLE LOG 4

File No. : 22-084
Project : 350 Wellington Road 7, Elora, ON
Client : Elora 7 OP Inc.



elev depth (m)	description
401.2	**GROUND SURFACE**
	225mm **TOPSOIL**
	SILT AND SAND, some clay, trace gravel, trace rootlets, loose to very loose, dark brown, moist (DISTURBED) ...at 0.8 m, brown, wet
398.9 2.3	**SAND**, some silt, trace clay, loose, brown, wet
396.6 4.6	**SANDY SILT**, clayey, trace gravel, hard, brown, moist (GLACIAL TILL) ...at 6.1 m, grey
393.0 8.2	

number	type	SPT N-value	lab data and comments
1A	SS	4	
1B			
2	SS	3	
3	SS	3	5 39 43 13
4	SS	6	
5	SS	7	
6	SS	35	
7	SS	39	13 26 41 20
			6.7m: spoon bouncing
			7.0m: auger grinding
8	SS	31	

END OF BOREHOLE

Unstabilized water level measured at 2.1 m below ground surface upon completion of drilling.

50 mm dia. monitoring well installed.
No. 10 screen

GROUNDWATER LEVELS

date	depth (m)	elevation (m)
May 17, 2022	3.0	398.2
May 27, 2022	3.0	398.2
Jun 3, 2022	3.0	398.2

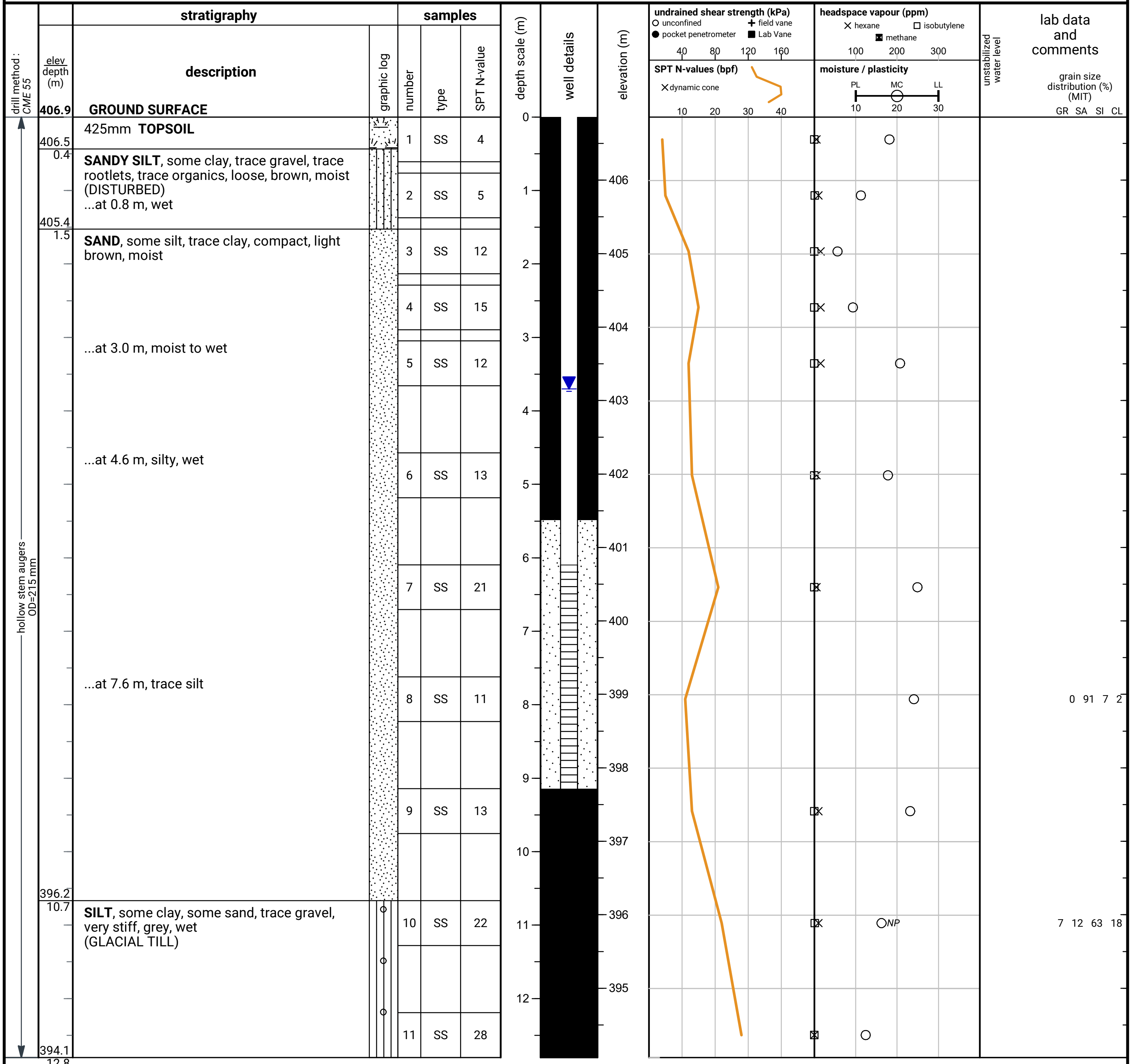
file: 22-084 gint.gpj

Tech : DI | **PM** : JN/JH | **Rev** : JH

Date Started : May 13, 2022
Position : E: 544754, N: 4837295 (UTM 17T)
Elev. Datum : Geodetic

BOREHOLE LOG 5

File No. : 22-084 **Project** : 350 Wellington Road 7, Elora, ON **Client** : Elora 7 OP Inc.



elev depth (m)	description	number	type	SPT N-value	lab data and comments GR SA SI CL
406.9	**GROUND SURFACE**				
	425mm **TOPSOIL**	1	SS	4	
406.5 0.4	**SANDY SILT**, some clay, trace gravel, trace rootlets, trace organics, loose, brown, moist (DISTURBED) ...at 0.8 m, wet	2	SS	5	
405.4 1.5	**SAND**, some silt, trace clay, compact, light brown, moist	3	SS	12	
		4	SS	15	
	...at 3.0 m, moist to wet	5	SS	12	
	...at 4.6 m, silty, wet	6	SS	13	
		7	SS	21	
	...at 7.6 m, trace silt	8	SS	11	0 91 7 2
		9	SS	13	
396.2 10.7	**SILT**, some clay, some sand, trace gravel, very stiff, grey, wet (GLACIAL TILL)	10	SS	22	7 12 63 18
		11	SS	28	
394.1 12.8	**END OF BOREHOLE**				

Borehole was filled with drill water upon completion of drilling.

50 mm dia. monitoring well installed.
No. 10 screen

GROUNDWATER LEVELS

date	depth (m)	elevation (m)
May 17, 2022	3.7	403.2
May 27, 2022	3.7	403.2
Jun 3, 2022	3.7	403.2

BOREHOLE LOG 6

Date Started : May 16, 2022
Position : E: 544849, N: 4837202 (UTM 17T)
Elev. Datum : Geodetic

File No. : 22-084
Project : 350 Wellington Road 7, Elora, ON
Client : Elora 7 OP Inc.

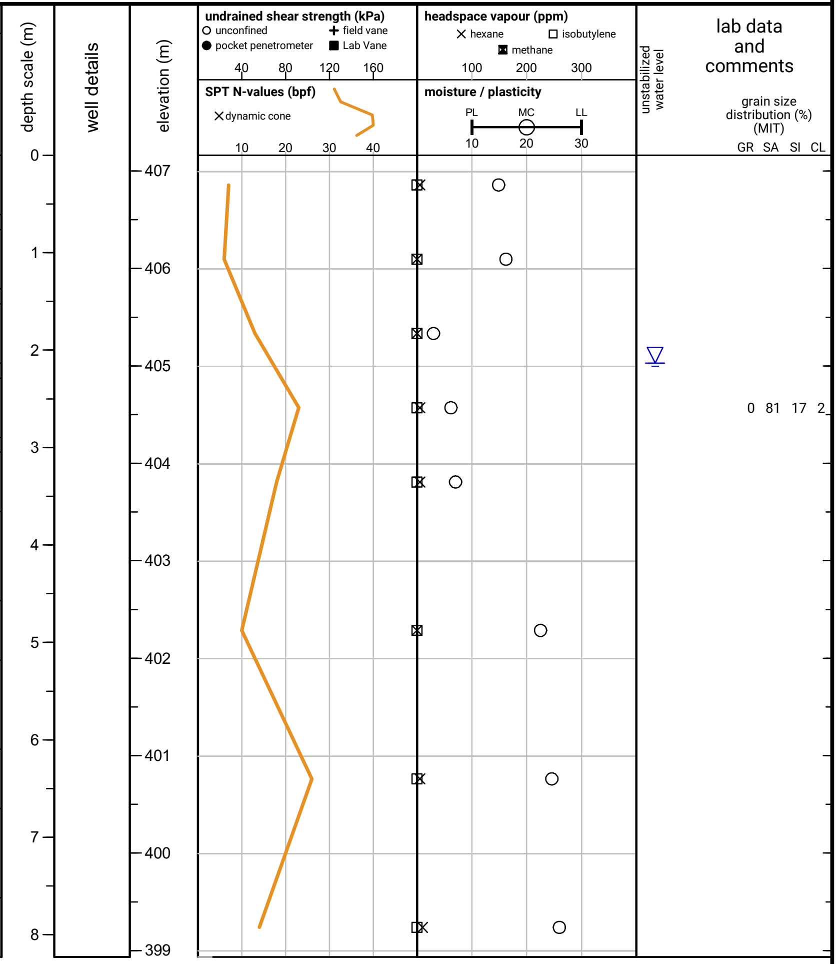
drill method : CME 55

hollow stem augers OD=215 mm

elev depth (m)	description
407.2	**GROUND SURFACE**
	300mm **TOPSOIL**
406.9 0.3	**SAND AND SILT**, some clay, loose, dark brown with orange, moist (DISTURBED)
405.7 1.5	**SILTY SAND**, trace clay, loose to compact, light brown, moist
	...at 4.6 m, sand and silt, wet
	...at 6.1 m, some silt
399.0 8.2	**END OF BOREHOLE**

Unstabilized water level measured at 2.1 m below ground surface upon completion of drilling.

number	type	SPT N-value	grain size distribution (%) (MIT) GR SA SI CL
1	SS	7	
2	SS	6	
3	SS	13	
4	SS	23	0 81 17 2
5	SS	18	
6	SS	10	
7	SS	26	
8	SS	14	



GROUNDED ENGINEERING

Date Started : May 9, 2022
Position : E: 544955, N: 4837096 (UTM 17T)
Elev. Datum : Geodetic

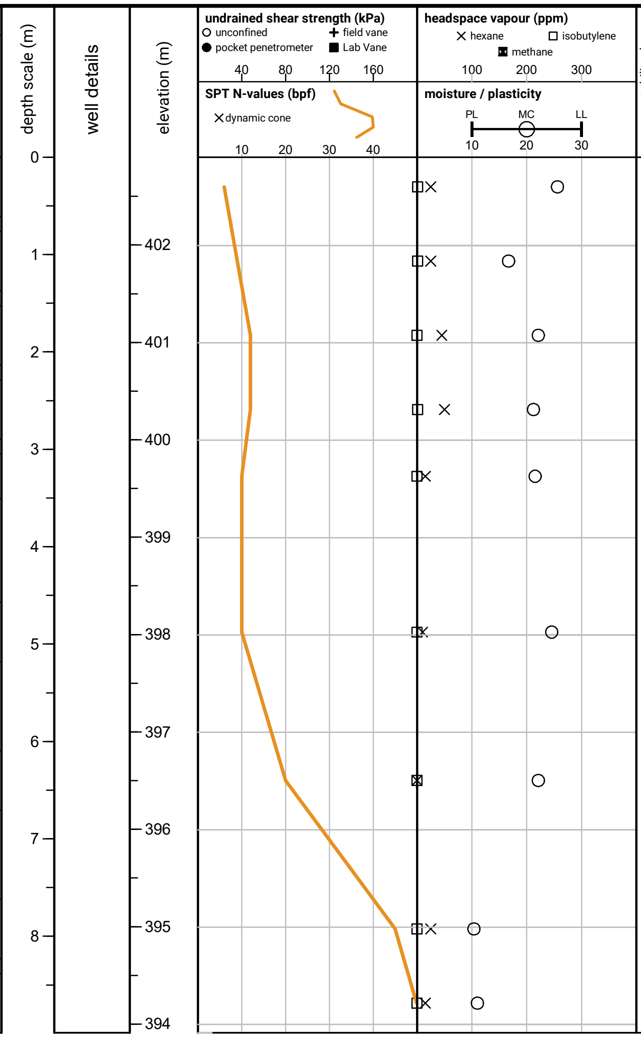
BOREHOLE LOG 7

File No. : 22-084 **Project** : 350 Wellington Road 7, Elora, ON **Client** : Elora 7 OP Inc.

drill method : CME 55

hollow stem augers OD=215 mm

stratigraphy		samples			
elev depth (m)	description	number	type	SPT N-value	lab data and comments
402.9	**GROUND SURFACE**				
	760mm **TOPSOIL**	1	SS	6	
402.1 0.8	**SAND**, some silt, trace clay, trace gravel, loose to compact, brown, wet	2	SS	9	SS2: BTEX, PAHs, PCBs, PHCs, VOCs, Pesticides
	...at 1.5 m, light brown	3	SS	12	SS3: H-Ms, Metals, ORPs
		4	SS	12	SS4: BTEX, PHCs, VOCs
	...at 3.0 m, silty	5	SS	10	
		6	SS	10	
		7	SS	20	
395.3 7.6	**SANDY SILT**, clayey, trace gravel, very stiff, brown, moist (GLACIAL TILL)	8	SS	45	
	...at 8.4 m, grey, hard	9	SS	52	
393.9 9.0					



END OF BOREHOLE

Unstabilized water level measured at 2.1 m below ground surface upon completion of drilling.

file: 22-084 gint.gpj

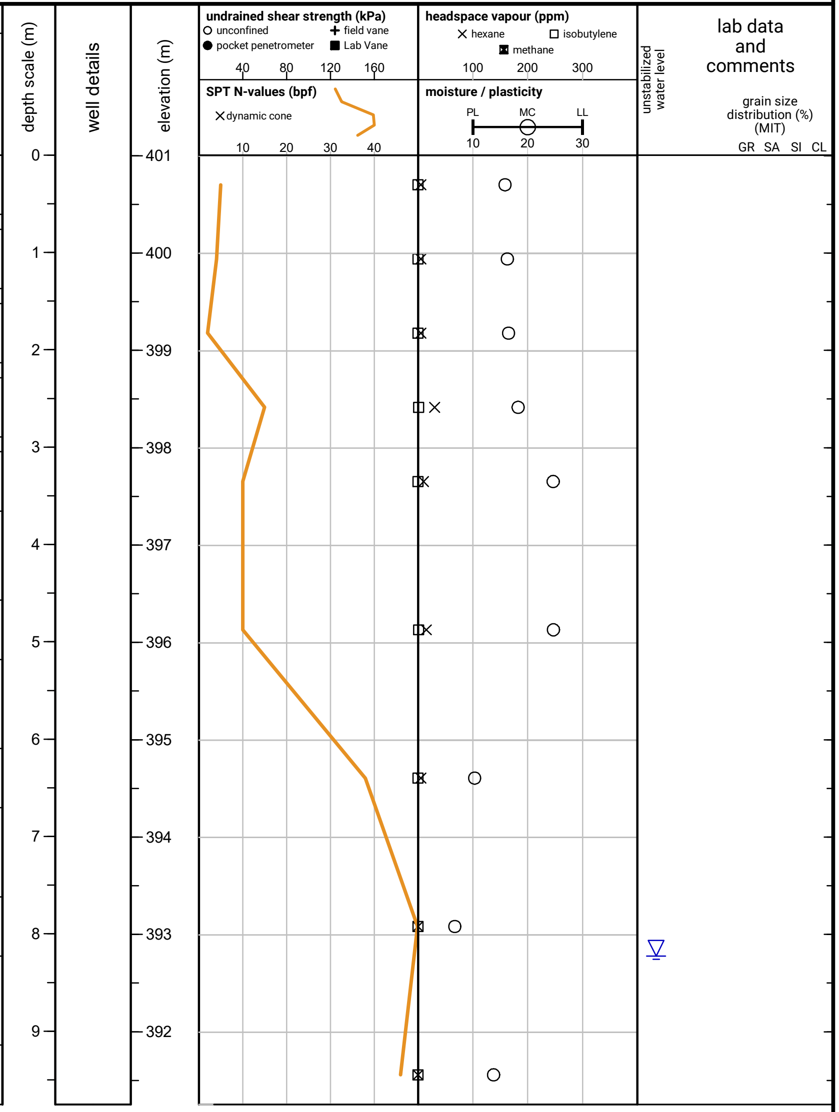
Date Started : May 11, 2022
Position : E: 545046, N: 4837005 (UTM 17T)
Elev. Datum : Geodetic

BOREHOLE LOG 8

File No. : 22-084
Project : 350 Wellington Road 7, Elora, ON
Client : Elora 7 OP Inc.

drill method : CME 55
hollow stem augers OD=215 mm

elev depth (m)	description	graphic log	number	type	SPT N-value
401.0	**GROUND SURFACE**				
	760mm **TOPSOIL**		1	SS	5
400.2 0.8	**SILT AND SAND**, some clay, trace gravel, loose to very loose, brown, wet (DISTURBED)		2	SS	4
	...at 1.5 m, gravel and sand, silty		3	SS	2
398.7 2.3	**SAND**, some silt, trace clay, compact, light brown, wet		4	SS	15
	...at 3.0 m, silty sand		5	SS	10
	...at 4.6 m, some silt		6	SS	10
394.9 6.1	**SANDY SILT**, clayey, trace gravel, hard, grey, moist (GLACIAL TILL)		7	SS	38
	...at 7.6 m, sand and silt, some clay, some gravel, wet, very dense		8	SS	66
	...at 9.1 m, clayey silt, some sand, trace gravel, moist, hard		9	SS	46
391.2 9.8					



END OF BOREHOLE

Unstabilized water level measured at 8.2 m below ground surface upon completion of drilling.

Date Started : May 11, 2022
Position : E: 545133, N: 4836915 (UTM 17T)
Elev. Datum : Geodetic

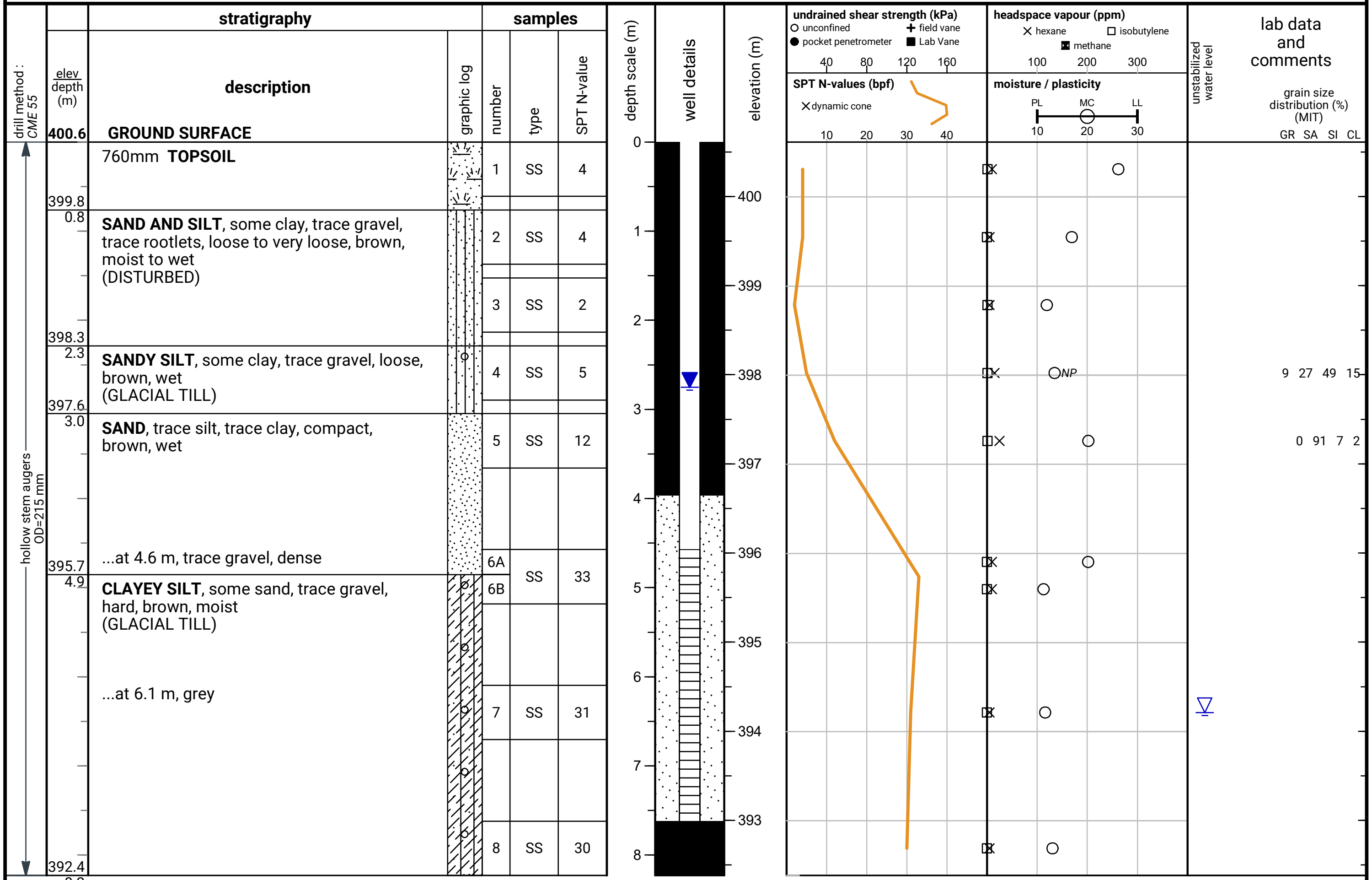
BOREHOLE LOG 9

File No. : 22-084
Project : 350 Wellington Road 7, Elora, ON
Client : Elora 7 OP Inc.

drill method : CME 55
hollow stem augers OD=215 mm

elev depth (m)	description
400.6	**GROUND SURFACE**
399.8 0.8	760mm **TOPSOIL**
398.3 2.3	**SAND AND SILT**, some clay, trace gravel, trace rootlets, loose to very loose, brown, moist to wet (DISTURBED)
397.6 3.0	**SANDY SILT**, some clay, trace gravel, loose, brown, wet (GLACIAL TILL)
395.7 4.9	**SAND**, trace silt, trace clay, compact, brown, wet ...at 4.6 m, trace gravel, dense
392.4 8.2	**CLAYEY SILT**, some sand, trace gravel, hard, brown, moist (GLACIAL TILL) ...at 6.1 m, grey

number	type	SPT N-value	grain size distribution (%) (MIT) GR SA SI CL
1	SS	4	
2	SS	4	
3	SS	2	
4	SS	5	9 27 49 15
5	SS	12	0 91 7 2
6A	SS	33	
6B			
7	SS	31	
8	SS	30	



END OF BOREHOLE

Unstabilized water level measured at 6.4 m below ground surface upon completion of drilling.

50 mm dia. monitoring well installed.
No. 10 screen

GROUNDWATER LEVELS

date	depth (m)	elevation (m)
May 17, 2022	2.6	398.0
May 27, 2022	2.7	397.9
Jun 3, 2022	2.8	397.8

Tech : DI | **PM** : JN/JH | **Rev** : JH

GROUNDED ENGINEERING

Date Started : May 12, 2022
Position : E: 544777, N: 4837227 (UTM 17T)
Elev. Datum : Geodetic

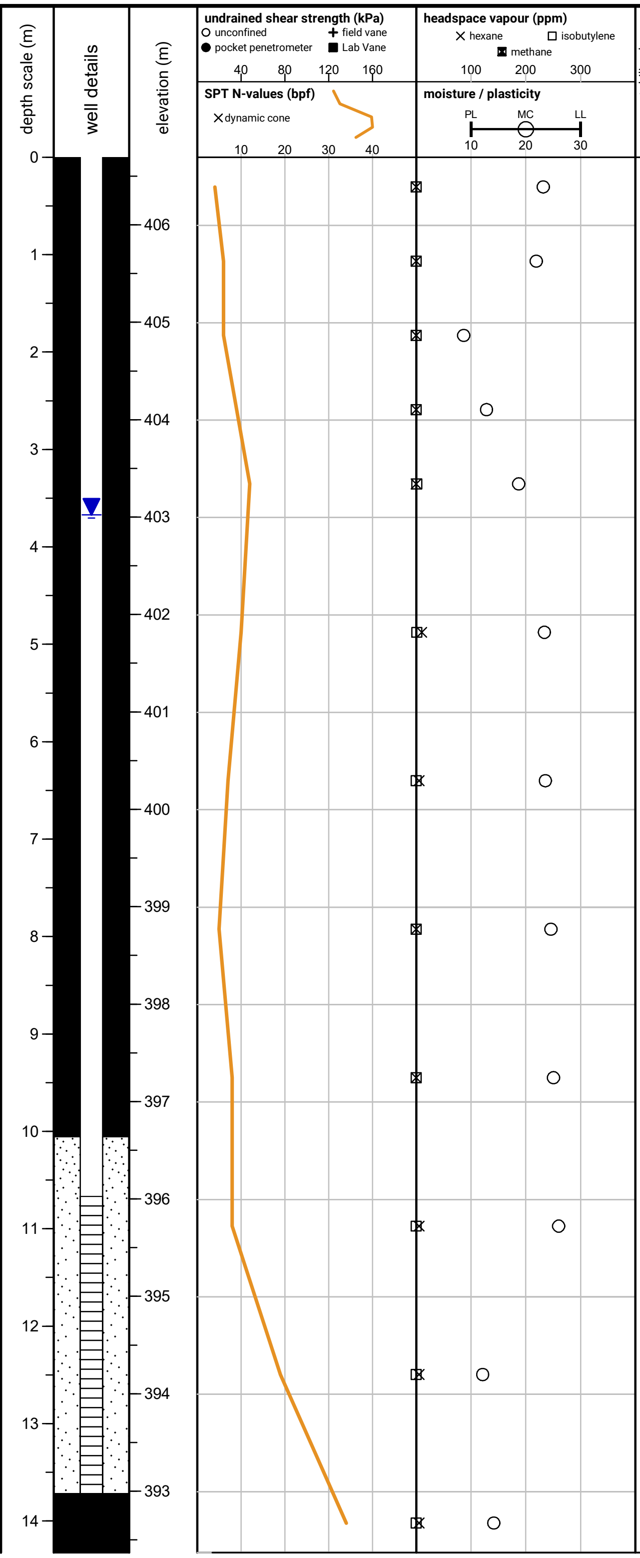
BOREHOLE LOG 10

File No. : 22-084 **Project** : 350 Wellington Road 7, Elora, ON **Client** : Elora 7 OP Inc.

drill method : CME 55

hollow stem augers OD=215 mm

elev depth (m)	stratigraphy description	samples number	type	SPT N-value	lab data and comments grain size distribution (%) (MIT) GR SA SI CL
406.7	**GROUND SURFACE**				
	760mm **TOPSOIL**	1	SS	4	
405.9 0.8	**SAND AND SILT**, some clay, loose, brown, moist (DISTURBED)	2	SS	6	
405.2 1.5	**SAND**, some silt, trace clay, loose, light brown, moist	3	SS	6	
		4	SS	9	
	...at 3.0 m, moist to wet, compact to loose	5	SS	12	
	...at 4.6 m, silty, wet	6	SS	10	
	...at 6.1 m, some silt	7	SS	7	
		8	SS	5	
		9	SS	8	
	...at 10.7 m, silt, some clay, trace sand	10	SS	8	0 4 78 18
394.5 12.2	**CLAYEY SILT**, some sand, trace gravel, very stiff, grey, moist (GLACIAL TILL)	11	SS	19	
	...at 13.7 m, hard	12	SS	34	
392.4 14.3					



END OF BOREHOLE

Borehole was filled with drill water upon completion of drilling.

50 mm dia. monitoring well installed. No. 10 screen

GROUNDWATER LEVELS

date	depth (m)	elevation (m)
May 17, 2022	3.7	403.0
May 27, 2022	3.7	403.0
Jun 3, 2022	3.7	403.0

Tech : DI | **PM** : JN/JH | **Rev** : JH

GROUNDED ENGINEERING

Date Started : May 12, 2022
Position : E: 544881, N: 4837121 (UTM 17T)
Elev. Datum : Geodetic

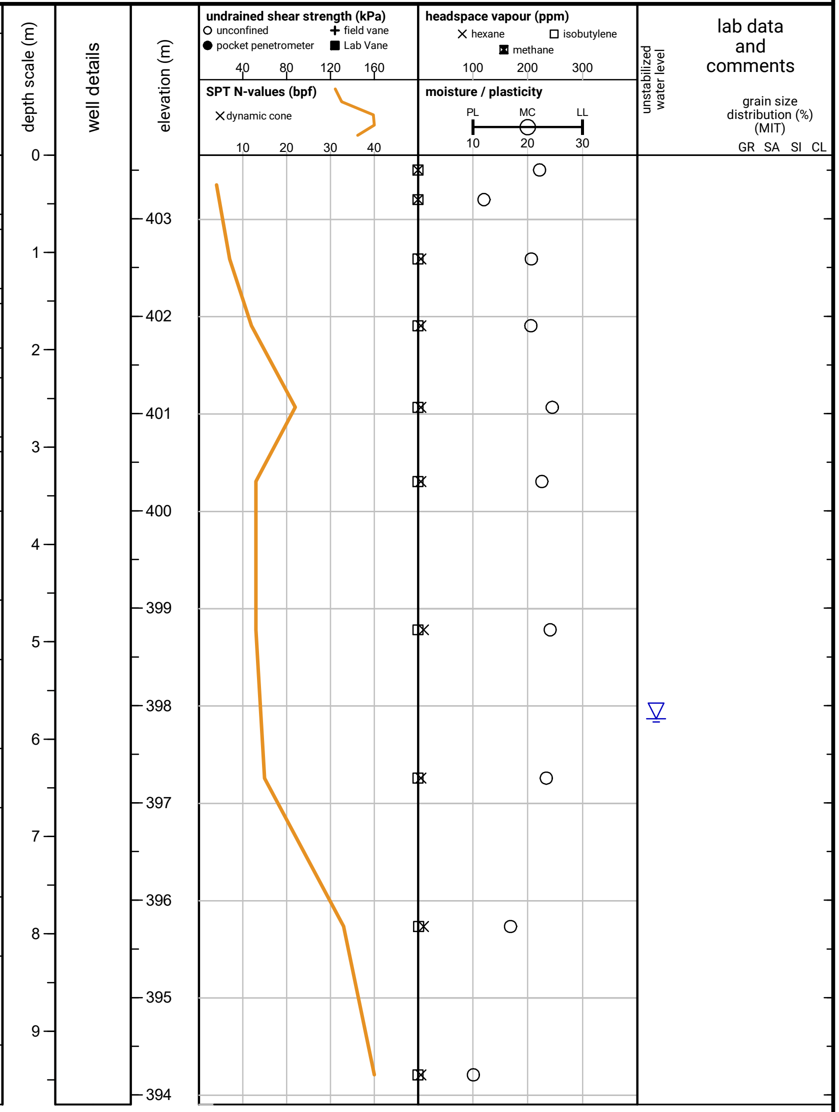
BOREHOLE LOG 11

File No. : 22-084 **Project** : 350 Wellington Road 7, Elora, ON **Client** : Elora 7 OP Inc.

drill method : CME 55

hollow stem augers OD=215 mm

elev depth (m)	description	graphic log	number	type	SPT N-value
403.7	**GROUND SURFACE**				
403.4 0.3	300mm **TOPSOIL**		1A	SS	4
402.9 0.8	**SILTY SAND**, some clay, trace rootlets, organic odour, loose, dark brown, moist (DISTURBED)		1B		
	SAND, some silt, trace clay, loose to compact, light brown, wet		2	SS	7
			3	SS	12
			4	SS	22
			5	SS	13
			6	SS	13
			7	SS	15
	...at 7.6 m, silt, some sand, some clay, dense		8	SS	33
394.6 9.1	**CLAYEY SILT**, sandy, trace gravel, hard, grey, moist (GLACIAL TILL)		9	SS	40
393.9 9.8					



END OF BOREHOLE

Unstabilized water level measured at 5.8 m below ground surface upon completion of drilling.

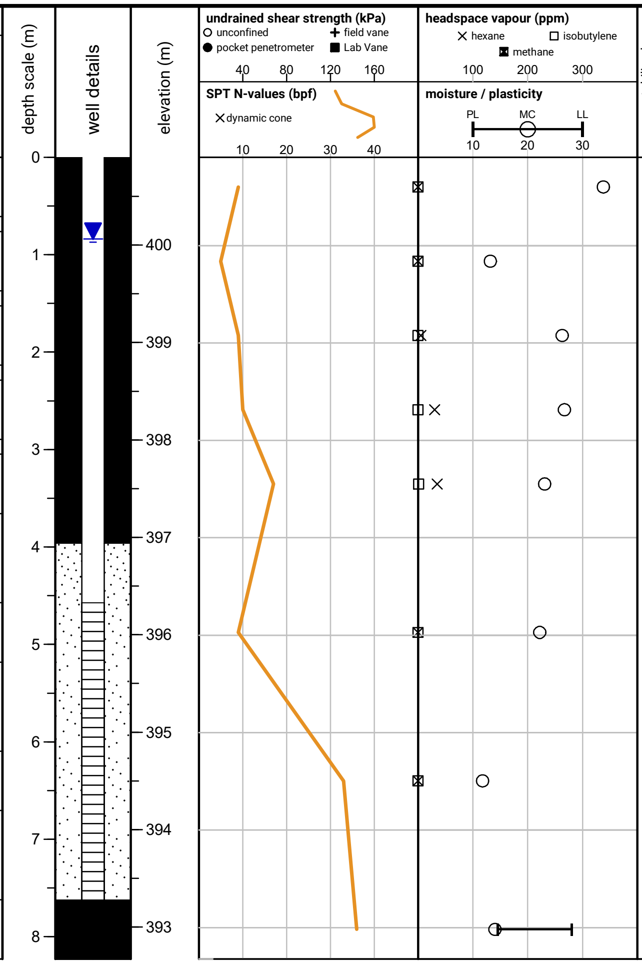
Date Started : May 10, 2022
Position : E: 544977, N: 4837025 (UTM 17T)
Elev. Datum : Geodetic

BOREHOLE LOG 12

File No. : 22-084 **Project** : 350 Wellington Road 7, Elora, ON **Client** : Elora 7 OP Inc.

drill method : CME 55
hollow stem augers OD=215 mm

elev depth (m)	description	number	type	SPT N-value	lab data and comments
400.9	**GROUND SURFACE**				
	760mm **TOPSOIL**	1	SS	9	
400.1 0.8	**SANDY SILT**, trace clay, trace gravel, loose, light brown, wet (GLACIAL TILL)	2	SS	5	SS2: PAHs, PCBs, Pesticides
399.4 1.5	**SAND**, some silt, trace clay, loose to compact, brown, wet	3	SS	9	SS3: H-Ms, Metals, ORPs
		4	SS	10	SS4: PAHs
		5	SS	17	SS5: BTEX, PHCs, VOCs
	...at 4.6 m, silt, some sand, loose	6	SS	9	SS6: H-Ms, Metals, ORPs
394.8 6.1	**CLAYEY SILT**, some sand, trace gravel, hard, grey, moist (GLACIAL TILL)	7	SS	33	SS7: BTEX, PHCs, VOCs
		8	SS	36	GR 7 SA 21 SI 42 CL 30
392.7 8.2					



END OF BOREHOLE

Unstabilized water level measured at 2.1 m below ground surface upon completion of drilling.

50 mm dia. monitoring well installed.
No. 10 screen

GROUNDWATER LEVELS

date	depth (m)	elevation (m)
May 17, 2022	0.8	400.1
May 27, 2022	0.8	400.1
Jun 3, 2022	0.8	400.1

file: 22-084 gint.gpj

Tech : DI | **PM** : JN/JH | **Rev** : JH

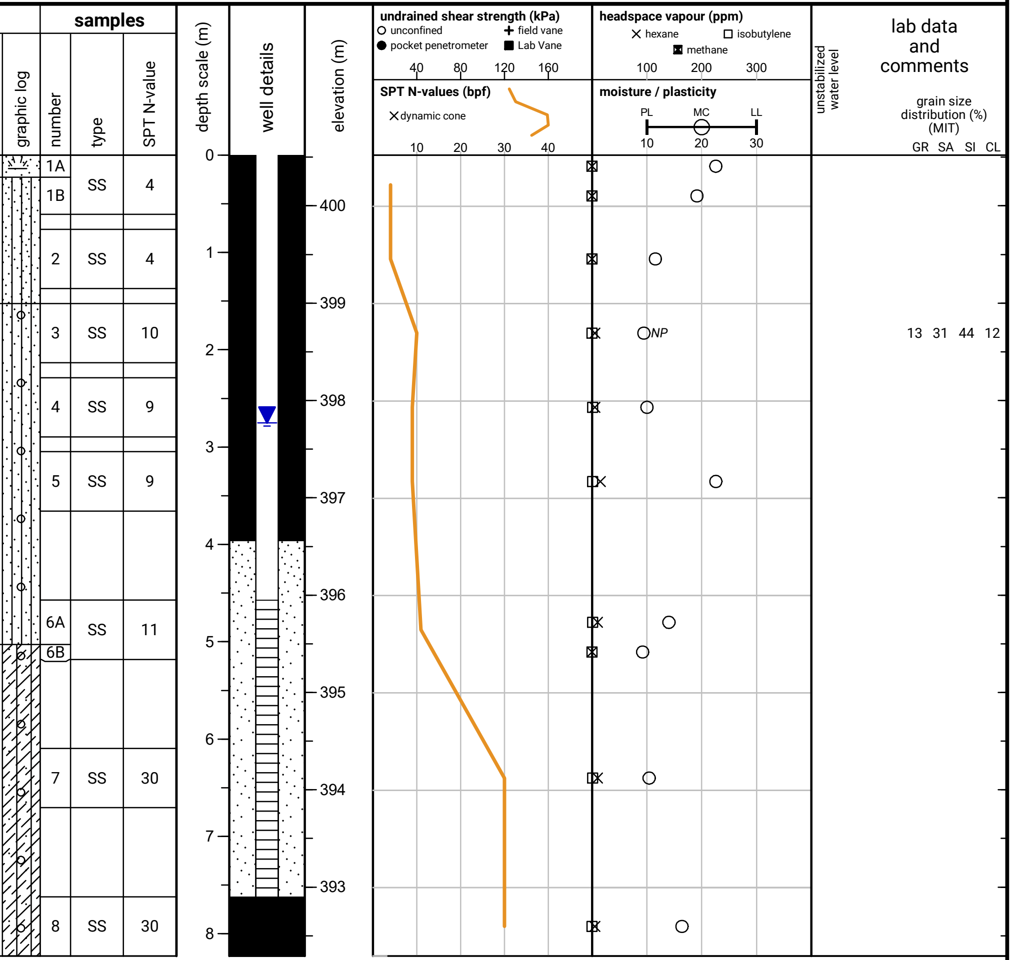
Date Started : May 11, 2022
Position : E: 545068, N: 4836935 (UTM 17T)
Elev. Datum : Geodetic

BOREHOLE LOG 13

File No. : 22-084 **Project** : 350 Wellington Road 7, Elora, ON **Client** : Elora 7 OP Inc.

drill method : CME 55
hollow stem augers OD=215 mm

elev depth (m)	description	number	type	SPT N-value
400.5	**GROUND SURFACE**			
	225mm **TOPSOIL**	1A		
	SAND AND SILT, some clay, trace organics, trace rootlets, loose, brown, moist (DISTURBED)	1B	SS	4
	...at 0.8 m, wet	2	SS	4
399.0 1.5	**SANDY SILT**, some gravel, some clay, loose, brown with mottled orange, wet (GLACIAL TILL)	3	SS	10
	...at 2.3 m, brown, trace rock fragments (cobble inferred)	4	SS	9
	...at 3.0 m, wet sand seam	5	SS	9
	...at 4.6 m, compact	6A	SS	11
395.5 5.0	**CLAYEY SILT**, some sand, trace gravel, stiff, grey, moist (GLACIAL TILL)	6B		
	...at 6.1 m, hard	7	SS	30
		8	SS	30
392.3 8.2				



END OF BOREHOLE

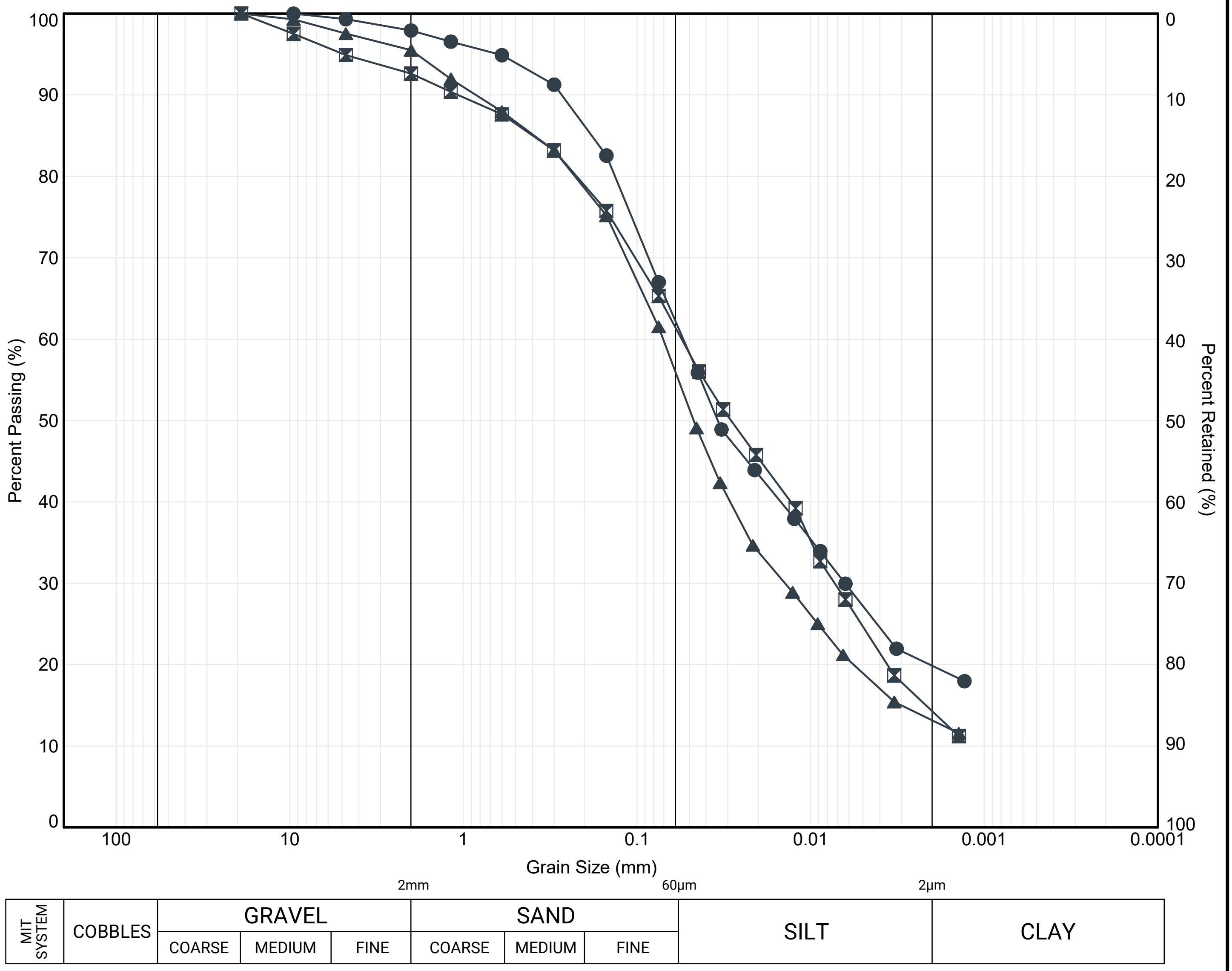
Borehole was dry upon completion of drilling.

50 mm dia. monitoring well installed.
No. 10 screen

GROUNDWATER LEVELS

date	depth (m)	elevation (m)
May 17, 2022	2.6	397.9
May 27, 2022	2.6	397.9
Jun 3, 2022	2.8	397.7

APPENDIX B



MIT SYSTEM

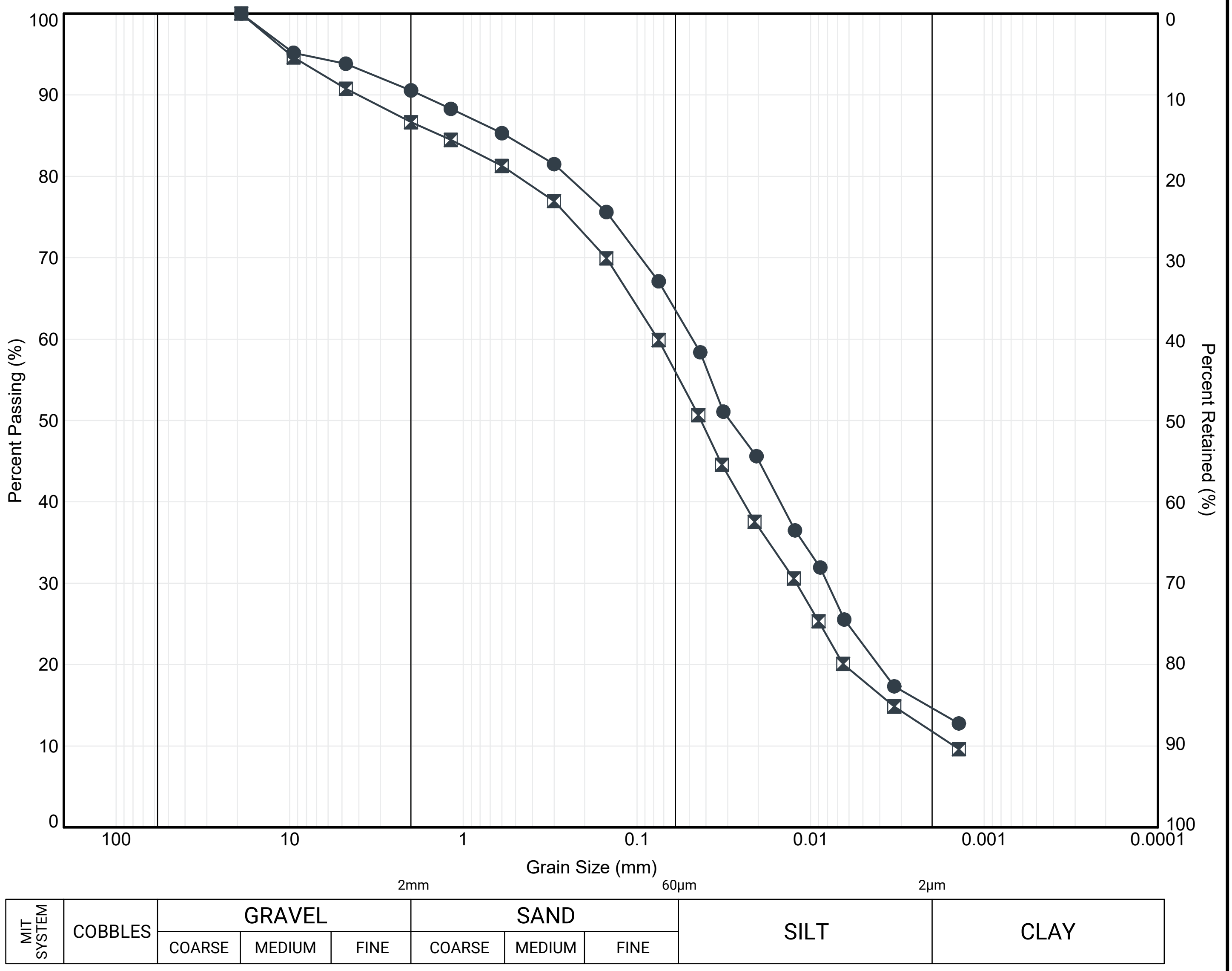
	Borehole	Sample	Depth (m)	Elev. (m)	Gravel (%)	Sand (%)	Silt (%)	Clay (%)
●	**1**	SS3	1.8	405.3	2	36	42	20
☒	**3**	SS2	1.1	401.0	7	32	47	14
▲	**4**	SS3	1.8	399.3	5	39	43	13

GROUNDED ENGINEERING

Title:

GRAIN SIZE DISTRIBUTION
DISTURBED SOILS

File No.: **22-084**



					MIT SYSTEM			
	Borehole	**Sample**	**Depth (m)**	**Elev. (m)**	**Gravel (%)**	**Sand (%)**	**Silt (%)**	**Clay (%)**
●	**9**	SS4	2.6	398.0	9	27	49	15
⊠	**13**	SS3	1.8	398.7	13	31	44	12

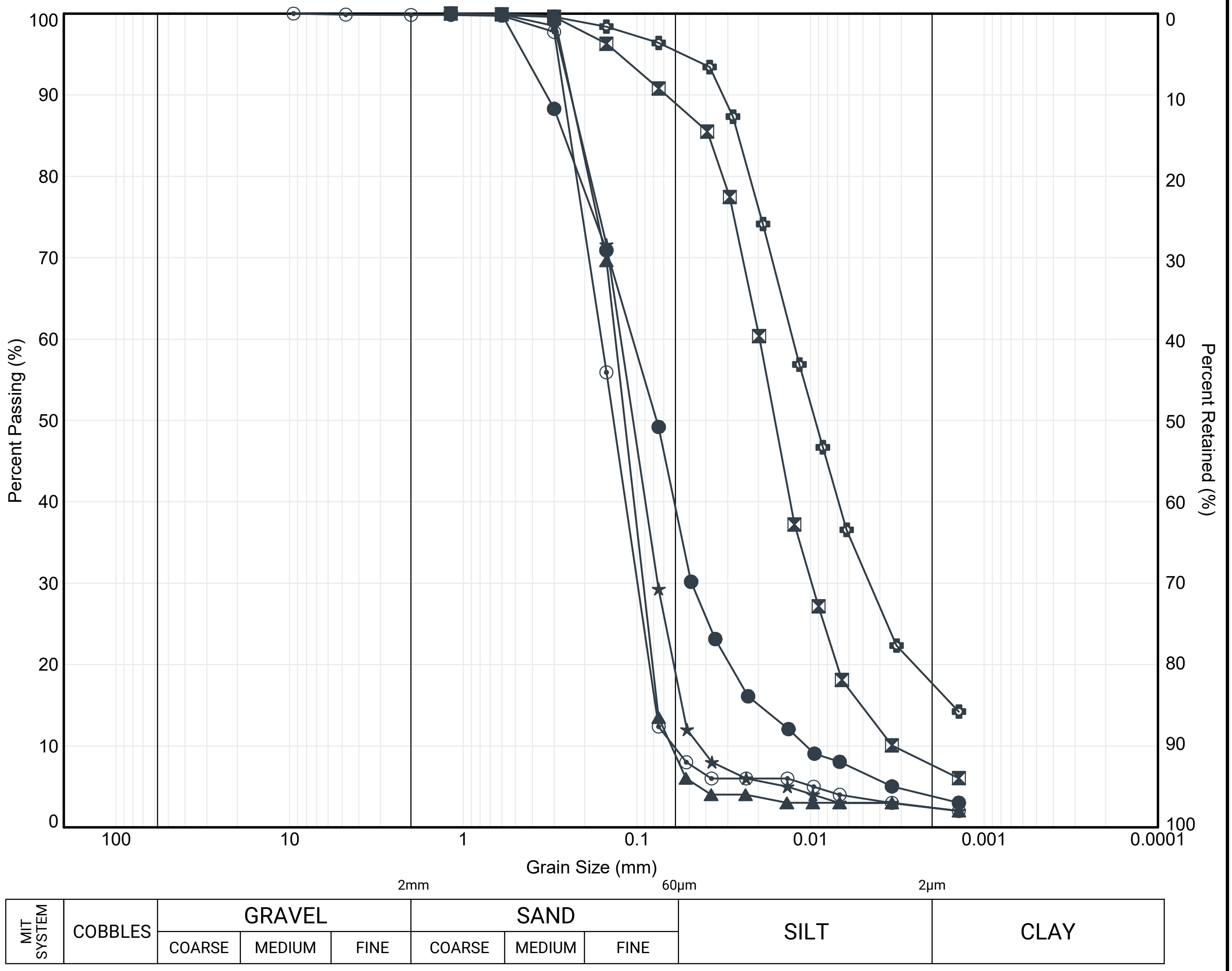
GROUNDED ENGINEERING

Title:

GRAIN SIZE DISTRIBUTION
UPPER GLACIAL TILL

File No.: **22-084**

file: 22-084 gint.gpi



MIT SYSTEM

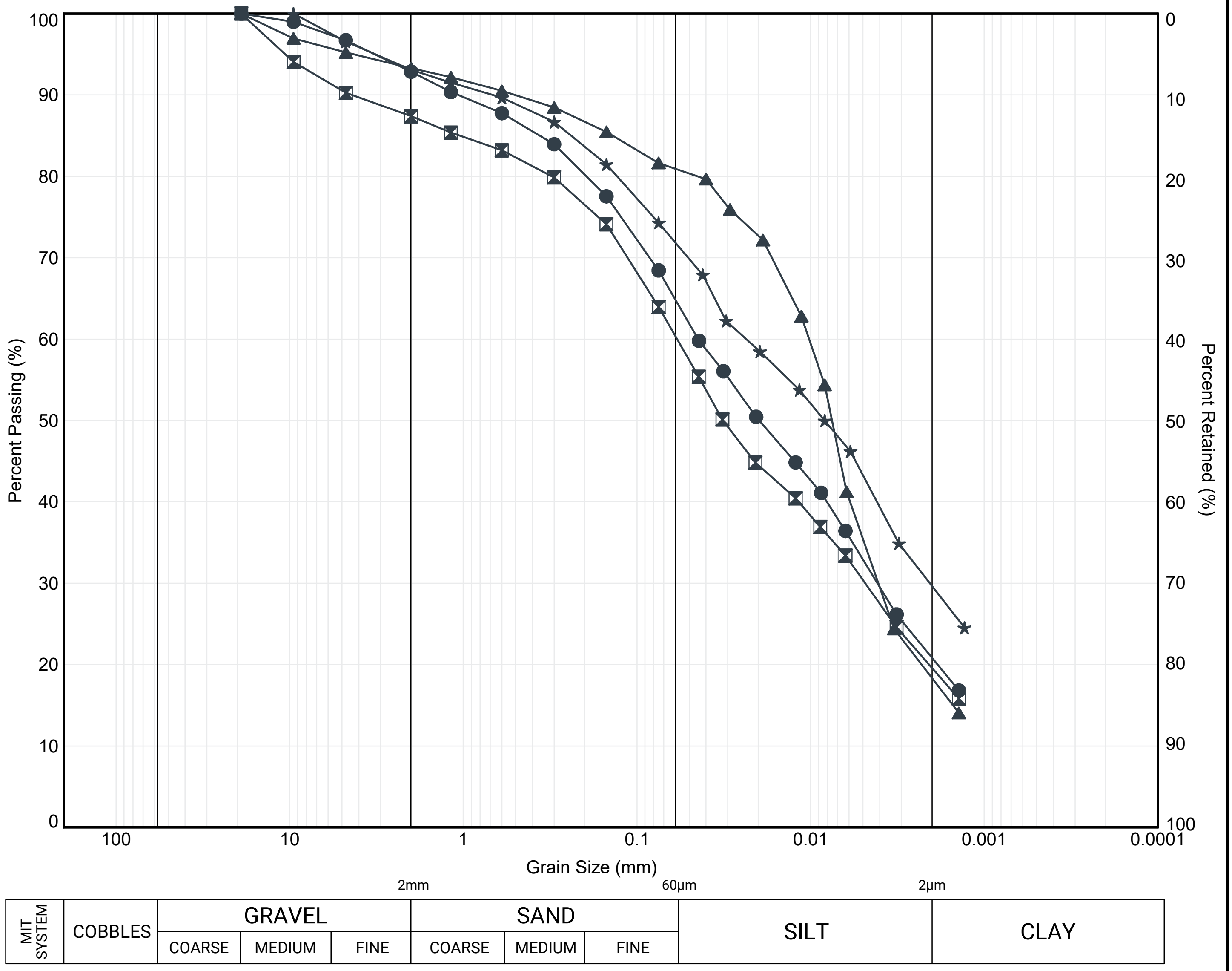
	Borehole	Sample	Depth (m)	Elev. (m)	Gravel (%)	Sand (%)	Silt (%)	Clay (%)
●	**1**	SS6	4.9	402.3	0	60	36	4
☒	**2**	SS8	7.9	396.4	0	11	81	8
▲	**5**	SS8	7.9	398.9	0	91	7	2
★	**6**	SS4	2.6	404.6	0	81	17	2
⊙	**9**	SS5	3.4	397.3	0	91	7	2
✚	**10**	SS10	11.0	395.7	0	4	78	18

GROUNDED
ENGINEERING

Title: **GRAIN SIZE DISTRIBUTION**
SANDS

File No.: **22-084**

file: 22-084 gint.gpi



MIT SYSTEM

	Borehole	Sample	Depth (m)	Elev. (m)	Gravel (%)	Sand (%)	Silt (%)	Clay (%)
●	**3**	SS7	6.4	395.6	7	28	44	21
☒	**4**	SS7	6.4	394.8	13	26	41	20
▲	**5**	SS10	11.0	395.9	7	12	63	18
★	**12**	SS8	7.9	393.0	7	21	42	30

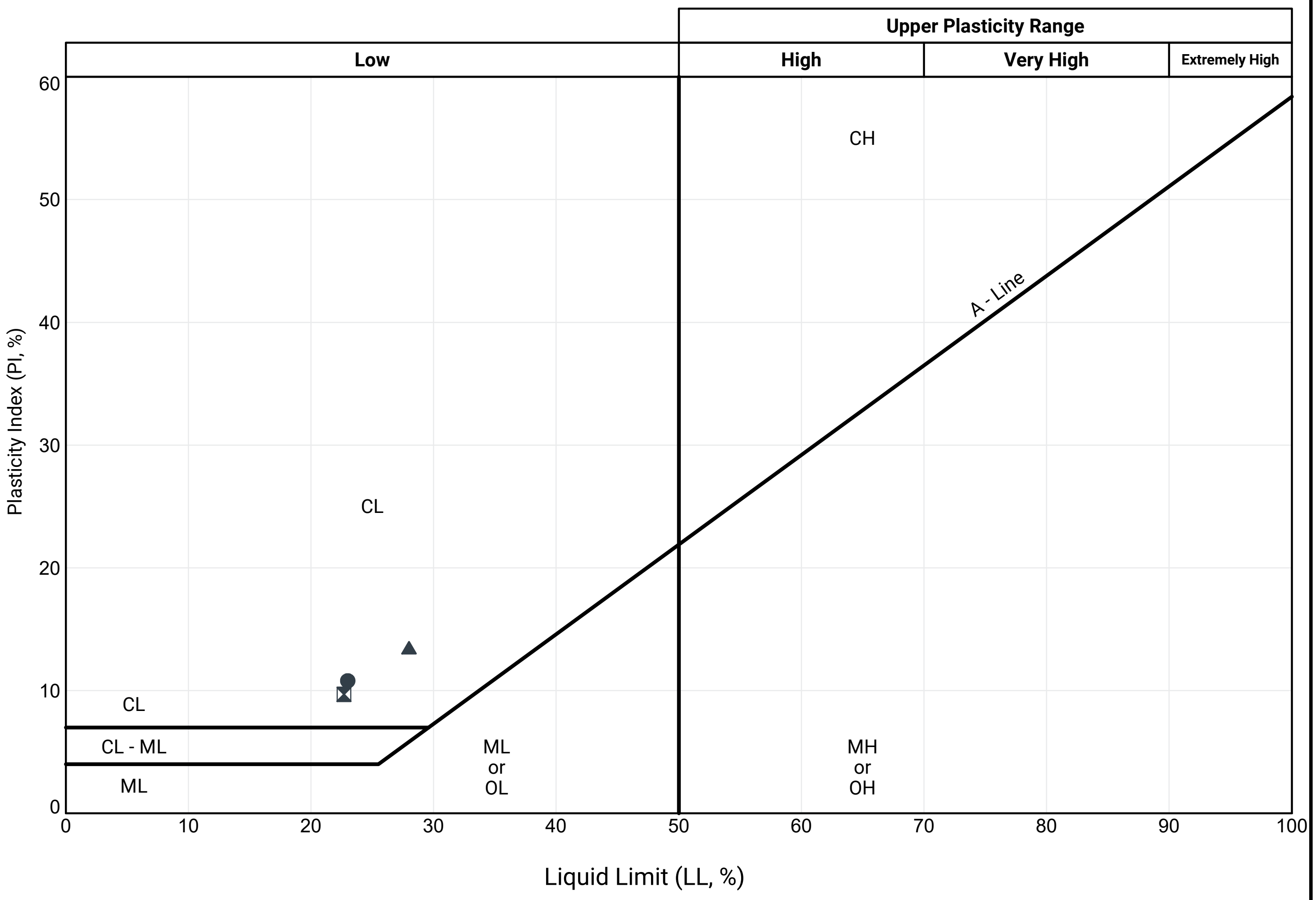
GROUNDED
ENGINEERING

Title:

GRAIN SIZE DISTRIBUTION
LOWER GLACIAL TILL

File No.: **22-084**

file: 22-084 gint.gpj



	Borehole	Sample	Depth (m)	Elev. (m)	LL (%)	PL (%)	PI (%)
●	**3**	SS7	6.4	395.6	23	12	11
☒	**4**	SS7	6.4	394.8	23	13	10
▲	**12**	SS8	7.9	393.0	28	15	14

GROUNDED ENGINEERING

Title: **ATTERBERG LIMITS CHART**

File No.: **22-084**

file: 22-084 gint.gpj

APPENDIX C

THURBER ENGINEERING LTD.

MOISTURE DENSITY REPORT

Client: Grounded Engineering

Thurber Project Number: P1

Client Project: 22-084

Date Tested: 08-Jun-22

Date Sampled: 03-Jun-22

Sample Source: 350 Wellington Rd 7, Elora, Ontario

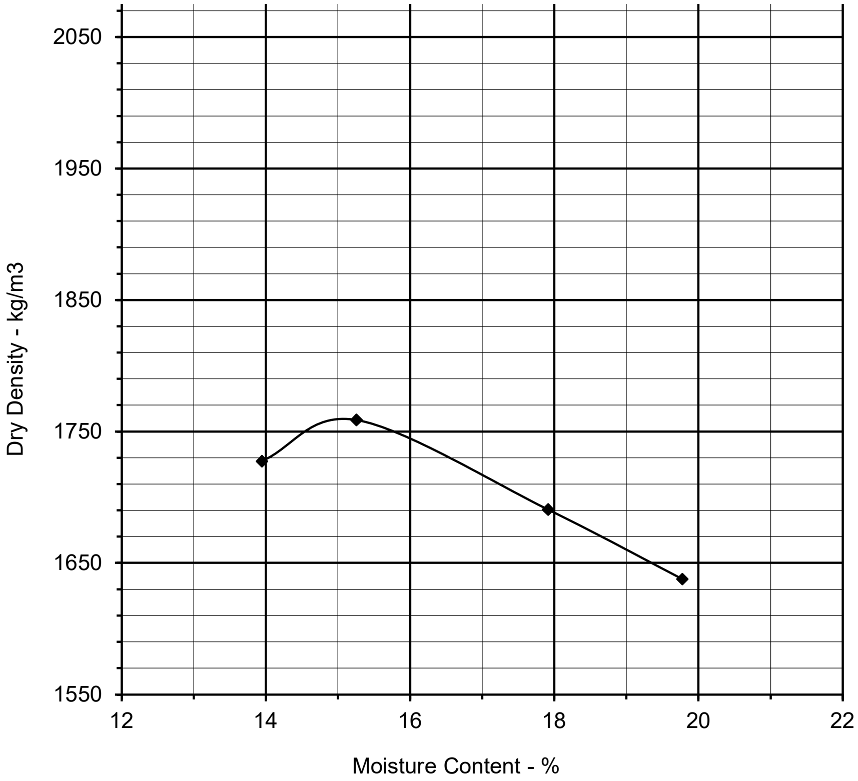
Sample Description: Silty sand, trace gravel

Oversized material:
1.0% retained on the 4.75 mm sieve

As-Received Moisture Content: 16.8%

Thurber Lab Series #: P1

Wet Density - kg/m³	1968	2027	1994	1962			
Dry Density - kg/m³	1727	1759	1691	1638			
Moisture Content- %	13.9	15.3	17.9	19.8			
Pocket Pen. (kg/cm²)							



Proctor Results

Max. Dry Density: **1760 kg/m³**

Optimum Moisture: **15.1%**

Preparation: Moist
Compaction Std.: ASTM D698
Method: A
Rammer Type: Manual

Sampled By: Client

Tested By: DM

Project Eng.: WM

Zero Air Voids Curve plotted for a Specific Gravity of 2.70

Comments:

Report Checked: GF

Tested in accordance with ASTM Designation D698 unless otherwise noted

MOISTURE DENSITY REPORT

Client: Grounded Engineering

Thurber Project Number: P2

Client Project: 22-084

Date Tested: 08-Jun-22

Date Sampled: 03-Jun-22

Sample Source: 350 Wellington Rd 7, Elora, Ontario

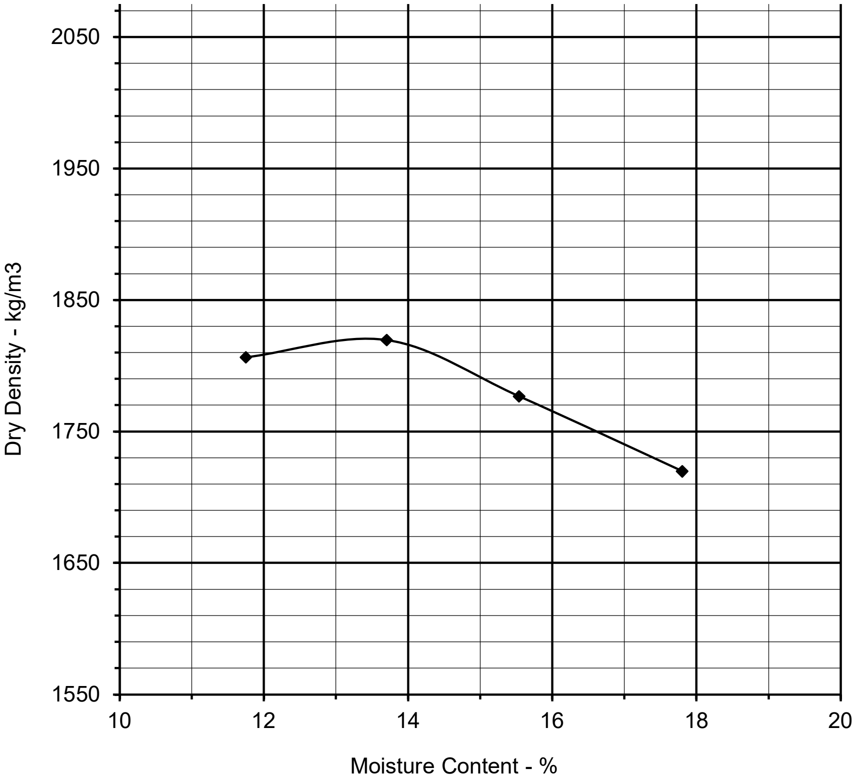
Sample Description: Silty sand, trace gravel

Oversized material:
10.0% retained on the 4.75 mm sieve

As-Received Moisture Content: 15.8%

Thurber Lab Series #: P2

Wet Density - kg/m³	2019	2069	2053	2026			
Dry Density - kg/m³	1806	1820	1777	1720			
Moisture Content- %	11.8	13.7	15.5	17.8			
Pocket Pen. (kg/cm²)							



Proctor Results

Max. Dry Density:	**1874 kg/m³**
Optimum Moisture:	**12.2%**

Rock Corrected for:
10.0% on the 4.75 mm sieve

Specific Gravity of Oversize: 2.55

Preparation:	Moist
Compaction Std.:	ASTM D698
Method:	A
Rammer Type:	Manual
Sampled By:	Client
Tested By:	DM
Project Eng.:	WM

Zero Air Voids Curve plotted for a Specific Gravity of 2.70

Comments:

Report Checked: GF

THURBER ENGINEERING LTD.

MOISTURE DENSITY REPORT

Client: Grounded Engineering

Thurber Project Number: P3

Client Project: 22-084

Date Tested: 09-Jun-22

Date Sampled: 03-Jun-22

Sample Source: 350 Wellington Rd 7, Elora, Ontario

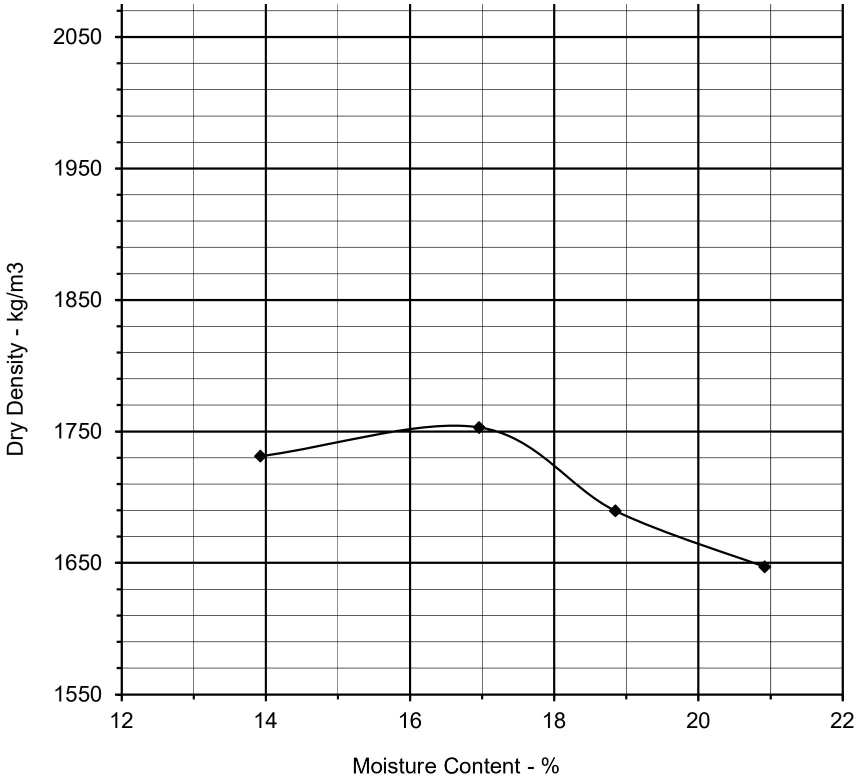
Sample Description: Silty sand, trace gravel

Oversized material:
6.4% retained on the 4.75 mm sieve

As-Received Moisture Content: 17.2%

Thurber Lab Series #: P3

Wet Density - kg/m³	1972	2050	2008	1992			
Dry Density - kg/m³	1731	1753	1690	1647			
Moisture Content- %	13.9	17.0	18.8	20.9			
Pocket Pen. (kg/cm²)							



Proctor Results

Max. Dry Density: **1791 kg/m³**

Optimum Moisture: **15.6%**

Rock Corrected for:
6.4% on the 4.75 mm sieve

Specific Gravity of Oversize: 2.55

Preparation: Moist
Compaction Std.: ASTM D698
Method: A
Rammer Type: Manual

Sampled By: Client

Tested By: DM/KB

Project Eng.: WM

Zero Air Voids Curve plotted for a Specific Gravity of 2.70

Comments:

Report Checked: GF

Tested in accordance with ASTM Designation D698 unless otherwise noted

MOISTURE DENSITY REPORT

Client: Grounded Engineering

Thurber Project Number: P4

Client Project: 22-084

Date Tested: 09-Jun-22

Date Sampled: 03-Jun-22

Sample Source: 350 Wellington Rd 7, Elora, Ontario

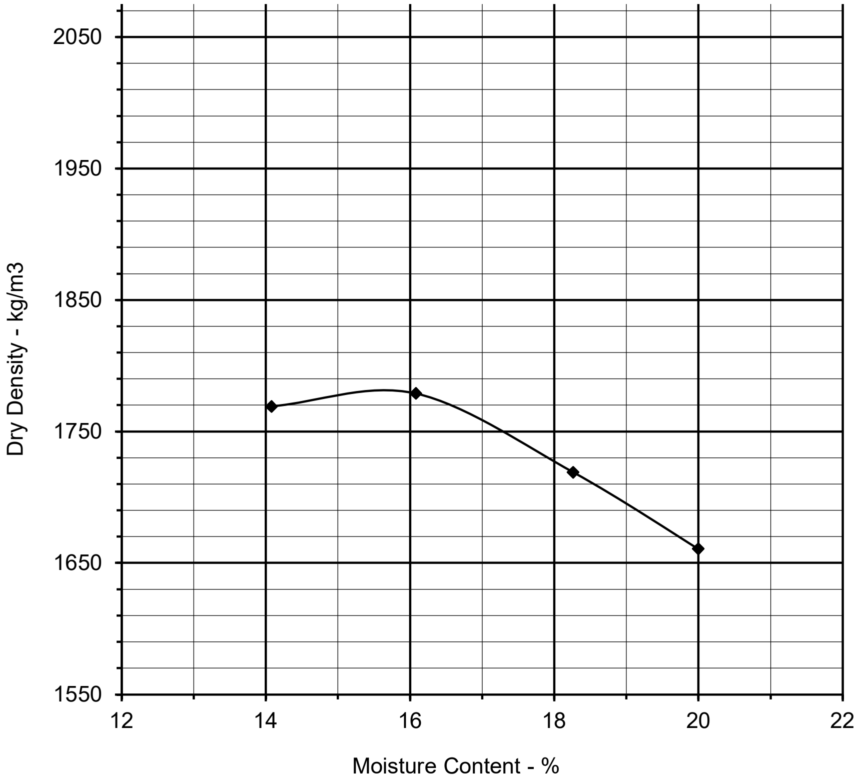
Sample Description: Silty sand, trace gravel

Oversized material:
6.4% retained on the 4.75 mm sieve

As-Received Moisture Content: 17.9%

Thurber Lab Series #: P4

Wet Density - kg/m³	2018	2065	2033	1993			
Dry Density - kg/m³	1769	1779	1719	1661			
Moisture Content- %	14.1	16.1	18.3	20.0			
Pocket Pen. (kg/cm²)							



Proctor Results

Max. Dry Density: **1817 kg/m³**

Optimum Moisture: **14.7%**

Rock Corrected for:
6.4% on the 4.75 mm sieve

Specific Gravity of Oversize: 2.55

Preparation: Moist
Compaction Std.: ASTM D698
Method: A
Rammer Type: Manual

Sampled By: Client

Tested By: DM/KB

Project Eng.: WM

Zero Air Voids Curve plotted for a Specific Gravity of 2.70

Comments:

Report Checked: GF

THURBER ENGINEERING LTD.

MOISTURE DENSITY REPORT

Client: Grounded Engineering

Thurber Project Number: P5

Client Project: 22-084

Date Tested: 09-Jun-22

Date Sampled: 03-Jun-22

Sample Source: 350 Wellington Rd 7, Elora, Ontario

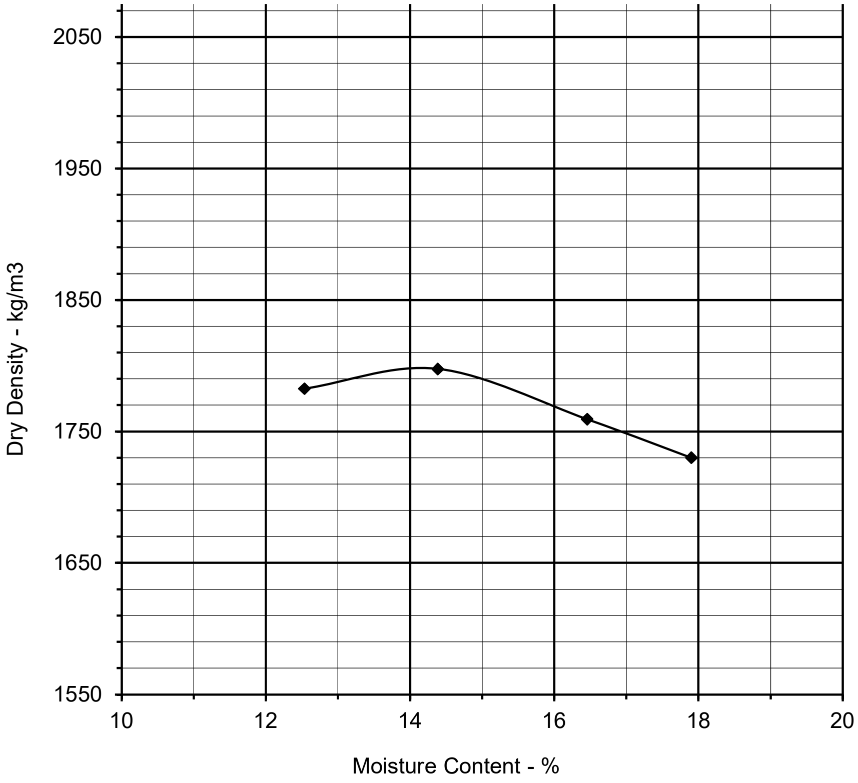
Sample Description: Silty sand, trace gravel

Oversized material:
8.3% retained on the 4.75 mm sieve

As-Received Moisture Content: 17.4%

Thurber Lab Series #: P5

Wet Density - kg/m³	2006	2056	2049	2040			
Dry Density - kg/m³	1783	1798	1759	1730			
Moisture Content- %	12.5	14.4	16.5	17.9			
Pocket Pen. (kg/cm²)							



Proctor Results

Max. Dry Density: **1843 kg/m³**

Optimum Moisture: **13.0%**

Rock Corrected for:
8.3% on the 4.75 mm sieve

Specific Gravity of Oversize: 2.55

Preparation: Moist
Compaction Std.: ASTM D698
Method: A
Rammer Type: Manual

Sampled By: Client

Tested By: KB/DM

Project Eng.: WM

Zero Air Voids Curve plotted for a Specific Gravity of 2.70

Comments:

Report Checked: GF

Tested in accordance with ASTM Designation D698 unless otherwise noted

MOISTURE DENSITY REPORT

Client: Grounded Engineering

Thurber Project Number: P6

Client Project: 22-084

Date Tested: 09-Jun-22

Date Sampled: 03-Jun-22

Sample Source: 350 Wellington Rd 7, Elora, Ontario

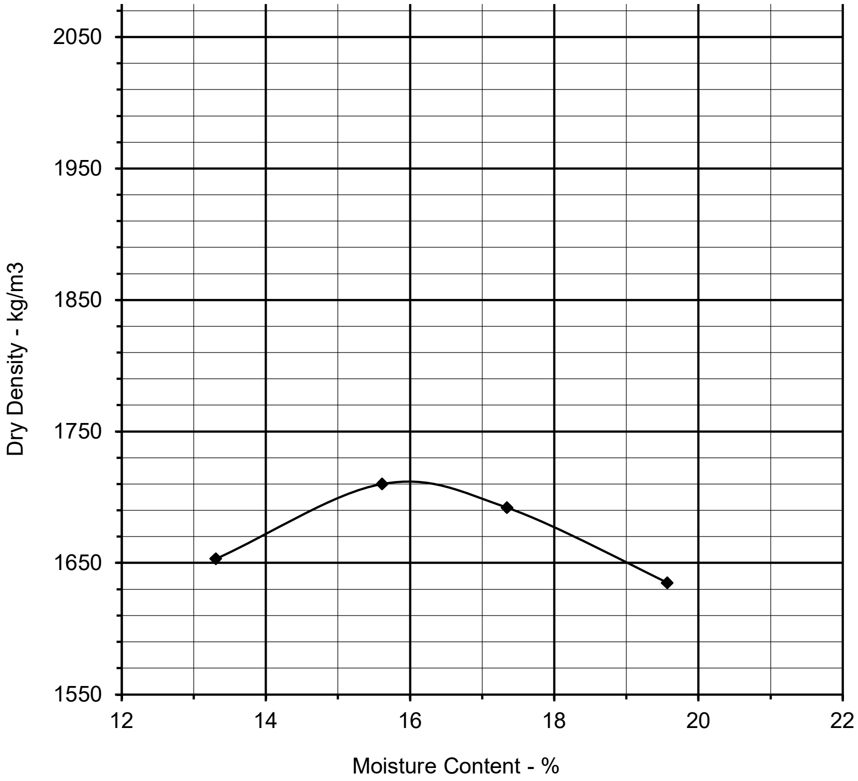
Sample Description: Silty sand, trace gravel

Oversized material:
7.7% retained on the 4.75 mm sieve

As-Received Moisture Content: 21.7%

Thurber Lab Series #: P6

Wet Density - kg/m³	1873	1977	1986	1955			
Dry Density - kg/m³	1653	1710	1692	1635			
Moisture Content- %	13.3	15.6	17.3	19.6			
Pocket Pen. (kg/cm²)							



Proctor Results

Max. Dry Density: **1756 kg/m³**

Optimum Moisture: **14.8%**

Rock Corrected for:
7.7% on the 4.75 mm sieve

Specific Gravity of Oversize: 2.55

Preparation: Moist
Compaction Std.: ASTM D698
Method: A
Rammer Type: Manual

Sampled By: Client

Tested By: KB/DM

Project Eng.: WM

Zero Air Voids Curve plotted for a Specific Gravity of 2.70

Comments:

Report Checked: GF

Tested in accordance with ASTM Designation D698 unless otherwise noted

APPENDIX D

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

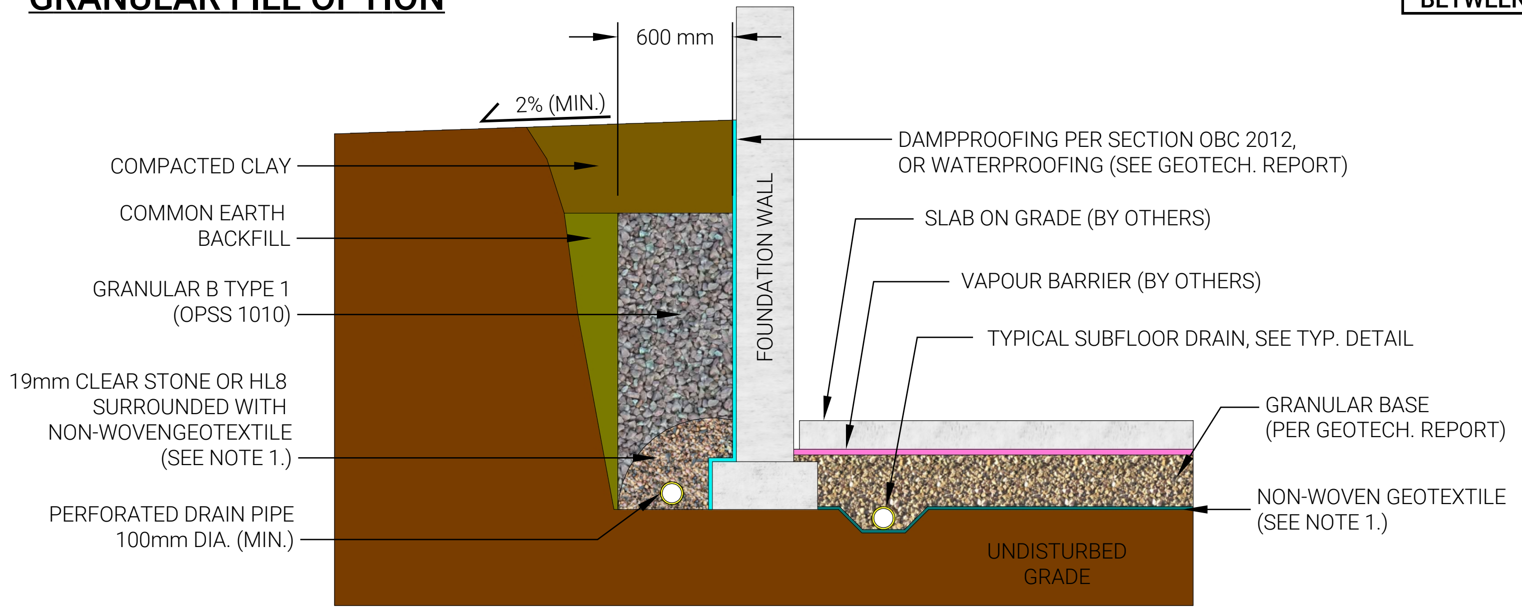
1. The Testing Engineer shall provide written summaries of the compaction and lab testing to the Geotechnical Engineer on a frequency of not less than every two weeks.

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

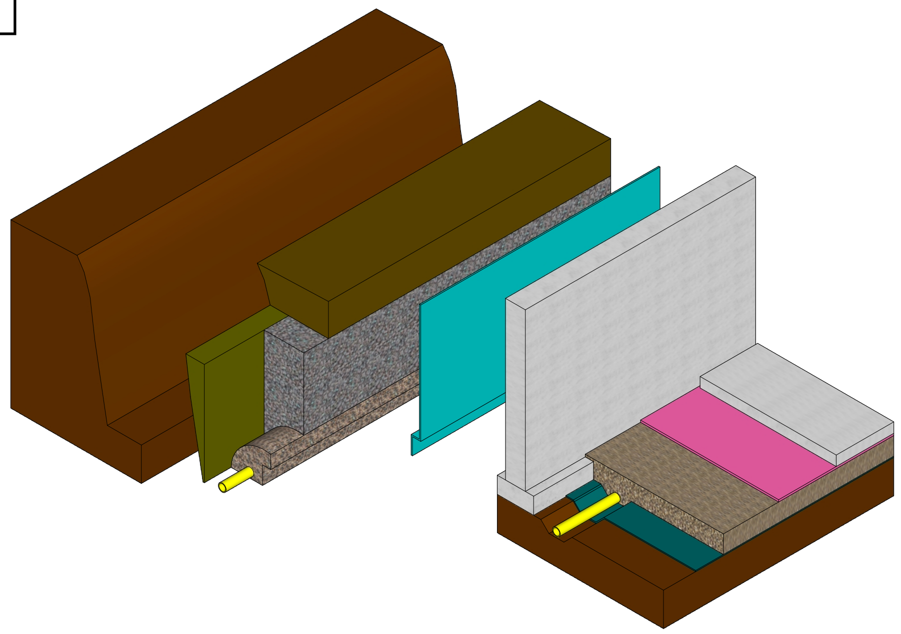
APPENDIX F

GRANULAR FILL OPTION



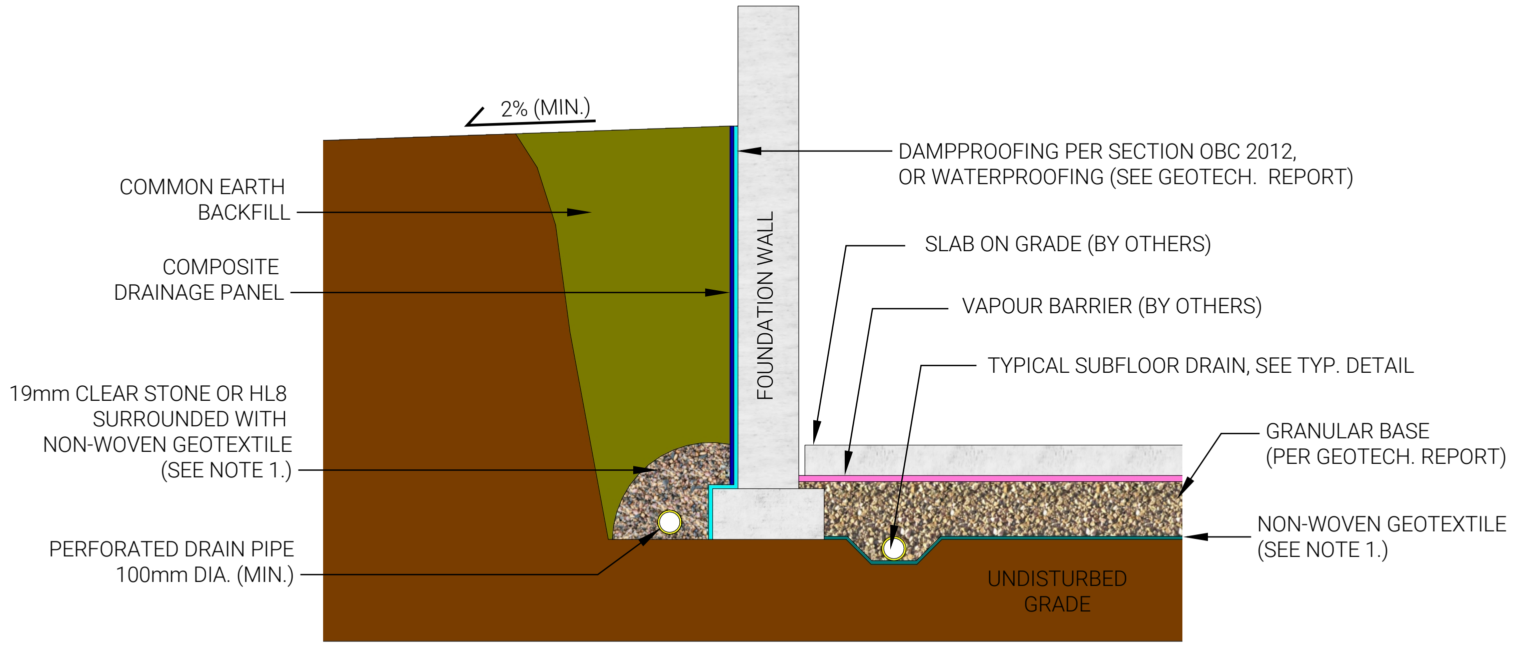
SECTIONAL VIEW

OBJECTS ARE COLOR-CODED
BETWEEN TWO VIEWS FOR CLARITY

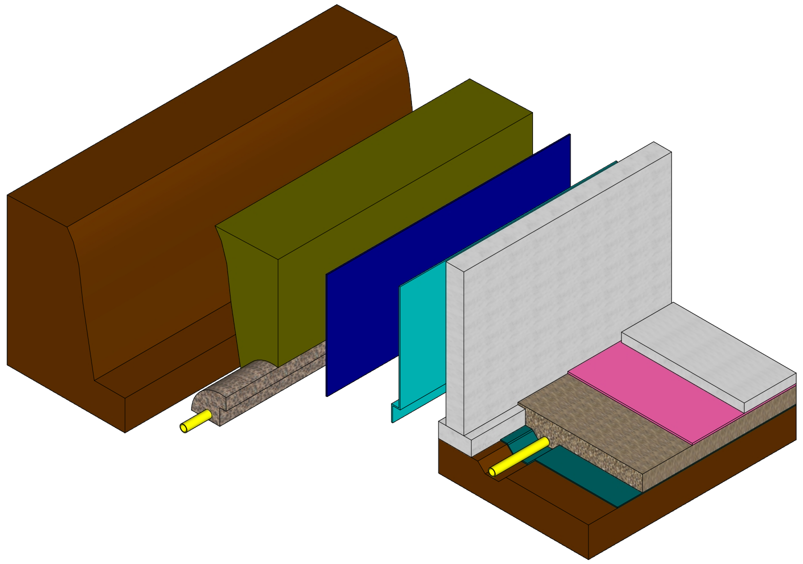


ISOMETRIC VIEW

GEO-COMPOSITE DRAINAGE PANEL OPTION



SECTIONAL VIEW



ISOMETRIC VIEW

NOTES

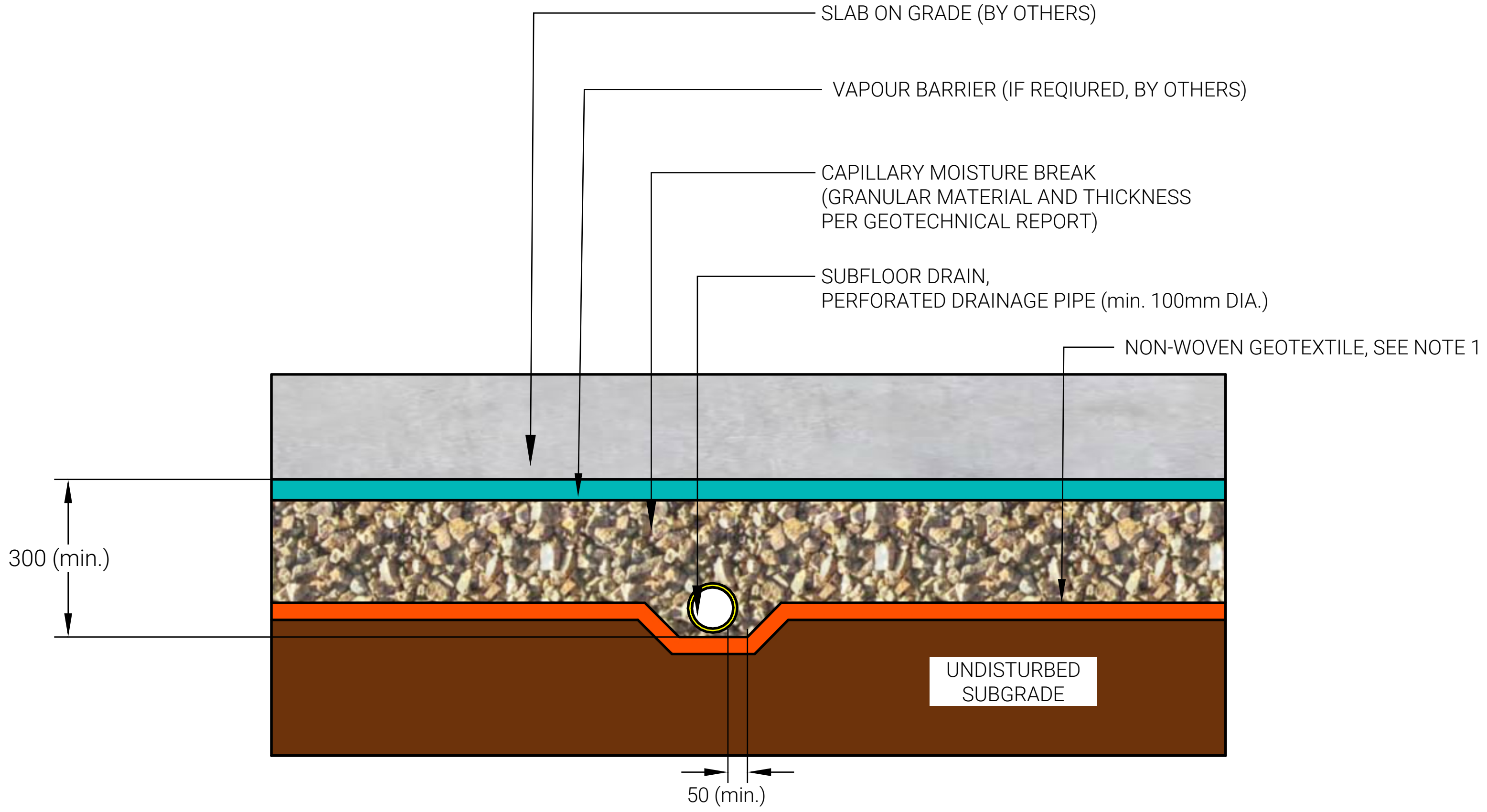
1. A NON-WOVEN GEOTEXTILE WITH AN APPARENT OPENING SIZE OF < 0.250mm AND A TEAR RESISTANCE OF > 200 N.

GROUNDED ENGINEERING

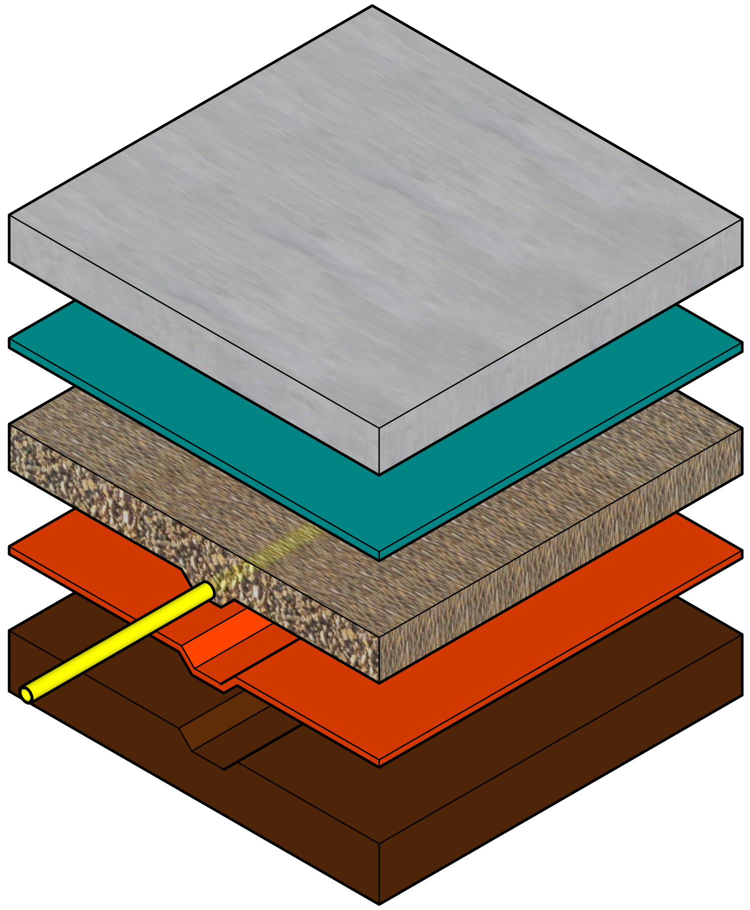
Title

BASEMENT DRAINAGE TYPICAL DETAIL

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 < 0.250mm AND A TEAR RESISTANCE OF > 200 N).

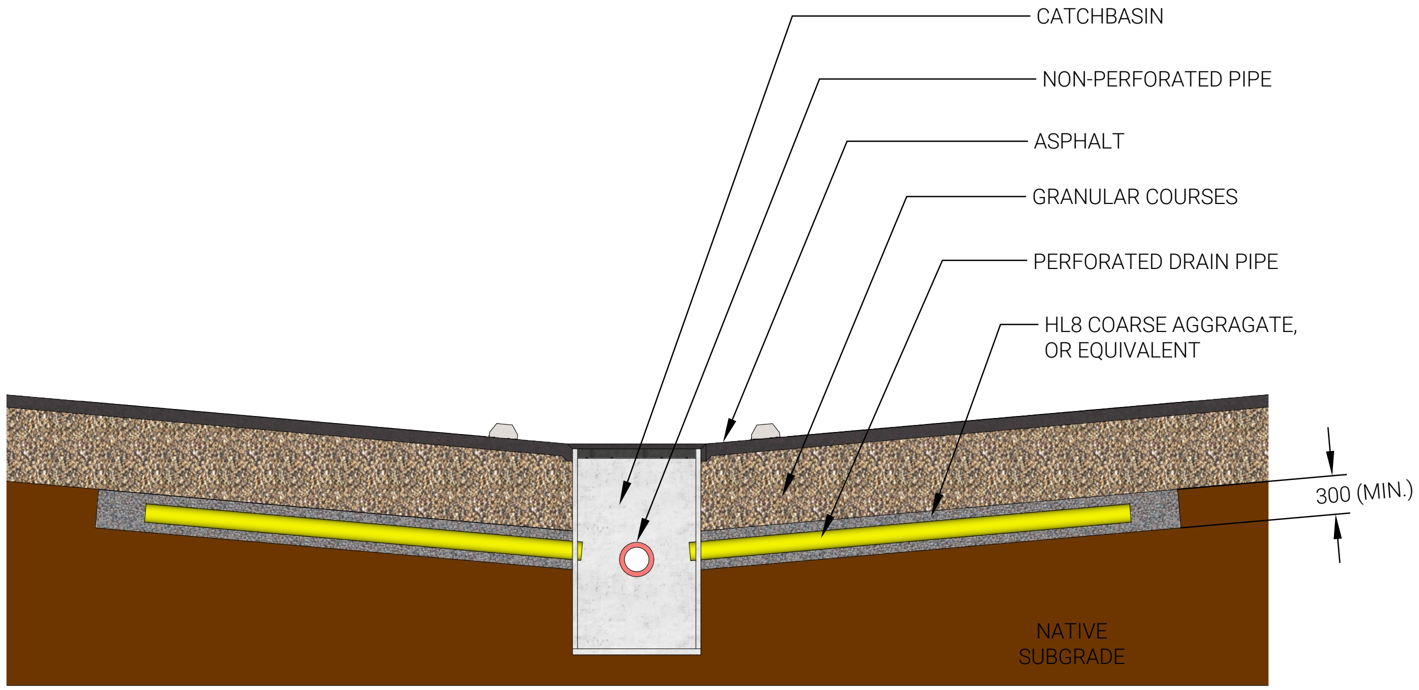
2. TYPICAL SCHEMATIC ONLY. MUST BE READ IN CONJUNCTION WITH GEOTECHNICAL REPORT.

GROUNDED
ENGINEERING

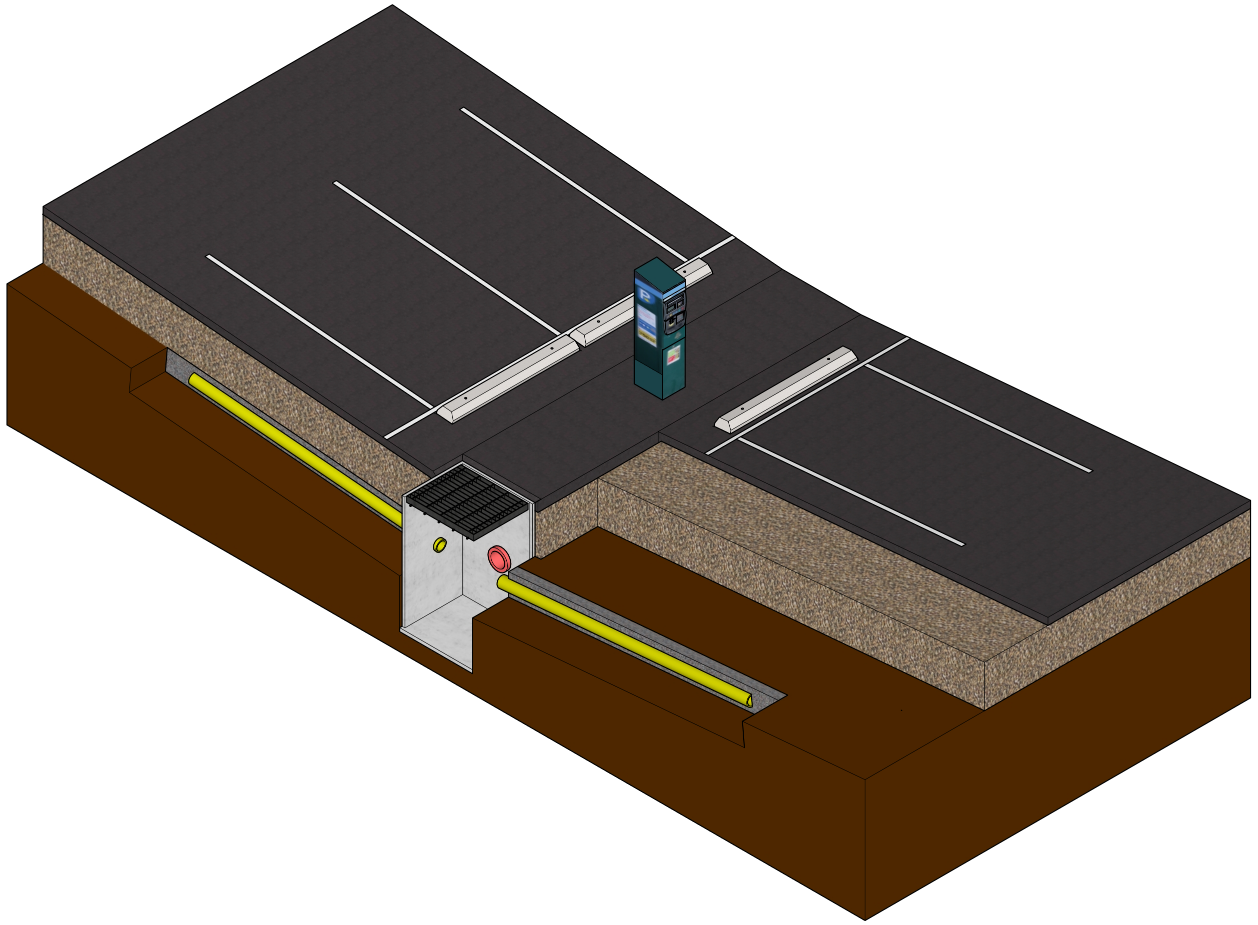
Title

BASEMENT SUBDRAIN TYPICAL DETAIL

OBJECTS ARE COLOR-CODED
BETWEEN TWO VIEWS FOR CLARITY



SECTIONAL VIEW



ISOMETRIC

GROUNDED
ENGINEERING

Title

LONGITUDINAL SUBDRAIN CONNECTION TO CATCHBASIN