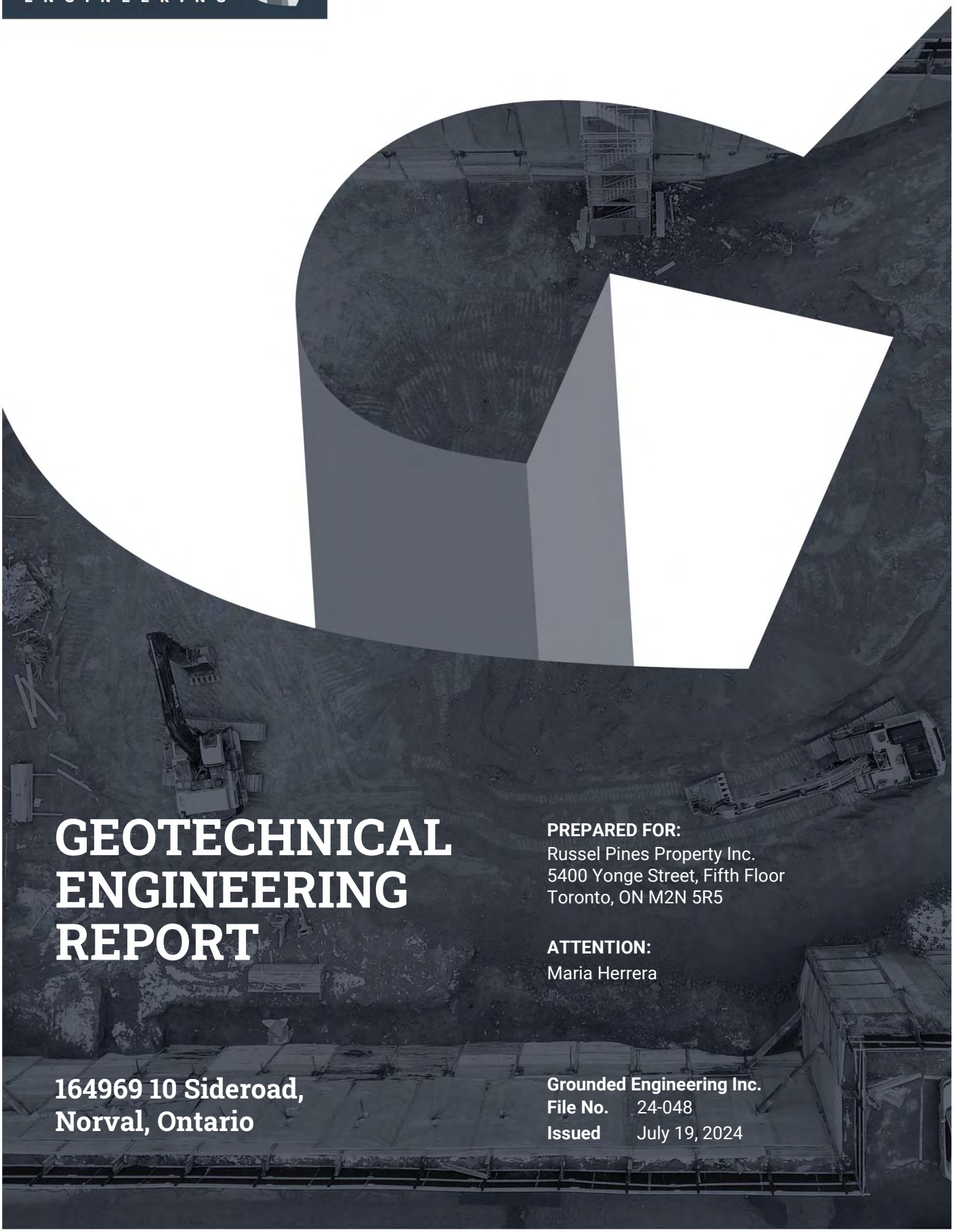

GEOTECHNICAL ENGINEERING REPORT

PREPARED FOR:
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File No. 24-048
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1 Introduction

Russel Pines Property Inc. has retained Grounded Engineering Inc. to provide preliminary geotechnical engineering design advice for their proposed development at 164969 10 Sideroad in Norval, Ontario. The site is generally located east of 10th Line, north of 10th Side Road, west of Winston Churchill Boulevard, and south of a tributary of the Credit River. For the purposes of this report, 10th Line is considered to be running in a north-south orientation.

The level of study presented in this report is considered preliminary and should be used for planning purposes only. Additional boreholes, in-situ testing, and a detailed geotechnical engineering report will be required for detailed design and building permit purposes.

The proposed project includes constructing a new residential subdivision development comprised of townhouses and single detached houses. It is assumed that the dwellings will include a single basement level. A stormwater management (SWM) pond, a park, and a future area for mixed uses are also shown on the draft plan of subdivision.

There is an existing slope along the northern property boundary which slopes down to a tributary of the Credit River. The slope is regulated by Credit Valley Conservation ("CVC"), and will require a slope stability and erosion risk assessment report for the purpose of determining the Long-term Stable Slope Crest (LTSSC) position. This report will be provided under separate cover. The subject site is located on tableland south of the slope crest. The area along the northern property boundary including the slope and the area immediately adjacent to the slope crest will remain as a natural area (Greenbelt Lands).

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

- Site survey, prepared by JD Barnes (March 6, 2020).
- "Draft Plan of Subdivision"; dated Feb 20, 2024, prepared by Glen Schnarr and Associates Inc.

Grounded's subsurface investigation of the site to date includes nineteen (19) boreholes (Boreholes 101 to 119) which were advanced from May 9th to 17th, 2024.

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, and pavement design. Construction preliminary considerations including excavation, groundwater control, and geostructural engineering design advice are also provided.

This geotechnical engineering report is considered preliminary and should be used for planning purposes only. Additional site-specific boreholes, wells, in situ and laboratory testing, and a detailed geotechnical engineering report will be required for detailed design.

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.

The boreholes were surveyed for horizontal coordinates and geodetic elevations with the Sokkia GCX3 system, connected to the Global Navigation Satellite System and the Can-Net Virtual Reference Station Network.

2.1 Stratigraphy

The following stratigraphic summary is based on the results of the boreholes and the geotechnical laboratory testing. A subsurface profile showing stratigraphy and engineering units is appended.

2.1.1 Topsoil and Reworked Native/Earth Fill

The boreholes encountered about 100 to 250 mm of topsoil at the existing ground surface. The reported topsoil thicknesses were observed in the individual borehole locations through the tops of the open boreholes. The thickness of the topsoil may vary between and beyond each borehole location.

Underlying the topsoil, the boreholes observed a layer of earth fill or reworked native soil that extends to depths of 0.8 to 2.3 metres below grade (Elev. 230.5 to 223.9 metres). The reworked native soil varies in composition but generally consists of sands and silts with varying amounts of clay and gravel, and trace rootlets. The earth fill/reworked native soil is typically brown to dark brown, and moist to wet. Standard Penetration Test (SPT) results (N-Values) measured in the fill range from 2 to 15 blows per 300 mm of penetration (“bpf”). Due to inconsistent placement and the inherent heterogeneity of the earth fill and reworked native materials, the relative density of the earth fill and reworked native soil varies from very loose to compact.

2.1.2 Sands

Underlying the topsoil and earth fill or reworked native soil, Boreholes 105, 106, 109, 110, 112, 113 and 118 encountered a stratum of undisturbed native cohesionless sand with trace silt to silty sand at depths of 0.2 to 1.5 m below grade (Elev. 230.4 to 222.7 m) extending down to depths of 1.7 to 2.6 m below grade (Elev. 228.9 to 221.8 m). This unit contains trace clay, trace to some

gravel, and is generally brown with orange to brown, and wet. SPT N-Values measured in the sands range from 5 to 13 bpf, indicating a loose to compact relative density.

Underlying the sands, Borehole 113 encountered a deposit of silty sand glacial till with some gravel and some clay at a depth of 2.3 m (Elev. 228.9 m) extending down to the target investigation depth of the borehole (8.1 m / Elev. 223.1 m). This unit was generally grey and wet to moist.

2.1.3 Clayey Silt to Silt and Clay (Glacial Till)

Underlying the topsoil and earth fill or reworked native soil in Boreholes 101 to 104, 107, 108, 111, 114 to 117 and 119, and beneath the sands in Boreholes 105, 106, 109, 110, 112, 113 and 118 the boreholes encountered a stratum of undisturbed native clayey silt to silt and clay glacial till at depths of 0.8 to 2.6 m below grade (Elev. 229.7 to 201.1 m) extending down to depths of 2.3 to 20.3 m below grade (Elev. 228.4 to 198.5 m). This unit contains varying amounts of sand (some sand to sandy), trace to some gravel, and is generally brown with black to grey with orange, and moist to wet. SPT N-Values measured in this unit vary from 8 to greater than 50 bpf, generally indicating a stiff to hard consistency. Boreholes 104, 114 to 119 reached the target investigation depth in this stratum.

Within the glacial till, Boreholes 103, 111, 112, 114 and 117 encountered a layer of clayey silt to silt and clay (not glacial till) with trace to some sand and trace gravel at depths ranging from 1.8 to 6.1 m (Elev. 228.4 to 220.4 m) extending to depths of 2.3 to 9.1 m (Elev. 224.3 to 217.4). This unit was generally grey and moist. SPT N-Values measured in this layer vary from 12 to greater than 50 bpf, generally indicating a stiff to hard consistency. Borehole 112 reached its target investigation depth within the clayey silt layer.

2.2 Inferred Bedrock

Bedrock was inferred in Boreholes 101 to 103 underlying the silt and clay to clayey silt till at depths of 4.6 to 13.7 m below grade (Elev. 225.4 to 212.8 m). Rock coring was not included in our scope. The bedrock was inferred from observations of auger and split spoon resistance, and limited sample recovery in the split spoons to depths of 6.2 to 15.3 below grade (Elev. 223.8 to 211.2 m), at which depths Boreholes 101 to 103 were terminated. The bedrock beneath the site is known to consist of reddish-brown shale of the Queenston Formation, which typically has a weathered zone at the surface of the bedrock, which transitions to unweathered (sound) bedrock. Sound bedrock elevations were not determined in the boreholes, as this was not part of the current scope of work.

2.3 Groundwater

The depth to groundwater and caved soils was measured in each of the boreholes immediately following the drilling.

Monitoring wells were installed in select boreholes, and stabilized groundwater levels were measured in each of the installed monitoring wells. The monitoring well details as well as the groundwater observations are shown on the Borehole Logs and are summarized in the following tables.

Well ID	Well Diameter (mm)	Ground Surface (masl)	Top of Screen (masl)	Bottom of Screen (masl)	Screened Geological Unit
BH101	50	230.0	229.1	229.1	Clayey Silt Till
BH102	50	227.4	225.2	225.2	Clayey Silt Till
BH103	50	226.5	217.3	217.3	Clayey Silt Till
BH104-S	50	224.7	220.2	220.2	Silt and Clay Till
BH104-D	50	224.7	208.0	208.0	Silt and Clay Till
BH106-S	50	224.2	223.2	223.2	Fill / Clayey Silt Till
BH106-D	50	224.2	219.6	219.6	Clayey Silt Till
BH107	50	225.8	222.8	222.8	Clayey Silt Till
BH109	50	229.1	226.1	226.1	Clayey Silt Till
BH112	50	228.8	225.8	225.8	Clayey Silt Till
BH114	50	230.7	228.9	228.9	Clayey Silt / Silt and Clay
BH115	50	226.0	224.5	224.5	Clayey Silt Till
BH117	50	226.0	224.5	224.5	Fill / Clayey Silt Till
BH118	50	226.1	224.6	224.6	Sand / Clayey Silt Till
BH119	50	225.4	223.9	223.9	Clayey Silt Till

Borehole No.	Borehole depth (m)	Upon completion of drilling		Water Level in Well, highest (m)	
		Depth to cave (m)	Unstabilized water level (m)	Date	Depth/Elev.
BH101	6.2	5.2	dry	2024-06-03	dry
BH102	11.6	n/a	Filled with drill fluid	2024-06-03	0.8 / 226.6
BH103	15.3	11.6	3.0	2024-06-03	2.9 / 223.6
BH104-S	20.3	18.6	dry	2024-06-03	2.3 / 222.4
BH104-D	20.3	18.6	dry	2024-05-27	18.2 / 206.5
BH105	6.7	4.6	0.9	n/a	n/a
BH106-S	6.7	open	2.1	2024-05-27	1.6 / 222.6
BH106-D	6.7	open	2.1	2024-06-03	2.8 / 221.4

Borehole No.	Borehole depth (m)	Upon completion of drilling		Water Level in Well, highest (m)	
		Depth to cave (m)	Unstabilized water level (m)	Date	Depth/Elev.
BH107	6.6	open	dry	2024-06-03	0.5 / 225.3
BH108	8.1	5.2	3.0	n/a	n/a
BH109	6.6	4.6	2.1	2024-05-27	0.9 / 228.2
BH110	6.6	5.5	dry	n/a	n/a
BH111	6.7	5.8	dry	n/a	n/a
BH112	6.6	4.9	1.9	2024-06-03	0.4 / 228.4
BH113	8.1	4.9	1.5	n/a	n/a
BH114	6.4	5.5	dry	2024-06-03	0.8 / 229.9
BH115	5.2	open	1.5	2024-06-03	1.9 / 224.1
BH116	3.7	2.1	1.5	n/a	n/a
BH117	5.2	open	3.7	2024-06-03	1.4 / 224.6
BH118	5.2	4.0	1.2	2024-06-03	1.6 / 224.5
BH119	5.2	open	1.2	2024-05-27	0.5 / 224.9

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 groundwater elevation changes across the site, generally following the existing grades. For engineering purposes, the groundwater table ranges from a depth of 0.4± to 2.9± metres below the existing site grades.

Grounded has prepared a hydrogeological report for this site (File No. 24-048) under separate cover.

2.4 Corrosivity and Sulphate Attack

Three (3) soil samples were submitted for corrosivity testing parameters (pH, Resistivity, Electrical Conductivity, Redox Potential, Sulphate, Sulphide and Chloride). The Certificate of Analyses and interpretation sheet is appended.

The soil samples were analysed for soluble sulphate concentration and compared to the Canadian Standard CAN3/CSA A23.1-M94 Table 3, *Additional Requirements for Concrete Subjected to Sulphate Attack*. Corrosivity parameters are also used for assessing soil corrosivity applicable to cast iron alloys, according to the 10-point soil evaluation procedure described in the American Water Work Association (AWWA) C-105 standard.

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

- All of the samples have negligible sulphate concentrations.
- All of the samples scored less than 10 points and corrosion protective measures are therefore not recommended for cast iron alloys.
- A more recent study by the AWWA has suggested that soil with a resistivity of less than about 2000 ohm.cm should be considered aggressive. All of the samples had resistivity measurements exceeding 2000 ohm.cm.

2.5 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:

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:

Stratum	Grain Size Percentage between 5 and 75 µm	Susceptibility to Frost Heaving
Earth Fill/Reworked Native	Est. 25 to 50%	Low to Moderate
Glacial Till	Approx. 30 to 55%	Moderate
Sand	Approx. 5%	Low

3 Preliminary Geotechnical Engineering Recommendations

Based on the factual data summarized above, preliminary geotechnical engineering recommendations are provided. They must be supplemented and confirmed by additional boreholes, wells, in situ and laboratory testing, 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.

Residential dwellings such as these are typically designed in accordance with the requirements of Part 9 of the Ontario Building Code (2012). Reference should be made to the Ontario Building Code for Part 9 structures, for additional requirements beyond the discussion provided below.

Should there be any applicable high-density residential or commercial structures added to the site, these portions of the developments will be designed by either Professional Engineers or Architects to conform to the requirements of Part 4 the Ontario Building Code (2012).

3.1 Site Grading

Site grading, including cutting and/or filling will be necessary to achieve the desired site grades prior to construction. Grounded has not been provided with a grading plan as per the date of this report, and hence the following site grading recommendations are general in nature and must be updated once a grading plan is available.

All fill must be placed on approved subgrade, in loose lifts of 150 mm and compacted to a minimum of 98% SPMDD at a moisture content within 2% of optimum. In areas that are not sensitive to settlement (e.g. landscaping areas), it may be acceptable to place compacted fill in loose lifts of 200 mm and compact to a minimum of 95% SPMDD at a moisture content within 2% of optimum. Soil that is used as compacted fill must have 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.

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

3.1.1 Compacted Fill / Engineered Fill

Compacted fill is suitable for raising grades to support new pavements, landscaping, and services. Engineered fill is required wherever the fill material must provide structural support for foundations.

An engineered fill earthworks specification is appended. Compacted fill is generally similar to engineered fill, with the following exceptions:

1. **Inspection and Testing:** Compacted fill does not need full-time inspection and testing, although it does need periodic geotechnical engineering testing and inspections for quality control. The frequency of periodic inspections can vary from once a day to once every 3 days and is to be confirmed after the construction schedule is available for review. Engineered fill requires full-time inspection and testing.
2. **Acceptable Subgrade:** Compacted fill can be made on an existing subgrade comprised of earth fill or reworked native soils provided it is proof rolled under the inspection of a

qualified geotechnical technician and approved by a geotechnical engineer prior to fill placement. Engineered fill requires an approved subgrade of undisturbed (dewatered) native soils, which implies that the existing earth fill must be sub-excavated down to the top of native soil across the site.

3. **Dewatering**: Engineered fill construction requires an undisturbed native subgrade for construction. If the top of native soil elevation is below the groundwater table, positive dewatering may be required to lower the groundwater table to 1.2 m below the top of native, to preserve the native soils in their undisturbed state. Compacted fill does not require that the existing fill materials be excavated (so long as they are proof rolled and approved as described below), which can reduce the need for dewatering during construction. Note that compacted fill may still require occasional sub-excavation below the groundwater table, to remediate any obvious loose/weak areas exposed during proof rolling.
4. **Slab on Grade Design:** Compacted fill typically has a lower modulus of subgrade reaction than engineered fill (see section below). Slabs made on compacted fill may need to be thicker or have more reinforcement.

The choice of compacted vs. engineered fill will be determined to a large extent by foundation requirements, as well as the construction practicalities of re-grading a site.

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

Compacted fill may be made on inspector-approved existing clean non-organic earth fill, or native soil. Engineered fill must be made to bear on inspector-approved undisturbed (dewatered) native soil only.

3.1.2 Subgrade Approval

Prior to placement of the engineered/compacted fill, the cut subgrade shall be proof-rolled and inspected under the supervision of a qualified geotechnical technician for obvious exposed loose or disturbed areas, or for areas containing excessive deleterious materials or moisture. These areas shall be recompacted in place and retested, or else replaced with Granular B placed as engineered fill (in lifts 150 mm thick or less and compacted to a minimum of 98 percent SPMDD). A static drum roller should be used to proof-roll the soils at this site, as vibration will cause unwanted disturbance, dilation, and strength reduction in the underlying native soils. Slabs on grade should not be placed on frozen subgrade, in order to prevent settlement of the slabs as the subgrade thaws. Areas of frozen subgrade should be removed during subgrade preparation.

3.1.3 Construction

All fill must be placed on approved subgrade, in loose lifts of 150 mm and compacted to a minimum of 98% SPMDD at a moisture content within 2% of optimum. Engineered fill must be placed under the full-time supervision of a qualified geotechnical technician, who shall perform frequent in situ density measurements to ensure the uniformity and adequacy of the compaction effort. Upon completion, engineered fill must be certified by a Geotechnical Engineer.

In areas that are not sensitive to settlement (e.g. landscaping areas), it may be acceptable to place compacted fill in loose lifts of 200 mm and compact to a minimum of 95% SPMDD at a moisture content within 2% of optimum. We can review and comment on these areas as needed.

Soil that is used as engineered or compacted fill must have 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. Representative soil samples must be collected from the proposed fill material 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 compaction as common or engineered fill.

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

The existing topsoil is not geotechnically suitable and must be removed from settlement sensitive areas (structures, pavements, etc.). Topsoil may be re-used in landscaped areas that are not sensitive to settlement, or wasted off-site. Moisture content measurements made on earth fill soil samples from the boreholes range from 4 to 26% (on average, 15.6%). They occasionally contain trace organics. We estimate that the existing reworked native soils and that potentially half of the existing fill may be suitable for immediate re-use as common earth fill or engineered fill if it is sorted or blended to remove any excess organics, moisture, or other deleterious materials.

Moisture content measurements made on glacial till and sands soil samples from the boreholes within 2 m of existing grade range from 11 to 22% (on average, 14%). We estimate that most of the undisturbed native soil at the site is likely suitable for immediate re-use on site.

As inferred by the boreholes, embedded cobbles and boulders should be anticipated in all existing fill and native soils.

Common earth fill or 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.

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.

3.1.4 Frost Susceptibility

Frost susceptible soils within 1.2 m of finished grades in unheated areas (e.g. pavements) could potentially cause pavements to heave or crack next to structures with no frost cover (e.g. curbs, catchbasins, pavements). 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 1.2 m of finished grades should be classified as having a low susceptibility to frost heaving, as defined in Section 2.5 of this report.

3.1.4.1 Post-Construction Settlement

Engineered/compacted fill can be expected to experience self-weight post-construction settlement on the order of about 1 to 2% of the depth of the compacted/engineered fill (depending on the fill composition). If the engineered fill is composed of sand or aggregate materials, then self-weight post-construction settlements of the engineered fill will be around 0.5% or less. 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

If compacted fill is constructed over an approved existing earth fill or reworked native soil subgrade, the subgrade will also be prone to settlement due to the increase in effective vertical stress. Organics in the existing earth fill or reworked native soils may also be subject to secondary consolidation (creep). For grade raises of over 0.5 m immediately above existing fill or reworked native soil, Grounded should be consulted to assess the potential for post-construction settlement, and provide recommendations for mitigation measures.

3.2 Foundation Design Parameters

The proposed development will consist of a new residential subdivision comprised of townhouses and single detached houses. The topsoil and existing earth fill or reworked native soils (in their current state) are considered unsuitable for the support of the proposed building foundations. The proposed dwellings are assumed to have a single basement level extending down 2 to 3± m below finished grades. The following foundation options have been considered in our analysis.

- Conventional Spread Footings on Native Soil
- Conventional Spread Footings on Engineered Fill

3.2.1 General Foundation Recommendations

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

When exposed to ambient environmental temperatures in this area of Ontario, the design earth cover for frost protection of foundations and grade beams is 1.2 metres.

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.

3.2.2 Spread Footings

Foundations made for the proposed dwellings may bear on undisturbed loose to compact sands, or stiff to hard clayey silt till. The depth and elevation of competent bearing soil varies across the site. Conventional spread footings made to bear on these soils may be designed using the following maximum factored geotechnical resistances at ULS, and maximum geotechnical reactions at SLS for an estimated maximum total settlement of 25 mm at the following elevations as determined at each borehole location within the proposed areas of development.

Borehole No.	Approximate Maximum Foundation Bearing Elevation (m)	
	100 kPa SLS / 150 kPa ULS	150 kPa SLS / 225 kPa ULS
101	*n/a*	229.0 ±
102	*n/a*	226.5 ±
103	*n/a*	225.0 ±
104	*n/a*	222.4 ±
105	223.5 ±	221.5 ±
106	222.5 ±	219.5 ±
107	*n/a*	224.0 ±
108	*n/a*	226.5 ±
109	*n/a*	227.5 ±
110	*n/a*	227.2 ±
111	*n/a*	226.5 ±

Borehole No.	Approximate Maximum Foundation Bearing Elevation (m)	
	100 kPa SLS / 150 kPa ULS	150 kPa SLS / 225 kPa ULS
112	227.5 ±	226.5 ±
113	230.0 ±	228.0 ±
114	*n/a*	229.5 ±
115	*n/a*	225.0 ±
116	*n/a*	223.5 ±
117	224.0 ±	223.5 ±
118	224.5 ±	223.5 ±
119	223.7 ±	223.0 ±

The capacities provided above are based on an individual spread footing foundations that are 1 to 3 m wide and embedded a minimum of 0.6 m below FFE. These minimum requirements apply in conjunction with the above recommended geotechnical resistance regardless of loading considerations. The geotechnical reaction at SLS refers to an estimated settlement which for practical purposes is linear and non-recoverable. Differential settlement is related to column spacing, column loads, and footing sizes.

3.2.3 Spread Footings on Engineered Fill

The proposed structures may be supported on 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 (comprising common earth 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.

For footings supported on engineered fill, the minimum width for conventional strip footings must be 600 mm, and the minimum width of individual spread footings must be 1000 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 timing of foundation construction must consider the post-construction settlement of the engineered fill (see Section 3.1).

3.3 Seismic Site Classification

The Ontario Building Code (2012) 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 (2012). The classification is based on the determination of the average shear wave velocity in the 30 metres of the site stratigraphy below spread footing/grade beam elevation, 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 (for spread footings or grade beams) of 3 m below existing site grades, the boreholes observe stiff to hard cohesive till or compact cohesionless till. 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 (2012). 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.

We have estimated the site designation based on quantitative analysis of penetration resistance (N-values) with assumed N-values for the soil stratigraphy beyond the investigation depth. If an improved seismic site class provides economic benefit to the project, consideration should be given to conducting a site-specific Multichannel Analysis of Surface Waves (MASW) to determine the average shear wave velocity in the top 30 meters of the site stratigraphy. MASW testing may result in an improved seismic site designation (to a Class C) which may help reduce the cost of the structure. In addition to potentially improving the seismic site class to Class C, MASW testing is expected to be required in the next version of the OBC, anticipated in 2024.

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.

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
Existing Reworked Native	19	29	0.35	0.52	2.88
Sands	21	30	0.33	0.50	3.00
Silts and Clays (Glacial Till)	21	31	0.32	0.48	3.12
Bedrock	26	28	n/a		

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	γ	=	soil bulk unit weight (kN/m^3)
h	=	the depth at which P is calculated (m)	γ'	=	submerged soil unit weight (γ - 9.8 kN/m^3)
K	=	earth pressure coefficient	q	=	total surcharge load (kPa)
h_w	=	height of groundwater (m) above depth h			

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

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

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

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

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

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

3.5 Slab on Grade Design Parameters

Slabs on grade constructed at the site may rest on native undisturbed sands or glacial till, existing fill, or on engineered fill. The undisturbed native soils or engineered fill will provide adequate subgrade for the support of a conventional slab on grade. In its present state the earth fill or reworked native/disturbed soils are not competent for the support of a slab on grade. If slabs on grade are to rest on existing fill / disturbed soils, the subgrade should be compacted in place, proof-rolled, and inspected under the supervision of Grounded for obvious exposed loose/soft or disturbed areas, or for areas containing excessive deleterious materials or moisture. Unacceptable material (as determined by Grounded) must be sub-excavated and replaced with Granular B (OPSS.MUNI 1010) compacted to a minimum of 98% SPMDD. The modulus of subgrade reaction appropriate for design of a slab on grade resting on the above noted subgrade types is summarized in the following table.

Subgrade Type	Modulus of Subgrade Reaction (kPa/m)
Sands (Native, undisturbed)	20,000
Silts and Clays (Glacial Till - Native, undisturbed)	30,000
Engineered Fill	22,000
Compacted Earth Fill/Reworked Native (Existing Fill or Placed Fill)	10,000

If the basements are made as a conventional drained structures, a permanent drainage system including subfloor drains is required (see section below). In this case, the slabs on grade must be provided with a drainage layer and capillary moisture break, which is achieved by forming the slabs on a minimum 200 mm thick layer of 19 mm clear stone (OPSS.MUNI 1004) vibrated to a dense state.

Wherever a slab-on-grade is made on native sands, the drainage layer must be separated from the underlying soils using a non-woven geotextile (with an apparent opening size of less than 0.250 mm and a tear resistance of more than 200 N) with a minimum 600 mm overlap. The stone drainage layer is then placed over the geotextile. Without this filtering layer, fines from the underlying subgrade will enter the drainage layer potentially resulting in loss of ground, loss of slab support, and clogging of the subfloor drainage system.

The subgrade should be cut neat and inspected by Grounded prior to placement of the capillary moisture break and construction of the slab. Disturbed or otherwise unacceptable material (as determined by Grounded) must be sub-excavated and replaced with Granular B (OPSS.MUNI 1010) compacted to a minimum of 98% SPMDD. The slabs on grade should not be placed on frozen subgrade, to prevent excessive settlement of the slab as the subgrade thaws. Areas of frozen subgrade should be removed during subgrade preparation.

3.6 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 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. Perimeter drainage must be collected and conveyed directly to the building sumps, and not discharged into the subfloor drainage system, the granular layer, or beneath the floor slab.

Subfloor drainage pipes are to be spaced at a maximum 9 m (measured on-centres).

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 drainpipe.

Typical basement drainage details are appended.

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

The drainage system should be connected directly to the municipal storm system if possible, or else discharge at grade.

The basement walls for new dwellings must be provided with damp-proofing provisions in conformance to Section 9.13.2 of the Ontario Building Code (2012).

The permanent dewatering requirements are provided in Grounded's Hydrogeological Report (File No. 24-048) under separate cover.

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 earth fill, reworked native soil or native soil. If earth fill or reworked native 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 sub-excavated and replaced with imported fill compacted to 98% SPMDD.

If trenches extend below the groundwater table, the groundwater table must be lowered to 1.2 m below the lowest excavation elevation prior to excavation. At this site, the stabilized groundwater table is shallow and within the fill materials. Native soils are low permeability and will generally preclude the free flow of groundwater. Test pits may be advanced to observe seepage at trench invert elevation, to inform dewatering requirements.

Bedding material below the groundwater table must consist of well graded granular fill such as Granular A (OPSS.MUNI 1010). The bedding material must be compacted to a minimum 98% SPMDD. Clear stone is specifically prohibited below 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 or reworked native and native soils on site will constitute adequate backfill material if the soil meets the backfill specifications:

- Any deleterious material in the earth fill or reworked native soil 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.

3.7.3 Trench Plugs

Trench plugs are installed when the invert of the trench is below the groundwater table, to prevent the groundwater from preferentially flowing through the granular bedding and backfill material, creating a local drawdown of the groundwater table. Where local drawdown is not tolerated, trench plugs can be installed in the granular bedding and backfill material. Trench plugs may be constructed as clay plugs or cut off collars around the pipe barrel.

Clay plugs should be installed every 50 m along the full length of the trench, where the trench invert is below the groundwater table. Clay plugs must be a minimum of 1 m thick along the length of the trench and will completely replace any bedding or backfill material around the pipe barrel. Material used for clay plugs must have greater than 15% of the particles finer than 2 microns and a coefficient of permeability of less than 10^{-8} m/s. The material must be compacted to 95% SPMDD. Unshrinkable fill is also a suitable clay plug material. A representative sample of clay plug material must be submitted prior to construction and during construction for permeability and particle size testing to confirm the material is adequate and in compliance with the above material specifications.

If cut off collars are used instead of clay plugs, the cut off collar must not be placed within 1 m of a pipe joint to ensure adequate compaction. The soils around the cut off collar must be compacted to 95% SPMDD. A watertight connection is required between the collar and the pipe wall.

The municipality may have its own minimum design requirements for trench plugs which may have to be considered. If this is the case, the relevant specifications should be reviewed and incorporated by the civil engineer, and the more stringent of the two specifications should be used.

3.7.4 Stormwater Management Ponds

One storm water management pond (SWMP) is proposed to be constructed at the east end of the site. This SWMP will be designed to infiltrate storm water.

Details of the SWMP design were not available for our review. Preliminary recommendations are provided below. Grounded should be retained to review detailed design drawings once they are available, for the purpose of slope stability analysis.

Borehole 106 was advanced in the proposed footprint of the SWMP. Borehole 106 encountered reworked native soil down to Elev. 222.7 m, underlain by native sand down to Elev. 221.8 which is underlain by a clayey silt glacial till to termination depth (Elev. 217.5 m). The stabilized ground water table measured in the monitoring well installed in Borehole 106 is at about Elev. 222.4± m. The base elevation of the SWMP is unknown at the time of this report. Based on this, the borehole data suggests that:

- the pond side slopes will consist of reworked native soil, native sand and clayey silt till.

The sides of the pond should be lined with an impermeable barrier consisting of well compacted fine-grained soils (i.e. clay based soils) or synthetic equivalent. The purpose of the liner will be to prevent groundwater from infiltrating into the storm pond, and to prevent stored water within the pond to infiltrate out. The liner must be designed to resist the difference in hydrostatic pressure between the prevailing groundwater table and the permanent pool elevation.

4 Pavement Engineering Recommendations

4.1 Asphalt Pavement

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

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

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

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

The City 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, and the more stringent of the two specifications should be used.

4.1.1 Pavement Subgrade Preparation

The subgrade must be adequately prepared prior to pavement construction. A discussion on site grading and subgrade preparation is provided in Section 3.1.

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

Existing earth fill or reworked native soil, 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 existing subgrade 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.

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 Asphalt Pavement Design

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

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

Basic **Pavement Structure**	**Compaction Requirement**	**Car Parking Minimum Component Thickness**	**Bus/Truck Traffic Minimum Component Thickness**
Asphalt Top Lift HL-3 (OPSS.MUNI 1150), and PG 58-28 (OPSS.MUNI 1101)	OPSS.MUNI 310	65 mm	40 mm
Asphalt Base Course HL-8 (OPSS.MUNI 1150), and PG 58-28 (OPSS.MUNI 1101)	OPSS.MUNI 310	N/A	50 mm

Basic Pavement Structure	**Compaction Requirement**	**Car Parking Minimum Component Thickness**	**Bus/Truck Traffic Minimum Component Thickness**
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 subgrade soils have a low to moderate susceptibility to frost heave, and pavement on these materials must be designed accordingly. To reduce frost heave, soil subgrade that is susceptible to frost (as defined in Section 2.5) should be replaced to a depth of 60 to 70 percent of the frost penetration depth with non-frost susceptible soils or with granular materials. The most effective ways of dealing with potential frost heave are to construct a good subsurface drainage system, and to stay above the groundwater table.

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/reworked native soil is a Type 3 soil
- The cohesive till is a Type 2 soil
- The sands are Type 4 soils if below the groundwater table, or Type 3 soils if dewatered / above the groundwater table.

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

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

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

Larger obstructions (e.g. buried concrete debris, other obstructions) not directly observed in the boreholes are likely present in the earth fill and reworked native soil. Similarly, larger inclusions (e.g. cobbles and boulders) may be encountered in the native soils. The size and distribution of these obstructions cannot be predicted with boreholes, as the split spoon sampler is not large

enough to capture particles of this size. Provision must be made in excavation contracts to allocate risks associated with the time spent and equipment utilized to remove or penetrate such obstructions when encountered.

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

5.2 Short-Term Groundwater Control

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

The groundwater table is relatively shallow and varies across the site, ranging from 0.4 to 2.9 ±m below existing site grade. Depending on final site grading, basement excavations for new dwellings may extend below the groundwater table. Seepage may be allowed to drain into the excavations 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. Excavation delays will occur as seepage (however limited) is controlled. These delays should be anticipated in the construction schedule.

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 excess settlement of the slab as the subgrade thaws. Areas of frozen subgrade should be removed during subgrade preparation. Depending on the project context, consideration should be given to frost effects (heaving, softening, etc.) on exposed subgrade surfaces.

5.4 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 foundation installations and the condition of the founding subgrade as the foundations are constructed is as much a part of the geotechnical engineering design function as the design itself; it is also required by Section 4.2.2.2 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.

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

Fill placement is typically measured relative to Standard Proctor Maximum Dry Density (SPMDD). A third-party testing agency can be retained to provide in situ density measurements on site to confirm that the specified density is achieved during fill or asphalt placement. Grounded can provide oversight and review services for this testing as needed.

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 geotechnical engineering report is considered preliminary due to the level of investigation at this stage and design details not being available at the time of this investigation. At detailed design, additional 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. Note that preliminary findings can vary significantly from the findings of a detailed comprehensive study.

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 Grounded's standard of practice as well as other reasonable and prudent 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 and mud rotary drilling equipment. 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 to potential site alteration.

This report provides preliminary geotechnical engineering advice intended for use by the owner and their retained design team for planning purposes 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 Russel Pines Property 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.

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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,

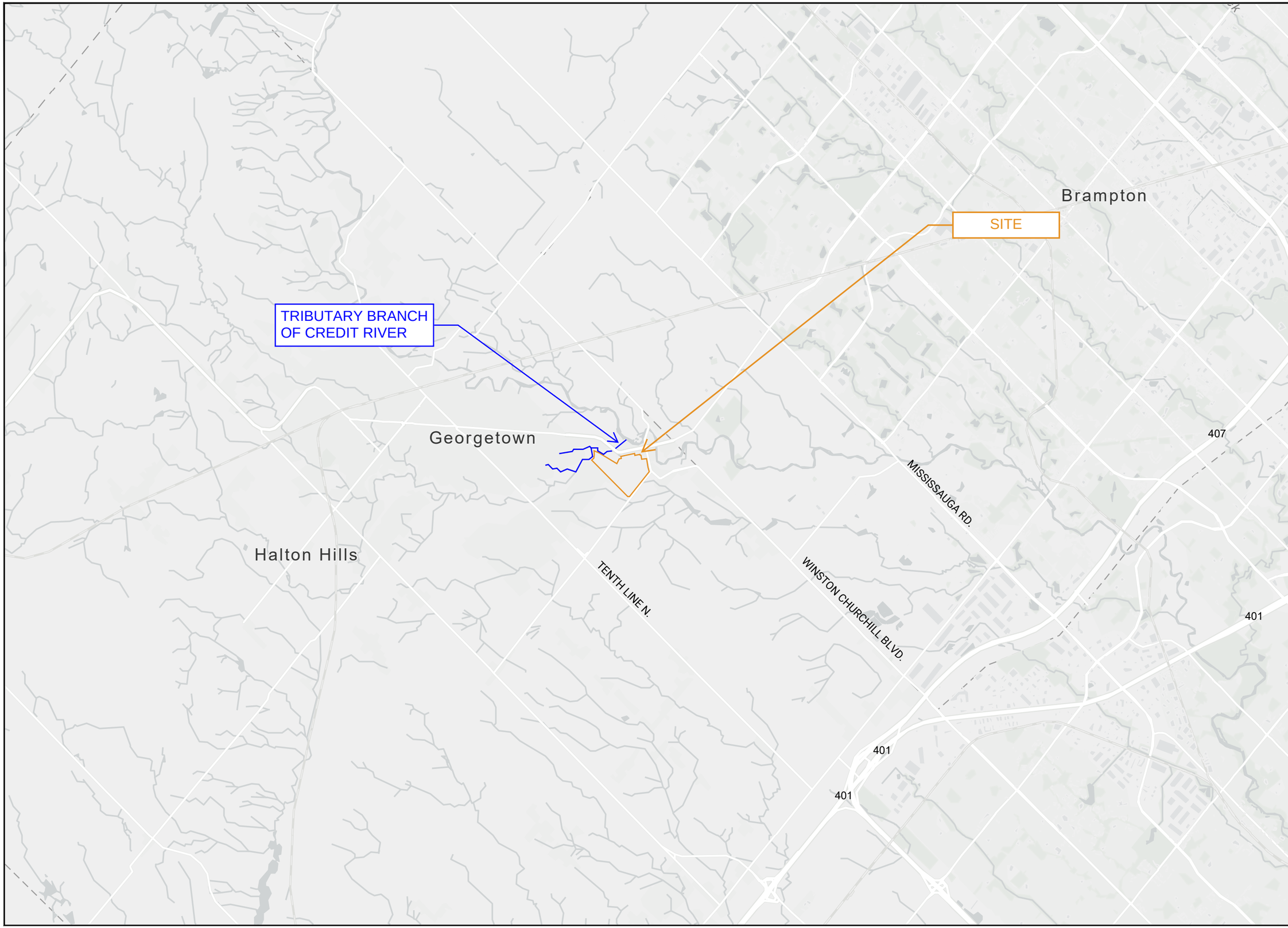
GROUNDED ENGINEERING

Sam Bastan, P. Eng.
Project Engineer

Kyle Byckalo, P.Eng.
Senior Geotechnical Engineer

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

FIGURES



GROUNDED
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LEGEND

- APPROXIMATE PROPERTY BOUNDARY
- WATER BODY

Note

Reference

ArcGIS Online 2024

Project

16469 10 SIDE ROAD, NORVAL, ONTARIO

Figure Title

SITE LOCATION PLAN

North

TRUE

PROJECT

Date

JUNE 2024

Scale

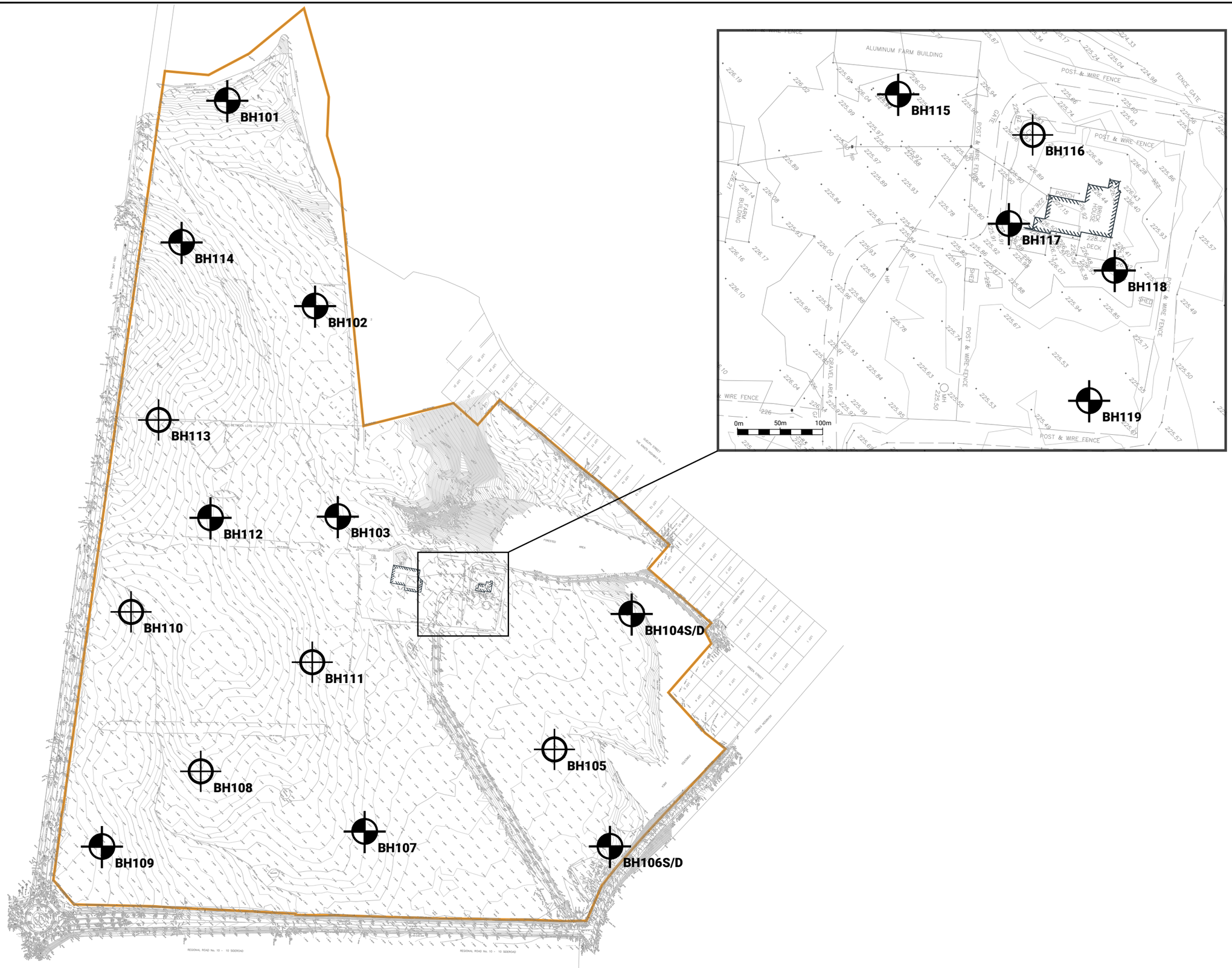
0m 1000m 2000m

Job No

24-048

Figure No

FIGURE 1



GROUNDED ENGINEERING

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www.groundedeng.ca

LEGEND

- PROPERTY BOUNDARY
- EXISTING BUILDING STRUCTURE
- MONITORING WELL/BOREHOLE BY GROUNDED

Note

Reference

Survey Drawing job no.
15-30-736-00-2020Topo
Dated March 06, 2020
Prepared by J.D.BARNES LTD.
Received on May 07, 2024.

Project

16469 10 SIDE ROAD, NORVAL, ONTARIO

Figure Title

BOREHOLE LOCATION PLAN - EXISTING SITE CONDITIONS

North

TRUE
PROJECT

Date

JUNE 2024

Scale

0m 50m 100m

Job No

24-048

Figure No

FIGURE 2

GROUNDED ENGINEERING
1 BANIGAN DRIVE, TORONTO, ONT., M4H 1G3
www.groundedeng.ca

LEGEND

- PROPERTY BOUNDARY
- EXISTING BUILDING STRUCTURE
- MONITORING WELL/BOREHOLE BY GROUNDED

Note

Reference

DRAFT PLAN OF SUBDIVISION
Dated February 20, 2024
Prepared by Glen Schnarr and Associates Inc.
Received on March 14, 2024.

Project

16469 10 SIDE ROAD, NORVAL, ONTARIO

Figure Title

BOREHOLE LOCATION PLAN - PROPOSED SITE CONDITIONS

North

TRUE
PROJECT

Date

JUNE 2024

Scale

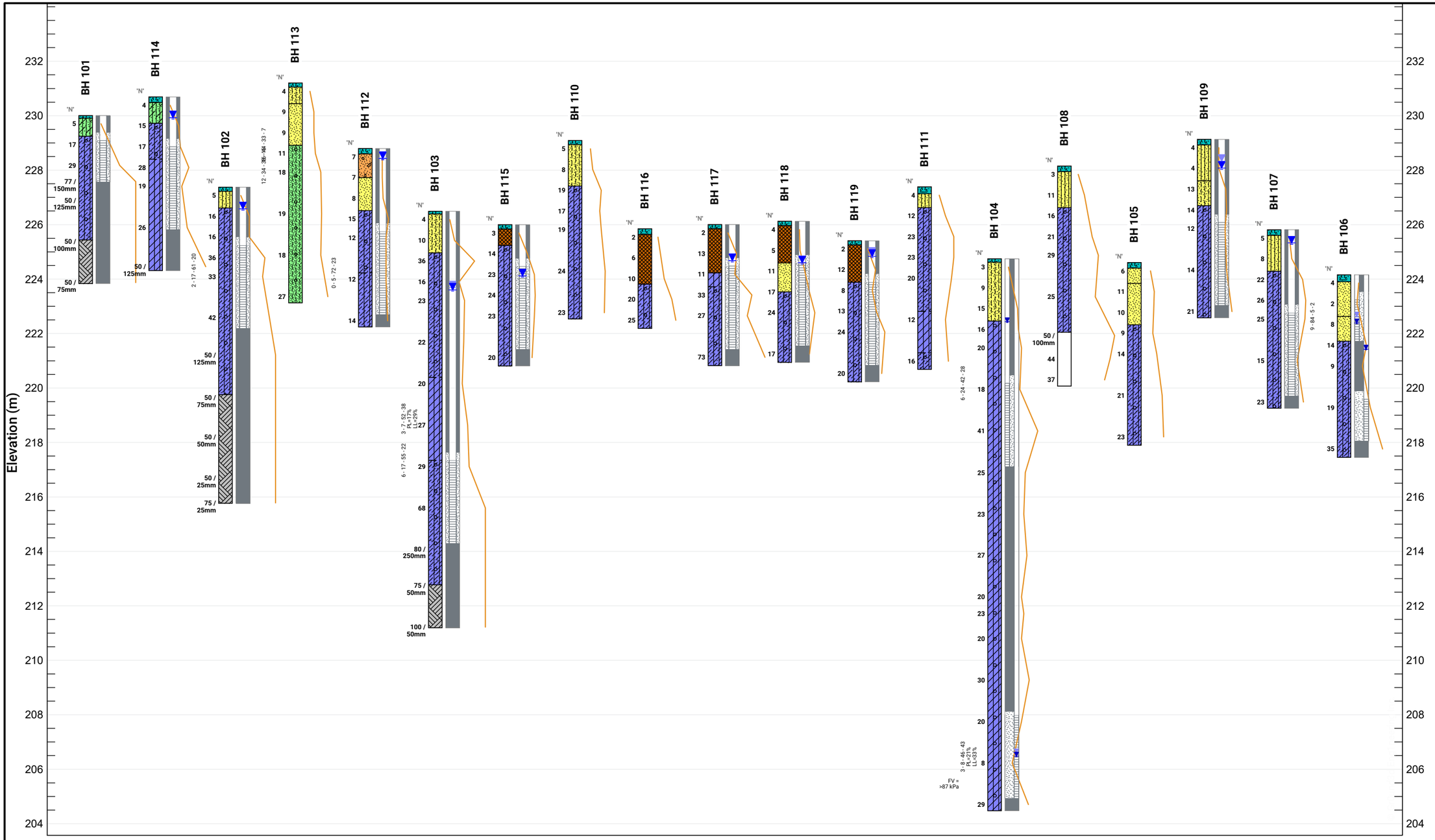
0m 50m 100m

Job No

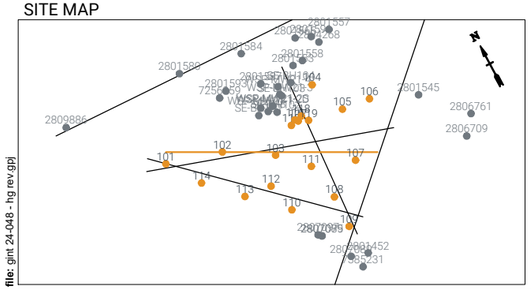
24-048

Figure No

FIGURE 3



SITE MAP



file: gint 24-048 - hg rev.gpj

Boreholes Equally Spaced

BOREHOLE STRATIGRAPHY LEGEND

Topsoil	Sandy Silt	Sand	Silty Sand Till
Sandy Silt (clayey)	Silty Sand	Blank	Fill
Clayey Silt Till	Silt and Clay	Gravelly Sand	
Bedrock (inferred)	Silt and Clay Till	Clayey Silt	

GROUNDED ENGINEERING

1 Banigan Drive, Toronto, Ont., M4H 1G3
www.groundedeng.ca

LEGEND

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

BH 101 BOREHOLES BY GROUNDED

T-BH7 BOREHOLES BY OTHERS

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

Project
16469 10 SIDE ROAD HALTON HILLS

Figure Title
SUBSURFACE PROFILE

Date
JULY 2024

Scale
AS INDICATED

Job No
24-048

Figure No
FIGURE 4

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

PI: plasticity index

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

COHESIONLESS

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

COHESIVE

Consistency	N-Value	Su (kPa)
Very Soft	<2	<12
Soft	2 - 4	12 - 25
Firm	4 - 8	25 - 50
Stiff	8 - 15	50 - 100
Very Stiff	15 - 30	100 - 200
Hard	>30	>200

COMPOSITION

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

ASTM STANDARDS

ASTM D1586 Standard Penetration Test (SPT)
Driving a 51 mm O.D. split-barrel sampler ("split spoon") into soil with a 63.5 kg weight free falling 760 mm. The blows required to drive the split spoon 300 mm ("bpf") after an initial penetration of 150 mm is referred to as the N-Value.

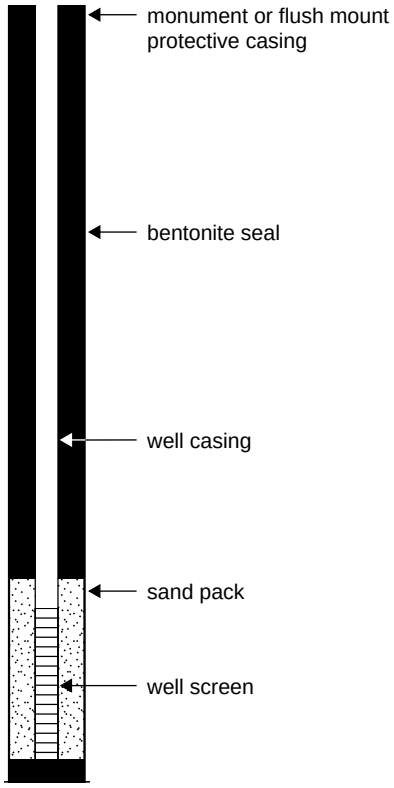
ASTM D3441 Cone Penetration Test (CPT)
Pushing an internal still rod with a outer hollow rod ("sleeve") tipped with a cone with an apex angle of 60° and a cross-sectional area of 1000 mm^2 into soil. The resistance is measured in the sleeve and at the tip to determine the skin friction and the tip resistance.

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



ROCK CORE TERMINOLOGY (MTO SHALE)

TCR **Total Core Recovery** the total length of recovery (soil or rock) per run, as a percentage of the drilled length
SCR **Solid Core Recovery** the total length of sound full-diameter rock core pieces per run, as a percentage of the drilled length
RQD **Rock Quality Designation** the sum of all pieces of sound rock core in a run which are 10 cm or greater in length, as a percentage of the drilled length

Natural Fracture Frequency (typically per 0.3 m) The number of natural discontinuities (joints, faults, etc.) which are present per 0.3m. Ignores mechanical or drill-induced breaks, and closed discontinuities (e.g. bedding planes).

LOGGING DISCONTINUITIES

Discontinuity Type

BP bedding parting
CL cleavage
CS crushed seam
FZ fracture zone
MB mechanical break
IS infilled seam
JT Joint
SS shear surface
SZ shear zone
VN vein
VO void

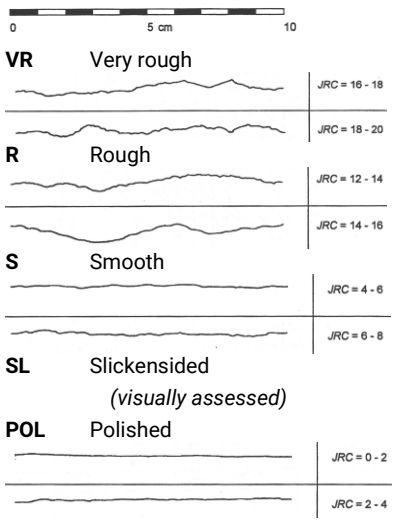
Coating

CN Clean
SN Stained
OX Oxidized
VN Veneer
CT Coating (>1 mm)

Dip Inclination

H	horizontal/flat	0 - 20°
D	dipping	20 - 50°
SV	sub-vertical	50 - 90°
V	vertical	90±°

Roughness (Barton et al.)



Spacing in Discontinuity Sets (*ISRM 1981*)

VC	very close	< 60 mm
C	close	60 – 200 mm
M	mod. close	0.2 to 0.6 m
W	wide	0.6 to 2 m
VW	very wide	> 2 m

Aperture Size

T	closed / tight	< 0.5 mm
GA	gapped	0.5 to 10 mm
OP	open	> 10 mm

Planarity

PR	Planar
UN	Undulating
ST	Stepped
IR	Irregular
DIS	Discontinuous
CU	Curved

GENERAL

Degree of Weathering (*after MTO, RR229 Evaluation of Shales for Construction Projects*)

Zone	Degree	Description
Z1	unweathered	shale, regular jointing
Z2	partially weathered	angular blocks of unweathered shale, no matrix, with chemically weathered but intact shale
Z3		soil-like matrix with frequent angular shale fragments < 25mm diameter
Z4a		soil-like matrix with occasional shale fragments < 3mm diameter
Z4b	fully weathered	soil-like matrix only

Strength classification (*after Marinos and Hoek, 2001; ISRM 1981b*)

Grade		UCS (MPa)	Field Estimate (Description)
R6	extremely strong	> 250	can only be chipped by geological hammer
R5	very strong	100 - 250	requires many blows from geological hammer
R4	strong	50 - 100	requires more than one blow from geological hammer
R3	medium strong	25 - 50	can't be scraped, breaks under one blow from geological hammer
R2	weak	5 - 25	can be peeled / scraped with knife with difficulty
R1	very weak	1 - 5	easily scraped / peeled, crumbles under firm blow of geo. hammer
R0	extremely weak	< 1	indented by thumbnail

Bedding Thickness (*Q. J. Eng. Geology, Vol 3, 1970*)

Very thickly bedded	> 2 m
Thickly bedded	0.6 – 2m
Medium bedded	200 – 600mm
Thinly bedded	60 – 200mm
Very thinly bedded	20 – 60mm
Laminated	6 – 20mm
Thinly Laminated	< 6mm

GROUNDED ENGINEERING

Date Started : May 15, 2024
Position : E: 591085, N: 4833066 (UTM 17T)
Elev. Datum : Geodetic

BOREHOLE LOG 101

File No. : 24-048 **Project** : 16469 10 Side Road, Halton Hills **Client** : Russell Pines Property Corp.

drill method : hollow stem augers OD=215 mm

elev depth (m)	description	graphic log	number	type	SPT N-value
230.0	**GROUND SURFACE**				
	100mm **TOPSOIL**		1	SS	5
229.2 / 0.8	**SANDY SILT**, clayey, trace rootlets, trace gravel, natural organic odour, firm, brown, moist (REWORKED)		2	SS	17
	CLAYEY SILT, some sand, trace gravel, very stiff to hard, brown, moist (GLACIAL TILL)		3	SS	29
	...at 1.5 m, trace shale fragments, trace rock fragments		4	SS	77 / 150mm
225.4	...at 2.3 m, some shale, reddish brown		5	SS	50 / 125mm
4.6	**INFERRED BEDROCK**, shale and limestone fragments, reddish brown		6	SS	50 / 100mm
223.8 / 6.2			7	SS	50 / 75mm

depth scale (m): 0, 1, 2, 3, 4, 5, 6
elevation (m): 230, 229, 228, 227, 226, 225, 224

well details

undrained shear strength (kPa)
■ unconfined + field vane
● pocket penetrometer ○ Lab Vane
40 80 120 160

SPT N-values (bpf)
× dynamic cone
10 20 30 40

headspace vapour (ppm)
× hexane □ isobutylene △ methane
100 200 300

moisture / plasticity
PL MC LL
10 20 30

unstabilized water level

lab data and comments

grain size distribution (%) (MIT)
GR SA SI CL

3.0m: auger grinding

4.6m: auger grinding

END OF BOREHOLE

Borehole was dry and caved to 5.2 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 27, 2024	dry	n/a
Jun 3, 2024	dry	n/a

BOREHOLE LOG 102

Date Started : May 16, 2024
Position : E: 591347, N: 4832990 (UTM 17T)
Elev. Datum : Geodetic

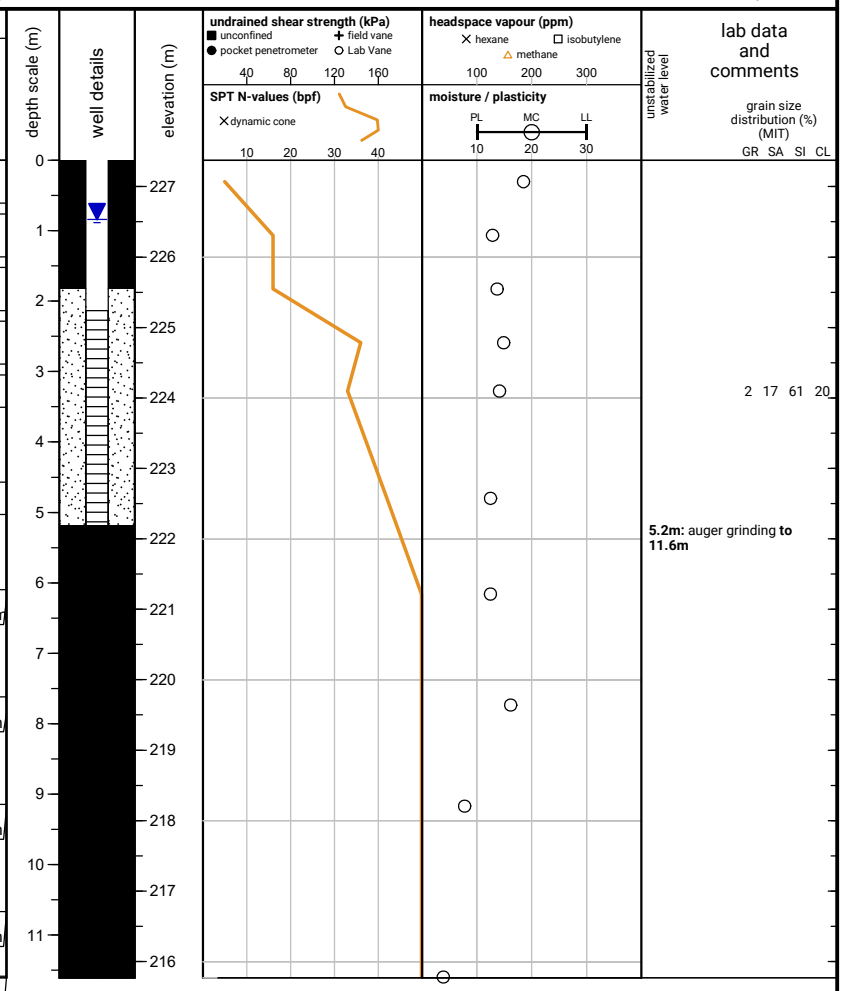
File No. : 24-048 **Project** : 16469 10 Side Road, Halton Hills **Client** : Russell Pines Property Corp.

drill method	elev depth (m)	description	number	type	SPT N-value
	227.4	**GROUND SURFACE**			
hollow stem augers OD=215 mm		150mm **TOPSOIL**	1	SS	5
	226.6	**SANDY SILT**, trace clay, trace gravel, trace rootlets, loose, dark brown, moist (REWORKED)			
	0.8		2	SS	16
		CLAYEY SILT, some sand, trace to some gravel, very stiff, brown, moist to wet (GLACIAL TILL)	3	SS	16
		...at 2.3 m, trace sand, hard, brownish grey, wet	4	SS	36
			5	SS	33
mud rotary Ig OD=135 mm		...at 4.6 m, sand seams	6	SS	42
		...at 6.1 m, some shale fragments, trace rock fragments, very dense, redish brown, wet	7	SS	50 / 125mm
	219.8				
	7.6	**INFERRED BEDROCK**, shale and limestone fragments, reddish brown	8	SS	50 / 75mm
			9	SS	50 / 50mm
			10	SS	50 / 25mm
	215.8				
	11.6	...at 11.6 m, grey	11	SS	75 / 25mm

END OF BOREHOLE

Contained drill water upon completion of drilling. Unstabilized water level not measured. Borehole was open.

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



GROUNDWATER LEVELS

date	depth (m)	elevation (m)
May 27, 2024	1.0	226.4
Jun 3, 2024	0.8	226.6

file: gint 24-048 - hg rev.gpj

Tech : BJW | **PM** : SB/LL | **Rev** : KB

BOREHOLE LOG 103

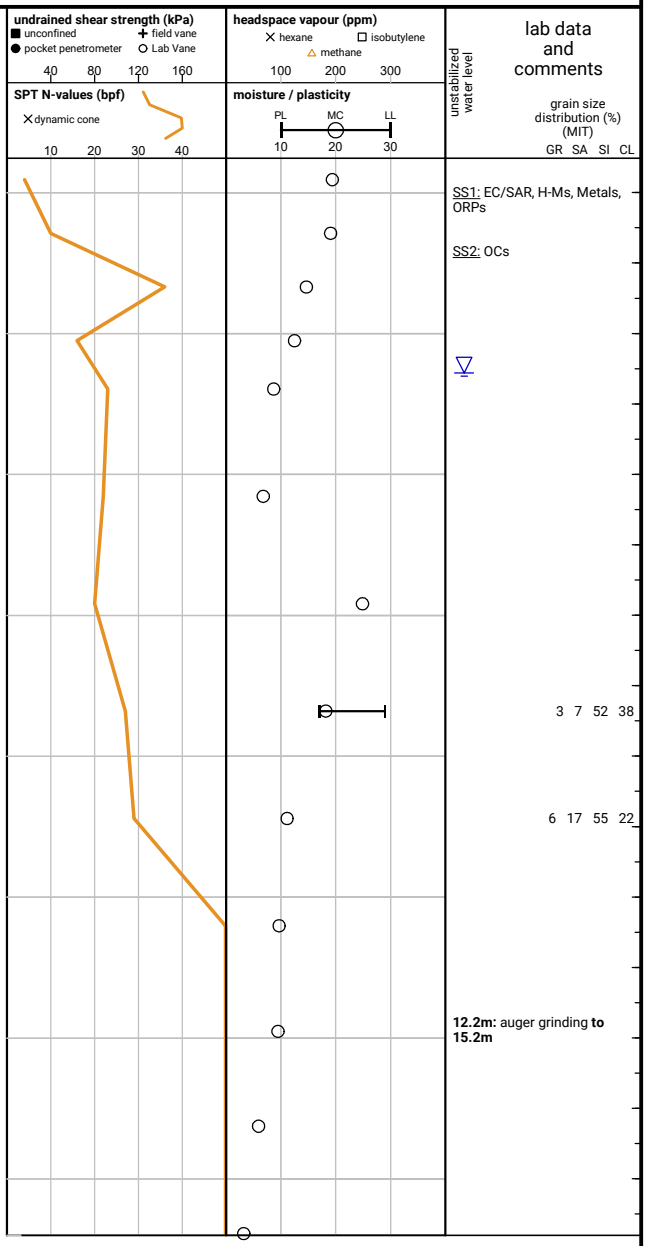
Date Started : May 16, 2024
Position : E: 591562, N: 4832858 (UTM 17T)
Elev. Datum : Geodetic

File No. : 24-048 **Project** : 16469 10 Side Road, Halton Hills **Client** : Russell Pines Property Corp.

drill method : hollow stem augers OD=215 mm

elev depth (m)	description	graphic log	number	type	SPT N-value
226.5	**GROUND SURFACE**				
	100mm **TOPSOIL**		1	SS	4
	SILTY SAND, some clay, some gravel, loose, brown, moist (REWORKED)		2	SS	10
225.0 / 1.5	**CLAYEY SILT**, some sand, trace gravel, hard, greyish brown, moist (GLACIAL TILL)		3	SS	36
	...at 2.3 m, very stiff, grey		4	SS	16
			5	SS	23
			6	SS	22
220.4 / 6.1	**SILT AND CLAY**, trace sand, very stiff, grey, moist		7	SS	20
	...at 7.6 m, trace gravel		8	SS	27
217.4 / 9.1	**CLAYEY SILT**, some sand, trace gravel, very stiff to hard, grey, moist (GLACIAL TILL)		9	SS	29
			10	SS	68
	...at 12.2 m, sandy silt, some clay, trace shale fragements, trace rock fragments, very dense		11	SS	80 / 250mm
212.8 / 13.7	**INFERRED BEDROCK**, shale and limestone fragments, reddish brown		12	SS	75 / 50mm
211.2 / 15.3	**END OF BOREHOLE**		13	SS	100 / 50mm

depth scale (m) | well details | elevation (m)



GROUNDWATER LEVELS

date	depth (m)	elevation (m)
May 27, 2024	2.9	223.6
Jun 3, 2024	2.9	223.6

Unstabilized water level measured at 3.0 m below ground surface; caved to 11.6 m below ground surface upon completion of drilling.

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

file: gint 24-048 - hg rev.gpj

Tech : BJW | **PM** : SB/LL | **Rev** : KB

Date Started : May 17, 2024
Position : E: 591871, N: 4833070 (UTM 17T)
Elev. Datum : Geodetic

BOREHOLE LOG 104

File No. : 24-048 **Project** : 16469 10 Side Road, Halton Hills **Client** : Russell Pines Property Corp.

drill method : hollow stem augers OD=215 mm

elev depth (m)	description	graphic log	number	type	SPT N-value
224.7	**GROUND SURFACE**				
	125mm **TOPSOIL**		1	SS	3
	SILTY SAND, trace clay, trace gravel, trace rootlets, very loose to loose, brown, moist (REWORKED)		2	SS	9
	...at 0.8 m, some silt				
	...at 1.5 m, silty, some clay, compact		3	SS	15
222.4 / 2.3	**SILT AND CLAY**, some sand, trace gravel, very stiff, brown, moist (GLACIAL TILL)		4	SS	16
	...at 3.0 m, clayey silt, sandy, grey		5	SS	20
			6	SS	18
	...at 6.1 m, hard to very stiff		7	SS	41
			8	SS	25
	...at 9.1 m, some sand		9	SS	23
	...at 10.7 m, trace rock fragments to 12.2 m		10	SS	27
			11	SS	20
	...at 12.8 m, sand seams to 13.7 m		12	SS	23
	...at 13.7 m, sandy		13	SS	20
	...at 15.2 m, sand seams to 16.8 m		14	SS	30
	...at 16.8 m, silt and clay, trace sand		15	SS	20
	...at 18.3 m, stiff		16	SS	8
				FV	
204.4 / 20.3	...at 19.8 m, clayey silt		17	SS	29

depth scale (m) 0–20; well details: S, D; elevation (m) 224–205

undrained shear strength (kPa): unconfined, field vane, pocket penetrometer, Lab Vane; 40 80 120 160
SPT N-values (bpf): dynamic cone; 10 20 30 40
headspace vapour (ppm): hexane, isobutylene, methane; 100 200 300
moisture / plasticity: PL MC LL; 10 20 30
unstabilized water level

lab data and comments

SS1: H-Ms, Metals, ORPs

SS2: OCs

grain size distribution (%) (MIT)

GR	SA	SI	CL
6	24	42	28
3	8	46	43

END OF BOREHOLE

Borehole was dry and caved to 18.6 m below ground surface upon completion of drilling.

S: 50 mm dia. monitoring well installed.
D: 50 mm dia. monitoring well installed.
No. 10 screen

104-S GROUNDWATER LEVELS

date	depth (m)	elevation (m)
May 27, 2024	2.4	222.3
Jun 3, 2024	2.3	222.4

104-D GROUNDWATER LEVELS

date	depth (m)	elevation (m)
May 27, 2024	18.2	206.5
Jun 3, 2024	18.3	206.4

file: gint 24-048 - hg rev.gpj

Tech : BJW | **PM** : SB/LL | **Rev** : KB

GROUNDED ENGINEERING

Date Started : May 9, 2024
Position : E: 591943, N: 4832901 (UTM 17T)
Elev. Datum : Geodetic

BOREHOLE LOG 105

File No. : 24-048 **Project** : 16469 10 Side Road, Halton Hills **Client** : Russell Pines Property Corp.

drill method : hollow stem augers OD=215 mm

elev depth (m)	description	graphic log	number	type	SPT N-value
224.6	**GROUND SURFACE**				
	200mm **TOPSOIL**		1	SS	6
223.8 / 0.8	**SAND**, some silt, trace clay, trace gravel, loose, brown, moist (REWORKED)		2	SS	11
	SAND, trace silt, trace clay, trace gravel, compact, brown, wet ...at 1.7 m, silt, some sand, trace clay, moist		3A 3B	SS	10
222.3 / 2.3	**CLAYEY SILT**, some sand, trace gravel, stiff to very stiff, grey, moist (GLACIAL TILL) ...at 3.0 m, natural organic odour to 6.1 m		4	SS	9
			5	SS	14
			6	SS	21
			7	SS	23
217.9 / 6.7	**END OF BOREHOLE**				

depth scale (m): 0 1 2 3 4 5 6

well details

elevation (m): 224 223 222 221 220 219 218

undrained shear strength (kPa): ■ unconfined ● pocket penetrometer + field vane ○ Lab Vane; 40 80 120 160

SPT N-values (bpf): × dynamic cone; 10 20 30 40

headspace vapour (ppm): × hexane □ isobutylene △ methane; 100 200 300

moisture / plasticity: PL MC LL; 10 20 30

unstabilized water level

lab data and comments

grain size distribution (%) (MIT): GR SA SI CL

Unstabilized water level measured at 0.9 m below ground surface; caved to 4.6 m below ground surface upon completion of drilling.

file: gint 24-048 - hg rev.gpj

Tech : BJW | **PM** : SB/LL | **Rev** : KB

GROUNDED ENGINEERING

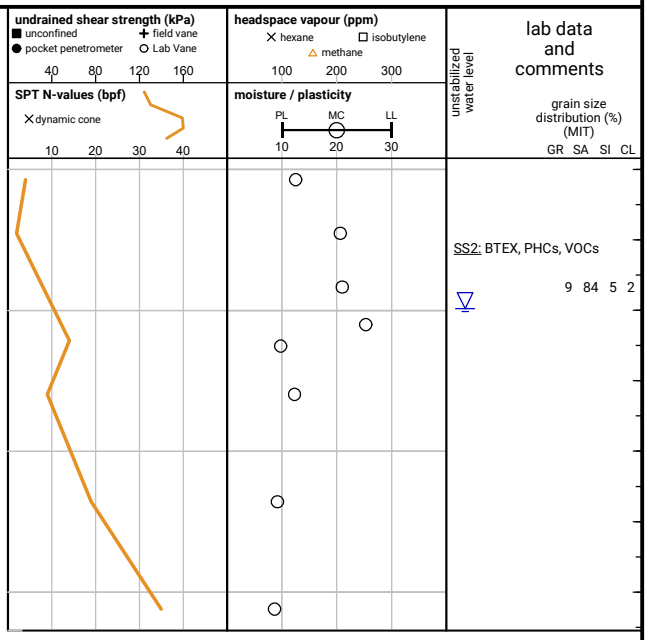
Date Started : May 9, 2024
Position : E: 592079, N: 4832884 (UTM 17T)
Elev. Datum : Geodetic

BOREHOLE LOG 106

File No. : 24-048 **Project** : 16469 10 Side Road, Halton Hills **Client** : Russell Pines Property Corp.

drill method : hollow stem augers OD=215 mm

elev depth (m)	description	graphic log	number	type	SPT N-value
224.2	**GROUND SURFACE**				
	250mm **TOPSOIL**		1	SS	4
	SAND, some silt, trace clay, trace gravel, very loose, brown, moist to wet (REWORKED)		2	SS	2
222.7 / 1.5	**SAND**, trace silt, trace clay, trace gravel, loose, brown, wet		3	SS	8
221.8 / 2.4	...at 2.3 m, silt, some sand, trace clay		4A / 4B	SS	14
	CLAYEY SILT, some sand, trace gravel, stiff to very stiff, grey, moist (GLACIAL TILL)		5	SS	9
			6	SS	19
	...at 6.1 m, hard		7	SS	35
217.5 / 6.7					



END OF BOREHOLE

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

S: 50 mm dia. monitoring well installed.
D: 50 mm dia. monitoring well installed.
No. 10 screen

106-S GROUNDWATER LEVELS

date	depth (m)	elevation (m)
May 27, 2024	1.6	222.6
Jun 3, 2024	1.8	222.4

106-D GROUNDWATER LEVELS

date	depth (m)	elevation (m)
May 27, 2024	2.9	221.3
Jun 3, 2024	2.8	221.4

file: gint 24-048 - hg rev.gpj

Tech : BJW | **PM** : SB/LL | **Rev** : KB

BOREHOLE LOG 107

Date Started : May 13, 2024
Position : E: 591884, N: 4832659 (UTM 17T)
Elev. Datum : Geodetic

File No. : 24-048 **Project** : 16469 10 Side Road, Halton Hills **Client** : Russell Pines Property Corp.

drill method : hollow stem augers OD=215 mm

elev depth (m)	description	graphic log	number	type	SPT N-value
225.8	**GROUND SURFACE**				
	200mm **TOPSOIL**		1	SS	5
	SANDY SILT, some clay, trace gravel, trace rootlets, loose, brown, moist (REWORKED)		2	SS	8
224.3 / 1.5	**CLAYEY SILT**, some sand to sandy, very stiff, brown with black, moist (GLACIAL TILL)		3	SS	22
	...at 1.8 m, natural organic odour		4	SS	26
			5	SS	25
			6	SS	15
219.2 / 6.6	...at 6.1 m, trace shale fragments		7	SS	23

depth scale (m): 0, 1, 2, 3, 4, 5, 6
elevation (m): 225, 224, 223, 222, 221, 220

undrained shear strength (kPa): unconfined, pocket penetrometer, field vane, Lab Vane; 40, 80, 120, 160
SPT N-values (bpf): dynamic cone; 10, 20, 30, 40
headspace vapour (ppm): hexane, isobutylene, methane; 100, 200, 300
moisture / plasticity: PL, MC, LL; 10, 20, 30
unstabilized water level
lab data and comments
grain size distribution (%) (MIT): GR SA SI CL

SS1: OCs

SS2: H-Ms, Metals, ORPs

END OF BOREHOLE

Dry and open upon completion of drilling.

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

GROUNDWATER LEVELS

date	depth (m)	elevation (m)
May 27, 2024	0.6	225.2
Jun 3, 2024	0.5	225.3

file: gint 24-048 - hg rev.gpj

Tech : BJW | **PM** : SB/LL | **Rev** : KB

BOREHOLE LOG 108

Date Started : May 13, 2024
Position : E: 591714, N: 4832553 (UTM 17T)
Elev. Datum : Geodetic

File No. : 24-048 **Project** : 16469 10 Side Road, Halton Hills **Client** : Russell Pines Property Corp.

drill method : hollow stem augers OD=215 mm

elev depth (m)	description	graphic log	number	type	SPT N-value
228.1	**GROUND SURFACE**				
	200mm **TOPSOIL**		1	SS	3
	SANDY SILT, some clay, trace gravel, very loose to compact, brown, moist (REWORKED)		2	SS	11
226.6 / 1.5	**CLAYEY SILT**, some sand, trace gravel, very stiff, brown with black, moist (GLACIAL TILL)		3	SS	16
			4	SS	21
	...at 3.0 m, grey with orange		5	SS	29
222.0 / 6.1	No split spoon sample recovery, inferred clayey silt glacial till, hard		6	SS	25
			7	SS	50 / 100mm
			8	SS	44
220.0 / 8.1			9	SS	37

depth scale (m): 0 1 2 3 4 5 6 7 8

well details

elevation (m): 228 227 226 225 224 223 222 221

undrained shear strength (kPa)
■ unconfined + field vane
● pocket penetrometer ○ Lab Vane
40 80 120 160

SPT N-values (bpf)
× dynamic cone
10 20 30 40

headspace vapour (ppm)
× hexane □ isobutylene △ methane
100 200 300

moisture / plasticity
PL MC LL
10 20 30

unstabilized water level

lab data and comments

grain size distribution (%) (MIT)
GR SA SI CL

6.1m: no recovery, auger cuttings are consistent with the above soils

6.9m: no recovery, auger cuttings are consistent with the above soils

7.6m: no recovery, auger cuttings are consistent with the above soils

END OF BOREHOLE

Unstabilized water level measured at 3.0 m below ground surface; caved to 5.2 m below ground surface upon completion of drilling.

GROUNDED ENGINEERING

Date Started : May 14, 2024
Position : E: 591710, N: 4832397 (UTM 17T)
Elev. Datum : Geodetic

BOREHOLE LOG 109

File No. : 24-048 **Project** : 16469 10 Side Road, Halton Hills **Client** : Russell Pines Property Corp.

drill method : hollow stem augers OD=215 mm

elev depth (m)	description	graphic log	number	type	SPT N-value
229.1	**GROUND SURFACE**				
	200mm **TOPSOIL**		1	SS	4
	SANDY SILT, some clay, trace gravel, trace rootlets, loose, brown, moist (REWORKED)		2A 2B	SS	4
227.6 1.5	...at 0.8 m, brown with orange ...at 1.0 m, wet		3	SS	13
	SILTY SAND, compact, brown, wet				
226.7 2.4	...at 2.3 m, sand and silt, some clay, trace gravel		4A 4B	SS	14
	CLAYEY SILT, some sand, trace gravel, stiff to very stiff, grey, moist (GLACIAL TILL)		5	SS	12
			6	SS	14
			7	SS	21
222.5 6.6					

depth scale (m): 0 1 2 3 4 5 6
well details
elevation (m): 229 228 227 226 225 224 223

undrained shear strength (kPa): ■ unconfined ● pocket penetrometer + field vane ○ Lab Vane; 40 80 120 160
SPT N-values (bpf): × dynamic cone; 10 20 30 40
headspace vapour (ppm): × hexane □ isobutylene △ methane; 100 200 300
moisture / plasticity: PL MC LL; 10 20 30
unstabilized water level
lab data and comments
grain size distribution (%) (MIT): GR SA SI CL

END OF BOREHOLE

Unstabilized water level measured at 2.1 m below ground surface; caved to 4.6 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 27, 2024	0.9	228.2
Jun 3, 2024	1.1	228.0

Tech : BJW | **PM** : SB/LL | **Rev** : KB

file: gint 24-048 - hg rev.gpj

GROUNDED ENGINEERING

Date Started : May 14, 2024
Position : E: 591508, N: 4832594 (UTM 17T)
Elev. Datum : Geodetic

BOREHOLE LOG 110

File No. : 24-048 **Project** : 16469 10 Side Road, Halton Hills **Client** : Russell Pines Property Corp.

drill method : hollow stem augers OD=215 mm

elev depth (m)	description	graphic log	number	type	SPT N-value
229.1	**GROUND SURFACE**				
	150mm **TOPSOIL**		1	SS	5
	SILTY SAND, trace clay, loose, brown with orange, wet (REWORKED)		2	SS	8
227.4	...at 1.5 m, compact		3A		
1.7	**CLAYEY SILT**, some sand, trace gravel, very stiff, grey with orange, moist (GLACIAL TILL) ...at 1.8 m, natural organic odour		3B	SS	19
			4	SS	17
			5	SS	19
			6	SS	24
	...at 6.1 m, sand seams		7	SS	23
222.5					
6.6	**END OF BOREHOLE**				

depth scale (m): 0 1 2 3 4 5 6

well details

elevation (m): 229 228 227 226 225 224 223

undrained shear strength (kPa)
■ unconfined + field vane
● pocket penetrometer ○ Lab Vane
40 80 120 160

SPT N-values (bpf)
× dynamic cone
10 20 30 40

headspace vapour (ppm)
× hexane □ isobutylene △ methane
100 200 300

moisture / plasticity
PL MC LL
10 20 30

unstabilized water level

lab data and comments

grain size distribution (%) (MIT)
GR SA SI CL

SS1: H-Ms, Metals, ORPs

SS2: OCs

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

file: gint 24-048 - hg rev.gpj

Tech : BJW | **PM** : SB/LL | **Rev** : KB

GROUNDED ENGINEERING

Date Started : May 13, 2024
Position : E: 591686, N: 4832732 (UTM 17T)
Elev. Datum : Geodetic

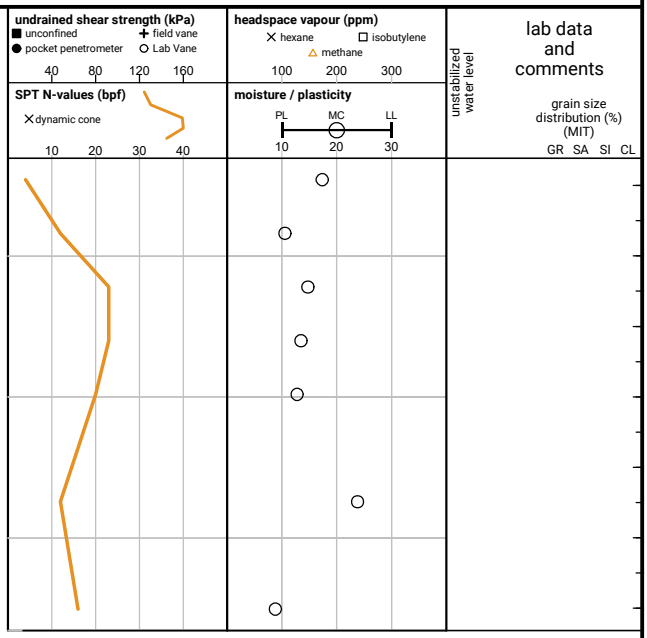
BOREHOLE LOG 111

File No. : 24-048 **Project** : 16469 10 Side Road, Halton Hills **Client** : Russell Pines Property Corp.

drill method : hollow stem augers OD=215 mm

elev depth (m)	description	graphic log	number	type	SPT N-value
227.4	**GROUND SURFACE**				
	250mm **TOPSOIL**		1	SS	4
226.6 / 0.8	**SANDY SILT**, trace clay, trace gravel, trace rootlets, loose, brown, moist (REWORKED)		2	SS	12
	CLAYEY SILT, some sand, trace gravel, trace light grey silt partings, stiff to very stiff, brown, moist (GLACIAL TILL)		3	SS	23
	...at 2.3 m, brown with orange		4	SS	23
	...at 3.0 m, grey, natural organic odour, sand seams		5	SS	20
222.8 / 4.6	**SILT AND CLAY**, trace sand, stiff, grey, moist		6	SS	12
221.3 / 6.1	**CLAYEY SILT**, some sand, trace gravel, very stiff, grey, moist (GLACIAL TILL)		7	SS	16
220.7 / 6.7	**END OF BOREHOLE**				

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



file: gint 24-048 - hg rev.gpj

Tech : BJW | **PM** : SB/LL | **Rev** : KB

GROUNDED ENGINEERING

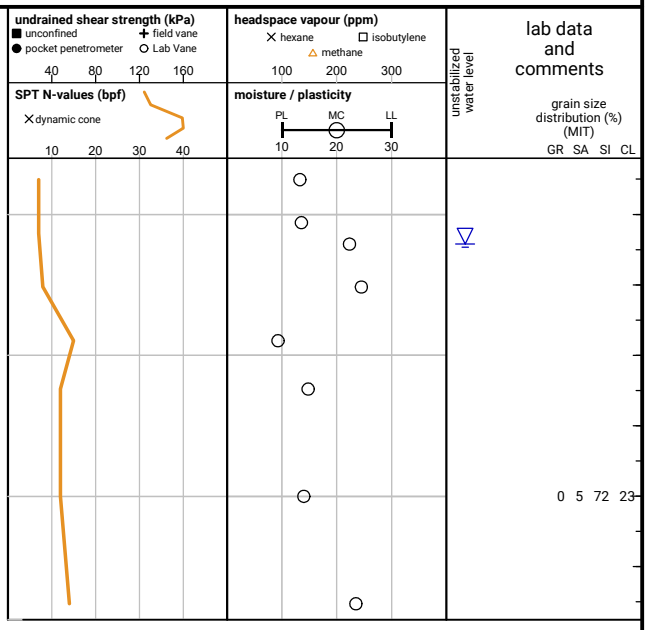
Date Started : May 15, 2024
Position : E: 591474, N: 4832739 (UTM 17T)
Elev. Datum : Geodetic

BOREHOLE LOG 112

File No. : 24-048 **Project** : 16469 10 Side Road, Halton Hills **Client** : Russell Pines Property Corp.

drill method : hollow stem augers OD=215 mm

elev depth (m)	description	graphic log	number	type	SPT N-value
228.8	**GROUND SURFACE**				
	200mm **TOPSOIL**		1	SS	7
227.7 / 1.1	**GRAVELLY SAND**, some silt, trace clay, loose, brown, moist (REWORKED)		2A / 2B	SS	7
	SAND, trace silt, trace clay, loose, brown, wet		3	SS	8
226.5 / 2.3	...at 1.5 m, silt, some sand				
	CLAYEY SILT, some sand, trace gravel, very stiff to stiff, grey, moist (GLACIAL TILL)		4	SS	15
	...at 3.0 m, silt and clay		5	SS	12
224.2 / 4.6	**CLAYEY SILT**, trace sand, stiff, grey, moist		6	SS	12
	...at 6.1 m, silt and clay, trace gravel, stiff		7	SS	14
222.2 / 6.6	**END OF BOREHOLE**				



Unstabilized water level measured at 1.2 m below ground surface; caved to 4.9 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 27, 2024	0.4	228.4
Jun 3, 2024	0.4	228.4

file: gint 24-048 - hg rev.gpj

Tech : BJW | **PM** : SB/LL | **Rev** : KB

GROUNDED ENGINEERING

Date Started : May 15, 2024
Position : E: 591342, N: 4832754 (UTM 17T)
Elev. Datum : Geodetic

BOREHOLE LOG 113

File No. : 24-048 **Project** : 16469 10 Side Road, Halton Hills **Client** : Russell Pines Property Corp.

drill method : hollow stem augers OD=215 mm

elev depth (m)	description	graphic log	number	type	SPT N-value
231.2	**GROUND SURFACE**				
	150mm **TOPSOIL**		1	SS	4
230.4 / 0.8	**SILTY SAND**, trace gravel, trace clay, loose, brown, moist (REWORKED)		2	SS	9
	SAND, some gravel, trace silt, trace clay, loose, brown, wet		3A / 3B	SS	9
228.9 / 2.3	...at 1.5 m, trace gravel ...at 1.7 m, silty sand		4	SS	11
	SILTY SAND, some gravel, some clay, compact, grey, wet (GLACIAL TILL)		5	SS	18
	...at 3.0 m, sandy silt, moist		6	SS	19
			7	SS	18
	...at 7.6 m, some sand, some clay, wet		8	SS	27
223.1 / 8.1	**END OF BOREHOLE**				

depth scale (m): 0 1 2 3 4 5 6 7 8

well details

elevation (m): 231 230 229 228 227 226 225 224

undrained shear strength (kPa)
■ unconfined + field vane
● pocket penetrometer ○ Lab Vane
40 80 120 160

SPT N-values (bpf)
× dynamic cone
10 20 30 40

headspace vapour (ppm)
× hexane □ isobutylene △ methane
100 200 300

moisture / plasticity
PL MC LL
10 20 30

unstabilized water level

lab data and comments

grain size distribution (%) (MIT)

GR	SA	SI	CL
16	44	33	7
12	34	38	16

Unstabilized water level measured at 1.5 m below ground surface; caved to 4.9 m below ground surface upon completion of drilling.

file: gint 24-048 - hg rev.gpj

Tech : BJW | **PM** : SB/LL | **Rev** : KB

BOREHOLE LOG 114

Date Started : May 15, 2024
Position : E: 591191, N: 4832907 (UTM 17T)
Elev. Datum : Geodetic

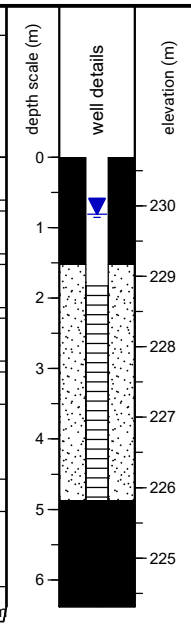
File No. : 24-048 **Project** : 16469 10 Side Road, Halton Hills **Client** : Russell Pines Property Corp.

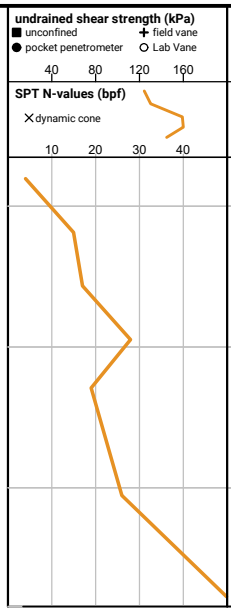
drill method : hollow stem augers OD=215 mm

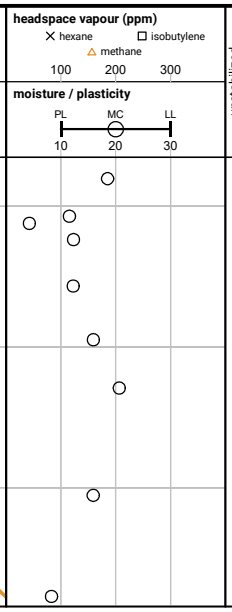
elev depth (m)	description	graphic log	number	type	SPT N-value
230.7	**GROUND SURFACE**				
	200mm **TOPSOIL**		1	SS	4
229.7 / 1.0	**SANDY SILT**, clayey, trace gravel, trace rootlets, loose, brown, moist (REWORKED)		2A 2B 2C	SS	15
	...at 0.8 m, some clay, compact				
	...at 0.9 m, black sand seam		3	SS	17
228.4 / 2.3	**CLAYEY SILT**, some sand, trace gravel, very stiff, brown, moist (GLACIAL TILL)		4	SS	28
	...at 1.5 m, trace shale fragments, brown with black		5	SS	19
	SILT AND CLAY, trace to some sand, trace gravel, very stiff, brown with orange, moist				
	...at 4.6 m, grey		6	SS	26
224.3 / 6.4	...at 6.1 m, silty sand, trace clay, trace rock fragments, very dense		7	SS	50 / 125mm

END OF BOREHOLE

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







unstabilized water level

lab data and comments

grain size distribution (%) (MIT)
GR SA SI CL

SS1: H-Ms, Metals, ORPs

2A: OCs

2C: PAHs

GROUNDWATER LEVELS

date	depth (m)	elevation (m)
May 27, 2024	2.2	228.5
Jun 3, 2024	0.8	229.9

file: gint 24-048 - hg rev.gpj

Tech : BJW | **PM** : SB/LL | **Rev** : KB

GROUNDED ENGINEERING

Date Started : May 10, 2024
Position : E: 591694, N: 4832947 (UTM 17T)
Elev. Datum : Geodetic

BOREHOLE LOG 115

File No. : 24-048 **Project** : 16469 10 Side Road, Halton Hills **Client** : Russell Pines Property Corp.

drill method : hollow stem augers OD=215 mm

elev depth (m)	description	graphic log	number	type	SPT N-value
226.0	**GROUND SURFACE**				
	150mm **TOPSOIL**		1	SS	3
225.2 / 0.8	**FILL**, silty sand, some clay, trace gravel, very loose, dark brown, moist		2	SS	14
	CLAYEY SILT, some sand, trace gravel, stiff to very stiff, brown, moist (GLACIAL TILL)		3	SS	23
	...at 1.5 m, wet				
	...at 2.4 m, grey, moist		4A/4B	SS	24
			5	SS	23
			6	SS	20
220.8 / 5.2					

depth scale (m): 0, 1, 2, 3, 4, 5
elevation (m): 225, 224, 223, 222, 221

undrained shear strength (kPa): unconfined, pocket penetrometer, field vane, Lab Vane; 40, 80, 120, 160
SPT N-values (bpf): dynamic cone; 10, 20, 30, 40
headspace vapour (ppm): hexane, isobutylene, methane; 100, 200, 300
moisture / plasticity: PL, MC, LL; 10, 20, 30
unstabilized water level

lab data and comments
grain size distribution (%) (MIT) GR SA SI CL

SS2: H-Ms, Metals, ORPs
SS3: BTEX, PHCs, VOCs

END OF BOREHOLE

Unstabilized water level measured at 1.5 m below ground surface; open upon completion of drilling.

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

GROUNDWATER LEVELS

date	depth (m)	elevation (m)
May 27, 2024	2.0	224.0
Jun 3, 2024	1.9	224.1

file: gint 24-048 - hg rev.gpj

Tech : BJW | **PM** : SB/LL | **Rev** : KB

GROUNDED ENGINEERING

Date Started : May 10, 2024
Position : E: 591721, N: 4832962 (UTM 17T)
Elev. Datum : Geodetic

BOREHOLE LOG 116

File No. : 24-048 **Project** : 16469 10 Side Road, Halton Hills **Client** : Russell Pines Property Corp.

drill method	elev / depth (m)	description	graphic log	samples: number	samples: type	samples: SPT N-value
	225.8	**GROUND SURFACE**				
hollow stem augers OD=215 mm		200mm **TOPSOIL**		1	SS	2
		FILL, silty sand, trace clay, trace gravel, very loose, brown, moist ...at 0.8 m, some silt, some gravel, loose		2	SS	6
		...at 1.5 m, compact		3A	SS	10
	223.8 2.0	**CLAYEY SILT**, some sand, trace gravel, very stiff, brown, moist (GLACIAL TILL)		3B		
		...at 2.3 m, grey		4	SS	20
	222.1 3.7			5	SS	25

depth scale (m): 0, 1, 2, 3
elevation (m): 225, 224, 223

undrained shear strength (kPa): unconfined, field vane, pocket penetrometer, Lab Vane; 40, 80, 120, 160
SPT N-values (bpf): dynamic cone; 10, 20, 30, 40
headspace vapour (ppm): hexane, isobutylene, methane; 100, 200, 300
moisture / plasticity: PL, MC, LL; 10, 20, 30

unstabilized water level

lab data and comments
grain size distribution (%) (MIT)
GR SA SI CL

SS1: OCs
SS2: H-Ms, Metals, ORPs

END OF BOREHOLE

Unstabilized water level measured at 1.5 m below ground surface; caved to 2.1 m below ground surface upon completion of drilling.

file: gint 24-048 - hg rev.gpj

Tech : BJW | **PM** : SB/LL | **Rev** : KB

GROUNDED ENGINEERING

Date Started : May 10, 2024
Position : E: 591732, N: 4832950 (UTM 17T)
Elev. Datum : Geodetic

BOREHOLE LOG 117

File No. : 24-048 **Project** : 16469 10 Side Road, Halton Hills **Client** : Russell Pines Property Corp.

drill method	elev / depth (m)	description	graphic log	number	type	SPT N-value
	226.0	**GROUND SURFACE**				
hollow stem augers OD=215 mm		150mm **TOPSOIL**		1	SS	2
		FILL, silty sand, trace clay, trace gravel, trace construction debris, very loose, dark brown, moist		2A/2B	SS	13
	224.2 / 1.8	...at 0.8 m, sandy silt, trace rootlets, compact ...at 0.9 m, gravelly sand, some silt		3A/3B	SS	11
	223.7 / 2.3	**SILT AND CLAY**, trace to some sand, trace gravel, stiff, brown, moist		4	SS	33
		CLAYEY SILT, some sand, trace gravel, hard to very stiff, grey, moist (GLACIAL TILL)		5	SS	27
	220.8 / 5.2	...at 4.6 m, trace rock fragments, sand seams		6	SS	73

depth scale (m) 0–5 | well details | elevation (m) 226–221

undrained shear strength (kPa): unconfined, field vane, pocket penetrometer, Lab Vane; 40 80 120 160
SPT N-values (bpf): dynamic cone; 10 20 30 40
headspace vapour (ppm): hexane, isobutylene, methane; 100 200 300
moisture / plasticity: PL MC LL; 10 20 30
unstabilized water level
lab data and comments
grain size distribution (%) (MIT): GR SA SI CL

3A: BTEX, VOCs

END OF BOREHOLE

Unstabilized water level measured at 3.7 m below ground surface; open upon completion of drilling.

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

GROUNDWATER LEVELS

date	depth (m)	elevation (m)
May 27, 2024	1.6	224.4
Jun 3, 2024	1.4	224.6

file: gint 24-048 - hg rev.gpj

Tech : BJW | **PM** : SB/LL | **Rev** : KB

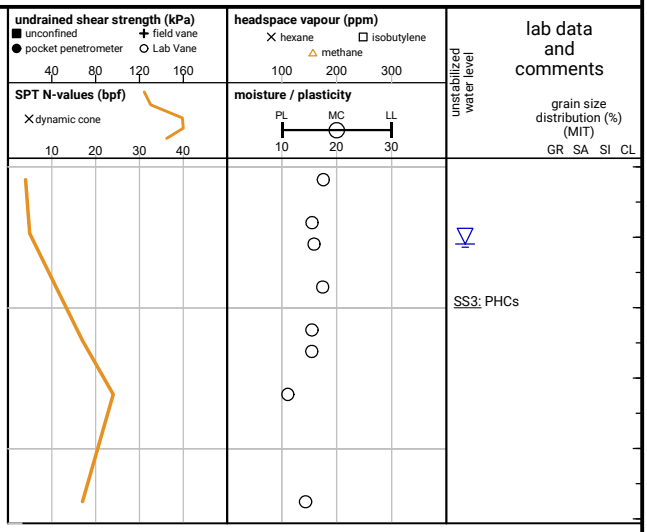
BOREHOLE LOG 118

Date Started : May 13, 2024
Position : E: 591756, N: 4832964 (UTM 17T)
Elev. Datum : Geodetic

File No. : 24-048 **Project** : 16469 10 Side Road, Halton Hills **Client** : Russell Pines Property Corp.

drill method : hollow stem augers OD=215 mm

elev depth (m)	description	graphic log	number	type	SPT N-value
226.1	**GROUND SURFACE**				
	150mm **TOPSOIL**		1	SS	4
	FILL, sandy silt, trace to some clay, trace rootlets, loose, dark brown, moist		2A	SS	5
	...at 1.1 m, gravelly sand, trace silt		2B		
224.6 1.5	**SAND**, some gravel, trace silt, compact, brown, wet		3	SS	11
223.5 2.6	...at 2.3 m, trace gravel		4A	SS	17
	CLAYEY SILT, some sand, trace gravel, very stiff, brown, moist (GLACIAL TILL)		4B		
	...at 3.0 m, grey		5	SS	24
	...at 4.6 m, trace rock fragments		6	SS	17
220.9 5.2	**END OF BOREHOLE**				



Unstabilized water level measured at 1.2 m below ground surface; caved to 4.0 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 27, 2024	1.6	224.5
Jun 3, 2024	1.6	224.5

file: gint 24-048 - hg rev.gpj

Tech : BJW | **PM** : SB/LL | **Rev** : KB

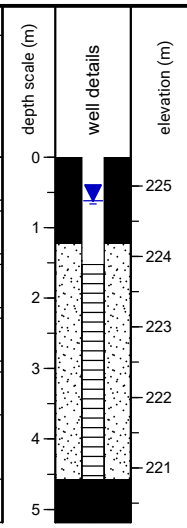
GROUNDED ENGINEERING

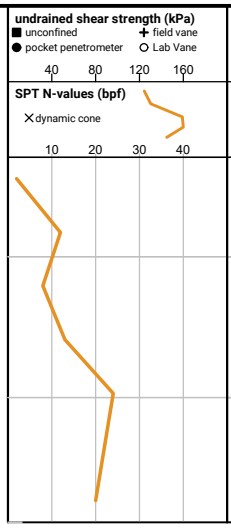
Date Started : May 10, 2024
Position : E: 591777, N: 4832930 (UTM 17T)
Elev. Datum : Geodetic

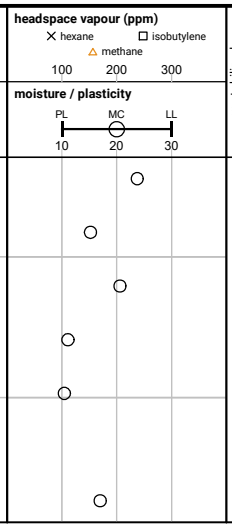
BOREHOLE LOG 119

File No. : 24-048 **Project** : 16469 10 Side Road, Halton Hills **Client** : Russell Pines Property Corp.

drill method	elev / depth (m)	description	graphic log	samples: number	samples: type	samples: SPT N-value
	225.4	**GROUND SURFACE**				
hollow stem augers OD=215 mm		150mm **TOPSOIL**		1	SS	2
		FILL, sand, some silt, trace gravel, trace clay, trace rootlets, very loose, dark brown, wet		2	SS	12
	223.9	...at 0.8 m, some gravel, trace silt				
	1.5	**CLAYEY SILT**, some sand, trace gravel, firm, brown, moist (GLACIAL TILL)		3	SS	8
		...at 2.3 m, sandy, stiff to very stiff, grey		4	SS	13
				5	SS	24
		...at 4.6 m, some sand		6	SS	20
	220.2					
	5.2	**END OF BOREHOLE**				







unstabilized water level

lab data and comments

grain size distribution (%) (MIT)
GR SA SI CL

SS5: BTEX, PHCs

Unstabilized water level measured at 1.2 m below ground surface; open upon completion of drilling.

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

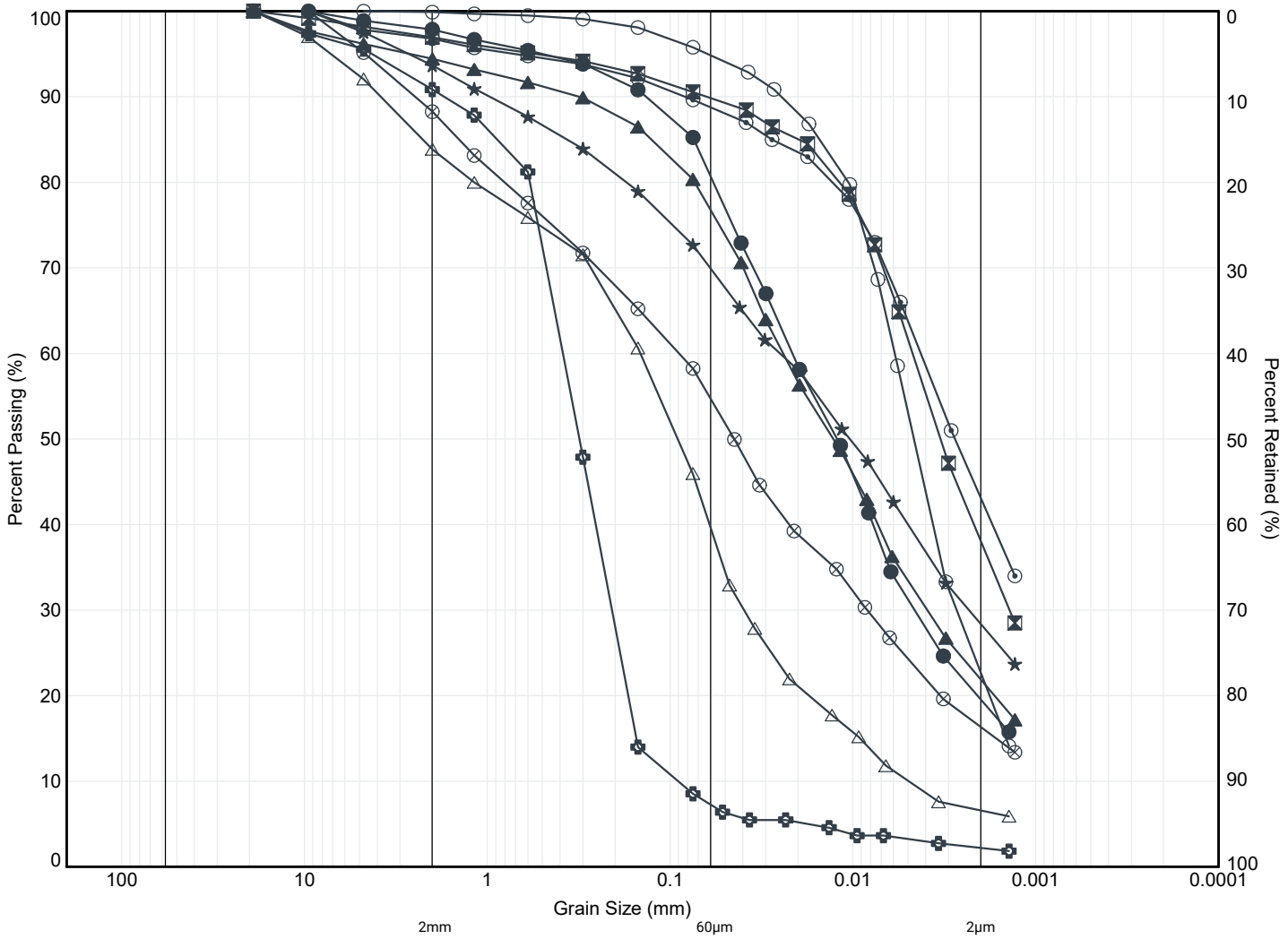
GROUNDWATER LEVELS

date	depth (m)	elevation (m)
May 27, 2024	0.5	224.9
Jun 3, 2024	0.6	224.8

file: gint 24-048 - hg rev.gpj

Tech : BJW | **PM** : SB/LL | **Rev** : KB

APPENDIX B



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

MIT SYSTEM

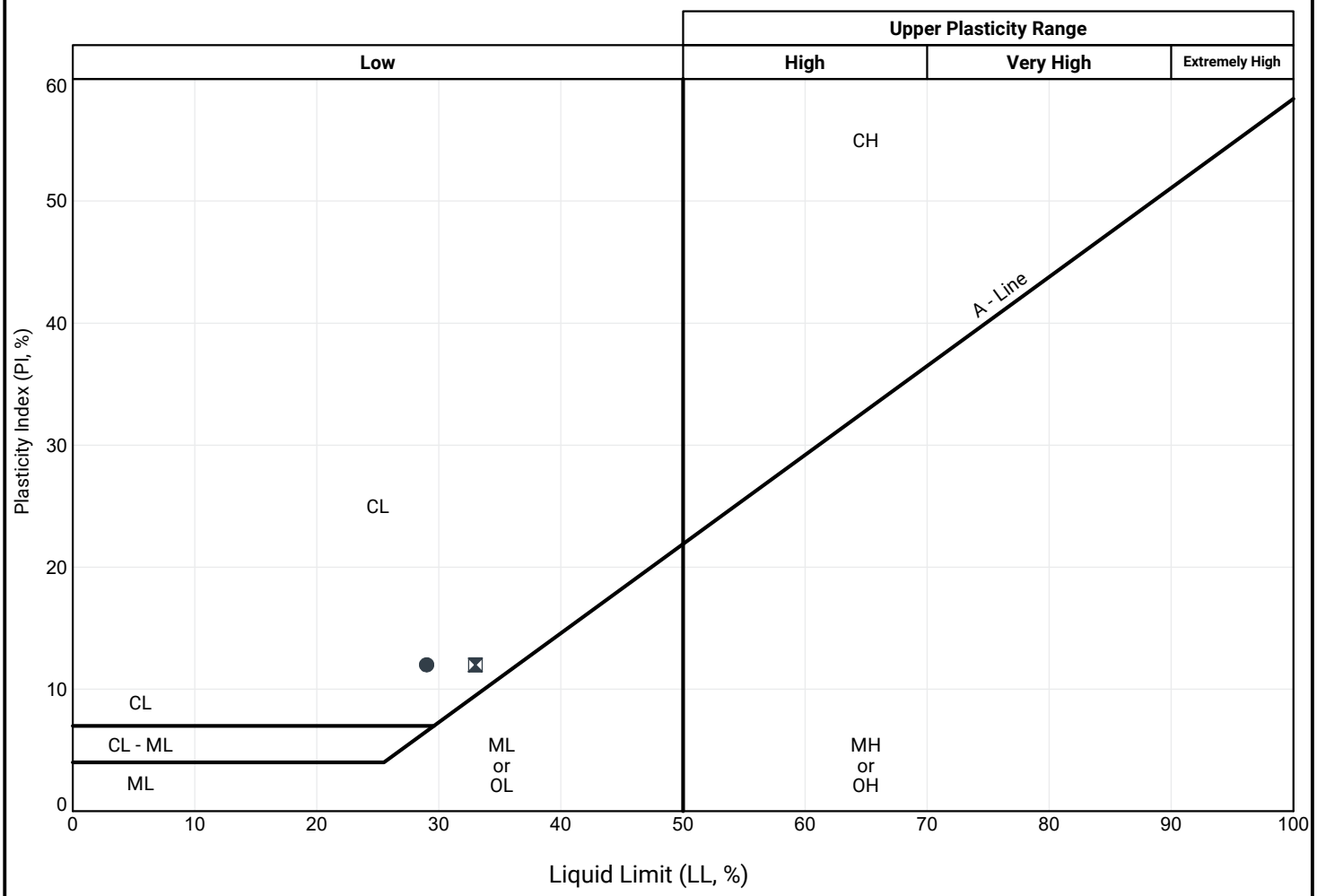
	Location	Sample	Depth (m)	Elev. (m)	Gravel (%)	Sand (%)	Silt (%)	Clay (%)	*(Fines, %)*
●	**BH 102**	SS5	3.3	224.1	2	17	61	20	*(0)*
⊠	**BH 103**	SS8	7.8	218.6	3	7	52	38	*(0)*
▲	**BH 103**	SS9	9.4	217.1	6	17	55	22	*(0)*
★	**BH 104**	SS6	4.8	219.9	6	24	42	28	*(0)*
⊙	**BH 104**	SS16	18.5	206.2	3	8	46	43	*(0)*
✿	**BH 106**	SS3	1.8	222.3	9	84	5	2	*(0)*
○	**BH 112**	SS6	4.8	224.0	0	5	72	23	*(0)*
△	**BH 113**	SS4	2.6	228.6	16	44	33	7	*(0)*
⊗	**BH 113**	SS5	3.3	227.9	12	34	38	16	*(0)*

GROUNDED ENGINEERING

Title: **GRAIN SIZE DISTRIBUTION**

File No.: **24-048**

file: gint 24-048.gpj



	Location	Sample	Depth (m)	Elev. (m)	LL (%)	PL (%)	PI (%)
●	**BH 103**	SS8	7.8	218.6	29	17	12
⊠	**BH 104**	SS16	18.5	206.2	33	21	12

GROUNDED ENGINEERING

Title: **ATTERBERG LIMITS CHART**

File No.: **24-048**

file: gint 24-048.gpj

APPENDIX C

CORROSIVITY (ALS)

Results Summary WT2412651

Project	24-048
Report To	Sam Bastan, Grounded Engineering Inc.
Date Received	21-May-2024 09:45
Issue Date	27-May-2024 20:02
Amendment	0

Client Sample ID			BH105-SS6	BH109-SS5	BH114-SS3
Date Sampled			09-May-2024	14-May-2024	15-May-2024
Time Sampled			16:00	13:40	11:55
ALS Sample ID			WT2412651-001	WT2412651-002	WT2412651-003
Analyte	Lowest Detection Limit	Units	Sub-Matrix: Soil/Solid	Sub-Matrix: Soil/Solid	Sub-Matrix: Soil/Solid
Physical Tests (Matrix: Soil/Solid)					
Conductivity (1:2 leachate)	5.00	µS/cm	275	242	121
Moisture	0.25	%	10.5	10.3	16.6
Oxidation-reduction potential [ORP]	0.10	mV	238	201	287
Resistivity	100	ohm cm	3640	4130	8260
pH (1:2 soil:CaCl2-aq)	0.10	pH units	7.74	7.71	7.28
Inorganics (Matrix: Soil/Solid)					
Sulfides, acid volatile	0.20	mg/kg	<0.22	<0.22	0.27
Leachable Anions & Nutrients (Matrix: Soil/Solid)					
Chloride, soluble ion content	5.0	mg/kg	<5.0	11.5	12.3
Sulfate, soluble ion content	20	mg/kg	141	103	<20

INTERPRETATION

AWWA C-105 Standard	Points	Points	Points
% Moisture	**1**	**1**	**1**
pH			
Is pH bet 6.5-7.5 ?	NO	NO	YES
Is Redox Potential < 100 mv?	NO	NO	NO
Are Sulphides present ?	NO	NO	NO
If above three conditions are met, pH is assigned 3 points			
pH - Score	3	3	3
Redox Potential	0	0	0
Resistivity	0	0	0
Acid Volatile Sulphides	**3.5**	**3.5**	**3.5**
TOTAL SCORE (AWWA C-105)	**7.5**	**7.5**	**7.5**

Sample		BH105-SS6	BH109-SS5	BH114-SS3
Corrosion Protection Recommended?		**No**	**No**	**No**
Resistivity less than 2000 ohm.cm?		**No**	**No**	**No**
Anions and Nutrients (Soil)				
Sulphate	%	141	103	<20
CLASS OF EXPOSURE		**Negligible**	**Negligible**	**Negligible**

ALS Canada Ltd.

right solutions. right partner.

CERTIFICATE OF ANALYSIS

Work Order	: **WT2412651**	Page	: 1 of 3
Client	: **Grounded Engineering Inc.**	Laboratory	: ALS Environmental - Waterloo
Contact	: Sam Bastan	Account Manager	: Amanda Overholster
Address	: 1 Banigan Drive Toronto ON Canada M4H 1G3	Address	: 60 Northland Road, Unit 1 Waterloo ON Canada N2V 2B8
Telephone	: ----	Telephone	: 1 416 817 2944
Project	: 24-048	Date Samples Received	: 21-May-2024 09:45
PO	: ----	Date Analysis Commenced	: 21-May-2024
C-O-C number	: 20-1085328	Issue Date	: 27-May-2024 20:02
Sampler	: CLIENT		
Site	: 16469 10 SITE RD		
Quote number	: 2024 SOA Pricing		
No. of samples received	: 3		
No. of samples analysed	: 3		

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. This document shall not be reproduced, except in full.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

Additional information pertinent to this report will be found in the following separate attachments: Quality Control Report, QC Interpretive report to assist with Quality Review and Sample Receipt Notification (SRN).

Signatories

This document has been electronically signed by the authorized signatories below. Electronic signing is conducted in accordance with US FDA 21 CFR Part 11.

Signatories	*Position*	*Laboratory Department*
Nik Perkio	Senior Analyst	Inorganics, Waterloo, Ontario
Niral Patel		Centralized Prep, Waterloo, Ontario

General Comments

The analytical methods used by ALS are developed using internationally recognized reference methods (where available), such as those published by US EPA, APHA Standard Methods, ASTM, ISO, Environment Canada, BC MOE, and Ontario MOE. Refer to the ALS Quality Control Interpretive report (QCI) for applicable references and methodology summaries. Reference methods may incorporate modifications to improve performance.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

Please refer to Quality Control Interpretive report (QCI) for information regarding Holding Time compliance.

Key : CAS Number: Chemical Abstracts Services number is a unique identifier assigned to discrete substances

LOR: Limit of Reporting (detection limit).

Unit	*Description*
%	percent
µS/cm	microsiemens per centimetre
mg/kg	milligrams per kilogram
mV	millivolts
ohm cm	ohm centimetres (resistivity)
pH units	pH units

<: less than.

>: greater than.

Surrogate: An analyte that is similar in behavior to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.

Test results reported relate only to the samples as received by the laboratory.

UNLESS OTHERWISE STATED on SRN or QCI Report, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.

Analytical Results

Sub-Matrix: Soil/Solid (Matrix: Soil/Solid)					Client sample ID	BH105-SS6	BH109-SS5	BH114-SS3	----	----
					Client sampling date / time	09-May-2024 16:00	14-May-2024 13:40	15-May-2024 11:55	----	----
Analyte	CAS Number	Method/Lab	LOR	Unit		WT2412651-001	WT2412651-002	WT2412651-003	--------	--------
						Result	Result	Result	----	----
Physical Tests										
Conductivity (1:2 leachate)	----	E100-L/WT	5.00	µS/cm		275	242	121	----	----
Moisture	----	E144/WT	0.25	%		10.5	10.3	16.6	----	----
Oxidation-reduction potential [ORP]	----	E125/WT	0.10	mV		238	201	287	----	----
pH (1:2 soil:CaCl2-aq)	----	E108A/WT	0.10	pH units		7.74	7.71	7.28	----	----
Resistivity	----	EC100R/WT	100	ohm cm		3640	4130	8260	----	----
Inorganics										
Sulfides, acid volatile	----	E396-L/WT	0.20	mg/kg		<0.22	<0.22	0.27	----	----
Leachable Anions & Nutrients										
Chloride, soluble ion content	16887-00-6	E236.Cl/WT	5.0	mg/kg		<5.0	11.5	12.3	----	----
Sulfate, soluble ion content	14808-79-8	E236.SO4/WT	20	mg/kg		141	103	<20	----	----

Please refer to the General Comments section for an explanation of any result qualifiers detected.

Please refer to the Accreditation section for an explanation of analyte accreditations.

ALS Canada Ltd.

QUALITY CONTROL INTERPRETIVE REPORT

Work Order	: **WT2412651**	Page	: 1 of 8
Client	: **Grounded Engineering Inc.**	Laboratory	: ALS Environmental - Waterloo
Contact	: Sam Bastan	Account Manager	: Amanda Overholster
Address	: 1 Banigan Drive Toronto ON Canada M4H 1G3	Address	: 60 Northland Road, Unit 1 Waterloo, Ontario Canada N2V 2B8
Telephone	: ----	Telephone	: 1 416 817 2944
Project	: 24-048	Date Samples Received	: 21-May-2024 09:45
PO	: ----	Issue Date	: 27-May-2024 20:01
C-O-C number	: 20-1085328		
Sampler	: CLIENT		
Site	: 16469 10 SITE RD		
Quote number	: 2024 SOA Pricing		
No. of samples received	: 3		
No. of samples analysed	: 3		

This report is automatically generated by the ALS LIMS (Laboratory Information Management System) through evaluation of Quality Control (QC) results and other QA parameters associated with this submission, and is intended to facilitate rapid data validation by auditors or reviewers. The report highlights any exceptions and outliers to ALS Data Quality Objectives, provides holding time details and exceptions, summarizes QC sample frequencies, and lists applicable methodology references and summaries.

Key

Anonymous: Refers to samples which are not part of this work order, but which formed part of the QC process lot.
CAS Number: Chemical Abstracts Service number is a unique identifier assigned to discrete substances.
DQO: Data Quality Objective.
LOR: Limit of Reporting (detection limit).
RPD: Relative Percent Difference.

Workorder Comments

Holding times are displayed as "---" if no guidance exists from CCME, Canadian provinces, or broadly recognized international references.

Summary of Outliers

Outliers : Quality Control Samples

- No Method Blank value outliers occur.
- No Duplicate outliers occur.
- No Laboratory Control Sample (LCS) outliers occur
- No Test sample Surrogate recovery outliers exist.

Outliers: Reference Material (RM) Samples

- No Reference Material (RM) Sample outliers occur.

Outliers : Analysis Holding Time Compliance (Breaches)

- Analysis Holding Time Outliers exist - please see following pages for full details.

Outliers : Frequency of Quality Control Samples

- No Quality Control Sample Frequency Outliers occur.

Analysis Holding Time Compliance

This report summarizes extraction / preparation and analysis times and compares each with ALS recommended holding times, which are selected to meet known provincial and /or federal requirements. In the absence of regulatory hold times, ALS establishes recommendations based on guidelines published by organizations such as CCME, US EPA, APHA Standard Methods, ASTM, or Environment Canada (where available). Dates and holding times reported below represent the first dates of extraction or analysis. If subsequent tests or dilutions exceeded holding times, qualifiers are added (refer to COA).

If samples are identified below as having been analyzed or extracted outside of recommended holding times, measurement uncertainties may be increased, and this should be taken into consideration when interpreting results.

Where actual sampling date is not provided on the chain of custody, the date of receipt with time at 00:00 is used for calculation purposes.

Where only the sample date without time is provided on the chain of custody, the sampling date at 00:00 is used for calculation purposes.

Matrix: **Soil/Solid**

Evaluation: × = Holding time exceedance ; ✓ = Within Holding Time

Analyte Group : Analytical Method / Container / Client Sample ID(s)	Method	Sampling Date	Extraction / Preparation				Analysis			
			Preparation Date	Holding Times Rec	Holding Times Actual	Eval	Analysis Date	Holding Times Rec	Holding Times Actual	Eval
Inorganics : Acid Volatile Sulfide in Soil by Colourimetry (0.2 mg/kg)										
Glass soil jar/Teflon lined cap [ON MECP]										
BH114-SS3	E396-L	15-May-2024	27-May-2024	14 days	12 days	✓	27-May-2024	7 days	0 days	✓
Inorganics : Acid Volatile Sulfide in Soil by Colourimetry (0.2 mg/kg)										
Glass soil jar/Teflon lined cap [ON MECP]										
BH109-SS5	E396-L	14-May-2024	27-May-2024	14 days	13 days	✓	27-May-2024	7 days	0 days	✓
Inorganics : Acid Volatile Sulfide in Soil by Colourimetry (0.2 mg/kg)										
Glass soil jar/Teflon lined cap [ON MECP]										
BH105-SS6	E396-L	09-May-2024	27-May-2024	14 days	18 days	× EHT	27-May-2024	7 days	0 days	✓
Leachable Anions & Nutrients : Water Extractable Chloride by IC										
Glass soil jar/Teflon lined cap [ON MECP]										
BH114-SS3	E236.Cl	15-May-2024	25-May-2024	30 days	10 days	✓	27-May-2024	28 days	2 days	✓
Leachable Anions & Nutrients : Water Extractable Chloride by IC										
Glass soil jar/Teflon lined cap [ON MECP]										
BH109-SS5	E236.Cl	14-May-2024	25-May-2024	30 days	11 days	✓	27-May-2024	28 days	2 days	✓
Leachable Anions & Nutrients : Water Extractable Chloride by IC										
Glass soil jar/Teflon lined cap [ON MECP]										
BH105-SS6	E236.Cl	09-May-2024	25-May-2024	30 days	16 days	✓	27-May-2024	28 days	2 days	✓
Leachable Anions & Nutrients : Water Extractable Sulfate by IC										
Glass soil jar/Teflon lined cap [ON MECP]										
BH114-SS3	E236.SO4	15-May-2024	25-May-2024	30 days	10 days	✓	27-May-2024	28 days	2 days	✓

Matrix: **Soil/Solid**

Evaluation: × = Holding time exceedance ; ✓ = Within Holding Time

Analyte Group : Analytical Method / Container / Client Sample ID(s)	*Method*	*Sampling Date*	*Extraction / Preparation*				*Analysis*			
			Preparation Date	*Holding Times* Rec	*Holding Times* Actual	*Eval*	*Analysis Date*	*Holding Times* Rec	*Holding Times* Actual	*Eval*
Leachable Anions & Nutrients : Water Extractable Sulfate by IC										
Glass soil jar/Teflon lined cap [ON MECP] BH109-SS5	E236.SO4	14-May-2024	25-May-2024	30 days	11 days	✓	27-May-2024	28 days	2 days	✓
Leachable Anions & Nutrients : Water Extractable Sulfate by IC										
Glass soil jar/Teflon lined cap [ON MECP] BH105-SS6	E236.SO4	09-May-2024	25-May-2024	30 days	16 days	✓	27-May-2024	28 days	2 days	✓
Physical Tests : Conductivity in Soil (1:2 Soil:Water Extraction) (Low Level)										
Glass soil jar/Teflon lined cap [ON MECP] BH105-SS6	E100-L	09-May-2024	23-May-2024	30 days	14 days	✓	24-May-2024	30 days	15 days	✓
Physical Tests : Conductivity in Soil (1:2 Soil:Water Extraction) (Low Level)										
Glass soil jar/Teflon lined cap [ON MECP] BH114-SS3	E100-L	15-May-2024	23-May-2024	30 days	8 days	✓	24-May-2024	30 days	9 days	✓
Physical Tests : Conductivity in Soil (1:2 Soil:Water Extraction) (Low Level)										
Glass soil jar/Teflon lined cap [ON MECP] BH109-SS5	E100-L	14-May-2024	23-May-2024	30 days	9 days	✓	24-May-2024	30 days	10 days	✓
Physical Tests : Moisture Content by Gravimetry										
Glass soil jar/Teflon lined cap [ON MECP] BH105-SS6	E144	09-May-2024	----	----	----		22-May-2024	----	12 days	
Physical Tests : Moisture Content by Gravimetry										
Glass soil jar/Teflon lined cap [ON MECP] BH109-SS5	E144	14-May-2024	----	----	----		22-May-2024	----	7 days	
Physical Tests : Moisture Content by Gravimetry										
Glass soil jar/Teflon lined cap [ON MECP] BH114-SS3	E144	15-May-2024	----	----	----		22-May-2024	----	7 days	
Physical Tests : ORP by Electrode										
Glass soil jar/Teflon lined cap [ON MECP] BH105-SS6	E125	09-May-2024	21-May-2024	180 days	12 days	✓	22-May-2024	180 days	13 days	✓

Matrix: **Soil/Solid**

Evaluation: × = Holding time exceedance ; ✓ = Within Holding Time

Analyte Group : Analytical Method / Container / Client Sample ID(s)	Method	Sampling Date	Extraction / Preparation				Analysis			
			Preparation Date	Holding Times Rec	Holding Times Actual	Eval	Analysis Date	Holding Times Rec	Holding Times Actual	Eval
Physical Tests : ORP by Electrode										
Glass soil jar/Teflon lined cap [ON MECP]										
BH114-SS3	E125	15-May-2024	21-May-2024	180 days	6 days	✓	22-May-2024	180 days	7 days	✓
Physical Tests : ORP by Electrode										
Glass soil jar/Teflon lined cap [ON MECP]										
BH109-SS5	E125	14-May-2024	21-May-2024	180 days	7 days	✓	22-May-2024	180 days	8 days	✓
Physical Tests : pH by Meter (1:2 Soil:0.01M CaCl2 Extraction) - As Received										
Glass soil jar/Teflon lined cap [ON MECP]										
BH105-SS6	E108A	09-May-2024	21-May-2024	30 days	12 days	✓	27-May-2024	30 days	18 days	✓
Physical Tests : pH by Meter (1:2 Soil:0.01M CaCl2 Extraction) - As Received										
Glass soil jar/Teflon lined cap [ON MECP]										
BH114-SS3	E108A	15-May-2024	22-May-2024	30 days	7 days	✓	27-May-2024	30 days	12 days	✓
Physical Tests : pH by Meter (1:2 Soil:0.01M CaCl2 Extraction) - As Received										
Glass soil jar/Teflon lined cap [ON MECP]										
BH109-SS5	E108A	14-May-2024	22-May-2024	30 days	8 days	✓	27-May-2024	30 days	13 days	✓

Legend & Qualifier Definitions

Rec. HT: ALS recommended hold time (see units).

Quality Control Parameter Frequency Compliance

The following report summarizes the frequency of laboratory QC samples analyzed within the analytical batches (QC lots) in which the submitted samples were processed. The actual frequency should be greater than or equal to the expected frequency.

Matrix: **Soil/Solid**

Evaluation: × = *QC frequency outside specification*; ✓ = *QC frequency within specification.*

Quality Control Sample Type			Count		Frequency (%)		
Analytical Methods	*Method*	*QC Lot #*	*QC*	*Regular*	*Actual*	*Expected*	*Evaluation*
Laboratory Duplicates (DUP)							
Acid Volatile Sulfide in Soil by Colourimetry (0.2 mg/kg)	E396-L	1461205	1	14	7.1	4.7	✓
Conductivity in Soil (1:2 Soil:Water Extraction) (Low Level)	E100-L	1451744	1	5	20.0	5.0	✓
Moisture Content by Gravimetry	E144	1452402	1	20	5.0	5.0	✓
ORP by Electrode	E125	1451834	1	14	7.1	5.0	✓
pH by Meter (1:2 Soil:0.01M CaCl2 Extraction) - As Received	E108A	1452560	2	40	5.0	5.0	✓
Water Extractable Chloride by IC	E236.Cl	1459343	1	9	11.1	5.0	✓
Water Extractable Sulfate by IC	E236.SO4	1459342	1	9	11.1	5.0	✓
Laboratory Control Samples (LCS)							
Acid Volatile Sulfide in Soil by Colourimetry (0.2 mg/kg)	E396-L	1461205	1	14	7.1	4.7	✓
Conductivity in Soil (1:2 Soil:Water Extraction) (Low Level)	E100-L	1451744	2	5	40.0	10.0	✓
Moisture Content by Gravimetry	E144	1452402	1	20	5.0	5.0	✓
ORP by Electrode	E125	1451834	1	14	7.1	5.0	✓
pH by Meter (1:2 Soil:0.01M CaCl2 Extraction) - As Received	E108A	1452560	2	40	5.0	5.0	✓
Water Extractable Chloride by IC	E236.Cl	1459343	2	9	22.2	10.0	✓
Water Extractable Sulfate by IC	E236.SO4	1459342	2	9	22.2	10.0	✓
Method Blanks (MB)							
Acid Volatile Sulfide in Soil by Colourimetry (0.2 mg/kg)	E396-L	1461205	1	14	7.1	4.7	✓
Conductivity in Soil (1:2 Soil:Water Extraction) (Low Level)	E100-L	1451744	1	5	20.0	5.0	✓
Moisture Content by Gravimetry	E144	1452402	1	20	5.0	5.0	✓
Water Extractable Chloride by IC	E236.Cl	1459343	1	9	11.1	5.0	✓
Water Extractable Sulfate by IC	E236.SO4	1459342	1	9	11.1	5.0	✓

Methodology References and Summaries

The analytical methods used by ALS are developed using internationally recognized reference methods (where available), such as those published by US EPA, APHA Standard Methods, ASTM, ISO, Environment Canada, BC MOE, and Ontario MOE. Reference methods may incorporate modifications to improve performance (indicated by "mod").

Analytical Methods	Method / Lab	Matrix	Method Reference	Method Descriptions
Conductivity in Soil (1:2 Soil:Water Extraction) (Low Level)	E100-L ALS Environmental - Waterloo	Soil/Solid	CSSS Ch. 15 (mod)/APHA 2510 (mod)	Conductivity, also known as Electrical Conductivity (EC) or Specific Conductance, is measured by immersion of a conductivity cell with platinum electrodes into a soil sample that has been added in a defined ratio of soil to deionized water, then shaken well and allowed to settle. Conductance is measured in the fluid that is observed in the upper layer.
pH by Meter (1:2 Soil:0.01M CaCl2 Extraction) - As Received	E108A ALS Environmental - Waterloo	Soil/Solid	MECP E3530	pH is determined by potentiometric measurement with a pH electrode, and is conducted at ambient laboratory temperature (normally 20 ± 5°C) and is carried out in accordance with procedures described in the Analytical Protocol (prescriptive method). A minimum 10g portion of the sample, as received, is extracted with 20mL of 0.01M calcium chloride solution by shaking for at least 30 minutes. The aqueous layer is separated from the soil by centrifuging, settling, or decanting and then analyzed using a pH meter and electrode. This method is equivalent to ASTM D4972 and is acceptable for topsoil analysis.
ORP by Electrode	E125 ALS Environmental - Waterloo	Soil/Solid	APHA 2580 (mod)	Oxidation Redution Potential (ORP) is reported as the oxidation-reduction potential of the platinum metal-reference electrode employed in the analysis, measured in mV.
Moisture Content by Gravimetry	E144 ALS Environmental - Waterloo	Soil/Solid	CCME PHC in Soil - Tier 1	Moisture is measured gravimetrically by drying the sample at 105°C. Moisture content is calculated as the weight loss (due to water) divided by the wet weight of the sample, expressed as a percentage.
Water Extractable Chloride by IC	E236.Cl ALS Environmental - Waterloo	Soil/Solid	EPA 300.1	Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection using a soil sample that has been added in a defined ratio of soil to deionized water, then shaken well and allowed to settle. Anions are measured in the fluid that is observed in the upper layer.
Water Extractable Sulfate by IC	E236.SO4 ALS Environmental - Waterloo	Soil/Solid	EPA 300.1	Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection using a soil sample that has been added in a defined ratio of soil to deionized water, then shaken well and allowed to settle. Anions are measured in the fluid that is observed in the upper layer.
Acid Volatile Sulfide in Soil by Colourimetry (0.2 mg/kg)	E396-L ALS Environmental - Waterloo	Soil/Solid	APHA 4500S2J	This analysis is carried out in accordance with the method described in APHA 4500 S2-J. After extraction the Acid Volatile Sulphide is determined colourimetrically.
Resistivity Calculation for Soil Using E100-L	EC100R ALS Environmental - Waterloo	Soil/Solid	APHA 2510 B	Soil Resistivity (calculated) is determined as the inverse of the conductivity of a 2:1 water:soil leachate (dry weight). This method is intended as a rapid approximation for Soil Resistivity. Where high accuracy results are required, direct measurement of Soil Resistivity by the Wenner Four-Electrode Method (ASTM G57) is recommended.

Preparation Methods	Method / Lab	Matrix	Method Reference	Method Descriptions

Preparation Methods	Method / Lab	Matrix	Method Reference	Method Descriptions
Leach 1:2 Soil:Water for pH/EC	EP108 ALS Environmental - Waterloo	Soil/Solid	BC WLAP METHOD: PH, ELECTROMETRIC, SOIL	The procedure involves mixing the dried (at <60°C) and sieved (No. 10 / 2mm) sample with deionized/distilled water at a 1:2 ratio of sediment to water.
Leach 1:2 Soil : 0.01CaCl2 - As Received for pH	EP108A ALS Environmental - Waterloo	Soil/Solid	MOEE E3137A	A minimum 10g portion of the sample, as received, is extracted with 20mL of 0.01M calcium chloride solution by shaking for at least 30 minutes. The aqueous layer is separated from the soil by centrifuging, settling or decanting and then analyzed using a pH meter and electrode.
Preparation of ORP by Electrode	EP125 ALS Environmental - Waterloo	Soil/Solid	APHA 2580 (mod)	Field-moist sample is extracted in a 1:2 ratio with DI water and then analyzed by ORP meter.
Anions Leach 1:10 Soil:Water (Dry)	EP236 ALS Environmental - Waterloo	Soil/Solid	EPA 300.1	5 grams of dried soil is mixed with 50 grams of distilled water for a minimum of 30 minutes. The extract is filtered and analyzed by ion chromatography.
Distillation for Acid Volatile Sulfide in Soil	EP396-L ALS Environmental - Waterloo	Soil/Solid	APHA 4500S2J	Acid Volatile Sulfide is determined by colourimetric measurement on a sediment sample that has been treated with hydrochloric acid within a purge and trap system, where the evolved hydrogen sulfide gas is carried into a basic solution by argon gas for analysis.

ALS Canada Ltd.

QUALITY CONTROL REPORT

Work Order	: **WT2412651**	Page	: 1 of 6
Client	: Grounded Engineering Inc.	Laboratory	: ALS Environmental - Waterloo
Contact	: Sam Bastan	Account Manager	: Amanda Overholster
Address	: 1 Banigan Drive Toronto ON Canada M4H 1G3	Address	: 60 Northland Road, Unit 1 Waterloo, Ontario Canada N2V 2B8
Telephone	: ----	Telephone	: 1 416 817 2944
Project	: 24-048	Date Samples Received	: 21-May-2024 09:45
PO	: ----	Date Analysis Commenced	: 21-May-2024
C-O-C number	: 20-1085328	Issue Date	: 27-May-2024 20:02
Sampler	: CLIENT		
Site	: 16469 10 SITE RD		
Quote number	: 2024 SOA Pricing		
No. of samples received	: 3		
No. of samples analysed	: 3		

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. This document shall not be reproduced, except in full.

This Quality Control Report contains the following information:

- Laboratory Duplicate (DUP) Report; Relative Percent Difference (RPD) and Data Quality Objectives
- Reference Material (RM) Report; Recovery and Data Quality Objectives
- Method Blank (MB) Report; Recovery and Data Quality Objectives
- Laboratory Control Sample (LCS) Report; Recovery and Data Quality Objectives

Signatories

This document has been electronically signed by the authorized signatories below. Electronic signing is conducted in accordance with US FDA 21 CFR Part 11.

Signatories	*Position*	*Laboratory Department*
Nik Perkio	Senior Analyst	Waterloo Inorganics, Waterloo, Ontario
Niral Patel		Waterloo Centralized Prep, Waterloo, Ontario

General Comments

The ALS Quality Control (QC) report is optionally provided to ALS clients upon request. ALS test methods include comprehensive QC checks with every analysis to ensure our high standards of quality are met. Each QC result has a known or expected target value, which is compared against predetermined Data Quality Objectives (DQOs) to provide confidence in the accuracy of associated test results. This report contains detailed results for all QC results applicable to this sample submission. Please refer to the ALS Quality Control Interpretation report (QCI) for applicable method references and methodology summaries.

Key :

Anonymous = Refers to samples which are not part of this work order, but which formed part of the QC process lot.
CAS Number = Chemical Abstracts Service number is a unique identifier assigned to discrete substances.
DQO = Data Quality Objective.
LOR = Limit of Reporting (detection limit).
RPD = Relative Percent Difference
# = Indicates a QC result that did not meet the ALS DQO.

Workorder Comments

Holding times are displayed as "---" if no guidance exists from CCME, Canadian provinces, or broadly recognized international references.

Laboratory Duplicate (DUP) Report

A Laboratory Duplicate (DUP) is a randomly selected intralaboratory replicate sample. Laboratory Duplicates provide information regarding method precision and sample heterogeneity. ALS DQOs for Laboratory Duplicates are expressed as test-specific limits for Relative Percent Difference (RPD), or as an absolute difference limit of 2 times the LOR for low concentration duplicates within ~ 4-10 times the LOR (cut-off is test-specific).

Sub-Matrix: **Soil/Solid**

					Laboratory Duplicate (DUP) Report						
Laboratory sample ID	*Client sample ID*	*Analyte*	*CAS Number*	*Method*	*LOR*	*Unit*	*Original Result*	*Duplicate Result*	*RPD(%) or Difference*	*Duplicate Limits*	*Qualifier*
Physical Tests (QC Lot: 1451744)											
WT2412438-002	Anonymous	Conductivity (1:2 leachate)	----	E100-L	5.00	µS/cm	0.139 mS/cm	139	0.360%	20%	----
Physical Tests (QC Lot: 1451834)											
WT2412191-001	Anonymous	Oxidation-reduction potential [ORP]	----	E125	0.10	mV	299	313	4.58%	25%	----
Physical Tests (QC Lot: 1452137)											
WT2412527-001	Anonymous	pH (1:2 soil:CaCl2-aq)	----	E108A	0.10	pH units	7.64	7.65	0.131%	5%	----
Physical Tests (QC Lot: 1452402)											
WT2412651-001	BH105-SS6	Moisture	----	E144	0.25	%	10.5	10.7	1.71%	20%	----
Physical Tests (QC Lot: 1452560)											
WT2412457-001	Anonymous	pH (1:2 soil:CaCl2-aq)	----	E108A	0.10	pH units	8.30	8.31	0.120%	5%	----
Inorganics (QC Lot: 1461205)											
SK2402040-030	Anonymous	Sulfides, acid volatile	----	E396-L	1.31	mg/kg	<1.30	<1.31	1.30	Diff <2x LOR	----
Leachable Anions & Nutrients (QC Lot: 1459342)											
WT2412444-008	Anonymous	Sulfate, soluble ion content	14808-79-8	E236.SO4	20	mg/kg	<20	<20	0	Diff <2x LOR	----
Leachable Anions & Nutrients (QC Lot: 1459343)											
WT2412444-008	Anonymous	Chloride, soluble ion content	16887-00-6	E236.Cl	5.0	mg/kg	70.4	72.1	2.39%	30%	----

Method Blank (MB) Report

A Method Blank is an analyte-free matrix that undergoes sample processing identical to that carried out for test samples. Method Blank results are used to monitor and control for potential contamination from the laboratory environment and reagents. For most tests, the DQO for Method Blanks is for the result to be < LOR.

Sub-Matrix: **Soil/Solid**

Analyte	CAS Number	Method	LOR	Unit	Result	Qualifier
Physical Tests (QCLot: 1451744)						
Conductivity (1:2 leachate)	----	E100-L	5	µS/cm	<5.00	----
Physical Tests (QCLot: 1452402)						
Moisture	----	E144	0.25	%	<0.25	----
Inorganics (QCLot: 1461205)						
Sulfides, acid volatile	----	E396-L	0.2	mg/kg	<0.20	----
Leachable Anions & Nutrients (QCLot: 1459342)						
Sulfate, soluble ion content	14808-79-8	E236.SO4	20	mg/kg	<20	----
Leachable Anions & Nutrients (QCLot: 1459343)						
Chloride, soluble ion content	16887-00-6	E236.Cl	5	mg/kg	<5.0	----

Laboratory Control Sample (LCS) Report

A Laboratory Control Sample (LCS) is an analyte-free matrix that has been fortified (spiked) with test analytes at known concentration and processed in an identical manner to test samples. LCS results are expressed as percent recovery, and are used to monitor and control test method accuracy and precision, independent of test sample matrix.

Sub-Matrix: **Soil/Solid**

					Laboratory Control Sample (LCS) Report				
					Spike	Recovery (%)	Recovery Limits (%)		
Analyte	CAS Number	Method	LOR	Unit	Target Concentration	LCS	Low	High	Qualifier
Physical Tests (QCLot: 1451744)									
Conductivity (1:2 leachate)	----	E100-L	5	µS/cm	1410 µS/cm	99.7	90.0	110	----
Physical Tests (QCLot: 1452137)									
pH (1:2 soil:CaCl2-aq)	----	E108A	----	pH units	7 pH units	101	98.0	102	----
Physical Tests (QCLot: 1452402)									
Moisture	----	E144	0.25	%	50 %	97.7	90.0	110	----
Physical Tests (QCLot: 1452560)									
pH (1:2 soil:CaCl2-aq)	----	E108A	----	pH units	7 pH units	100	98.0	102	----
Inorganics (QCLot: 1461205)									
Sulfides, acid volatile	----	E396-L	0.2	mg/kg	100 mg/kg	103	70.0	130	----
Leachable Anions & Nutrients (QCLot: 1459342)									
Sulfate, soluble ion content	14808-79-8	E236.SO4	20	mg/kg	1000 mg/kg	98.8	80.0	120	----
Leachable Anions & Nutrients (QCLot: 1459343)									
Chloride, soluble ion content	16887-00-6	E236.Cl	5	mg/kg	1000 mg/kg	98.5	80.0	120	----

Reference Material (RM) Report

A Reference Material (RM) is a homogenous material with known and well-established analyte concentrations. RMs are processed in an identical manner to test samples, and are used to monitor and control the accuracy and precision of a test method for a typical sample matrix. RM results are expressed as percent recovery of the target analyte concentration. RM targets may be certified target concentrations provided by the RM supplier, or may be ALS long-term mean values (for empirical test methods).

Sub-Matrix:

					Reference Material (RM) Report				
					RM Target	Recovery (%)	Recovery Limits (%)		
Laboratory sample ID	Reference Material ID	Analyte	CAS Number	Method	Concentration	RM	Low	High	Qualifier
Physical Tests (QCLot: 1451744)									
QC-1451744-003	RM	Conductivity (1:2 leachate)	----	E100-L	3460 µS/cm	90.9	70.0	130	----
Physical Tests (QCLot: 1451834)									
QC-1451834-001	RM	Oxidation-reduction potential [ORP]	----	E125	475 mV	102	90.0	110	----
Leachable Anions & Nutrients (QCLot: 1459342)									
QC-1459342-003	RM	Sulfate, soluble ion content	14808-79-8	E236.SO4	172 mg/kg	77.6	70.0	130	----
Leachable Anions & Nutrients (QCLot: 1459343)									
QC-1459343-003	RM	Chloride, soluble ion content	16887-00-6	E236.Cl	601 mg/kg	86.3	70.0	130	----

Chain of Custody (COC) / Analytical Request Form

www.alsglobal.com

Canada Toll Free: 1 800 668 9878

COC Numb

Environmental Division
Waterloo
Work Order Reference
WT2412651

Telephone : +1 519 886 6910

Report To	Contact and company name below will appear on the final report	Reports / Recipients	Turnaround Time (TAT) Requested
Company:	Grounded Eng Inc	Select Report Format: ☑ PDF ☐ EXCEL ☐ EDD (DIGITAL)	☑ Routine [R] if received by 3pm M-F - no surcharges appl
Contact:	Sam Bastan	Merge QC/QCI Reports with COA ☑ YES ☐ NO ☐ N/A	☐ 4 day [P4] if received by 3pm M-F - 20% rush surcharge
Phone:	647-361-5439	☐ Compare Results to Criteria on Report - provide details below if box checked	☐ 3 day [P3] if received by 3pm M-F - 25% rush surcharg
	Company address below will appear on the final report	Select Distribution: ☑ EMAIL ☐ MAIL ☐ FAX	☐ 2 day [P2] if received by 3pm M-F - 50% rush surcharg
Street:	1 Banigan Dr	Email 1 or Fax Sbastan@groundedeng.ca	☐ 1 day [E] if received by 3pm M-F - 100% rush surcharg
City/Province:	Toronto, ON	Email 2	☐ Same day [E2] if received by 10am M-S - 200% rush surch may apply to rush requests on weekends, statutory holidays
Postal Code:	M4H 1G3	Email 3	Date and Time Required for all E&P TATs:

Invoice To		Invoice Recipients
	Same as Report To ☑ YES ☐ NO	Select Invoice Distribution: ☑ EMAIL ☐ MAIL ☐ FAX
	Copy of Invoice with Report ☑ YES ☐ NO	Email 1 or Fax Sbastan@groundedeng.ca
Company:		Email 2
Contact:		

For all tests with rush TATs requested, please contact your AM to confirm availability.

Project Information		Oil and Gas Required Fields (client use)	
ALS Account # / Quote #:		AFE/Cost Center:	PO#
Job #:	24-048	Major/Minor Code:	Routing Code:
PO / AFE:		Requisitioner:	
LSD:	16469 10 SBK RJ	Location:	
ALS Lab Work Order # (ALS use only):	WT2412651 RJ	ALS Contact:	Sampler:

Analysis Request

Indicate Filtered (F), Preserved (P) or Filtered and Preserved (F/P) below

ALS Sample # (ALS use only)	Sample Identification and/or Coordinates (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	NUMBER OF CONTAINERS	Corrosivity	SAMPLES ON HOLD	EXTENDED STORAGE REQUIRED	SUSPECTED HAZARD (see notes)
	BH105-S56	05-09-24	16:00	Soil	1	X			
	BH109-S55	05-14-24	13:40	↓	1	X			
	BH114-S53	05-15-24	11:55	↓	1	X			

Drinking Water (DW) Samples[1] (client use)	Notes / Specify Limits for result evaluation by selecting from drop-down below (Excel COC only)
Are samples taken from a Regulated DW System? ☐ YES ☐ NO	
Are samples for human consumption/ use? ☐ YES ☐ NO	

SAMPLE RECEIPT DETAILS (ALS use only)

Cooling Method: ☐ NONE ☑ ICE ☐ ICE PACKS ☐ FROZEN ☐ COOLING INITIATED

Submission Comments identified on Sample Receipt Notification: ☐ YES ☐ NO

Cooler Custody Seals Intact: ☐ YES ☐ N/A Sample Custody Seals Intact: ☐ YES ☐ N/A

INITIAL COOLER TEMPERATURES °C			FINAL COOLER TEMPERATURES °C		
			4.1		

SHIPMENT RELEASE (client use)			INITIAL SHIPMENT RECEPTION (ALS use only)			FINAL SHIPMENT RECEPTION (ALS use only)		
Released by: BJW	Date: 05/17/24	Time: 13:30	Received by:	Date:	Time:	Received by: BB	Date: 05/21/24	Time: 9:41

REFER TO BACK PAGE FOR ALS LOCATIONS AND SAMPLING INFORMATION

WHITE - LABORATORY COPY YELLOW - CLIENT COPY

AUG 2020 FRONT

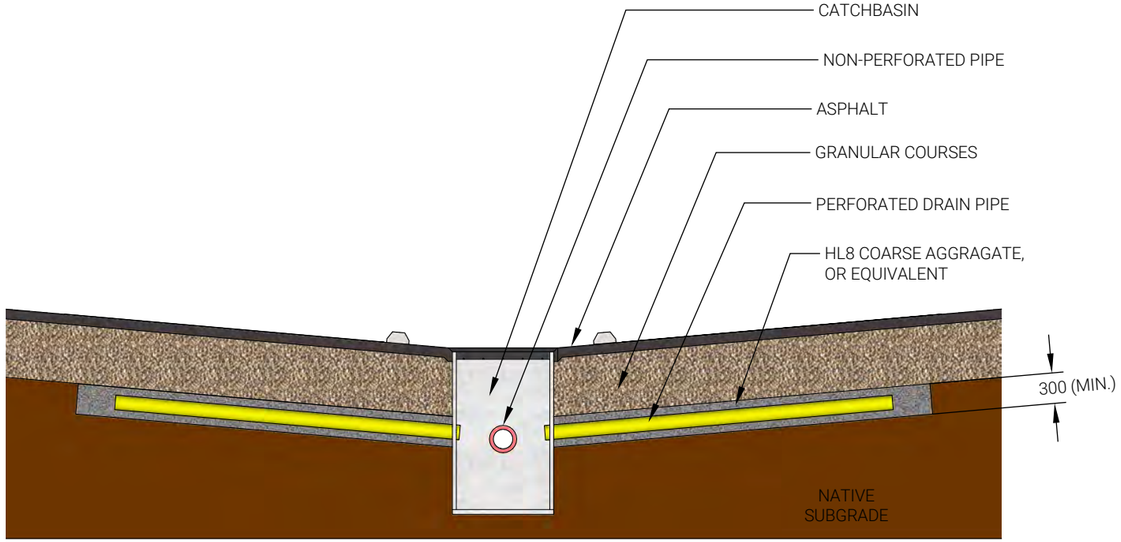
Failure to complete all portions of this form may delay analysis. Please fill in this form LEGIBLY. By the use of this form the user acknowledges and agrees with the Terms and Conditions as specified on the back page of the white - report copy.

1. If any water samples are taken from a **Regulated Drinking Water (DW) System**, please submit using an **Authorized DW COC form.**

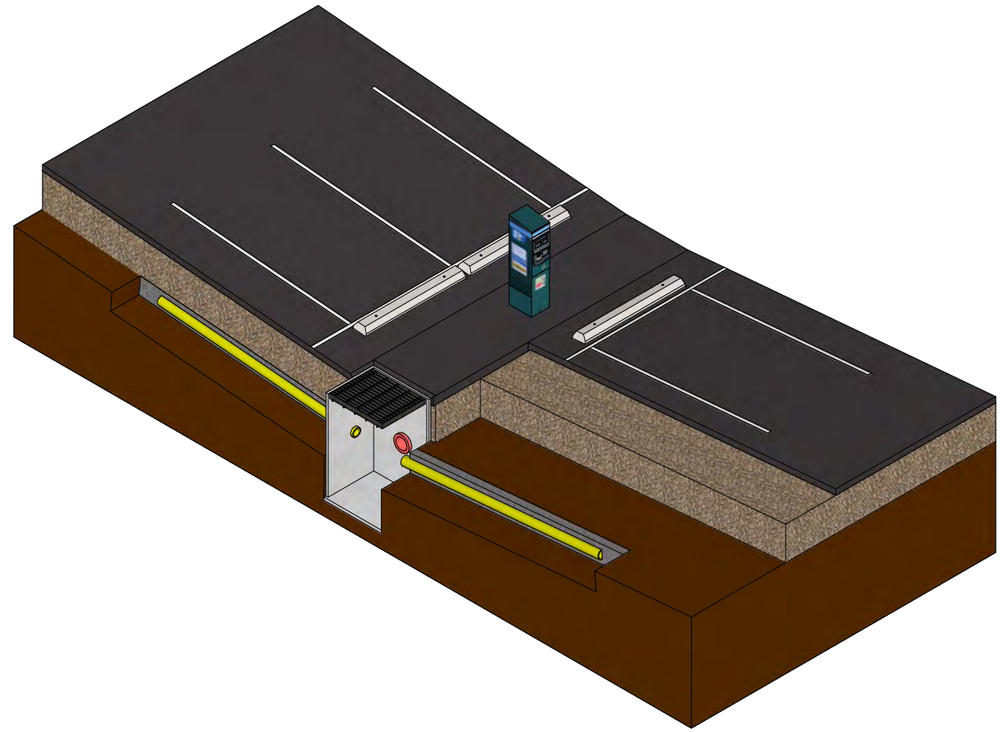
SOL-111

APPENDIX D

OBJECTS ARE COLOR-CODED BETWEEN TWO VIEWS FOR CLARITY



SECTIONAL VIEW



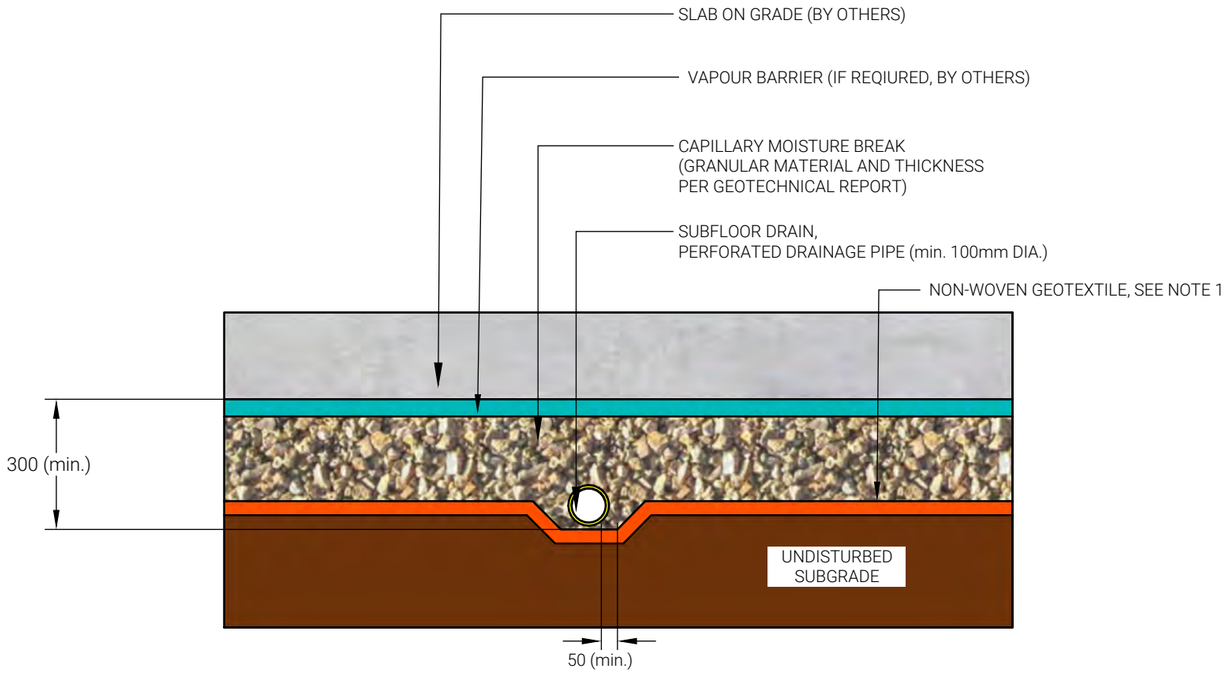
ISOMETRIC

GROUNDED ENGINEERING

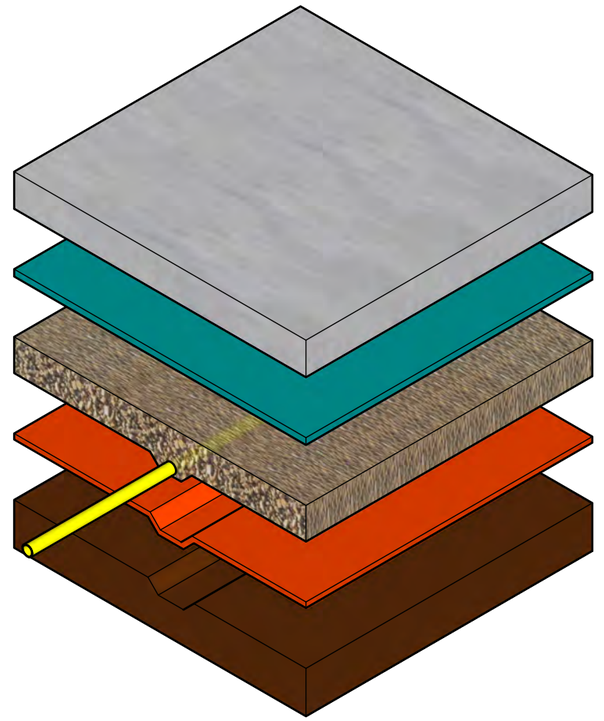
Title

LONGITUDINAL SUBDRAIN CONNECTION TO CATCHBASIN

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).

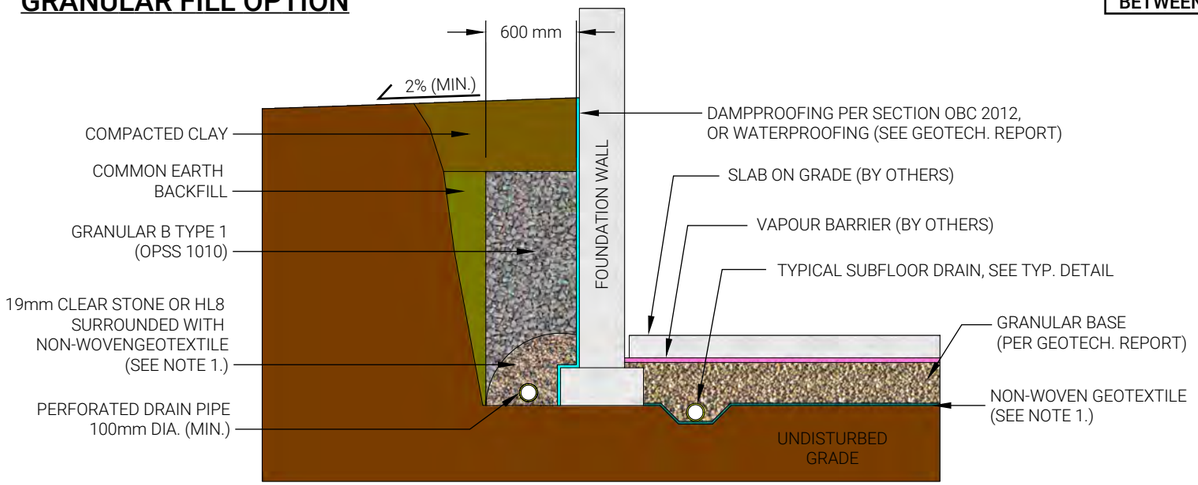
2. TYPICAL SCHEMATIC ONLY. MUST BE READ IN CONJUNCTION WITH GEOTECHNICAL REPORT.

GROUNDED ENGINEERING

Title

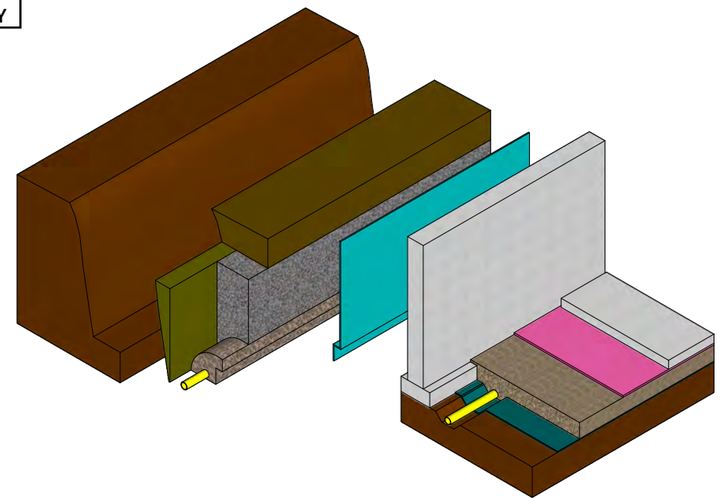
BASEMENT SUBDRAIN TYPICAL DETAIL

GRANULAR FILL OPTION



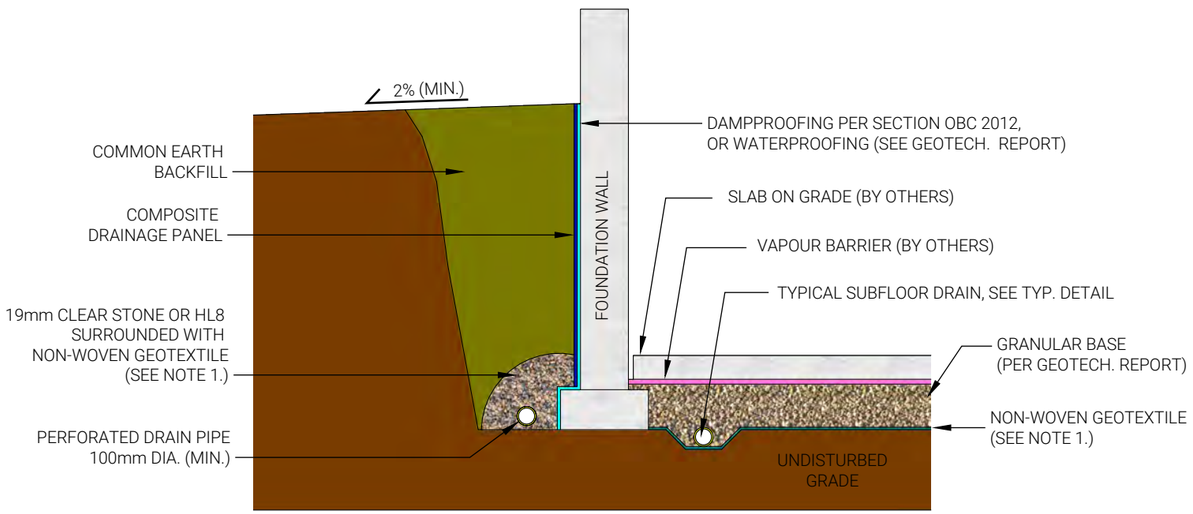
SECTIONAL VIEW

OBJECTS ARE COLOR-CODED BETWEEN TWO VIEWS FOR CLARITY

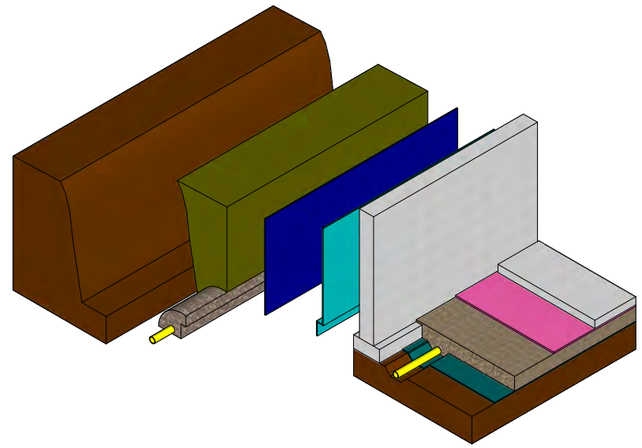


ISOMETRIC VIEW

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