

PRELIMINARY GEOTECHNICAL ENGINEERING REPORT

**163-164 Edward Street East
Clearview Township (Creemore),
Ontario**

PREPARED FOR:

Lamb Development Corp.
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ATTENTION:

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1 Introduction

Lamb Development Corp. has retained Grounded Engineering Inc. ("Grounded") to provide preliminary geotechnical engineering design advice for their proposed development at 163-164 Edward Street East, in Clearview Township (Creemore), Ontario.

The proposed site occupies an area of approximately 24 hectares and is comprised mostly of farmland. The site is used as agricultural land with the remains of a demolished single-family residence and a barn in the center of the property. The proposed project includes development of a residential subdivision consisting of single-family residences and a hotel structure with all associated infrastructure including services and pavements. The Finished Floor Elevations (FFE) will vary across site. FFEs of the single-family residences are assumed to have 1 residential basement level $2\pm$ meters below grade, and the hotel structure is assumed to have 1 basement level with an FFE of Elev. $248.0\pm$ m (4 meters below grade).

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

- Site survey, prepared by Tatham Engineering (October, 2019).
- Draft Development Concept Plan, "163-164 Edward St E, Township of Clearview County of Simcoe"; Project 8216-1, dated May 5th, 2022 (draft issued for client review), prepared by Weston Consulting.
- Draft Preliminary Concept Plan, "163,164 Edward St E, Creemore"; Project 419453, dated October 2019, prepared by Tatham Engineering

The preliminary grading details in the provided Draft Preliminary Concept Plan propose an approximate $2\pm$ m grade increase across the site. Provided design grades range from Elev. $254\pm$ m at western portion of the site to Elev. $249\pm$ m at the eastern portion of the site.

Grounded's subsurface investigation of the site to date includes sixteen (16) boreholes (Boreholes 101 to 116) which were advanced from April 18th to 27th, 2022.

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

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



Site grading and architectural plans are not currently available for review. Grounded must be retained to review the site grading plan and architectural plans prior to construction to ensure borehole coverage is adequate and that the boreholes are sufficient deep for the proposed development.

This preliminary geotechnical engineering report is appropriate for due diligence and planning purposes only. A complete grading plan, additional boreholes, wells, 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.

Elevations are measured by a professional surveyor relative to geodetic datum as provided by Tatham Engineering by email correspondence on May 25th, 2022. The horizontal coordinates are provided relative to the Universal Transverse Mercator (UTM) geographic coordinate system.

2.1 Soil Stratigraphy

The following soil stratigraphy summary is based on the borehole results and the geotechnical laboratory testing. A subsurface profile showing stratigraphy and engineering units is appended. The design groundwater table elevation varies across the site, at typically 0.5-1.5± m below grade.

2.1.1 Surficial Fill and Disturbed Soil

All 16 boreholes encountered topsoil at ground surface ranging between 100 to 200 mm in thickness.

Underlying the topsoil, all boreholes observed a layer of reworked/disturbed soils that extend to depths of 0.8 to 0.9 m below grade (Elev. 248.2 to 251.6 m). Disturbed soils are interpreted as native soil that has been disturbed or reworked in place by agricultural activities previously conducted at this site and natural freeze-thaw cycles. The disturbed soils vary in composition but generally consists of sandy silt to silty sand, with some clay. This material contains trace amounts of rootlets, wood fragments, and rock fragments. It frequently has an organic odour. The disturbed soils are typically dark brown and moist. Due to inconsistent placement and the inherent heterogeneity of reworked soil materials, the relative density/consistency of the reworked soil varies but is on average compact.



2.1.2 Sand and Gravel

Underlying the reworked materials, all boreholes encountered an undisturbed native deposit of cohesionless sandy gravel to gravelly sand (the “sands and gravels” unit) at 0.8 to 0.9 m below grade (Elev. 248.2 to 251.6 m), extending down to a depth of 3.0 to 6.4 m below grade (Elev. 244.5 to 247.8 m). This unit contains rock fragments (inferred and probable cobbles boulders), and is generally moist and brown. Standard Penetration Test (SPT) results (N-Values) measured in the sand and gravel range from 14 to over 50 blows per 300 mm of penetration (“bpf”), indicating a relative density ranging from compact to very dense (on average dense). The lower N-values observed at depth (3± m below groundwater table) are likely due to basal disturbance during drilling. Higher undisturbed SPT N-values may be achieved with mud rotary drilling methods, if needed.

2.1.3 Sands

Underlying the sands and gravels unit, all boreholes encounter an undisturbed native sand deposit at 3.0 to 6.4 m below grade (Elev. 244.5 to 247.8 m). All boreholes were terminated within this unit at depths of 8.2 to 9.8 m below grade (Elev. 239.9 to 244.1 m).

The composition of this unit ranges from cohesionless sands with some silt to silty sands. The sand is generally wet and brown to greyish brown. SPT N-values measured in this unit range from 5 to over 50 bpf (on average compact). The lower N-values observed at depth (3± m below groundwater table) are likely due to basal disturbance during drilling.

Occasional seams of silt and clay (e.g. Borehole 104 from Elev. 246.2 to 244.8, and Borehole 115 from Elev. 245.0 to 243.6) were observed in this unit, and may be found throughout the unit across the site. Cobbles and boulders, while not directly observed in the split spoon samples, may also be present.

2.2 Groundwater

Monitoring wells were installed in each of the boreholes, and stabilized groundwater levels were measured in each of the monitoring wells after the completion of drilling. The boreholes were cased by hollow stem augers on completion, and cave measurement was not practical.

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

Borehole No.	Depth of borehole (m)	Upon completion of drilling		Strata Screened	Water Level in Well, Depth/Elev. (m)		
		Depth to cave (m)	Unstabilized water level (m)		April 29, 2022	May 5, 2022	June 15, 2022
101	7.6	n/a	1.2	Sand Unit	1.1 / 249.7	1.1 / 249.7	1.2 / 249.6
102	7.6	n/a	0.8	Sand and Gravel Unit / Sand Unit	0.9 / 250.7	-	0.8 / 250.8
103	7.6	n/a	0.8	Sand and Gravel Unit / Sand Unit	0.8 / 251.0	0.7 / 251.1	0.7 / 251.1



Borehole No.	Depth of borehole (m)	Upon completion of drilling		Strata Screened	Water Level in Well, Depth/Elev. (m)		
		Depth to cave (m)	Unstabilized water level (m)		April 29, 2022	May 5, 2022	June 15, 2022
104	7.6	n/a	0.8	Sand and Gravel Unit / Sand Unit	0.3 / 252.1	0.2 / 252.2	0.3 / 252.1
105	7.6	n/a	0.6	Sand and Gravel Unit / Sand Unit	0.8 / 251.4	0.7 / 251.5	0.9 / 251.3
106	7.6	n/a	0.8	Sand and Gravel Unit / Sand Unit	0.8 / 250.5	0.8 / 250.5	0.8 / 250.5
107	7.6	n/a	0.8	Sand and Gravel Unit / Sand Unit	0.9 / 249.9	0.9 / 249.9	0.9 / 249.9
108	7.6	n/a	1.2	Sand and Gravel Unit / Sand Unit	1.2 / 249.5	-	1.3 / 249.4
109	7.3	7.3	1.5	Sand and Gravel Unit / Sand Unit	1.0 / 250.7	0.8 / 250.9	1.0 / 250.7
110	7.6	n/a	1.5	Sand Unit	-	-	1.2 / 249.8
111	7.6	n/a	1.2	Sand and Gravel Unit / Sand Unit	1.1 / 248.9	1.1 / 248.9	1.3 / 248.7
112	7.6	n/a	0.8	Sand and Gravel Unit / Sand Unit	-	-	1.2 / 248.3
113	7.6	n/a	0.8	Sand and Gravel Unit / Sand Unit	-	1.0 / 248.4	1.3 / 248.1
114	7.6	n/a	1.2	Sand and Gravel Unit / Sand Unit	-	-	1.3 / 247.8
115	9.1	n/a	0.6	Sand Unit	-	0.5 / 249.2	0.8 / 248.9
116	7.6	n/a	1.5	Sand and Gravel Unit / Sand Unit	-	-	2.1 / 248.0

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

The design groundwater table for engineering purposes is 0.5 to 1.5 m below grade across the site and follows the surface topography (i.e. at Elev. 252.1± m at the northwestern end of the site at Borehole 104 and sloped down to Elev. 247.8± m at the southeast end of the site at Borehole 114). The sands and gravels and the lower sand deposit have relatively high permeability and will yield free-flow water when penetrated below the groundwater table. There is also infiltrated stormwater perched in the reworked native (disturbed soils). Grounded has prepared a Hydrogeological Report for this site (File No. 22-052).

2.3 Corrosivity and Sulphate Attack

Four (4) soil samples were submitted for corrosivity testing parameters (pH, Resistivity, Electrical Conductivity, Redox Potential, Sulphate, Sulphide and Chloride). The Certificate of Analyses 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*. The results are summarized as follows:

Parameter	BH103 SS1	BH107 SS6	BH114 SS4	BH113 SS3
Soluble Sulphate (SO ₄) in soil sample	<20 µg/g < 0.1 %	<20 µg/g < 0.1 %	<20 µg/g < 0.1 %	20 µg/g < 0.1 %
Class of Exposure	Negligible	Negligible	Negligible	Negligible

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 results are summarized as follows:

Parameter	AWWA C-105 Standard – Assigned Points							
	BH103 SS1		BH107 SS6		BH114 SS4		BH113 SS3	
	Result	Points	Result	Points	Result	Points	Result	Points
Resistivity (ohm.cm)	5800	0	8880	0	4720	0	8980	0
pH	7.61	0	7.74	0	7.79	0	8.03	0
Redox Potential (mV)	376	0	312	0	255	0	422	0
Sulfides (%)	0.6	3.5	0.002	2	No Test*		0.002	2
Moisture (%)	18.5	2	13.0	2	11.5	2	9.1	1
Corrosion protection recommended?	No		No		No		No	
Resistivity less than 2000 ohm.cm?	No		No		No		No	

*Not enough sample to complete the laboratory test.

The analytical results only provide an indication of the potential for corrosion. All four 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 four samples had resistivity measurements exceeding 2000 ohm.cm.



2.4 Frost Heave Susceptibility of Soils

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

Table 2.1: Relationship Between Grain Size and Frost Susceptibility (MTO)

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

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

Table 2.2: Summary of Susceptibility to Frost Heave

Stratum	Grain Size Percentage between 5 and 75 μm	Susceptibility to Frost Heaving
Disturbed Soils	Est. 30 to 35%	Low
Sand and Gravel	Est. 5 to 10%	Low
Sands	Est. 35 to 50%	Low to Moderate

3 Preliminary Geotechnical Engineering Recommendations

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

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

The proposed low-density residential subdivision will consist of structures designed in accordance with the requirements of Part 9 of the Ontario Building Code (2012). Reference should



be made to the following sections of the Ontario Building Code (2012) which stipulate the geotechnical design and construction requirements for residential structures.

- 9.3. Materials, Systems and Equipment
- 9.4. Structural Requirements
- 9.12. Excavation
- 9.13. Dampproofing, Waterproofing, and Soil Gas Control
- 9.14. Drainage
- 9.15. Footings and Foundations
- 9.16. Slabs-on-ground

Should there be any high density residential or commercial structures added to the site (e.g. the proposed hotel), these portions of the developments will be designed by either Professional Engineers or Architects to conform to the requirements of the Ontario Building Code (2012). Structural design will be compliant with Part 4 of the Code.

3.1 Preliminary Site Grading

Existing grade will be altered across the site per Tatham Engineering's (draft) Preliminary Concept Plan (Oct. 2019). The proposed plan shows sanitary and storm alignments with top of rim elevations at $2\pm$ metres above existing grades across the site.

The proposed residential dwellings are assumed to be constructed with up to one basement level ($2\pm$ m below grade). The proposed hotel structure is assumed to be constructed with one basement level $4\pm$ meters below grade, with an approximate FFE of Elev. $249\pm$ m.

The existing topsoil and disturbed (reworked native) soils are 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. The disturbed soils (Section 2.1.1) in their current condition are unsuitable and must be removed beneath the proposed development. These soils must be subexcavated down to the native subgrade.

For pavement areas, grade raises may comprise compacted fill or engineered fill. For building areas where fill is required to provide structural support for foundations, engineered fill is required.

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

1. 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. Compacted fill can be made on an existing earth fill subgrade if it is proof rolled under our inspection and approved by us prior to fill placement. Engineered fill requires an approved subgrade of native soils.

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

Across the entire fill area, the topsoil and other deleterious materials must be removed. The proposed subgrade must be cut neat and must be inspected by Grounded to identify any voids, organics, or soft, wet, or weak zones. Any identified areas must be sub-excavated to a competent subgrade. 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 native soil.

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

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

Soil that is used as engineered or common earth 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 test per the requirements of O.Reg 406/19 and approved by the Environmental QP for the site.

The existing topsoil and disturbed soils are 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 disturbed soil samples from the boreholes range from 8 to 33% (on average, 20%). They occasionally contain trace amounts of rootlets, wood fragments, and rock fragments. We estimate that potentially half of the existing disturbed soils beneath the topsoil 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.

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.

Frost susceptible soils within 1.6 m of finished grades in unheated areas (e.g. pavements) could potentially cause pavements to heave or crack next to other structures (e.g. curbs, catchbasins, etc.). The degree of heaving is unknown. If frost susceptibility is to be considered in design (to be determined by the Owner based on their own pavement performance criteria), all soil placed within 1.6 m of finished grades must be classified to have a low susceptibility to frost heaving, as defined in Section 2.4 above.

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

For the expected heights of engineered fill to be placed, post-construction settlements of the engineered fill itself (i.e. due to self-weight) can be expected to be around 1% of the height of soil placed, depending on the composition of the engineered fill. If the engineered fill is composed of sand or aggregate materials, then post-construction settlements of the engineered fill will be around 0.5% or less and will occur within a week or two. .

3.2 Preliminary Foundation Design Parameters

All foundations must bear on engineered fill, or on undisturbed native soils. The topsoil and near-surficial disturbed soils are considered unsuitable for the support of the proposed building foundations. Foundations for both new residential single-family dwellings and the hotel structure will consist of conventional spread footings, bearing on undisturbed native sands and gravels, or on properly constructed and inspected engineered fill. Conventional foundations for individual or attached buildings should be founded entirely on one continuous subgrade type (i.e. entirely on undisturbed native soils, or engineered fill), and must not bridge from one soils type to another within the overall building envelope.

The design groundwater table for engineering purposes is 0.5 to 1.5 m below grade and generally follows the ground surface topography (at Elev. $252.1 \pm$ m at the northwestern end of the site near Borehole 104, and sloping down to Elev. $247.8 \pm$ m at the southeast end of the site near Borehole 114). To minimize groundwater control during construction, bases of footings should be $1.2 \pm$ m above the design groundwater table. Otherwise, footing excavations must be dewatered to a minimum 1.2 m below proposed excavation elevation prior to excavation, to preserve the in-situ integrity of the native soils. If the subsurface is not dewatered prior to excavation, the native soils will become disturbed by the ingress of groundwater and the above recommendations for bearing capacity will not be valid.



When exposed to ambient environmental temperatures in the Creemore area, the design earth cover for frost protection of foundations and grade beams is 1.6 m.

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

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.

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

3.2.1 Spread Footings on Engineered Fill

Foundations made for the proposed new residential single-family dwellings with an assumed FFE at $2\pm$ m below grade may be supported on conventional spread footing foundations resting on engineered fill. An engineered fill specification is appended and discussed in Section 3.1.

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

For footings supported on engineered fill, the minimum width for conventional strip footings must be 500 mm, and the minimum size of individual spread footings must be 800 mm x 800 mm. These minimum requirements apply in conjunction with the above recommended geotechnical resistance regardless of loading considerations. The geotechnical reaction at SLS refers to a settlement which for practical purposes is linear and non-recoverable. Differential settlement is related to column spacing, column loads, and footing sizes.

3.2.2 Spread Footings on Native Soil

The closest boreholes to the proposed hotel are Boreholes 110 and 115. Based on the Oct. 2019 Tatham preliminary concept plan, the final grade in this area is at approximate Elev. $252\pm$ m. Foundations made for the proposed hotel structure with an assumed FFE of $4\pm$ m below grade (Elev. 248.0 m) will be made below the groundwater table on compact to dense sands and gravels (and probably cobbles and boulders). The soils must be dewatered to minimum 1.2 m below the lowest excavation elevation prior to excavation to preserve the integrity of the existing soil



capacity. The cohesionless compact native soils are considered suitable to support the proposed building foundations in their undisturbed state.

Conventional spread footings made to bear on these undisturbed native soils (dewatered prior to excavation) may be designed using a maximum factored geotechnical resistance at ULS of 400 kPa. The net geotechnical reaction at SLS is 300 kPa, for an estimated total settlement of 25 mm.

The above recommended minimum foundation depths assume a minimum embedment depth of 600 mm into the undisturbed native soils. The minimum size of isolated footings should be 1000 mm x 1000 mm, in conjunction with the above bearing pressure. At this site, the SLS bearing pressures provided above also limit the maximum footing sizes for spread footings to 3500 mm. 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.

3.3 Earthquake Design Parameters

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 top 30 metres of the site stratigraphy, where shear wave velocity (v_s) measurements have been taken. Alternatively, the classification is estimated from the rational analysis of undrained shear strength (s_u) or penetration resistance (N-values) according to the OBC and National Building Code of Canada.

New structures for the proposed development will bear on engineered fill or native soils. Boreholes at the site observe compact sands and gravels. 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 implication for the structure.



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
Disturbed Soils	19	29	0.35	0.52	2.88
Compacted / Engineered Earth Fill	20	30	0.33	0.50	3.00
Sand and Gravels (native / undisturbed)	21	32	0.31	0.47	3.25

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

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

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

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

P	=	horizontal pressure (kPa) at depth h	γ	=	soil bulk unit weight (kN/m ³)
h	=	the depth at which P is calculated (m)	γ'	=	submerged soil unit weight ($\gamma - 9.8$ 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:

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

Where walls are made directly against shoring, prefabricated composite drainage panel covering the blind side of the wall is used to provide drainage. Water from the composite drainage panel is collected and discharged through the basement wall in solid ports directly to the sumps. This is discussed in Section 3.6.

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

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



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

R_f	=	frictional resistance (kN)
Φ	=	reduction factor per Canadian Foundation Engineering Manual (CFEM) Ed. 4 (0.8)
N	=	normal load at base of footing (kN)
φ	=	internal friction angle (see table above)

3.5 Slab on Grade Design Parameters

The proposed townhomes are assumed to be constructed with up to one basement level (2± m below grade) with a subgrade of engineered fill. The proposed hotel structure is assumed to be constructed with one basement level 4± meters below grade, with an approximate FFE of Elev. 248± m. At the proposed basement elevations for the new structures, the subgrade may consist of undisturbed native soils or engineered fill, each of which will provide adequate subgrade for the support of a conventional slab on grade. The modulus of subgrade reaction (MSR) for slab-on-grade design for new dwellings at the site are shown in the following table for each of the above-mentioned subgrade types.

Bearing Subgrade	Modulus of Subgrade Reaction (kPa/m)
Engineered Fill (basement slab for single family dwellings)	16,000
Native Soils, Compact to dense gravels and sands (basement slab for hotel structure)	30,000

If this basement structure is made as a conventional drained structure, a permanent drainage system including subfloor drains is required (see Section 3.6).

An engineered fill specification is appended and discussed in Section 3.1. Disturbed or otherwise unacceptable material (as determined by Grounded) must be subexcavated and replaced with Granular B (OPSS.MUNI 1010) compacted to a minimum of 98% SPMDD. The slab on grade should not be placed on frozen subgrade, to prevent settlement of the slab as the subgrade thaws. Areas of frozen subgrade should be removed during subgrade preparation.

For the hotel, the slab on grade must be provided with a drainage layer and capillary moisture break, which is achieved by forming the slab on a minimum 300 mm thick layer of 19 mm clear stone (OPSS.MUNI 1004) vibrated to a dense state. In areas where the slab on grade subgrade is expected to be below the groundwater table, HL8 coarse aggregate (OPSS.MUNI 1150) or HPB is recommended to be used instead of clear stone. The slab-on-grade is to be made on cohesionless sands, and therefore the drainage layer must be separated from the sands using a non-woven geotextile and Granular A filter. In this case, the bulk excavation is subexcavated a min. 150 mm and replaced by Granular A (OPSS.MUNI 1010) compacted to 98% of SPMDD. A non-woven geotextile (with an apparent opening size of less than 0.250 mm and a tear resistance of more than 200 N) is to be placed on the surface of the compacted Granular A. The subfloor drains are then laid directly on the flat subgrade and backfilled with a minimum 300 mm thick



layer of HL8 coarse aggregate (OPSS.MUNI 1150) or HPB, vibrated to a dense state. Any solid collection pipes must be sloped so that they positively discharge to the sumps.

The drainage layer for single family dwellings can consist of 200 mm of Granular A (compacted to 98% SPMDD) where the basement is above the groundwater table, and 200 mm of HPB below the groundwater table. A geotextile as above must also be used for the single family dwellings or townhomes, where the basement is below the groundwater table.

Without proper filtering there may be entry of fines from the surrounding subgrade soils into the bedding. This loss of ground could result in a loss of support of the slab and clogging of the subfloor drainage system.

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.

The design groundwater table for engineering purposes is 0.5 to 1.0 m below grade across the site and follows the surface topography (i.e. at Elev. 252.1± m at the northwestern end of the site at Borehole 104 and sloped down to Elev. 247.8± m at the southeast end of the site at Borehole 114). The native soils at the site will yield free-flowing water when penetrated. To minimize groundwater seepage, it is recommended that all basement remain at least 1± m above the design groundwater table.

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. The exterior faces of foundation walls should be provided with a layer of waterproofing to protect interior finishes.

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

Below the groundwater table, subfloor drainage pipes are to be spaced at maximum 3 m (measured on-centres). If subdrain elevation conflicts with top of footing elevation, footings should be lowered as necessary.

The walls of the hotel substructure are to be fully drained to eliminate hydrostatic pressure. In an open cut excavation, basement wall drainage is installed directly against the basement wall from the open cut side. Perimeter foundation drains made in this application comprise perforated pipe (minimum 100 mm diameter) surrounded by a granular filter of OPSS.MUNI HL-8 Coarse Aggregate providing a minimum 300 mm of cover over the drain pipe. Typical basement drainage details are appended.



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

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

The permanent dewatering requirements are provided in Grounded's Hydrogeological Report (File No. 22-052).

3.7 Site Servicing

Preliminary site servicing was provided by Tatham Engineering. The invert of proposed storm sewer with maintenance chambers range from Elev. 252.2± m to Elev. 248.2± m. These installations will be situated on engineered fill and undisturbed native soils. The existing topsoil and disturbed (reworked native) soils are not geotechnically suitable. The invert elevations of proposed storm sewer extend below the groundwater table. The invert of proposed sanitary sewer are not provided. All services must have at least 1.6 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 engineered fill or native soil. If earth fill is encountered, the subgrade must be compacted in place to a minimum 98% SPMDD. The trench base must be inspected for obvious loose, wet, or disturbed material. Any unsuitable material must be subexcavated and replaced with imported fill compacted to 98% SPMDD.

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.

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

3.7.2 Backfill

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

- Any deleterious material in the earth fill is removed prior to reuse as backfill.



- The moisture content is within 2% of optimum, or moisture conditioned to within 2% of optimum.
- The backfill must be compacted to a minimum 98% SPMDD.

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.

3.8 Stormwater Management Ponds

Preliminary details of the SMWP 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.

Two storm water management ponds (SWMP) are proposed to be constructed at the east end of the site. SWIMP Facility #1 to the northeast has a proposed permanent pool elevation at Elev. 249.4 m. SWIMP Facility #2 to the southeast has a proposed permanent pool elevation at Elev. 249.5 m.

Borehole 116 was advanced in the proposed footprint of the SWMP Facility #1. Borehole 116 encountered disturbed soils to Elev. 249.2 m, and is underlain by undisturbed sand and gravel native soils to Elev. 247.1 m and gravelly sands to sands to termination depth (Elev. 241.9 m). The stabilized ground water table measured in the monitoring well installed in Borehole 116 is at about Elev. $248.0 \pm$ m (June, 2022). The base elevation of the SWMP is understood to be at Elev. $248.4 \pm$ m. Proposed grade of the maintenance access road at the crest of the SWMP is Elev. $251.2 \pm$ m.



Borehole 114 was advanced in the proposed footprint of the SWMP Facility #2. Borehole 114 encountered disturbed soils to Elev. 248.2 m, and is underlain by undisturbed sand and gravel native soils to Elev. 244.5 m and sands to termination depth (Elev. 240.9 m). The stabilized ground water table measured in the monitoring well installed in Borehole 114 is at about Elev. 247.8± m (June, 2022). The base elevation of the SWMP is understood to be at Elev. 248.4± m. Proposed grade of the maintenance access road at the crest of the SWMP is Elev. 251.2± m.

Based on this, the borehole data suggests that:

- the pond side slopes will consist of engineered fill.
- the pond base of SWMP Facility #1 will consist of engineered fill.
- the pond base of SWMP Facility #2 will consist of native sands and gravels.

These permeable zones would allow for a greater amount of water infiltration/exfiltration into the pond. Since the groundwater table is within 1±m of the base of the proposed SWMP facilities, the base and sides of the pond should be lined with an impermeable barrier consisting of well compacted fine-grained soils (i.e. clay based soils) or a synthetic equivalent to prevent groundwater from infiltrating into the storm pond. The liner should be designed to resist the difference in hydrostatic pressure between the prevailing groundwater table and the permanent pool elevation.

4 Pavement Design Advice

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.



4.1.1 Pavement Subgrade Preparation

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

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

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

4.1.2 Pavement Design

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

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

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

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



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

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

If roads are to be assumed by the municipality, then the thicker of the municipal standard pavement design or those provided above shall govern.

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 (existing or placed) and farm-tilled / disturbed soils are Type 3 soils
- The wet gravels and sands are Type 4 soils, or Type 3 soils if dewatered

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

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

Minimum support system requirements for steeper excavations are stipulated in Sections 235 through 238 and 241 of the Act and Regulations and include provisions for timbering, shoring and moveable trench boxes. Any excavation slopes greater than 3 m in height should be checked by Grounded for global stability issues.

Larger obstructions (e.g. buried concrete debris, other obstructions) not directly observed in the boreholes are likely present in the earth fill. Similarly, larger inclusions (e.g. cobbles and boulders) will 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. Test pits could be advanced to get a sense of the size and distribution of cobbles and boulders. Provision must be made in excavation contracts to allocate risks associated with the time spent and equipment utilized to remove or penetrate such obstructions when encountered.

5.2 Short-Term Groundwater Control

The design groundwater table for engineering purposes is 0.5 to 1.5 m below grade across the site and follows the surface topography (i.e. at Elev. 252.1± m at the northwestern end of the site at Borehole 104 and sloped down to Elev. 247.8± m at the southeast end of the site at Borehole 114). The watertable is present in all native soil units, and there is infiltrated stormwater in the disturbed / farm-tilled soils.



Excavations for new dwellings and are proposed to be made above the groundwater table, and the hotel structure is proposed to be made below the groundwater table in cohesionless wet gravels and sands, yielding free-flowing water below the groundwater table when penetrated. Therefore, it is recommended that all excavations remain $1.2\pm$ m above the design groundwater table. Where excavations are $1.2\pm$ m above the design groundwater table, there is still infiltrated stormwater in the upper stratigraphy. It is expected that infiltrated stormwater, if encountered, will be of limited extend. Infiltrated stormwater may be allowed to drain into the excavation and then pumped out. In open excavations, it is anticipated that seepage volumes will be limited to the extent that temporary pumping will sufficiently control any groundwater seepage. Regardless, excavation delays will occur as seepage (however limited) is controlled. These delays should be anticipated in the construction schedule.

The water level must be kept at least 1.2 m below the lowest excavation elevation during construction. Failure to dewater prior to excavation will result in unrecoverable disturbance of the subgrade, which will render advice provided for undisturbed subgrade conditions inapplicable.

Local dewatering of excavations (e.g. for the hotel and some services) may be required to maintain the integrity of the subgrade for foundation and slab-on-grade support. Water be discharged to other areas of site during construction.

For the hotel structure proposed to be made below the groundwater table, positive dewatering may be required to lower the groundwater table will be required to facilitate construction as well as to maintain the integrity of the subgrade for foundation and slab-on-grade support. Dewatering will take some time to accomplish prior to the start of excavation. The water level must be kept at least 1.2 m below the lowest excavation elevation during construction. Failure to dewater prior to excavation will result in unrecoverable disturbance of the subgrade, which will render advice provided for undisturbed subgrade conditions inapplicable.

A professional dewatering contractor should be consulted to review the subsurface conditions and to design a site-specific dewatering system. It is the dewatering contractor's responsibility to assess the factual data and to provide recommendations on dewatering system requirements.

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

5.3 Earth-Retention Shoring Systems

Shoring may be required for the hotel structure. The hotel structure is assumed to have 1 basement level with an FFE of Elev. $248.0\pm$ m (4 meters below grade).

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

Excavation zone of influence guidelines are appended.



Continuous interlocking caisson wall shoring is to be used where the excavation must be constructed as a rigid shoring system. Caisson wall shoring preserves the support capabilities and integrity of the soil beneath existing foundations of adjacent buildings, in a state akin to the at-rest condition. Otherwise, excavations can be supported using conventional soldier pile and lagging walls with active dewatering prior to and during construction.

5.3.1 Lateral Earth Pressure Distribution

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

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

$$P = 0.65 K[\gamma H + q] + \gamma_w h_w \dots \text{in cohesionless soils}$$

P =	maximum horizontal pressure (kPa)
K =	earth pressure coefficient (see Section 3.4)
H =	total depth of the excavation (m)
h_w =	height of groundwater (m) above the base of excavation
γ =	soil bulk unit weight (kN/m ³)
q =	total surcharge loading (kPa)

Where shoring walls are drained to effectively eliminate hydrostatic pressure on the shoring system (e.g. pile and lagging walls), h_w is equal to zero. For the design of impermeable shoring, a design groundwater table at 2± m below grade must be accounted for. In cohesionless soils, the lateral earth pressure distribution is rectangular.

5.3.2 Soldier Pile Toe Embedment

Soldier pile toes for the hotel structure will be made in compact to dense undisturbed wet sand and gravel unit. Soldier pile toes resist horizontal movement due to the passive earth pressure acting on the toe below the base of excavation.

The subgrade soils at this site are cohesionless, wet, and permeable. Augered holes for piles made into these soils will be prone to caving and blowback. Temporarily cased holes are required to prevent borehole caving during installations in drilled holes. To prevent groundwater issues (groundwater inflow, caving and blowback into the drill holes, disturbance to placed concrete, etc.) during drilling and installation, construction methods such as utilizing temporary liners, pre-advancing liners deeper than the augured holes, mud/slurry/polymer drilling techniques, or other methods as deemed necessary by the shoring contractor are required.



To protect drill holes against basal disturbance caused by the inflow of groundwater, and to prevent loss of ground, it will be necessary at this site to control the bases of any drill holes. This may include dewatering to below the drill hole depths prior to installation, or the use of drilling muds (slurry. Polymer, etc.), pre-advancing casing, or other techniques as deemed necessary by the shoring contractor.

5.3.3 Lateral Bracing Elements

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

In the undisturbed dense subgrade below Elev. 249.0± m, it is expected that post-grouted anchors can be made such that an anchor will safely carry up to 80 kN/m of adhered anchor length (at a nominal borehole diameter of 150 mm).

At least one prototype anchor per tieback level must be performance-tested to 200% of the design load to demonstrate the anchor capacity and validate design assumptions. Given the potential variability in soil conditions or installation quality, all production anchors must also be proof-tested to 133% of the design load.

The undisturbed dense sand and gravels below the proposed FFE is suitable for the placement of raker foundations. If the compact soils are encountered (Boreholes 108, 111 and 113), it should be subexcavated down to the underlying undisturbed dense soils. Raker footings established on dense undisturbed soils at an inclination of 45 degrees can be designed for a maximum factored geotechnical resistance at ULS of 200 kPa.

5.4 Site Work

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

The effects of work on site can greatly impact soil integrity. Care must be taken to prevent this damage. Site work carried out during periods of inclement weather may result in the subgrade becoming disturbed, unless a granular working mat is placed to preserve the subgrade soils in their undisturbed condition. Subgrade preparation activities should not be conducted in wet weather and the project must be scheduled accordingly.



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

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

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

5.5 Engineering Review

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

All foundation installations must be reviewed in the field by Grounded, the Geotechnical Engineer of Record, as they are constructed. The on-site review of the condition of the founding subgrade as the foundations are constructed is as much a part of the geotechnical engineering design function as the design itself; it is also required by Section 4.2.2.2 of the Ontario Building Code. If Grounded is not retained to carry out foundation engineering field review during construction, then Grounded accepts no responsibility for the performance or non-performance of the foundations, even if they are constructed in general conformance with the engineering design advice contained in this report.

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

The long-term performance of a slab on grade is highly dependent upon the subgrade support and drainage conditions. Strict procedures must be maintained during construction to maintain the integrity of the subgrade to the extent possible. The design advice in this report is based on an assessment of the subgrade support capabilities as indicated by the boreholes. These conditions may vary across the site depending on the final design grades and therefore, the preparation of the subgrade and the compaction of all fill should be monitored by Grounded at the time of construction to confirm material quality, thickness, and to ensure adequate compaction.



6 Limitations and Restrictions

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

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

6.1 Investigation Procedures

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

Borehole drilling services were provided to Grounded by a specialist professional contractor. The drilling was observed and recorded by Grounded's field supervisor on a full-time basis. Drilling was conducted using conventional drilling rigs equipped with hollow stem augers 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 this potential site alteration.

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

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

6.3 Report Use

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

The local municipal/regional governing bodies may also make use of and rely upon this report, subject to the limitations as stated.



7 Closure

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

For and on behalf of our team,



K Falkenstein

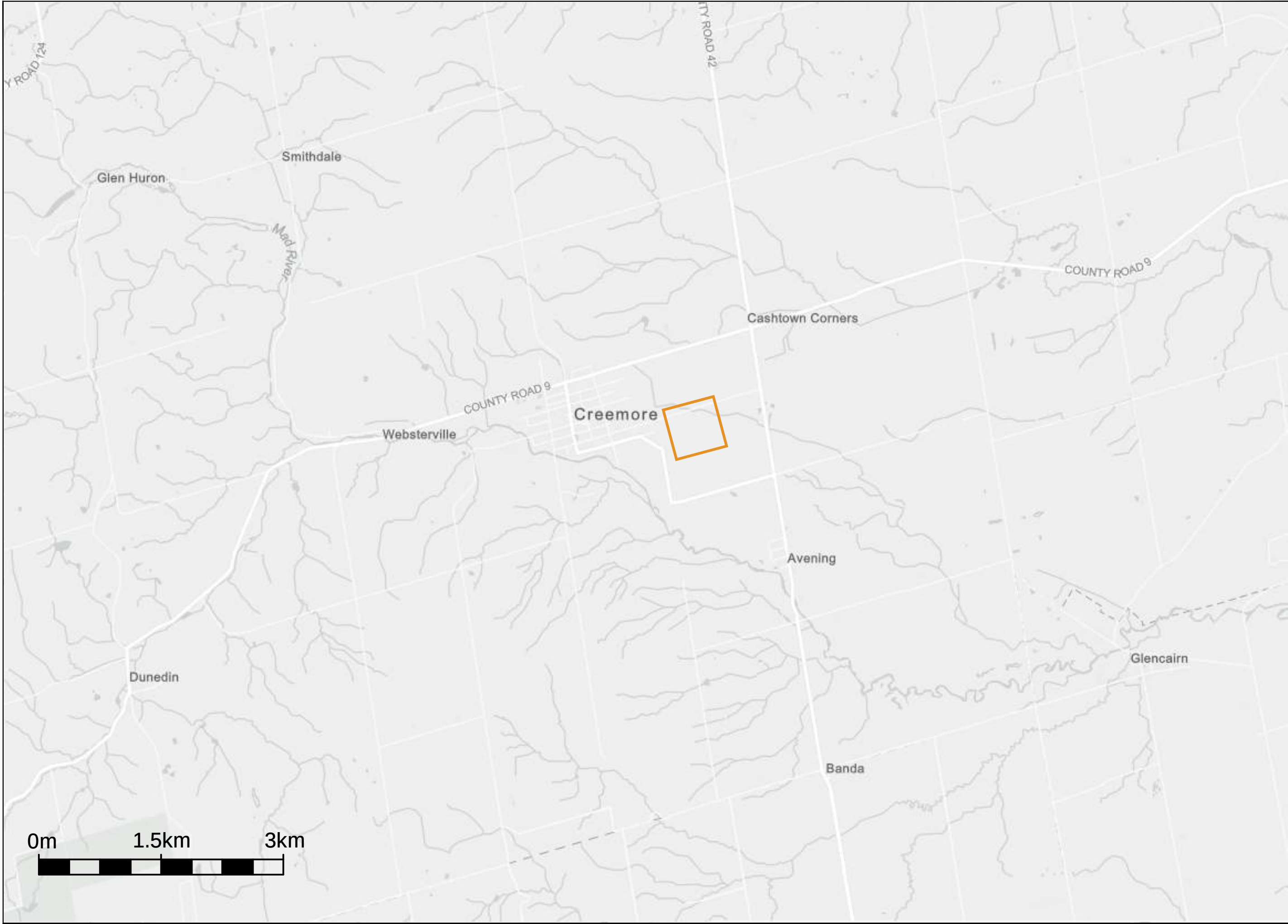
Kimberlee Falkenstein, M.A.Sc., P.Eng.
Project Engineer



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

FIGURES





GROUND
ENGINEERING

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

LEGEND

— APPROXIMATE PROPERTY BOUNDARY

Note

Reference

ArcGIS - My Map. 2022.

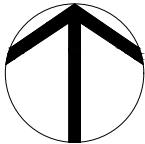
Project

**163-164 EDWARD
STREET EAST,
CREEMORE, ONTARIO**

Figure Title

SITE LOCATION PLAN

North



Date

JULY, 2022

Scale

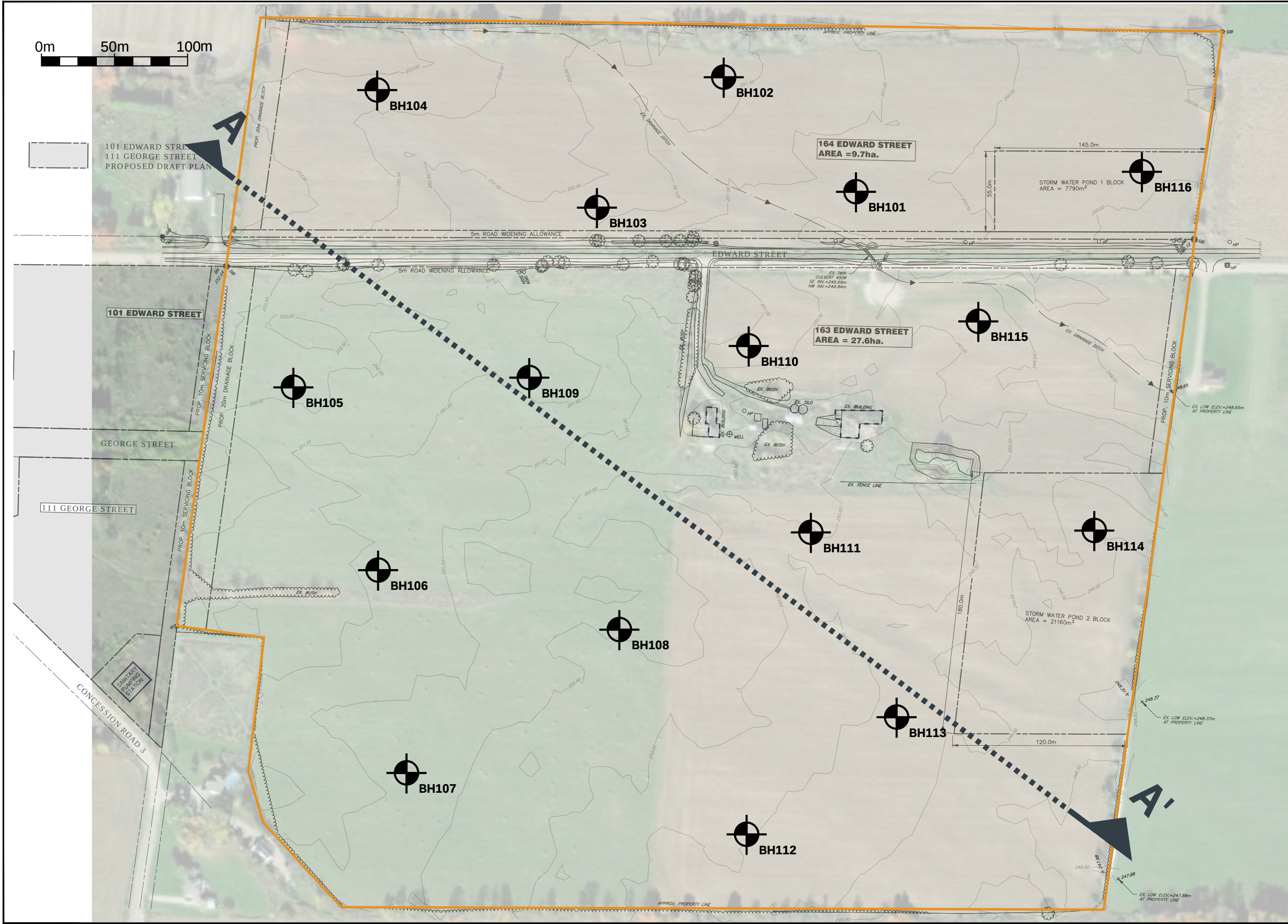
AS INDICATED

Job No

22-052

Figure No

FIGURE 1



LEGEND

- APPROXIMATE PROPERTY BOUNDARY
- DEMOLISHED BUILDING STRUCTURE
- GROUND BOREHOLE AND MONITORING WELL

Note

Reference

Tatham Engineering. Preliminary Constraints Mapping: 163, 164 Edward Street, Creemore. Dated October 2019. Scale 1:1250. Drawing No. CM-1.

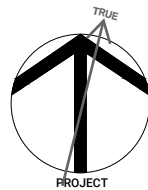
Project

163-164 EDWARD STREET EAST, CREEMORE, ONTARIO

Figure Title

BOREHOLE LOCATION PLAN - EXISTING CONDITIONS

North



Date

JULY, 2022

Scale

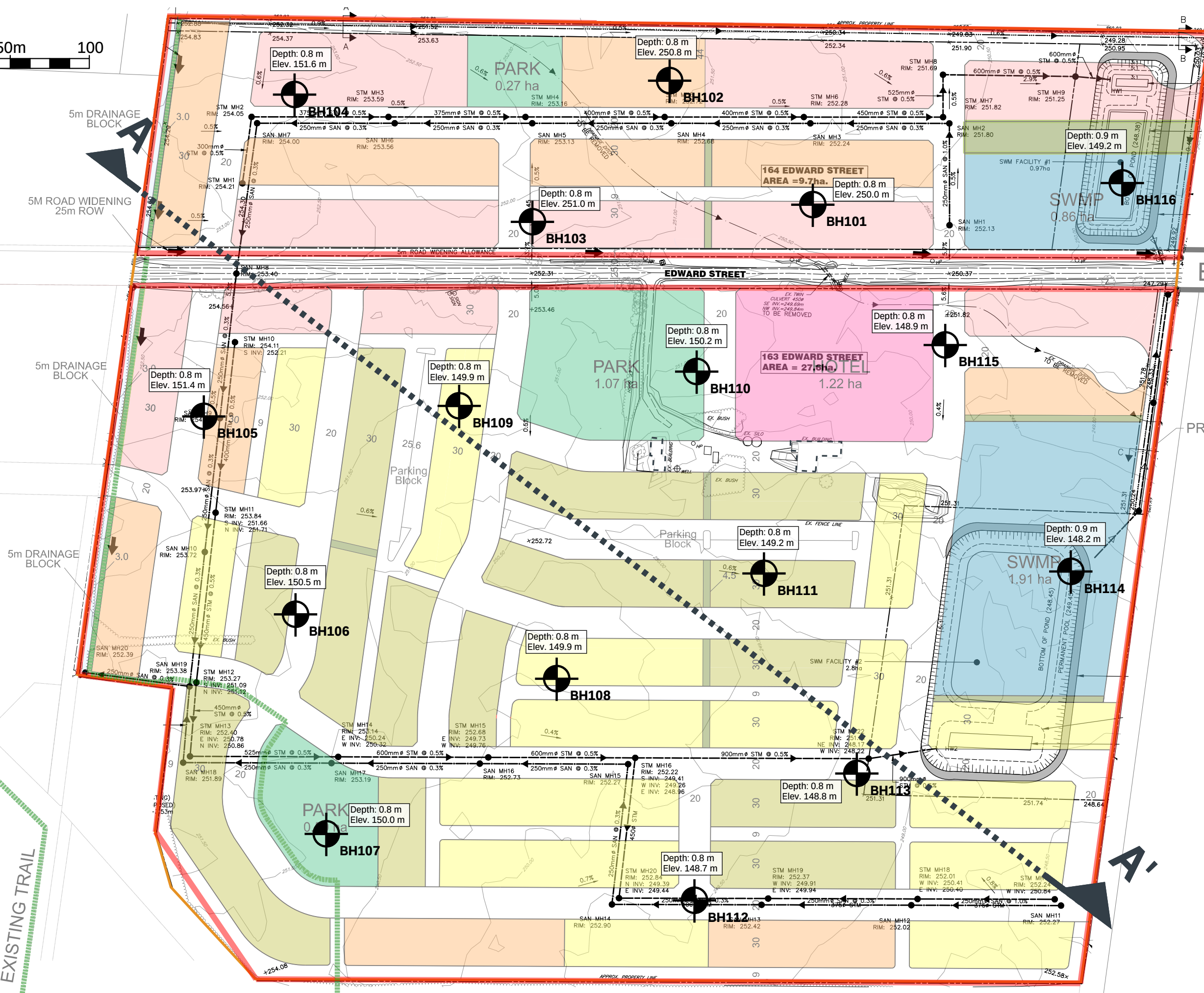
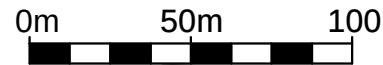
AS INDICATED

Job No

22-052

Figure No

FIGURE 2



EXISTING TRAIL



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

LEGEND

- APPROXIMATE PROPERTY BOUNDARY
- DEMOLISHED BUILDING STRUCTURE
- GROUNDING BOREHOLE AND MONITORING WELL

×249.73 PROPOSED SPOT ELEVATION

×249.73 EXISTING SPOT ELEVATION

Depth: 2.3 m
Elev. 149.0 m
DEPTH/ELEVATION OF SOIL TO BE SUBEXCAVATED (TOP OF NATIVE SOILS)

Note
Proposed Grading Plan drawing from:
Tatham Engineering. Project Number 419453;
Preliminary Concept Plan. 163.164 Edward St.,
Creemore. Dated October, 2022.

(Received by email correspondence with Lamb
Development Corp. July 12th, 2022)

Reference

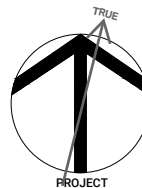
Weston Consulting. Project Number 8216-1;
Development Concept (Issued for Client
Review),
163-164 Edward St E., Township of
Clearview, Simcoe. Dated May 5, 2022.

Project

**163-164 EDWARD
STREET EAST,
CREEMORE, ONTARIO**

Figure Title
**BOREHOLE LOCATION
PLAN - PROPOSED
CONDITIONS**

North



Date

JULY, 2022

Scale

AS INDICATED

Job No

22-052

Figure No

FIGURE 3

LEGEND

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

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

Project
163-164 EDWARD STREET EAST, CREEMORE, ONTARIO

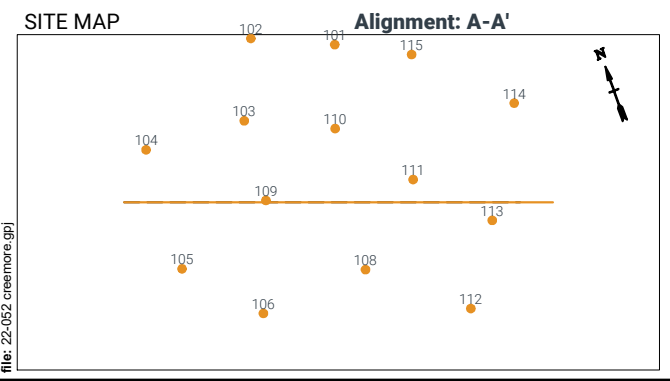
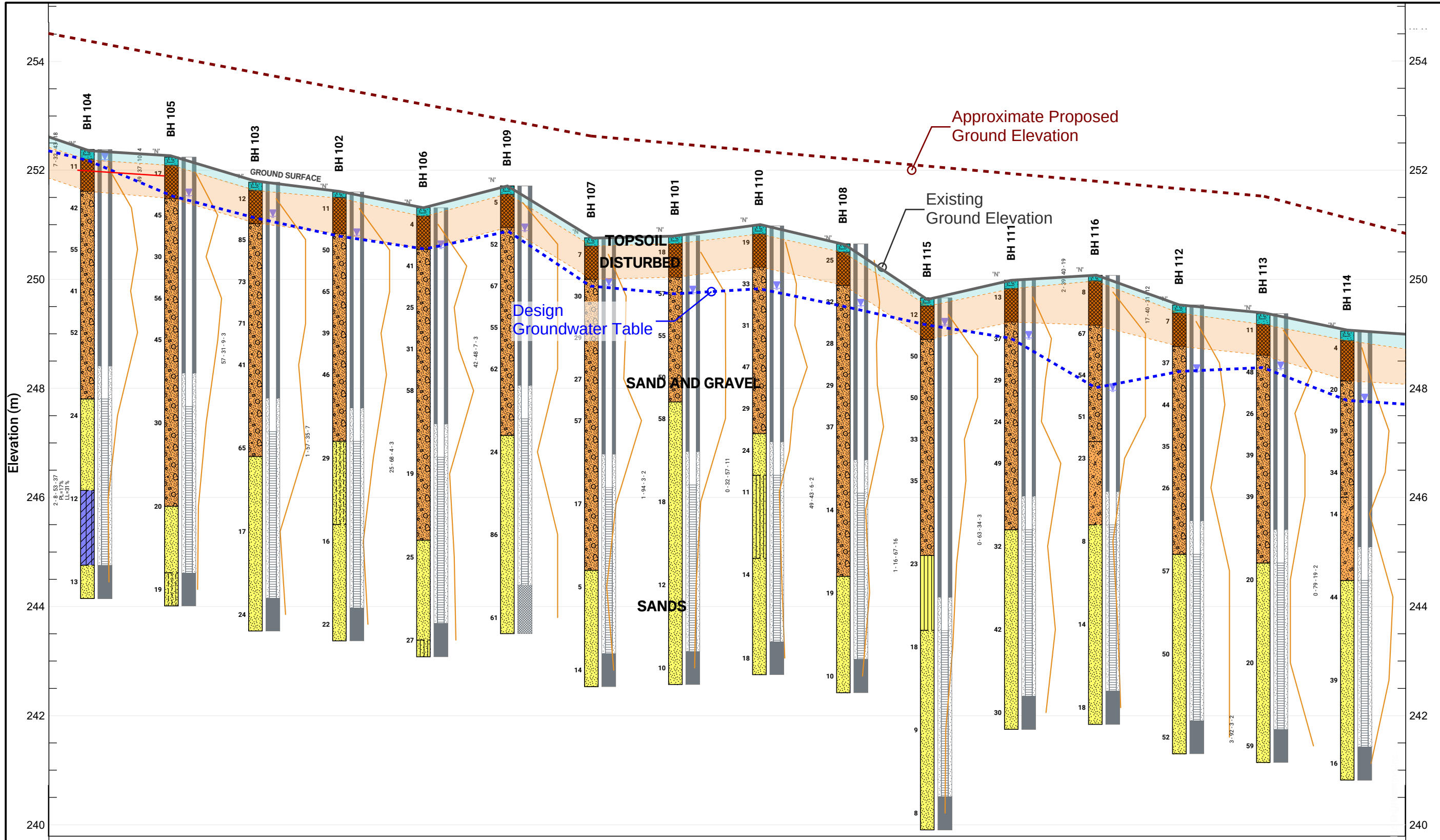
Figure Title
SUBSURFACE PROFILE A-A'

Date
JULY 2022

Scale
AS INDICATED

Job No
22-052

Figure No
FIGURE 4



BOREHOLE STRATIGRAPHY LEGEND

- Topsoil
- Fill
- Sand and Gravel
- Sand
- Silty Sand
- Silt and Clay
- Sandy Silt
- Gravelly Sand
- Silt

Boreholes Equally Spaced

APPENDIX A



SAMPLING/TESTING METHODS

SS: split spoon sample
 AS: auger sample
 GS: grab sample
 FV: shear vane
 DP: direct push
 PMT: pressuremeter test
 ST: shelly 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
 unstabalized 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
silty	20 - 35
sand and silt	>35

ASTM STANDARDS**ASTM D1586 Standard Penetration Test (SPT)**

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

ASTM D3441 Cone Penetration Test (CPT)

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

ASTM D2573 Field Vane Test (FVT)

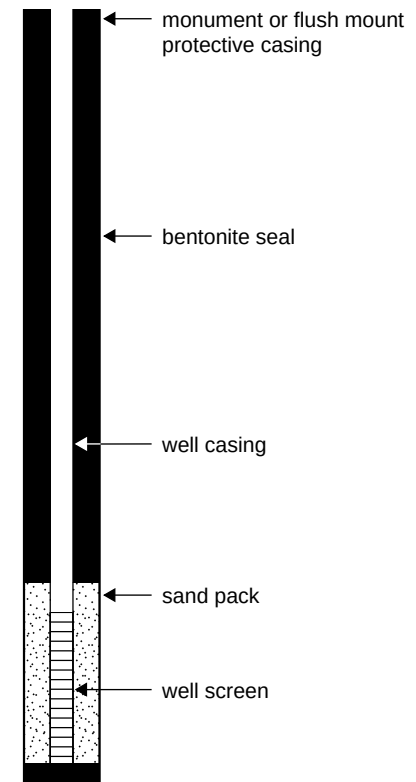
Pushing a four blade vane into soil and rotating it from the surface to determine the torque required to shear a cylindrical surface with the vane. The torque is converted to the shear strength of the soil using a limit equilibrium analysis.

ASTM D1587 Shelby Tubes (ST)

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

ASTM D4719 Pressuremeter Test (PMT)

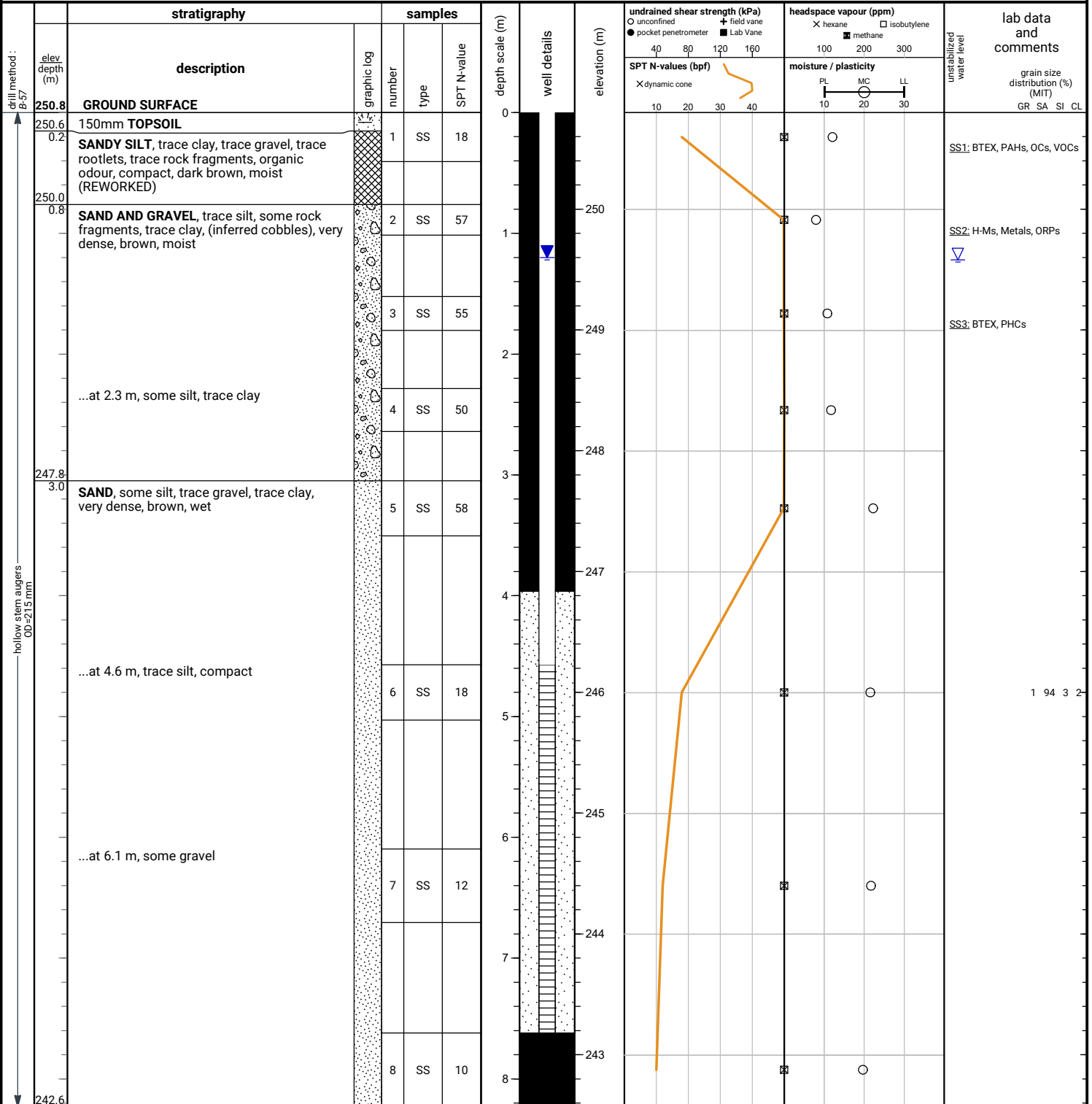
Place an inflatable cylindrical probe into a pre-drilled hole and expanding it while measuring the change in volume and pressure in the probe. It is inflated under either equal pressure increments or equal volume increments. This provides the stress-strain response of the soil.

WELL LEGEND

File No. : 22-052

Project : 163-164 Edward St, Creemore, ON

Client : Lamb Development Corp.



END OF BOREHOLE

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

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

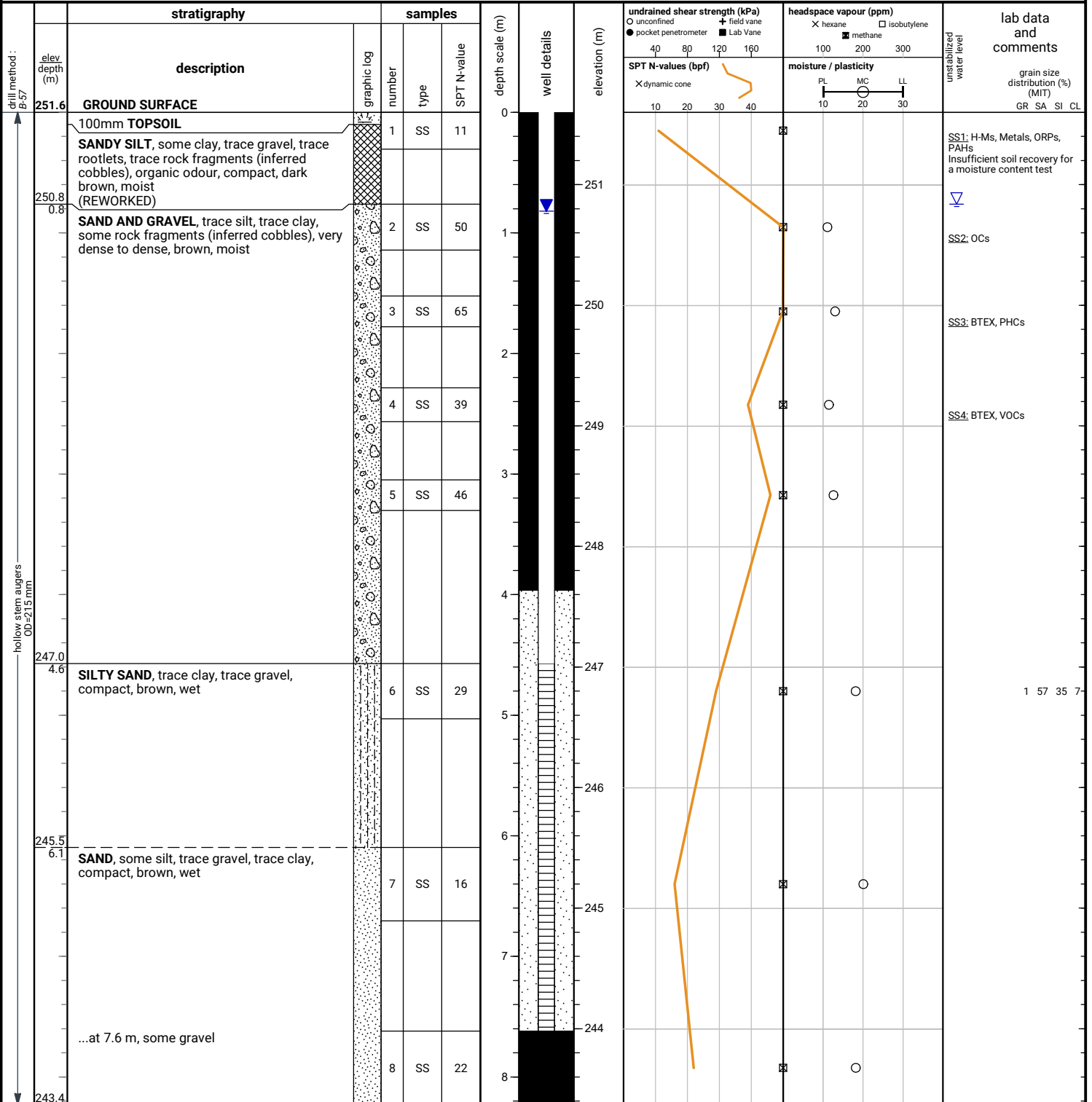
GROUNDWATER LEVELS

date	depth (m)	elevation (m)
Apr 29, 2022	1.1	249.7
May 5, 2022	1.1	249.7
Jun 15, 2022	1.2	249.6

File No. : 22-052

Project : 163-164 Edward St, Creemore, ON

Client : Lamb Development Corp.



END OF BOREHOLE

Unstabilized water level measured at 0.8 m below ground surface upon completion of drilling.

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

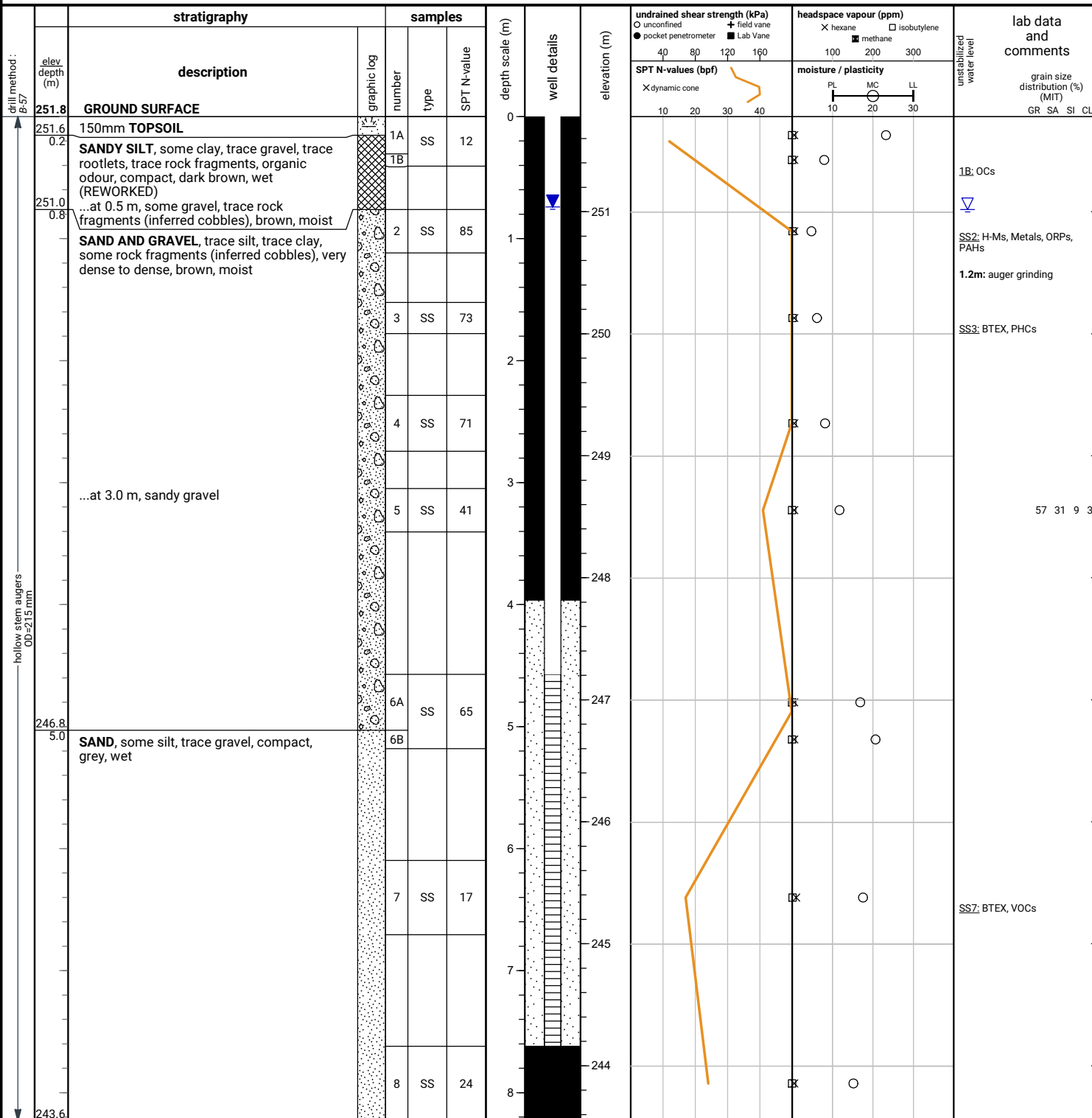
GROUNDWATER LEVELS

date	depth (m)	elevation (m)
Apr 29, 2022	0.9	250.7
Jun 15, 2022	0.8	250.8

File No. : 22-052

Project : 163-164 Edward St, Creemore, ON

Client : Lamb Development Corp.



END OF BOREHOLE

Unstabilized water level measured at 0.8 m below ground surface upon completion of drilling.

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

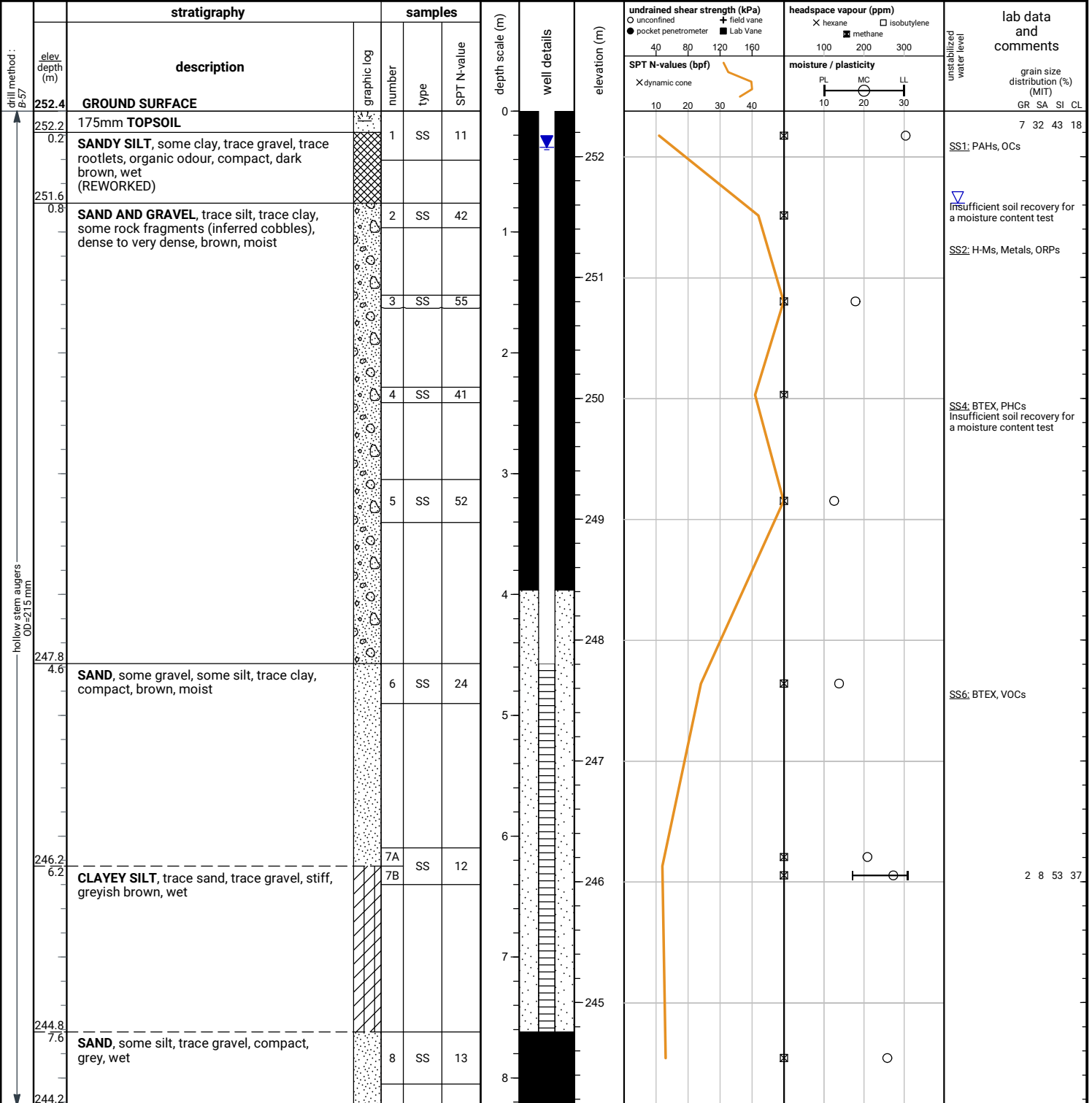
GROUNDWATER LEVELS

date	depth (m)	elevation (m)
Apr 29, 2022	0.8	251.0
May 5, 2022	0.7	251.1
Jun 15, 2022	0.7	251.1

File No. : 22-052

Project : 163-164 Edward St, Creemore, ON

Client : Lamb Development Corp.



END OF BOREHOLE

Unstabilized water level measured at 0.8 m below ground surface upon completion of drilling.

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

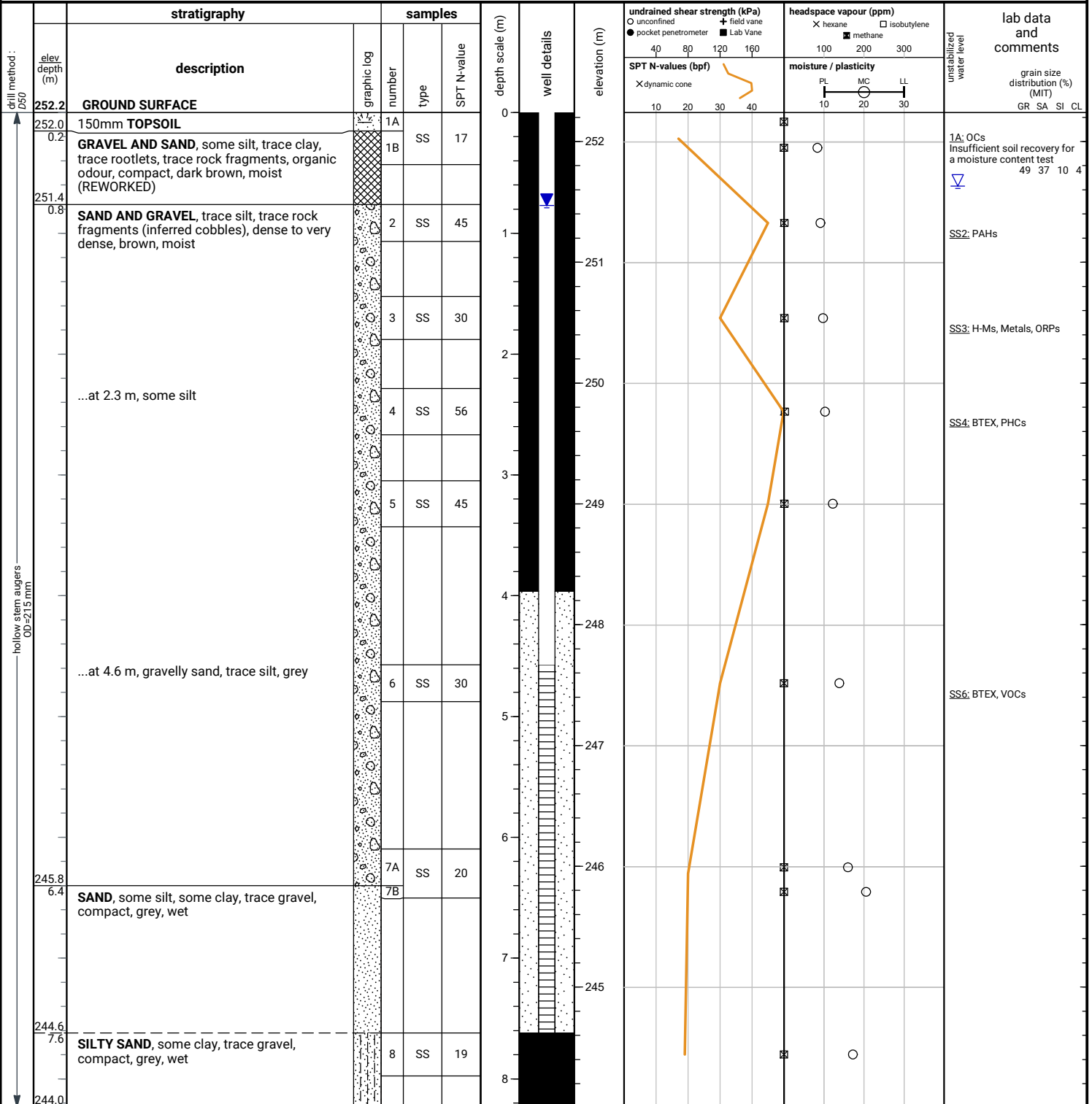
GROUNDWATER LEVELS

date	depth (m)	elevation (m)
Apr 29, 2022	0.3	252.1
Jun 15, 2022	0.2	252.2
Jun 16, 2022	0.3	252.1

File No. : 22-052

Project : 163-164 Edward St, Creemore, ON

Client : Lamb Development Corp.



END OF BOREHOLE

Unstabilized water level measured at 0.6 m below ground surface upon completion of drilling.

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

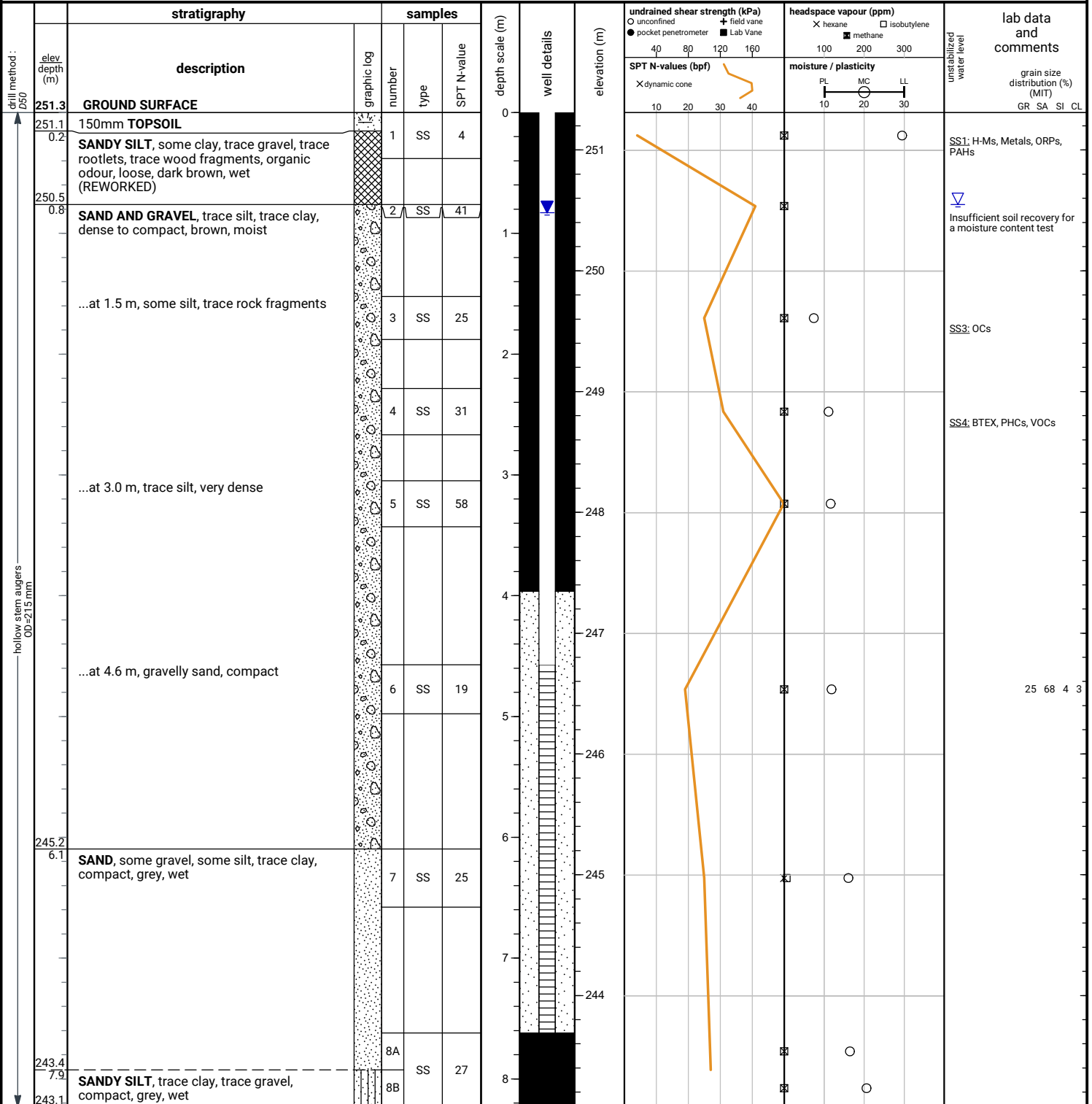
GROUNDWATER LEVELS

date	depth (m)	elevation (m)
Apr 29, 2022	0.8	251.4
May 5, 2022	0.7	251.5
Jun 15, 2022	0.9	251.3
Jun 16, 2022	0.8	251.4

File No. : 22-052

Project : 163-164 Edward St, Creemore, ON

Client : Lamb Development Corp.



END OF BOREHOLE

Unstabilized water level measured at 0.8 m below ground surface upon completion of drilling.

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

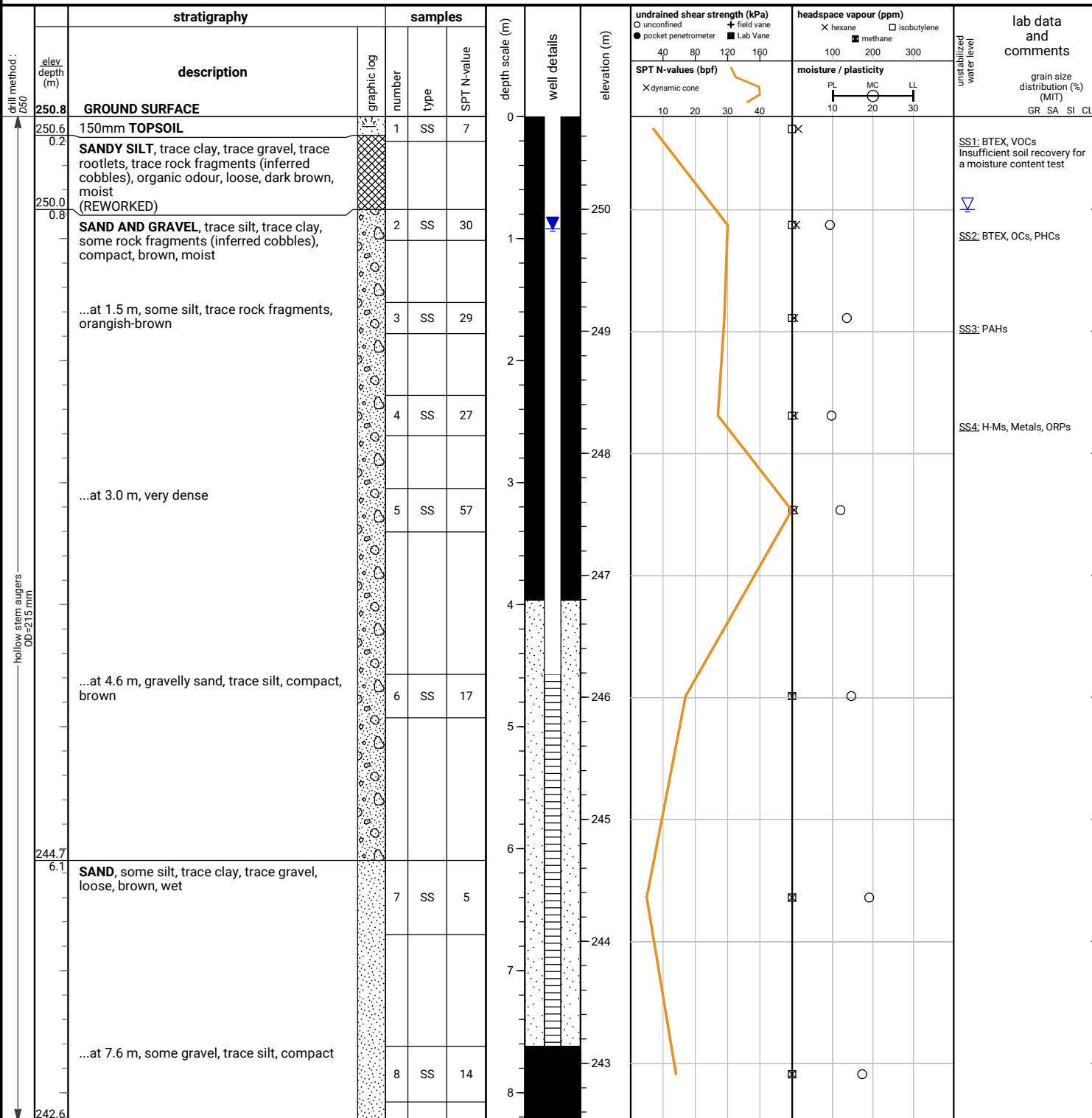
GROUNDWATER LEVELS

date	depth (m)	elevation (m)
Apr 29, 2022	0.8	250.5
Jun 15, 2022	0.8	250.5
Jun 16, 2022	0.8	250.5

File No. : 22-052

Project : 163-164 Edward St, Creemore, ON

Client : Lamb Development Corp.



END OF BOREHOLE

Unstabilized water level measured at 0.8 m below ground surface upon completion of drilling.

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

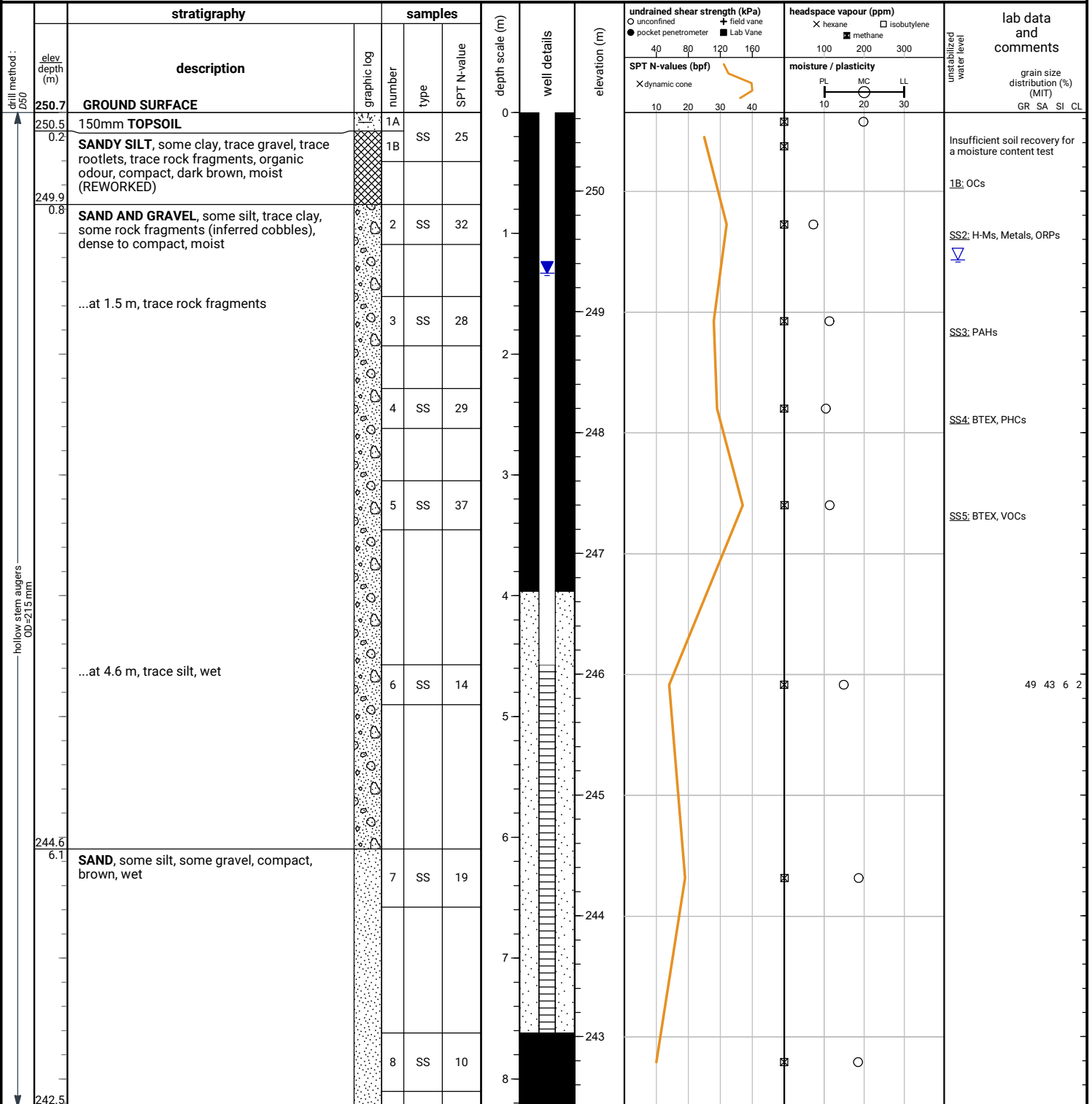
GROUNDWATER LEVELS

date	depth (m)	elevation (m)
Apr 29, 2022	0.9	249.9
May 5, 2022	0.9	249.9
Jun 15, 2022	0.9	249.9
Jun 16, 2022	0.9	249.9

File No. : 22-052

Project : 163-164 Edward St, Creemore, ON

Client : Lamb Development Corp.



END OF BOREHOLE

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

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

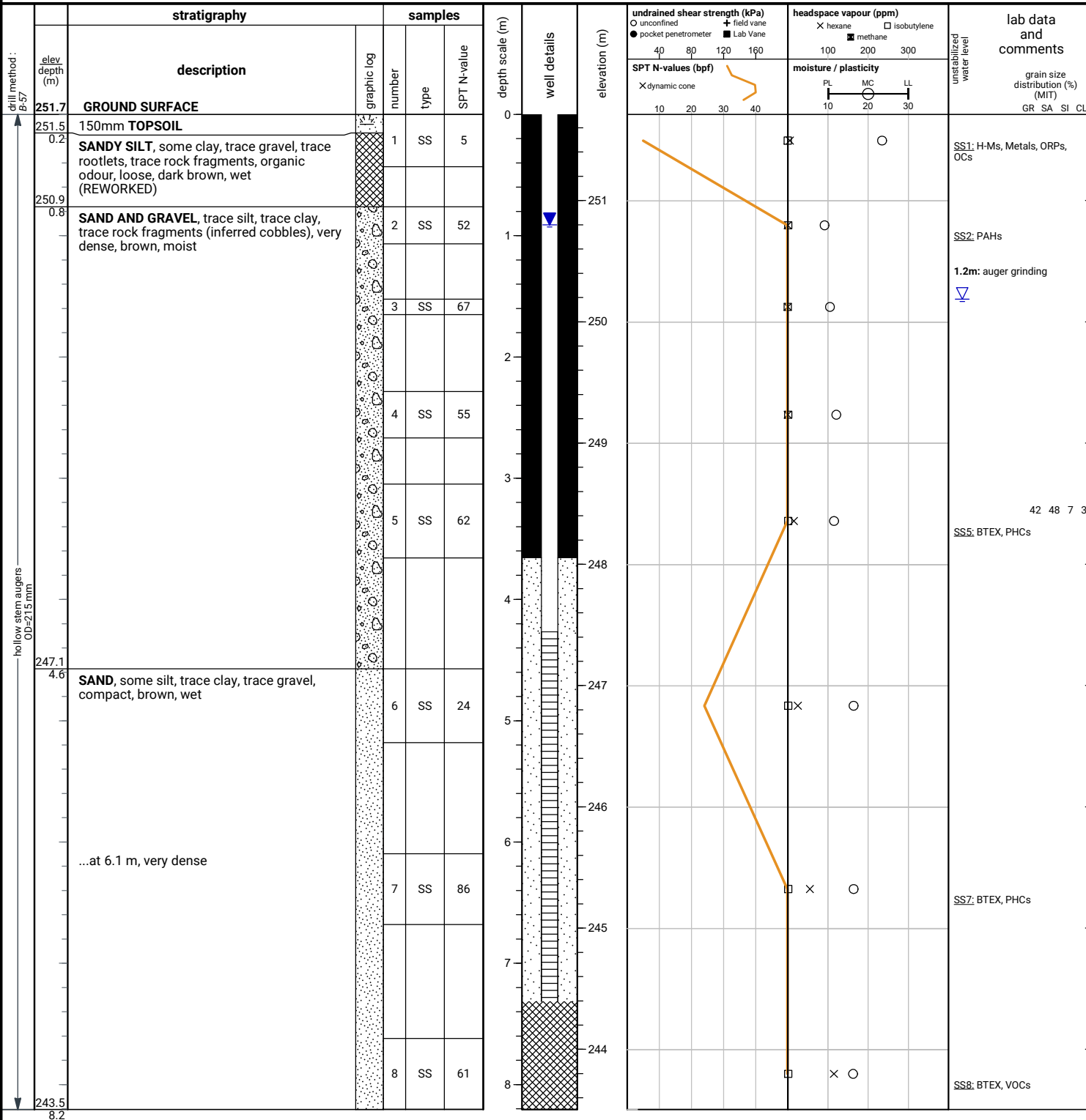
GROUNDWATER LEVELS

date	depth (m)	elevation (m)
Apr 29, 2022	1.2	249.5
Jun 15, 2022	1.3	249.4

File No. : 22-052

Project : 163-164 Edward St, Creemore, ON

Client : Lamb Development Corp.



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

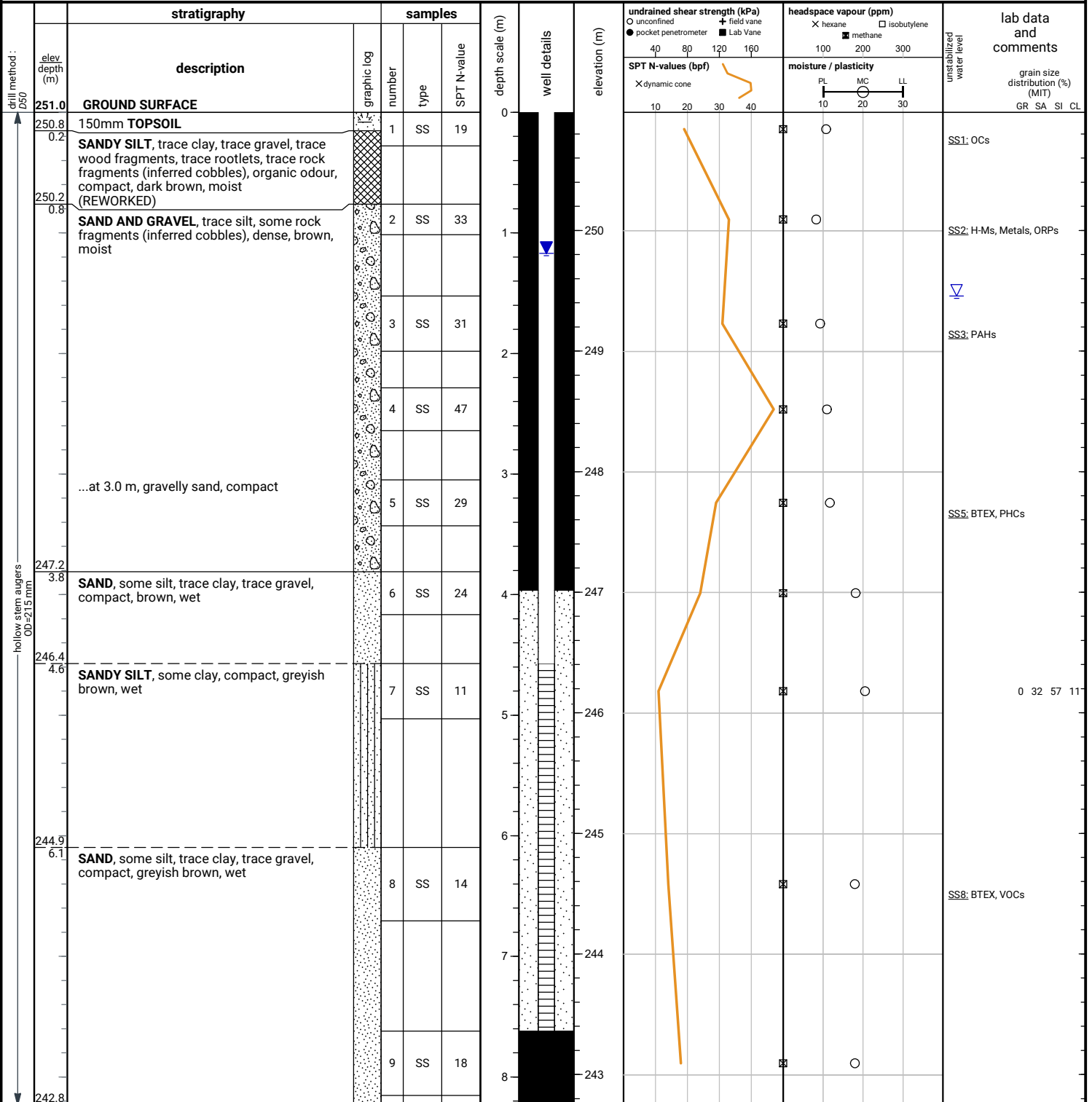
GROUNDWATER LEVELS

date	depth (m)	elevation (m)
Apr 29, 2022	1.0	250.7
May 5, 2022	0.8	250.9
Jun 15, 2022	1.0	250.7
Jun 16, 2022	0.9	250.8

File No. : 22-052

Project : 163-164 Edward St, Creemore, ON

Client : Lamb Development Corp.



END OF BOREHOLE

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

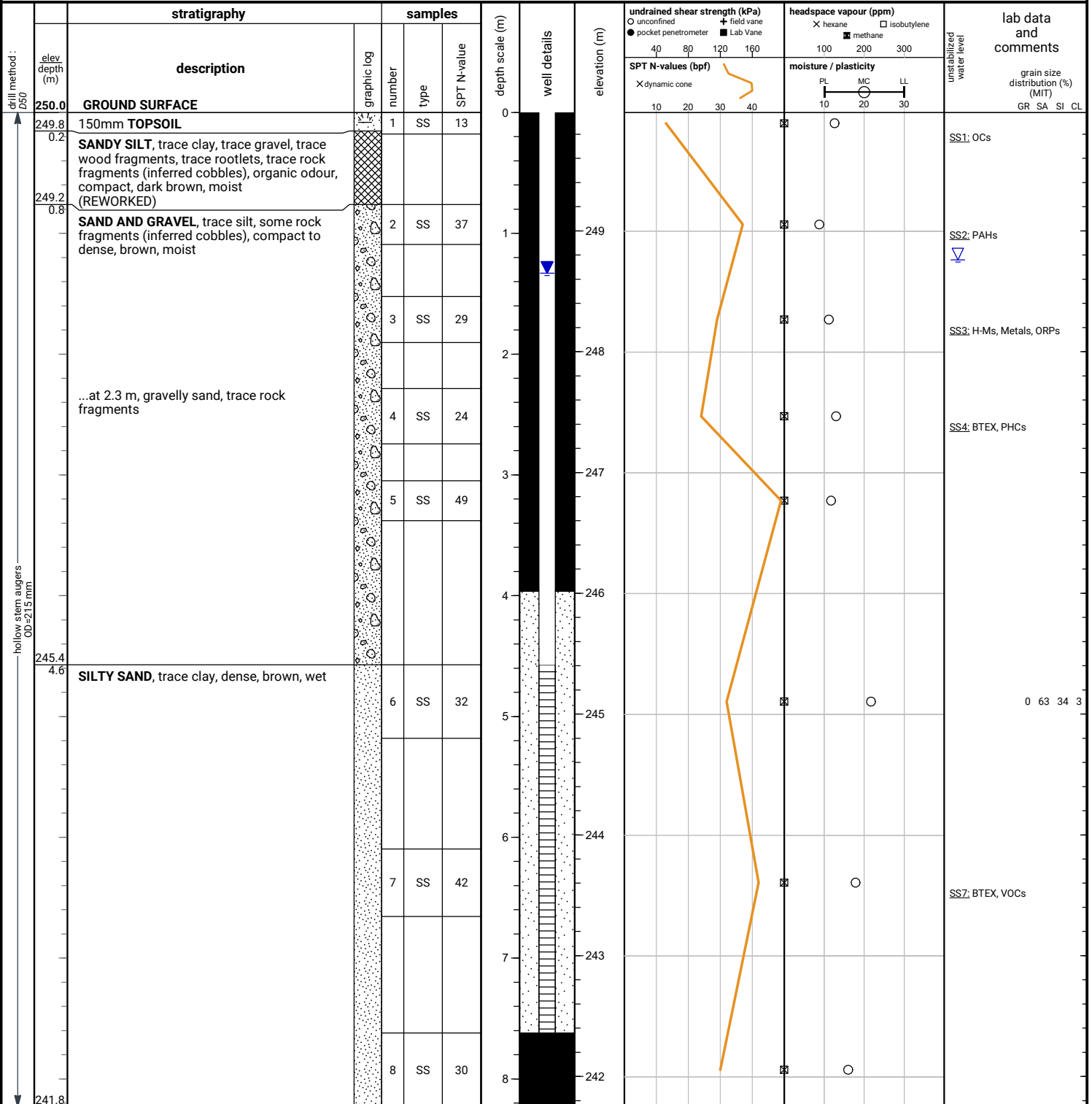
50 mm dia. monitoring well installed.
No. 10 screen

GROUNDWATER LEVELS
date depth (m) elevation (m)
Jun 15, 2022 1.2 249.8

File No. : 22-052

Project : 163-164 Edward St, Creemore, ON

Client : Lamb Development Corp.



END OF BOREHOLE

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

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

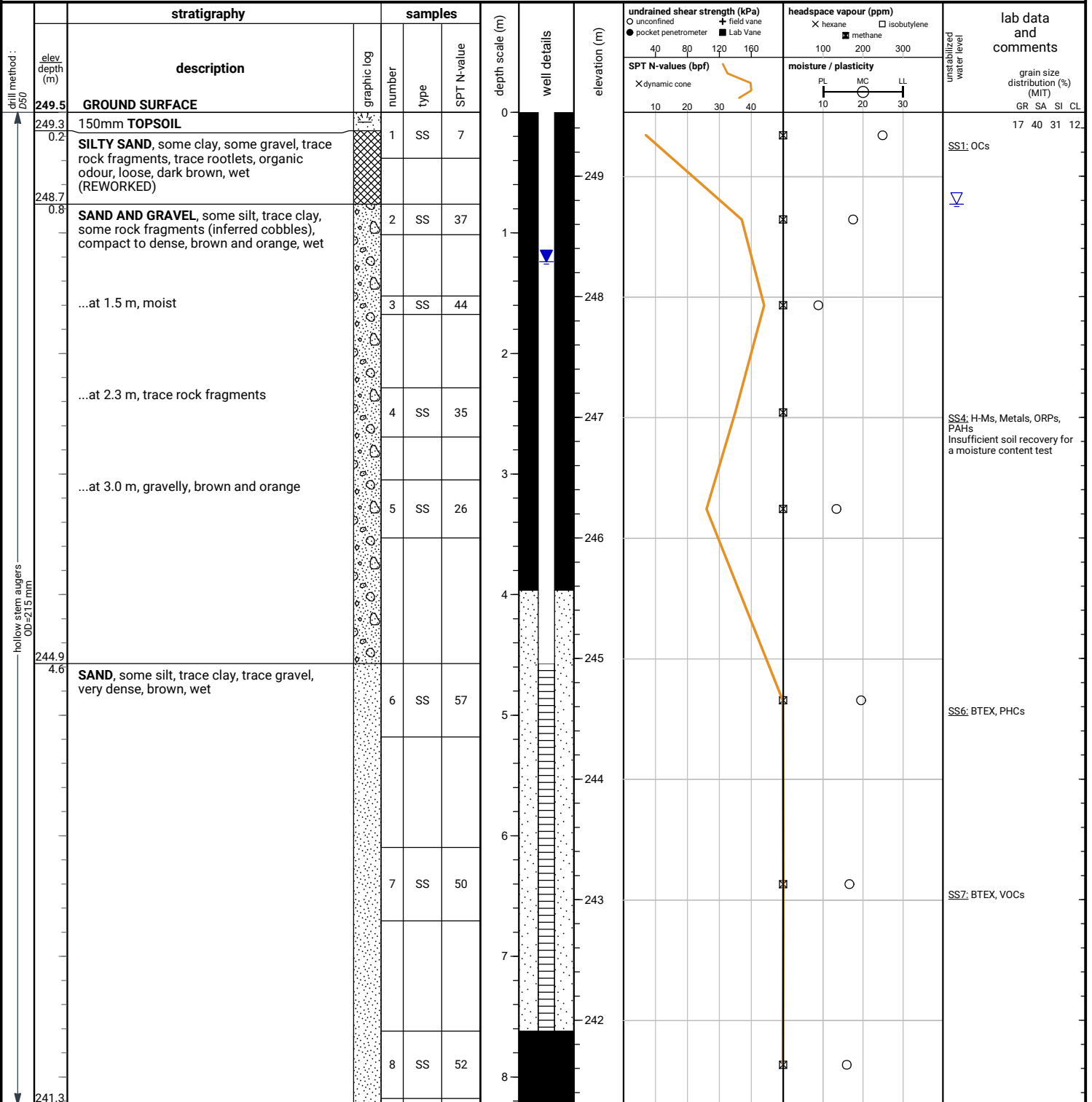
GROUNDWATER LEVELS

date	depth (m)	elevation (m)
Apr 29, 2022	1.1	248.9
May 5, 2022	1.1	248.9
Jun 15, 2022	1.3	248.7

File No. : 22-052

Project : 163-164 Edward St, Creemore, ON

Client : Lamb Development Corp.



END OF BOREHOLE

Unstabilized water level measured at 0.8 m below ground surface upon completion of drilling.

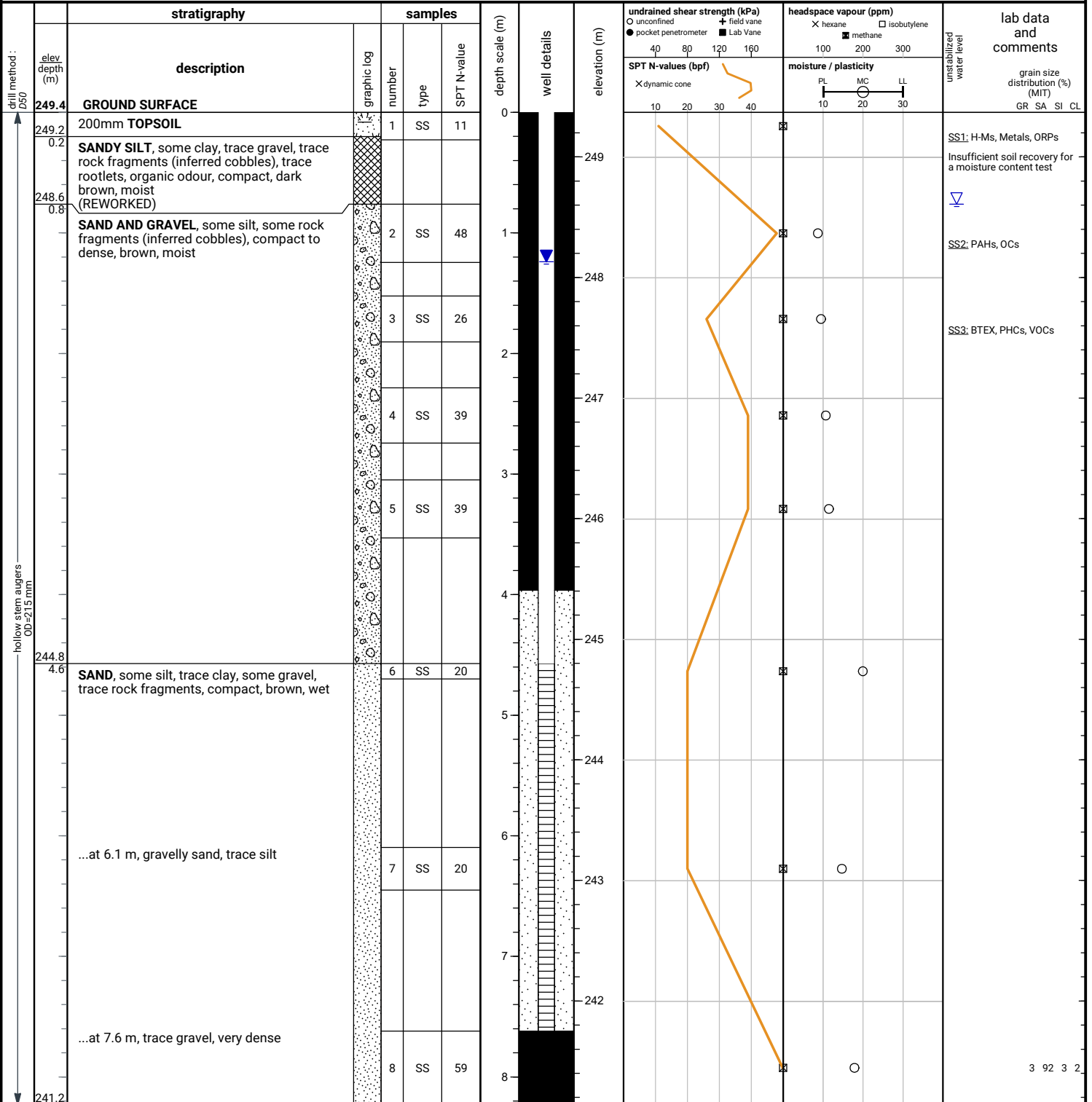
50 mm dia. monitoring well installed.
No. 10 screen

GROUNDWATER LEVELS
date depth (m) elevation (m)
Jun 15, 2022 1.2 248.3

File No. : 22-052

Project : 163-164 Edward St, Creemore, ON

Client : Lamb Development Corp.



END OF BOREHOLE

Unstabilized water level measured at 0.8 m below ground surface upon completion of drilling.

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

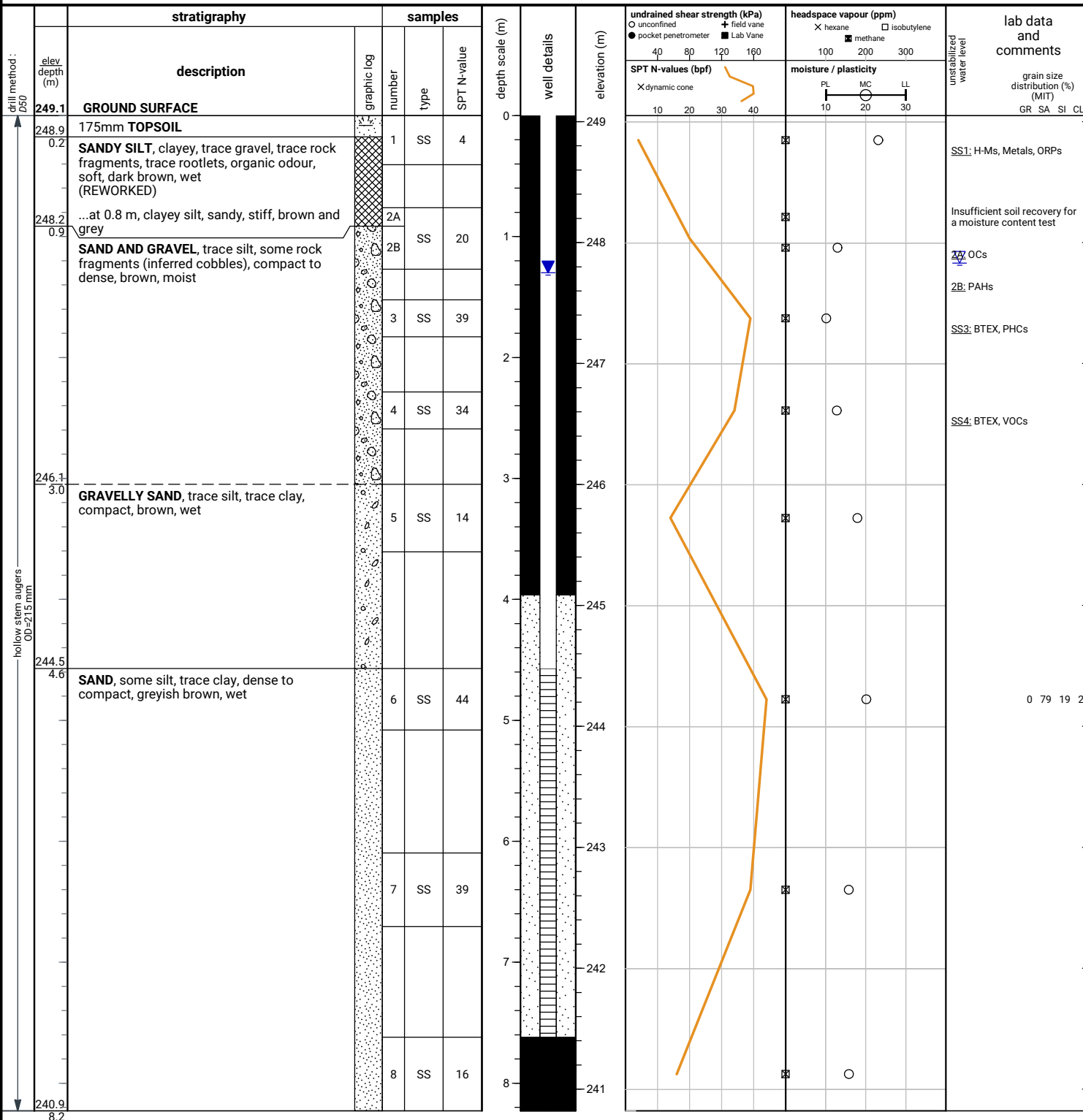
GROUNDWATER LEVELS

date	depth (m)	elevation (m)
May 5, 2022	1.0	248.4
Jun 15, 2022	1.3	248.1
Jun 16, 2022	1.2	248.2

File No. : 22-052

Project : 163-164 Edward St, Creemore, ON

Client : Lamb Development Corp.



END OF BOREHOLE

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

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

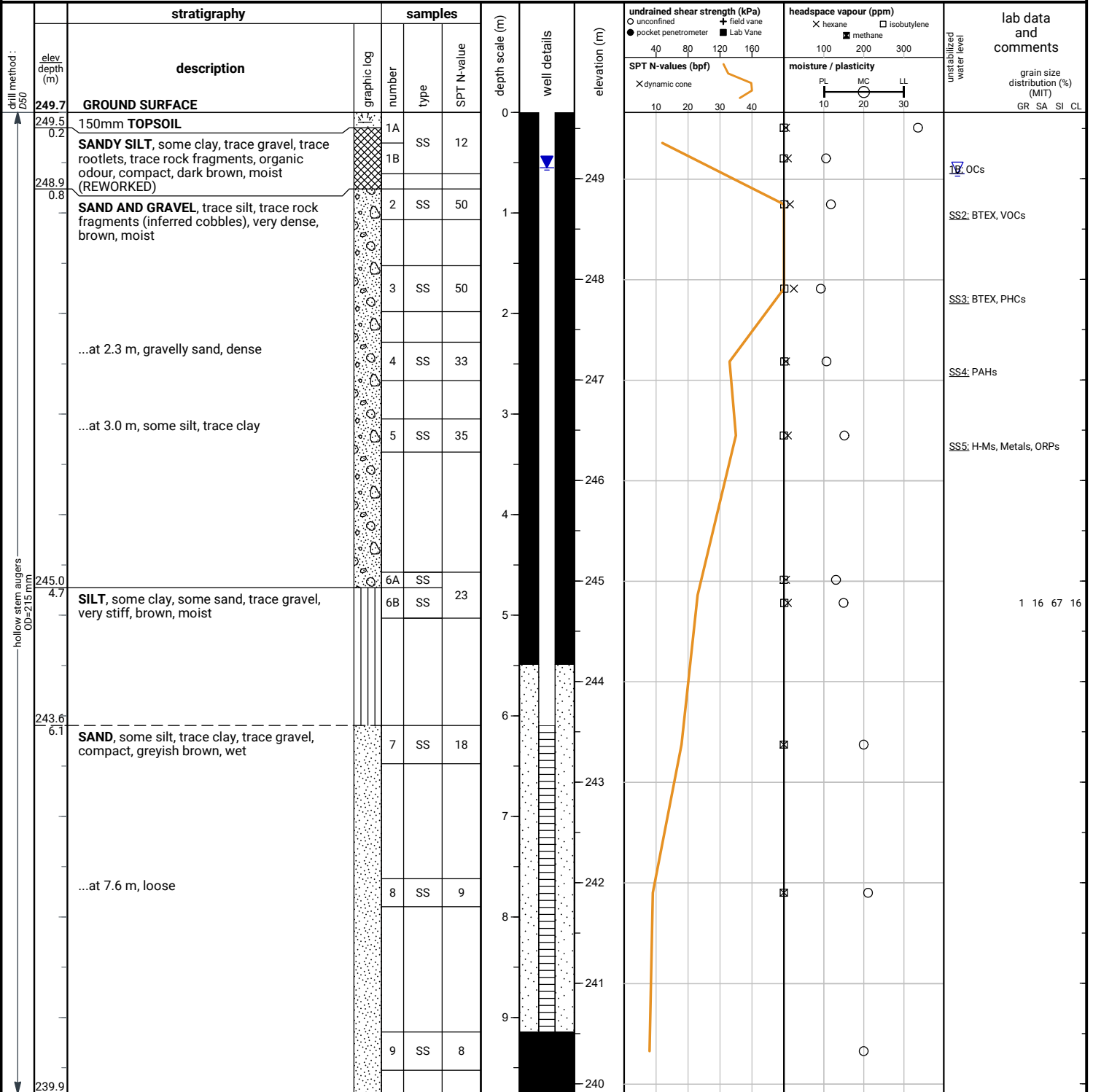
GROUNDWATER LEVELS

<u>date</u>	<u>depth (m)</u>	<u>elevation (m)</u>
Jun 15, 2022	1.3	247.8

File No. : 22-052

Project : 163-164 Edward St, Creemore, ON

Client : Lamb Development Corp.



END OF BOREHOLE

Unstabilized water level measured at 0.6 m below ground surface upon completion of drilling.

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

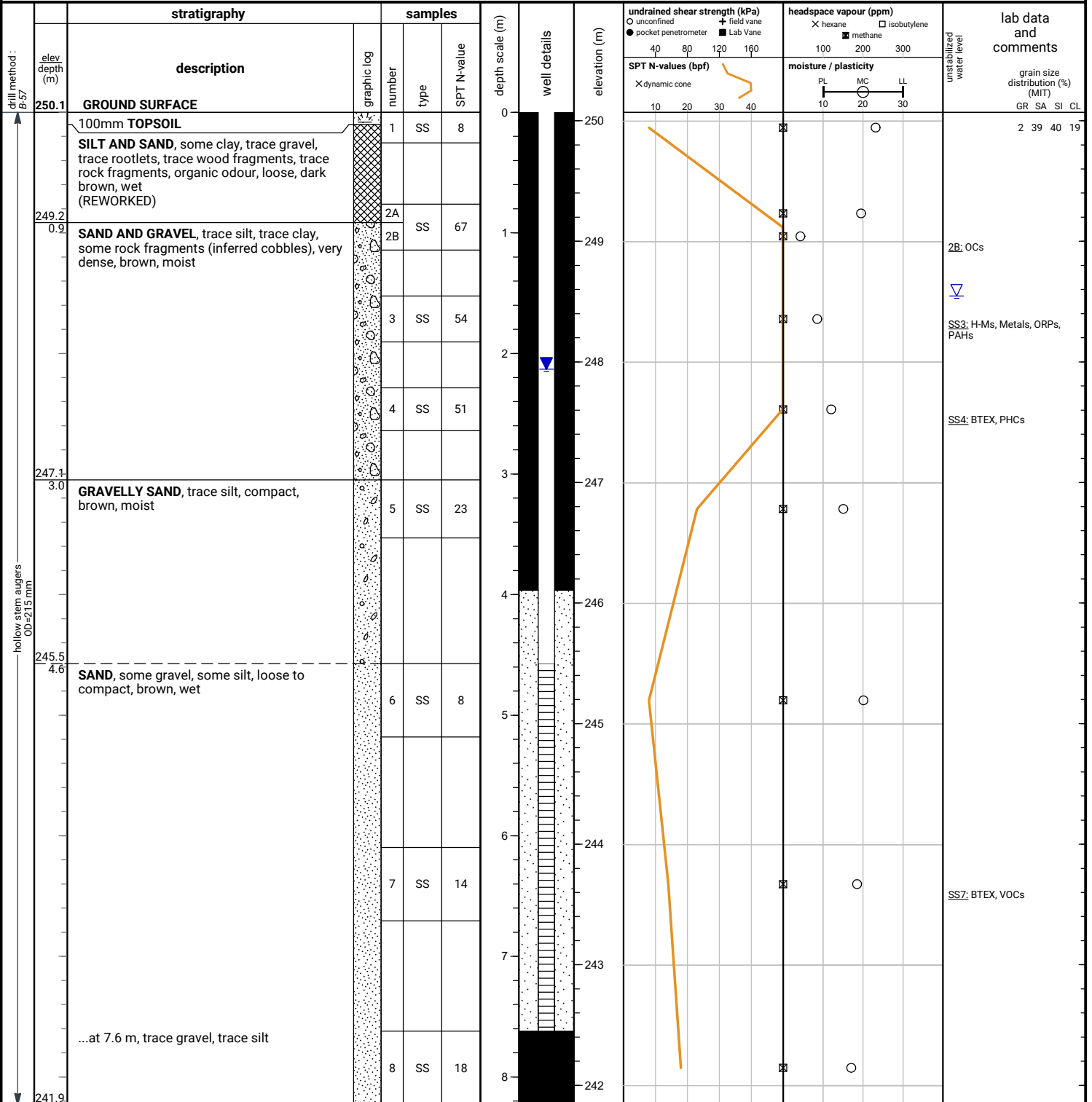
GROUNDWATER LEVELS

date	depth (m)	elevation (m)
May 5, 2022	0.5	249.2
Jun 15, 2022	0.8	248.9
Jun 16, 2022	0.6	249.1

File No. : 22-052

Project : 163-164 Edward St, Creemore, ON

Client : Lamb Development Corp.



END OF BOREHOLE

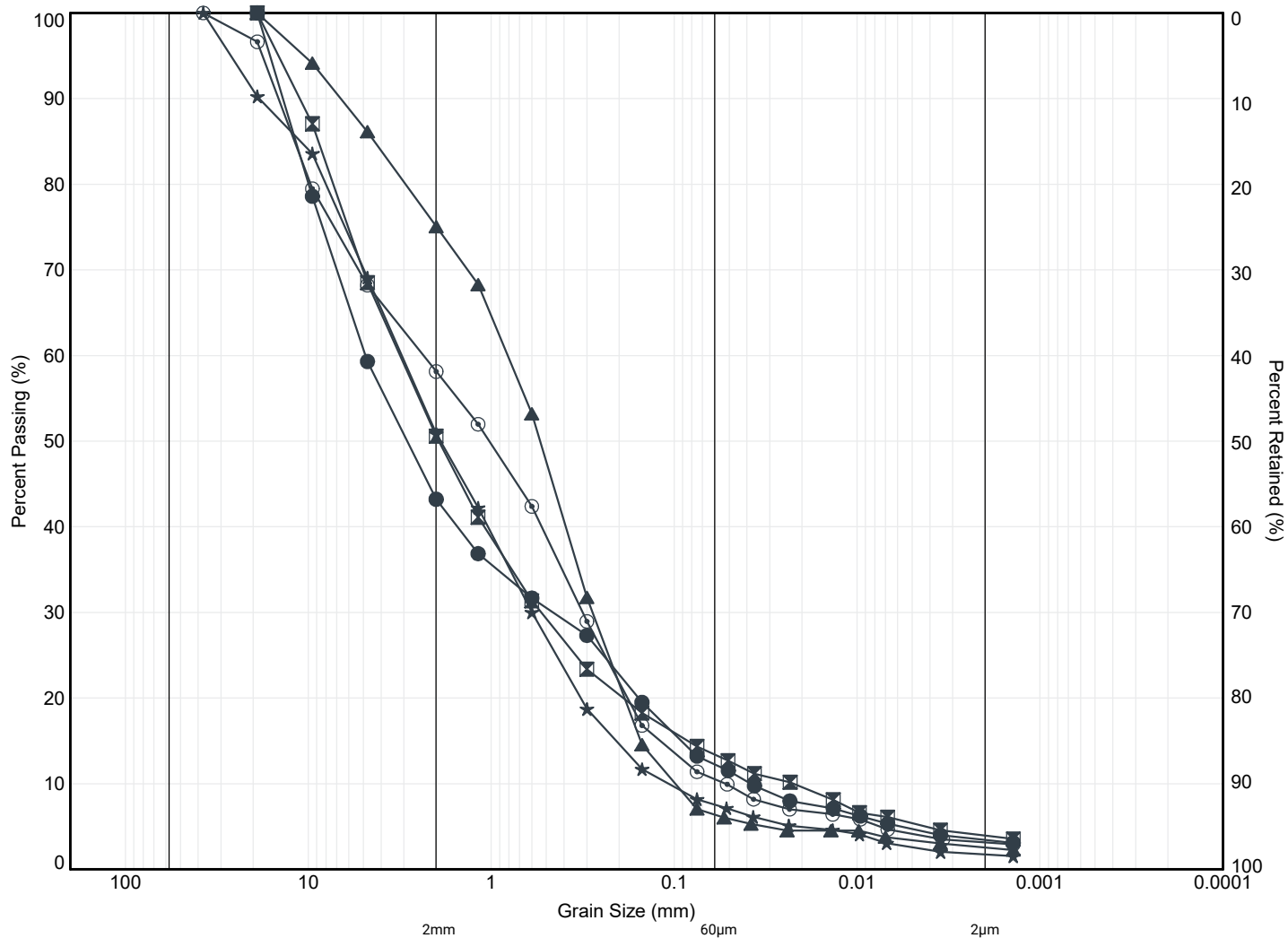
Unstabilized water level measured at 1.5 m below ground surface upon completion of drilling.

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

GROUNDWATER LEVELS
date: Jun 15, 2022
depth (m): 2.1
elevation (m): 248.0

APPENDIX B





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

MIT SYSTEM

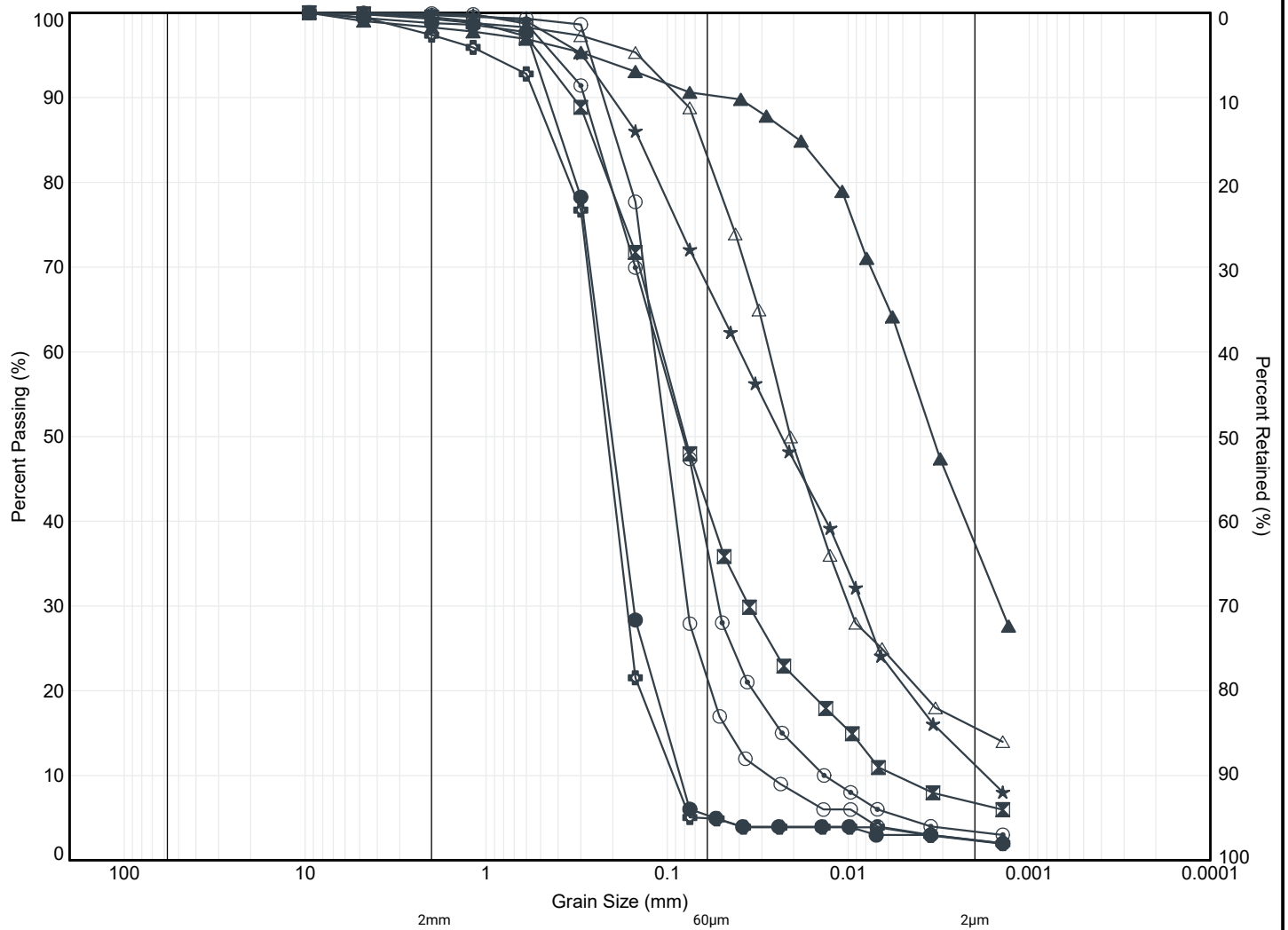
Borehole	Sample	Depth (m)	Elev. (m)	Gravel (%)	Sand (%)	Silt (%)	Clay (%)
● 103	SS5	3.4		57	31	9	3
⊠ 105	SS1B	0.4		49	37	10	4
▲ 106	SS6	4.9		25	68	4	3
★ 108	SS6	4.9		49	43	6	2
⊙ 109	SS5	3.4		42	48	7	3

Title:

**GRAIN SIZE DISTRIBUTION
GRAVELS AND SANDS**

File No.:

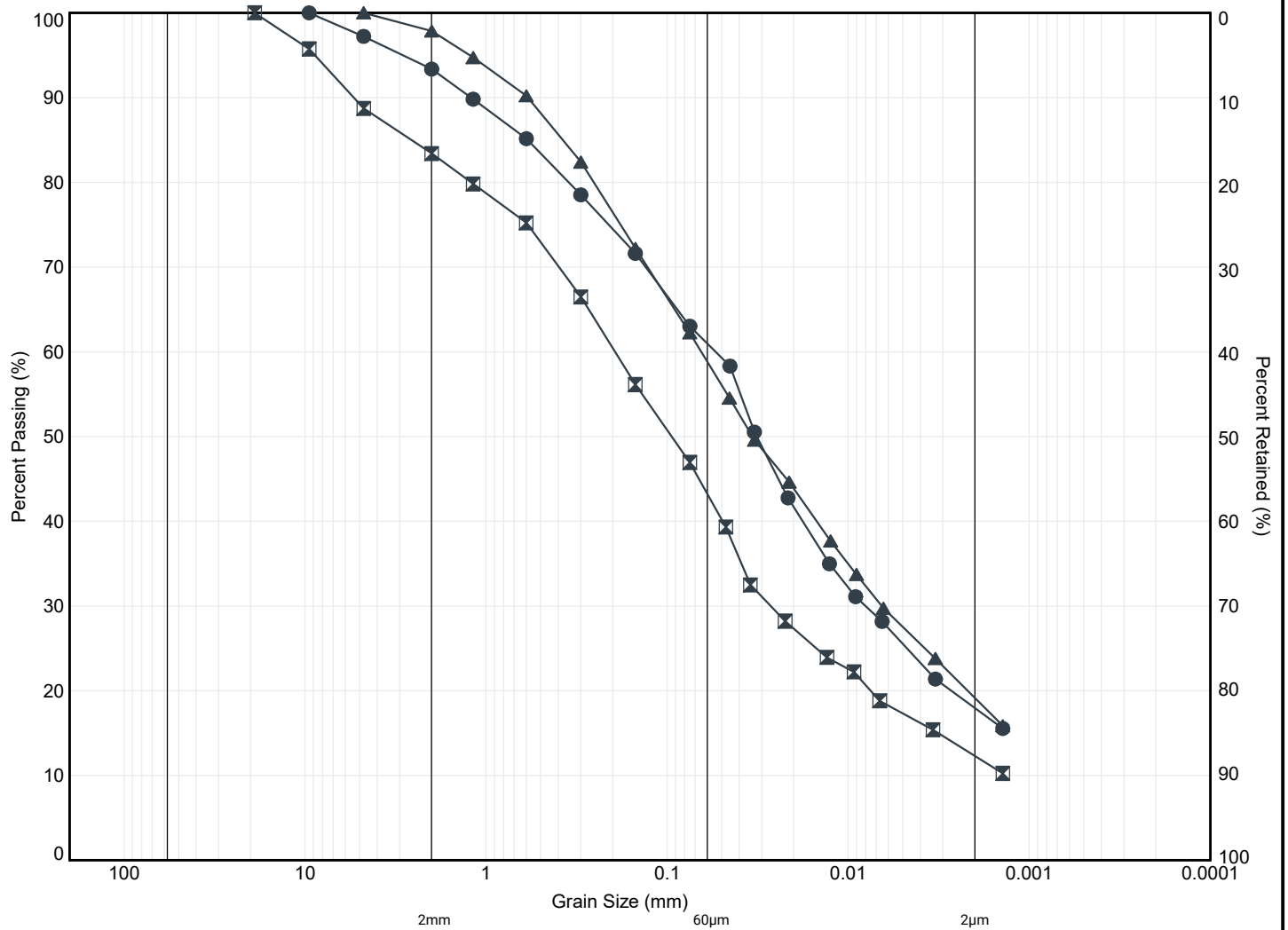
22-052



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

MIT SYSTEM

Borehole	Sample	Depth (m)	Elev. (m)	Gravel (%)	Sand (%)	Silt (%)	Clay (%)
● 101	SS6	4.9		1	94	3	2
⊠ 102	SS6	4.9		1	57	35	7
▲ 104	SS7B	6.5		2	8	53	37
★ 110	SS7	4.9		0	32	57	11
⊙ 111	SS6	4.9		0	63	34	3
⊕ 113	SS8	7.9		3	92	3	2
○ 114	SS6	4.9		0	79	19	2
△ 115	SS6B	5.0		1	16	67	16



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

MIT SYSTEM

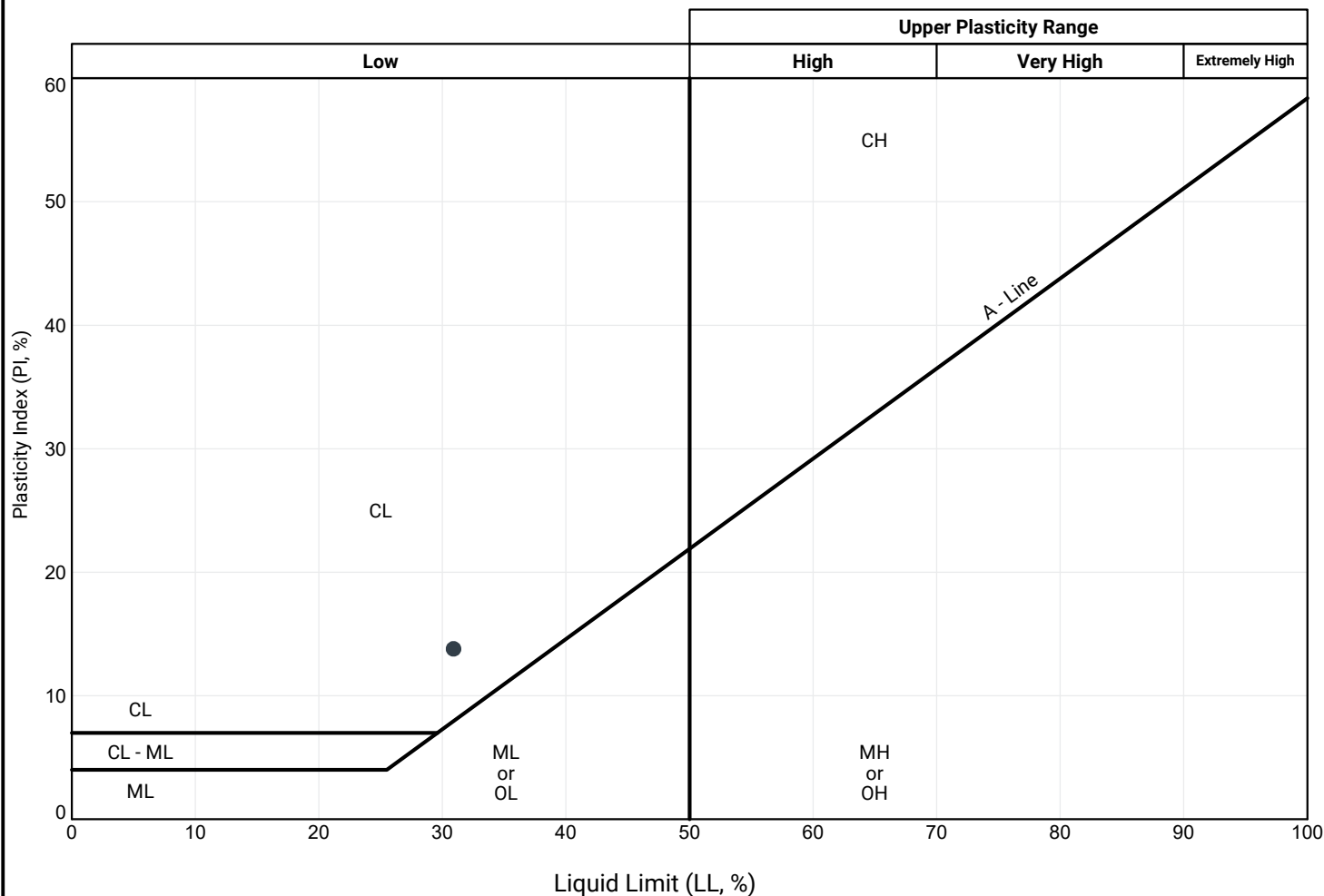
Borehole	Sample	Depth (m)	Elev. (m)	Gravel (%)	Sand (%)	Silt (%)	Clay (%)
● 104	SS1	0.3		7	32	43	18
☒ 112	SS1	0.3		17	40	31	12
▲ 116	SS1	0.3		2	39	40	19

Title:

**GRAIN SIZE DISTRIBUTION
FILL**

File No.:

22-052



Borehole	Sample	Depth (m)	LL (%)	PL (%)	PI (%)
● 104	SS7B	6.5	31	17	14

APPENDIX C



CORROSIVITY (ALS)



Results Summary L2703301 & L2705696

Job Reference	22-052
Report To	Kim Falkenstein, Grounded Engineering Inc
Date Received	4-May-2022 10:45
Report Date	17-May-2022 13:08
Report Version	1

Client Sample ID			BH103 SS1	BH107 SS6	BH114 SS4	BH113 SS3
Date Sampled			3-May-2022	3-May-2022	3-May-2022	10-May-2022
Time Sampled			13:00	13:00	13:00	12:30
ALS Sample ID			L2703301-1	L2703301-2	L2703301-3	L2705696-1
Parameter	Lowest Detection Limit	Units	Soil	Soil	Soil	Soil

Physical Tests (Soil)

Conductivity	0.0040	mS/cm	0.173	0.113	0.212	0.111
% Moisture	0.25	%	18.5	13.0	11.5	9.12
pH	0.10	pH units	7.61	7.74	7.79	8.03
Redox Potential	-1000	mV	376	312	255	422
Resistivity	1.0	ohm*cm	5800	8880	4720	8980

Leachable Anions & Nutrients (Soil)

Chloride	5.0	ug/g	<5.0	9.9	15.1	21.3
----------	-----	------	------	-----	------	------

Anions and Nutrients (Soil)

Sulphate	20	ug/g	20	20	20	20
----------	----	------	----	----	----	----

Inorganic Parameters (Soil)

Acid Volatile Sulphides	0.20	mg/kg	61.2	<0.20	-	<0.20
-------------------------	------	-------	------	-------	---	-------

INTERPRETATION

AWWA C-105 Standard

	Points	Points	Points	Points
% Moisture	2	2	2	1
pH	0	0	0	0
Redox Potential	0	0	0	0
Resistivity	0	0	0	0
Acid Volatile Sulphides	3.5	2	0	2

TOTAL SCORE (AWWA C-105)

	5.5	4	2	3
Sample	BH103 SS1	BH107 SS6	BH114 SS4	BH113 SS3
Corrosion Protection Recommended?	No	No	No	No
Resistivity less than 2000 ohm.cm?	No	No	No	No

Anions and Nutrients (Soil)

Sulphate	%	0.002	0.002	0.002	0.002
CLASS OF EXPOSURE		Negligible	Negligible	Negligible	Negligible



Grounded Engineering Inc
ATTN: Kim Falkenstein
1 Banigan Drive
TORONTO ON M4H 1G3

Date Received: 04-MAY-22
Report Date: 17-MAY-22 13:08 (MT)
Version: FINAL

Client Phone: 647-264-7943

Certificate of Analysis

Lab Work Order #: L2703301
Project P.O. #: NOT SUBMITTED
Job Reference: 22-052
C of C Numbers:
Legal Site Desc:

Amanda Overholster
Account Manager

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ADDRESS: 5730 Coopers Avenue, Unit #26, Mississauga, ON L4Z 2E9 Canada | Phone: +1 905 507 6910 | Fax: +1 905 507 6927
ALS CANADA LTD Part of the ALS Group An ALS Limited Company

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters		Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L2703301-1 BH103 SS1 Sampled By: CLIENT on 03-MAY-22 @ 13:00 Matrix: SOIL								
Physical Tests								
Conductivity		0.173		0.0040	mS/cm		09-MAY-22	R5774642
% Moisture		18.5		0.25	%	05-MAY-22	06-MAY-22	R5771982
pH		7.61		0.10	pH units		06-MAY-22	R5772876
Redox Potential		376		-1000	mV		05-MAY-22	R5772485
Resistivity		5800		1.0	ohm*cm		09-MAY-22	
Leachable Anions & Nutrients								
Chloride		<5.0		5.0	ug/g	06-MAY-22	09-MAY-22	R5774921
Anions and Nutrients								
Sulphate		<20		20	ug/g	06-MAY-22	09-MAY-22	R5774921
Inorganic Parameters								
Acid Volatile Sulphides		61.2		0.20	mg/kg	05-MAY-22	05-MAY-22	R5772491
L2703301-2 BH107 SS6 Sampled By: CLIENT on 03-MAY-22 @ 13:00 Matrix: SOIL								
Physical Tests								
Conductivity		0.113		0.0040	mS/cm		11-MAY-22	R5777496
% Moisture		13.0		0.25	%	05-MAY-22	06-MAY-22	R5771982
pH		7.74		0.10	pH units		06-MAY-22	R5772876
Redox Potential		312		-1000	mV		05-MAY-22	R5772485
Resistivity		8880		1.0	ohm*cm		11-MAY-22	
Leachable Anions & Nutrients								
Chloride		9.9		5.0	ug/g	06-MAY-22	09-MAY-22	R5774921
Anions and Nutrients								
Sulphate		<20		20	ug/g	06-MAY-22	09-MAY-22	R5774921
Inorganic Parameters								
Acid Volatile Sulphides		<0.20		0.20	mg/kg	05-MAY-22	05-MAY-22	R5772491
L2703301-3 BH114 SS4 Sampled By: CLIENT on 03-MAY-22 @ 13:00 Matrix: SOIL								
Physical Tests								
Conductivity		0.212		0.0040	mS/cm		11-MAY-22	R5777496
% Moisture		11.5		0.25	%	05-MAY-22	06-MAY-22	R5771982
pH		7.79		0.10	pH units		06-MAY-22	R5772876
Redox Potential		255		-1000	mV		05-MAY-22	R5772485
Resistivity		4720		1.0	ohm*cm		11-MAY-22	
Leachable Anions & Nutrients								
Chloride		15.1		5.0	ug/g	06-MAY-22	09-MAY-22	R5774921
Anions and Nutrients								
Sulphate		<20		20	ug/g	06-MAY-22	09-MAY-22	R5774921

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
CL-R511-WT	Soil	Chloride-O.Reg 153/04 (July 2011)	EPA 300.0
5 grams of dried soil is mixed with 10 grams of distilled water for a minimum of 30 minutes. The extract is filtered and analyzed by ion chromatography.			
Analysis conducted in accordance with the Protocol for Analytical Methods Used in the Assessment of Properties under Part XV.1 of the Environmental Protection Act (July 1, 2011 and as of November 30, 2020), unless a subset of the Analytical Test Group (ATG) has been requested (the Protocol states that all analytes in an ATG must be reported).			
EC-WT	Soil	Conductivity (EC)	MOEE E3138
A representative subsample is tumbled with de-ionized (DI) water. The ratio of water to soil is 2:1 v/w. After tumbling the sample is then analyzed by a conductivity meter.			
Analysis conducted in accordance with the Protocol for Analytical Methods Used in the Assessment of Properties under Part XV.1 of the Environmental Protection Act (July 1, 2011).			
MOISTURE-WT	Soil	% Moisture	CCME PHC in Soil - Tier 1 (mod)
PH-WT	Soil	pH	MOEE E3137A
A minimum 10g portion of the sample 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 and then analyzed using a pH meter and electrode.			
Analysis conducted in accordance with the Protocol for Analytical Methods Used in the Assessment of Properties under Part XV.1 of the Environmental Protection Act (July 1, 2011).			
REDOX-POTENTIAL-WT	Soil	Redox Potential	APHA 2580
This analysis is carried out in accordance with the procedure described in the "APHA" method 2580 "Oxidation-Reduction Potential" 2012. Samples are extracted at a fixed ratio with DI water. Results are reported as observed oxidation-reduction potential of the platinum metal-reference electrode employed, in mV.			
RESISTIVITY-CALC-WT	Soil	Resistivity Calculation	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.			
SO4-WT	Soil	Sulphate	EPA 300.0
5 grams of soil is mixed with 50 mL of distilled water for a minimum of 30 minutes. The extract is filtered and analyzed by ion chromatography.			
SULPHIDE-WT	Soil	Sulphide, Acid Volatile	APHA 4500S2J
This analysis is carried out in accordance with the method described in APHA 4500 S2-J. Hydrochloric acid is added to sediment samples within a purge and trap system. The evolved hydrogen sulphide (H2S) is carried into a basic solution by inert gas. The acid volatile sulfide is then determined colourimetrically.			

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location
WT	ALS ENVIRONMENTAL - WATERLOO, ONTARIO, CANADA

Chain of Custody Numbers:

Reference Information

GLOSSARY OF REPORT TERMS

Surrogates are compounds that are similar in behaviour to target analyte(s), but that do not normally occur in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery. In reports that display the D.L. column, laboratory objectives for surrogates are listed there.

- mg/kg - milligrams per kilogram based on dry weight of sample*
- mg/kg wwwt - milligrams per kilogram based on wet weight of sample*
- mg/kg lwt - milligrams per kilogram based on lipid weight of sample*
- mg/L - unit of concentration based on volume, parts per million.*
- < - Less than.*
- D.L. - The reporting limit.*
- N/A - Result not available. Refer to qualifier code and definition for explanation.*

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.



Quality Control Report

Workorder: L2703301

Report Date: 17-MAY-22

Page 1 of 3

Client: Grounded Engineering Inc
1 Banigan Drive
TORONTO ON M4H 1G3

Contact: Kim Falkenstein

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
CL-R511-WT	Soil							
Batch	R5774921							
WG3724652-7	CRM	AN-CRM-WT						
Chloride			100.6		%		70-130	09-MAY-22
WG3724652-8	DUP	WG3724652-9						
Chloride		<5.0	<5.0	RPD-NA	ug/g	N/A	30	09-MAY-22
WG3724652-6	LCS							
Chloride			103.4		%		80-120	09-MAY-22
WG3724652-5	MB							
Chloride			<5.0		ug/g		5	09-MAY-22
EC-WT	Soil							
Batch	R5774642							
WG3724832-4	DUP	WG3724832-3						
Conductivity		0.228	0.226		mS/cm	0.9	20	09-MAY-22
WG3724832-2	IRM	WT SAR4						
Conductivity			107.4		%		70-130	09-MAY-22
WG3725070-1	LCS							
Conductivity			97.7		%		90-110	09-MAY-22
WG3724832-1	MB							
Conductivity			<0.0040		mS/cm		0.004	09-MAY-22
Batch	R5777496							
WG3725180-4	DUP	WG3725180-3						
Conductivity		0.0668	0.0683		mS/cm	2.2	20	11-MAY-22
WG3725180-2	IRM	WT SAR4						
Conductivity			113.8		%		70-130	11-MAY-22
WG3726124-1	LCS							
Conductivity			94.4		%		90-110	11-MAY-22
WG3725180-1	MB							
Conductivity			<0.0040		mS/cm		0.004	11-MAY-22
MOISTURE-WT	Soil							
Batch	R5771982							
WG3723803-3	DUP	L2703416-3						
% Moisture		6.01	5.89		%	2.1	20	06-MAY-22
WG3723803-2	LCS							
% Moisture			100.6		%		90-110	06-MAY-22
WG3723803-1	MB							
% Moisture			<0.25		%		0.25	06-MAY-22
PH-WT	Soil							

Quality Control Report

Workorder: L2703301

Report Date: 17-MAY-22

Page 2 of 3

Client: Grounded Engineering Inc
1 Banigan Drive
TORONTO ON M4H 1G3

Contact: Kim Falkenstein

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
PH-WT	Soil							
Batch	R5772876							
WG3723727-1	DUP	L2702571-8						
pH		6.38	6.40	J	pH units	0.02	0.3	06-MAY-22
WG3724026-1	LCS							
pH			7.02		pH units		6.9-7.1	06-MAY-22
REDOX-POTENTIAL-WT	Soil							
Batch	R5772485							
WG3723940-1	CRM	WT-REDOX						
Redox Potential			104.2		%		90-110	05-MAY-22
WG3723842-1	DUP	L2703328-1						
Redox Potential		287	289		mV	0.7	25	05-MAY-22
SO4-WT	Soil							
Batch	R5774921							
WG3724652-7	CRM	AN-CRM-WT						
Sulphate			102.5		%		60-140	09-MAY-22
WG3724652-8	DUP	WG3724652-9						
Sulphate		<20	<20	RPD-NA	ug/g	N/A	25	09-MAY-22
WG3724652-6	LCS							
Sulphate			103.1		%		70-130	09-MAY-22
WG3724652-5	MB							
Sulphate			<20		ug/g		20	09-MAY-22
SULPHIDE-WT	Soil							
Batch	R5772491							
WG3724060-3	DUP	L2703328-2						
Acid Volatile Sulphides		1.17	1.01		mg/kg	15	45	05-MAY-22
WG3724060-2	LCS							
Acid Volatile Sulphides			71.4		%		70-130	05-MAY-22
WG3724060-1	MB							
Acid Volatile Sulphides			<0.20		mg/kg		0.2	05-MAY-22

Quality Control Report

Workorder: L2703301

Report Date: 17-MAY-22

Client: Grounded Engineering Inc
1 Banigan Drive
TORONTO ON M4H 1G3
Contact: Kim Falkenstein

Page 3 of 3

Legend:

Limit	ALS Control Limit (Data Quality Objectives)
DUP	Duplicate
RPD	Relative Percent Difference
N/A	Not Available
LCS	Laboratory Control Sample
SRM	Standard Reference Material
MS	Matrix Spike
MSD	Matrix Spike Duplicate
ADE	Average Desorption Efficiency
MB	Method Blank
IRM	Internal Reference Material
CRM	Certified Reference Material
CCV	Continuing Calibration Verification
CVS	Calibration Verification Standard
LCSD	Laboratory Control Sample Duplicate

Sample Parameter Qualifier Definitions:

Qualifier	Description
J	Duplicate results and limits are expressed in terms of absolute difference.
RPD-NA	Relative Percent Difference Not Available due to result(s) being less than detection limit.

Hold Time Exceedances:

All test results reported with this submission were conducted within ALS recommended hold times.

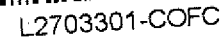
ALS recommended hold times may vary by province. They are assigned to meet known provincial and/or federal government requirements. In the absence of regulatory hold times, ALS establishes recommendations based on guidelines published by the US EPA, APHA Standard Methods, or Environment Canada (where available). For more information, please contact ALS.

The ALS Quality Control Report is provided to ALS clients upon request. ALS includes 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 pre-determined data quality objectives to provide confidence in the accuracy of associated test results.

Please note that this report may contain QC results from anonymous Sample Duplicates and Matrix Spikes that do not originate from this Work Order.



Canada Toll Free: 1 800 668 9878



COC Number: 17 -

Page of

[illegible]

REFER TO BACK PAGE FOR ALS LOCATIONS AND SAMPLING INFORMATION

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Bure 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.

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



Grounded Engineering Inc
ATTN: Kim Falkenstein
1 Banigan Drive
TORONTO ON M4H 1G3

Date Received: 12-MAY-22
Report Date: 20-MAY-22 10:29 (MT)
Version: FINAL

Client Phone: 647-264-7943

Certificate of Analysis

Lab Work Order #: L2705696
Project P.O. #: NOT SUBMITTED
Job Reference: 22-052
C of C Numbers:
Legal Site Desc:

Amanda Overholster
Account Manager

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ADDRESS: 5730 Coopers Avenue, Unit #26, Mississauga, ON L4Z 2E9 Canada | Phone: +1 905 507 6910 | Fax: +1 905 507 6927
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Sample Details/Parameters		Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L2705696-1	BH113 SS3							
Sampled By:	CLIENT on 10-MAY-22 @ 12:30							
Matrix:	SOIL							
Physical Tests								
Conductivity		0.111		0.0040	mS/cm		19-MAY-22	R5785404
% Moisture		9.12		0.25	%	12-MAY-22	13-MAY-22	R5779119
pH		8.03		0.10	pH units		13-MAY-22	R5779622
Redox Potential		422		-1000	mV		16-MAY-22	R5781901
Resistivity		8980		1.0	ohm*cm		19-MAY-22	
Leachable Anions & Nutrients								
Chloride		21.3		5.0	ug/g	19-MAY-22	19-MAY-22	R5785579
Anions and Nutrients								
Sulphate		<20		20	ug/g	19-MAY-22	19-MAY-22	R5785579
Inorganic Parameters								
Acid Volatile Sulphides		<0.20		0.20	mg/kg	17-MAY-22	17-MAY-22	R5783378

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
CL-R511-WT	Soil	Chloride-O.Reg 153/04 (July 2011)	EPA 300.0
5 grams of dried soil is mixed with 10 grams of distilled water for a minimum of 30 minutes. The extract is filtered and analyzed by ion chromatography.			
Analysis conducted in accordance with the Protocol for Analytical Methods Used in the Assessment of Properties under Part XV.1 of the Environmental Protection Act (July 1, 2011 and as of November 30, 2020), unless a subset of the Analytical Test Group (ATG) has been requested (the Protocol states that all analytes in an ATG must be reported).			
EC-WT	Soil	Conductivity (EC)	MOEE E3138
A representative subsample is tumbled with de-ionized (DI) water. The ratio of water to soil is 2:1 v/w. After tumbling the sample is then analyzed by a conductivity meter.			
Analysis conducted in accordance with the Protocol for Analytical Methods Used in the Assessment of Properties under Part XV.1 of the Environmental Protection Act (July 1, 2011).			
MOISTURE-WT	Soil	% Moisture	CCME PHC in Soil - Tier 1 (mod)
PH-WT	Soil	pH	MOEE E3137A
A minimum 10g portion of the sample 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 and then analyzed using a pH meter and electrode.			
Analysis conducted in accordance with the Protocol for Analytical Methods Used in the Assessment of Properties under Part XV.1 of the Environmental Protection Act (July 1, 2011).			
REDOX-POTENTIAL-WT	Soil	Redox Potential	APHA 2580
This analysis is carried out in accordance with the procedure described in the "APHA" method 2580 "Oxidation-Reduction Potential" 2012. Samples are extracted at a fixed ratio with DI water. Results are reported as observed oxidation-reduction potential of the platinum metal-reference electrode employed, in mV.			
RESISTIVITY-CALC-WT	Soil	Resistivity Calculation	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.			
SO4-WT	Soil	Sulphate	EPA 300.0
5 grams of soil is mixed with 50 mL of distilled water for a minimum of 30 minutes. The extract is filtered and analyzed by ion chromatography.			
SULPHIDE-WT	Soil	Sulphide, Acid Volatile	APHA 4500S2J
This analysis is carried out in accordance with the method described in APHA 4500 S2-J. Hydrochloric acid is added to sediment samples within a purge and trap system. The evolved hydrogen sulphide (H2S) is carried into a basic solution by inert gas. The acid volatile sulfide is then determined colourimetrically.			

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location
WT	ALS ENVIRONMENTAL - WATERLOO, ONTARIO, CANADA

Chain of Custody Numbers:

Reference Information

GLOSSARY OF REPORT TERMS

Surrogates are compounds that are similar in behaviour to target analyte(s), but that do not normally occur in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery. In reports that display the D.L. column, laboratory objectives for surrogates are listed there.

- mg/kg - milligrams per kilogram based on dry weight of sample*
- mg/kg wwwt - milligrams per kilogram based on wet weight of sample*
- mg/kg lwt - milligrams per kilogram based on lipid weight of sample*
- mg/L - unit of concentration based on volume, parts per million.*
- < - Less than.*
- D.L. - The reporting limit.*
- N/A - Result not available. Refer to qualifier code and definition for explanation.*

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.



Quality Control Report

Workorder: L2705696

Report Date: 20-MAY-22

Page 1 of 3

Client: Grounded Engineering Inc
1 Banigan Drive
TORONTO ON M4H 1G3

Contact: Kim Falkenstein

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
CL-R511-WT		Soil						
Batch	R5785579							
WG3729356-3	CRM	AN-CRM-WT						
Chloride			98.0		%		70-130	19-MAY-22
WG3729356-4	DUP	L2705696-1						
Chloride		21.3	23.4		ug/g	9.3	30	19-MAY-22
WG3729356-2	LCS							
Chloride			101.9		%		80-120	19-MAY-22
WG3729356-1	MB							
Chloride			<5.0		ug/g		5	19-MAY-22
EC-WT		Soil						
Batch	R5785404							
WG3729001-4	DUP	WG3729001-3						
Conductivity		1.03	0.983		mS/cm	4.7	20	19-MAY-22
WG3729001-2	IRM	WT SAR4						
Conductivity			100.4		%		70-130	19-MAY-22
WG3729633-1	LCS							
Conductivity			94.5		%		90-110	19-MAY-22
WG3729001-1	MB							
Conductivity			<0.0040		mS/cm		0.004	19-MAY-22
MOISTURE-WT		Soil						
Batch	R5779119							
WG3726783-3	DUP	L2705559-2						
% Moisture		11.0	11.6		%	5.4	20	13-MAY-22
WG3726783-2	LCS							
% Moisture			99.4		%		90-110	13-MAY-22
WG3726783-1	MB							
% Moisture			<0.25		%		0.25	13-MAY-22
PH-WT		Soil						
Batch	R5779622							
WG3726901-1	DUP	L2705849-4						
pH		7.81	7.83	J	pH units	0.02	0.3	13-MAY-22
WG3727138-1	LCS							
pH			7.06		pH units		6.9-7.1	13-MAY-22
REDOX-POTENTIAL-WT		Soil						
Batch	R5781901							
WG3727873-1	CRM	WT-REDOX						
Redox Potential			103.8		%		90-110	16-MAY-22
WG3726905-1	DUP	L2705696-1						



Quality Control Report

Workorder: L2705696

Report Date: 20-MAY-22

Page 2 of 3

Client: Grounded Engineering Inc
1 Banigan Drive
TORONTO ON M4H 1G3

Contact: Kim Falkenstein

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
REDOX-POTENTIAL-WT	Soil							
Batch	R5781901							
WG3726905-1	DUP	L2705696-1						
Redox Potential		422	371		mV	13	25	16-MAY-22
SO4-WT	Soil							
Batch	R5785579							
WG3729356-3	CRM	AN-CRM-WT						
Sulphate			97.3		%		60-140	19-MAY-22
WG3729356-4	DUP	L2705696-1						
Sulphate		<20	<20	RPD-NA	ug/g	N/A	25	19-MAY-22
WG3729356-2	LCS							
Sulphate			102.0		%		70-130	19-MAY-22
WG3729356-1	MB							
Sulphate			<20		ug/g		20	19-MAY-22
SULPHIDE-WT	Soil							
Batch	R5783378							
WG3728496-3	DUP	L2705208-1						
Acid Volatile Sulphides		<0.20	0.23	RPD-NA	mg/kg	N/A	45	17-MAY-22
WG3728496-2	LCS							
Acid Volatile Sulphides			76.5		%		70-130	17-MAY-22
WG3728496-1	MB							
Acid Volatile Sulphides			<0.20		mg/kg		0.2	17-MAY-22

Quality Control Report

Workorder: L2705696

Report Date: 20-MAY-22

Client: Grounded Engineering Inc
1 Banigan Drive
TORONTO ON M4H 1G3
Contact: Kim Falkenstein

Page 3 of 3

Legend:

Limit	ALS Control Limit (Data Quality Objectives)
DUP	Duplicate
RPD	Relative Percent Difference
N/A	Not Available
LCS	Laboratory Control Sample
SRM	Standard Reference Material
MS	Matrix Spike
MSD	Matrix Spike Duplicate
ADE	Average Desorption Efficiency
MB	Method Blank
IRM	Internal Reference Material
CRM	Certified Reference Material
CCV	Continuing Calibration Verification
CVS	Calibration Verification Standard
LCSD	Laboratory Control Sample Duplicate

Sample Parameter Qualifier Definitions:

Qualifier	Description
J	Duplicate results and limits are expressed in terms of absolute difference.
RPD-NA	Relative Percent Difference Not Available due to result(s) being less than detection limit.

Hold Time Exceedances:

All test results reported with this submission were conducted within ALS recommended hold times.

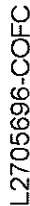
ALS recommended hold times may vary by province. They are assigned to meet known provincial and/or federal government requirements. In the absence of regulatory hold times, ALS establishes recommendations based on guidelines published by the US EPA, APHA Standard Methods, or Environment Canada (where available). For more information, please contact ALS.

The ALS Quality Control Report is provided to ALS clients upon request. ALS includes 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 pre-determined data quality objectives to provide confidence in the accuracy of associated test results.

Please note that this report may contain QC results from anonymous Sample Duplicates and Matrix Spikes that do not originate from this Work Order.



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APPENDIX D



1 GENERAL

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

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

1.1 Description

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

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

Poured concrete foundation walls must be provided with nominal reinforcing steel to provide stiffening of the foundation walls and to protect against excessive crack formation within the foundation walls.

The Engineered Fill to be constructed is shown on the Design Drawings prepared by the Design Civil Engineer and as described by these specifications. The work included in this section includes the following:

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

1.2 The Project Parties

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

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

2 MATERIALS

2.1 Definitions

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

3 ENGINEERED FILL DESIGN

3.1 Design Foundation Pressure

1. Engineered Fill can be expected to experience post-construction settlement on the order of 1 percent of the depth of the Engineered Fill. The time (after initial placement) over which this settlement typically occurs depends on the composition of the Engineered Fill as follows:
 - a) sand or gravel soil; several days
 - b) silt soil; several weeks
 - c) clay or clayey soil; several months.

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

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

2. Unless otherwise stated, the Engineered Fill is to be placed over the entire lot area or site area.
3. Engineered Fill is to extend up to at least 1 m above the highest level of required foundation support. Typically, this can be within 1 m of the design final grades. Additional common fill can be placed over the Engineered Fill to provide protection against environmental factors such as wind, frost, precipitation, and the like.

4. An allowable design foundation pressure (net geotechnical reaction at SLS for 25 mm of settlement) of 150 kPa is typically recommended for the Engineered Fill, unless it consists of glaciolacustrine silt and clay in which case a lower design foundation pressure will need to be determined on a site specific basis. Foundations shall have minimum widths of 0.8 m for continuous strip footings, and minimum dimensions of 1 m for column footings.
5. At the foundation level, sufficient Engineered Fill shall be constructed to ensure that it extends at least 1.0 m laterally beyond the edge of any foundations, and that it extends outward within an area defined by a 1 to 1 line downward from the edge of any Engineered Fill.
6. Foundations placed on the Engineered Fill must be provided with nominal reinforcing steel for stiffening of basement foundation walls and for protection against excessive minor cracking. The reinforcing steel must consist of 2-15M bars continuous at the top of the foundation wall, and 2-15M bars continuous at the bottom of the foundation walls.
7. At the time of foundation construction, foundation excavations must be reviewed by the Geotechnical Engineer to confirm suitable bearing capacity of the Engineered Fill. The Geotechnical Engineer must inspect the foundation subgrade immediately after excavation, and must inspect the foundation subgrade immediately prior to placement of concrete for footings. The Geotechnical Engineer must also inspect the placement of reinforcing steel in the foundation walls. Written approval must be obtained from the Geotechnical Engineer prior to,
 - a) placement of footing concrete, and
 - b) placement of foundation wall concrete.

4 CONSTRUCTION

4.1 Survey Layout

1. The survey layout shall be carried out and maintained throughout the construction of Engineered Fill activities. A suitable layout stake shall be placed at the corners of the start and finish of every block or work area to receive Engineered Fill.
2. At least two temporary survey elevation benchmarks shall be provided for every work area to receive Engineered Fill, to assist in monitoring the level of the Engineered Fill as it is constructed. Benchmark positions may need to be reviewed by Grounded if consolidation settlement is expected to influence their elevations.
3. The ground elevations of the subgrade approved for receiving Engineered Fill shall be surveyed and recorded on a regular grid pattern. Engineered Fill shall not be placed on any work area without the written approval of the Testing Engineer.
4. The ground elevations of the Engineered Fill on each work area shall be surveyed and recorded on a regular grid pattern at the end of each day during the placement of Engineered Fill.
5. On completion of Engineered Fill construction, the final ground elevations shall be surveyed and recorded on a regular grid pattern.

4.2 Topsoil Stripping

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

4.3 Test Holes Into Subgrade

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

4.4 Subgrade Proof-rolling

1. Prior to placing any Engineered Fill, the exposed subgrade must be proofrolled under the observation of the Testing Engineer.
2. If unstable subgrade conditions are encountered, the unstable subgrade must be sub-excavated. If wet site conditions exist during filling, stabilization with granular materials may be required.

4.5 Engineered Fill Placement

1. Engineered fill must not be placed without the approval of the Testing Engineer. Prior to placing any Engineered Fill, the topsoil must be stripped, the subgrade must be investigated for old buried fill or deleterious material, the subgrade must be proof-rolled, and the subgrade elevations must be surveyed.
2. Prior to the placement of Engineered Fill, the source or borrow area for the Engineered Fill must be evaluated for its suitability both geotechnically and environmentally. Samples of the proposed fill material must be obtained and tested by the Testing Engineer. The samples must be tested in a geotechnical laboratory for Standard Proctor Maximum Dry Density. Samples must also be tested per the requirements of Ontario Regulation 406/19, prior to approval of the material for use as Engineered Fill. The results of the lab testing must be approved by the Geotechnical Engineer and the results of the environmental testing must be approved by the site Qualified Person, prior to import.
3. The Engineered Fill must be placed in maximum loose lift thicknesses of 150 mm. Each lift of Engineered Fill must be compacted with a heavy roller, to at least 98 percent Standard Proctor Maximum Dry Density (SPMDD), at the optimum water content plus or minus 2 percent.
4. Field density tests must be taken by the Testing Engineer, on each lift of Engineered Fill, on each lot area. Any Engineered Fill which is tested and found to not meet the specifications, shall be either removed or, reworked and retested.
5. Engineered fill must not be placed during the period of the year when cold weather occurs, i.e. when there are freezing ambient temperatures during the daytime and overnight.

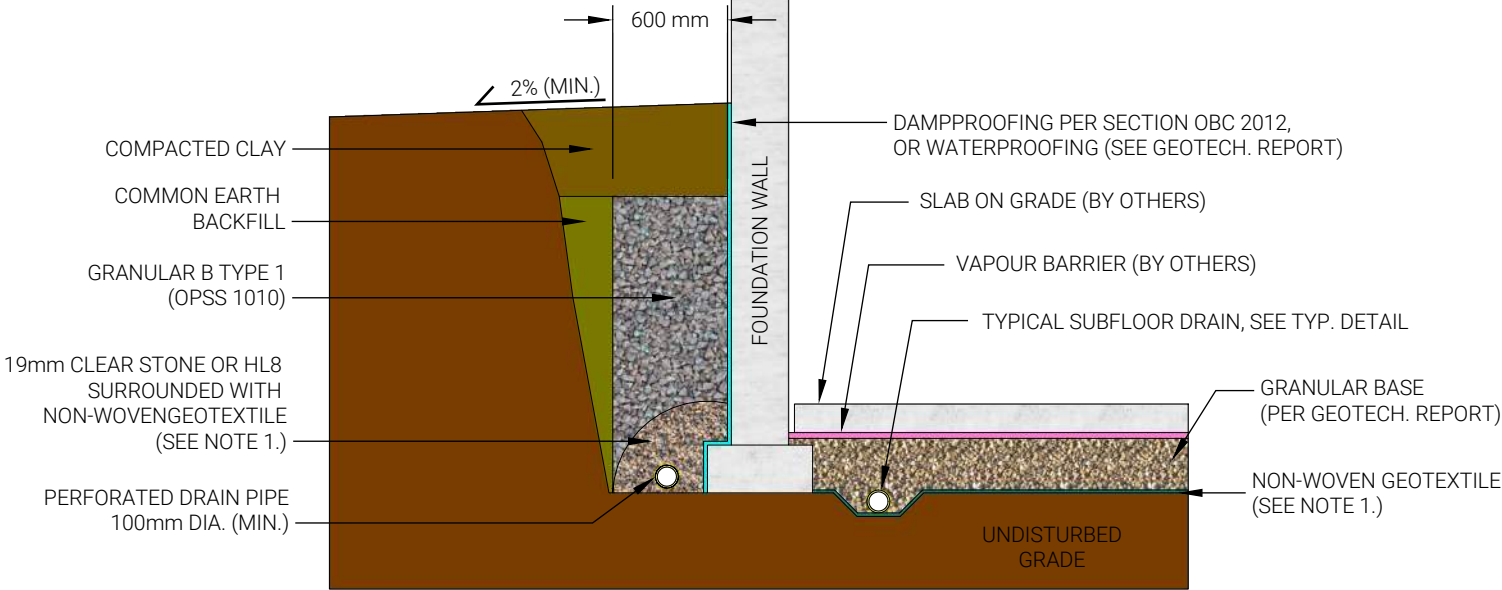
4.6 Certification

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

APPENDIX E

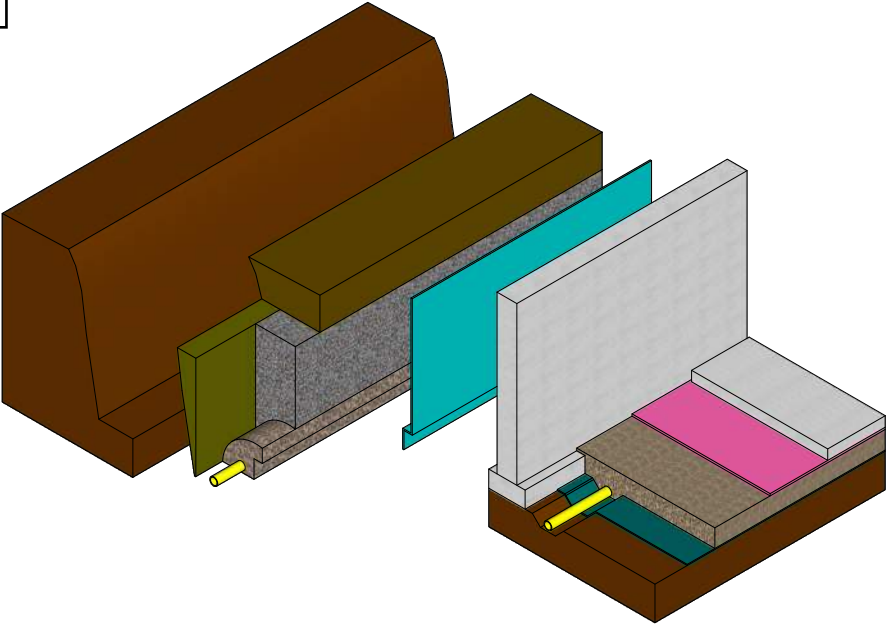


GRANULAR FILL OPTION



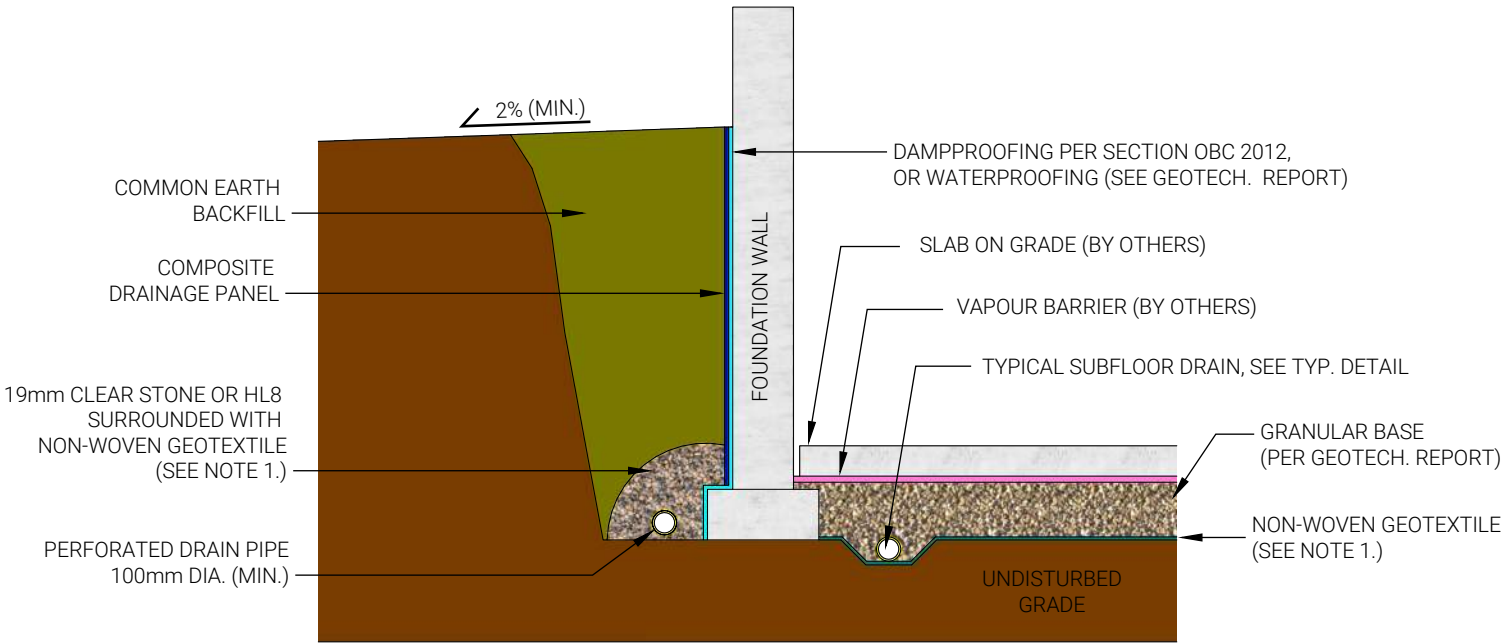
SECTIONAL VIEW

OBJECTS ARE COLOR-CODED BETWEEN TWO VIEWS FOR CLARITY

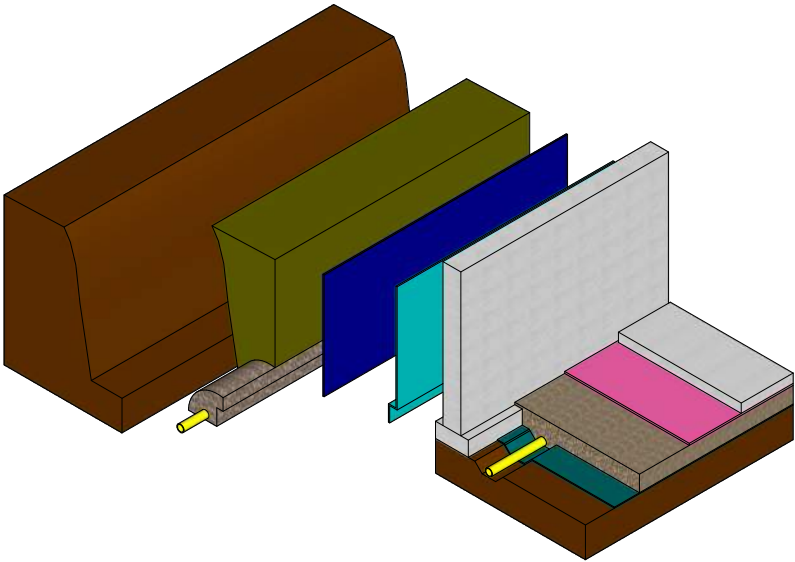


ISOMETRIC VIEW

GEO-COMPOSITE DRAINAGE PANEL OPTION



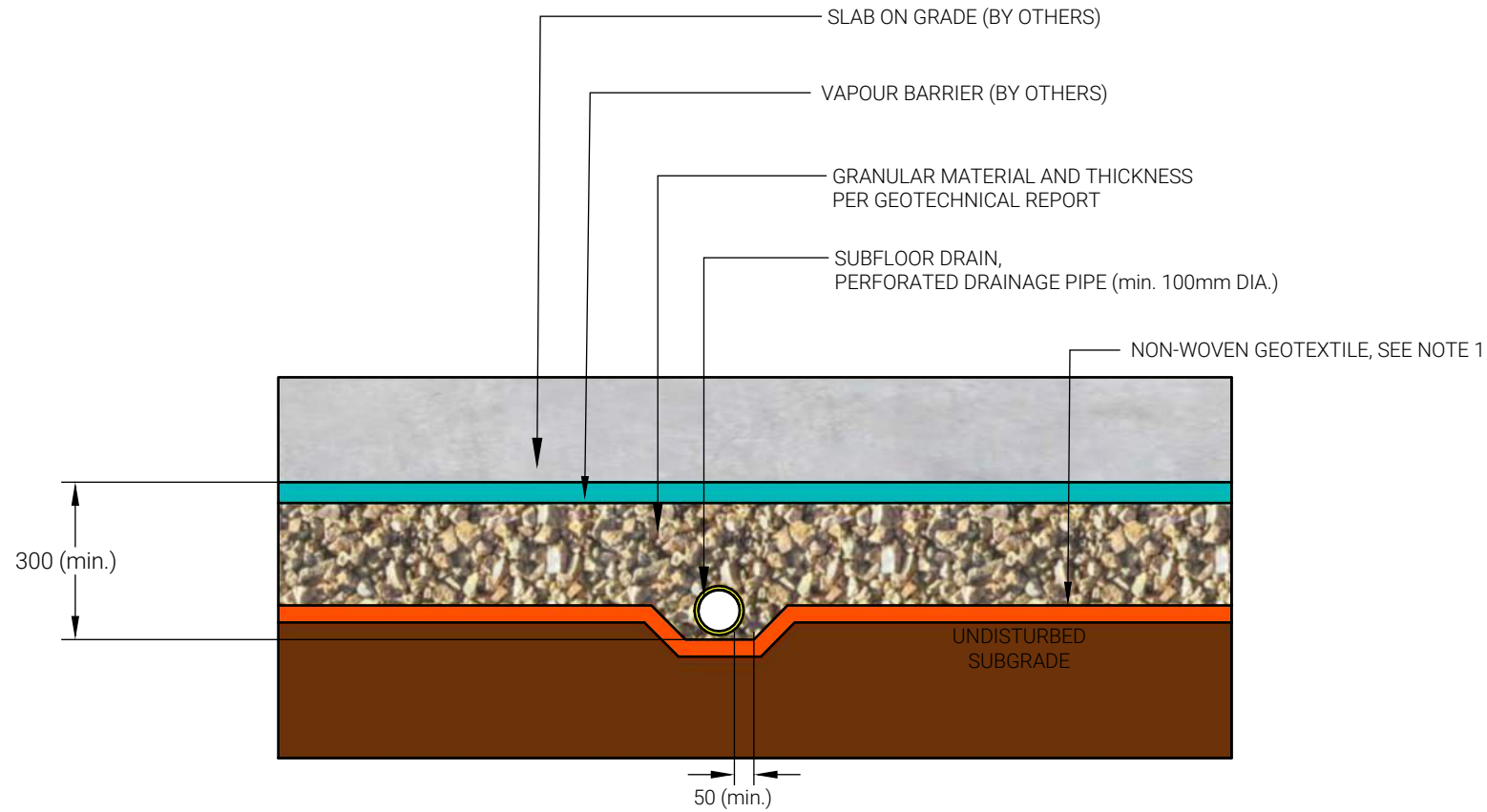
SECTIONAL VIEW



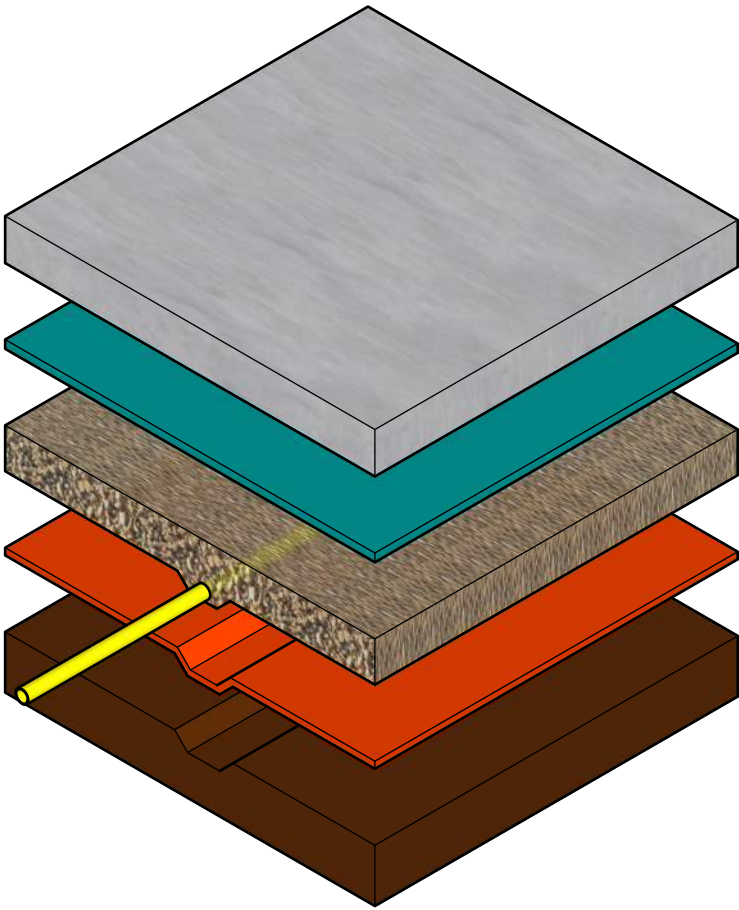
ISOMETRIC VIEW

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

OBJECTS ARE COLOR-CODED
BETWEEN TWO VIEWS FOR CLARITY



SECTIONAL VIEW



ISOMETRIC VIEW

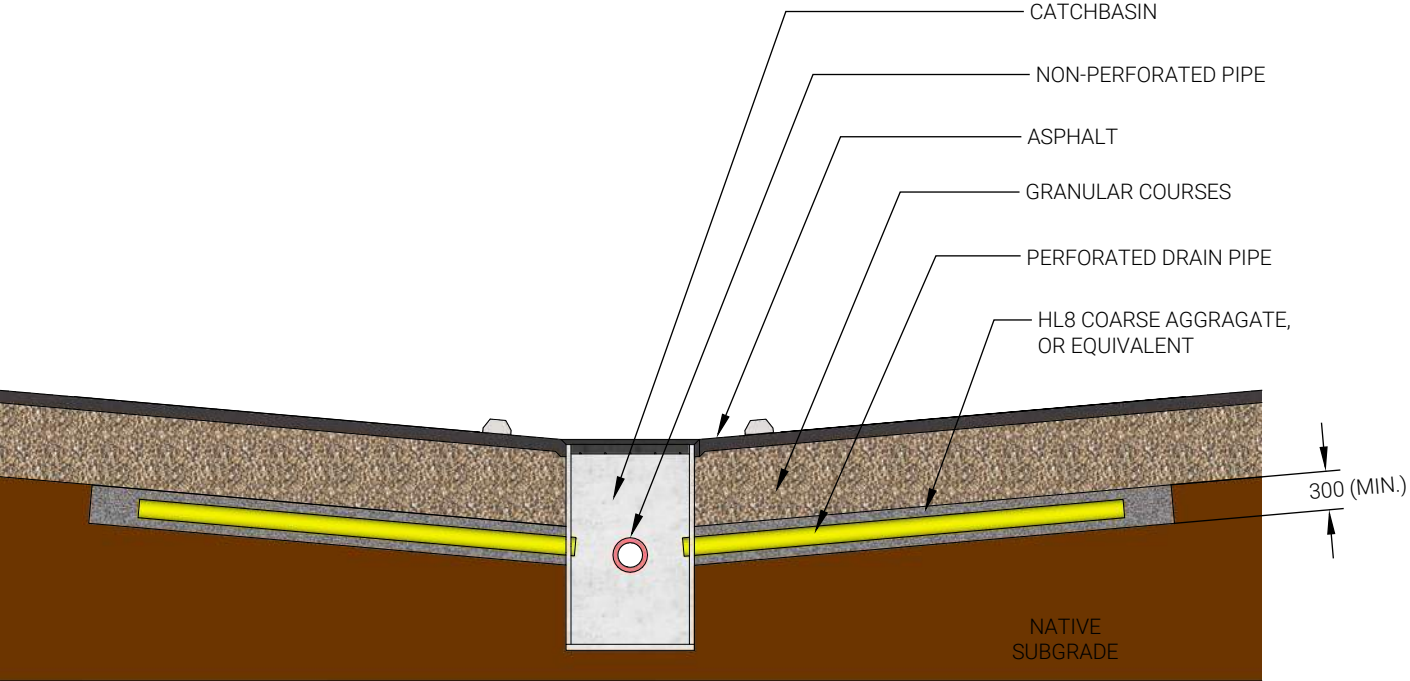
NOTES

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

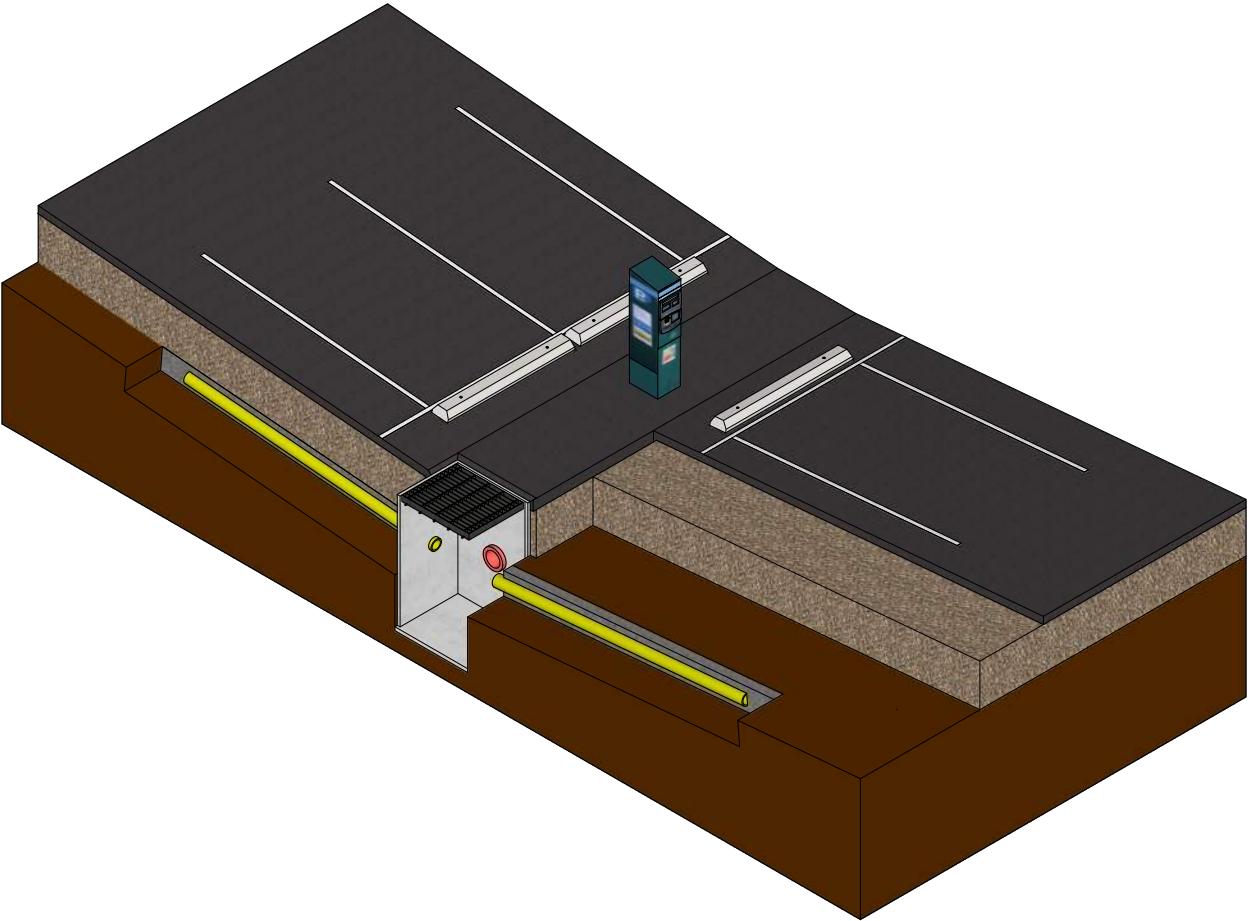
APPENDIX F



OBJECTS ARE COLOR-CODED
BETWEEN TWO VIEWS FOR CLARITY



SECTIONAL VIEW



ISOMETRIC