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A REPORT TO
RHEMM PROPERTIES LTD.

A GEOTECHNICAL INVESTIGATION FOR PROPOSED RESIDENTIAL DEVELOPMENT

372 GREY ROAD 21 WEST

TOWN OF THE BLUE MOUNTAINS

REFERENCE NO. 2201-S051B

SEPTEMBER 2022

DISTRIBUTION

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1.0 INTRODUCTION

In accordance with the authorization dated January 17, 2022, from Mr. John Rodgers, President of Rhemm Properties Ltd., a geotechnical investigation was conducted at 372 Grey Road 21 West in the Town of The Blue Mountains.

The purpose of this investigation was to reveal the subsurface conditions and determine the engineering properties of the disclosed soils for the design and construction of a proposed residential development. The geotechnical findings and resulting recommendations are presented in this Report.

2.0 SITE AND PROJECT DESCRIPTION

The Town of The Blue Mountains, situated on the south shore of Georgian Bay, is in the Simcoe Lowlands bordering the Niagara Escarpment where lacustrine sand and silt deposits have bedded onto undulated Black River and Trenton Group Limestone Bedrock.

The subject site, located on the south side of Georgian Trail and about 1.2 km west of Grey Road 21, encompasses an approximate area of 7 acres. Furthermore, the subject site is located at approximately 500 m from the shoreline of Georgian Bay. The majority of the site is woodland. Access pathways to the site were provided by Rhemm Properties Ltd. to conduct the geotechnical investigation. The existing site gradient generally descends to the north towards Georgian Trail.

According to the Regulation Map (Ontario Regulation 151/06), the subject property is a watershed of Grey Sauble, meaning that any development or building structure at the site is regulated by Grey Sauble Conservation Authority.

This report is limited on the investigation and findings at the west portion of the land parcel. Based on the site plan of development, this area will be developed for a residential subdivision with municipal services and paved roadways meeting urban standards.

3.0 FIELD WORK

The field work, consisting of seven (7) sampled boreholes, was performed on April 18, 2022, at the locations shown on the Location Plan, Drawing No. 1. These boreholes were drilled on the west end of the land parcel in conjunction with the subsurface investigation of a nearby parcel (labelled as Boreholes 5 to 10 and 12). Borehole 11 was cancelled due to inaccessibility with mature tree specimens. These boreholes were terminated at the refusal depth of augering, at 0.6 m to 3.4 m from the prevailing ground surface. Boreholes 1 to 4, drilled on the east end of the land parcel, are presented under a separate report (Reference No. 2201-S051A).

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

Upon the completion of borehole drilling and sampling, five (5) monitoring wells were installed in the selected boreholes to facilitate groundwater monitoring. Details of the monitoring wells are included in the corresponding Borehole Logs.

The ground elevation of each borehole and monitoring well location were obtained using the Global Navigation Satellite System (GNSS).

4.0 SUBSURFACE CONDITIONS

The boreholes were drilled in the woodland along the pathway provided by the Rhemm Properties Ltd. The investigation has revealed that beneath a layer of topsoil, the area is underlain by a sand and gravel deposit, overlying probable bedrock at a depth of 0.6 to 3.4 m.

Detailed descriptions of the encountered subsurface conditions from boreholes are presented on the Borehole Logs, comprising Figures 1 to 8, inclusive. The revealed stratigraphy is plotted on the Subsurface Profile, Drawing No. 2. The engineering properties of the disclosed soils are discussed herein.

4.1 **Topsoil** (All Boreholes)

The revealed topsoil thickness is approximately 20 to 36 cm in the boreholes. Thicker topsoil may occur in places beyond the borehole locations.

4.2 **Sand and Gravel** (All Boreholes)

The sand and gravel deposit was encountered beneath the topsoil layer. It is well graded, with a trace to some silt. Cobbles or boulders could have been contacted due to high resistance and difficulty in augering. The boreholes extend to a depth of 0.6 to 3.1 m, where refusal to augering on probable bedrock was contacted.

The recorded 'N' values of the sand and gravel deposit ranged from 5 to 100, with a median of 14 blows per 30 cm of penetration, indicating that the deposit is loose to very dense, generally being compact in relative density, with the loose deposit in the weathered zone near the ground surface.

The sand and gravel is damp to wet, having natural water content values ranging from 4% to 25%, with a median of 14%, indicating that the deposit is likely water bearing. It should be noted that the recorded water content of the sample may be lower than the in-situ condition as the soil sample may have been predrained during sampling due to pervious nature of the soil.

The engineering properties of the sand and gravel deposit are presented below:

- Low frost susceptibility and low soil adfreezing potential.
- Highly water erodible.
- Pervious with an estimated coefficient of permeability of 10^{-2} to 10^{-3} cm/sec and a percolation time of 4 to 8 min/cm.
- The shear strength is derived from internal friction and is soil density dependent.
- In steep cuts, the sand and gravel will slough to its angle of repose.
- Good pavement-supportive material, with an estimated CBR value of more than 20%.
- Low corrosivity to buried metal, with an estimated electrical resistivity of 6000 ohm·cm.

4.3 **Interpretation of Refusal to Augering** (All Boreholes)

Rock fragments and refusal to augering was encountered at the termination depth of the boreholes, ranging from 0.6 to 3.4 m below the prevailing ground surface. This may infer that limestone bedrock occurs at this level. However, this is not proven by rock coring, which is beyond the scope of this investigation.

4.4 Compaction Characteristics of the Revealed Soils

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

Table 1 - Estimated Water Content for Compaction

Soil Type	Determined Natural Water Content (%)	Water Content (%) for Standard Proctor Compaction	
		100% (optimum)	Range for 95% or +
Sand and Gravel	4 to 25 (median 14)	7	6 to 8

The above values show that the soils on site are generally too wet for compaction. The wet sand and gravel can be properly stockpiled to allow draining of the excess water prior to backfilling.

The shattered rock from excavation in bedrock can be reused in non-structural backfill area where future ground settlement will have no consequences.

5.0 GROUNDWATER CONDITION

The boreholes were checked for the presence of groundwater upon completion of drilling. Groundwater was recorded in the boreholes ranging from 0.4 to 2.4 m (or El. 181.8 m to El. 184.6 m). The groundwater depths are plotted in the borehole logs and summarized in Table 2.

Table 2 - Groundwater Levels Upon Completion of Drilling

Borehole No.	Ground Elevation (m)	Borehole Depth (m)	Groundwater Level	
			Depth (m)	Elevation (m)
5	183.7	1.6	0.6	183.1
6	183.6	0.6	0.6	183.0
7	184.2	1.6	0.4	183.8
8	184.8	1.7	0.8	184.0
9	185.3	2.1	0.8	184.5

Borehole No.	Ground Elevation (m)	Borehole Depth (m)	Groundwater Level	
			Depth (m)	Elevation (m)
10	185.6	1.2	1.0	184.6
12	184.2	3.1	2.4	181.8

Groundwater was recorded in the monitoring wells on April 27, 2022 and May 27, 2022. The groundwater records in the monitoring wells are summarized in Table 3.

Table 3 - Groundwater Level in Monitoring Wells

Monitoring Well No.	Ground Elevation (m)	April 27, 2022		May 27, 2022	
		Depth (m)	Elevation (m)	Depth (m)	Elevation (m)
5	183.7	0.5	183.2	1.1	182.6
7	184.2	0.4	183.8	0.7	183.5
9	185.3	0.7	184.6	1.0	184.3
10	185.6	1.0	184.6	1.1	184.5
12	184.2	2.2	182.0	3.0	181.2

Continuous groundwater is apparent in the sand and gravel at a depth of 0.4 to 3.0 m (or El. 181.2 to El. 184.6 m). The recorded water level generally represents the groundwater regime in the vicinity and is subject to seasonal fluctuations.

Detailed groundwater condition of the site will be discussed in the hydrogeological report, which will be presented under a separate cover.

6.0 DISCUSSION AND RECOMMENDATIONS

The subject property is a watershed of Grey Sauble. Any development or building structure at the site is regulated by Grey Sauble Conservation Authority.

The investigation has revealed that beneath a layer of topsoil, the area is underlain by a saturated sand and gravel deposit, overlying probable bedrock at a depth of 0.6 to 3.4 m.

Continuous groundwater is apparent in the sand and gravel at a depth of 0.4 to 3.0 m (or El. 181.2 to El. 184.6 m). The recorded water level generally represents the groundwater regime in the vicinity and is subject to seasonal fluctuations.

The area covered in this report will be developed for a residential subdivision with municipal services and paved roadways meeting urban standards. The geotechnical findings which warrant special consideration are presented below:

1. The topsoil and trees must be removed for site development. The topsoil can be re-used for landscaping in designated areas only. Any surplus should be removed off-site.
2. Where site grading with additional fill is required, it is economical to place an engineered fill to regrade the site for development.
3. The houses can be constructed on conventional spread and strip footing founded on engineered fill, native sand and gravel or bedrock. To prevent the abrupt settlement and wall cracks on the structure, the footings of each individual house should either be founded on bedrock or on soil stratum.
4. It is recommended that the slab-on-grade or basement floor of new structures must be at least 1.0 m above the highest groundwater level unless the submerged portion is waterproofed and designed to resist the hydrostatic pressure.
5. Any excavation into the bedrock will require considerable effort by the use of pneumatic hammering or controlled blasting.
6. Where excavation extend below the groundwater level, dewatering with closely spaced sumps will be required.

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

6.1 **Site Preparation**

The subject property is a watershed of Grey Sauble. Any development or building structure at the site is regulated by Grey Sauble Conservation Authority.

The topsoil and trees must be removed for site development. The topsoil can be re-used for landscaping in designated areas only.

The engineering requirements for a certifiable fill for municipal services, pavement and house foundations are presented below:

1. After removal of topsoil and unsuitable material, the subgrade must be inspected and proof-rolled prior to any fill placement. Badly weathered soils should also be subexcavated, sorted free of topsoil inclusions and deleterious materials, if any, aerated and properly compacted in layers.
2. Inorganic soils must be used, and they must be uniformly compacted in 20 cm thick lifts to 98% or + of the maximum Standard Proctor dry density (SPDD) up to the proposed finished grade. The soil moisture must be properly controlled near the optimum. If the foundations are to be built soon after the fill placement, the densification process for the engineered fill must be increased to 100% SPDD.
3. If the engineered fill is compacted with the moisture content on the wet side of the optimum, the underground services and pavement construction should not begin until the pore pressure within the fill mantle has completely dissipated. This must be further assessed at the time of the engineered fill construction.
4. If imported fill is to be used, it should be inorganic soils, free of deleterious or any material with environmental issue (contamination). Any potential imported earth fill from off site must be reviewed for geotechnical and environmental quality by the appropriate personnel as authorized by the developer or agency, before it is hauled to the site.
5. The engineered fill must not be placed during the period where freezing ambient temperatures occur either persistently or intermittently. This is to ensure that the fill is free of frozen soils, ice and snow.
6. Where the ground is wet due to groundwater seepage, an appropriate dewatering or drainage scheme must be implemented prior to the fill placement.
7. The fill operation must be inspected on a full-time basis by a technician under the direction of a geotechnical engineer.
8. The engineered fill must extend over the entire graded area; the engineered fill envelope and finished elevations must be clearly and accurately defined in the field, and they must be precisely documented by qualified surveyors.
9. House foundations founded on engineered fill must be reinforced. It should be designed by a structural engineer to allow distribution of stress induced by the abrupt differential settlement (about 15 mm) in engineered fill.
10. The foundation and underground services subgrade must be inspected by the geotechnical consulting firm that inspected the engineered fill placement. This is to ensure that the foundations and services pipes are placed within the engineered fill envelope, and the integrity of the fill has not been compromised by interim construction, environmental degradation and/or disturbance by the footing excavation.
11. Use of shattered rock from excavation should be limited in non-structural backfill area where future ground settlement will have no consequences.

6.2 **House Foundations**

The houses can be constructed on conventional spread and strip footings founded on engineered fill, native sand and gravel or bedrock. If there is a basement structure, the structure must be designed above the highest recorded groundwater level; or otherwise, the underground structure must be waterproofed, with a raft foundation to resist the hydrostatic uplift pressure.

The design bearing pressures for conventional footings and raft foundation founded on the engineered fill or native subsoil are presented below:

- Maximum Soil Bearing Pressure, at Serviceability Limit State (SLS) = 150 kPa
- Factored Ultimate Bearing Pressure, at Ultimate Limit State (ULS) = 240 kPa
- A Modulus of Subgrade Reaction of 12 MPa/m can be used for the design of raft foundation.

The total and differential settlements of footings designed using the bearing pressure at SLS is estimated to be 25 mm and 20 mm, respectively.

The design bearing pressures for conventional footings and raft foundation founded on bedrock can be increased as presented below:

- Maximum Bearing Pressure, at SLS = 800 kPa
- Factored Ultimate Bearing Pressure, at ULS = 1200 kPa
- A Modulus of Subgrade Reaction of 80 MPa/m can be used for the design of raft foundation.

The settlements of foundation founded on bedrock are negligible.

Due to the anticipated settlements, each individual house structure should either be founded on bedrock or on soil stratum, to prevent the abrupt settlement and wall cracks on the structure. The foundation subgrade must be inspected by a geotechnical engineer, or a senior geotechnical technician to assess its suitability for bearing the designed foundations.

The foundation must be poured immediately after subgrade inspection. For raft foundation construction, the area will have to be left open for forming and rebar installation. The subgrade, thus, must be protected by a mud-slab of lean concrete immediately after exposure. This will prevent construction disturbance and costly rectification of the bearing subsoil.

Foundation exposed to weathering or in unheated area should be provided with at least 1.4 m of earth cover for protection against frost action, or must be properly insulated.

The building foundations should meet the requirements specified in the latest Ontario Building Code. Structures founded on bedrock should be designed to resist an earthquake force using Site Classification 'C' (soft rock). However, structures founded on the native sand and gravel or engineered fill should be designed to resist an earthquake force using Site Classification 'D' (stiff soil).

6.3 Basement Structure

The soil parameters in Section 6.8 can be used for evaluation of the lateral and uplift pressure. It is recommended that the basement floor or slab-on-grade of the structures should be founded at least 1.0 m above the highest groundwater level.

In conventional design of basement structure founded at least 1.0 m above the highest groundwater level, the perimeter walls of basement structures should be provided with a perimeter drainage system and subdrain (Drawing No. 3) at the wall base. The subdrains should be encased in fabric filter to protect them against blockage by silting and connected to positive outlets. In case the basement floor is less than 1.0 m above the highest groundwater level, an underfloor drainage system is recommended in the basement floor bedding.

The subgrade for conventional basement floor and slab-on-grade should consist of sound native soil or properly compacted inorganic earth fill. The slab should be constructed on granular bedding, 20 cm thick, consisting of 19-mm Crusher-Run Limestone (CRL), or equivalent, compacted to 98% SPDD. In case underfloor drainage is necessary, the thickness of granular bedding should be increased to 30 cm.

If the basement structure is designed below the highest groundwater level, the underground structure must be waterproofed and designed with a raft foundation to resist the hydrostatic uplift pressure at the time of flooding. The basement slab will be poured on a granular fill above the raft where the underground utilities and pipes will be laid.

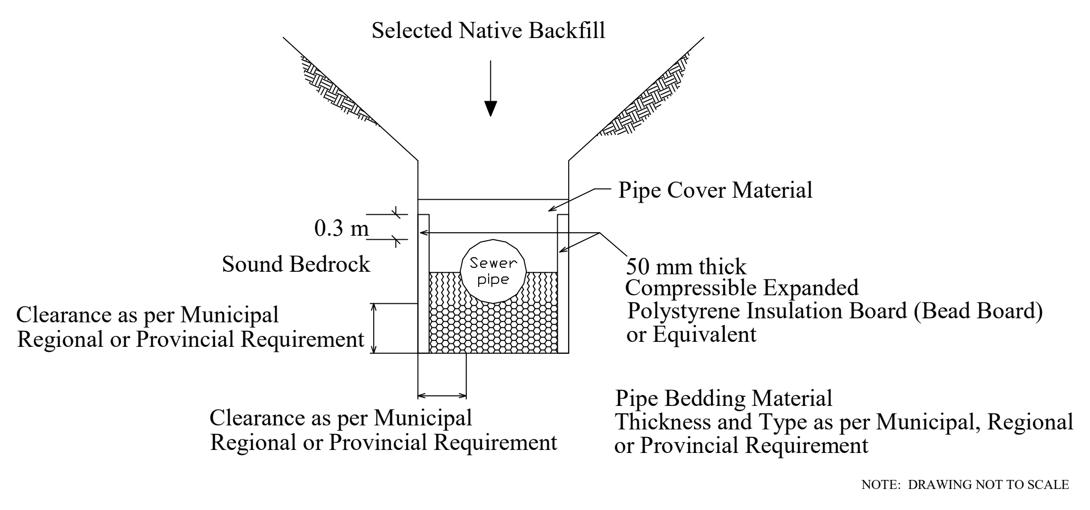
The external grading should be such that runoff is directed away from the foundation and structures.

6.4 Underground Services

The subgrade for underground service pipes should consist of sound native soils, properly compacted inorganic earth fill or bedrock. A Class ‘B’ bedding, consisting of compacted 19-mm CRL, or equivalent, is recommended for construction of underground services. Where saturated sand and gravel is evident in the subgrade or where dewatering is required, a Class ‘A’ concrete bedding should be considered.

Where the pipe is to be placed in sound rock, the trench sides should be slightly sloped rather than vertical due to the residual stress relief and the swelling characteristics in sound rock. The side slopes should be no steeper than 2V:1H. Alternatively, the rock face can be lined with a cushioning layer such as Styrofoam, then backfilled with fine sand to 0.3 m above the crown of the pipe and flooded. The recommended scheme is illustrated in Diagram 1.

Diagram 1 - Sewer Installation in Sound Rock



Pipe joints connecting into manholes and catch basins should be leak-proof, or wrapped with an appropriate waterproof membrane. Openings to subdrains and catch basins should be shielded with a fabric filter to prevent blockage by silting.

In order to prevent pipe floatation when the sewer trench is deluged with water, a soil cover of at least two times the diameter of the pipe should be in place at all times after completion of the pipe installation.

All metal fittings for the underground services should be protected against soil corrosion. For estimation of anode weight requirements, the estimated electrical resistivity of the disclosed soil can be used. This, however, should be confirmed by testing the soil along the service pipe alignment at the time of site service construction. The proposed anode weight must meet the minimum requirements as specified by the town standard.

6.5 **Backfilling in Trenches and Excavated Areas**

The on-site inorganic soil is generally too wet for use as trench backfill and will need to be properly stockpiled to allow draining of the excess water prior to its use as structural backfill. Moreover, the soils should be sorted free of topsoil, organics and oversized rock fragments (over 15 cm in size). Use of shattered rock from rock excavation should be limited in non-structural backfill area where future ground settlement will have no consequences.

The backfill in service trenches should be compacted to at least 95% SPDD. In the zone within 1.0 m below the pavement, the material should be compacted to 98% SPDD, with the water content controlled at 2% or 3% drier than the optimum. The lift of each backfill layer should be limited to a thickness of 20 cm, or the thickness should be determined by test strips at the time of compaction.

In normal construction practice, the problem areas of pavement settlement largely occur adjacent to manholes, catch basins, services crossings, foundation walls and columns. These trenches should be cut at 1 vertical:2 horizontal so that the backfill in the trenches can be effectively compacted. Otherwise, soil arching in the trenches will prevent achievement of the proper compaction. In confined areas where the desired slope cannot be achieved or the operation of a proper kneading-type roller cannot be facilitated, imported granular fill, which can be appropriately compacted by using a smaller vibratory compactor, must be used.

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

- It is often difficult to achieve uniform compaction of the backfill in the lower vertical section of a trench which is an open cut or is stabilized by a trench box, particularly in the sector close to the trench walls or the sides of the box. These sectors must be backfilled with sand and the compaction must be carried out diligently prior to the placement of the backfill above this sector, i.e., in the upper sloped trench section. This measure is necessary in order to prevent consolidation of inadvertent voids and loose backfill which will compromise the compaction of the backfill in the upper section.
- When construction is carried out in freezing weather, frozen soil layers may inadvertently be mixed with the structural trench backfill. Should the in situ soils have a water content on the dry side of the optimum, it would be impossible to wet the soils due to the freezing condition, rendering difficulties in obtaining uniform and proper compaction. Furthermore, the freezing condition will prevent wetting of the backfill or when it is required, such as when the trench box is removed. The above will invariably cause backfill settlement in the next few years.
- In areas where the underground services construction is carried out during the winter months, prolonged exposure of the trench walls will result in frost heave within the soil mantle of the walls. This may result in some settlement as the frost recedes, and repair costs will be incurred prior to final surfacing of the new pavement and the slab-on-grade.
- In areas where groundwater movement is expected in the sand fill mantle, anti-seepage collars should be provided.

6.6 **Driveways, Sidewalks and Interlocking Stone Pavement**

The driveway at the entrances to the garages should be backfilled with non-frost susceptible granular material, with a recommended frost taper at a slope of 1V:1H.

Concrete sidewalks should be designed to tolerate seasonal movement. Any structure in areas which are sensitive to frost-induced ground movement must be constructed on a free-draining, non-frost-susceptible granular material such as Granular ‘B’. The material should extend to 0.3 to 1.4 m below the slab or pavement surface, depending on the degree of tolerance to movement, and be provided with positive drainage, such as weeper subdrains connected to manholes or catch basins.

The exterior grade should slope away from the structures to prevent ponding of water adjacent to the structures.

6.7 Pavement Design

The recommended pavement design for residential roads is presented in Table 4.

Table 4 - Pavement Design

Course	Thickness (mm)	OPS Specifications
Asphalt Surface	40	HL3
Asphalt Binder	65	HL8
Granular Base	150	Granular ‘A’
Granular Sub-base	450	Granular ‘B’

After fine grading, the pavement subgrade should be inspected and proof-rolled. Any soft spots as identified should be subexcavated and replaced with selected on-site material, free of organics, compacted to 98% SPDD, with the water content at 2% to 3% drier than the optimum. In the lower zone, a 95% Standard Proctor compaction is considered adequate. All the granular bases should be compacted to 100% SPDD.

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

- If the pavement construction does not immediately follow the trench backfilling, the subgrade should be properly crowned and smooth-rolled to allow interim precipitation to be properly drained.
- Lot areas adjacent to the roads should be properly graded to prevent ponding of large amounts of water. Otherwise, the water will seep into the subgrade mantle and induce a regression of the subgrade strength with costly consequences for the pavement construction.
- Fabric filter-encased curb subdrains should be provided on both sides of roadways.
- If the pavement is to be constructed during wet seasons and extensively soft subgrade occurs, the granular sub-base should be thickened in order to compensate for the inadequate strength of the subgrade. This can be assessed during construction.

6.8 Soil Parameters

The recommended soil parameters for the project design are given in Table 5.

Table 5 - Soil Parameters

Unit Weight and Bulk Factor	**Unit Weight γ (kN/m^3)**		**Estimated Bulk Factor**	
	Bulk	**Submerged**	**Loose**	**Compacted**
Sand and Gravel	21.5	11.5	1.25	1.00
Fractured Rock	24.5	14.5	1.40	1.35
Lateral Earth Pressure Coefficients		**Active K_a**	**At Rest K_0**	**Passive K_p**
Compacted Earth Fill		0.40	0.55	2.50
Sand and Gravel		0.25	0.40	3.85
Coefficients of Friction				
Between Concrete and Granular Base/Bedrock				0.50
Between Concrete and Sound Native Soil				0.35

6.9 Excavation

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

Table 6 - Classification of Soils for Excavation

Material	**Type**
Fractured Rock	2
Drained Sand and Gravel	3
Saturated Sand and Gravel	4

Continuous groundwater is apparent in the ground at a depth of 0.4 to 3.0 m. It may represent the groundwater regime in the vicinity. Any excavation into the saturated sand and gravel will require vigorous pumping from closely spaced sumps and sump wells.

Excavation into the bedrock will require considerable effort by an excavator equipped with a rock-ripper and the use of pneumatic hammering or controlled blasting.

Prospective contractors should assess the in situ subsurface conditions for soil cuts by digging test pits to at least 0.5 m below the intended bottom of excavation prior to excavating. These test pits may be allowed to remain open for a few hours to assess its stability conditions.

7.0 LIMITATIONS OF REPORT

This report was prepared by Soil Engineers Ltd. for the account Rhemm Properties Ltd., and for review by the designated consultants and government agencies. The material in the report reflects the judgement of Cedric Ramos, B.A.Sc. and Kin Fung Li, P.Eng., in light of the information available to it at the time of preparation.

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

SOIL ENGINEERS LTD.

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LIST OF ABBREVIATIONS AND DESCRIPTION OF TERMS

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

SAMPLE TYPES

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

PENETRATION RESISTANCE

Dynamic Cone Penetration Resistance:

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

Plotted as '—●—'

Standard Penetration Resistance or 'N' Value:

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

Plotted as '○'

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

SOIL DESCRIPTION

Cohesionless Soils:

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

Cohesive Soils:

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

Method of Determination of Undrained Shear Strength of Cohesive Soils:

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

△ Laboratory vane test

□ Compression test in laboratory

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

METRIC CONVERSION FACTORS

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

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JOB NO.: 2201-S051B

LOG OF BOREHOLE: 5

FIGURE NO.: 1

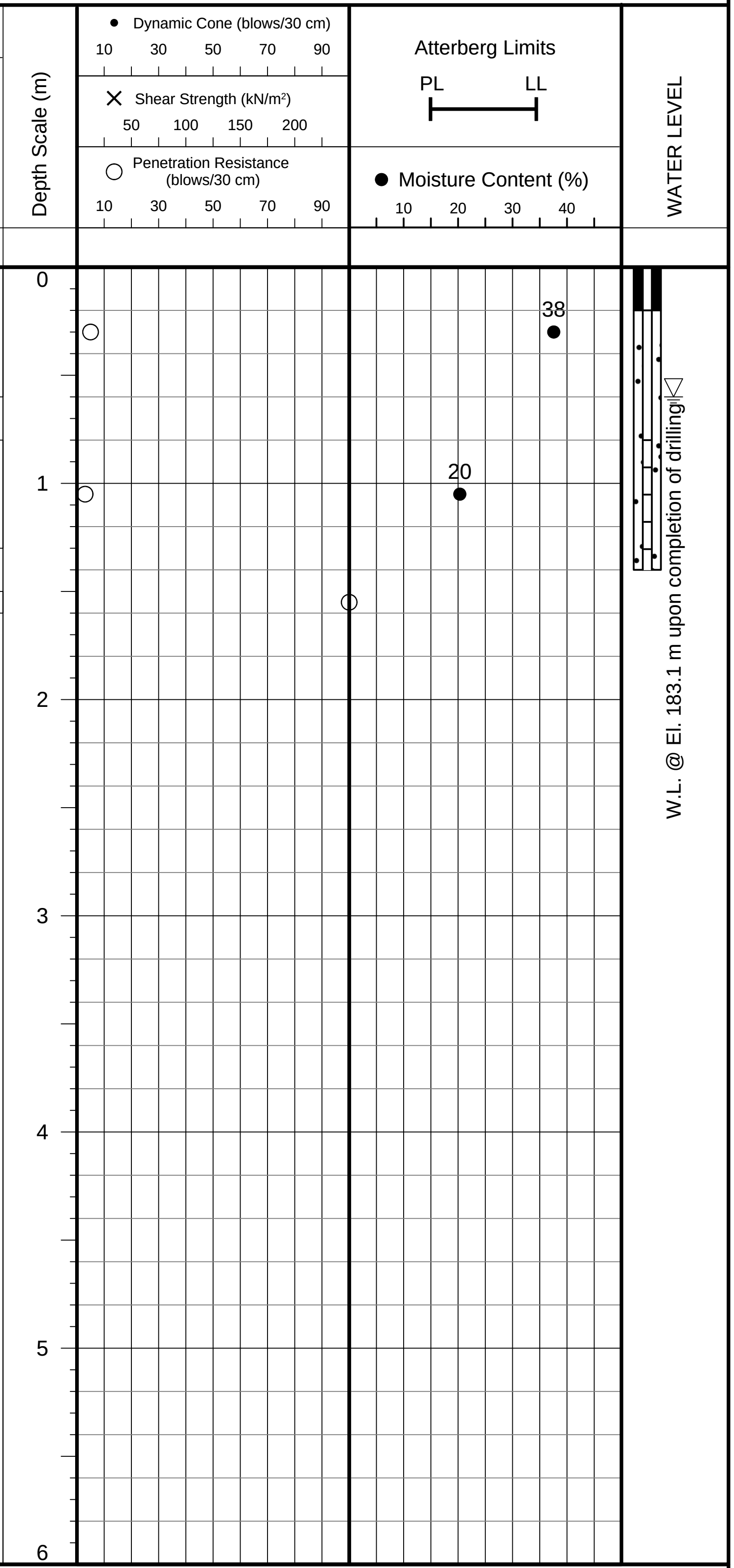
PROJECT DESCRIPTION: Proposed Residential Development

METHOD OF BORING: Flight Auger

PROJECT LOCATION: 372 Grey Road 21 West, Town of The Blue Mountains

DRILLING DATE: April 18, 2022

El. (m) Depth (m)	SOIL DESCRIPTION	SAMPLES Number	Type	N-Value
183.7	Ground Surface			
0.0	**30 cm Topsoil**			
	Brown, loose to very dense **SAND AND GRAVEL** a trace to some silt occ. cobbles and boulders	1	DO	5
	weathered	2	DO	14
182.1 1.6		3	DO	50/3
	END OF BOREHOLE due to auger refusal on probable bedrock Installed 50 mm Ø monitoring well to 1.4 m completed with 0.6 m screen Sand backfill from 0.2 to 1.4 m Bentonite seal from 0.0 m to 0.2 m Provided with a monument steel casing			



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JOB NO.: 2201-S051B

LOG OF BOREHOLE: 6

FIGURE NO.: 2

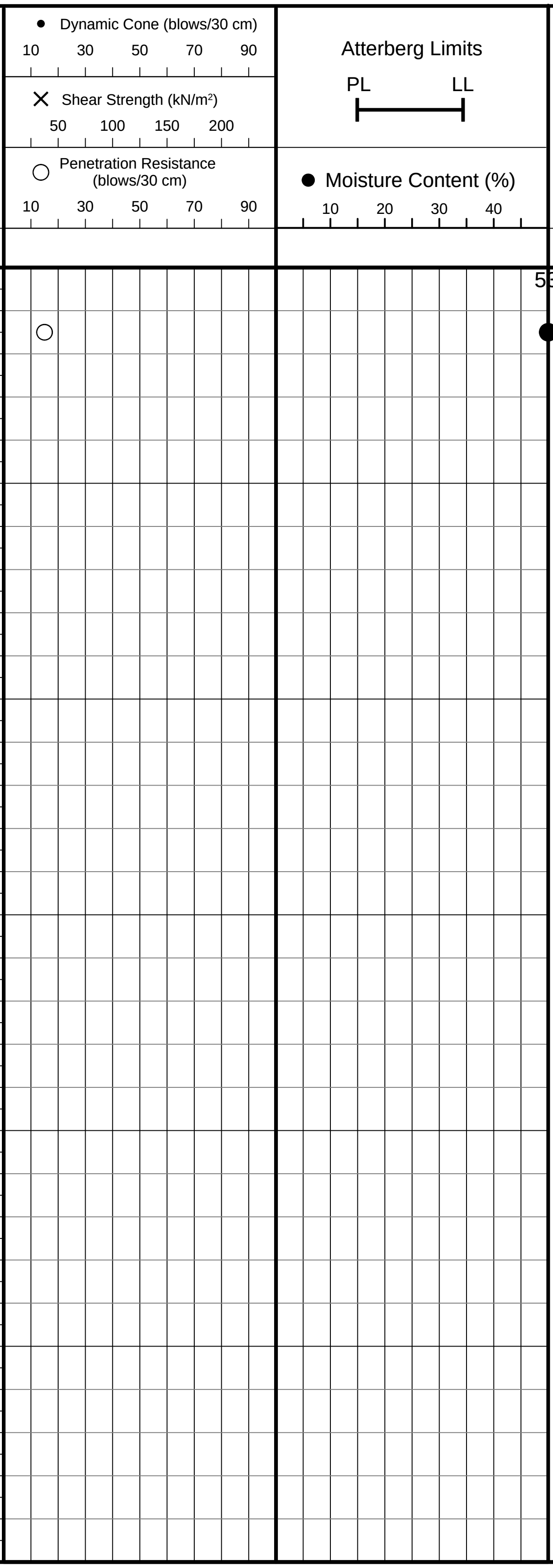
PROJECT DESCRIPTION: Proposed Residential Development

METHOD OF BORING: Flight Auger

PROJECT LOCATION: 372 Grey Road 21 West, Town of The Blue Mountains

DRILLING DATE: April 18, 2022

El. (m) Depth (m)	SOIL DESCRIPTION	SAMPLES Number	SAMPLES Type	SAMPLES N-Value	Depth Scale (m)	WATER LEVEL
183.6	Ground Surface					
0.0	**20 cm Topsoil**				0	
	Brown, very dense **SAND AND GRAVEL** a trace to some silt occ. cobbles and boulders weathered	1	DO	15		W.L. @ El. 183.0 m upon completion of drilling ▽
183.0 0.6	**END OF BOREHOLE due to auger refusal on probable bedrock**				1 2 3 4 5 6	



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JOB NO.: 2201-S051B

LOG OF BOREHOLE: 7

FIGURE NO.: 3

PROJECT DESCRIPTION: Proposed Residential Development

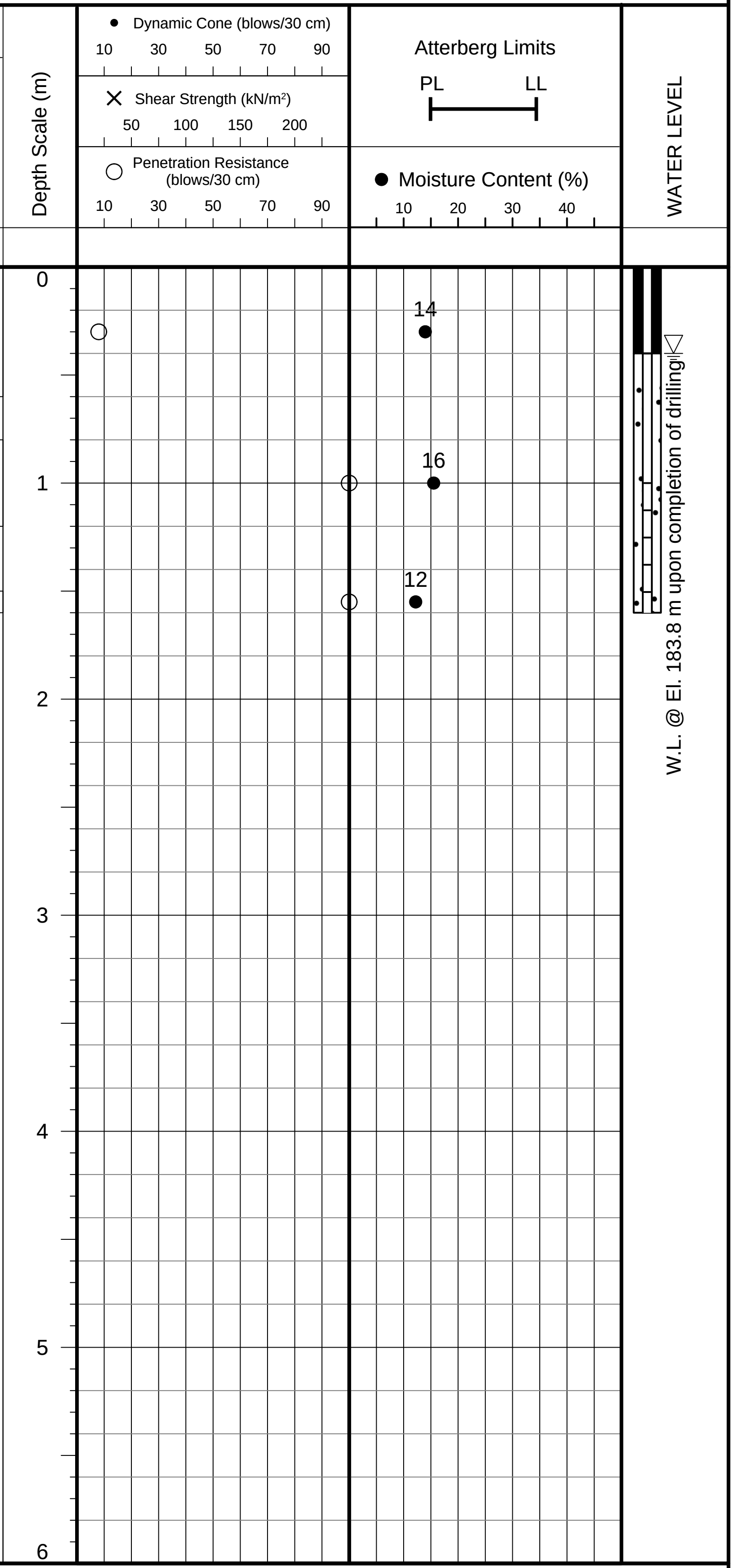
METHOD OF BORING: Flight Auger

PROJECT LOCATION: 372 Grey Road 21 West, Town of The Blue Mountains

DRILLING DATE: April 18, 2022

El. (m) Depth (m)	SOIL DESCRIPTION	SAMPLES		
		Number	Type	N-Value
184.2	Ground Surface			
0.0	**25 cm Topsoil**			
	Brown, loose to very dense **SAND AND GRAVEL** a trace to some silt occ. cobbles and boulders	1	DO	8
	weathered			
		2	DO	50/23
		3	DO	50/8
182.6 1.6	**END OF BOREHOLE due to auger refusal on probable bedrock**			

Installed 50 mm Ø monitoring well to 1.6 m
completed with 0.6 m screen
Sand backfill from 0.4 to 1.6 m
Bentonite seal from 0.0 m to 0.4 m
Provided with a monument steel casing



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JOB NO.: 2201-S051B

LOG OF BOREHOLE: 8

FIGURE NO.: 4

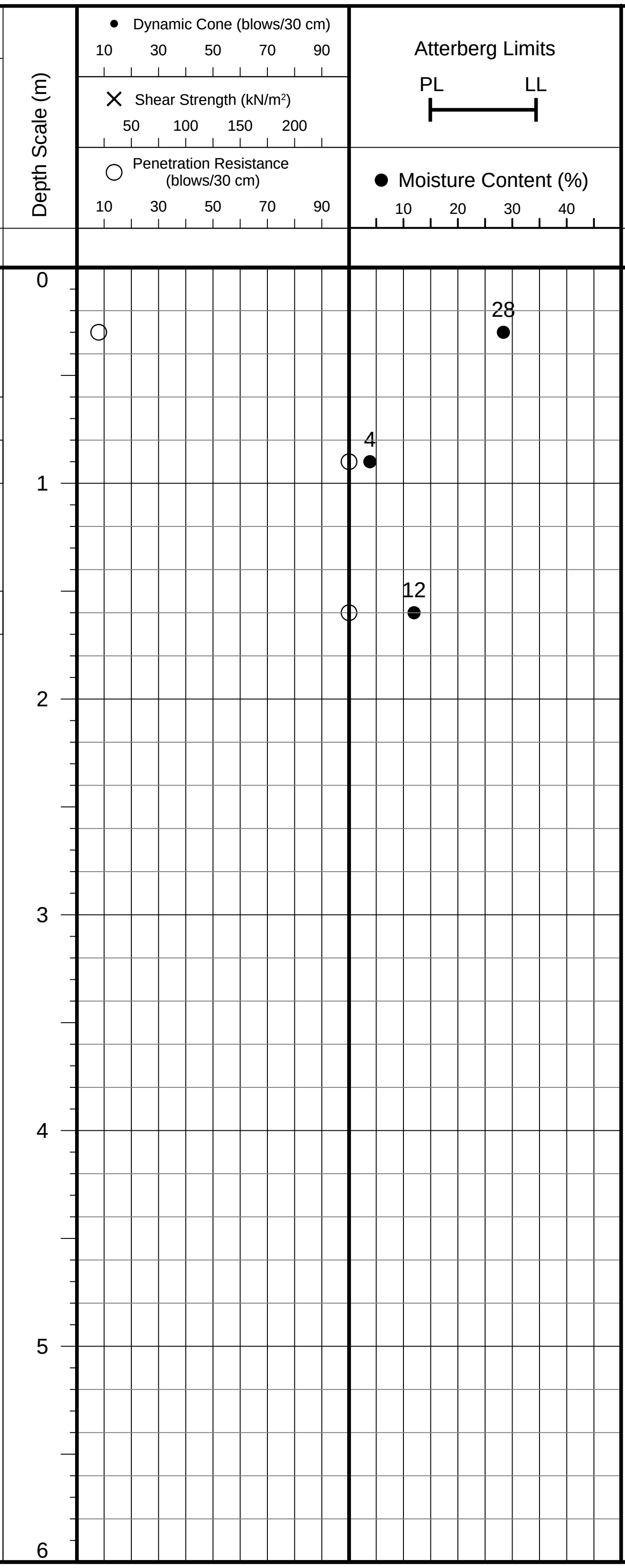
PROJECT DESCRIPTION: Proposed Residential Development

METHOD OF BORING: Flight Auger

PROJECT LOCATION: 372 Grey Road 21 West, Town of The Blue Mountains

DRILLING DATE: April 18, 2022

El. (m) Depth (m)	SOIL DESCRIPTION	SAMPLES Number	SAMPLES Type	SAMPLES N-Value
184.8	Ground Surface			
0.0	**36 cm Topsoil**	1	DO	12
	Brown, compact to very dense **SAND AND GRAVEL** a trace to some silt occ. cobbles and boulders weathered	2	AS	50/15
183.1 1.7		3	DO	50/15
	END OF BOREHOLE due to auger refusal on probable bedrock			



WATER LEVEL

W.L. @ El. 184.0 m upon completion of drilling

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JOB NO.: 2201-S051B

LOG OF BOREHOLE: 9

FIGURE NO.: 5

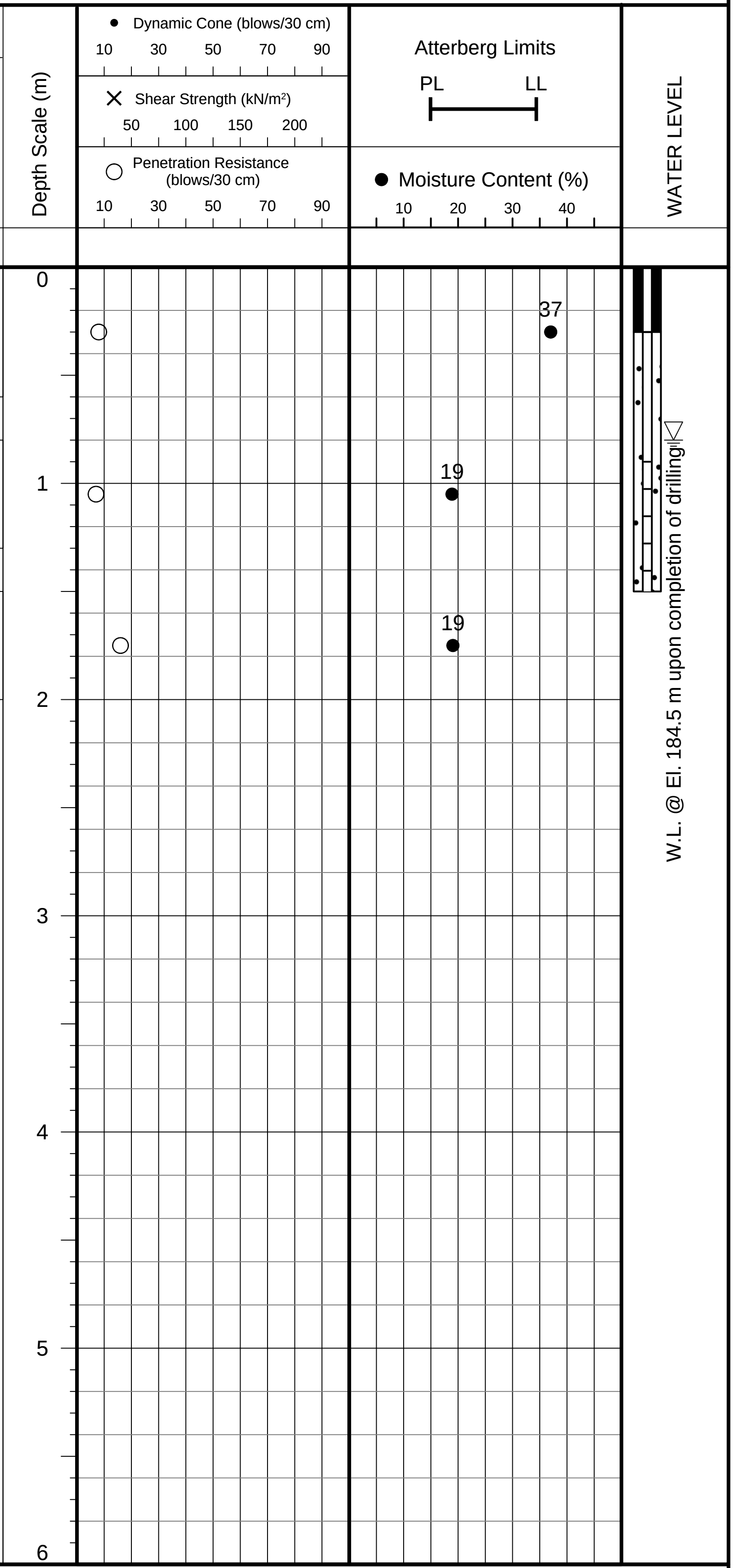
PROJECT DESCRIPTION: Proposed Residential Development

METHOD OF BORING: Flight Auger

PROJECT LOCATION: 372 Grey Road 21 West, Town of The Blue Mountains

DRILLING DATE: April 18, 2022

El. (m) Depth (m)	SOIL DESCRIPTION	SAMPLES Number	SAMPLES Type	SAMPLES N-Value
185.3 0.0	Ground Surface **36 cm Topsoil**			
	Brown, loose to compact **SAND AND GRAVEL** a trace to some silt occ. cobbles and boulders weathered disturbed	1	DO	8
		2	DO	7
		3	DO	16
183.2 2.1	**END OF BOREHOLE due to auger refusal on probable bedrock** Installed 50 mm Ø monitoring well to 1.5 m completed with 0.6 m screen Sand backfill from 0.3 to 1.5 m Bentonite seal from 0.0 m to 0.3 m Provided with a monument steel casing			



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JOB NO.: 2201-S051B

LOG OF BOREHOLE: 10

FIGURE NO.: 6

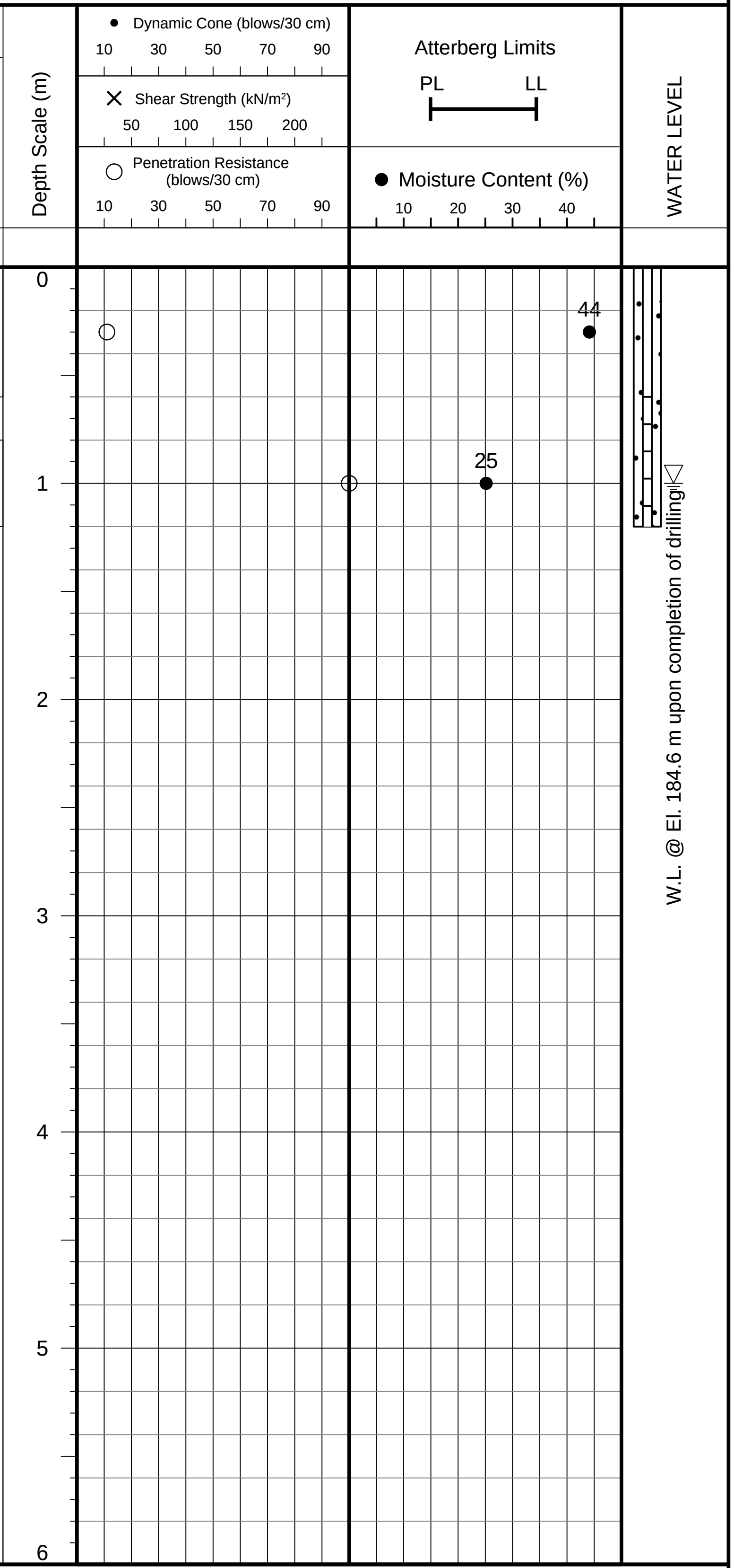
PROJECT DESCRIPTION: Proposed Residential Development

METHOD OF BORING: Flight Auger

PROJECT LOCATION: 372 Grey Road 21 West, Town of The Blue Mountains

DRILLING DATE: April 18, 2022

El. (m) Depth (m)	SOIL DESCRIPTION	SAMPLES Number	Type	N-Value
185.6	Ground Surface			
0.0	**36 cm Topsoil**	1	DO	11
	Brown, compact to very dense **SAND AND GRAVEL** a trace to some silt occ. cobbles and boulders weathered	2	DO	50/20
184.4 1.2	**END OF BOREHOLE due to auger refusal on probable bedrock** Installed 50 mm Ø monitoring well to 1.2 m completed with 0.6 m screen Sand backfill from 0.0 to 1.2 m Provided with a monument steel casing			



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JOB NO.: 2201-S051B

LOG OF BOREHOLE: 11

FIGURE NO.: 7

PROJECT DESCRIPTION: Proposed Residential Development

METHOD OF BORING: N/A

PROJECT LOCATION: 372 Grey Road 21 West, Town of The Blue Mountains

DRILLING DATE: N/A

El. (m) Depth (m)	SOIL DESCRIPTION	SAMPLES Number	SAMPLES Type	SAMPLES N-Value	Depth Scale (m)	● Dynamic Cone (blows/30 cm) 10 30 50 70 90 × Shear Strength (kN/m²) 50 100 150 200 ○ Penetration Resistance (blows/30 cm) 10 30 50 70 90	Atterberg Limits PL ⊢—⊣ LL ● Moisture Content (%) 10 20 30 40	WATER LEVEL
100.0	Ground Surface							
0.0	**BOREHOLE CANCELLED DUE TO INACCESSIBILITY**				0			
					1			
					2			
					3			
					4			
					5			
					6			

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JOB NO.: 2201-S051B

LOG OF BOREHOLE: 12

FIGURE NO.: 8

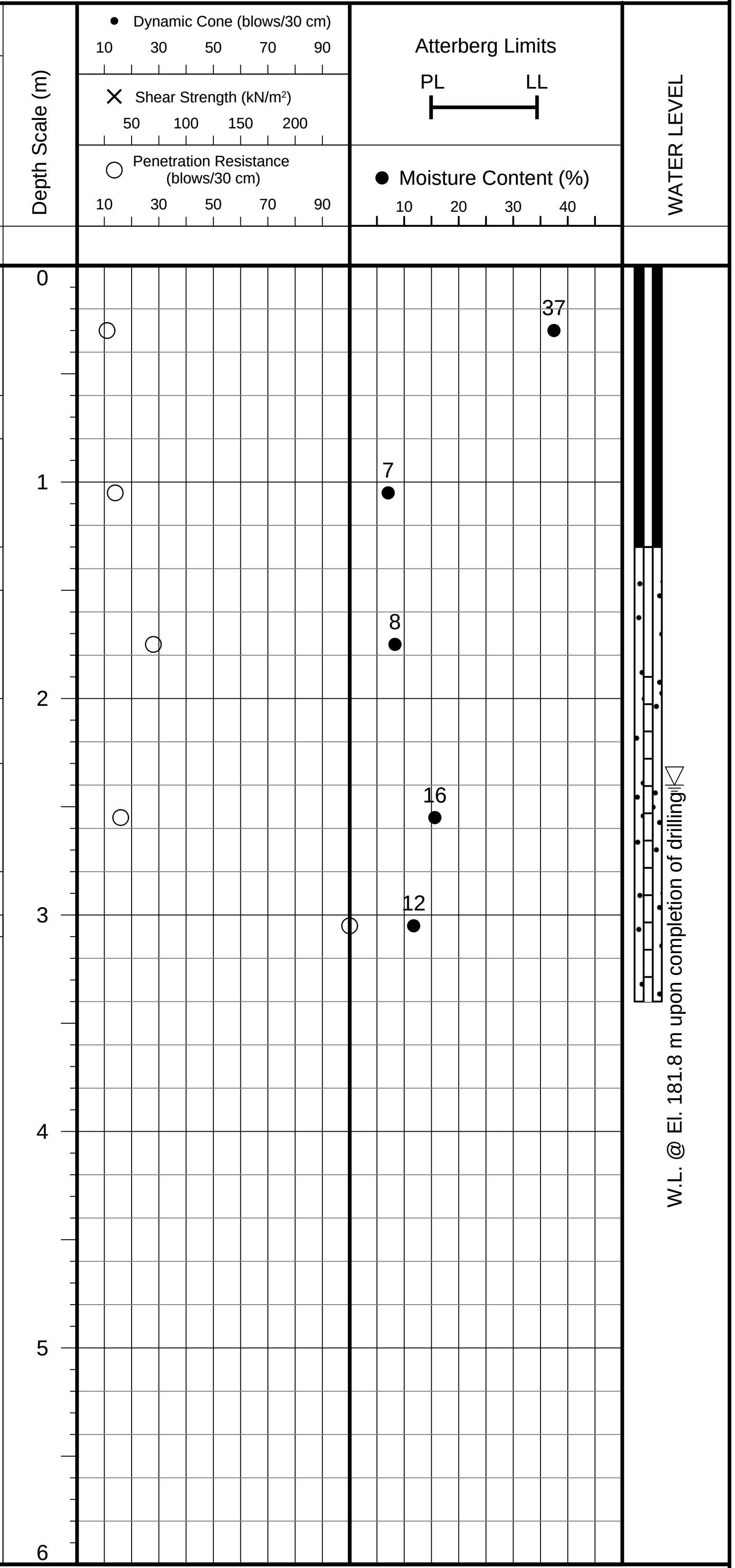
PROJECT DESCRIPTION: Proposed Residential Development

METHOD OF BORING: Flight Auger

PROJECT LOCATION: 372 Grey Road 21 West, Town of The Blue Mountains

DRILLING DATE: April 18, 2022

El. (m) Depth (m)	SOIL DESCRIPTION	SAMPLES Number	Type	N-Value
184.2	Ground Surface			
0.0	**30 cm Topsoil**			
	Brown, compact to very dense **SAND AND GRAVEL** a trace to some silt occ. cobbles and boulders weathered	1	DO	11
		2	DO	14
		3	DO	28
	disturbed	4	DO	16
		5	DO	50/15
180.8 3.4	**END OF BOREHOLE due to auger refusal on probable bedrock** Installed 50 mm Ø monitoring well to 3.4 m completed with 1.5 m screen Sand backfill from 1.3 to 3.4 m Bentonite seal from 0.0 m to 1.3 m Provided with a monument steel casing			



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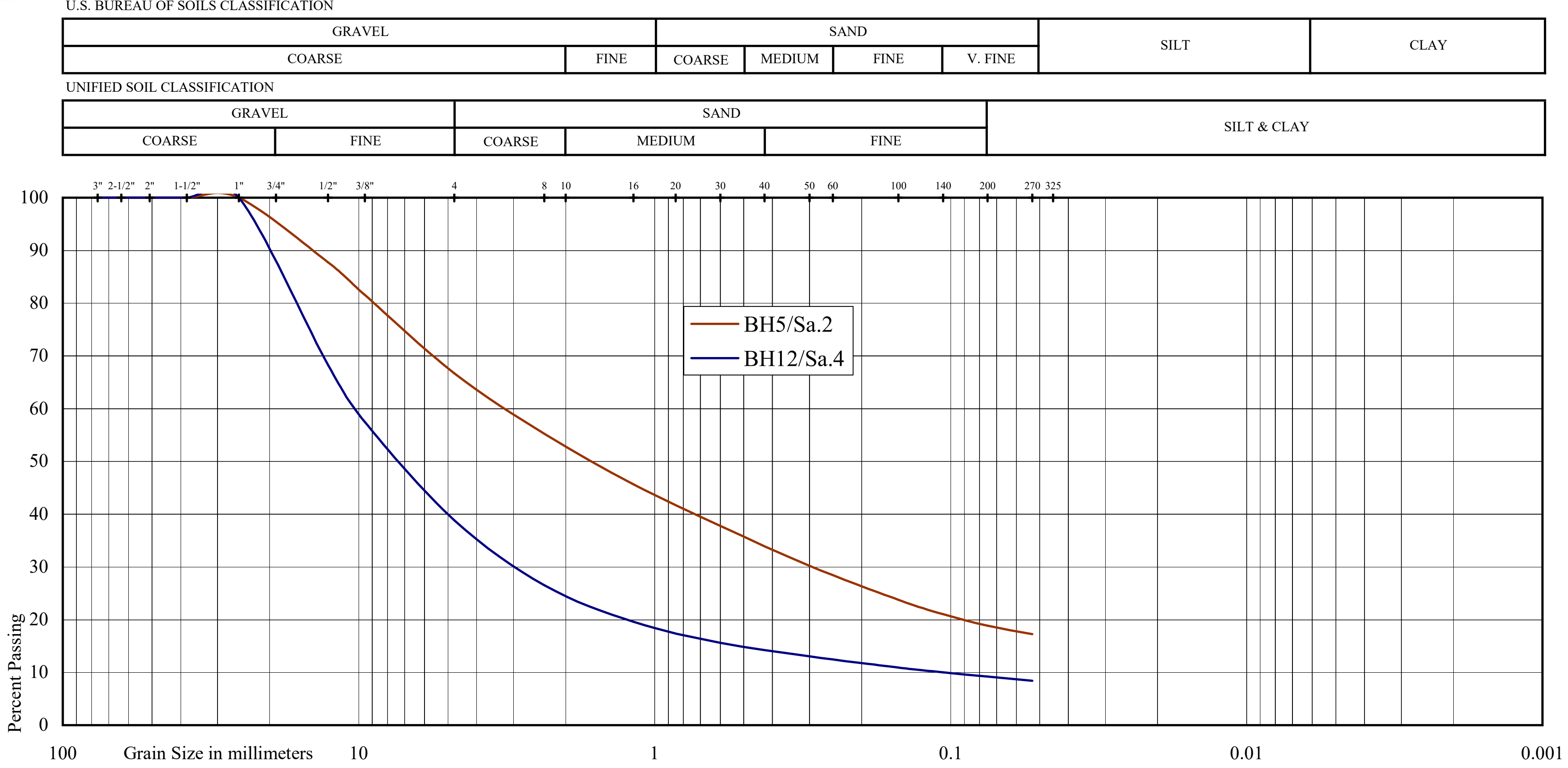
GRAIN SIZE DISTRIBUTION

Reference No: 2201-S051B



Project: Proposed Residential Development

Location: 372 Grey Road 21 West, Town of The Blue Mountains

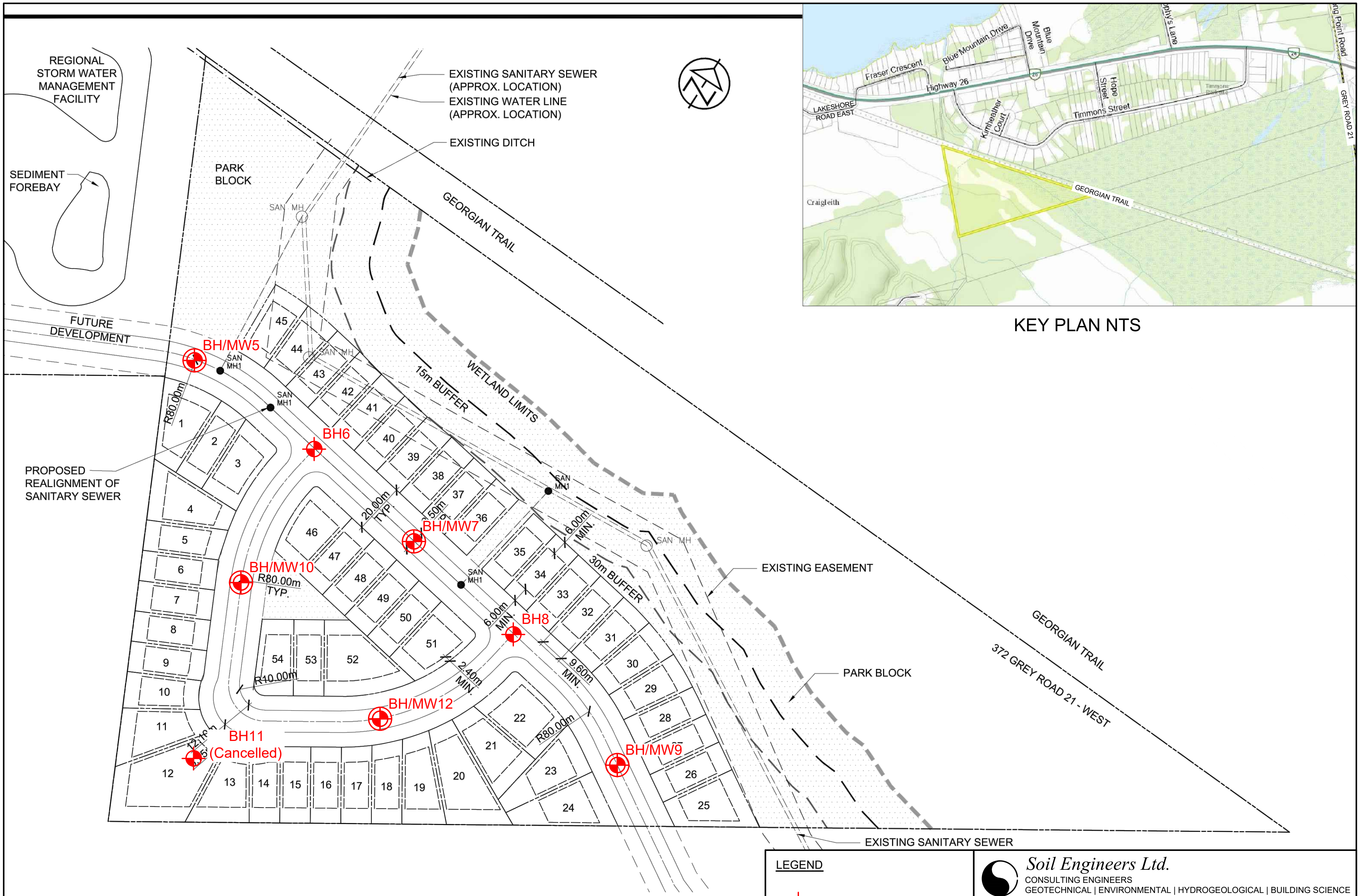
Borehole No:	5	12
Sample No:	2	4
Depth (m):	0.8	2.3
Elevation (m):	182.9	181.9

BH/Sa.:	5/2	12/4
Liquid Limit (%) =	-	-
Plastic Limit (%) =	-	-
Plasticity Index (%) =	-	-
Moisture Content (%) =	16	20
Estimated Permeability (cm./sec.) =	10^{-3}	10^{-2}

Classification of Sample [& Group Symbol]: SAND AND GRAVEL

a trace to some silt

Figure 9



KEY PLAN NTS

LEGEND

⊕ Boreholes

⊕ Boreholes/ Monitoring Wells

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Borehole/Monitoring Well Location Plan

SITE: 372 Grey Road 21 West, Town of The Blue Mountains

DESIGNED BY: C.R. **CHECKED BY:** K.F.L. **DWG NO.:** 1

SCALE: 1:2000 **REF. NO.:** 2201-S051B **DATE:** September 2022 **REV** -

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SUBSURFACE PROFILE
DRAWING NO. 2
SCALE: AS SHOWN

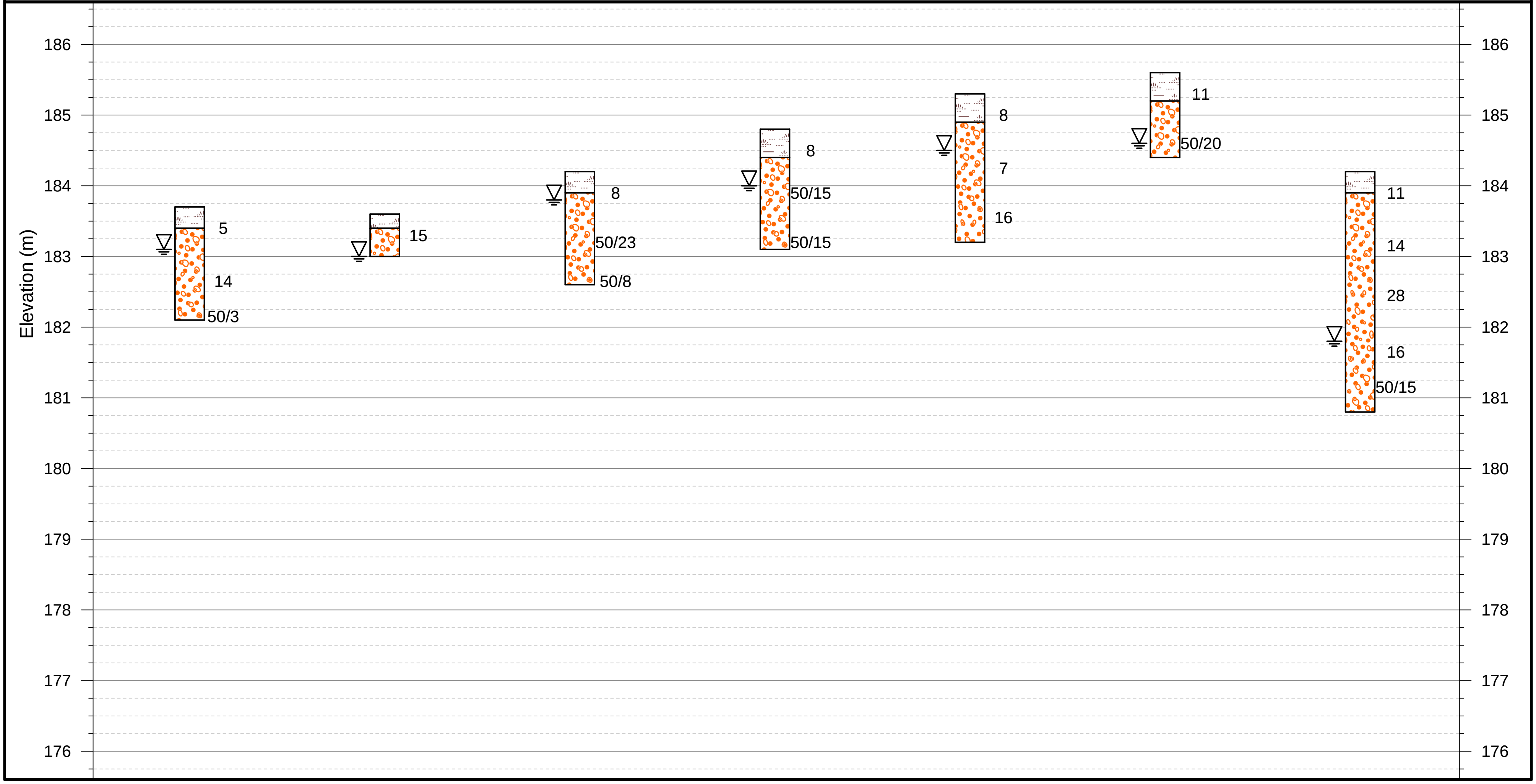
JOB NO.: 2201-S051B
REPORT DATE: September 2022
PROJECT DESCRIPTION: Proposed Residential Development
PROJECT LOCATION: 372 Grey Road 21 West, Town of The Blue Mountains

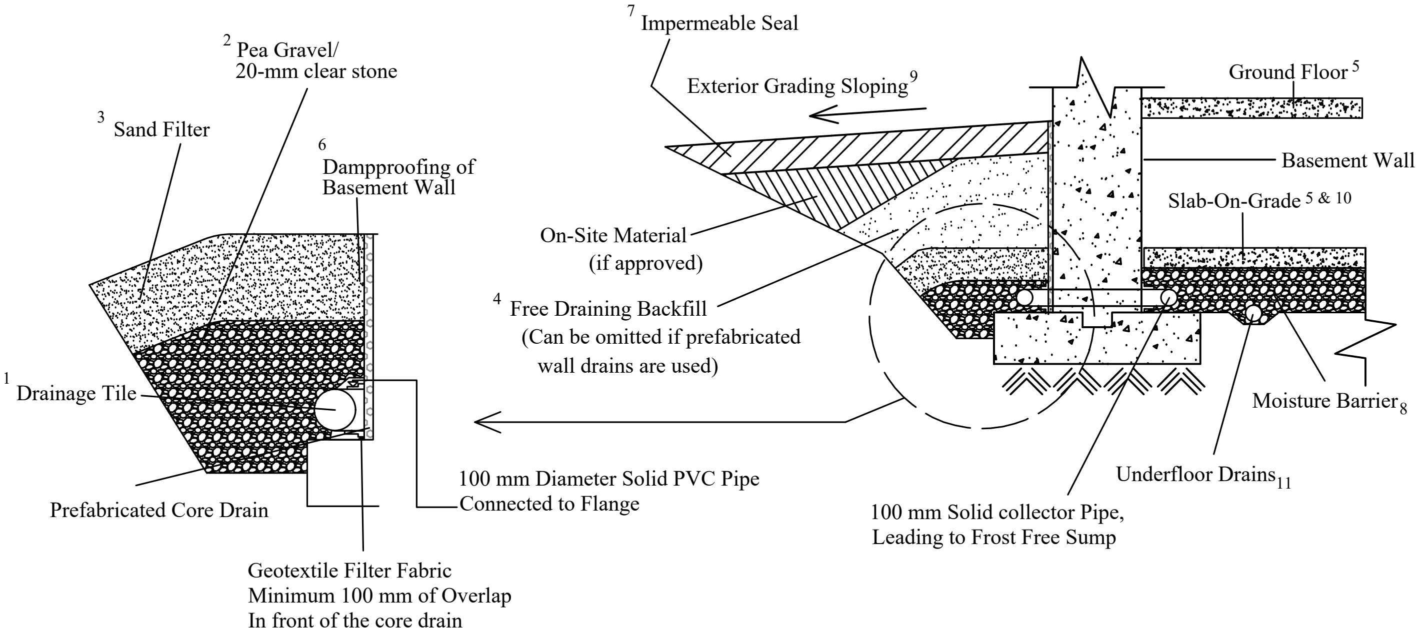
LEGEND

▨ SAND AND GRAVEL ▤ TOPSOIL

▽ WATER LEVEL (END OF DRILLING)

BH No.:	5	6	7	8	9	10	12
El. (m):	183.7	183.6	184.2	184.8	185.3	185.6	184.2





NOTES:

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

2. **Pea gravel**: at 150 mm (6") on the top and sides of drain. If drain is not placed on concrete footing, provide 100 mm (4") of pea gravel below drain. The pea gravel may be replaced by 20 mm clear stone provided that the drain is covered by a porous geotextile membrane of Terrafix 270R or equivalent.

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

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

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

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

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

8. **Moisture barrier**: 20-mm clear stone or compacted OPSS Granular 'A', or equivalent. The thickness of this layer should be 150 mm (6") minimum.

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

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

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

*Underfloor drains can be deleted where not required.

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Details of Perimeter Drainage System

SITE 372 Grey Road 21 East, Town of The Blue Mountains

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

SCALE N.T.S. **REF. NO.** 2201-S051B **DATE** September 2022 **REV** -