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A REPORT TO
LSR SALEM

A GEOTECHNICAL INVESTIGATION
FOR
PROPOSED RESIDENTIAL SUBDIVISION

500 SALEM ROAD

TOWN OF INNISFIL

REFERENCE NO. 2203-S111

JULY 2022

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ENCLOSURES

1.0 INTRODUCTION

In accordance with the written authorization dated March 23, 2022, from Mr. Adam Steeves of LSR Salem, a geotechnical investigation was carried out at 500 Salem Road in the Town of Innifil.

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 proposed residential subdivision. The geotechnical findings and resulting recommendations are presented in this Report.

2.0 SITE AND PROJECT DESCRIPTION

The Town of Innisfill is situated in the Lake Simcoe basin, where the glacial till has been partly eroded in places by glacial Lake Algonquin and filled with lacustrine sand and silt.

The subject land parcel, encompassing an approximate area of 3.33 hectares, is located to the north of Salem Road and approximately 60 m east of County Road 27 in the Town of Innisfil. An Environmental Land, consisting of a creek with wetland on both sides, separates the land parcel into two. The investigated area is located to the east of the Environmental Land, which encompasses an approximate area of 0.68 hectares. Based on aerial photographs and our site visit, earth works had occurred in the past within the investigated area. The existing site gradient generally descends north-westerly towards the creek.

Based on the Conceptual Site Plan provided by Innovative Planning Solutions, the site will be regraded for townhouse development, with municipal services and paved roadways meeting urban standards.

3.0 FIELD WORK

The field work, consisting of three (3) sampled boreholes extending to a depth of 6.6 m to 8.1 m, was performed on April 7, 2022, at the locations shown on the Location Plan, Drawing No. 1.

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, three (3) monitoring wells were installed in the boreholes to facilitate groundwater monitoring and a hydrogeological study, performed by other consultant. Details of the monitoring wells are included in the corresponding borehole logs.

The ground elevation of each borehole location was determined using hand-held Global Navigation Satellite System (GNSS) survey equipment.

4.0 SUBSURFACE CONDITIONS

The boreholes were drilled in the open area, covered with weed. The investigation has revealed that beneath the topsoil and a layer of earth fill, the area is underlain by sand and silty sand till deposits.

Detailed descriptions of the encountered subsurface conditions from the boreholes are presented on the Borehole Logs, comprising Figures 1 to 3, inclusive. The revealed stratigraphy is plotted on the Subsurface Profiles, Drawing No. 2. The engineering properties of the disclosed soils are discussed herein.

4.1 **Topsoil** (All Boreholes)

The revealed topsoil thickness is 15 to 25 cm in the boreholes. Topsoil thicker may be found beyond the borehole locations, particularly in treed and low lying areas.

4.2 **Earth Fill** (All Boreholes)

A layer of earth fill, extending to a depth of 0.7 m to 2.2 m, was contacted beneath the topsoil. It consisted of silty clay, with rootlets, organics, and rock fragments.

The recorded ‘N’ values ranged from 8 to 35 blows per 30 cm of penetration, indicating that the fill was non-uniform in compaction.

The water content values of the earth fill samples ranged from 7% to 21%, with a median of 17%, indicating generally moist conditions.

One must be aware that the samples retrieved from boreholes may not be truly representative of the geotechnical and environmental quality of the earth fill. It can be assessed by laboratory testing and/or test pits if necessary.

4.3 **Sand** (All Boreholes)

The sand deposit was encountered beneath the earth fill and extends to a depth of 5.6 m to 6.6 m from the prevailing ground surface in the boreholes. It is fine to medium grained, with a trace of silt. Grain size analyses were performed on two representative samples; the results are plotted on Figure 4.

The recorded ‘N’ values of the sand deposit ranged from 14 to 65, with a median of 31 blows per 30 cm of penetration, indicating that the deposit is compact to very dense, being generally dense in relative density. The natural water content values of the sand samples range from 2% to 22%, with a median of 17%, indicating generally wet conditions and is likely water bearing. The relatively low ‘N’ value can be a result of disturbance in the deposit by the hydrostatic pressure during the drilling and sampling operation.

The engineering properties of the sand deposit are presented below:

- Low frost susceptibility and high in water erodibility.
- Pervious, with an estimated coefficient of permeability of 10^{-2} to 10^{-3} cm/sec and a percolation time of 4 min/cm to 8 min/cm.
- The shear strength is derived from internal friction and is soil density dependent.
- The deposit will slough to its angle of repose in excavation, runs with water seepage and will boil with piezometric head of 0.3 m.
- Fair pavement-supportive material, with an estimated California Bearing Ratio (CBR) value of over 12%.
- Low corrosivity to buried metal, with an estimated electrical resistivity of 6000 ohm.cm.

4.4 **Silty Sand Till** (Boreholes 1 and 3)

The native silty sand till stratum was contacted in the lower stratigraphy of the boreholes. The boreholes were terminated within the till deposit and the lower limit of the till was not established.

The silty sand till is heterogeneous in structure, consisting of a random mixture of particle sizes ranging from clay to gravel, with sand and silt being the dominant fraction. Sample examinations disclosed that the till deposit was slightly cemented and displayed some cohesion when remoulded. Grain size analysis was performed on a representative sample and the result is plotted on Figure 5.

High resistance in borehole drilling was detected, indicating probable cobbles or boulders in the till mantle. The obtained ‘N’ values are 11, 48 and 80 blows per 30 cm penetration, indicating the till is compact to very dense in relative density.

The natural water content value of the till samples is 10%, indicating moist conditions.

The engineering properties of the silty sand till deposit are listed below:

- Moderate to moderately high frost susceptibility and low water erodibility.
- Relatively pervious, with an estimated coefficient of permeability of 10^{-4} cm/sec, and a percolation time of 12 min/cm.
- The till will be relatively stable in steep excavation; however, the sand layers in the till deposit may slough after prolonged exposure.
- A fair pavement-supportive material, with an estimated CBR value of 8%.
- Moderate corrosivity to buried metal, with an estimated electrical resistivity of 4500 ohm/cm.

4.5 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 +
Existing Earth Fill	7 to 21 (median 17)	15	11 to 18
Sand	2 to 22 (median 17)	8	5 to 10
Silty Sand Till	10	10	8 to 13

The above values show that the till is suitable for structural compaction while the sand is generally too wet. The wet sand can be properly stockpiled to allow draining of the excess water prior to backfilling. The existing earth fill must be sorted free of organics and other deleterious material prior to reuse for structural backfill.

When compacting the till on the dry side of the optimum, the compactive energy will frequently bridge over the chunks in the soil and be transmitted laterally into the soil mantle. Therefore, the lifts of these soils must be limited to 20 cm or less before compaction.

Rock and boulders will prevent transmission of the compactive energy into the underlying material to be compacted. Any boulders over 15 cm in size must be sorted and not be included for structural backfill and/or construction of engineered fill.

5.0 GROUNDWATER CONDITION

The boreholes were checked for the presence of groundwater and cave-in upon completion of drilling. Free groundwater was measured at depths of 2.1 m to 3.4 m (or El. 304.8 m to 305.6 m) upon borehole completion. Cave-in was logged at depths of 4.6 m and 6.1 m (or El. 300.8 m to 304.1 m) in the boreholes. The groundwater and cave-in depths are plotted on the Borehole Logs and summarized in Table 2.

Table 2 - Groundwater and Cave-in Levels Upon Completion

Borehole No.	**Ground Elevation (m)**	**Borehole Depth (m)**	**Groundwater/Cave-In* Level**	
			Depth (m)	**Elevation (m)**
1	306.9	8.1	2.1/6.1*	304.8/300.8*
2	308.3	6.6	3.4/4.6*	304.9/303.7*
3	308.7	6.6	3.1/4.6*	305.6/304.1*

Groundwater was recorded in the monitoring wells on July 8, 2022. The well records are summarized in Table 3.

Table 3 - Groundwater Records in Monitoring Wells

Monitoring Well No.	Ground Elevation (m)	Well Depth (m)	July 8, 2022	
			Depth (m)	**Elevation (m)**
1	306.9	6.0	1.5	305.4
2	308.3	6.0	2.4	305.9
3	308.7	6.0	2.6	306.1

Free groundwater level was recorded in the monitoring wells at a depth of 1.5 m to 2.4 m (or El. 305.4 m to 306.1 m). The recorded water level may represent the groundwater regime in the vicinity and it could have been derived from the creek. It is subject to seasonal fluctuations.

6.0 DISCUSSION AND RECOMMENDATIONS

The investigation has disclosed that beneath the topsoil and a layer of earth fill, the site is underlain by sand and silty sand till deposits.

Free groundwater level was recorded in the monitoring wells at a depth of 1.5 m to 2.4 m (or El. 305.4 m to 306.1 m). The recorded water level may represent the groundwater regime in the vicinity and it could have been derived from the creek. It is subject to seasonal fluctuations.

Based on the Conceptual Site Plan, the site will be regraded for the townhouse development, with municipal services and paved roadways meeting urban standards. The geotechnical findings which warrant special consideration are presented below:

1. The topsoil must be removed before site grading and development. It can be stockpiled on site and reused in landscaped areas of the new subdivision. Any surplus should be removed off site.
2. The history and quality of fill are not known. The existing fill is not suitable for supporting any structure sensitive to movement. In using the fill for engineered fill or structural backfill, it should be subexcavated, inspected for its geotechnical and chemical properties, sorted free of topsoil or deleterious material, aerated and properly compacted in layers.
3. Where additional fill is required for site grading, it is economical to place an engineered fill to the development.

4. The houses can be constructed on conventional spread and strip footings founded on engineered fill or native subsoil.
5. 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; otherwise, underfloor subdrains will be required. Where the lowest floor level is less than 0.5 m above the highest groundwater level, or submerged into the groundwater, the underground structure must be waterproofed and designed with a raft foundation to resist the hydrostatic uplift pressure.

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

Prior to site grading, the topsoil must be removed. The topsoil can be stockpiled on site to be reused in landscaped areas. Any surplus should be removed off site.

If the existing earth fill is to be reused as engineered/structural fill, the type and quality of material must be reviewed in order to confirm suitability. The engineering requirements for a certifiable fill for house foundations, municipal services, and pavement construction are presented below:

1. After the existing topsoil is removed, the subgrade must be inspected and proof-rolled prior to any fill placement. The existing fill should 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% of the maximum SPDD.
3. Rock and boulders over 15 cm in size must be sorted and not be included for structural backfill and/or construction of engineered fill.
4. 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.

5. 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.
6. 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.
7. If the engineered fill is to be left over the winter months, adequate earth cover, or equivalent, must be provided for protection against frost action. Placement of engineered fill and backfill material shall be free of any frozen material.
8. Where the ground is wet due to subsurface water seepage, an appropriate subdrain scheme must be implemented prior to the fill placement.
9. Where the fill is to be placed on sloping ground, the area must be benched or flattened to 1 vertical (V):3 horizontal (H) so that it is suitable for safe operation of the compactor and the required compaction can be obtained.
10. The fill operation must be inspected on a full-time basis by a technician under the direction of a geotechnical engineer.
11. The footing 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 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.
12. Any excavation carried out in certified engineered fill must be reported to the geotechnical consultant who supervised the fill placement in order to document the locations of the excavation and/or to supervise reinstatement of the excavated areas to engineered fill status. If construction on the engineered fill does not commence within a period of 2 years from the date of certification, the condition of the engineered fill must be assessed for re-certification.
13. Despite stringent control in the placement of engineered fill, variations in soil type and density may occur in engineered fill. Therefore, strip footings and the upper section of foundation walls constructed on engineered fill will require continuous reinforcement. The required number and size of reinforcing bars must be assessed by considering the uniformity as well as the thickness of the engineered fill beneath the foundations.
14. In sewer construction, the engineered fill is considered to have the same structural proficiency as a natural inorganic soil.

6.2 House Foundations

The houses can be constructed on conventional footings founded on engineered fill or native subsoil. If there is a basement structure, the structure must be designed at least 1.0 above the highest groundwater table. 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

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

Foundations exposed to weathering or in unheated areas should have at least 1.4 m of earth cover for protection against frost action.

The foundation subgrade should be inspected by the geotechnical engineer or a senior geotechnical technician to ensure that the revealed conditions are compatible with the foundation design requirements.

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 and inspection. This will prevent construction disturbance and costly rectification of the bearing subsoil.

The building foundations should meet the requirements specified in the latest Ontario Building Code and the structures should be designed to resist an earthquake force using Site Classification ‘D’ (stiff soil).

6.3 Basement and Slab-On-Grade Construction

Continuous groundwater is apparent at a depth of 1.5 m to 2.6 m (or El. 305.4 m to 306.1 m). The recorded water level may represent the groundwater regime in the vicinity. 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, the basement structure, founded at least 1.0 m above the highest groundwater level, should be provided with a perimeter drainage system at the wall base as shown on Drawing No. 3. The subdrains should be encased in fabric filter to protect them against blockage by silting and connected to positive outlets. In case where 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 founded less than 0.5 m above the highest groundwater level or submerged into the groundwater, the underground structure must be waterproofed and designed with a raft foundation to resist the hydrostatic uplift pressure. The basement slab will be poured on a granular fill above the raft where the underground utilities and pipes will be laid.

The soil parameters in Section 6.8 can be used for evaluation of the lateral pressure and uplift pressure.

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

The pipe joints connecting into the manholes and catch basins must be leak-proof to prevent the migration of fines through the joints. 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 not less than 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 requirement must meet the minimum requirement as specified by the Town Standard.

6.5 Backfilling in Trenches and Excavated Areas

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 settlement largely occur adjacent to manholes, catch basins, service crossings, foundation walls and columns. In areas which are inaccessible to a heavy compactor, granular backfill should be used for compaction with a smaller vibratory compactor.

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

- When construction is carried out in freezing winter weather, allowance should be made for these following conditions. Despite stringent backfill monitoring, 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 flooding of the backfill when it is required, such as in a narrow vertical trench section, or when the trench box is removed. The above will invariably cause backfill settlement that may become evident within one to several years, depending on the depth of the trench which has been backfilled.
- 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.

- To backfill a deep trench, one must be aware that future settlement is to be expected, unless the side of the cut is flattened to at least 1V:1.5+H, and the lifts of the fill and its moisture content are stringently controlled; i.e., lifts should be no more than 20 cm (or less if the backfilling conditions dictate) and uniformly compacted to achieve at least 95% SPDD, with the moisture content on the wet side of the optimum.
- 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 granular fill or sand. In a trench stabilized by a trench box, the void left after the removal of the box will be filled by the backfill. It is necessary to backfill this sector with granular fill or sand, and the compacted backfill must be flooded for a few days, 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.
- In areas where groundwater movement is expected in the sand fill mantle, anti-seepage collars should be provided.

6.6 Driveways, Sidewalks, 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 road pavement should meet the Town's standard. The recommended road pavement design for local roads is presented in Table 4.

Table 4 - Pavement Design

Course	Thickness (mm)	OPS Specifications
Asphalt Surface	40	HL 3
Asphalt Binder	60	HL 8
Granular Base	150	OPSS Granular 'A' or equivalent
Granular Sub-base	400	OPSS Granular 'B' or equivalent

In preparation of the road subgrade, all topsoil and compressible material should be removed. After fine grading and before placement of the granular base, the subgrade must be proof-rolled. Any soft spot as identified must be sub-excavated and replaced with selected inorganic material, compacted to the specified density. The subgrade within 1.0 m below the underside of the granular sub-base must be compacted to at least 98% SPDD, with the water content at 2% to 3% drier than its optimum. The granular base and sub-base should be compacted to 100% SPDD.

The road 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:

- The subgrade should be properly crowned and smooth-rolled to allow interim precipitation to be properly drained prior to pavement construction.
- Lot areas adjacent to the roads should be properly graded to prevent ponding of large amounts of water.
- If the roads are to be constructed during wet seasons and extensive soft subgrade occurs, the granular sub-base may require thickening. This can be assessed during construction.
- Fabric filter-encased curb subdrains are required on both sides of roadway to meet the Town's requirements.

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/m³)**		**Estimated Bulk Factor**	
	Bulk	**Submerged**	**Loose**	**Compacted**
Existing Earth Fill	20.5	10.5	1.25	1.00
Sand	21.5	11.5	1.20	1.00
Silty Sand Till	22.5	12.5	1.30	1.03

Lateral Earth Pressure Coefficients	**Active K_a**	**At Rest K_0**	**Passive K_p**
Compacted Earth Fill	0.40	0.55	2.50
Sand	0.30	0.45	3.40
Silty Sand Till	0.30	0.50	3.10

Coefficients of Friction	
Between Concrete and sound native Soil	0.35
Between Concrete and Granular Base	0.50

6.9 Excavation

Excavation should be carried out in accordance with Ontario Regulation 213/91. The types of soils are classified in Table 6.

Table 6 - Classification of Soils for Excavation

Material	**Type**
Sound Till	2
Earth Fill, drained Sand	3
Saturated Soils	4

Continuous groundwater is expected in the sand deposit. Any excavation into the saturated soils will require vigorous pumping from closely spaced sumps and sump wells.

Excavation into the tills containing boulders may require extra effort and the use of a heavy-duty excavator.

Prospective contractors must be asked to assess the in situ subsurface conditions for soil cuts by digging test pits to 0.5 m below the anticipated depth of excavation. These test pits should be allowed to remain open for a few hours to assess the trenching conditions.

7.0 LIMITATIONS OF REPORT

This report was prepared by Soil Engineers Ltd. for the account of LSR Salem, and for review by its designated consultants and government agencies. Use of this report is subject to the conditions and limitations of the contractual agreement.

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. 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.

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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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GEOTECHNICAL • ENVIRONMENTAL • HYDROGEOLOGICAL • BUILDING SCIENCE

JOB NO.: 2203-S111

LOG OF BOREHOLE: 1

FIGURE NO.: 1

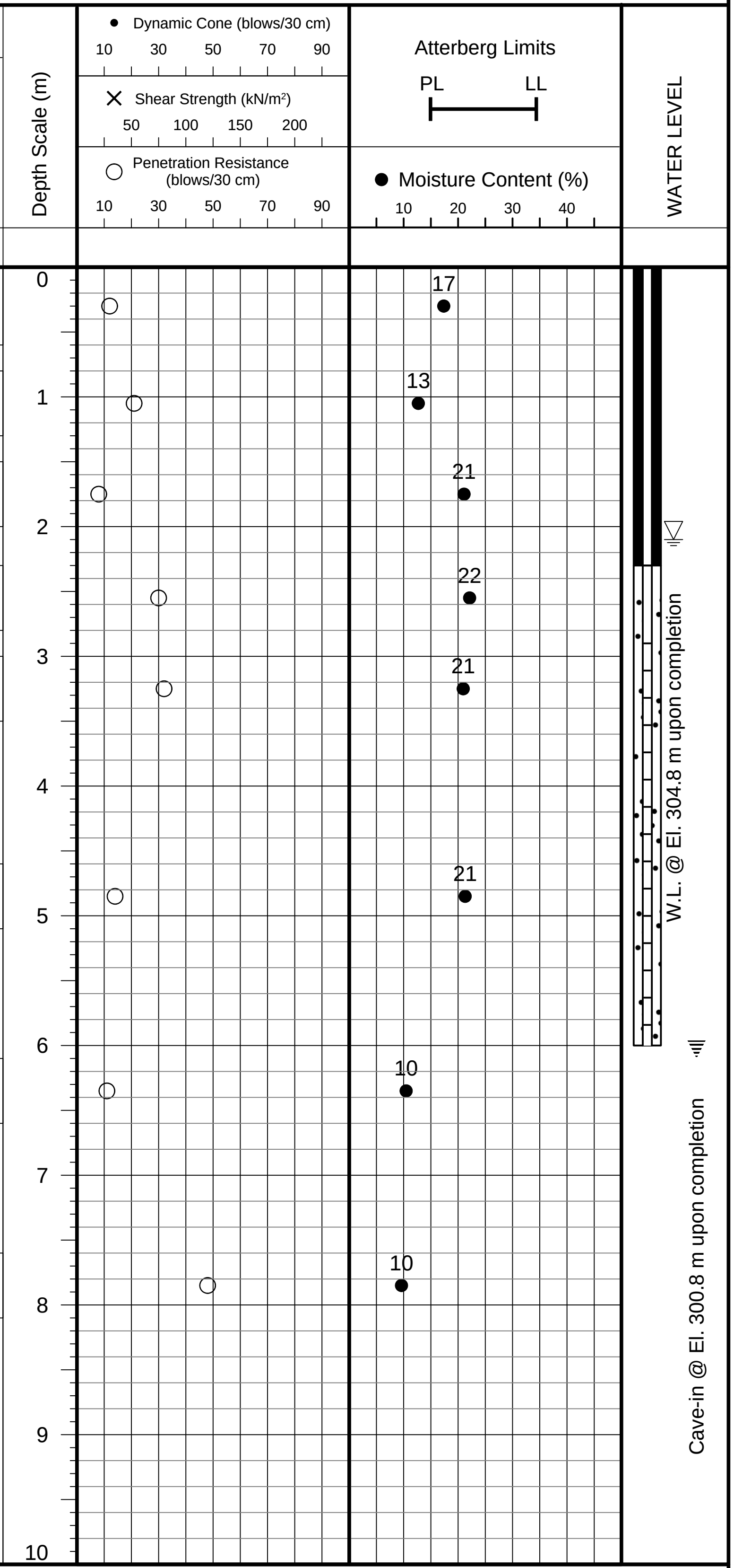
PROJECT DESCRIPTION: Proposed Residential Subdivision

METHOD OF BORING: Flight Auger
(Hollow Stem)

PROJECT LOCATION: 500 Salem Road, Town of Innisfil

DRILLING DATE: April 7, 2022

El. (m) Depth (m)	SOIL DESCRIPTION	SAMPLES Number	Type	N-Value
306.9	Ground Surface			
0.0	**20 cm of Topsoil** **EARTH FILL** Dark brown silty clay occ. organics, rootlets and rock fragments	1	DO	12
		2	DO	21
		3	DO	8
304.7 2.2	Grey, compact to dense, wet **SAND** traces of silt and gravel	4	DO	30
		5	DO	32
		6	DO	14
301.3 5.6	Grey, compact to dense **SILTY SAND TILL** traces of clay and gravel occ. sand seams and layers occ. cobbles and boulders	7	DO	11
		8	DO	48
298.8 8.1	**END OF BOREHOLE** Installed 50 mm Ø monitoring well to 6.0 m completed with 3.1 m screen Sand backfill from 2.3 to 6.0 m Bentonite seal from 0.0 m to 2.3 m Provided with a momument steel casing			



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JOB NO.: 2203-S111

LOG OF BOREHOLE: 2

FIGURE NO.: 2

PROJECT DESCRIPTION: Proposed Residential Subdivision

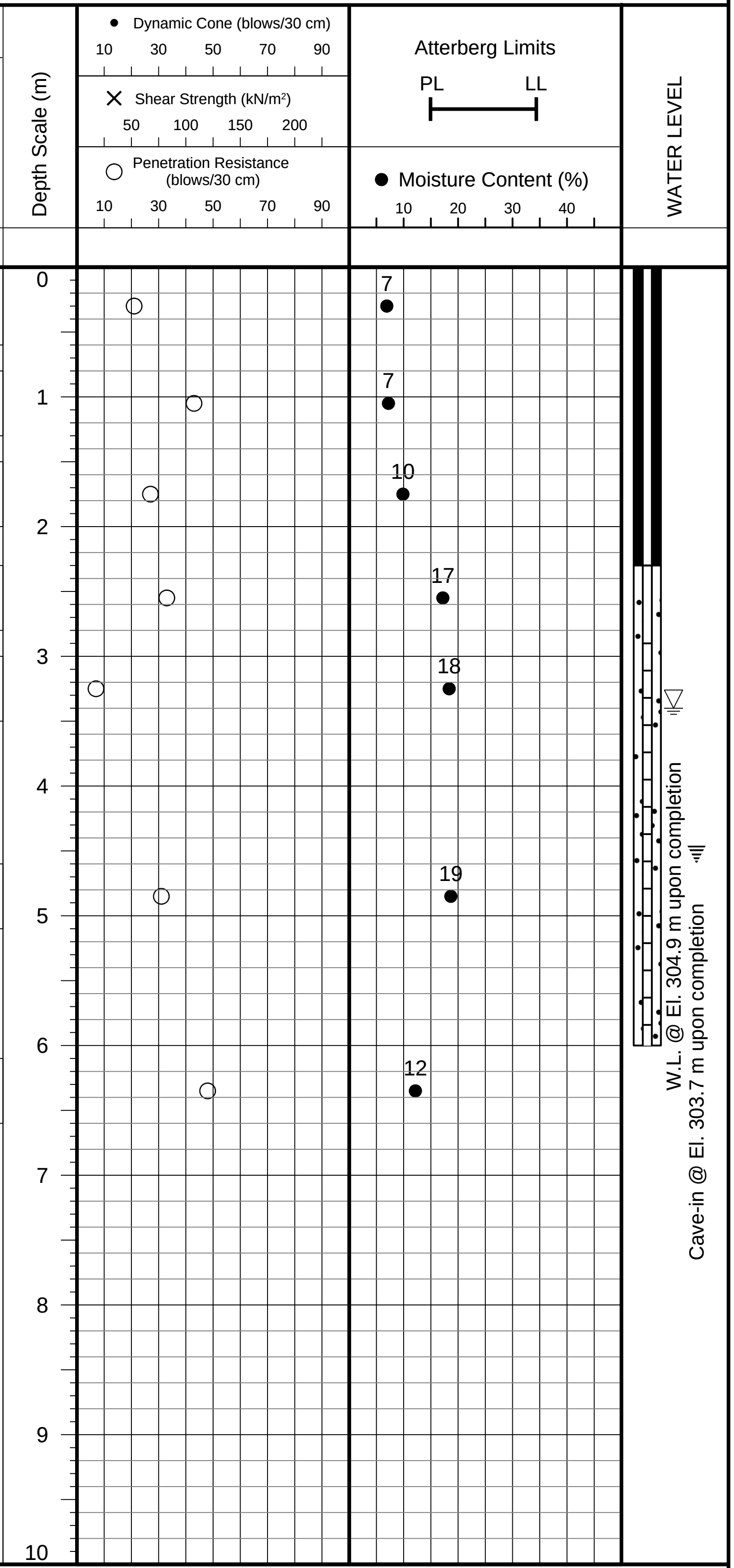
METHOD OF BORING: Flight Auger (Hollow Stem)

PROJECT LOCATION: 500 Salem Road, Town of Innisfil

DRILLING DATE: April 7, 2022

El. (m) Depth (m)	SOIL DESCRIPTION
308.3	Ground Surface
0.0	**15 cm of Topsoil**
	EARTH FILL Dark brown silty clay occ. organics, rootlets and rock fragments
307.6 0.7	Compact to dense **SAND** traces of silt and gravel wet below 2.3 m — — gravelly — — disturbed — — brown / grey
301.7 6.6	**END OF BOREHOLE** Installed 50 mm Ø monitoring well to 6.0 m completed with 3.1 m screen Sand backfill from 2.3 to 6.0 m Bentonite seal from 0.0 m to 2.3 m Provided with a momument steel casing

SAMPLES		
Number	Type	N-Value
1	DO	21
2	DO	43
3	DO	27
4	DO	33
5	DO	7
6	DO	31
7	DO	48



Soil Engineers Ltd.

JOB NO.: 2203-S111

LOG OF BOREHOLE: 3

FIGURE NO.: 3

PROJECT DESCRIPTION: Proposed Residential Subdivision

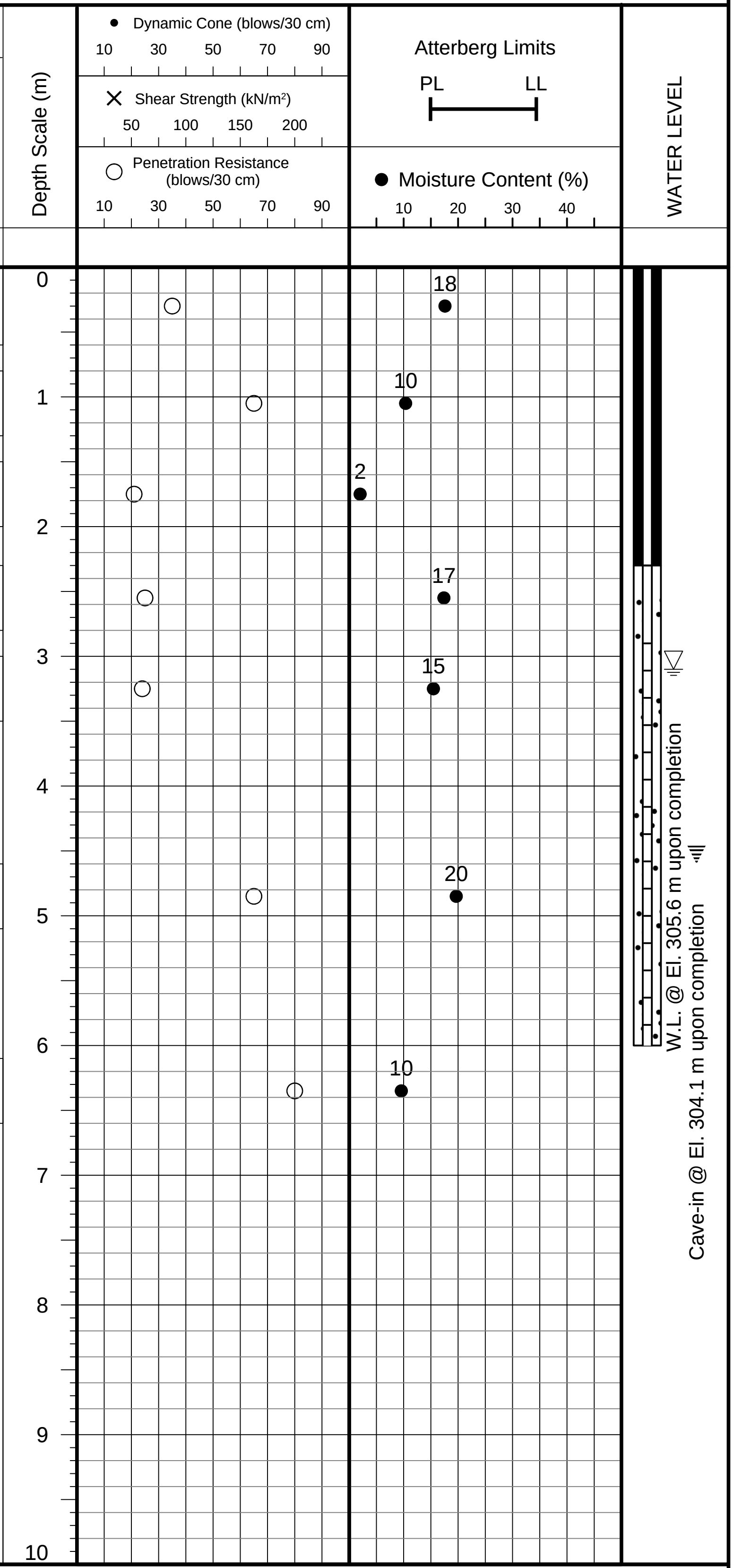
METHOD OF BORING: Flight Auger (Hollow Stem)

PROJECT LOCATION: 500 Salem Road, Town of Innisfil

DRILLING DATE: April 7, 2022

El. (m) Depth (m)	SOIL DESCRIPTION	SAMPLES Number	Type	N-Value
308.7	Ground Surface			
0.0	**25 cm of Topsoil**			
	EARTH FILL Dark brown silty clay occ. organics, rootlets and rock fragments	1	DO	35
308.0 0.7	Brown, compact to very dense **SAND** traces of silt and gravel wet below 2.3 m gravelly	2	DO	65
		3	DO	21
		4	DO	25
		5	DO	24
		6	DO	65
303.1 5.6	Grey, very dense **SILTY SAND TILL** traces of clay and gravel occ. sand seams and layers occ. cobbles and boulders	7	DO	80
302.1 6.6	**END OF BOREHOLE**			

Installed 50 mm Ø monitoring well to 6.0 m
completed with 3.1 m screen
Sand backfill from 2.3 to 6.0 m
Bentonite seal from 0.0 m to 2.3 m
Provided with a momument steel casing



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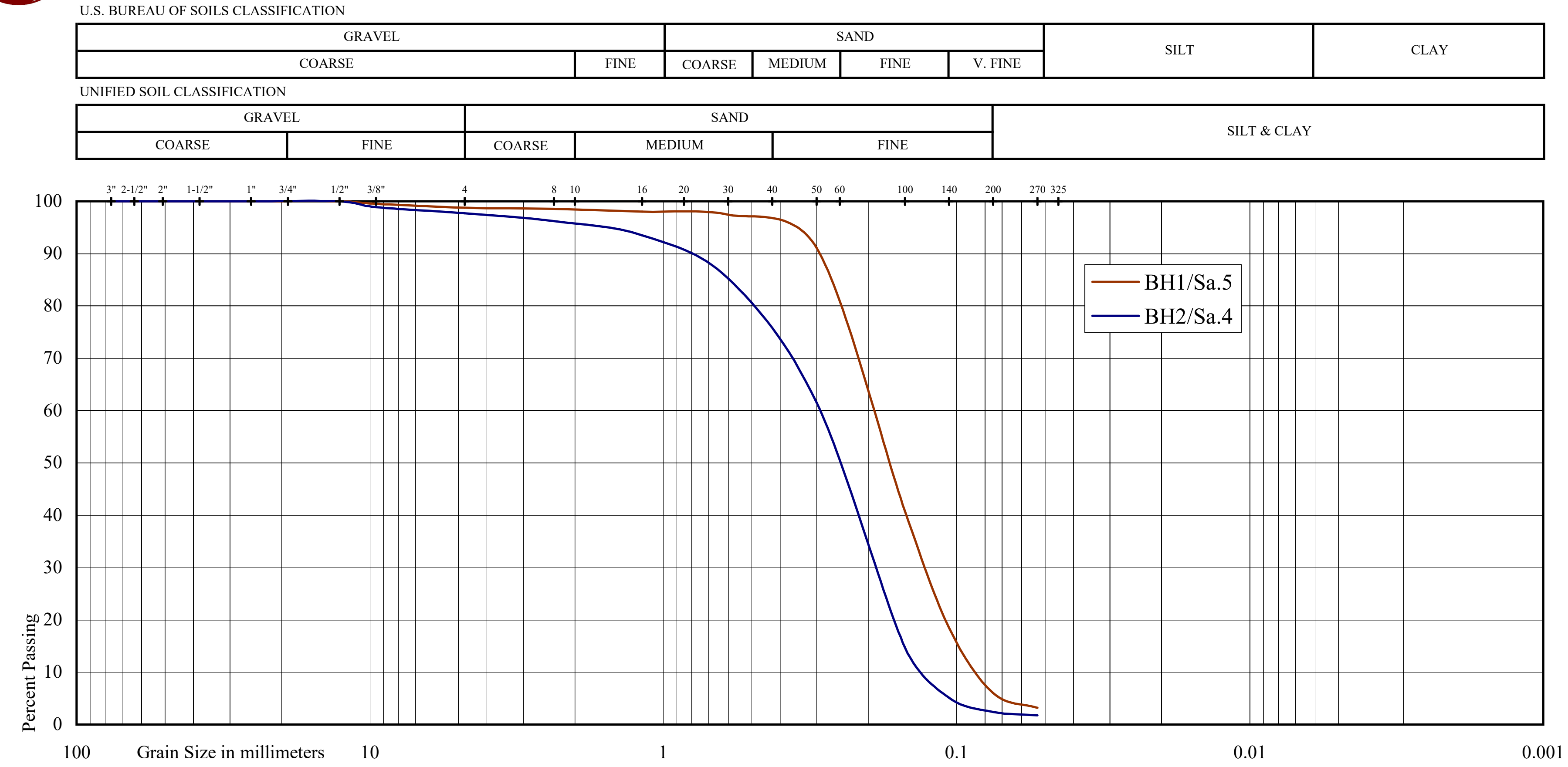
GRAIN SIZE DISTRIBUTION

Reference No: 2203-S111



Project: Proposed Residential Development

Location: 500 Salem Road, Town of Innisfil

Borehole No:	1	2
Sample No:	5	4
Depth (m):	3	2.3
Elevation (m):	303.9	306.0

BH/Sa.:	1/5	2/4
Liquid Limit (%) =	-	-
Plastic Limit (%) =	-	-
Plasticity Index (%) =	-	-
Moisture Content (%) =	21	17
Estimated Permeability (cm./sec.) =	10^{-3}	10^{-2}

Classification of Sample [& Group Symbol]: SAND

Fine to medium grained, traces of silt and gravel

Figure: 4

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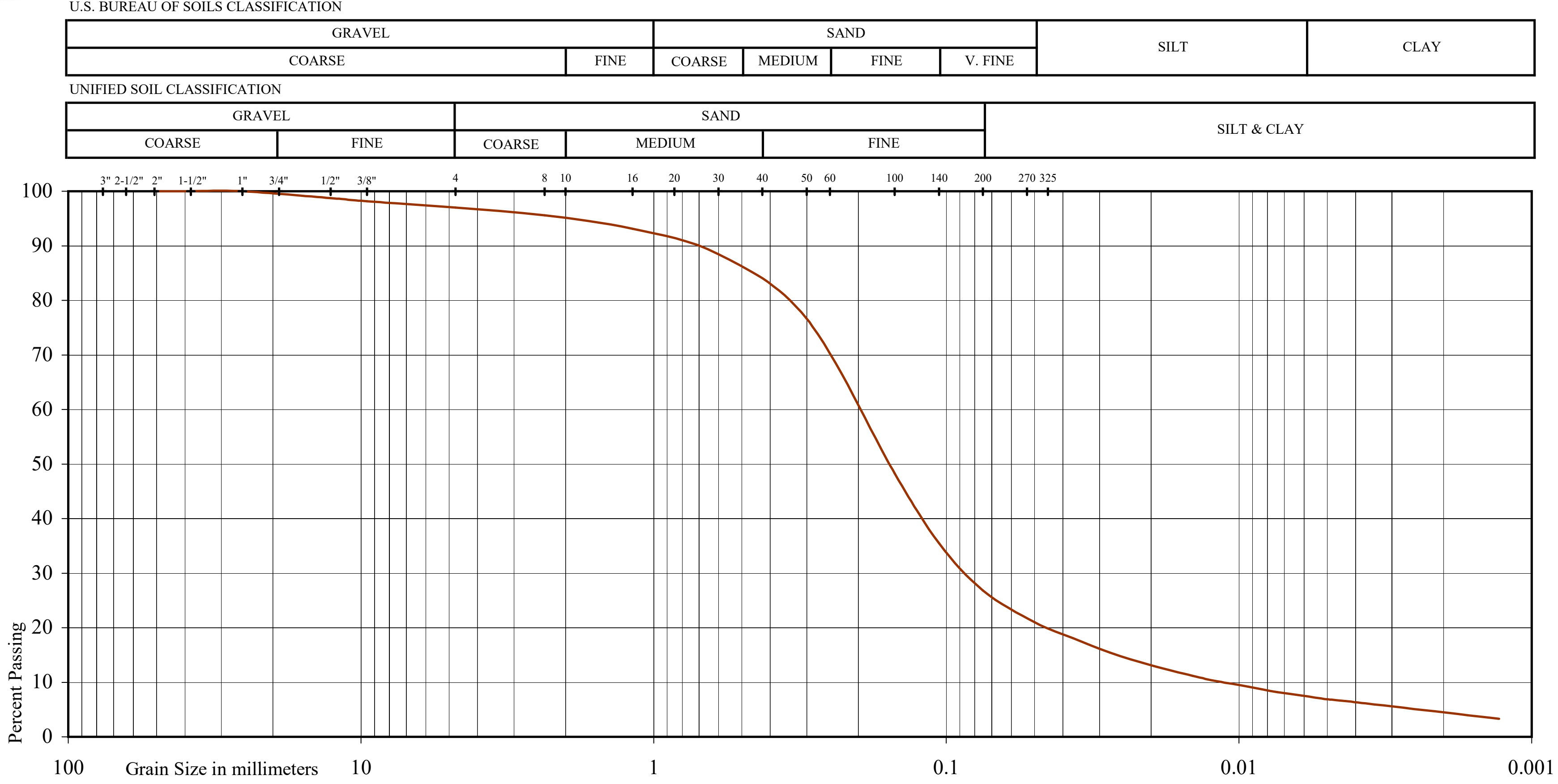
GRAIN SIZE DISTRIBUTION

Reference No: 2203-S111



Project: Proposed Residential Development

Location: 500 Salem Road, Town of Innisfil

Liquid Limit (%) = -

Plastic Limit (%) = -

Plasticity Index (%) = -

Moisture Content (%) = 10

Estimated Permeability

(cm./sec.) = 10^{-4}

Borehole No: 3

Sample No: 7

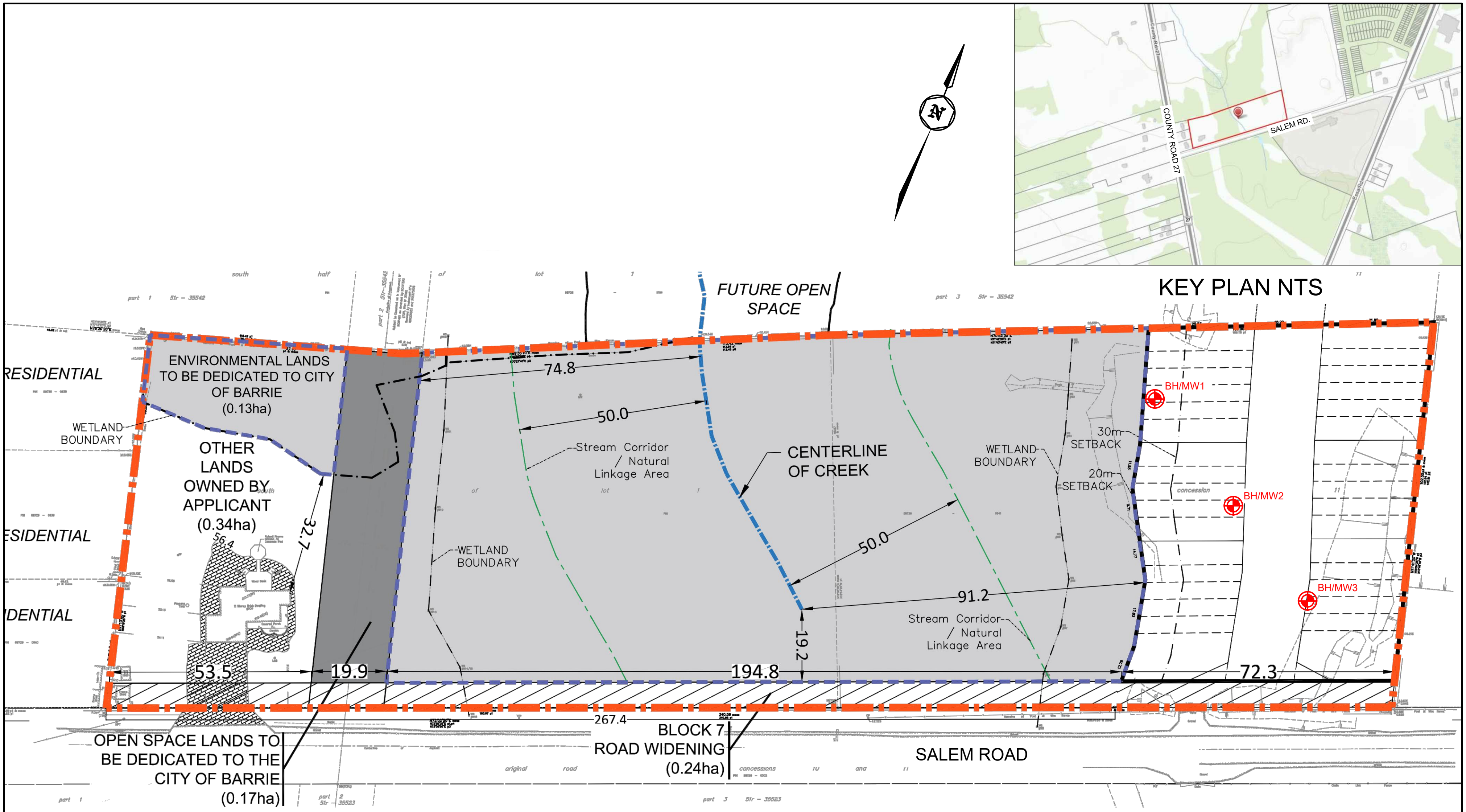
Depth (m): 6.1

Elevation (m): 302.6

Classification of Sample [& Group Symbol]: SILTY SAND TILL

traces of clay and gravel

Figure: 5



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90 WEST BEAVER CREEK ROAD, SUITE #100, RICHMOND HILL, ONTARIO L4B 1E7 · TEL: (416) 754-8515 · FAX: (905) 881-8335

Borehole/Monitoring Well Location Plan

SITE: 500 Salem Road, Town of Innisfil

DESIGNED BY: CR	**CHECKED BY:** KFL	**DWG NO.:** 1	
SCALE: 1:1500	**REF. NO.:** 2203-S111	**DATE:** August 2022	**REV** -

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SUBSURFACE PROFILE
DRAWING NO. 2
SCALE: AS SHOWN

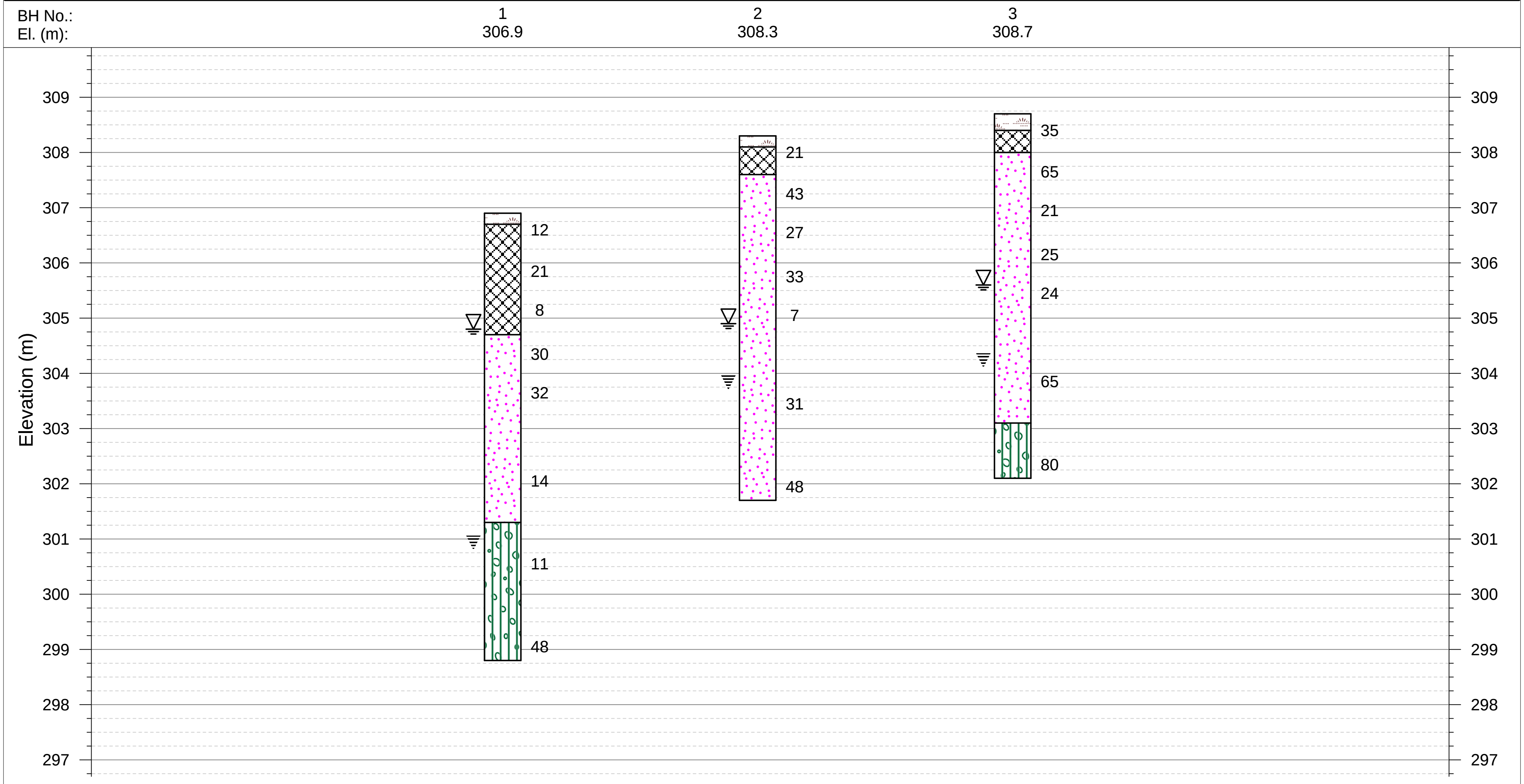
JOB NO.: 2203-S111
REPORT DATE: July 2022
PROJECT DESCRIPTION: Proposed Residential Subdivision

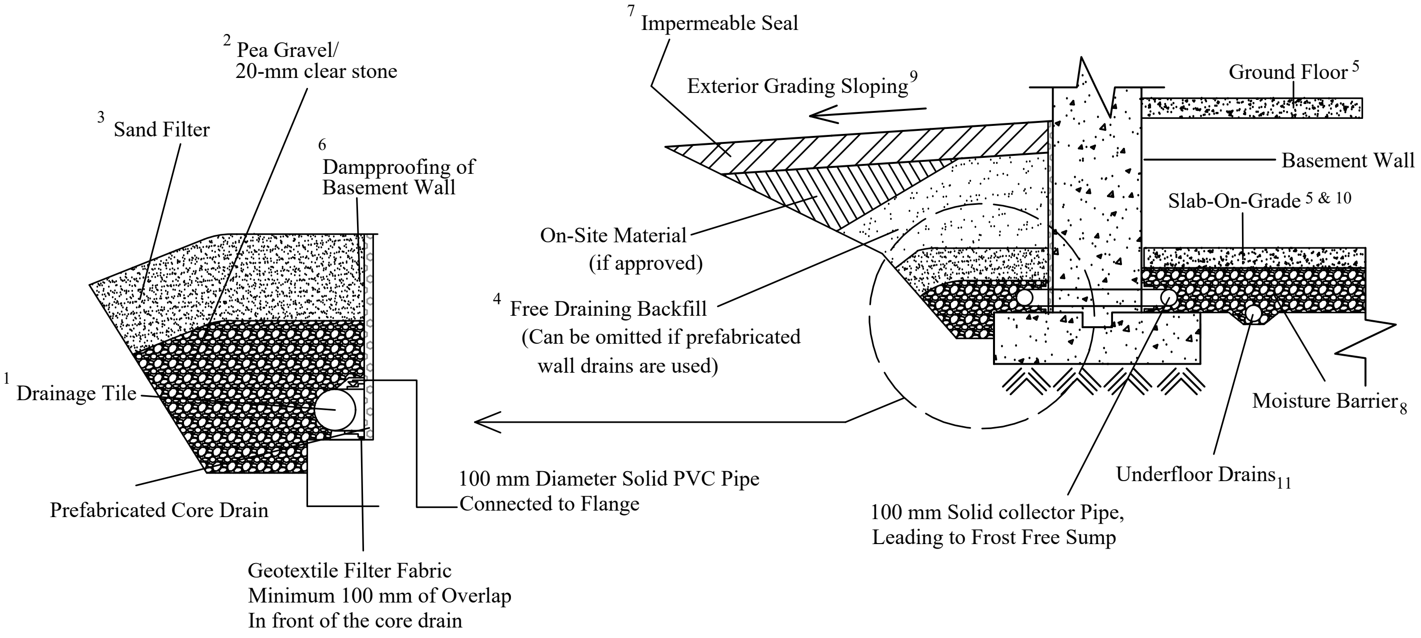
PROJECT LOCATION: 500 Salem Road, Town of Innisfil

LEGEND

▨ FILL ⁘ SAND ▥ SILTY SAND TILL ▤ TOPSOIL

≡ CAVE-IN ▽ WATER LEVEL (END OF DRILLING)





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 500 Salem Road, Town of Innisfil

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

SCALE N.T.S. **REF. NO.** 2203-S111 **DATE** July 2022 **REV** -