GEOTECHNICAL INVESTIGATION REPORT

Proposed Residential Development
640 Liverpool Road
Pickering, Ontario

December 5, 2022

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1.0 INTRODUCTION

Terrapex Environmental Ltd. (**Terrapex**) was retained by Liverpool Road Limited Partnership (Liverpool) to carry out a geotechnical investigation for the proposed residential development at a bundle of properties consisting of 640 Liverpool Road, 607 Annland Street, and 1280, 1288, 1290, 1292, 1294 Wharf Street, Pickering, Ontario.

The Site is approximately rectangular in shape and is located on the southwest corner of the intersection of Annland Street and Liverpool Road.

We understand that it is proposed to demolish the existing buildings at the site and redevelop the property with residential townhouse blocks. It is unknown at this time if the buildings will contain basement levels.

A grading plan was not available at the time of the investigation, and accordingly the recommendations provided in this report are considered to be preliminary in nature, subject for review and revision upon completion of proposed grading plans.

The purpose of this investigation was to characterize the subsurface soil and groundwater conditions, to determine the engineering properties of the various soil deposits underlying the site, and to provide preliminary geotechnical engineering recommendations pertaining to the proposed re-development. The geotechnical investigation was performed in conjunction with a hydrogeological and limited environmental assessments by Terrapex; which are reported under separate covers.

This report presents the results of the investigation performed in accordance with the general terms of reference outlined above and is intended for the guidance of the client and the design architects or engineers only. It is assumed that the design will be in accordance with the applicable building codes and standards.

2.0 FIELDWORK

The fieldwork for this investigation was carried out during the period February 24 to March 2, 2022. It consisted of thirteen (13) boreholes designated as Boreholes MW101, BH102, BH103, MW104, BH105, BH106, MW107, BH108, MW109, BH110, BH111, MW112, and MW113. The boreholes were advanced by a drilling contractor commissioned by Terrapex. The locations of the boreholes were chosen by Terrapex to provide general coverage of the site, as well as to install monitoring wells in areas with potential contaminants of concern, to enable sampling of groundwater. Monitoring wells were installed in six of the boreholes; at MW101, MW104, MW107, MW109, MW112, MW113. The locations of the boreholes are shown on the Borehole Location Plan enclosed in Appendix B.

MW113 was terminated at a depth of 4.9 m below ground surface (mbgs) as it was installed for environmental sampling. The remaining boreholes were extended to depths ranging from 7.2 to

8.0 mbgs. Groundwater level observations were made in the boreholes upon completion of each of their advancement, and subsequently in the monitoring wells on March 18, 2022. The results of groundwater measurements are discussed in Section 4.7 of this report.

The ground surface elevations and the locations of the boreholes were established by Terrapex using Topcon Hiper V GNSS Receiver.

Standard penetration tests were carried out while advancing the boreholes to take representative soil samples and to measure penetration index values (N-values) to characterize the condition of the various soil materials. The number of blows of the striking hammer required to drive the split spoon sampler to 300 mm depth was recorded and these are presented on the logs as penetration index values. Results of SPT are shown on the borehole log sheets in Appendix C of this report.

The fieldwork for this project was carried out under the supervision of an experienced geo-environmental technician from this office who laid out the positions of the boreholes in the field; arranged locates of buried services; effected the drilling, sampling and in situ testing; observed groundwater conditions; and prepared field borehole log sheets.

3.0 LABORATORY TESTS

The soil samples retained from the split spoon sampler were properly sealed, labelled and brought to our laboratory. They were visually classified and water content tests were conducted on all soil samples retained from Boreholes MW101, BH103, BH110 and MW112. The results of the classification, water contents, and Standard Penetration Tests are presented on the borehole logs sheets attached in Appendix C of this report.

Grain-size analyses were carried out in our laboratory on three (3) native soil samples, BH106-3, BH106-5, and BH106-8. The results of these tests are presented as Figures D-1 through D-3 in Appendix D.

In addition, two soil samples were submitted to an analytical laboratory for chemical analyses for pH and soluble sulphate tests. The results of these tests are enclosed in Appendix F; discussed in Section 5.8 of this report.

4.0 SITE AND SUBSURFACE CONDITONS

Full details of the subsurface and groundwater conditions at the site are given on the borehole Log sheets attached in Appendix C of this report.

The following paragraphs present a description of the site and a commentary on the engineering properties of the various soil materials contacted in the boreholes.

It should be noted that the boundaries of soil types indicated on the borehole logs are inferred from non-continuous soil sampling and observations made during drilling. These boundaries are intended to reflect transition zones for the purpose of geotechnical design, and therefore, should not be construed as exact planes of geological change.

4.1. SITE DESCRIPTION

The property is located on the west side of Liverpool Road, approximately 380 m north of Lake Ontario. It is bounded by Annland street to the north, Liverpool Road to the east, Wharf Street to the south, and residential properties to the west.

The site is rectangular in shape with approximate dimensions of 150 m and 90 m. The west half of the property appears to have been used for residential purposes, containing detached dwellings at the time of the investigation. The east section of the site is occupied by a house and two large metal shed / storage structures. The indications are that the east section of the property was also used for small maintenance and towing company.

The ground surface topography of the site is not level. It generally slopes down from the northeast to southwest. The ground surface at the site ranges from a high of 80.15 m at MW104 to a low of 77.73 m at MW109.

4.2. Topsoil

Topsoil is present in MW101, MW104, BH108, MW109 MW112. The thickness of the topsoil at the borehole locations ranges between approximately 150 and 250 mm.

It should be noted that the topsoil thickness will vary between boreholes. Thicker topsoil than that found in the borehole may be present in other places.

4.3. Sand and Gravel Pavement

The ground surface at Boreholes BH102, BH103, BH105, BH106, MW107, BH110, BH111, and MW113 is covered with granular pavement consisting of sand and gravel. The thickness of the granular material at the borehole locations ranges between approximately 130 mm and 600 mm.

4.4. Fill

Fill material is present below the granular pavement in Boreholes BH106 and MW107 in the southeast corner of the site, below the topsoil in Borehole MW112, and at the surface of the ground at MW113. It generally consists of sandy silt some clay and clayey silt; likely reworked native material. It extends to a depth of approximately 1.5 mbgs in the boreholes.

Standard Penetration Test (SPT) carried out in the clayey silt fill material measured N-values ranging from 2 to 16 indicating soft to stiff consistency.

The fill material is olive in color and moist in appearance.

4.5. NATIVE SOIL

The native soil situated below the surficial topsoil, granular soil and fill material is comprised of sandy silt (till) some clay, clayey silt, layers of wet sand, wet silt or wet gravelly sand seams, and shale bedrock.

4.5.1 Sandy Silt (till) some clay

Sandy silt (till) some clay is present below the fill material and the topsoil in all boreholes. It extends to depths ranging from 6.1 to 8.0 m. The sandy silt (till) is a glacial deposit, consisting of a random mixture of soil particles ranging from clay to gravel with the sand and silt being the predominant fractions. Cobbles and boulders are probably present within this soil stratum but would not be representatively sampled with the equipment used in this investigation.

The sandy silt (till) soil is generally brown in colour turning to grey at 3.0 to 4.5 mbg. The water content of the tested sandy silt (till) samples from Boreholes MW101, BH103, BH110 and MW112 range from approximately 9 to 15% by weight, generally being moist in appearance.

Standard Penetration Resistance in the sandy silt (till) provided N-values ranging from 8 to 76, indicating compact to very dense compactness condition, typically being compact to dense.

Grain size analyses were carried out on two representative sample of the soil. The test result is enclosed in Appendix D as Figure 1, 2 and summarized below.

Sample No. and Depth	Sample Description	Gravel %	Coarse Sand %	Fine Sand %	Silt %	Clay %
BH106-3, 1.5 mbg	Sandy SILT Some clay, some gravel	18	10	27	31	14
BH106-5, 3.0 mbg	Sandy SILT Some clay, some gravel	16	10	27	31	16

Based on the results of the grain size analysis, the Coefficient of Permeability (k) of the sand is estimated to be less than 10^{-6} cm/sec, corresponding to low relative permeability.

4.5.2 Clayey Silt

Clayey Silt is present below the Sandy Silt (till) in Boreholes MW101, BH102, BH103, BH106, MW107, BH110, and BH111. It extends to the termination depths of boreholes BH103 and MW107, to 8.0 mbgs, and to depths ranging from 6.1 to 7.7 mbgs at Boreholes MW101, BH102, BH106, BH110, and BH111.

The Clayey Silt soil is generally grey in colour. The water content of the tested clayey silt samples from Boreholes MW101, BH103 and BH110 range from 9 to 17% by weight; generally being moist in appearance; wet in BH102.

Standard Penetration Resistance in the sandy silt (till) soils provided N-values ranging from 18 to 50/75 mm penetration, indicating very stiff to hard consistency; typically being hard.

Grain size analysis was carried out on one representative sample of the soil. The test result is enclosed in Appendix D as Figure 3 and summarized below.

Sample No. and Depth	Sample Description	Gravel %	Coarse Sand %	Fine Sand %	Silt %	Clay %
BH106-8, 6.1 mbg	SILT Some clay, some sand, trace gravel	5	4	10	65	16

Based on the results of the grain size analysis, the Coefficient of Permeability (k) of the sand is estimated to be less than 10^{-7} cm/sec, corresponding to very low relative permeability.

4.5.3 Shale Bedrock

Underlying the clayey silt and sandy silt (till) strata, Boreholes MW101, BH102, BH105, BH106, BH110, and BH111 encountered weathered shale bedrock at depths ranging from 6.0-7.7 mbgs. Boreholes BH103, MW107, BH108, MW109, and MW112 had fragments of shale in the spoon at termination depths of approximately 8.0 mbs.

Standard Penetration Resistance in the shale bedrock provided N-values ranging from 50/75mm to 50/100mm.

4.5.4 Wet Sand, Silt, and Gravel

Boreholes BH105, BH111, and MW112 encountered wet seams in the strata. BH105 encountered a wet silt at 3.05 m that is approximately 100mm thick. BH111 encountered a wet sand seam at 3.8 mbgs of approximately 610 mm thickness. MW112 encountered a wet gravelly sand layer at 6.1 mbgs of approximately 610 mm in thickness.

Due to inconsistency of the wet seams, it is likely these material consists of small deposits of coarse material allowing water to perch in the deposit. After initial drainage of these coarse deposits, they are not expected to pose a water problem.

4.6. SUMMARY OF SOIL UNITS

The table below summarizes the soil units encountered at the boreholes.

BH No.	Ground Elevation (m)	Topsoil (mm)	Granular Soil (mm)	Fill (mbg)	Sandy SILT (till) some clay (mbg)	Clayey SILT (mbg)	Shale bedrock (mbg)	Silty Sand (till) (mbg)	Wet seam (mbg)
MW101	79.13	150	-	-	0.15 - 4.6	4.6 – 6.1	6.1 – 6.8	-	-
BH102	79.62	-	300	-	0.3 – 6.1	-	6.1 – 7.7	-	-
BH103	80.12	-	600	-	0.6 – 6.1	6.1 – 8.0	-	-	-
MW104	80.16	200	-	-	0.2 – 6.1	7.6 – 8.0	-	6.1 – 7.6	-
BH105	78.35	-	200	-	0.2 – 6.8	-	6.8 – 7.0	-	3.0 – 3.4
BH106	79.60	-	200	0.2 – 1.5	1.5 – 6.1	6.1 – 7.7	7.7 – 8.0	-	-
MW107	79.7	-	150	0.15 – 1.5	1.5 – 6.1	6.1 – 8.0	-	-	-
BH108	80.08	150	-	-	0.15 – 8.0	-	-	-	-
MW109	77.73	150	-	-	0.15 – 8.0	-	-	-	-
BH110	78.86	-	300	-	0.3 – 6.1	6.1 – 7.7	7.7 – 8.0	-	-
BH111	79.19	-	250	-	0.25 – 3.8	4.6 – 7.7	7.7 – 8.0	-	3.8 – 4.6
MW112	79.75	200	-	0.2 – 1.5	1.5 – 6.1	7.6 – 7.7	-	-	6.1 – 7.6
MW113	80.13	-	-	0 – 1.5	1.5 – 5.2	-	-	-	-

4.7. GROUNDWATER

Groundwater level and cave-in of the unlined sidewalls of the boreholes were measured upon completion of the boreholes. Groundwater was encountered immediately following drilling in boreholes BH102, BH103, BH105, BH106, BH108, and BH111 at depths ranging from 2.1 to 7.0 mbgs. The groundwater measurements are shown on the individual borehole logs.

Groundwater levels in the monitoring wells were measured on March 18, 2022. The groundwater levels are shown in the following table.

Borehole No.	Riser Elevation (m)	Groundwater Depth (mbr)	Groundwater Elevation (mbgs)
MW101	79.10	0.75	78.35
MW104	80.13	0.30	79.83
MW107	79.66	3.78	75.88
MW109	77.70	2.18	75.52
MW112	79.70	0.82	78.88
MW113	80.08	0.95	79.13

It should be noted that groundwater levels are subject to seasonal fluctuations. A higher groundwater level condition will likely develop in the spring and following significant rainfall events.

5.0 DISCUSSION AND RECOMMENDATIONS

The following discussions and recommendations are based on the factual data obtained from the boreholes advanced at the site by **Terrapex** and are intended for use by the client's architects and design engineers only.

We understand that the site would be re-developed with townhouse blocks possibly with slab-on-grade or single level basement construction. It is anticipated that there will be some modifications to site grading, but this has not been established at the time of reporting. The provided recommendations are considered to be preliminary in nature, subject for review and revision upon completion of proposed grading plans.

The investigation has revealed that in general the soil conditions at the site consist of compact to very dense sandy silt (till) with some clay resting on very stiff to hard clayey silt, followed by shale bedrock. Groundwater at the site is situated below an approximate depth of 2.3 to 3.0 mbgs.

The houses and structures found on site will have to be demolished, the existing buried services decommissioned, and the excavations left behind will need to be engineered.

Contractors bidding on this project or conducting work associated with this project should make their own interpretation of the factual data and/or carry out their own investigations.

On the basis of our fieldwork, laboratory tests and other pertinent information supplied by the client, the following comments and recommendations are made.

5.1 EXCAVATION, BACKFILL AND GROUNDWATER CONTROL

Based on the field results, excavations for foundations, basements (if any), sewer trenches, and utilities are not expected to pose any difficulty. Excavation of the soils at this site can be carried out with hydraulic excavators.

All excavations must be carried out in accordance with Occupational Health and Safety Act (OHSA). With respect to OHSA, the fill material is expected to conform to Type 3 soils. The compact to dense sandy silt till and very stiff to hard clayey silt soils are classified as Type 2 soil.

Temporary excavations for slopes in Type 3 soil should not exceed 1.0 horizontal to 1.0 vertical. In the event very loose and/or soft soils are encountered at shallow depths or within zones of persistent seepage, it will be necessary to flatten the side slopes as necessary to achieve stable conditions. Excavations in Type 2 soil may be cut with vertical side-walls within the lower 1.2 m height of excavation and 1.0 horizontal to 1.0 vertical above this height.

For excavations through multiple soil types, the side slope geometry is governed by the soil with the highest number designation. Excavation side-slopes should not be unduly left exposed to inclement weather.

Where workers must enter excavations extending deeper than 1.2 m below grade, the excavation side-walls must be suitably sloped and/or braced in accordance with the Occupational Health and Safety Act and Regulation for Construction Projects.

It should be noted that the till is non-sorted sediment and therefore may contain boulders. Provisions must be made in the excavation and foundation installation contracts for the removal of possible boulders.

On-site excavated inorganic soils are considered suitable for reuse as backfill material or engineered fill, provided their water content is within 2% of their optimum water contents (OWC) as determined by Standard Proctor test, and the materials are effectively compacted with heavy compaction rollers.

While the quality of the native soils are considered suitable for backfilling; the moisture content of the soils and the lift thickness for compaction must be properly controlled during the backfilling. Alternatively, imported suitable material should be used.

Measured water contents of soil samples from Boreholes MW101, BH103, BH110 and MW112, range from 6 to 17% for native soils. On-site soils that are wetter than their OWC should be dried sufficiently prior to use as backfill to achieve the specified degree of compaction. Spreading the material in a wide area and air drying will be required to achieve the specified compaction of the native material. Thorough vertical mixing of the excavated soils will be required to provide a material that can be adequately compacted.

Excavations resulting from demolition of the existing buildings and removal of old utilities would need to be backfilled with an engineered fill material if the fill is to support underground services and the pavement structure. Care should be taken during the demolition of the structures such that surrounding soils are not mixed in with the construction debris; if this were to occur these soils would not be considered suitable fill material for engineered fill and would likely have to be disposed of off-site as waste.

Based on observations made during the drilling of the boreholes and close examination of the soil samples extracted from the boreholes, significant groundwater problems are not anticipated within the presumed excavation depths. Any groundwater that may seep into excavations is expected to be very minimal and it will be possible to maintain the excavations functionally free of water by means of light duty submersible pumps.

Surface water should be directed away from open excavations.

5.2 FOUNDATION DESIGN

It is understood that the proposed townhouse blocks may contain basements.

It is anticipated that there will be some modifications to site grading, but this has not been established at the time of reporting.

The borehole findings reveal that the native sandy silt till soil throughout the site is suitable for the support of building foundations. Locally, it will be necessary to deepen the foundations where the native soil is less competent in strength. Conventional shallow strip and spread footings may be used to support the proposed buildings. The footings must be founded at a minimum depth of 300 mm into the undisturbed native soil.

Footings founded at shallow depths into the native soil may be designed based on bearing resistance of 200 KPa at Serviceability Limit States (SLS), and factored geotechnical bearing resistances at Ultimate Limit States (ULS) of 300 kPa.

The geotechnical bearing resistance value recommended above is for vertical and centric loads only. The total and differential settlements of foundations designed in accordance with the bearing resistance values recommended above should not exceed the conventional limits of 25 mm and 19 mm, respectively.

In the event necessary, the stepping of the footings at different elevations should be carried out at an angle no steeper than 2 horizontal (clear horizontal distance between footings) to 1 vertical (difference in elevation) and no individual footing step should be greater than 0.6 m.

All exterior footings should be provided by at least 1.2 m of soil cover or equivalent artificial thermal insulation for frost protection purposes.

Due to variations in the consistency of the founding soils and/or loosening caused by to excavating disturbance and/or seasonal frost effects, all footing subgrade must be evaluated by the Geotechnical Engineer prior to placing foundation concrete to ensure that the soil exposed at the excavation base is consistent with the design geotechnical bearing resistance.

Rainwater or groundwater seepage entering the foundation excavations must be pumped away (not allowed to pond). The foundation subgrade soils should be protected from freezing, inundation and equipment traffic at all times. If unstable subgrade conditions develop, **Terrapex** should be contacted in order to assess the conditions and make appropriate recommendations.

The native soils tend to weather and deteriorate rapidly on exposure to atmosphere or surface water, so construction scheduling should consider the amount of excavation left exposed to the elements, during foundation preparation. **Terrapex** recommends that footings placed on the exposed native soil should be poured on the same day as they are excavated, after removal of all unsuitable founding materials and approval of the bearing surface. Alternatively, a concrete mud slab could be used to protect a bearing surface where footing construction is to be delayed.

5.3 CONCRETE FLOOR SLAB

For building(s) without basement construction, the subgrade supporting the ground floor slab will in general consist of sandy silt (till) and locally fill soils, which are adequate to support a slab-on-grade construction. Subgrade preparation should include the removal of surface vegetation, organic materials, weak and softened soils. After removal of all unsuitable materials, the subgrade should then be proof-rolled with heavy rubber tired equipment and adjudged as satisfactory before preparing the granular base course. The proof-rolling operation should be witnessed by the Geotechnical Engineer. Any soft or unsuitable subgrade areas which deflect significantly should be sub-excavated and replaced with suitable engineered fill material compacted to at least 98% of Standard Proctor Maximum Dry Density (SPMDD).

Where new fill is required to raise the grade, the native sandy silt (till) soils from the site or similar clean imported fill material may be used, free from topsoil, organic or deleterious matter, provided the material is placed in large areas where it can be compacted with a heavy vibratory roller. The fill material should not be frozen and should not be too dry or too wet for efficient compaction (moisture content at optimum or 2% greater than optimum). The fill placement should not be performed during winter months when freezing temperatures occur persistently or intermittently. All fill placed below the slab on grade areas of the buildings must be placed in thin lifts of 150 mm thickness or less and compacted to a minimum of 98% of SPMDD.

Provided the subgrade, under-floor fill and granular base are prepared in accordance with the above recommendations, the Modulus of Subgrade Reaction (ks) for floor slab design will be 25,000 kPa/m.

It is recommended that a combined moisture barrier and a leveling course, comprised of free draining material such as 150 mm thick layer of either Granular “A” or 19 mm clear crushed limestone be provided as a base for the slab-on-grade. The Granular “A” should be compacted to 100% of its SPMDD.

For above grade buildings, perimeter drainage at the foundation level and sub-floor drains will not be required, provided that the underside of the concrete slab is at least 150 mm above the finished exterior grade and the surrounding surface slopes away from the building at a gradient of at least 2% to promote surface water run-off and to reduce groundwater infiltration adjacent to foundations.

For building(s) containing a basement level, an exterior perimeter drainage system, consisting of 100 mm diameter weeping tile wrapped in filter fabric and covered with a minimum 150 mm clear crushed stone should be placed along the exterior foundation walls, below the level of the granular base of the floor slab.

The perimeter foundation drains must be connected to a positive frost-free outlet from which the water can be removed or connected to a sump located in the basement. The water from the sump must be pumped out to a suitable discharge point.

Sub-floor drains may also be required below the basement floor slab. It is recommended that a decision in this regard be made once final grade and basement floor elevations have been established.

Typical details of perimeter and underfloor drainage systems are included in Appendix E of this report. The installation of the perimeter and sub-floor drains as well as the outlet must conform to the applicable plumbing code requirements.

Free draining soil such as Granular B must be used to backfill along the exterior basement walls. The native soil may be used to backfill excavations along basement walls provided that prefabricated drainage sheets (Terradrain 600 or equivalent) are placed continuously against the walls.

5.4 LATERAL EARTH PRESSURE

Parameters used in the determination of earth pressure acting on structures subject to unbalanced pressures are defined below.

SOIL PARAMETERS

Parameter	Definition	Units
Φ'	angle of internal friction	degrees
γ	bulk unit weight of soil	kN/m^3
Ka	active earth pressure coefficient (Rankine)	dimensionless
Ko	at-rest earth pressure coefficient (Rankine)	dimensionless
Kp	passive earth pressure coefficient (Rankine)	dimensionless

The appropriate un-factored values for use in the design of structures subject to unbalanced earth pressures at this site are tabulated as follows:

SOIL PARAMETER VALUES

SOIL	Parameters				
	Φ’	γ	Ka	Kp	Ko
Compacted Granular Fill(1) – Granular ‘A’ (OPSS 1010)	36°	23.0	0.26	3.85	0.41
Compacted Granular Fill(1) – Granular ‘B’ (OPSS 1010)	34°	21.0	0.28	3.54	0.44
Fill Material	28	20	0.36	2.77	0.53
Sandy Silt Till	32	21	0.31	3.25	0.47
Very stiff to hard Clayey Silt	32	19	0.31	3.25	0.47

Notes:

1. Compacted to a minimum of 95% Standard Proctor Maximum Dry Density.
2. Passive and sliding resistance within the zone subject to frost action (i.e. within 1.2 m below finished grade) should be disregarded in the lateral resistance computations.
3. Temporary and/or permanent surcharges at the ground surface should be considered in accordance with the applicable Soil Mechanics methods.

The design earth pressures in compacted backfill should be augmented with the dynamic effects of the compaction efforts, which typically are taken as a uniform 12 kPa pressure over the entire depth below grade where the calculated earth pressure based on the above earth pressure factors is less than 12 kPa.

Shoring subject to unbalanced earth pressures must be designed to resist a pressure that can be calculated based on the following formula:

$$\mathbf{P = K (\gamma\ h + q)}$$

where **P** = lateral pressure in kPa acting at a depth h (m) below ground surface

K = applicable lateral earth pressure coefficient (use ko for basement wall design)

γ = bulk unit weight of backfill (kN/m^3)

h = height at any point along the interface (m)

q = the complete surcharge loading (kPa)

This equation assumes that free-draining backfill and positive drainage is provided behind the walls.

Resistance to sliding of earth retaining structures is developed by friction between the base of the footing and the soil. This friction (R) depends on the normal load on the soil contact (N) and the frictional resistance of the soil (tan Φ’) expressed as: **R = N tan Φ’**. This is an ultimate resistance value and does not contain a factor of safety.

5.5 SERVICE TRENCHES

Based on the site grades, sewer pipes and water mains will be supported on undisturbed native sandy silt (till) which is considered suitable for supporting water mains, sewer pipes, manholes, catch basins and other related structures.

The type of bedding depends mainly on the strength of the subgrade immediately below the invert levels. Normal Class ‘B’ bedding is recommended for underground utilities. Granular ‘A’ or 19 mm crusher-run limestone can be used as bedding material; all granular materials should meet OPS 1010 specifications. The bedding material should be compacted to a minimum of 95% SPMDD. Trenches dug for these purposes should not be unduly left exposed to inclement weather.

Pipe bedding and backfill for flexible pipes should be undertaken in accordance with OPSD 802.010. Pipe embedment and cover for rigid pipes should be undertaken in accordance with OPSD 802.030.

If unsuitable bedding conditions occur, careful preparation and strengthening of the trench bases prior to sewer installation will be required. The subgrade may be strengthened by placing a thick mat consisting of 50 mm crusher-run limestone. Field conditions will determine the depth of stone required. Geotextiles and/or geogrids may be helpful and these options should be reviewed by Terrapex on a case by case basis.

Sand cover material should be placed as backfill to at least 300 mm above the top of pipes. Placement of additional granular material (thickness dictated by the type of compaction equipment) as required or use of smaller compaction equipment for the first few lifts of native material above the pipe will probably be necessary to prevent damage to the pipe during the trench backfill compaction.

It is recommended that service trenches be backfilled with on-site native soils compacted to 95% of SPMDD. Lift thicknesses should not exceed 200 mm in a loose state and the excavated site material should be compacted using heavy, vibratory pad-type rollers.

In areas of narrow trenches or confined spaces such as around manholes, catch basins, etc., imported sand or OPSS Granular ‘B’ should be used and compacted to the specified SPMDD.

5.6 PAVEMENT DESIGN

Based on the existing topography of the subject site and the presumption that there will be minor re-grading, it is anticipated that the sub-grade material for the pavement will generally comprise fill or native soils.

Given the frost susceptibility and drainage characteristics of the subgrade soils, the pavement design presented below is recommended.

Minimal Asphaltic Concrete Pavement Structure Design

Pavement Layer	Compaction Requirements	House Driveways Minimum Component Thickness	Internal Road Minimum Component Thickness
Surface Course Asphaltic Concrete	as per OPSS 310	40 mm Hot-Laid HL3 (OPSS 1150)	40 mm Hot-Laid HL3 (OPSS 1150)
Binder Course Asphaltic Concrete	as per OPSS 310	40 mm Hot Laid HL8 (OPSS 1150)	50 mm Hot-Laid HL8 (OPSS 1150)
Granular Base	100% SPMDD	200 mm Granular 'A' (OPSS 1010) Pit Run or 19 mm Crusher Run Limestone	150 mm Granular 'A' (OPSS 1010) Pit Run or 19 mm Crusher Run Limestone
Granular Subbase	100% SPMDD	-	300 mm Granular 'B' Type II (OPSS 1010)

The subgrade must be compacted to at least 98% of SPMDD for at least the upper 600 mm and 95% below this level. The granular base and sub-base materials should be compacted to a minimum of 100% SPMDD.

The long-term performance of the proposed pavement structure is highly dependent upon the subgrade support conditions. Stringent construction control procedures should be maintained to ensure that uniform subgrade moisture and density conditions are achieved as much as practically possible when fill is placed and that the subgrade is not disturbed and weakened after it is exposed.

Control of surface water is a significant factor in achieving good pavement life. Grading adjacent to the pavement areas must be designed so that water is not allowed to pond adjacent to the outside edges of the pavement or curb. In addition, the need for adequate drainage cannot be over-emphasized. The subgrade must be free of depressions and sloped (preferably at a minimum gradient of two percent) to provide effective drainage toward subgrade drains. Sub-drains are recommended to intercept excess subsurface moisture at the curb lines and catch basins. The invert of sub-drains should be maintained at least 0.3 m below subgrade level.

Additional comments on the construction of pavement areas are as follows:

- As part of the subgrade preparation, the proposed pavement areas should be stripped of vegetation, topsoil, unsuitable earth fill and other obvious objectionable material. The subgrade should be properly shaped and sloped as required, and then proof-rolled.

Loose/soft or spongy subgrade areas should be sub-excavated and replaced with suitable approved material compacted to at least 98% of SPMDD.

- Where new fill is needed to increase the grade or replace disturbed portions of the subgrade, excavated inorganic soils or similar clean imported fill materials may be used, provided their moisture content is maintained within 2 % of the soil's optimum moisture content. All fill must be placed and compacted to not less than 98% of SPMDD.
- For fine-grained soils, as encountered at the site, the degree of compaction specification alone cannot ensure distress free subgrade. Proof-rolling must be carried out and witnessed by **Terrapex** personnel for final recommendations of sub-base thicknesses.
- If pavement construction takes place in the spring thaw, the late fall, or following periods of significant rainfall, it should be anticipated that an increase in thickness of the granular sub-base layer will be required to compensate for reduced subgrade strength.

5.7 EARTHQUAKE DESIGN PARAMETERS

The 2012 Ontario Building Code stipulates the methodology for earthquake design analysis, as set out in Subsection 4.18.7. 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 the Site Classification for Seismic Site Response are set out in Table 4.1.8.4.A of the Ontario Building Code. The classification is based on the determination of the average shear wave velocity in the top 30 metres of the site stratigraphy, where shear wave velocity (vs) measurements have been taken. In the absence of such measurements, the classification is estimated on the basis of empirical analysis of undrained shear strength or penetration resistance. The applicable penetration resistance is that which has been corrected to a rod energy efficiency of 60% of the theoretical maximum or the (N60) value.

Based on the borehole information, the subsurface stratigraphy generally comprises native dense to very dense sandy silt till, and very stiff to hard clayey silt strata underlain by shale bedrock at an approximate depth of 7 mbg. Based on the above, the site designation for seismic analysis is Class C.

The site specific 5% damped spectral acceleration coefficients, and the peak ground acceleration factors are provided in the Ontario Building Code - Supplementary Standard SB-1, Table 1.2, location Pickering, Ontario.

5.8 CHEMICAL CHARACTERIZATION OF SUBSURFACE SOIL

Two (2) native soil samples obtained from Boreholes BH102 (Sample 3; 1.5 m depth) and BH111 (Sample 6; 3.8 m depth) were submitted to Bureau Veritas ILboratories for pH index test and water-soluble sulphate content to determine the potential of attacking the subsurface concrete. The Certificate of Analysis provided by the analytical chemical testing laboratory is contained in

Appendix F of this report.

The test results revealed that the pH index of the soil samples are 7.93 and 7.83; indicating a slight alkalinity.

The water-soluble sulphate content of the soil samples are 0.0290% and 0.0034%. The concentration of water-soluble sulphate content of the tested samples is below the CSA Standard of 0.1% water-soluble sulphate (Table 12 of CSA A23.1, Requirements for Concrete Subjected to Sulphate Attack). Special concrete mix against sulphate attack is therefore not required for the sub-surface concrete of the proposed building.

6 LIMITATIONS OF REPORT

The Limitations of Report, as quoted in Appendix 'I', are an integral part of this report.

Yours respectfully,
Terrapex Environmental Ltd.

LICENSED PROFESSIONAL ENGINEER
V. NERSESIAN
33778705
December 5, 2022
PROVINCE OF ONTARIO

Alex Dobrogost, E.I.T., B.Eng
Project Manager

Vic Nersesian, P.Eng.
Senior Geotechnical Engineer

APPENDIX A

LIMITATIONS OF REPORT

LIMITATIONS OF REPORT

The conclusions and recommendations in this report are based on information determined at the inspection locations. Soil and groundwater conditions between and beyond the test holes may differ from those encountered at the test hole locations, and conditions may become apparent during construction which could not be detected or anticipated at the time of the soil investigation.

The design recommendations given in this report are applicable only to the project described in the text, and then only if constructed substantially in accordance with details of alignment and elevations stated in the report. Since all details of the design may not be known to us, in our analysis certain assumptions had to be made as set out in this report. The actual conditions may, however, vary from those assumed, in which case changes and modifications may be required to our recommendations.

This report was prepared for Liverpool Road Limited Partnership by Terrapex. The material in it reflects Terrapex's judgement 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 which the Third Party may make based on it, are the sole responsibility of such Third Parties.

We recommend, therefore, that we be retained during the final design stage to review the design drawings and to verify that they are consistent with our recommendations or the assumptions made in our analysis. We recommend also that we be retained during construction to confirm that the subsurface conditions throughout the site do not deviate materially from those encountered in the test holes. In cases where these recommendations are not followed, the company's responsibility is limited to accurately interpreting the conditions encountered at the test holes, only.

The comments given in this report on potential construction problems and possible methods are intended for the guidance of the design engineers and architects, only. The number of inspection locations may not be sufficient to determine all the factors that may affect construction methods and costs. The contractors bidding on this project or undertaking the construction should, therefore, make their own interpretation of the factual information presented and draw their own conclusions as to how the subsurface conditions may affect their work.

APPENDIX B

BOREHOLE LOCATION PLAN

TERRAPEX

BOREHOLE LOCATION PLAN

640 LIVERPOOL ROAD, PICKERING, ONTARIO

CLIENT

LIVERPOOL LIMITED PARTNERSHIP

LEGEND

🟥 SITE BOUNDARY

- BOREHOLE (TERRAPEX)
- MONITORING WELL (TERRAPEX)
- MONITORING WELL (EDWARD WONG)
- MONITORING WELL (PINCHIN)

DATA SOURCE: MAPCAST, 2020

PROJECT #
CT3414.00

DATE
MARCH 2022

DRAWN
JS

CHECKED

DRAWING #
FIGURE 1

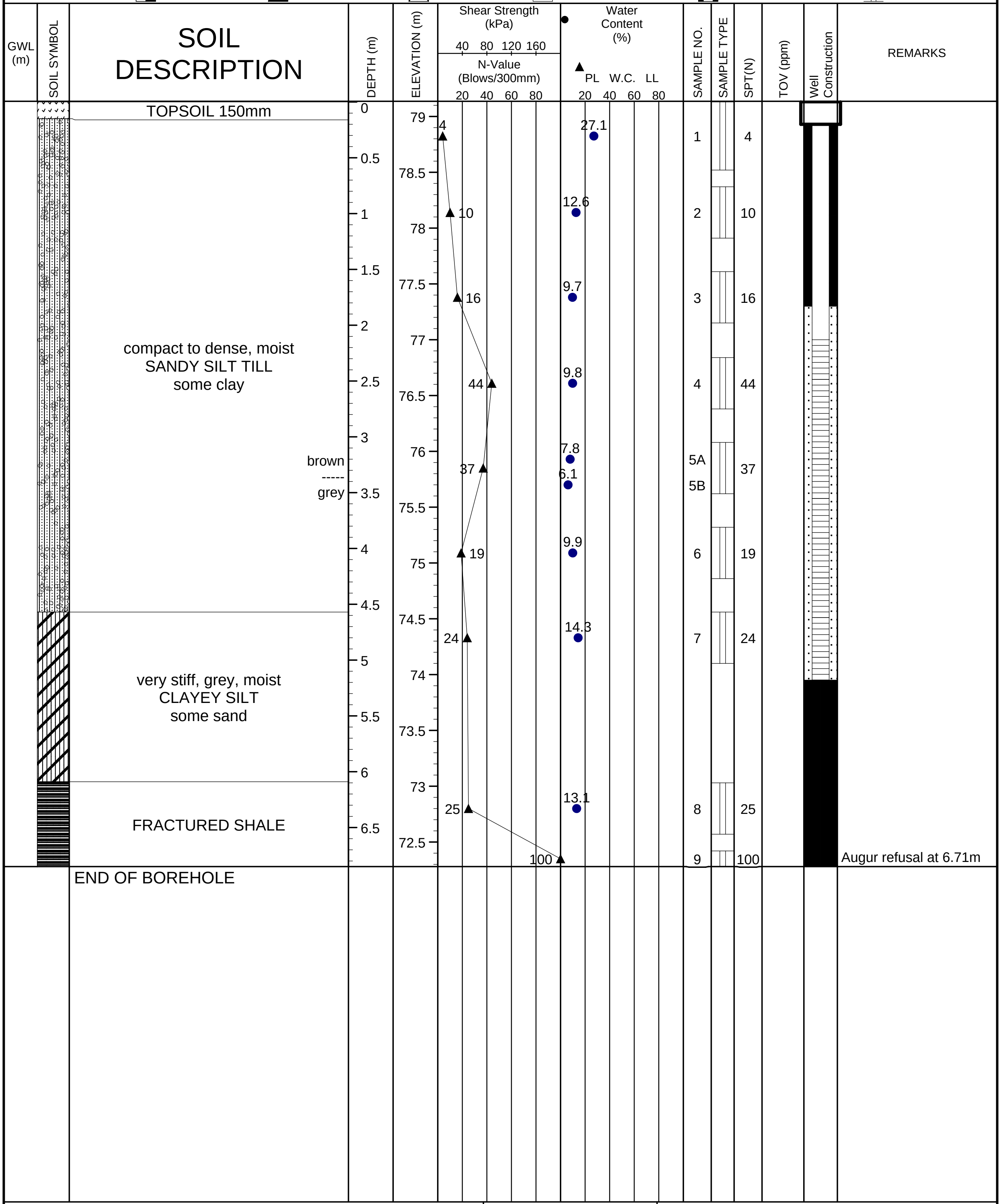
jserroul W:\PROJECTS\Toronto\CT3414.00 640 Liverpool Rd, Pickering\MXD\GEOTECHNICAL\CT3414.00 FIG 1 BH LOCATION PLAN.mxd

APPENDIX C

BOREHOLE LOG SHEETS

CLIENT: Liverpool Road Limited Partnership	METHOD: 0.2m hollow stem augur with split spoon		
PROJECT: 640 Liverpool Road	PROJECT ENGINEER: VN	ELEV. (m) 79.13	**BH No.: MW101**
LOCATION: Pickering, Ontario	NORTHING: 4853251.12	EASTING: 654122.84	PROJECT NO.: CT3414.00

SAMPLE TYPE: AUGER, DRIVEN, CORING, DYNAMIC CONE, SHELBY, SPLIT SPOON



SOIL DESCRIPTION

TOPSOIL 150mm

compact to dense, moist
SANDY SILT TILL
some clay

brown
-----
grey

very stiff, grey, moist
CLAYEY SILT
some sand

FRACTURED SHALE

END OF BOREHOLE

SAMPLE NO.	SPT(N)	Water Content (%)
1	4	27.1
2	10	12.6
3	16	9.7
4	44	9.8
5A	37	7.8
5B		6.1
6	19	9.9
7	24	14.3
8	25	13.1
9	100	

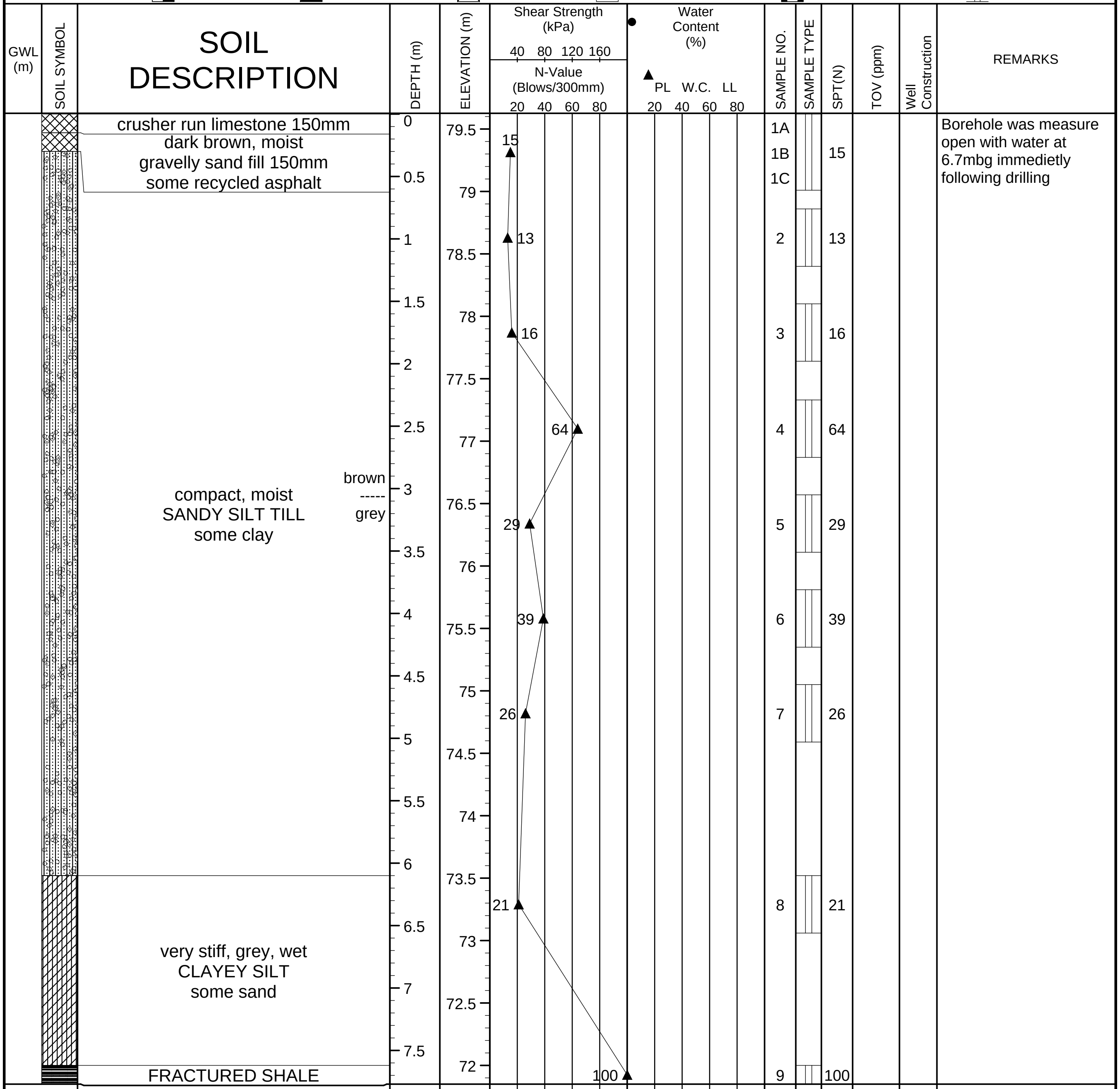
REMARKS: Augur refusal at 6.71m

TERRAPEX

LOGGED BY: AD
REVIEWED BY: VN
DRILLING DATE: MARCH 1, 2022
Page 1 of 1

CLIENT: Liverpool Road Limited Partnership	METHOD: 0.2m hollow stem augur with split spoon		**BH No.: BH102**
PROJECT: 640 Liverpool Road	PROJECT ENGINEER: VN	ELEV. (m) 79.62	
LOCATION: Pickering, Ontario	NORTHING: 4853261.43	EASTING: 654154.09	PROJECT NO.: CT3414.00

SAMPLE TYPE ▮ AUGER ◪ DRIVEN ⧓ CORING ▀ DYNAMIC CONE ▮▮ SHELBY ⌶ SPLIT SPOON



crusher run limestone 150mm

dark brown, moist
gravelly sand fill 150mm
some recycled asphalt

compact, moist
SANDY SILT TILL
some clay

brown
-----
grey

very stiff, grey, wet
CLAYEY SILT
some sand

FRACTURED SHALE

END OF BOREHOLE

SAMPLE NO.	SPT(N)
1A	
1B	15
1C	
2	13
3	16
4	64
5	29
6	39
7	26
8	21
9	100

REMARKS: Borehole was measure open with water at 6.7mbg immedietly following drilling

TERRAPEX

LOGGED BY: AD	DRILLING DATE: February 24, 2022
REVIEWED BY: VN	Page 1 of 1

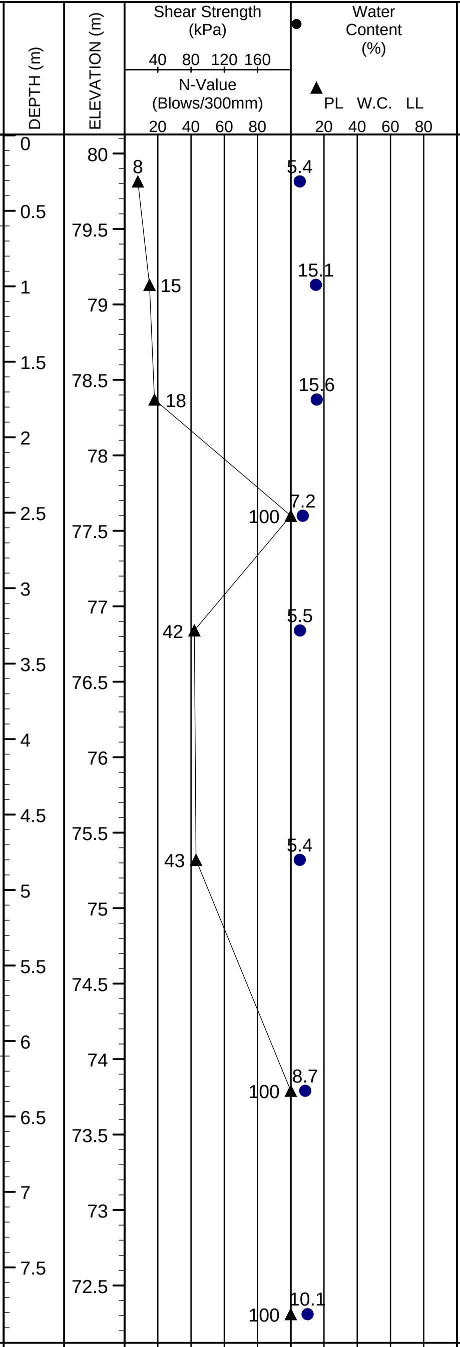
CLIENT: Liverpool Road Limited Partnership
METHOD: 0.2m hollow stem augur with split spoon
PROJECT: 640 Liverpool Road
PROJECT ENGINEER: VN
ELEV. (m) 80.12

BH No.: BH103

LOCATION: Pickering, Ontario
NORTHING: 4853270.50
EASTING: 654184.67
PROJECT NO.: CT3414.00

SAMPLE TYPE: AUGER, DRIVEN, CORING, DYNAMIC CONE, SHELBY, SPLIT SPOON

GWL (m)	SOIL DESCRIPTION	SAMPLE NO.	SAMPLE TYPE	SPT(N)	Water Content (%) W.C.	TOV (ppm)	Well Construction	REMARKS
	reclaimed granular - 600mm	1		8	5.4			Borehole was measure open with water at 6.7mbg immedietly following drilling
	compact to dense, moist SANDY SILT TILL some clay brown ----- grey	2		15	15.1			
		3		18	15.6			
		4		100	7.2			
		5		42	5.5			
		6		43	5.4			
	hard, grey, moist CLAYEY SILT some sand some fractured shale	7		100	8.7			
		8		100	10.1			



END OF BOREHOLE

LOGGED BY: AD
DRILLING DATE: February 24, 2022
REVIEWED BY: VN
Page 1 of 1

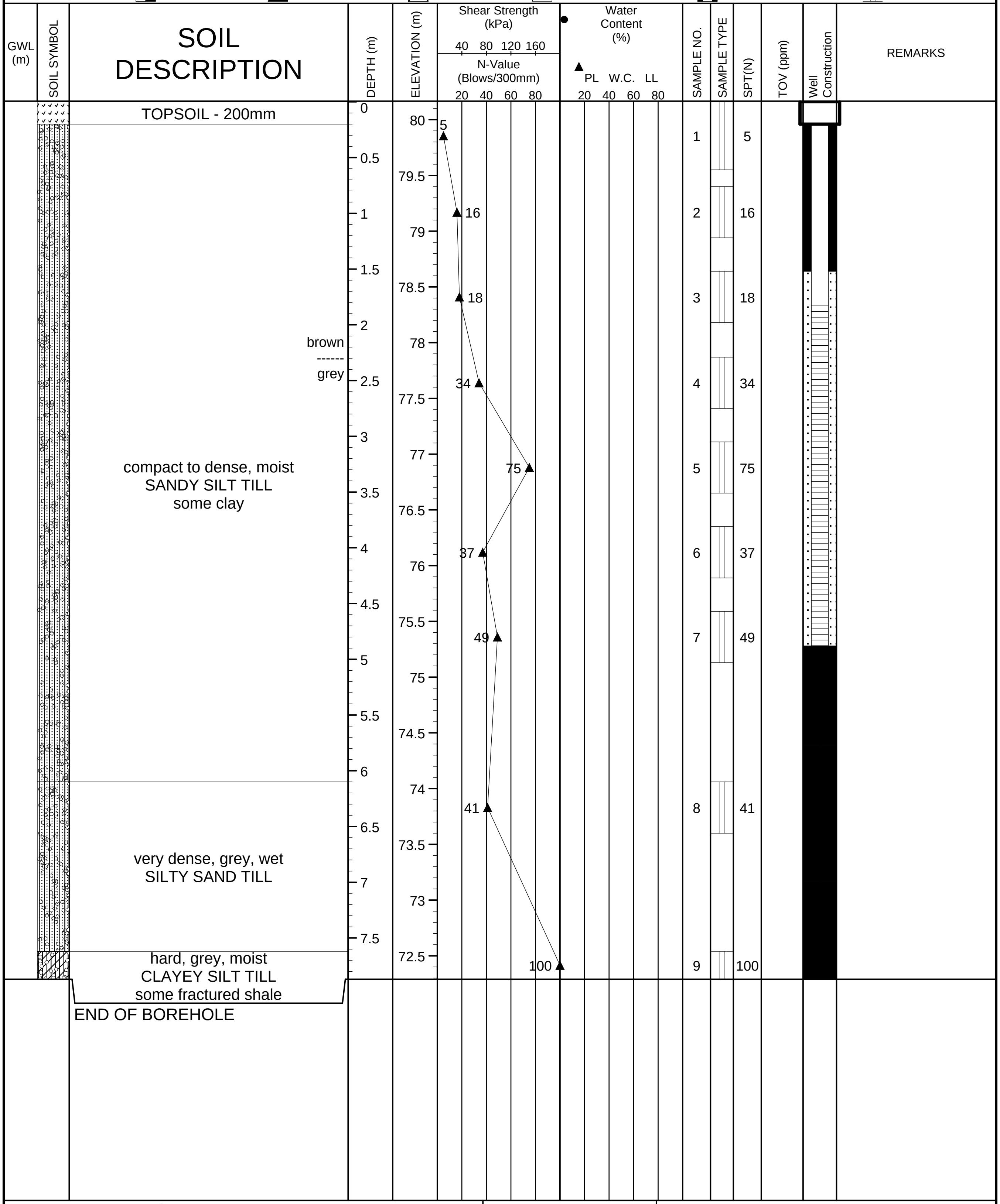
CLIENT: Liverpool Road Limited Partnership
METHOD: 0.2m hollow stem augur with split spoon

BH No.: MW104

PROJECT: 640 Liverpool Road
PROJECT ENGINEER: VN
ELEV. (m) 80.16

LOCATION: Pickering, Ontario
NORTHING: 4853285.82
EASTING: 654227.19
PROJECT NO.: CT3414.00

SAMPLE TYPE ◨ AUGER ◢ DRIVEN ⧓ CORING ⬒ DYNAMIC CONE ▯ SHELBY ⌶ SPLIT SPOON



SOIL DESCRIPTION

TOPSOIL - 200mm

compact to dense, moist
SANDY SILT TILL
some clay

brown
------
grey

very dense, grey, wet
SILTY SAND TILL

hard, grey, moist
CLAYEY SILT TILL
some fractured shale

END OF BOREHOLE

SAMPLE NO.	SPT(N)
1	5
2	16
3	18
4	34
5	75
6	37
7	49
8	41
9	100

TERRAPEX

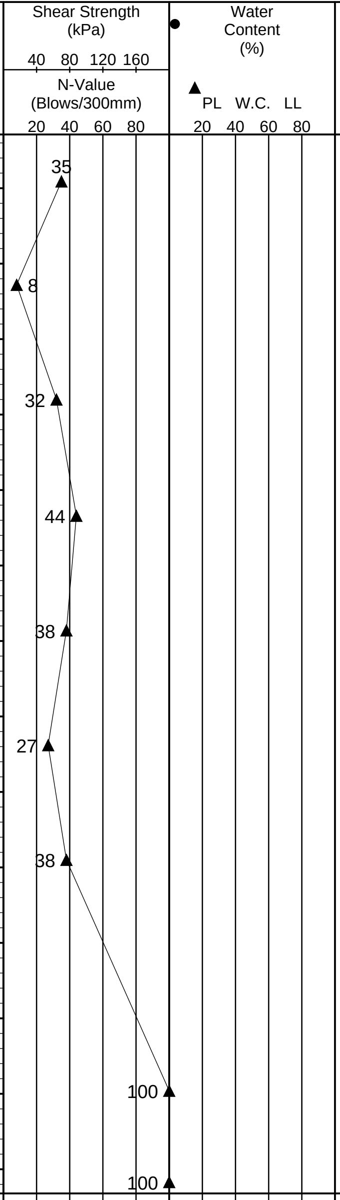
LOGGED BY: AD
DRILLING DATE: February 25, 2022
REVIEWED BY: VN
Page 1 of 1

CLIENT: Liverpool Road Limited Partnership	METHOD: 0.2m hollow stem augur with split spoon		**BH No.: BH105**
PROJECT: 640 Liverpool Road	PROJECT ENGINEER: VN	ELEV. (m) 78.35	
LOCATION: Pickering, Ontario	NORTHING: 4853224.05	EASTING: 654127.30	PROJECT NO.: CT3414.00

SAMPLE TYPE ▮ AUGER ◢ DRIVEN ⧓ CORING ▀ DYNAMIC CONE ▯ SHELBY ⌶ SPLIT SPOON

SOIL DESCRIPTION

DEPTH (m)	SOIL DESCRIPTION
0 – 0.2	sand and gravel fill - 200mm
0.2 – 3.05	compact to dense, brown, moist SANDY SILT TILL some clay
3.05 – 3.45	dense, grey, wet SILT trace sand
3.45 – 6.9	compact to dense, grey, moist SANDY SILT TILL --------------- clayey silt seams --------------- (at approx. 4 m)
6.9 – 7	FRACTURED SHALE
	END OF BOREHOLE



SAMPLE NO.	SAMPLE TYPE	SPT(N)
1	⌶	35
2	⌶	8
3	⌶	32
4	⌶	44
5A 5B	⌶	38
6A 6B	⌶	27
7	⌶	38
8	⌶	100
9	⌶	100

GWL (m) | SOIL SYMBOL | ELEVATION (m) | TOV (ppm) | Well Construction

REMARKS

Borehole was measure open with water at 6.7mbg immedietly following drilling

Augur refusal at 6.86m

TERRAPEX	LOGGED BY: AD	DRILLING DATE: MARCH 1, 2022
	REVIEWED BY: VN	Page 1 of 1

CLIENT: Liverpool Road Limited Partnership

METHOD: 0.2m hollow stem augur with split spoon

PROJECT: 640 Liverpool Road

PROJECT ENGINEER: VN

ELEV. (m) 79.60

BH No.: BH106

LOCATION: Pickering, Ontario

NORTHING: 4853240.36

EASTING: 654161.78

PROJECT NO.: CT3414.00

SAMPLE TYPE: AUGER, DRIVEN, CORING, DYNAMIC CONE, SHELBY, SPLIT SPOON

GWL (m) | SOIL SYMBOL | SOIL DESCRIPTION | DEPTH (m) | ELEVATION (m) | Shear Strength (kPa) / N-Value (Blows/300mm) | Water Content (%) | SAMPLE NO. | SAMPLE TYPE | SPT(N) | TOV (ppm) | Well Construction | REMARKS

sand and gravel fill - 200mm

olive, moist
sandy silt FILL
some clay

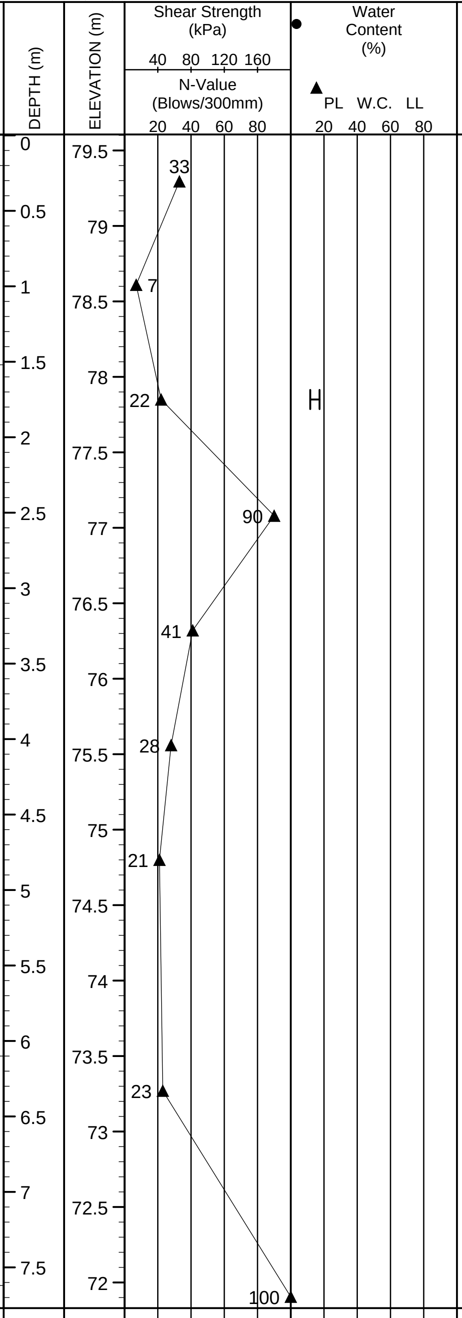
compact to dense
SANDY SILT TILL
some clay

brown, moist
----
grey, moist

very stiff, grey, moist
CLAYEY SILT
some sand

FRACTURED SHALE

END OF BOREHOLE



SAMPLE NO.	SPT(N)
1	33
2	7
3	22
4	90
5	41
6	28
7	21
8	23
9	100

REMARKS: Borehole was measure open with water at 7.0mbg immedietly following drilling

TERRAPEX

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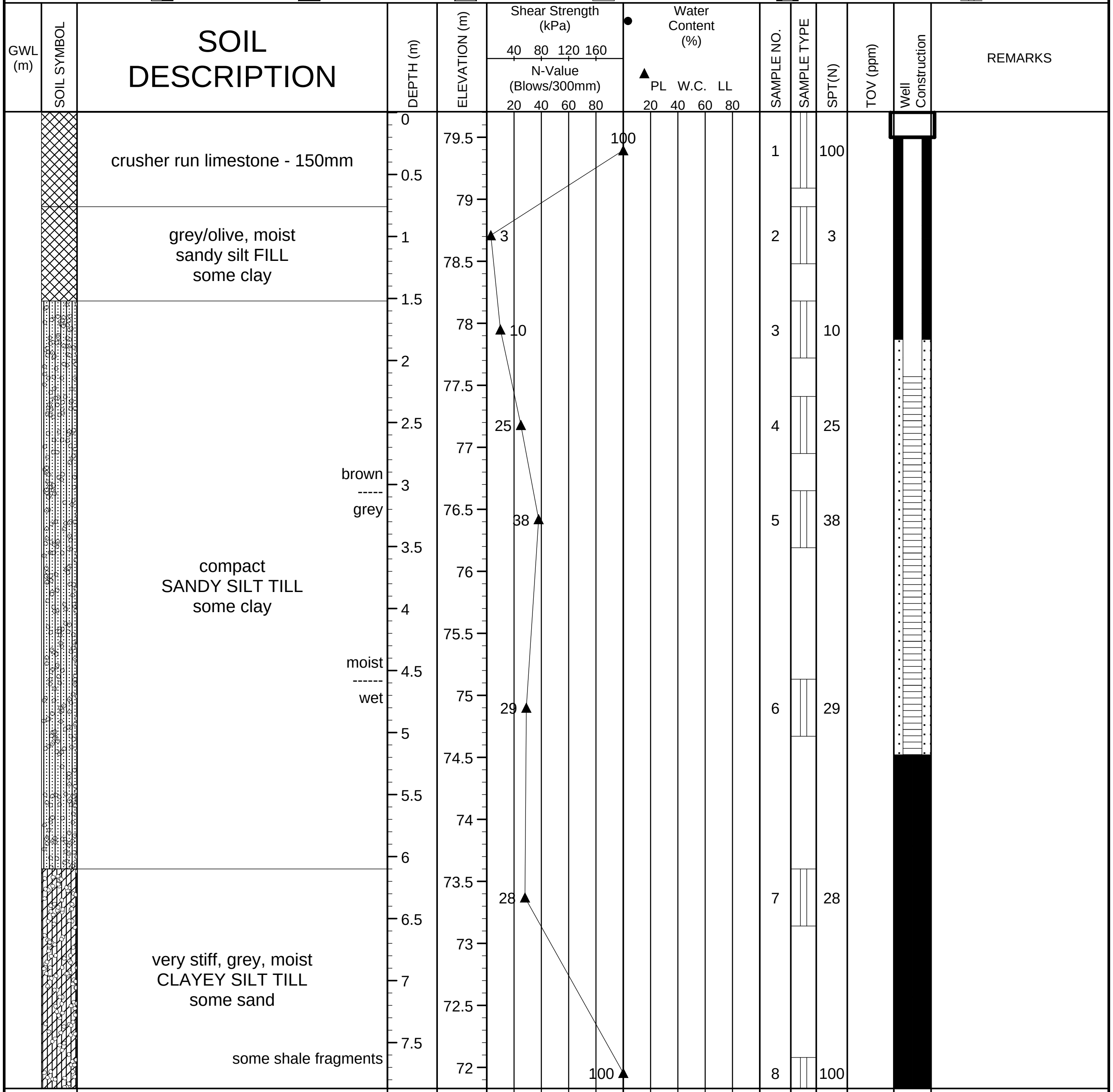
DRILLING DATE: February 25, 2022

REVIEWED BY: VN

CLIENT: Liverpool Road Limited Partnership	METHOD: 0.2m hollow stem augur with split spoon		**BH No.: MW107**
PROJECT: 640 Liverpool Road	PROJECT ENGINEER: VN	ELEV. (m) 79.70	
LOCATION: Pickering, Ontario	NORTHING: 4853247.93	EASTING: 654205.81	PROJECT NO.: CT3414.00

SAMPLE TYPE: AUGER, DRIVEN, CORING, DYNAMIC CONE, SHELBY, SPLIT SPOON



SOIL DESCRIPTION

crusher run limestone - 150mm

grey/olive, moist
sandy silt FILL
some clay

compact
SANDY SILT TILL
some clay

brown
-----
grey

moist
------
wet

very stiff, grey, moist
CLAYEY SILT TILL
some sand

some shale fragments

END OF BOREHOLE

SAMPLE NO.	SPT(N)
1	100
2	3
3	10
4	25
5	38
6	29
7	28
8	100

TERRAPEX

LOGGED BY: AD	DRILLING DATE: February 28, 2022
REVIEWED BY: VN	Page 1 of 1

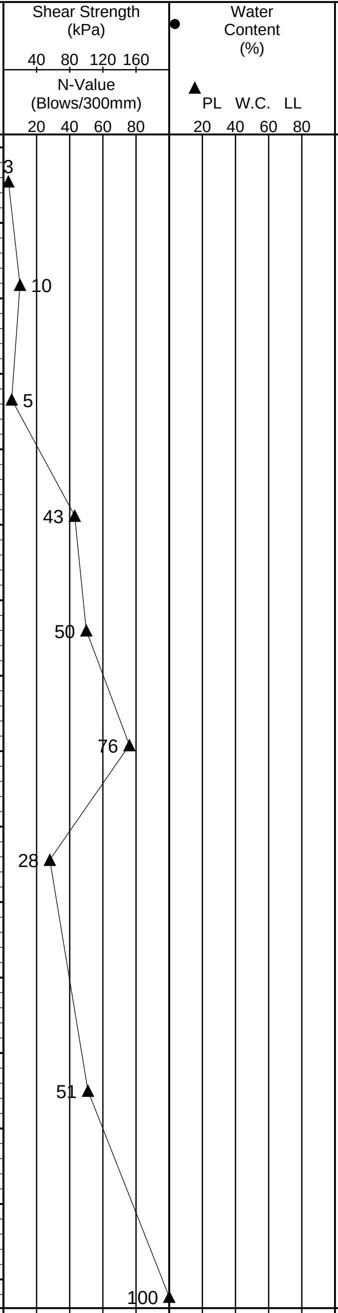
CLIENT: Liverpool Road Limited Partnership
METHOD: 0.2m hollow stem augur with split spoon
PROJECT: 640 Liverpool Road
PROJECT ENGINEER: VN
ELEV. (m) 80.08

BH No.: BH108

LOCATION: Pickering, Ontario
NORTHING: 4853264.81
EASTING: 654235.33
PROJECT NO.: CT3414.00

SAMPLE TYPE: AUGER, DRIVEN, CORING, DYNAMIC CONE, SHELBY, SPLIT SPOON

GWL (m)	SOIL SYMBOL	SOIL DESCRIPTION	DEPTH (m)	ELEVATION (m)
		TOPSOIL 150mm	0	80
		compact to very dense, moist SANDY SILT TILL some clay brown ----- grey some shale fragments	0 – 7.5	80 – 72.5
		END OF BOREHOLE		



SAMPLE NO.	SAMPLE TYPE	SPT(N)
1	SPLIT SPOON	3
2	SPLIT SPOON	10
3	SPLIT SPOON	5
4	SPLIT SPOON	43
5	SPLIT SPOON	50
6	SPLIT SPOON	76
7	SPLIT SPOON	28
8	SPLIT SPOON	51
9	SPLIT SPOON	100

TOV (ppm)

Well Construction

REMARKS: Borehole was measure open to 4.9mbg with water at 2.1mbg immedietly following drilling

TERRAPEX

LOGGED BY: AD
DRILLING DATE: February 25, 2022
REVIEWED BY: VN

CLIENT: Liverpool Road Limited Partnership

METHOD: 0.2m hollow stem augur with split spoon

PROJECT: 640 Liverpool Road

PROJECT ENGINEER: VN

ELEV. (m) 77.73

BH No.: MW109

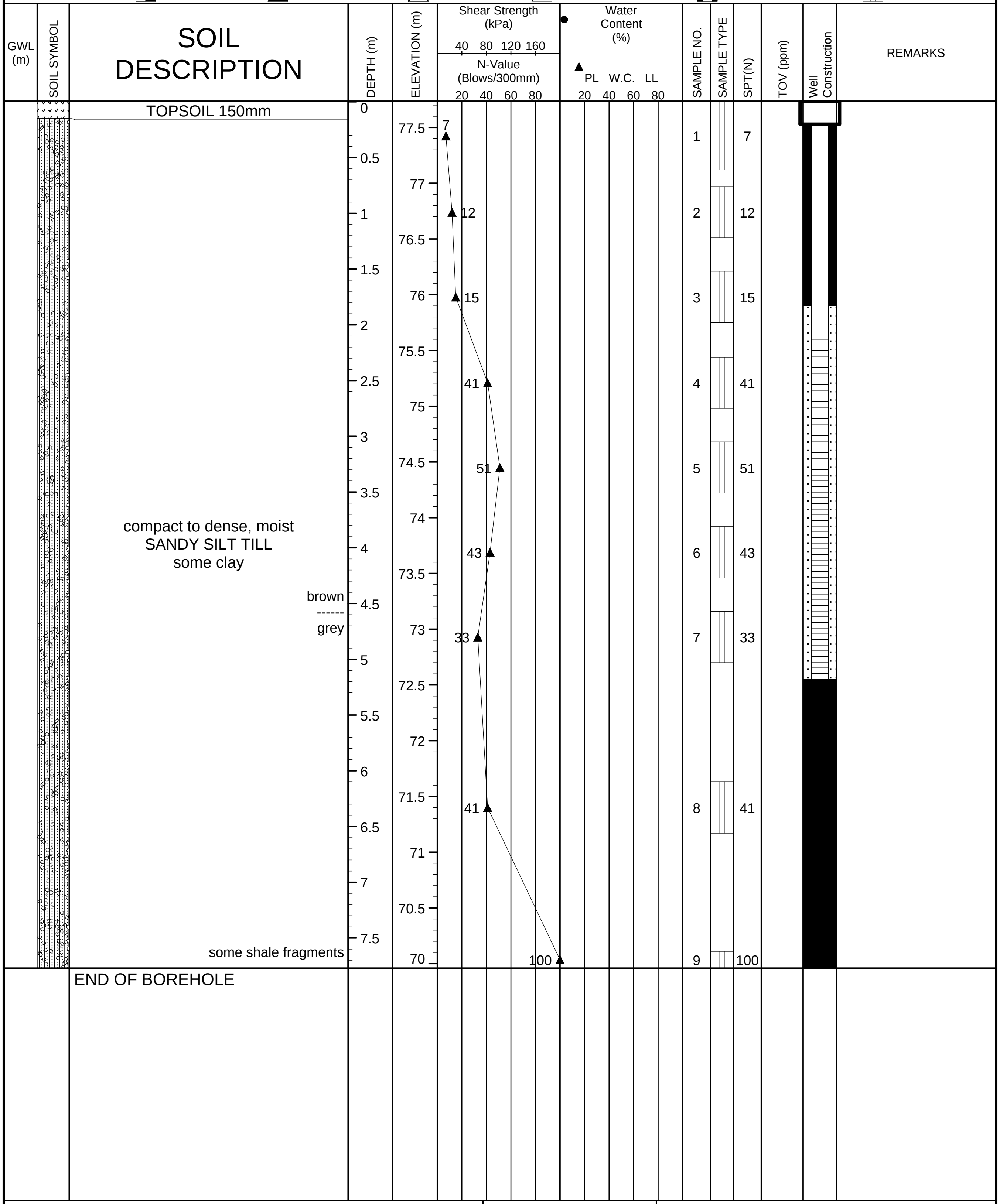
LOCATION: Pickering, Ontario

NORTHING: 4853187.11

EASTING: 654136.90

PROJECT NO.: CT3414.00

SAMPLE TYPE ▮ AUGER ◢ DRIVEN ⧗ CORING ▀ DYNAMIC CONE ▯ SHELBY ‖ SPLIT SPOON



TOPSOIL 150mm

compact to dense, moist
SANDY SILT TILL
some clay

brown
------
grey

some shale fragments

END OF BOREHOLE

SAMPLE NO.	SPT(N)
1	7
2	12
3	15
4	41
5	51
6	43
7	33
8	41
9	100

TERRAPEX

LOGGED BY: AD

DRILLING DATE: MARCH 2, 2022

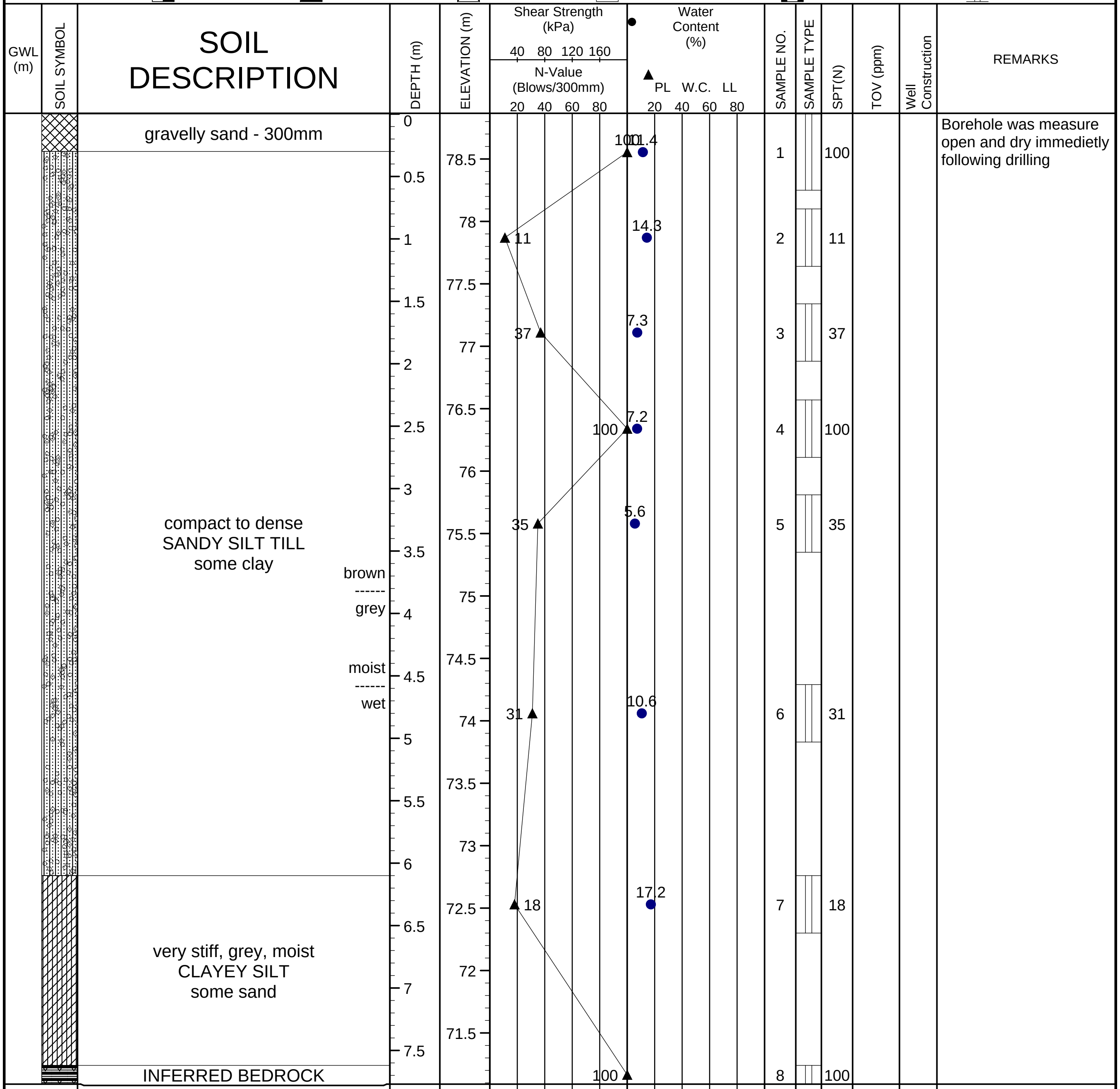
REVIEWED BY: VN

CLIENT: Liverpool Road Limited Partnership
METHOD: 0.2m hollow stem augur with split spoon
PROJECT: 640 Liverpool Road
PROJECT ENGINEER: VN
ELEV. (m) 78.86

BH No.: BH110

LOCATION: Pickering, Ontario
NORTHING: 4853204.42
EASTING: 654174.27
PROJECT NO.: CT3414.00

SAMPLE TYPE: ◧ AUGER ◩ DRIVEN ⧓ CORING ▀ DYNAMIC CONE ▯ SHELBY ⌶ SPLIT SPOON



gravelly sand - 300mm

compact to dense
SANDY SILT TILL
some clay

brown
------
grey

moist
------
wet

very stiff, grey, moist
CLAYEY SILT
some sand

INFERRED BEDROCK

END OF BOREHOLE

SAMPLE NO.	SPT(N)	Water Content (%)
1	100	11.4
2	11	14.3
3	37	7.3
4	100	7.2
5	35	5.6
6	31	10.6
7	18	17.2
8	100	

REMARKS: Borehole was measure open and dry immedietly following drilling

TERRAPEX

LOGGED BY: AD
REVIEWED BY: VN
DRILLING DATE: February 28, 2022
Page 1 of 1

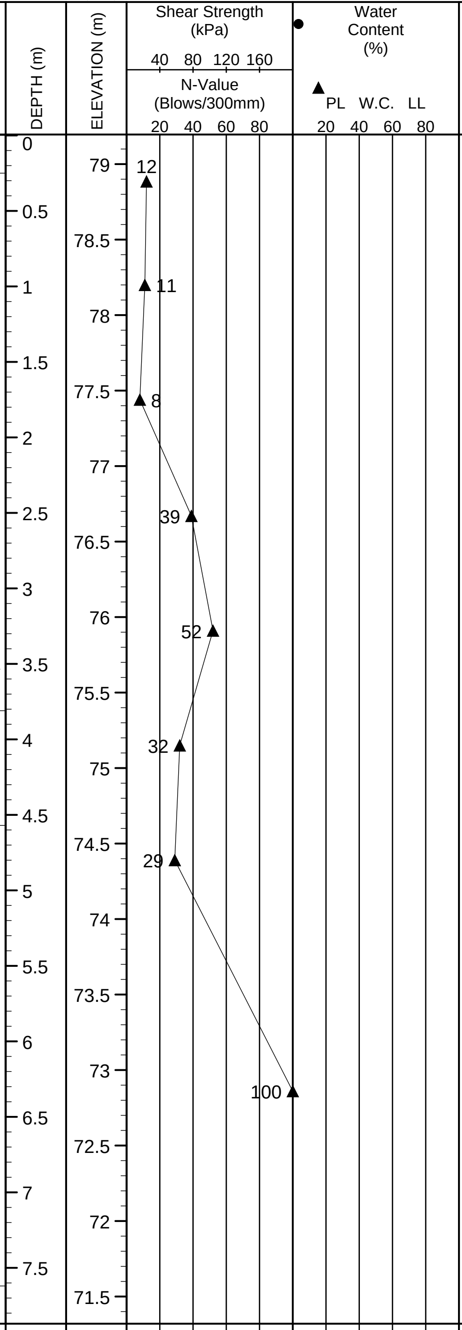
CLIENT: Liverpool Road Limited Partnership
METHOD: 0.2m hollow stem augur with split spoon
PROJECT: 640 Liverpool Road
PROJECT ENGINEER: VN
ELEV. (m) 79.19

BH No.: BH111

LOCATION: Pickering, Ontario
NORTHING: 4853215.82
EASTING: 654208.51
PROJECT NO.: CT3414.00

SAMPLE TYPE: AUGER, DRIVEN, CORING, DYNAMIC CONE, SHELBY, SPLIT SPOON

GWL (m)	SOIL SYMBOL	SOIL DESCRIPTION	SAMPLE NO.	SAMPLE TYPE	SPT(N)	TOV (ppm)	Well Construction	REMARKS
		gravelly sand fill 250mm						Borehole was measure open to 6.7mbg with water at 5.5mbg immedietly following drilling
		compact to very dense, moist SANDY SILT TILL some clay	1		12			
			2		11			
			3		8			
			4		39			
		brown ------ grey	5A 5B		52			
		dense, brown, wet SAND trace silt	6		32			
		very stiff to hard, grey, moist CLAYEY SILT TILL some sand	7		29			
			8		100			
		WEATHERED SHALE	9					
		END OF BOREHOLE						



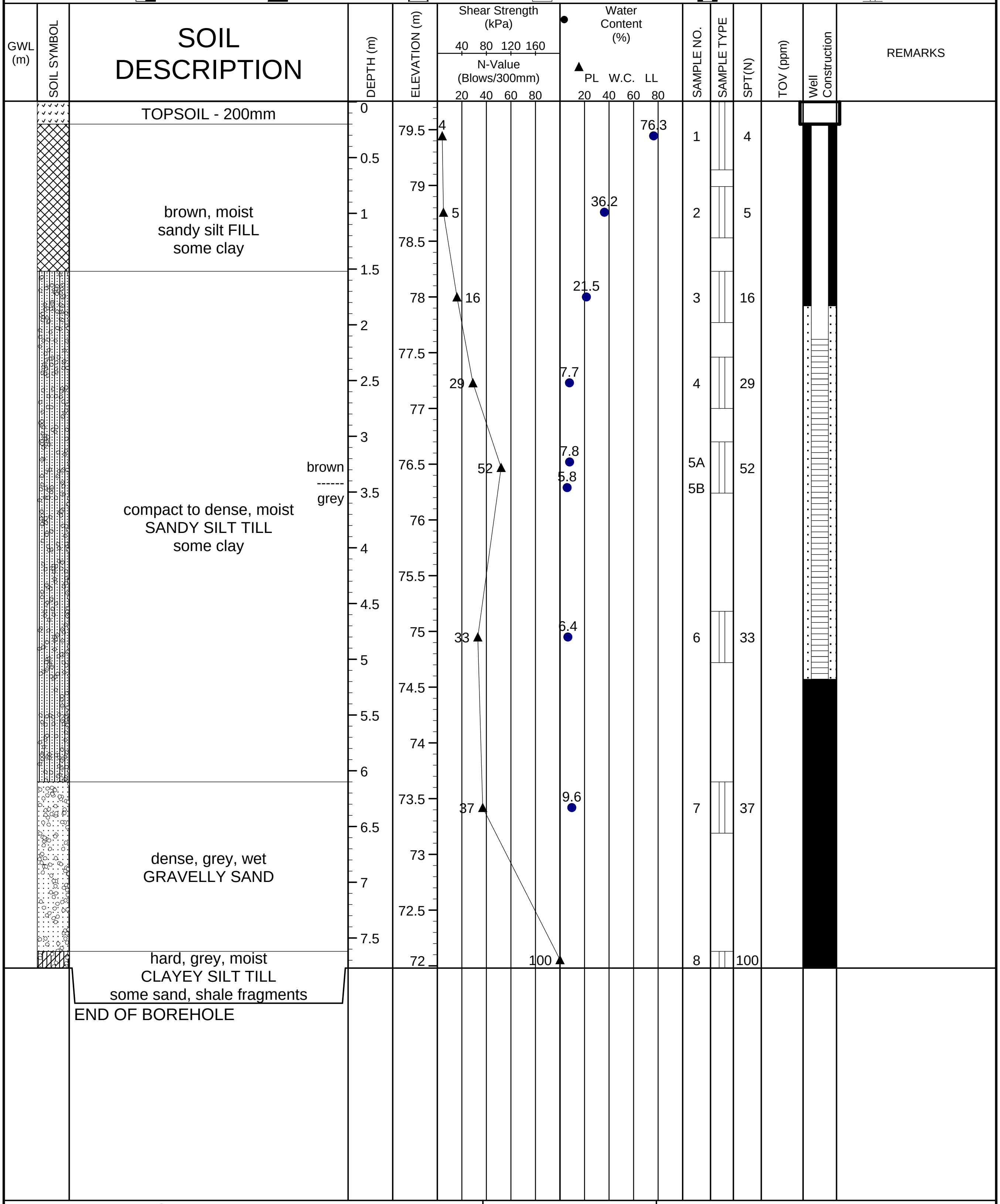
TERRAPEX
LOGGED BY: AD
DRILLING DATE: MARCH 1, 2022
REVIEWED BY: VN
Page 1 of 1

CLIENT: Liverpool Road Limited Partnership
METHOD: 0.2m hollow stem augur with split spoon
PROJECT: 640 Liverpool Road
PROJECT ENGINEER: VN
ELEV. (m) 79.75

BH No.: MW112

LOCATION: Pickering, Ontario
NORTHING: 4853236.13
EASTING: 654235.94
PROJECT NO.: CT3414.00

SAMPLE TYPE: AUGER, DRIVEN, CORING, DYNAMIC CONE, SHELBY, SPLIT SPOON



TOPSOIL - 200mm

brown, moist
sandy silt FILL
some clay

compact to dense, moist
SANDY SILT TILL
some clay

brown
------
grey

dense, grey, wet
GRAVELLY SAND

hard, grey, moist
CLAYEY SILT TILL
some sand, shale fragments

END OF BOREHOLE

SAMPLE NO.	N-Value	Water Content (%)	SPT(N)
1	4	76.3	4
2	5	36.2	5
3	16	21.5	16
4	29	7.7	29
5A	52	7.8	52
5B		5.8	
6	33	6.4	33
7	37	9.6	37
8	100		100

TERRAPEX

LOGGED BY: AD
DRILLING DATE: February 28, 2022
REVIEWED BY: VN
Page 1 of 1

CLIENT: Liverpool Road Limited Partnership

METHOD: 0.2m hollow stem augur with split spoon

PROJECT: 640 Liverpool Road

PROJECT ENGINEER: VN

ELEV. (m) 80.13

BH No.: MW113

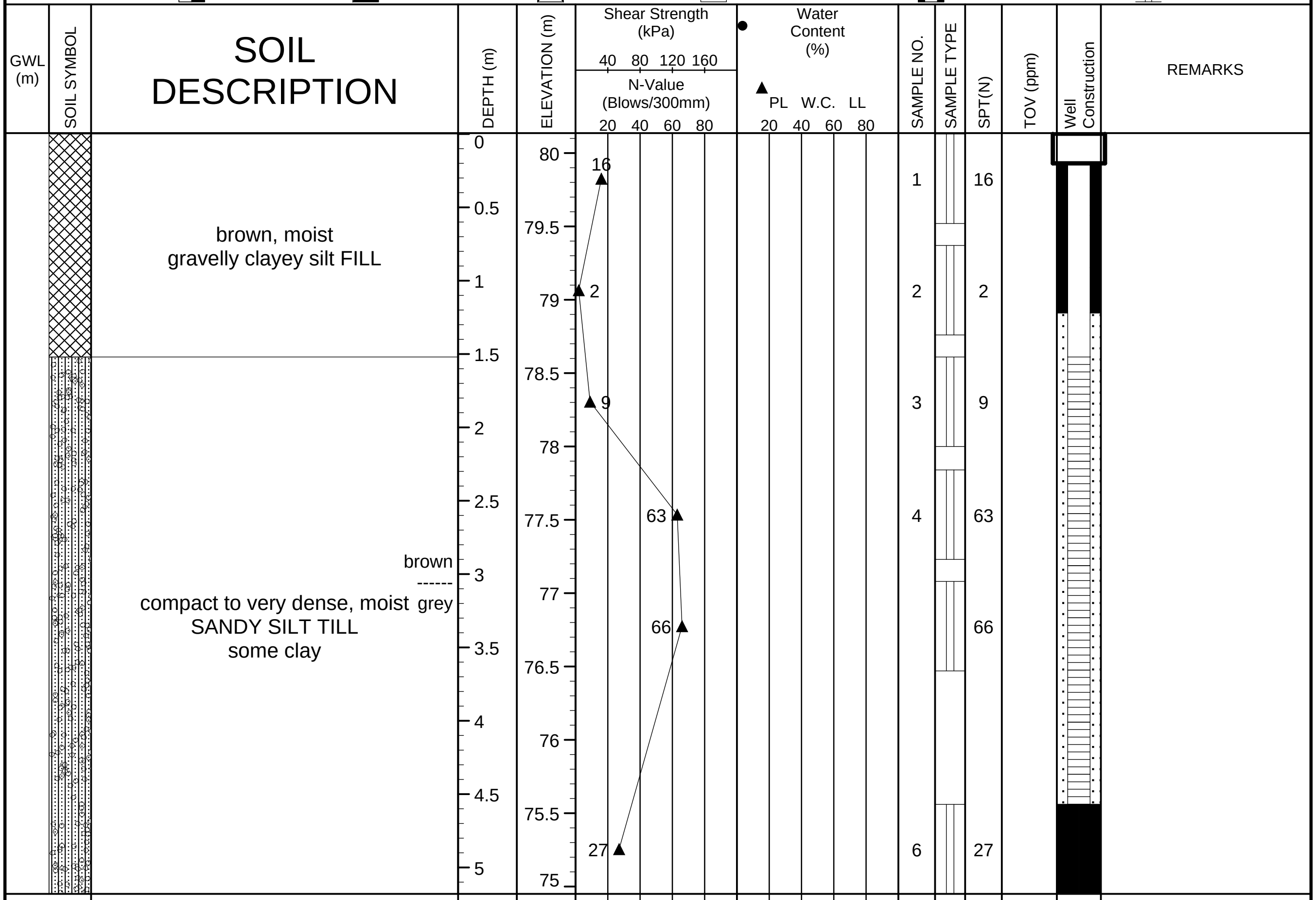
LOCATION: Pickering, Ontario

NORTHING: 4853252.72

EASTING: 654212.318

PROJECT NO.: CT3414.00

SAMPLE TYPE AUGER DRIVEN CORING DYNAMIC CONE SHELBY SPLIT SPOON



brown, moist
gravelly clayey silt FILL

compact to very dense, moist
SANDY SILT TILL
some clay

brown
------
grey

SAMPLE NO.	SPT(N)
1	16
2	2
3	9
4	63
	66
6	27

END OF BOREHOLE

TERRAPEX

LOGGED BY: AD

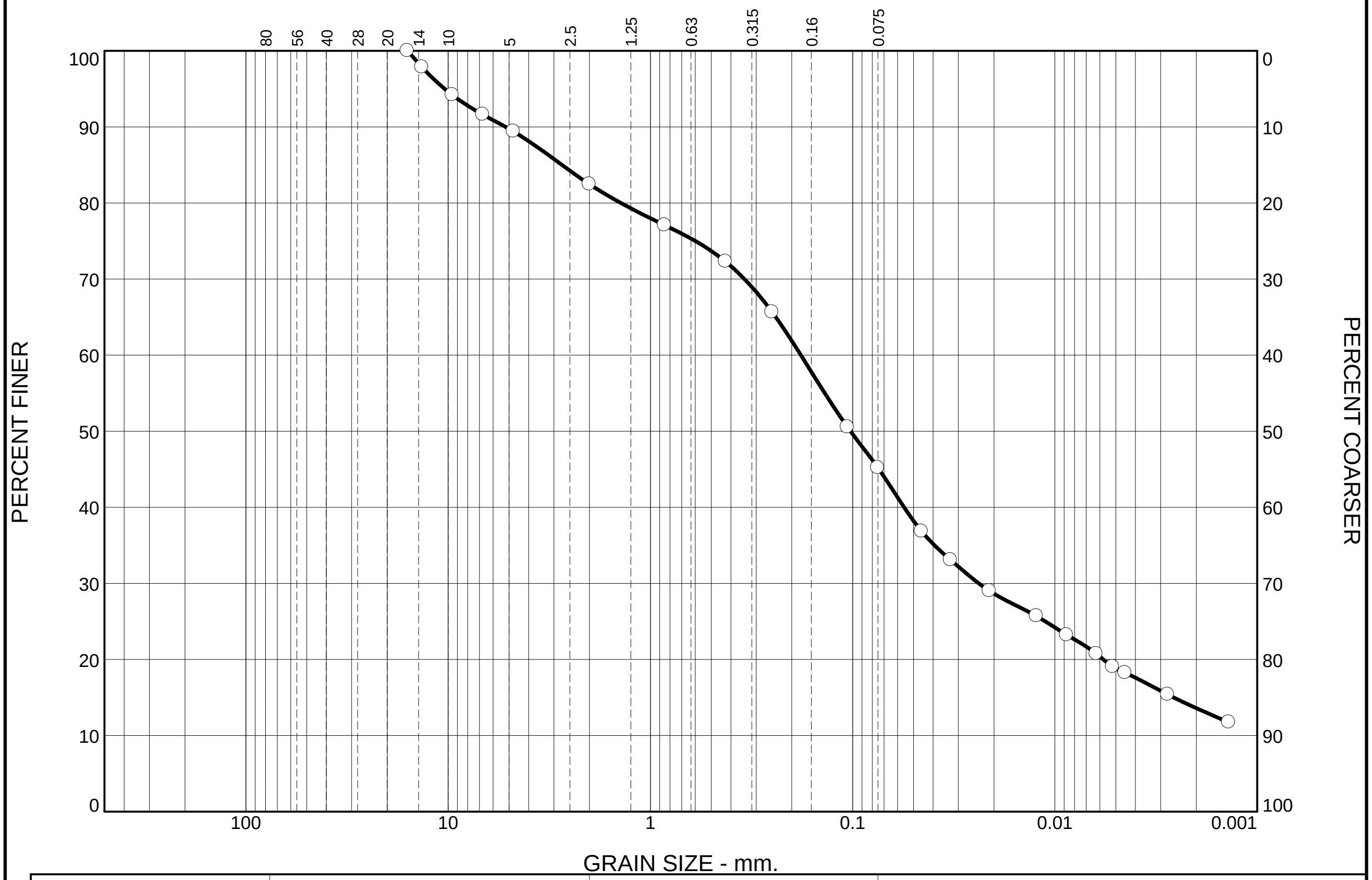
DRILLING DATE: MARCH 1, 2022

REVIEWED BY: VN

APPENDIX D

LABORATORY TEST RESULTS

Particle Size Distribution Report



	% +3"	% Gravel	% Sand		% Fines	
			Coarse	Fine	Silt	Clay
○	0	18	10	27	31	14

☒	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○	17.3	11.7	2.7354	0.1802	0.1025	0.0238	0.0026			

Material Description	USCS	AASHTO
○ SILTY SAND some gravel some clay	SC-SM	A-4(0)

Project No. CT3414 **Client:** Liverpool Limited Partnership

Project: 640 Liverpool Road, Pickering

○ **Sample Number:** BH 106, Sample 3

Terrapex

Toronto, Ontario

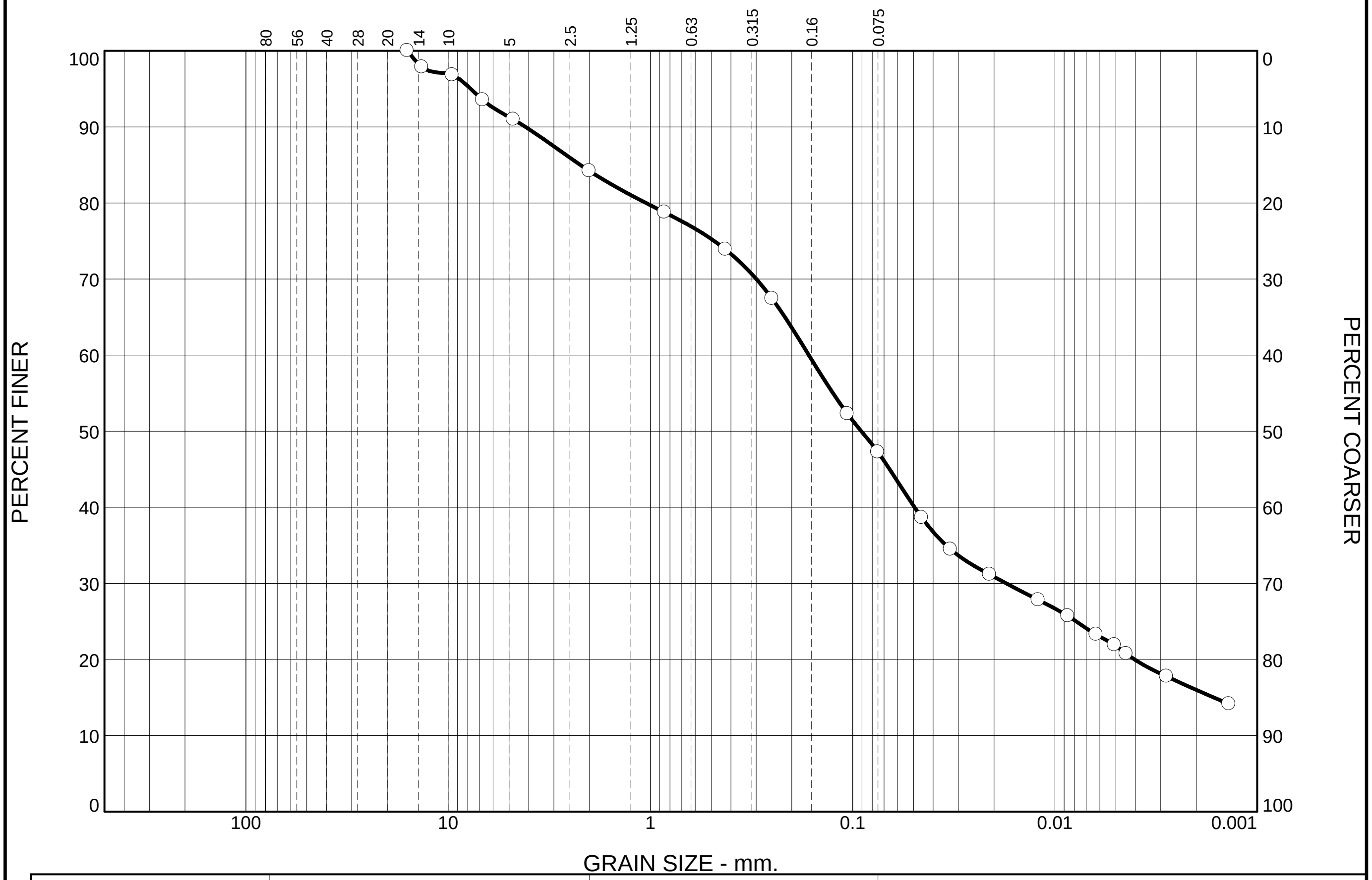
Remarks:

○HYDROMETER DETAILS: Spec. Grav. 2.75(assumed);Vb=53cm^3; L2=13.8cm; L1=10.7cm; hs= 0.16cm/Div; A=30.2cm^2; Mass of Disp. Agent=40g/1 Test Date: March 7, 2022

Figure 1

Tested By: AM

Particle Size Distribution Report



	% +3"	% Gravel	% Sand		% Fines	
			Coarse	Fine	Silt	Clay
○	0	16	10	27	31	16

☒	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○			2.2198	0.1646	0.0906	0.0174	0.0016			

Material Description	USCS	AASHTO
○ SILTY SAND some gravel some clay		

Project No. CT3414 **Client:** Liverpool Limited Partnership

Project: 640 Liverpool Road, Pickering

○ **Sample Number:** BH 106, Sample 5

Terrapex

Toronto, Ontario

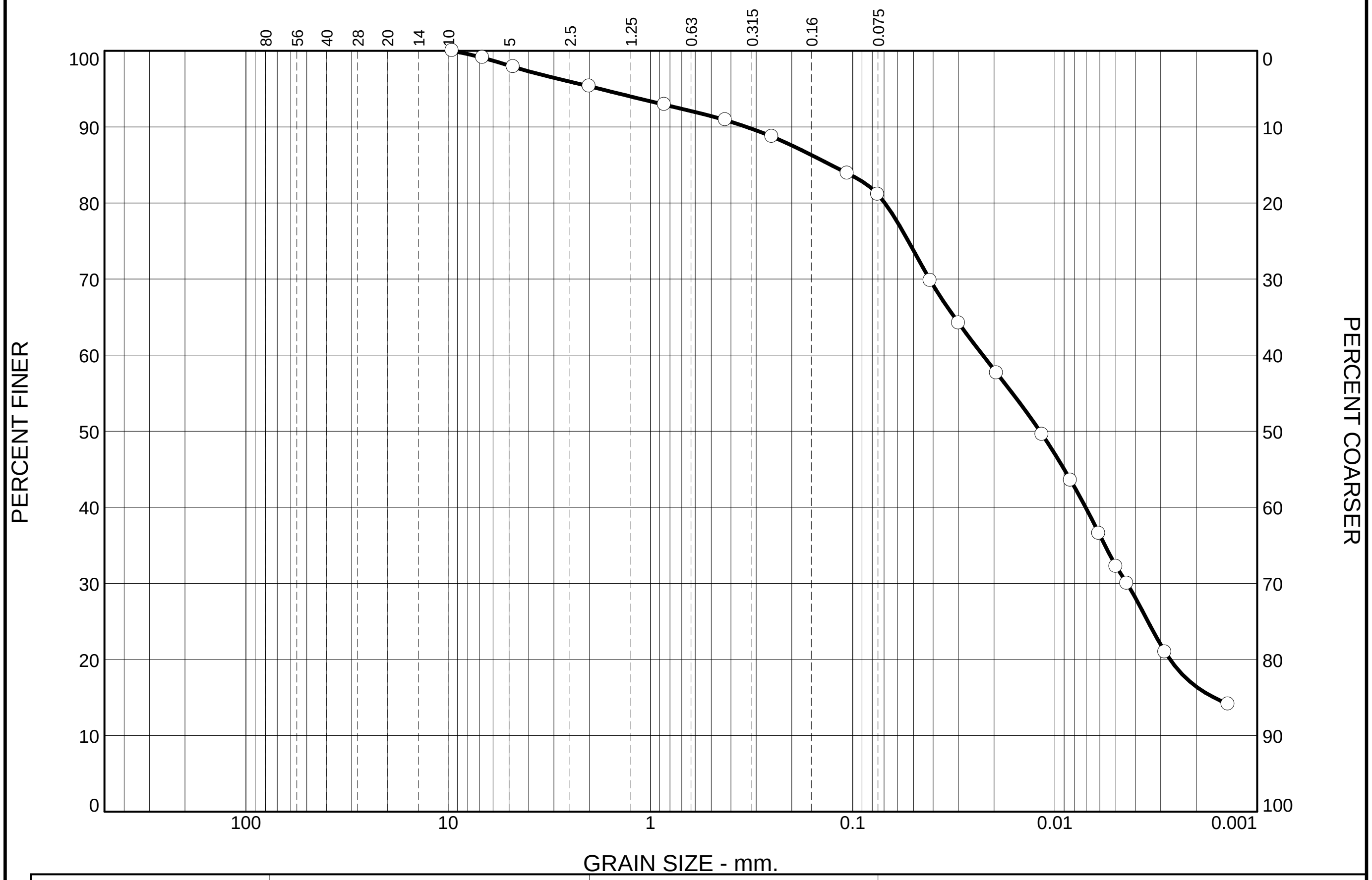
Remarks:

○HYDROMETER DETAILS: Spec. Grav. 2.75(assumed);Vb=53cm^3; L2=13.8cm; L1=10.7cm; hs= 0.16cm/Div; A=30.2cm^2; Mass of Disp. Agent=40g/1 Test Date: March 7, 2022

Figure 2

Tested By: AM/UB

Particle Size Distribution Report



	% +3"	% Gravel	% Sand		% Fines	
			Coarse	Fine	Silt	Clay
○	0	5	4	10	65	16

	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○			0.1281	0.0227	0.0119	0.0044	0.0016			

Material Description	USCS	AASHTO
○ SILT some sand some clay trace gravel		

Project No. CT3414 **Client:** Liverpool Limited Partnership

Project: 640 Liverpool Road, Pickering

○ **Sample Number:** BH 106, Sample 8

Terrapex

Toronto, Ontario

Remarks:

○HYDROMETER DETAILS: Spec. Grav. 2.75(assumed);Vb=53cm^3; L2=13.8cm; L1=10.7cm; hs= 0.16cm/Div; A=30.2cm^2; Mass of Disp. Agent=40g/1 Test Date: March 7, 2022

Figure 3

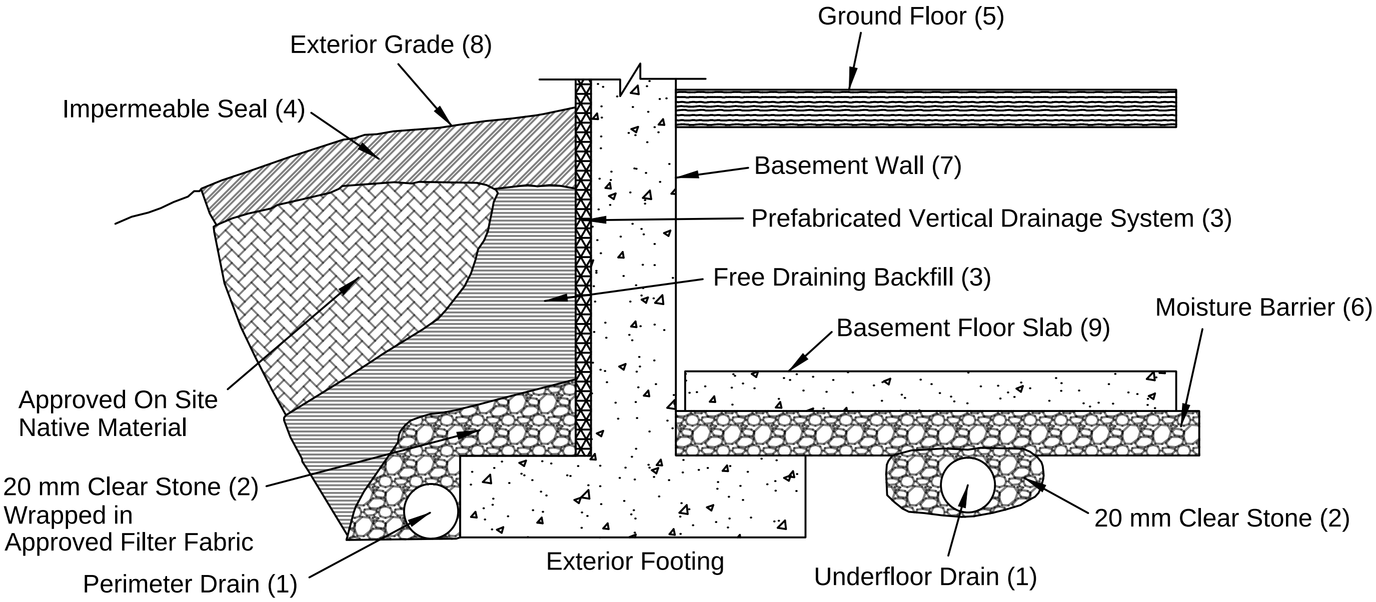
Tested By: AM

APPENDIX E

TYPICAL PERIMETER AND UNDERFLOOR DRAINAGE SYSTEM

TERRAPEX

Drainage and Backfill Details



Notes

1. Perimeter and underfloor drains shall consist of 100 mm diameter weeping tile with fabric sock or equivalent perforated pipe leading to a positive sump or outlet. Invert to be a minimum of 300 mm below underside of basement floor slab. Perimeter drain is required for sections of basement wall installed below exterior grade.
2. 20 mm Clear Stone - 150 mm top and side of drain, surrounded by approved filter fabric (Terrafix 270R or equivalent).
3. Free draining backfill - OPSS Granular B or equivalent compacted to the specified density. Do not use heavy compaction equipment within 450 mm of the wall. Use hand controlled light compaction equipment within 1.8 m of the wall. Free draining backfill is not required if a prefabricated vertical drainage system (such as Miradrain 6000) is installed on the exterior of the basement wall.
4. Impermeable backfill seal (min. 600 mm) - relatively impervious compacted silty clay, clayey silt, or equivalent. If on-site native backfill is impermeable, seal may be omitted.
5. Do not backfill until wall is supported by basement floor slab and ground floor framing, or adequate bracing is provided.
6. Moisture barrier to be at least 200 mm of compacted 20 mm clear stone of equivalent free draining material.
7. Basement wall to be damp-proofed.
8. Exterior grade to slope away from building at minimum gradient of 2%.

DRAINAGE AND BACKFILL RECOMMENDATIONS
(Not to Scale)

APPENDIX F

CERTIFICATE OF CHEMICAL ANALYSIS

Your Project #: CT3414.00
Your C.O.C. #: 857364-07-01

Attention: Alex Dobrogost

Terrapex Environmental Ltd
90 Scarsdale Rd
Toronto, ON
CANADA M3B 2R7

Report Date: 2022/03/15
Report #: R7044739
Version: 1 - Final

CERTIFICATE OF ANALYSIS

BUREAU VERITAS JOB #: C265156
Received: 2022/03/11, 15:35

Sample Matrix: Soil
Samples Received: 2

Analyses	Quantity	Date Extracted	Date Analyzed	Laboratory Method	Analytical Method
pH CaCl2 EXTRACT	2	2022/03/15	2022/03/15	CAM SOP-00413	EPA 9045 D m
Sulphate (20:1 Extract)	2	2022/03/15	2022/03/15	CAM SOP-00464	EPA 375.4 m

Remarks:

Bureau Veritas is accredited to ISO/IEC 17025 for specific parameters on scopes of accreditation. Unless otherwise noted, procedures used by Bureau Veritas are based upon recognized Provincial, Federal or US method compendia such as CCME, MELCC, EPA, APHA.

All work recorded herein has been done in accordance with procedures and practices ordinarily exercised by professionals in Bureau Veritas' profession using accepted testing methodologies, quality assurance and quality control procedures (except where otherwise agreed by the client and Bureau Veritas in writing). All data is in statistical control and has met quality control and method performance criteria unless otherwise noted. All method blanks are reported; unless indicated otherwise, associated sample data are not blank corrected. Where applicable, unless otherwise noted, Measurement Uncertainty has not been accounted for when stating conformity to the referenced standard.

Bureau Veritas liability is limited to the actual cost of the requested analyses, unless otherwise agreed in writing. There is no other warranty expressed or implied. Bureau Veritas has been retained to provide analysis of samples provided by the Client using the testing methodology referenced in this report. Interpretation and use of test results are the sole responsibility of the Client and are not within the scope of services provided by Bureau Veritas, unless otherwise agreed in writing. Bureau Veritas is not responsible for the accuracy or any data impacts, that result from the information provided by the customer or their agent.

Solid sample results, except biota, are based on dry weight unless otherwise indicated. Organic analyses are not recovery corrected except for isotope dilution methods.
Results relate to samples tested. When sampling is not conducted by Bureau Veritas, results relate to the supplied samples tested.
This Certificate shall not be reproduced except in full, without the written approval of the laboratory.
Reference Method suffix “m” indicates test methods incorporate validated modifications from specific reference methods to improve performance.
* RPDs calculated using raw data. The rounding of final results may result in the apparent difference.

Your Project #: CT3414.00
Your C.O.C. #: 857364-07-01

Attention: Alex Dobrogost

Terrapex Environmental Ltd
90 Scarsdale Rd
Toronto, ON
CANADA M3B 2R7

Report Date: 2022/03/15
Report #: R7044739
Version: 1 - Final

CERTIFICATE OF ANALYSIS

BUREAU VERITAS JOB #: C265156
Received: 2022/03/11, 15:35

Encryption Key

Please direct all questions regarding this Certificate of Analysis to your Project Manager.
Kudrat Bajwa, B.Sc., Project Manager
Email: Kudrat.Bajwa@bureauveritas.com
Phone# (905)817-5755
==
This report has been generated and distributed using a secure automated process.
Bureau Veritas has procedures in place to guard against improper use of the electronic signature and have the required "signatories", as per ISO/IEC 17025, signing the reports.
For Service Group specific validation please refer to the Validation Signature Page.

RESULTS OF ANALYSES OF SOIL

Bureau Veritas ID		SBL897	SBL898		
Sampling Date		2022/02/24 10:15	2022/03/01 09:30		
COC Number		857364-07-01	857364-07-01		
	UNITS	**BH102-3**	**BH111-6**	**RDL**	**QC Batch**
Inorganics					
Available (CaCl2) pH	pH	7.93	7.83		7883026
Soluble (20:1) Sulphate (SO4)	ug/g	290	34	20	7882290

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch

TEST SUMMARY

Bureau Veritas ID: SBL897
Sample ID: BH102-3
Matrix: Soil

Collected: 2022/02/24
Shipped:
Received: 2022/03/11

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
pH CaCl2 EXTRACT	AT	7883026	2022/03/15	2022/03/15	Taslima Aktar
Sulphate (20:1 Extract)	KONE/EC	7882290	2022/03/15	2022/03/15	Avneet Kour Sudan

Bureau Veritas ID: SBL898
Sample ID: BH111-6
Matrix: Soil

Collected: 2022/03/01
Shipped:
Received: 2022/03/11

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
pH CaCl2 EXTRACT	AT	7883026	2022/03/15	2022/03/15	Taslima Aktar
Sulphate (20:1 Extract)	KONE/EC	7882290	2022/03/15	2022/03/15	Avneet Kour Sudan

GENERAL COMMENTS

Each temperature is the average of up to three cooler temperatures taken at receipt

Package 1	-1.0°C

Results relate only to the items tested.

QUALITY ASSURANCE REPORT

			Matrix Spike		SPIKED BLANK		Method Blank		RPD	
QC Batch	**Parameter**	**Date**	**% Recovery**	**QC Limits**	**% Recovery**	**QC Limits**	**Value**	**UNITS**	**Value (%)**	**QC Limits**
7882290	Soluble (20:1) Sulphate (SO4)	2022/03/15	NC	70 - 130	109	70 - 130	<20	ug/g	1.7	35
7883026	Available (CaCl2) pH	2022/03/15			100	97 - 103			1.6	N/A

N/A = Not Applicable

Duplicate: Paired analysis of a separate portion of the same sample. Used to evaluate the variance in the measurement.

Matrix Spike: A sample to which a known amount of the analyte of interest has been added. Used to evaluate sample matrix interference.

Spiked Blank: A blank matrix sample to which a known amount of the analyte, usually from a second source, has been added. Used to evaluate method accuracy.

Method Blank: A blank matrix containing all reagents used in the analytical procedure. Used to identify laboratory contamination.

NC (Matrix Spike): The recovery in the matrix spike was not calculated. The relative difference between the concentration in the parent sample and the spike amount was too small to permit a reliable recovery calculation (matrix spike concentration was less than the native sample concentration)

VALIDATION SIGNATURE PAGE

The analytical data and all QC contained in this report were reviewed and validated by:

Eva

Eva Pranjic

Ewa Pranjic, M.Sc., C.Chem, Scientific Specialist

BUREAU VERITAS

Bureau Veritas Laboratories
6740 Campobello Road, Mississauga, Ontario Canada L5N 2L8 Tel:(905) 817-5700 Toll-free:800-563-6266 Fax:(905) 817-5777 www.bvna.com

Page 1 of 1

11-Mar-22 15:35
Ema Gitej
C265156
RMT ENV-1729

INVOICE TO:

Company Name: #4398 Terrapex Environmental Ltd
Attention: Accounts Payable
Address: 90 Scarsdale Rd
Toronto ON M3B 2R7
Tel: (416) 245-0011 Fax: (416) 245-0012
Email: accounts.payable@terrapex.com

REPORT TO:

Company Name: #6839 Terrapex Environmental Ltd
Attention: ~~Geoff Lussier~~ Alex Dobrogost
Address: 65 Nebo Road
Hamilton ON L8W 2C9
Tel: (905) 632-5939 Ext: 228 Fax: (905) 632-6793
Email: ~~g.lussier@terrapex.com~~ A.Dobrogost@Terrapex.com

PROJECT INFORMATION:

Quotation #: C01024
P.O. #:
Project: CT3414.00
Project Name:
Site #:
Sampled By: AD

Bottle Order #: 857364

COC #: C#857364-07-01

Project Manager: Ema Gitej

MOE REGULATED DRINKING WATER OR WATER INTENDED FOR HUMAN CONSUMPTION MUST BE SUBMITTED ON THE BUREAU VERITAS DRINKING WATER CHAIN OF CUSTODY

Regulation 153 (2011)

☐ Table 1 ☐ Res/Park ☐ Medium/Fine
☐ Table 2 ☐ Ind/Comm ☐ Coarse
☐ Table 3 ☐ Agri/Other ☐ **For RSC**
☐ Table ___

Other Regulations

☐ CCME ☐ Sanitary Sewer Bylaw
☐ Reg 558 ☐ Storm Sewer Bylaw
☐ MISA Municipality ___
☐ PWQO ☐ Reg 406 Table ___
☐ Other ___

Special Instructions

Include Criteria on Certificate of Analysis (Y/N)? N

ANALYSIS REQUESTED (PLEASE BE SPECIFIC)

Turnaround Time (TAT) Required:
Please provide advance notice for rush projects

Regular (Standard) TAT: ☒
(will be applied if Rush TAT is not specified):
Standard TAT = 5-7 Working days for most tests.
Please note: Standard TAT for certain tests such as BOD and Dioxins/Furans are > 5 days - contact your Project Manager for details.

Job Specific Rush TAT (if applies to entire submission) ☐
Date Required: ___ Time Required: ___
Rush Confirmation Number: ___ *(call lab for #)*

	Sample Barcode Label	Sample (Location) Identification	Date Sampled	Time Sampled	Matrix	Field Filtered (please circle): Metals / Hg / Cr VI	O.Reg 153 VOCs by HS & F1-F4 (Soil)	O.Reg 153 PAHs (Soil)	O.Reg 153 Metals & Inorganics Pkg (Soil)	O.Reg 153 OC Pesticides (incl. PCBs)	Sieve, 75um	O.Reg 558 TCLP VOCs by HS	O.Reg 558 TCLP Inorganics Package	O.Reg 558 TCLP Semi-Volatile Organics	PH/Sulphate		# of Bottles	Comments
1																		
2																		
3		BH102-3	2022/02/24	10:15 am	Soil										X		1	for geo-tech
4		BH111-6	2022/03/01	9:30 am	Soil										X		1	"
5																		
6																		
7																		
8																		
9																		
10																		

* RELINQUISHED BY: (Signature/Print)	Date: (YY/MM/DD)	Time	RECEIVED BY: (Signature/Print)	Date: (YY/MM/DD)	Time	# jars used and not submitted
A.D. Alex Dobrogost	22/03/11	9:30am	2 VJ TRina	2022/03/11	15:35	

Laboratory Use Only

Time Sensitive	Temperature (°C) on Recei	Custody Seal	Yes	No
	-1/-1/-1	Present	✓	
		Intact	✓	

White: Bureau Veritas Yellow: Client

* UNLESS OTHERWISE AGREED TO IN WRITING, WORK SUBMITTED ON THIS CHAIN OF CUSTODY IS SUBJECT TO BUREAU VERITAS'S STANDARD TERMS AND CONDITIONS. SIGNING OF THIS CHAIN OF CUSTODY DOCUMENT IS ACKNOWLEDGMENT AND ACCEPTANCE OF OUR TERMS WHICH ARE AVAILABLE FOR VIEWING AT WWW.BVLABS.COM/TERMS-AND-CONDITIONS.

* IT IS THE RESPONSIBILITY OF THE RELINQUISHER TO ENSURE THE ACCURACY OF THE CHAIN OF CUSTODY RECORD. AN INCOMPLETE CHAIN OF CUSTODY MAY RESULT IN ANALYTICAL TAT DELAYS.

** SAMPLE CONTAINER, PRESERVATION, HOLD TIME AND PACKAGE INFORMATION CAN BE VIEWED AT WWW.BVLABS.COM/RESOURCES/CHAIN-OF-CUSTODY-FORMS.

#1 P43 623

SAMPLES MUST BE KEPT COOL (< 10° C) FROM TIME OF SAMPLING UNTIL DELIVERY TO BUREAU VERITAS