TIL Toronto Inspection LTD.
GEO-ENVIRONMENTAL CONSULTANTS

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April 9, 2021
Project No.: 5607-21-GB

Armland Management Inc.
8700 Dufferin Street
Concord, Ontario
L4K 4S6

Attention: Ms. Lisa La Civita

Re: Preliminary Geotechnical Investigation
4375 Millcroft Park Drive, Burlington, Ontario

Toronto Inspection Ltd. has conducted a preliminary geotechnical investigation at the above referenced site. The purpose of the investigation was to determine the subsoil and groundwater conditions encountered at boreholes, and provide our assessment on the founding conditions for the design and construction of a future residential subdivision.

At the time of the investigation, the site was vacant and the site grade was slightly dipping from northwest to southeast. The surrounding properties were occupied by residential subdivisions to the north, south and west, and a park to the east.

Five sampled boreholes, 20BH-1 to 20BH-5, were drilled on April 5, 2021 at the locations shown on the appended Borehole Location Plan, Drawing No. 1. The boreholes were carried out in conjunction with Standard Penetration Testing to a termination depth of 7.9m below the existing ground level. The detailed subsoil and groundwater conditions, encountered at the borehole locations, are shown in the appended Borehole Logs, Drawing Nos. 2 to 6.

1.0 Summarized Subsurface Conditions

The boreholes revealed that the subsoil, below the 75mm to 200mm thick surficial topsoil, consisted of a layer of fill, overlying a native sandy silt till deposit, followed by weathered shale. Brief descriptions of the subsoils, encountered at the borehole locations were as follows:

1.1 Fill

A layer of fill was encountered below the topsoil at the borehole locations. The fill was composed generally of clayey to sandy silt with traces of gravel and organics. Seams of gravelly sand, and soil with a slight organic odour were encountered in some of the boreholes. The fill at the borehole locations extended to depths of between 0.9m and 2.2m from grade. Based on the standard penetration N-values in the range of 3 to 31 blows for a penetration of 300mm, the relative density of the fill was very loose to dense.

The in-situ moisture content of the soil samples, obtained from the fill ranged from 10% to 21%, indicating moist to very moist conditions.

1.2 Sandy Silt Till

Below the fill, at the borehole locations, a native deposit of sandy silt till was contacted. This deposit consisted of a heterogeneous mixture of silt, sand, trace to some gravel and trace clay. The sandy silt till at the borehole locations extended to depths of between 3.6m and 7.0m from grade. Based on the standard penetration N-values in the range of 14 and more than 100 blows for a penetration of 300mm, the relative density of the sandy silt till deposit was compact to very dense. The in-situ moisture content of the soil samples, obtained from the sandy silt till deposit ranged from 6% to 14%, indicating moist to very moist conditions.

1.3 Weathered Shale

Below the sandy silt till, at the borehole locations, weathered shale was contacted. The spoon samples from this deposit consisted of platy to powdery fragments of brick red weathered shale. All of the boreholes were terminated in the weathered shale at a depth of 7.9m from grade. Based on the standard penetration N-values of more than 100 blows for a penetration of 300mm, the relative density of the weathered shale was very dense. The in-situ moisture content of the soil samples, obtained from the weathered shale ranged from 3% to 7%, indicating moist conditions.

1.4 Groundwater

A free water surface encountered in borehole 21BH-3 at a depth of 6.9m from grade on completion of drilling. No free water was evident at boreholes 21BH-1, 21BH-2, 21BH-4 and 20BH-5, which were dry and open to the full depth, or to the cave in depths of between 7.1m and 7.55m from grade, on completion of the investigation.

Based on the field observations during the drilling investigation and the moisture content profile of the subsoils at the borehole locations, it is our opinion that the groundwater at the site is located at a depth of at least 6.9m below grade.

2.0 Recommendations

2.1 Foundations

We understand that the site is proposed to be developed for a residential subdivision with a number of single detached dwellings with basements or without basements, and an access road/fire route from Millcroft Park Drive.

Based on the subsoil and groundwater conditions, encountered at the locations of the boreholes, it is our opinion that the site, under its current conditions, is suitable for conventional spread / strip footings founded in the native sandy silt till deposit. For footings founded at depths of 2.0m to 2.3m below the existing ground level, for one basement level, bearing pressures of 150 kPa at SLS and 225 kPa at ULS can be used.

For houses without a basement, the existing fill within the house footprint should be replaced with engineered fill. For footings on the engineered fill or on the native sandy silt till founded at depths of 0.6m from grade (for internal footings) to at least 1.2m from finished grade (for exterior footings), bearing pressures of 150 kPa at SLS and 225 kPa at ULS can be used. Footings on engineered fill should be reinforced. The Guidelines for Engineered Fill, shown in Appendix A, provides some of the conditions that must be satisfied for fill to be classified as engineered fill.

2.2 Earthquake

The Ontario Building Code requires that all buildings be designed to resist earthquake forces. In accordance with Table 4.1.8.4.A of the Ontario Building Code, the site classification for Seismic Site Response is Class C (Very dense soil and soft rock).

2.3 Lateral Earth Pressure

Where subsurface retaining walls will retain unbalanced loads, the lateral earth pressure may be computed using the following equation:

$$P = K (\gamma H + q)$$

where	P = Lateral earth pressure	kPa
	K = Lateral earth pressure coefficient	0.36 for fill; 0.30 for sandy silt till
	γ = Bulk unit weight of the soil	21.0 kN / m^3
	H = Depth of wall below the finished grade	m
	q = Surcharge loads adjacent to the basement wall	kPa

The equation assumes that a permanent free draining system will be provided to prevent the buildup of hydrostatic pressure next to the buried foundation walls. The drainage system should include a free-draining granular backfill or a drainage membrane placed against the concrete wall, together with an effective perimeter weeping tile drainage system at the wall base. The weeping tile should consist of a minimum 100mm diameter perforated pipe, surrounded by a geotextile filter fabric (OPSS 405) and installed on a positive grade leading to a frost free sump or outlet.

2.4 Excavation and Trench Backfilling

All excavations should comply with the Ontario Occupational Health and Safety Act. The fill can be classified as Type 3 soil, and the compact to dense sandy silt till deposit can be classified as Type 2 soil. Any excavation in the fill should be sloped back to a safe angle of 45^{o} or flatter. Excavation deeper than 1.2m in the compact to dense sandy silt till deposit, should be sloped back to a safe angle of 45^{o}.

Although we do not anticipate major ground water conditions during excavations for foundations or service trenches, flowing sand conditions from possible wet sand seams can be anticipated within the sandy silt till deposits. If these conditions are encountered, a flatter excavation slope might have to be used. Any water draining into the excavation can be removed from sumps by pumping.

The topsoil, existing fill and other compressible soil removed from the site may be reused in landscape areas, subject to the approval of the landscape architect. Surplus topsoil should be disposed off-site. We recommend that the contractor bidding for the job should arrange their own excavator to evaluate the thickness of topsoil, fill material, and other compressible soil to be removed.

The excavated native sandy silt till will generally be suitable for re-use for backfilling the foundations and service trenches, as long as the moisture content of the soil is within 2% of its optimum value. If wet pockets are encountered, these should be dried out to or below its optimum moisture content before and during placement. If the seasonal conditions are not favourable for drying out the wet material, the reuse of the on-site material will be limited to areas where future settlement will be of little consequence.

The bedding for the underground services, within the sandy silt till, should consist of OPSS Granular A, 20 mm clear stone or approved equivalent. If the subsoil at the bottom of the trench consists of wet sands, the bedding in the service trenches should consist of 20mm clear limestone and a geotextile filter fabric should be used to separate the clear stone bedding from the base and the sides of the excavation. The geotextile filter fabric must surround the clear stone bedding completely, to prevent internal erosion (loss of fines) from the surrounding soils.

Backfill around catch basins, manholes, and narrow trenches, should consist of imported granular material. The backfill should be compacted using a smaller vibratory equipment.

2.5 Pavement Construction

The existing fill and the sandy silt till material is considered to be highly frost susceptible. The following minimum pavement designs are recommended based on the assumption that perforated sub-drains will be installed to prevent buildup of water in the granular bases of the pavement:

Pavement Structure		Light Duty Parking	Heavy Duty Access Road/Fire Route
Asphaltic Concrete:	**OPSS HL3 or equivalent**	**65mm**	**40mm**
	OPSS HL8 or equivalent	**-**	**50mm**
Base:	**OPSS Granular A or 20mm crusher-run**	**150mm**	**150mm**
Sub-base:	**OPSS Granular B or 50mm crusher-run**	**200mm**	**300mm**

The granular base and sub-base should be compacted to a minimum of 100% SPMDD. Asphaltic concrete should be compacted to at least 96% Marshall density.

The above pavement thicknesses are based on favourable site conditions and the construction being carried out during the drier time of the year, that the subgrade is stable, and not heaving under construction traffic. If the subgrade is wet and unstable, additional thickness of sub-base material will be required.

Following site grading, the subgrade of the entire pavement should be proof-rolled using a heavy vibratory roller. Any soft spots revealed by the proof rolling should be sub-excavated and replaced with an approved dry material and compacted to at least 98% of its SPMDD.

Provision should be made for the water to drain out of and not collect in the granular base courses for the pavement to function properly.

Catch basins and manholes should be backfilled with OPSS Granular B material. The catch basins should be perforated just above the drain level and the weep holes should be screened with a filtered fabric. This will help the pavement structure as well as alleviate the differential movement of the catch basins or the manholes due to the frost action.

The thicknesses of pavements to be assumed by the City should be as per the City's design standard.

3.0 Comments for Site Development

The subsoil and groundwater data obtained at the current borehole locations indicates that the subject site is suitable for development of single detached dwellings with basements, founded on normal spread / strip foundations. The design bearing pressures recommended above are preliminary only and should be confirmed when the actual locations of the structures and the founding depths have been established. Due to the limited coverage of the site, we recommend that additional boreholes should be carried out when the development plan has been finalized.

4.0 GENERAL STATEMENT OF LIMITATION

The comments and recommendations presented in this report are based on the subsoil and ground water conditions encountered at the borehole locations, indicated in the borehole location plan, and are intended for the guidance of the design engineer. Although we consider this report to be representative of the existing subsurface conditions at the subject property, the soil and the ground water conditions between and beyond the borehole locations may differ from those encountered at the time of our investigation and may become apparent during construction. Any contractor bidding on, or undertaking the works, should decide on their own investigation and interpretations of the groundwater and the soil conditions between the borehole locations.

Any use and / or the interpretation of the data presented in this report, and any decisions made on it by the third party are responsibility of the third parties. The responsibility of ***Toronto Inspection Ltd.*** is limited to the accurate interpretation of the soil and ground water conditions prevailing in the locations investigated and accepts no responsibility for the loss of time and damages, if any, suffered by the third party as a result of decisions or actions based on this report.

Any legal actions arising directly or indirectly from this work and/or ***Toronto Inspection Ltd.'s*** performance of the services shall be filed no longer than two years from the date of ***Toronto Inspection Ltd.'s*** substantial completion of the services. ***Toronto Inspection Ltd.*** shall not be responsible to the client for lost revenues, loss of profits, cost of content, claims of customers, or other special indirect, consequential, or punitive damages.

To the fullest extent permitted by law, the client's maximum aggregate recovery against ***Toronto Inspection Ltd.***, its directors, employees, sub-contractors, and representatives, for any and all claims by the client for all causes including, but not limited to, claims of breach of contract, breach of warranty and/or negligence, shall be the amount of the fee paid to ***Toronto Inspection Ltd.*** for its professional services rendered under the agreement with respect to the particular site which is the subject of the claim by the client.

Yours very sincerely,
TORONTO INSPECTION LTD.



René Quiambao, P. Eng.
Senior Engineer

Toronto Inspection Ltd.

Drawings

Borehole Location Plan
Borehole Logs



LEGEND:

Borehole and Monitoring Well Location — — — Site Boundary

Scale (m)
0 25 50

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TITLE:	Borehole Location Plan		
LOCATION:	4375 Millcroft Park Drive, Burlington, Ontario		
PROJECT NO.	5607-21-GB	DATE : April 2021	DRAWING NO: 1

Project No. 5607-21-GB

Log of Borehole 21BH-1

Dwg No. 2

Project: Geotechnical Investigation

Sheet No. 1 of 1

Location: 4375 Millcroft Park Drive, Burlington, Ontario

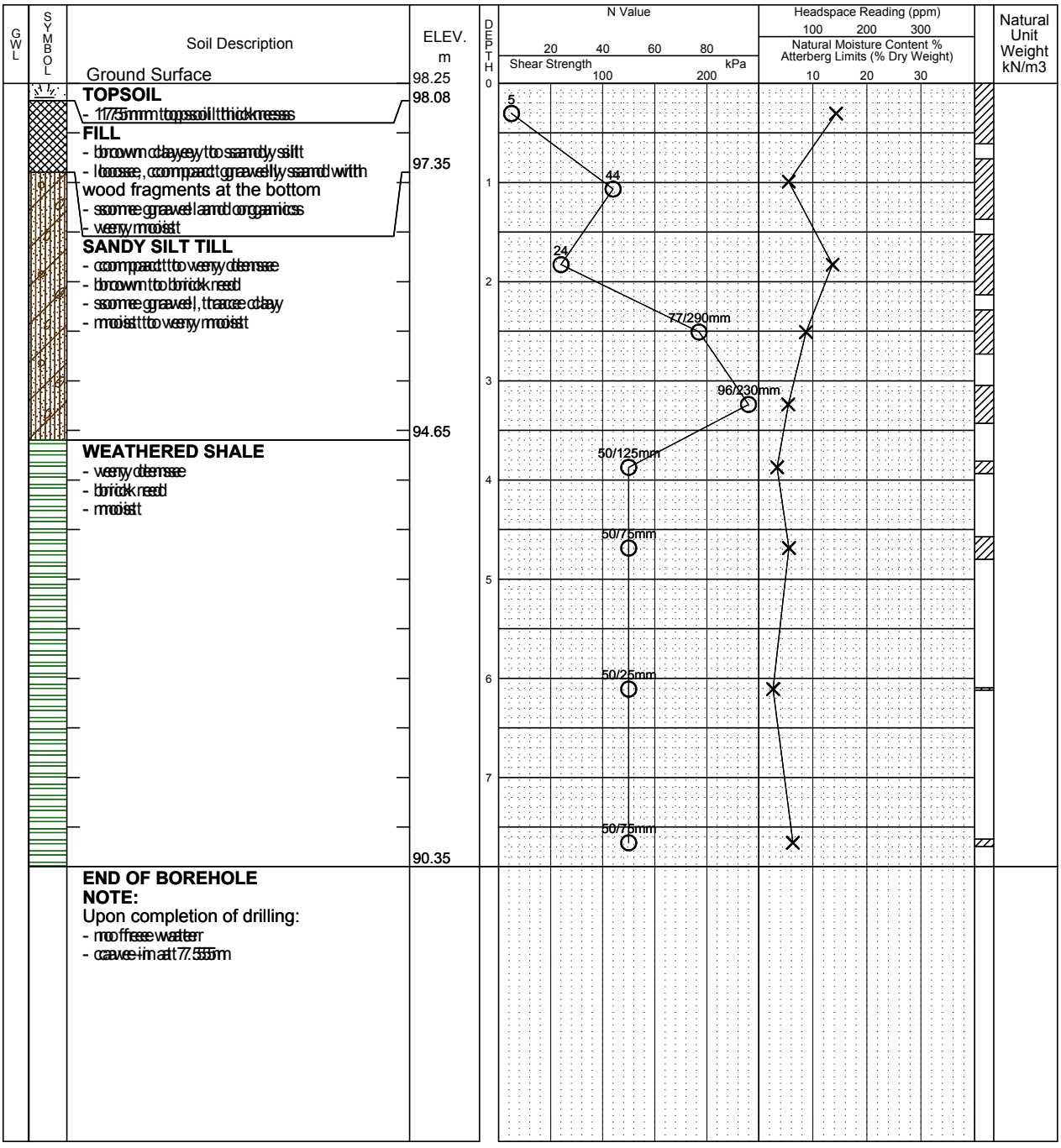
Date Drilled: 4/5/21

Drill Type: Truck Mounted Drill Rig

Datum: Temporary

Auger Sample
SPT (N) Value
Dynamic Cone Test
Shelby Tube
Field Vane Test (S)

Headspace Reading (ppm)
Natural Moisture
Plastic and Liquid Limit
Unconfined Compression
% Strain at Failure
Penetrometer



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NOTE: THE BOREHOLE DATA NEEDS INTERPRETATION ASSISTANCE BY TORONTO INSPECTION LTD. BEFORE USE BY OTHERS

Toronto Inspection Ltd.

Time	Water Level (m)	Depth to Cave (m)

Project No. 5607-21-GB

Log of Borehole 21BH-2

Dwg No. 3

Project: Geotechnical Investigation

Sheet No. 1 of 1

Location: 4375 Millcroft Park Drive, Burlington, Ontario

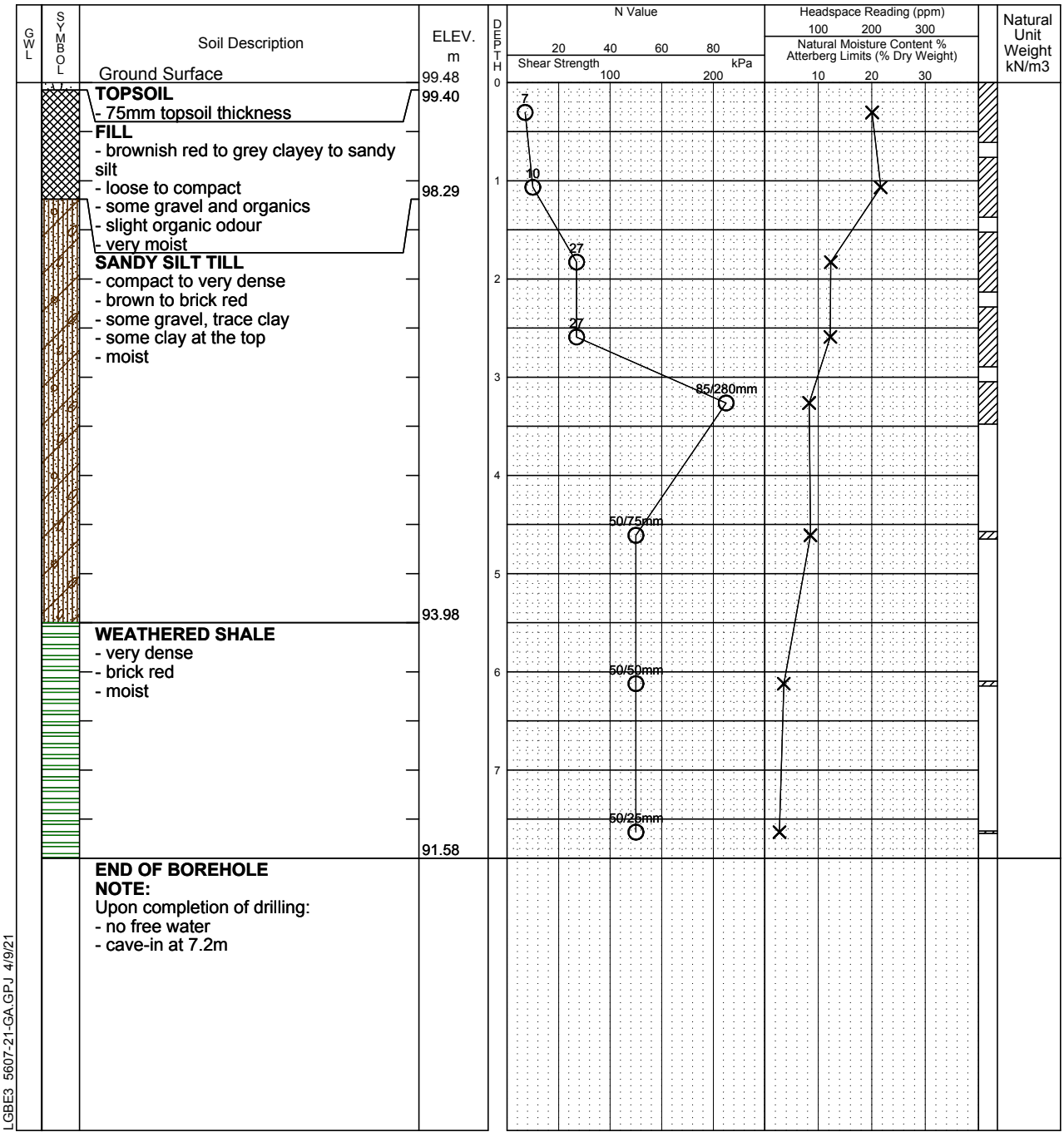
Date Drilled: 4/5/21

Drill Type: Truck Mounted Drill Rig

Datum: Temporary

Auger Sample
SPT (N) Value
Dynamic Cone Test
Shelby Tube
Field Vane Test (S)

Headspace Reading (ppm)
Natural Moisture
Plastic and Liquid Limit
Unconfined Compression
% Strain at Failure
Penetrometer



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Toronto Inspection Ltd.

Time	Water Level (m)	Depth to Cave (m)

Project No. 5607-21-GB

Log of Borehole 21BH-3

Dwg No. 4

Project: Geotechnical Investigation

Sheet No. 1 of 1

Location: 4375 Millcroft Park Drive, Burlington, Ontario

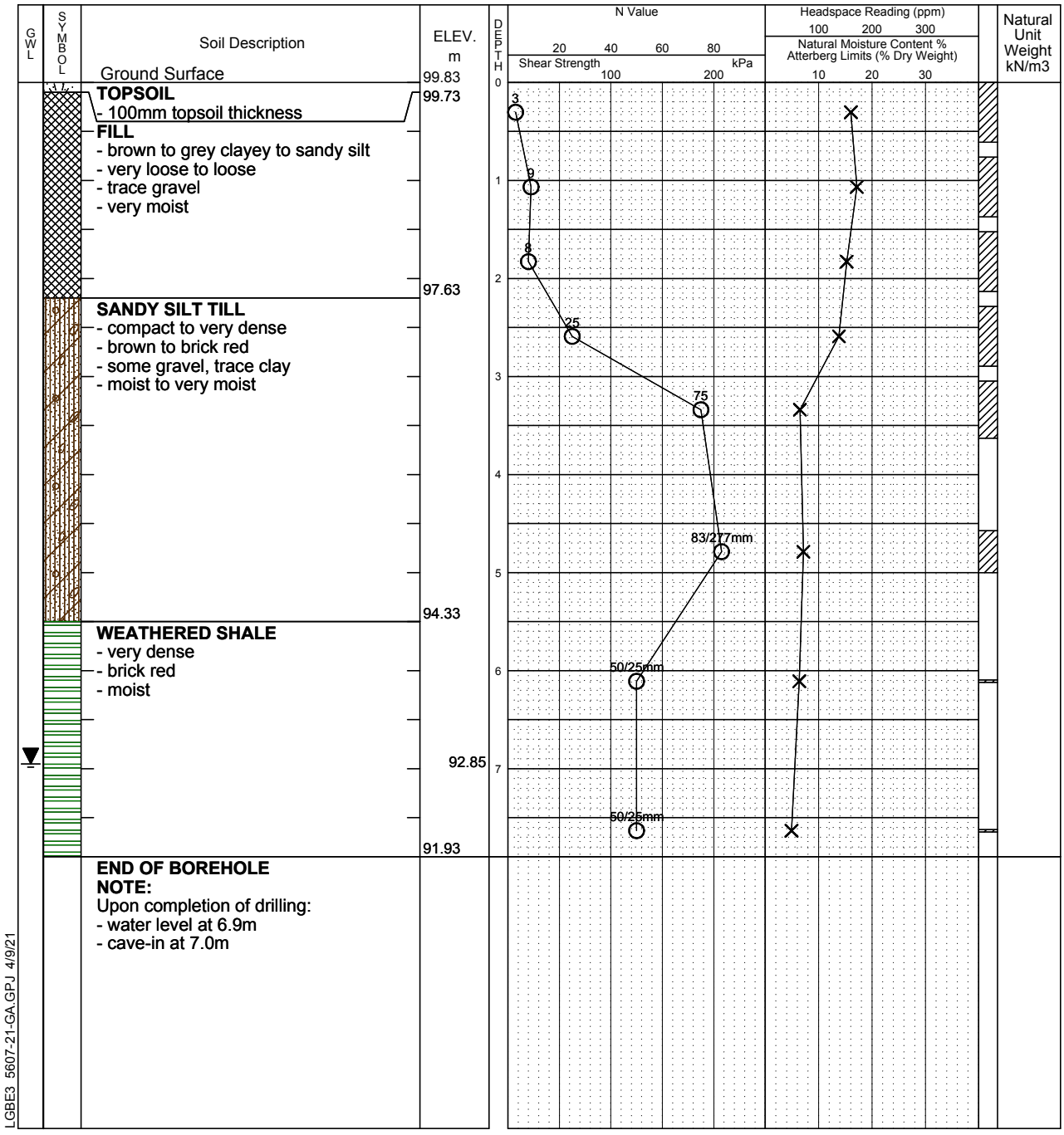
Date Drilled: 4/5/21

Drill Type: Truck Mounted Drill Rig

Datum: Temporary

Auger Sample
SPT (N) Value
Dynamic Cone Test
Shelby Tube
Field Vane Test (S)

Headspace Reading (ppm)
Natural Moisture
Plastic and Liquid Limit
Unconfined Compression % Strain at Failure
Penetrometer



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Toronto Inspection Ltd.

Time	Water Level (m)	Depth to Cave (m)

Project No. 5607-21-GB

Log of Borehole 21BH-4

Dwg No. 5

Project: Geotechnical Investigation

Sheet No. 1 of 1

Location: 4375 Millcroft Park Drive, Burlington, Ontario

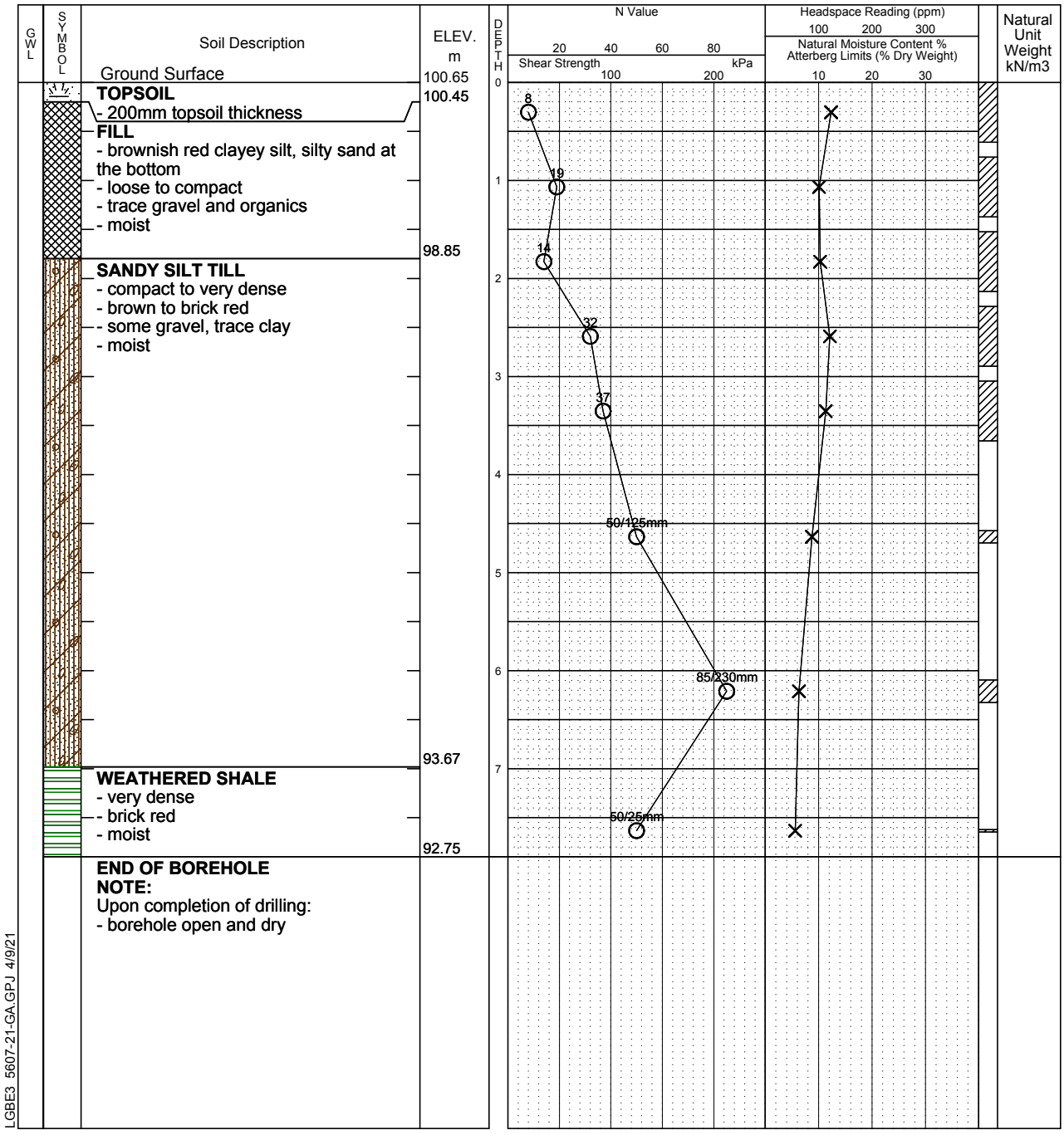
Date Drilled: 4/5/21

Drill Type: Truck Mounted Drill Rig

Datum: Temporary

Auger Sample
SPT (N) Value
Dynamic Cone Test
Shelby Tube
Field Vane Test (S)

Headspace Reading (ppm)
Natural Moisture
Plastic and Liquid Limit
Unconfined Compression
% Strain at Failure
Penetrometer



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Toronto Inspection Ltd.

Time	Water Level (m)	Depth to Cave (m)

Project No. 5607-21-GB

Log of Borehole 21BH-5

Dwg No. 6

Project: Geotechnical Investigation

Sheet No. 1 of 1

Location: 4375 Millcroft Park Drive, Burlington, Ontario

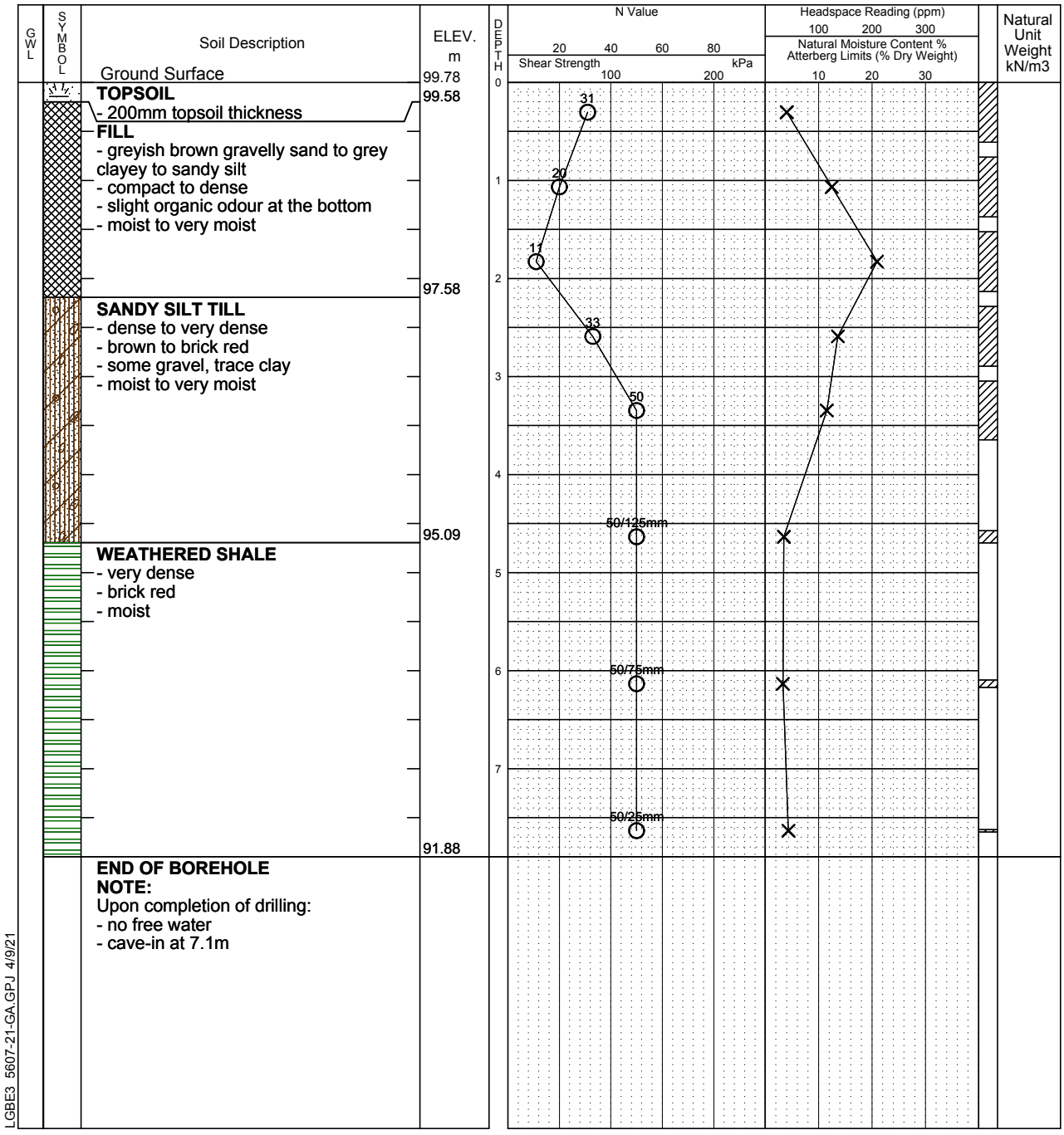
Date Drilled: 4/5/21

Drill Type: Truck Mounted Drill Rig

Datum: Temporary

Auger Sample
SPT (N) Value
Dynamic Cone Test
Shelby Tube
Field Vane Test (S)

Headspace Reading (ppm)
Natural Moisture
Plastic and Liquid Limit
Unconfined Compression
% Strain at Failure
Penetrometer



LGBE3 5607-21-GA.GPJ 4/9/21

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Toronto Inspection Ltd.

Time	Water Level (m)	Depth to Cave (m)

Appendix A

Guideline for Engineered Fill

GUIDELINES FOR ENGINEERED FILL

The information presented in this guideline is intended for general guidance only. Site specific and prevailing weather conditions may require modification of the material(s) to be used and the compaction standards or procedures changed. The site preparation and the material(s) to be used must be discussed and procedures agreed with ***Toronto Inspection Ltd.*** prior to the start of the earthworks and must be subjected to on going review during construction.

For fill to be classified as engineered fill, suitable for supporting structural loads, a number of conditions must be satisfied, including but not necessarily limited to the following:

1. Areal Extent

The engineered fill must extend beyond the envelope of the structure to be supported. The minimum extent should be 2.0m beyond the envelope in all directions at the foundation level, including the loading dock pad and the front sidewalk, and sloping downwards to the sub-grade at 45°. Once the envelope is set, the structure cannot be moved out of the envelope without consultation with ***Toronto Inspection Ltd.*** Similarly, no excavation should encroach on the engineered fill envelope without consultation with ***Toronto Inspection Ltd.***

2. Survey Control

Accurate survey control is essential to the success of an engineered fill project. The boundaries of the engineered fill must be laid out by a surveyor. During construction. it is necessary to have qualified surveyors providing control stations on the three-dimensional extent of the engineered fill.

3. Subsurface Preparation

Prior to placement of the engineered fill, the sub-grade must be prepared to the satisfaction of ***Toronto Inspection Ltd.*** All deleterious material must be removed and in some cases excavation of native mineral soils may also be required. Particular attention must be paid to wet sub-grade and possible additional measures required to achieve sufficient compaction. Where fill is placed against a slope, benching will be necessary and natural drainage paths must not be blocked.

4. Suitable Fill Material

All material to be used as fill must be approved by ***Toronto Inspection Ltd.*** Such approval will be influenced by weather factors. External sources of fill material must be sampled, tested and approved prior to material being hauled to the job site.

5. Trial Test Section

In advance of the construction of the engineered fill pad, the contractor should conduct a trial test section. The compaction criterion will be assessed for the backfill material to be used, using specified lift thicknesses and number of passes for the compaction equipment proposed by the contractor. To achieve a uniform degree of compaction of each layer, the lift thickness of loose

material, prior to start of compaction, must not exceed 200mm (8 inches). Additional trial test section(s) may be required throughout the course of the project to reflect changes in material sources, the moisture content of the material and the weather conditions.

6. Degree of Compaction

The minimum degree of compaction for the engineered fill should not be less than 100% of the Standard Proctor maximum dry density, or 95% of the Modified Proctor maximum dry density, to the level at or above 0.3m from proposed footing founding level. Each layer must be tested and approved by this office before the next layer is placed.

7. Inspection and Testing

Uniform and thorough compaction is crucial to the performance of the fill and the supported structure. Hence, all subgrade preparation, filling and compacting must be done with full time inspection and to the satisfaction of ***Toronto Inspection Ltd.*** All founding surfaces must be inspected and approved by ***Toronto Inspection Ltd.*** prior to placement of concrete.

8. Protection of Fill

Fills are generally more susceptible to the effects of weather than are natural soils. Fill placed and approved to the level at which structural support is required must be protected from excessive wetting, drying, erosion or freezing. Where inadequate protection had been provided, it may be necessary to provide deeper founding level for footings or to strip and re-compact some of the filled layers.

9. Limitations

The engineered fill is subjected to the following limitations:

i. Proper drainage must be maintained at all times within the engineered fill pad.
ii. If the engineered fill is left in place during the winter months, adequate protection must be provided against frost penetration to the proposed footing depths.
iii. If the engineered fill depth exceeds 5m below the foundation depth, the construction of the foundations might have to be delayed for a period of 1 year after placement, depending on the type of fill material used.
iv. Strip footings and foundation walls founded on engineered fill must be reinforced continuously with a minimum of two 15mm steel bars with at least 1m of overlap.