Geotechnical Investigation Report

Pavement Reconstruction

320 Balmoral Drive, Brantford, Ontario

Cart Storage Area - Walter Gretzky Golf Course
Final Report

August 26, 2022
04.02203032.000-GE-R-0001-00

ENGLOBE

City of Brantford

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APPENDICES

1 General Information

Englobe Corp. (Englobe) was retained by the City of Brantford to carry out a geotechnical investigation for a cart storage area in the Walter Gretzky golf course located at 320 Balmoral Drive, in Brantford, Ontario at the location shown on Drawing 1, appended.

The purpose of this investigation was explore the subsurface soil, groundwater conditions at the subject site and prepare a geotechnical report. The geotechnical report includes geotechnical recommendations for design and construction of the new pavement for the cart storage area.

2 Field and Laboratory Investigation

2.1 Field Program

2.1.1 Drilling Program

The fieldwork for this investigation was performed on June 28, 2022 and involved drilling of two boreholes. The locations of the boreholes are shown on Drawing No. 2 in Appendix A, are provided in the following Table 1, and the boreholes are listed on the Borehole Logs in Appendix B.

Table 1: Summary of Boreholes

Borehole ID	Ground Surface Evaluation	Depth of Borehole (m)
BH-01-22	100.34	3.5
BH-02-22	99.80	3.5

The field investigation was carried out in general conformance with the professional standards set out in the Canadian Foundation Engineering Manual (CFEM 2006, 4th Edition), applicable Ontario Regulations, and the ASTM International. The following is a summary of field investigation tasks:

- Public and Private utility companies were contacted prior to the start of drilling activities in order to demarcate underground utilities on the site.
- The boreholes were advanced using a track mount drill rig equipped with continuous flight solid stem augers supplied and operated by London Soil Test Ltd. under the supervision of Englobe's drilling supervisor. The boreholes were logged by our geotechnical supervisor.

- Soil samples were recovered from the boreholes at regular depth intervals using a 50 mm outside diameter split spoon sampler in accordance with ASTM D1586 Standard Penetration Test (SPT) and the results are provided on the borehole logs (Appendix B).
- Groundwater measurements were taken in the open boreholes and are provided on the borehole logs (Appendix B).
- The boreholes were backfilled with soil cuttings and bentonite in accordance with Ontario Regulation 903 as amended, under the Ontario Water Resources Act.
- The borehole locations and ground surface elevations were surveyed by Englobe. The boreholes were located relative to existing site features and property lines. The ground surface elevations are referred to the following temporary benchmark (TBM) provided by:

  TBM: FFE at CL of East overhead door to existing equipment storage hut

  Elevation: 100.00 m (Local datum)

2.2 Laboratory Testing

2.2.1 Geotechnical Laboratory Testing

All soil samples recovered during the investigation were returned to our laboratory for visual examination and moisture content testing. The moisture content values are shown on the appended borehole logs and selected soil samples were submitted for particle size analysis. The number of tests conducted are shown in the following Table 2.

Table 2: List of laboratory tests conducted as per ASTM Standards

Test	Standard	Number of Samples
Natural Moisture Content	ASTM D2216	8
Particle Size Analysis (Sieve and Hydrometer)	ASTM D7298	1

Detailed description and the results of the laboratory tests are provided in Appendix C and Section 3 of this report.

It is important to note that as per the standard policy of Englobe, the soil samples will be stored for a period of three months from the date of sampling. These soil samples will be discarded after the three-month period unless prior arrangements have been made for longer storage.

3 Subsurface Conditions

Detailed descriptions of the subsurface conditions revealed at the boreholes are shown on the enclosed Record of Borehole Logs in Appendix B. The following is a brief description of revealed subsurface conditions at this site.

The boreholes revealed a topsoil layer, over native sand, over native silt .

Geological conditions are innately variable. Information about the subsurface stratigraphy is only available at discrete borehole locations at the time of report preparation. To develop recommendations from the available information, it is necessary to make some assumptions concerning conditions at locations between boreholes. Adequate inspection should be provided during construction to check that these assumptions are reasonable.

Descriptions for the subsurface conditions are detailed in the following sections:

3.1 Topsoil

A topsoil layer was encountered from ground surface to 0.3 m. The layer comprised of sand and some silt.

3.2 Native Sand

A native sand with some silt and trace of clay was encountered below the topsoil layer in the boreholes and extends to 1.5 m below ground surface.

Standard Penetration Test results (N Values) recorded in the native sand material ranged between 3 and 4 (average value of 3.5) blows per 305 mm of penetration, indicating a very loose compactness condition. The moisture content of this native sand layer ranged between 7.1% and 28.8% indicating moist to wet conditions.Table 3 highlights the soil composition of the native sand layer.

Table 3: Particle Size Distribution Analyses – Sand

Borehole and Sample Number	Sample Depth (m)	Soil Type	Gravel (%)	Sand (%)	Silt (%)	Clay (%)
BH-02-22-SS-01	0.76-1.22	SAND, some silt, trace clay	-	81.6	12.2	6.2

3.3 Native Silt

A native silt with some sand to sandy silt layer was encountered below the sand layer in both the boreholes and extends to the termination depth of the boreholes.

Standard Penetration Test results (N Values) recorded in the silt material ranged between 7 and 16 (average value of 13) blows per 305 mm of penetration, indicating a mainly compact compactness condition. The moisture content of this native layer ranged between 17.3% and 26.1 indicating wet to saturated conditions.

3.4 Groundwater

Groundwater observations and measurements were carried out in the open boreholes. Table 4 highlights the depth of the water encountered on site.

Table 4: Ground water measurements

Borehole and Sample Number	Ground Surface Elevation	Water Level Depth (m)	Elevation (m)
BH-01-22	100.34	2.21	98.13
BH-02-22	99.8	2.74	97.06

Perched groundwater may occur above relatively less permeable layers of the soil (silty sand) at the site, particularly following heavy rainfall or snow melt.

It is important to note that the groundwater conditions described in this report refer only to those observed at the place and time of observation noted in the report. These elevations and conditions may vary locally due to seasonal fluctuations, groundwater regimes encountered at the site or as a consequence of construction activities on the site or adjacent sites.

4 Pavement Design

4.1 Pavement Design Recommendations

The pavement component thicknesses in Table 5 are recommended based on the anticipated pavement usage, the frost-susceptibility, and strength of the subgrade soils. The pavement structure must be reviewed once the final grades are established.

Table 5: Asphalt Pavement Component Thicknesses

Pavement Component	Cart Storage Area Thickness (mm)
Hot-Mix Asphalt	60
Granular A Base Course	150
Granular B Type 1 Subbase Course	200

The pavement design assumes that the subgrade is stable as determined by proof-rolling and inspection by Englobe. If any soft or unstable areas are noted, then the pavement subbase thickness should be increased.

4.2 Pavement Construction Recommendations

- Remove existing asphalt pavement and loose fill to the design subgrade elevation.
- The prepared subgrade should be carefully proof-rolled to a consistently dense state in the presence of a qualified representative of a geotechnical engineering firm, and any soft or wet spots or other obviously objectionable materials (such as organic material, construction debris, etc.) sub-excavated and properly replaced with suitable, approved material.

– Construct the pavement subbase with 200 mm of OPSS.MUNI 1010 Granular B Type 1 and compact to 100% SPMDD.
– Construct the pavement base with 150 mm of OPSS.MUNI 1010 Granular A and compact to 100% SPMDD.
– Place one lift of hot-mix asphalt (60 mm lift of OPSS 1150 HL 3 or HL4 surface course) and compact in conformance with OPSS 310 requirements.
– Pavements should be provided with a continuous centre-to-edge cross fall of 3 percent at top of subgrade and 2 percent for granular layers and pavement and should be maintained periodically.

It is recommended that PG 58-28 be used in the hot mix asphalt. Performance graded asphalt cement (PGAC) should conform to OPSS 1101 requirements.

The pavement subgrade and granular courses will lose their strength to support traffic loads if allowed to become wet due to surface water or groundwater infiltration; therefore, drainage of the pavement and the granular courses is essential. The finished pavement surface and the underlying subgrade should be free of depressions and should be sloped to provide effective drainage. Surface water should not be allowed to pond adjacent to the outside edges of the pavement area.

Appropriate quality control/quality assurance laboratory and field testing of the pavement structure components (granular base and subbase and hot-mix asphalt) should be conducted. Compaction testing of the hot-mix asphalt should be carried out at the time of placement.

Systematic routine preventative maintenance is strongly recommended for all newly reconstructed or rehabilitated pavements. Crack routing and sealing will generally be required within 2 to 3 years of rehabilitation/construction. As the pavements age, it will also be necessary to patch areas of medium to high severity distresses (i.e., potholes, ravelling). In some cases, routine maintenance may be considered to extend the life of an existing section by several years. For example, spray patching may be carried out to retard water infiltration at edge crack locations.

All pavement construction, rehabilitation and maintenance work should only be completed during periods of favourable weather. The Englobe pavement design recommendations are contingent upon provision of a consistently competent, stable subgrade that is properly drained and free of soft spots and objectionable materials (such as organic material) and is capable of supporting the design traffic loads.

4.3 Construction Inspection and Testing

4.3.1 Materials Testing and Inspections

Appropriate laboratory and field testing of the pavement structure components (granular and hot-mix asphalt) should be conducted. Compaction testing of the hot-mix asphalt should be carried out at the time of placement. Mix designs for the hot-mix asphalt should be reviewed for suitability and specification compliance at least two weeks prior to production and placement.

The need for continuous repair work and paving supervision by a pavement inspector and quality assurance testing during pavement rehabilitation/construction projects cannot be over emphasized. It is also recommended that an annual maintenance program including localized repairs and crack sealing be implemented to ensure that the pavements are maintained at a suitable level.

Englobe would be pleased to provide the above noted inspection and testing services upon request.

5 Statement of Limitations

The analyses and recommendations provided in this report are based on field measurements and observations made by Englobe technical staff.

The geotechnical recommendations provided in this report are applicable only to the project described in the text and then only if constructed substantially in accordance with the details stated in this report. Since all details of the design may not be known at the time of report preparation, we recommend that we be retained during the final design stage to verify that the geotechnical recommendations have been correctly interpreted in the design. Also, if any further clarification and/or elaboration are needed concerning the geotechnical aspects of the project, Englobe should be contacted. We recommend that we be retained during construction to confirm that the subsurface conditions do not deviate materially from those encountered in the test holes and to ensure that our recommendations are properly understood.

The geotechnical recommendations provided in this report are intended for the use of the owner and its retained designer. They are not intended as specifications or instructions to contractors. Any use which a contractor makes of this report, or decisions made based on it, are the responsibility of the contractor. The contractor must also accept the responsibility for means and methods of construction, seek additional information if required, and draw their own conclusions as to how the subsurface conditions may affect their work. Englobe accepts no responsibility and denies any liability whatsoever for any damages arising from improper or unauthorized use of the report or parts thereof.

It is important to note that the geotechnical investigation involves a limited sampling of the site gathered at specific test hole locations and the conclusions in this report are based on this information gathered. The subsurface geotechnical, hydrogeological, environmental and geologic conditions

Appendix A
Drawings

Drawing 1: Location Plan

Drawing 2: Site Plan

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NOTES:

1-REFERENCE: © OpenStreetMap contributors (2022).

2-Drawing scale may be distorted due to file conversion and/or copying. Measurements taken from the drawing must be verified in the field.

0 100 200 300 400 500 m

SCALE 1:15000

Project

Geotechnical Investigation

320 Balmoral Dr, Brantford

Title

LOCATION PLAN

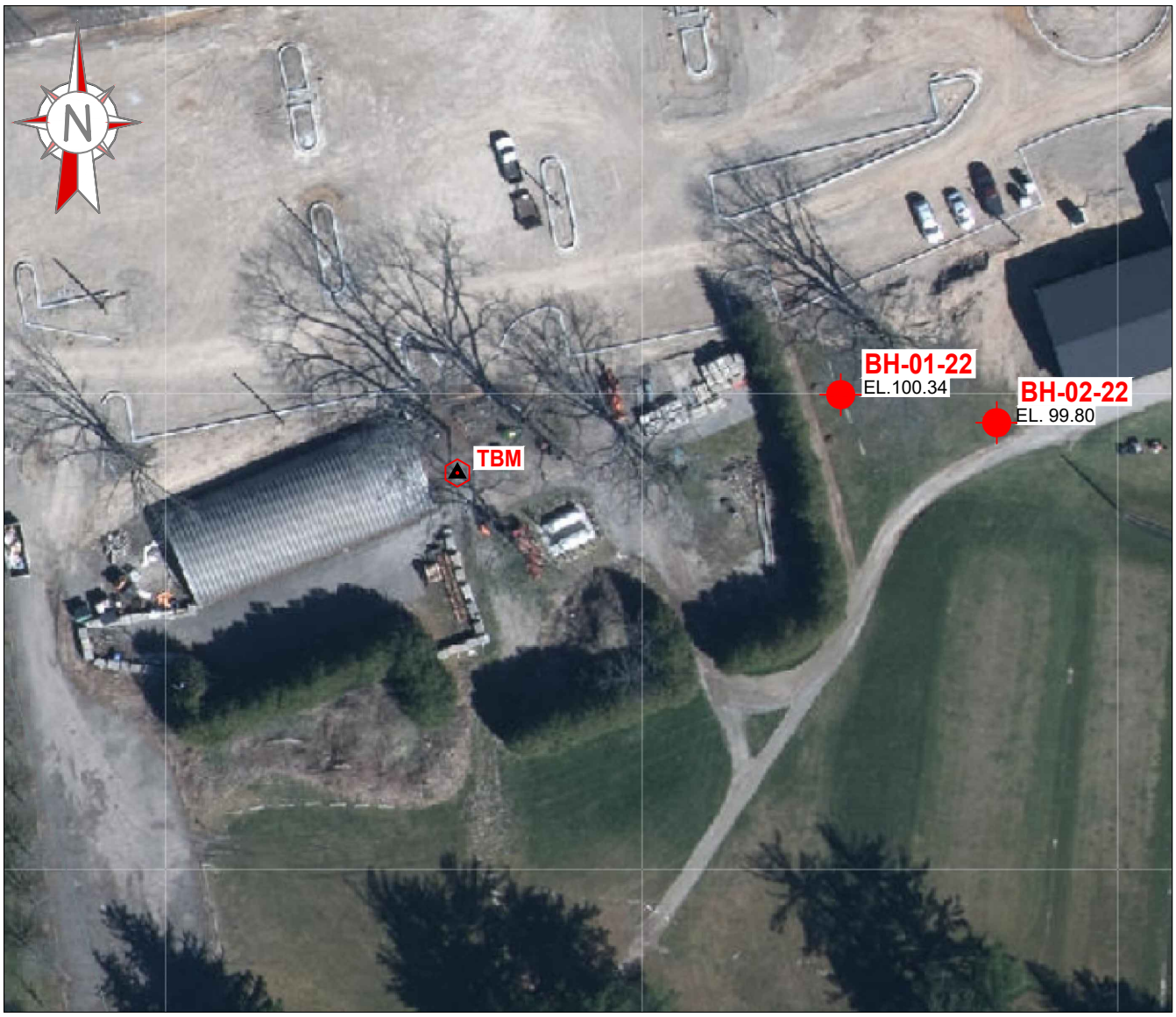
ENGLOBE

440, Hardy Road, Unit 3
Brantford (Ontario) N3T 5L8
Telephone : 519.720.0078
Fax : 519.720.0976

Prepared	E.Nimer	Discipline	GEOTECHNICAL	Project manager	T.Staples
Drawn	E.Nimer	Scale	1 : 15000	Sequence no.	01 of 02
Checked	T.Staples	Date	2022-06-13		

M. dept.	Project	Disc.	Dwg no.	Rev.
04	02203032.000	GE	001	00

DRAWING2.DWG



LEGEND:

BOREHOLE LOCATION

EL. 100.00 GROUND SURFACE ELEVATION (m)

TBM TEMPORARY BENCHMARK

0 10 20 30 m

SCALE 1:750

NOTES:

1-REFERENCES: Queen's printer for Ontario, 2022

2-TEMPORARY BENCHMARK: description: FFE at CL of Overhead doors Elevation 100.000 m (assumed local datum)

3-Drawing scale may be distorted due to file conversion and/or copying. Measurements taken from the drawing must be verified in the field.

Project

Geotechnical Investigation

320 Balmoral Dr, Brantford

Title

SITE PLAN

ENGLOBE

12-60 Meg Drive
London (Ontario) N6E 3T6
Telephone : 519.685.6400
Fax : 519.685.0943

Prepared	E.Nimer	Discipline	GEOTECHNICAL	Project manager	T.Staples
Drawn	E.Nimer	Scale	1 : 15000	Sequence no.	02 of 02
Checked	T.Staples	Date	2022-07-13		

M. dept.	Project	Disc.	Dwg no.	Rev.
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Appendix B
Borehole Logs

List of Abbreviations

Boreholes BH-01-22 to BH-02-22

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List of Abbreviations

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

Sample Types		Soil Test and Properties	
AS	Auger Sample	SPT	Standard Penetration Test
CS	Core Sample	UC	Unconfined Compression
RC	Rock Core	FV	Field Vane Test
SS	Split Spoon	ø	Angle of internal friction
TW	Thinwall, Open	γ	Unit weight
WS	Wash Sample	w_p	Plastic Limit
BS	Bulk Sample	w	Water content
GS	Grab Sample	w_L	Liquid Limit
WC	Water Content Sample	I_L	Liquidity Index
TP	Thinwall, Piston	I_p	Plastic Index
		PP	Pocket Penetrometer

Penetration Resistances	
Dynamic Penetration Resistance	The number of blows by a 63.5 kg (140 lb.) hammer dropped 760 mm (30 in.) required to drive a 50 mm (2 in.) diameter 60˚ cone a distance 300 mm (12 in.). The cone is attached to 'A' size drill rods and casing is not used.
Standard Penetration Resistance, N (ASTM D1586)	The number of blows by a 63.5 kg (140 lb.) hammer dropped 760 mm (30 in.) required to drive a standard split spoon sampler 300 mm (12 in.)
WH	Sampler advanced by weight of hammer
PH	Sampler advanced by hydraulic pressure
PM	Sampler advanced by manual pressure

Soil Description		
Cohesionless Soils Compactness Condition	**SPT N-Value** (blows per 0.3 m)	**Relative Density (D_r)** (%)
Very Loose	0 to 4	0 to 20
Loose	4 to 10	20 to 40
Compact	10 to 30	40 to 60
Dense	30 to 50	60 to 80
Very Dense	Over 50	80 to 100
Cohesive Soils Consistency	**Undrained Shear Strength (C_u) kPa**	**psf**
Very Soft	Less than 12	Less than 250
Soft	12 to 25	250 to 500
Firm	25 to 50	500 to 1000
Stiff	50 to 100	1000 to 2000
Very Stiff	100 to 200	2000 to 4000
Hard	over 200	over 4000
DTPL	Drier than plastic limit	Low Plasticity, W_L<30
APL	About plastic limit	Medium Plasticity, 30<W_L<50
WTPL	Wetter than plastic limit	High Plasticity, W_L>50

LOG OF BOREHOLE No. BH-01-22

Englobe

Project No. 02203032.000 DRAWING No. 01

Project: W. Gretzky Golf Course Sheet No. 1 of 1

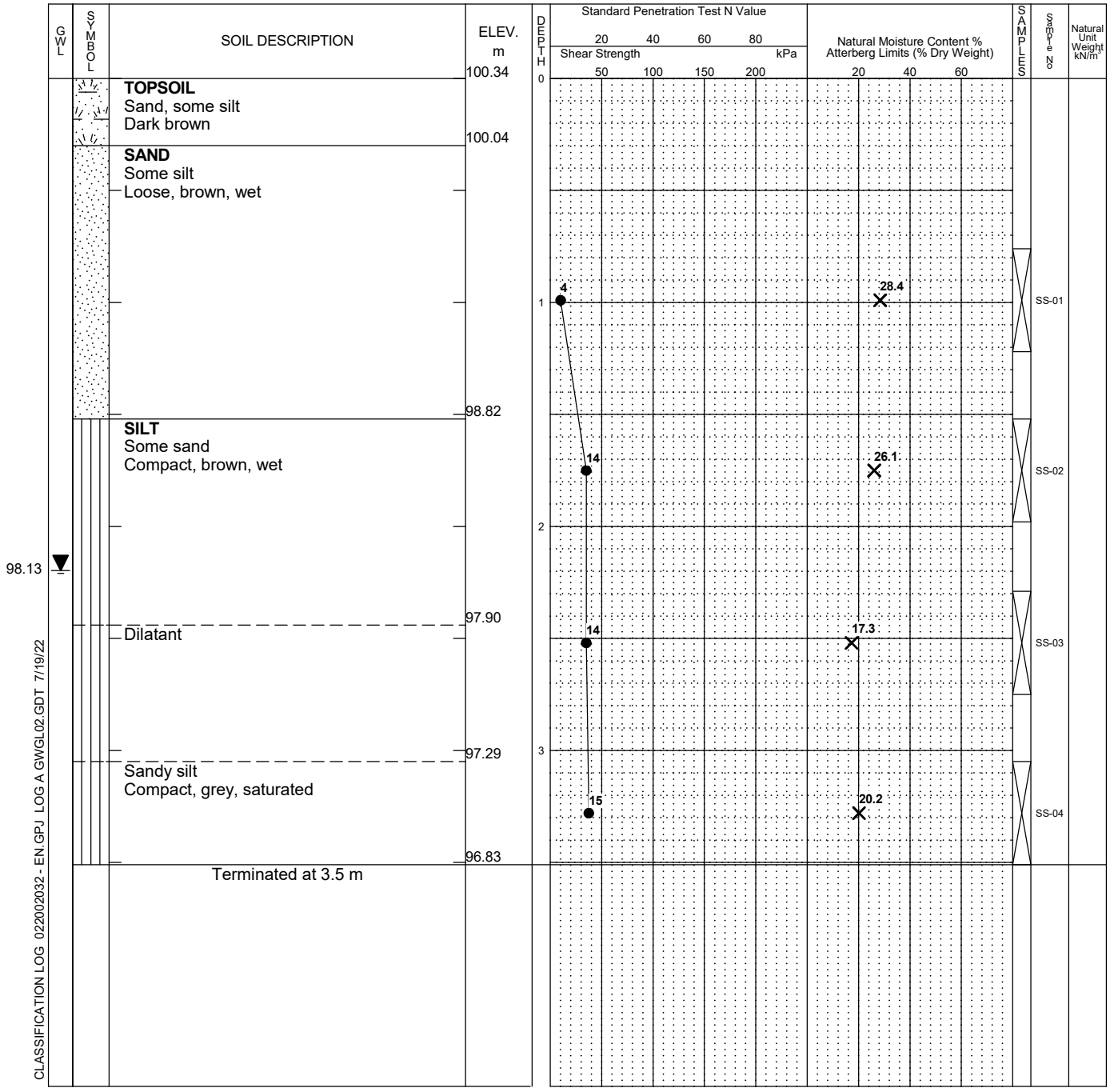
Location: 320 Balmoral Drive

Date Drilled: 6/28/2022

Drill Type: Solid STEM Auger

Datum:

Split Spoon Sample
Auger Sample
SPT (N) Value
Dynamic Cone Test
Shelby Tube
Shear Strength by Vane Test
Natural Moisture Content
Atterberg Limits
Undrained Triaxial at % Strain at Failure
Shear Strength by Penetrometer Test



CLASSIFICATION LOG 022002032 - EN.GPJ LOG A GWGL02.GDT 7/19/22

Time	Water Level (m)	Depth to Cave (m)
Upon Completion	2.2	2.2

LOG OF BOREHOLE No. BH-02-22

Englobe

Project No. 02203032.000 DRAWING No. 02

Project: W. Gretzky Golf Course Sheet No. 1 of 1

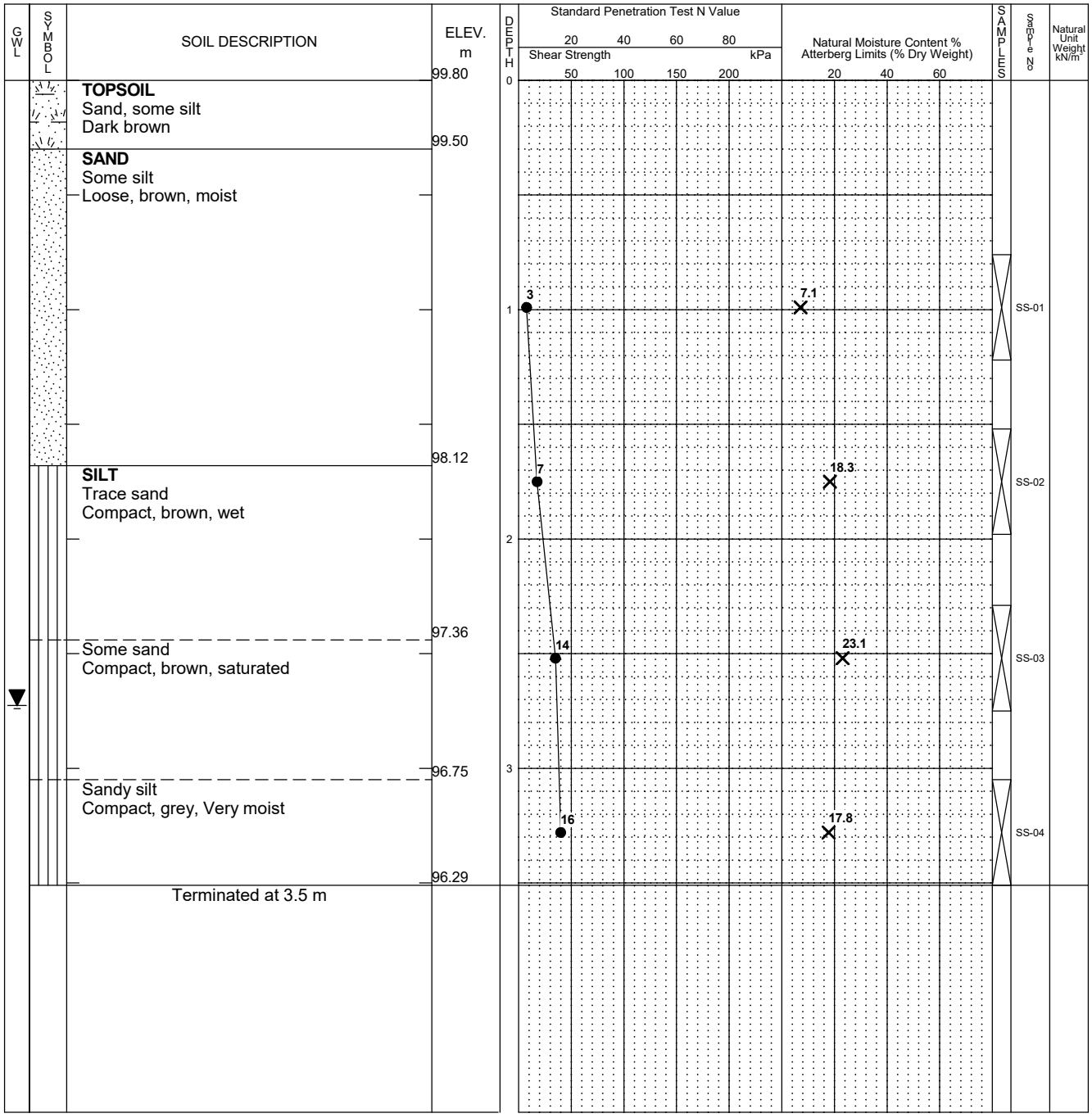
Location: 320 Balmoral Drive

Date Drilled: 6/28/2022

Drill Type: Solid STEM Auger

Datum:

Split Spoon Sample
Auger Sample
SPT (N) Value
Dynamic Cone Test
Shelby Tube
Shear Strength by Vane Test
Natural Moisture Content
Atterberg Limits
Undrained Triaxial at % Strain at Failure
Shear Strength by Penetrometer Test



Time	Water Level (m)	Depth to Cave (m)
Upon Completion	2.7	3.0

CLASSIFICATION LOG 022002032 - EN.GPJ LOG A GWGL02.GDT 7/19/22

Appendix C
Geotechnical Lab Results

Figure 1: BH-02-22 SS1 - Grain Size and Hydrometer Analysis

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GRAIN SIZE AND HYDROMETER ANALYSIS REPORT
LS-602, 702 & 703/704

PROJECT NUMBER:	04-02203032.000	**PROJECT NAME:**	W. Gretzky Golf Course Cart Storage	**CLIENT:**	City of Brantford
LAB NUMBER:	S-480	**SAMPLE ID:**	BH02-22, S1	**SAMPLE DEPTH:**	2.5'
SAMPLED BY:	Englobe	**DATE RECEIVED:**	June 29, 2022	**DATE COMPLETED:**	July 6, 2022

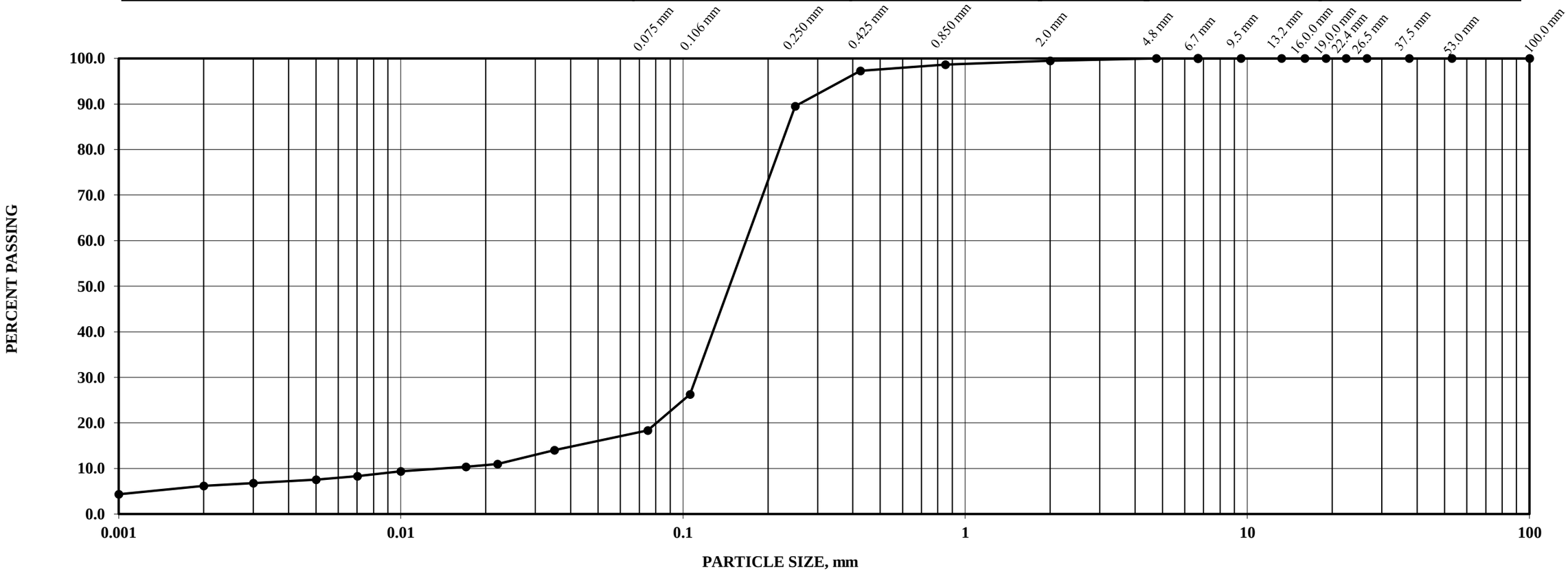
PARTICLE SIZE DISTRIBUTION, MTO LS-702

U.S. BUREAU OF SOILS CLASSIFICATION (AS USED IN MINISTRY OF TRANSPORTATION OF ONTARIO PAVEMENT DESIGNS)

CLAY	SILT	VERY FINE SAND	FINE SAND	MEDIUM SAND	COARSE SAND	FINE GRAVEL	GRAVEL

UNIFIED SOILS CLASSIFICATION ASTM D 2487

FINES (SILT & CLAY)	FINE SAND	MEDIUM SAND	COARSE SAND	FINE GRAVEL	COARSE GRAVEL



COEFFICIENTS

D60	0.183	**D30**	0.114	**D10**	0.014	**Cc**	4.955	**Cu**	12.63

GRAIN SIZE ANALYSIS		HYDROMETER ANALYSIS	
SIEVE SIZE mm	**% PASSING**	**DIAMETER mm**	**% PASSING**
53	100.0	0.035	14.0
37.5	100.0	0.022	11.0
26.5	100.0	0.017	10.3
22.4	100.0	0.010	9.4
19	100.0	0.007	8.3
16	100.0	0.005	7.6
13.2	100.0	0.002	6.2
9.5	100.0	0.001	4.3
6.7	100.0	**ATTERBERG LIMITS**	
4.75	100.0		
2.00	99.5	Liquid Limit	
0.850	98.7		
0.425	97.3	Plastic Limit	
0.250	89.5		
0.106	26.3	Plastic Index	
0.075	18.4		

GRAIN SIZE PROPORTIONS, %	
% GRAVEL (> 4.75 mm):	
% SAND (75 µm to 4.75 mm):	81.6
% SILT (2 µm to 75 µm):	12.2
% CLAY (<2 µm):	6.2
SOIL DESCRIPTION:	SAND, Some Silt, Trace Clay

REMARKS

Figure: 1

TESTED BY: Yuwei Gu — Laboratory Technician

REVIEWED BY David McBay, CET. — Laboratory Supervisor

Reporting of these test results constitutes a testing service only. Engineering interpretation or evaluation of test results is provided only on written request.