SOILTEST SERVICES LTD.
GEOTECHNICAL, ENVIRONMENTAL AND MATERIALS ENGINEERS

SUPPLEMENTAL FOUNDATION INVESTIGATION
PROPOSED UNDERGROUND GARAGE
1100 EGLINTON AVENUE EAST
TORONTO, ONTARIO

Prepared for:

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1.0 INTRODUCTION

Soiltest Services Ltd. was retained by Circon Construction Corporation to carry out a supplemental foundation investigation for the proposed underground garage at 1100 Eglinton Avenue East, Toronto, Ontario.

At the time of the field work, the former inn on the park building had been demolished and the site was vacant.

We understand that a new Lexus Dealership building, a new Toyota Dealership building, a new service facility building and a new underground garage will be developed at the site. Locations and layouts of the buildings are shown on the appended Borehole Location Plan, Plate 1.

A foundation investigation was carried out by us for the proposed Lexus Dealership building, Toyota Dealership building and service facility building in February 2007. Results of the investigation were documented in our foundation investigation report Ref. No. 2061087-1 dated February 15, 2007.

Based on the foregoing, the purpose of the supplemental investigation was to reveal the subsurface soil and groundwater conditions at the site of the proposed underground garage and, based on this information, to determine the relevant soil properties for the geotechnical design and construction of the basement and foundations of the underground garage.

2.0 FIELD WORKS

The field work for this investigation was carried out on April 9, 2007, and consisted of six boreholes which were put down to depths of between 6.4 m and 8.1 m below grade at the locations as shown on the appended Borehole Location Plan, Plate 1.

The boreholes (designated as Boreholes BH23 to BH28 inclusive) were advanced using a bombardier mounted drilling rig equipped with continuous flight augers, supplied and operated by a specialist drilling contractor. Standard Penetration tests were carried out at frequent intervals of depth in the boreholes to obtain representative soil samples and to measure the penetration resistance of various soil strata. Recorded 'N' values were used to infer the consistency or the compactness condition of the substrata.

After completion of the drilling, a piezometer was installed in Borehole BH24 for long term groundwater monitoring. The groundwater level in the piezometer was measured on April 13, 2007. Details of the piezometer and the groundwater level were given in the appended log of Borehole BH24, Plate 3.

The field work for this project was supervised by Mr. Gordon Lo, P.Eng. He directed the drilling operation, sampling and in-situ testing. He also observed groundwater conditions in the open boreholes and piezometer, and prepared field borehole logs.

Upon completion of the field work, the soil samples were brought to our laboratory for detailed visual examination. To supplement this work, moisture content tests were carried out on representative soil samples. Results of the laboratory tests are presented on the appended borehole logs.

The ground surface elevations at the borehole locations were interpolated from the spot elevations marked on the Site Plan, Drawing No. A-1 prepared by Plaston Architect Limited.

3.0 SUBSURFACE CONDITIONS

The stratigraphy encountered at the site, as revealed in the boreholes, comprised of topsoil or granular base underlain by fills and followed by clayey silt till.

Details of the subsurface conditions encountered in the boreholes at the site are summarized below and are presented on the appended Borehole Logs. It should be noted that the subsurface conditions are confirmed at the borehole locations only and may vary at other locations, particularly with respect to depths of fills.

3.1 Topsoil/Granular Base/Fills

Borehole BH28 encountered a surficial deposit of topsoil, 140 mm thick. In addition, Boreholes BH24 and BH26 encountered 100 mm to 360 mm thick granular base.

The topsoil at Borehole BH28, the granular base at Boreholes BH24 and BH26, and the ground surface at the remaining boreholes were underlain by a surficial deposit of earth fills which extended to depths of between 0.2 m (BH24) and 3.8 m (BH23) below grade.

The fill at Borehole BH25 consisted of a sand and gravel matrix. The fill at the remaining boreholes consisted of silty sand or fine sand matrixes. We note that the silty sand fill at Borehole BH23 and the sand and gravel fill at Borehole BH25 were underlain by clayey silt fill. Standard Penetration tests in the fills ranged from 0 to 20 blows/0.3 m. Moisture contents were found to range from 10.5% to 20.0%. Based on the test results, together with a visual and tactile examination of the samples recovered, the fills are considered to be in a generally loose to compact condition.

It should be pointed out that in our experience the thickness of fills frequently varies between borehole locations and therefore allowance should be made for possible variations when making estimates, etc.

3.2 Clayey Silt Till

The fills at the site were underlain by a surficial deposit of clayey silt till which extended to the limits of the investigation, i.e. depths of between 6.4 m and 8.1 m below grade. The till consisted of a clayey silt matrix which contained fine gravel and occasional boulders. We note that the clayey silt till also contained fine sand layers below a depth of 7.6± m below grade. Moisture contents were found to range from 6.1% to 18.2%. Standard Penetration tests in the deposit ranged from 17 to more than 100 blows/0.3 m. Based on the test results, together with a visual and tactile examination of the samples recovered, the clayey silt till is considered to have a generally very stiff to hard consistency.

4.0 GROUNDWATER CONDITIONS

Groundwater observation was made in the open boreholes during drilling and at the completion of the boreholes.

Groundwater was encountered in the granular fill at Borehole BH25 location during drilling. The water level at Borehole BH25 was located at a depth of 0.91± m below grade approximately one hour after completion of the drilling. The remaining boreholes were dry on completion of the drilling.

The groundwater level in the piezometer at Borehole BH24 location was monitored on April 13, 2007. The monitoring result indicated that the piezometer was dry on April 13, 2007.

An examination of the soil samples indicated that the silty sand fill, fine sand fill, clayey silt fill and clayey silt till were damp. The sand and gravel fill was wet.

Based on the foregoing, we consider that the permanent groundwater table at the site was located below the maximum depth of the investigation. It should, however, be noted that a perched water condition occurred in the sand and gravel backfill of the former excavation at Borehole BH25 location.

5.0 DISCUSSIONS AND RECOMMENDATIONS

The revealed stratigraphy at the site consists of topsoil or granular base underlain by loose to compact fills, followed by very stiff to hard clayey silt till.

Details regarding our conclusions and recommendations are outlined in the following sections. The anticipated construction conditions are also discussed, but only to the extent that they may influence decisions. Contractors conducting work associated with this project should be aware that the data and their interpretation presented in this report may not be sufficient to assess all factors that may have an effect upon construction.

5.1 Foundation

We understand that the finished floor level of the basement will be 118.00 m. Based on this and the borehole logs, we anticipate that the footing subgrade of the proposed underground garage will consist of hard clayey silt till which is suitable for supporting normal spread/strip footings designed to the allowable soil bearing pressure of up to 350 kPa.

To assure that the footings are founded on undisturbed competent subsoil capable of sustaining the above-mentioned bearing pressure, we recommend that the foundation excavation be inspected and approved by a geotechnical engineer.

All exterior footings and footings in unheated areas should have a permanent earth cover of at least 1.2 m or equivalent insulation for frost protection.

It is estimated that the total and differential settlements of footings designed to this bearing pressure will be less than 25 and 20 mm respectively, which are normally considered to be acceptable for the proposed structure.

It should be noted that the glacial till at the site is susceptible to disturbance and loss of strength particularly in the presence of water. Rainwater or groundwater seepage into the excavation should be directed away, and any disturbed material should be removed from the base of the excavation. If foundation excavations are expected to remain open for a considerable time, the foundation subgrade should be protected against disturbance by a 50 mm thick layer of lean concrete. Should the construction be done during cold weather, care should be taken to ensure that the foundations are not poured on a frozen subgrade and that they are adequately protected against frost.

5.2 Excavation and Groundwater Control

Foundation excavation in the overburden should be straight forward using conventional equipment and can be carried out in accordance with the current Occupational Health and Safety Act.

No major construction problems due to groundwater are anticipated with basement excavations at the site. Provision should, however, be made for the control of any surface water runoff and subsurface seepage from the granular backfill and any wet sand layers in the clayey silt till by pumping from local sumps as and where required.

The sides of the excavation in the fills and glacial till are expected to be temporarily stable at 1:1 slopes. The side slopes should be protected from infiltration of surface runoff or precipitation utilizing tarpaulins or equivalent. In addition, heavy weight, fills, cranes, truck, etc. should not be placed within 6 m of the top of the slope.

Where vertical excavations are required, the sides of the excavation should be supported to comply with the safety regulations. By means of good construction techniques, the disturbance of the foundations of the adjoining building and their founding soil must be prevented. Otherwise, unacceptable settlement of the existing building could be experienced.

The shoring structure will likely be a multilevel support system. Based on this assumption, the lateral earth pressure distribution can be assumed to be constant with depth according to the following formula.

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

where	P	=	unit earth pressure	kPa
	h	=	depth below ground surface	m
	γ	=	bulk unit weight of compact fills and glacial till	21.0 kN/m^3
	K	=	coefficient of lateral earth pressure for glacial tills	0.3
	q	=	any surcharge load, i.e. building & traffic	kPa

Caisson wall and soldier pile wall supported by struts or rakers and raker footings may be used as shoring systems at the site. In the areas where ground and building settlement are not tolerable, a caisson wall is recommended. This will prevent the foundation soil of the adjoining building from being disturbed by the excavation operation. Should a soldier pile wall be selected, the front of the lagging should be pressure-grouted.

The struts or rakers should be installed while an earth berm remains in front of the wall and should be preloaded to a minimum of 50% of the full design load prior to excavating the berm. The rakers should be inclined at an angle of 45° to the horizontal. Raker footings should be designed so that the load acts on a soil bearing surface at right angles to the raker. The very stiff to hard clayey silt till is suitable for supporting raker footings designed to an allowable soil bearing pressure of up to 150 kPa.

An alternative type of support for the shoring structure would be soil anchors installed into the hard clayey silt till. Design, construction and testing of anchors should be carried out in accordance with Canadian Foundation Engineering Manual (4th Edition). For preliminary design, the pullout resistance, R, in the very stiff clayey silt till can be estimated from the equation on Page 9:

$$R = A_s L_s C_a$$

where A_s = effective unit surface area of the anchor
L_s = effective embedment length of the anchor
C_a = adhesion of the clayey silt till (use 35 kPa which includes factor of safety)

The overall factor of safety of the anchored block of soil must also be considered. At least six full scale tests should be carried out on the anchors. This test should be taken to 200% of the design load or until there is a significant increase in the pull out rate. In the latter case, the design load must be limited to 50% of the load at which the pull out increases. Based on the results of the pull out tests, it may be necessary to modify the anchor design and place limits on the capacity.

5.3 Slab-On-Grade Construction

The subgrade for the basement floor slab is likely to consist of hard clayey silt till which is suitable for the slab-on-grade construction.

After subgrade preparation, a layer of well-graded, free-draining granular material (O.P.S. Granular 'A'), at least 200 mm thick and uniformly compacted to 98% of its Standard Proctor maximum dry density, should be placed under the slab-on-grade to provide a uniform bearing surface and to act as a vapour barrier.

5.4 Basement Wall

For the design of basement walls, the lateral earth pressure distribution can be assumed to increase with depth according to the following formula.

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

where	P	=	unit earth pressure at depth 'h'	kPa
	h	=	depth below ground surface	m
	γ	=	bulk unit weight of competent tills	21.5 kN/m^3
	K	=	coefficient of lateral earth pressure for glacial tills	0.42
	q	=	any surcharge load that may exist	kPa

This formula is based on the following assumptions:

a) the basement wall is a rigid wall which does not permit relaxation of the soil or movement;

b) the backfill to the wall consists of free draining granular material, such as Granular 'B' and the backfill should be compacted to at least 95% of the material's Standard Proctor maximum dry density;

c) an effective perimeter drainage system is provided to prevent the build-up of hydrostatic pressure behind the wall.

We recommend that the subsurface walls be dampproofed.

In areas where the excavation is shored, we recommend that vertical drains attached to the lagging be employed to provide perimeter drainage. In areas where shoring is not required, the exterior basement walls should be backfilled with free draining material, such as Granular 'B'. Perimeter weeping tiles should be provided around exterior footings. In addition, collector drains should be provided in the granular base of the basement floor slab.

Groundwater collected in the vertical drains, perimeter drains and collector drains should be connected to the local storm drainage system either by gravity or by a permanent sump pump. The drainage system should consist of perforated pipe (min. 100 mm dia.), surrounded by at least 100 mm of pea gravel all wrapped with geotextile filter fabric such as Terrafix 270-R or equivalent.

Heavy compaction equipment should not be used immediately adjacent to the wall because it may result in excessive earth pressures and wall deflection. Surface drainage around the building should be directed away from the building.

5.5 Underground Services

The subgrade for the underground services located at the site will consist of very stiff to hard clayey silt till which will provide adequate support for the pipes and allow the use of normal Class 'B' bedding using Granular 'A' material.

Backfill placed in the trenches in areas sensitive to ground settlement, should be organic free and be uniformly compacted in 200 mm thick lifts to at least 95% of the material's Standard Proctor maximum dry density.

5.6 Insulation

Should the underground garage be unheated, Styrofoam insulation 50 mm or equivalent should be placed above the footings and the floor sub-drains.

Insulation, comprising of 50 mm thick Styrofoam, should be considered for areas in the vicinity of garage fresh air intakes and in other locations where frost penetration may cause structural damage due to soil heaving.

In addition, the subgrade at the garage entrance should be replaced with 0.6 m of compacted non-frost-susceptible granular material and should be provided with sub-drains. This will prevent slab movement due to frost action.

6.0 GENERAL STATEMENT

The comments given in this report are intended only for the guidance of the design engineers, and on the assumption that the design will be in accordance with the acceptable applicable codes and standards. No other warranty expressed or implied is made as to the nature of the recommendations. The contents of this report are not intended for use by other parties or for other purposes. It may or may not contain sufficient information for other uses.

The comments and recommendations presented in this report are based on the subsurface conditions and geotechnical tests on the soil samples obtained from the boreholes at the locations indicated on the Borehole Location Plan, Plate 1. Our responsibility is limited to an accurate interpretation of the soil and groundwater conditions prevailing at the location investigated.

It should be noted that the comments and recommendations given in this report were based upon 118.0 m, the proposed elevation of the basement floor slab. Should the elevation of the basement floor slab be changed in the future, the suitability of the recommendations given in this report should be reviewed by us.

SOILTEST SERVICES LTD.

Gordon Lo, M.Eng., P.Eng.

LICENSED PROFESSIONAL ENGINEER
W-B. LO
PROVINCE OF ONTARIO

APPENDIX 'A'

Borehole Location Plan
Borehole Log Sheets

L I S T O F A B B R E V I A T I O N S

PENETRATION RESISTANCE

'N' STANDARD PENETRATION RESISTANCE: THE NUMBER OF BLOWS REQUIRED TO ADVANCE A STANDARD SPLIT BARREL SAMPLER 0.30 m INTO THE SUBSOIL, DRIVEN BY MEANS OF A HAMMER, HAVING 63.5 kg MASS, FALLING FREELY A DISTANCE OF 0.76 m.

DYNAMIC PENETRATION RESISTANCE: THE NUMBER OF BLOWS REQUIRED TO ADVANCE A 51 mm DIAMETER 60 DEGREE STEEL CONE FITTED TO THE END OF 45 mm O.D. DRILL RODS, 0.3 m INTO THE SUBSOIL. THE DRIVING ENERGY BEING 475 J PER BLOW.

SOIL DESCRIPTION

COHESIVE SOIL

CONSISTENCY	C_u STRENGTH kPa
VERY SOFT.......	0 - 12
SOFT............	12 - 25
FIRM............	25 - 50
STIFF...........	50 - 100
VERY STIFF......	100 - 200
HARD............	> 200

COHESIONLESS SOIL

RELATIVE DENSITY	'N' VALUE BLOWS/0.3 m
VERY LOOSE........	0 - 4
LOOSE.............	4 - 10
COMPACT...........	10 - 30
DENSE.............	30 - 50
VERY DENSE........	> 50

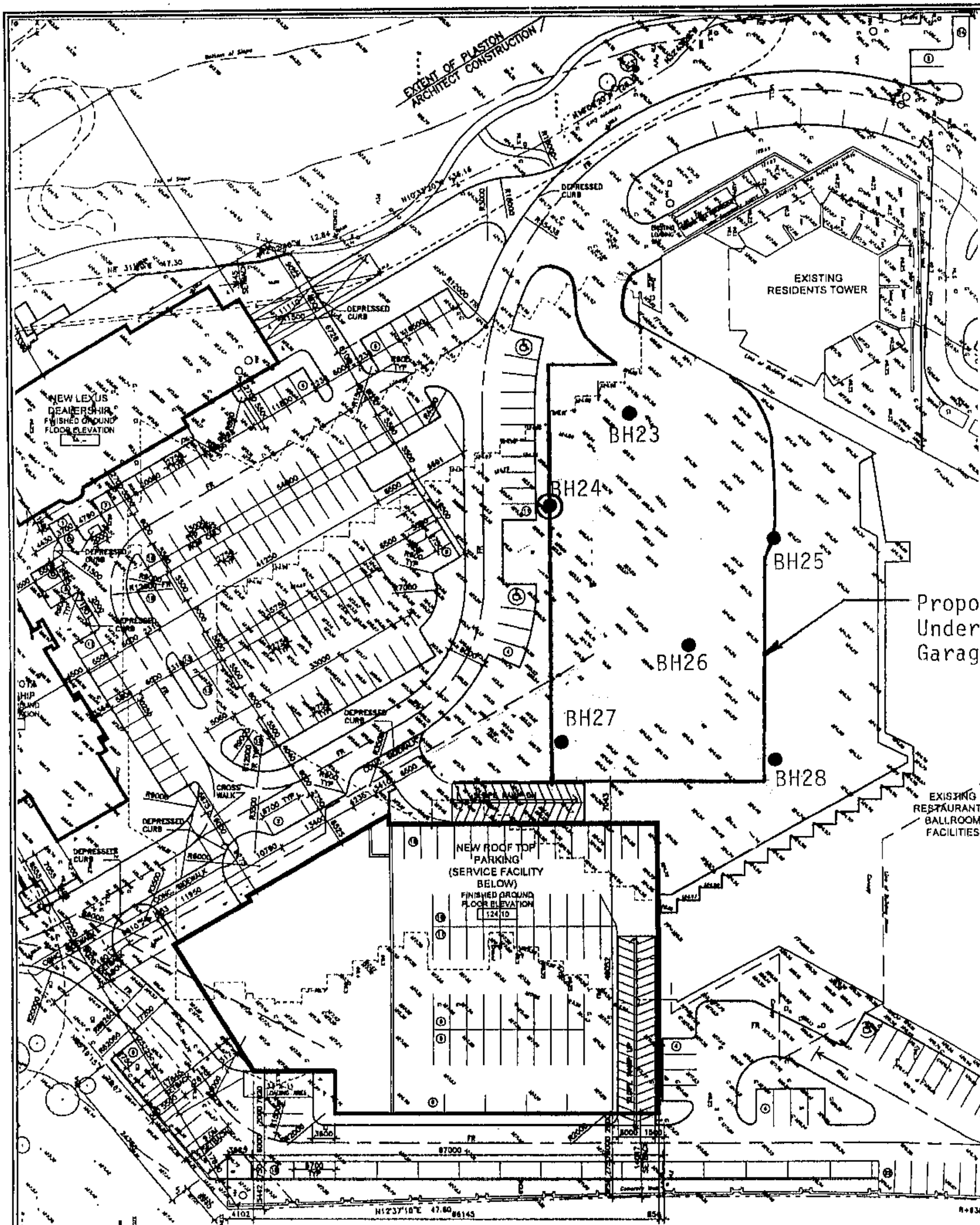
TYPE OF SAMPLE

AS - AUGER SAMPLE
CS - CHUNK SAMPLE
FS - FOIL SAMPLE
OS - OESTERBERG SAMPLE
RC - ROCK CORE

SS - SPLIT BARREL SAMPLE
ST - SLOTTED TUBE SAMPLE
TW - THIN-WALLED OPEN
TP - THIN-WALLED PISTON
WS - WASHED SAMPLE

PH - SAMPLER ADVANCED HYDRAULICALLY
PM - SAMPLER ADVANCED MANUALLY
WH - SAMPLER ADVANCED BY STATIC WEIGHT

■ - DEPTH AT WHICH 'UNDISTURBED' SAMPLE WAS EXTRACTED
▨ - DEPTH AT WHICH DISTURBED SAMPLE WAS EXTRACTED
□ - SAMPLING ATTEMPT WITH NO RECOVERY



Legend:

● BH23 Borehole

◉ BH24 Borehole with piezometer

BOREHOLE LOCATION PLAN

Scale 1 : 1,000

Log of Borehole BH23

Project No: 2061087-2
Project: Proposed Underground Garage
Location: 1100 Eglinton Avenue East, Toronto, On.
Client: Circon Construction Corporation
Sheet: 1 of 1

Depth (m)	Description	Elevation (m)	Sample Number	Type	Blows/ft	Water Content %
0	Ground Surface	124.8				
	brown Silty Sand Fill		1	SS	11	10.5
1	grey Clayey Silt Fill with fine gravel damp — compact		2	SS	12	
2	loose		3	SS	4	12.5
			4	SS	5	
3	v. loose		5	SS	0	14.8
3.8		121				
5	grey Clayey Silt Till with gravel damp — very stiff		6	SS	35	
6			7	SS	20	12.8
7	hard					
8	change to brown and have fine sand layers below 7.6 m	116.7	8	SS	100+	
	End of Borehole					
9	Borehole dry on completion					

Standard Penetration Test blows/ft (10, 30) | Water Content % (10, 20) | Well Data | Remarks

Drill Method: S/S Auger
Drill Date: April 9, 2007
Hole Size: 150 mm

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Toronto, Ontario
M1P 3E6

Datum: Geodetic
Checked by: Gordon Lo
Plate: 2

Project No: 2061087-2

Project: Proposed Underground Garage

Location: 1100 Eglinton Avenue East, Toronto, On.

Client: Circon Construction Corporation

Log of Borehole BH24

Sheet: 1 of 1

Depth (m)	Description (SUBSURFACE PROFILE)	Elevation (m)	Number	Type	Blows/ft	Water Content %	Remarks
0	Ground Surface	123.1					
	Granular Base (100 mm) brown, compact Fine Sand Fill		1	SS	11		
1	grey Clayey Silt Till with gravel and fissures damp to dry		2	SS	17	11.6	
			3	SS	18		
3			4	SS	22	12.8	
4							Date 4/13/07, Water Level dry
	very stiff / hard		5	SS	100+		
		116.7	6	SS	100+	6.1	
	End of Borehole						
	Borehole dry on completion						

Standard Penetration Test blows/ft: 10, 30

Water Content %: 10, 20

Well Data

Drill Method: S/S Auger

Drill Date: April 9, 2007

Hole Size: 150 mm

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Datum: Geodetic

Checked by: Gordon Lo

Plate: 3

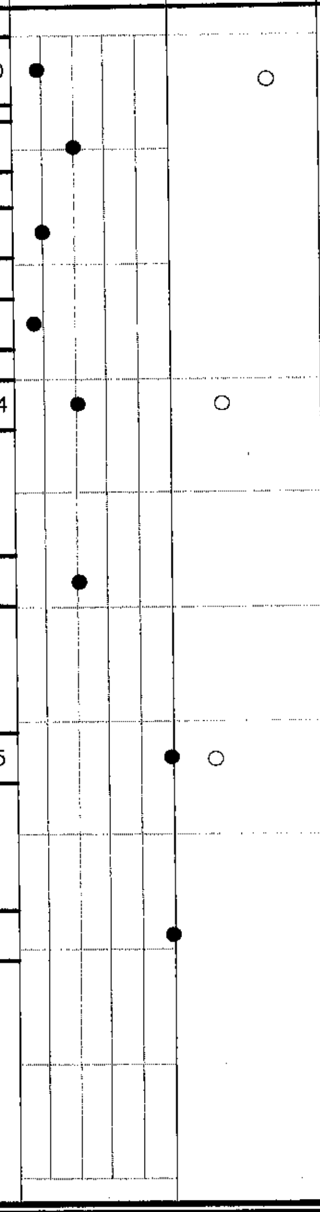
Log of Borehole BH25

Project No: 2061087-2
Project: Proposed Underground Garage
Location: 1100 Eglinton Avenue East, Toronto, On.
Client: Circon Construction Corporation

Sheet: 1 of 1

Depth (m)	Description	Elevation (m)	Sample Number	Type	Blows/ft	Water Content %	Well Data	Remarks
0	Ground Surface	124.1						
0–2.7	brown, loose to compact Sand and Gravel Fill, wet		1	SS	9	20.0		
			2	SS	20			
			3	SS	10			
	grey, loose Clayey Silt Fill with fine gravel, moist	121.4	4	SS	7			
2.7–8.1	grey Clayey Silt Till with gravel, damp; very stiff / hard		5	SS	21	10.4		
			6	SS	21			
			7	SS	100+	8.5		
	with fine sand layers below 7.6 m	116	8	SS	64			
	End of Borehole							
	Water level at 0.91 m one hour after completion							

Standard Penetration Test blows/ft (10, 30) — Water Content % (10, 20)



Drill Method: S/S Auger
Drill Date: April 9, 2007
Hole Size: 150 mm

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Checked by: Gordon Lo
Plate: 4

Project No: 2061087-2

Project: Proposed Underground Garage

Location: 1100 Eglinton Avenue East, Toronto, On.

Client: Circon Construction Corporation

Log of Borehole BH26

Sheet: 1 of 1

Depth (m)	Symbol	Description	Elevation (m)	Sample Number	Sample Type	Blows/ft	Water Content %	Standard Penetration Test blows/ft	Water Content %	Well Data	Remarks
		Ground Surface	123.7								
0		Granular Base (360 mm) brown, compact Silty Sand Fill, damp	122.8	1	SS	10					
1		grey Clayey Silt Till with gravel damp; very stiff		2	SS	18	10.4				
				3	SS	19					
3				4	SS	27	10.8				
				5	SS	19					
5		hard									
6				6	SS	61	16.9				
		with fine sand seams below 7.6 m	115.6	7	SS	65	14.7				
8		End of Borehole									
9		Borehole dry on completion									
10											

Drill Method: S/S Auger

Drill Date: April 9, 2007

Hole Size: 150 mm

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Plate: 5

Project No: 2061087-2

Project: Proposed Underground Garage

Location: 1100 Eglinton Avenue East, Toronto, On.

Client: Circon Construction Corporation

Log of Borehole BH27

Sheet: 1 of 1

Depth (m)	Symbol	Description	Elevation (m)	Number	Type	Blows/ft	Water Content %	Remarks
0		Ground Surface	124.1					
0–2.6	Fill	brown, loose Silty Sand Fill with fine gravel damp		1	SS	9		
				2	SS	15		
				3	SS	7	13.2	
2.6			121.5	4	SS	11		
2.6–8.1	Till	grey Clayey Silt Till with gravel damp; very stiff / hard		5	SS	23	10.9	
				6	SS	17		
				7	SS	100+	9.9	
		change to brown and have fine sand seams below 8.0 m	116	8	SS	61		
		End of Borehole						
		Borehole dry on completion						

Standard Penetration Test blows/ft: 10, 30

Water Content %: 10, 20

Well Data

Drill Method: S/S Auger

Drill Date: April 9, 2007

Hole Size: 150 mm

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Datum: Geodetic

Checked by: Gordon Lo

Plate: 6

Log of Borehole BH28

Project No: 2061087-2
Project: Proposed Underground Garage
Location: 1100 Eglinton Avenue East, Toronto, On.
Client: Circon Construction Corporation

Sheet: 1 of 1

Depth (m)	Description	Elevation (m)	Sample Number	Type	Blows/ft	Water Content %	Standard Penetration Test blows/ft	Water Content %	Well Data	Remarks
0	Ground Surface	124.3								
	Topsoil (140 mm) brown, loose Silty Sand Fill and Clayey Silt Fill, damp	124	1	SS	10					
1	grey Clayey Silt Till with gravel damp; very stiff		2	SS	27	11.1				
			3	SS	23					
2			4	SS	22					
3			5	SS	50					
4–5	hard		6	SS	59	16.6				
6			7	SS	67					
8		116.2	8	SS	100+	18.2				
	End of Borehole									
	Borehole dry on completion									

Drill Method: S/S Auger
Drill Date: April 9, 2007
Hole Size: 150 mm

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Datum: Geodetic
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Plate: 7