Submitted to:

CITY OF WINNIPEG

GEOTECHNICAL INVESTIGATION

AIR CANADA WINDOW PARK, 345 PORTAGE AVENUE, WINNIPEG, MANITOBA

JULY 2017

FILE NO. 17-217-02

ENG-TECH CONSULTING LIMITED

"Engineering and Testing Solutions That Work for You"

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ATTACHMENTS

1.0 INTRODUCTION

ENG-TECH Consulting Limited (ENG-TECH) completed the requested geotechnical investigation for installing the proposed art pieces in the Air Canada Window Park located at 345 Portage Avenue, Winnipeg, Manitoba. The park is surrounded by the Air Canada building to the north and APTN building to the east. ENG-TECH was informed that the artworks weigh approximately between 4.5 and 7.0 kN. The purpose of the investigation is to assess the soil conditions to provide recommendation on foundation, grade preparation and concrete durability.

1.1 Scope of Work

ENG-TECH completed the following scope of work:

- Clearances of all underground public and private utility services.
- A test hole drilling and soil sampling program.
- A laboratory testing program.
- An assessment and engineering report outlining the investigation and recommendations as outlined above.

2.0 TEST HOLE DRILLING, SOIL SAMPLING AND LABORATORY TESTING

ENG-TECH supervised the drilling of five (5) test holes (TH1 to TH5) on June 1 & 7, 2017 at the locations shown on Figure 1. Air Canada Park is located in downtown Winnipeg and many public and private underground utilities exist in this area. ENG-TECH ensured that the location of each test hole maintains a safe distance from any existing underground utility. All test holes were drilled using a B20L drill rig equipped with 125 mm diameter solid stem augers owned and operated by Maple Leaf Drilling. Upon completion of drilling, all test holes were backfilled using the auger soil cuttings and bentonite. The excess auger cuttings were removed from the work areas and the site was cleaned up after drilling the test holes.

The soil stratigraphy was visually classified at the time of drilling using the modified Unified Soil Classification System (USCS). Soil samples were collected off the auger flights and by means of Shelby tubes at select depths and retained for testing in ENG-TECH's Winnipeg laboratory. Moisture contents were determined on all soil samples collected (48), while three (3) unconfined compressive strength tests were completed on select samples. The results are shown on the test hole summary logs.

On June 1, 2017 TH1 was drilled to 2.3 m below existing grade, while TH2 and TH3 were advanced to 12.2 m and 6.1 m below grade, respectively. On June 7, 2017, TH4 and TH5 were drilled to 9.1 m below existing grade. TH1, TH3, TH4 and TH5 were drilled on the existing pavements of the park and some of the concrete blocks had to be removed to perform the drilling. All the removed blocks were put back in place upon the completion of the drilling.

All the test holes, except TH1, were drilled without hitting any obstacles in the ground. In TH1, which is located on Carlton Avenue, a hard obstacle was encountered at approximately 1 m below existing grade. ENG-TECH decided to change the location of the hole and another hole was drilled approximately 1 m to the east of the first hole. In this hole, another obstacle was encountered, this time at around 2.3 m, and ENG-TECH decided to leave the hole at this depth. It is speculated that the encountered obstacle might be the remnants of an old structure that was torn down prior to building the park.

3.0 STRATIGRAPHY

Overall, the stratigraphy at the site consists mostly of highly plastic inorganic clay. The clay was light to dark brown, moist and firm in the first 1.5 m and became soft with depth. In TH5, a layer of odorous black clay was encountered between the depths of 1.5 m and 2.4 m which was moist, soft and had traces of rootlets/wood chips, sand and gravel. In TH2 and TH3, traces of silt were present in the clay. In TH2 a 0.3 m layer of fine grained sand was encountered between the depths of 10.6 and 11.0 m. The sand layer was followed by a silt layer which extended to the depth explored (12.2 m).

Water seepage and sloughing were encountered only in TH2 at 2.7 m and 11.9 m, respectively. Detailed stratigraphy descriptions are presented in the test hole logs.

4.0 RECOMMENDATIONS

4.1 General

Based on the soil conditions and the magnitude of the loads for the proposed art pieces, shallow foundations such as square footings would be suitable and economical to support the proposed art pieces. However, shallow foundations are more prone to vertical and differential movement than deep foundations such as piles. Shallow foundations would be suitable to support the proposed structures providing the client is willing to accept the risk of vertical and differential movements typical for footings using the recommended bearing capacities. The expected differential movements are usually half of the total movements.

ENG-TECH cautions that for footings there is an increased potential for movements resulting from changes in soil moisture content or frost jacking, however these movements can be minimized with adequate sub-grade preparation, site drainage, and foundation insulation. The amount of heave due to frost will depend on the soil moisture content at the time of freezing. Movements associated with the shrinkage and swelling of the clay due to changing moisture content should be expected with shallow footings at this site.

Deep foundations such as cast-in-place friction piles can also be used to support and limit vertical and differential movements of the heavier art pieces. Deep foundations must be used if the client does not accept any risk of vertical and differential movements of the proposed art pieces.

Other foundation types could also be used to support the proposed art pieces, although they were not considered as practical or economical as the above options. Therefore, only recommendations for footings and cast-in-place concrete friction piles will be presented in this report

The most current revision of the City of Winnipeg Standard Construction Specifications (Table CW 3110 – R19) shall be used for the base and sub-base material recommended in this report.

4.2 Foundations

4.2.1 Footings

The art pieces can be founded on the native clay layer approximately from 0.6 m below grade. The footings can be designed using an ultimate limit state (ULS) bearing pressure of 90 kPa and a serviceable limit state (SLS) pressure of 70 kPa. The footings must be no less than 0.7 m or greater than 1.5 m and be founded on a compacted limestone base course. The base preparation for the proposed footings shall extend 200 mm beyond the perimeter edge and be prepared as outlined below:

- Remove all soft material from the surface to their full depth within the footprint of the proposed footings, with an additional 0.2 m width on each side of the footings to 100 mm below the underside of the footings design elevations. The exposed sub-grade will consist of sand and gravel fill or high plastic clay.
- Compact the top 200 mm of the sub-grade to a minimum of 98% of the soil's Maximum Dry Density (MDD) near optimum moisture content.
- Place approximately 100 mm of limestone base course and compact the lift to 100% of the materials MDD near optimum moisture content.
- The base of the footings should be protected from inundation and drying prior to placement of the base material and concrete.

4.2.2 Cast-in-Place Concrete Friction Piles

Cast-in-place concrete friction piles were assessed using a geotechnical resistance factor of 0.4 to obtain the ULS and SLS values that can be used in design as outlined in Table 1 below for vertical resistance:

Table 1
ULS and SLS Skin Friction Static Resistances for Cast-In-Place Concrete Piles

Depth Range (m)	ULS Skin Friction Resistance (kPa)	SLS Skin Friction Resistance (kPa)
The greater of 2.5 m below existing grade or 1.0 m below the grade beam	0	0
Between the above and 7 m below existing grade	13	11
Between the above and 16 m below existing grade	12	10

The following recommendations also apply to the use of cast-in-place concrete friction piles:

- The piles should be spaced at least 2.5 pile diameters apart, as measured from center to center in order to have the piles act individually. For a two (2) pile group, the capacity per pile as outlined above could be used to establish the capacity of the group.

- A minimum embedment depth of 7.5 m must be used for all piles.

- The piles may be treated as supported columns throughout their depth below final grade.

- The weight of the embedded portion of the pile may be neglected in the design when determining the load on a pile.

- Each pile must be reinforced to at least 6 m, with reinforcement to resist up-lift pressures due to structural forces as determined by the structural engineer. The design of piles to resist up-lift from soil swell pressure is not required since significant differential changes in moisture content are not expected around the piles with depth. The use of a Sona tube wrapped with a layer of 4 mil poly and inserted in the upper 2.5 m of the bore holes prior to placement of concrete will aid to reduce the potential of uplift pressures on the piles due to frost.

- The piles should be poured immediately after the completion of drilling to reduce the potential for seepage, sloughing, swelling and squeezing of the boreholes, and should be poured in accordance with Clause 7.2.7 of the Canadian Standards Association A23.1-14 (Concrete Materials and Methods of Concrete Construction). In case of encountering any seepage during the installation of the cast-in-place piles, pumping may be required to remove excess water from the boreholes prior to pouring the concrete. Steel sleeving varying in length (including to full length) may also be required if sloughing is encountered during the installation of the piles. As such, sleeving and a pump should be available on site and used on an as required basis

- A minimum compressible void form of 150 mm should be maintained under all pile caps and structures supported on piles to prevent damage due to uplift pressures and potential swelling of the underlying soils, should it occur.

- If old foundation or rubble is encountered then coring through it will be required, and the core diameter must be at least 100 mm greater than the pile diameter. The above will limit the risk of the obstruction interfering with the pile.

4.3 Concrete

General

All concrete should be designed, specified, and constructed in accordance with CSA standard A23.1-14, Concrete Materials and Methods of Concrete Construction using the Performance Specification Alternative as outlined in Table 5 of CSA A23.1-14.

Under the performance alternative, the concrete supplier shall assume responsibility for the performance of the concrete as delivered and the contractor shall assume responsibility for the concrete in place. The owner shall specify performance requirements including: the required structural criteria and concrete strength at age, the concrete exposure class for durability, and any other properties that may be required to meet the owner's performance requirements such as colour, architectural requirements, and special surface finishes. The owner reserves the right to request the supplier to provide satisfactory documentation that the proposed mix design will achieve the strength, durability, and performance requirements specified by the owner, and that the mix design satisfies the requirements of CSA A23.1-14. In addition, the owner may request the contractor to submit documentation demonstrating the owner's performance requirements have been met during construction and placement.

Based on Tables 1, 2, 3, and 4 of CSA A23.1-14, the concrete for piles, pile caps and the footings can be an S-2 exposure class since they will be in contact with clayey soils. The concrete design can be selected as structurally required; however, the concrete must be designed to meet the minimum specifications outlined below for durability.

Piles, Pile Caps and Footings (S-2)

56 day minimum compressive strength of 32 MPa
Maximum water/cementing materials ratio of 0.45
Maximum nominal aggregate size of 20 mm
Type HS or HSb cement
Air content of 4-7%

5.0 CLOSURE

This report was based on the outlined scope of work and was prepared in accordance with acceptable professional engineering principles and practices. If you have any questions, please contact the undersigned.

Sincerely,

ENG-TECH Consulting Limited

Arash Gholamzadeh, M.Sc., EIT
Engineering Department

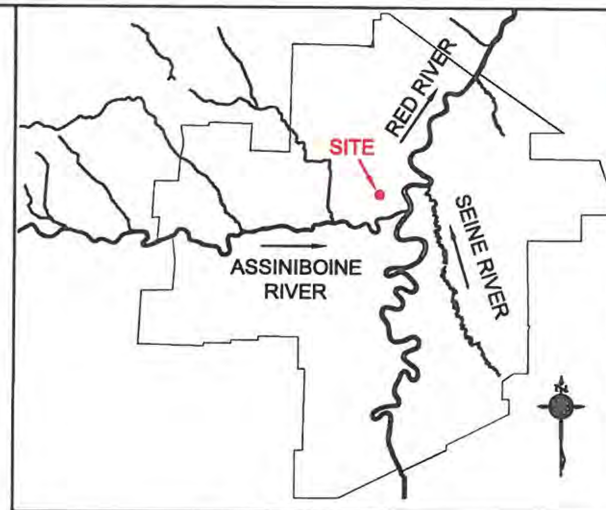
Clark Hryhoruk, M.Sc., P.Eng.
President, Geotechnical Engineer

PROVINCE OF MANITOBA
C. D. HRYHORUK
July 11/17
REGISTERED PROFESSIONAL ENGINEER

CDH/ag

ENGINEERS GEOSCIENTISTS MANITOBA
Certificate of Authorization
ENG-TECH Consulting Limited
No.2475

TEST HOLE LOCATION TABLE		
HOLE #	GPS COORDINATES OF TEST HOLES DRILLED ON JUNE 01 & 07, 2017	
	UTM 14U N	E
TH1	5528398	633163
TH2	5528418	633160
TH3	5528400	633195
TH4	5528389	633168
TH5	5528417	633191



KEYMAP

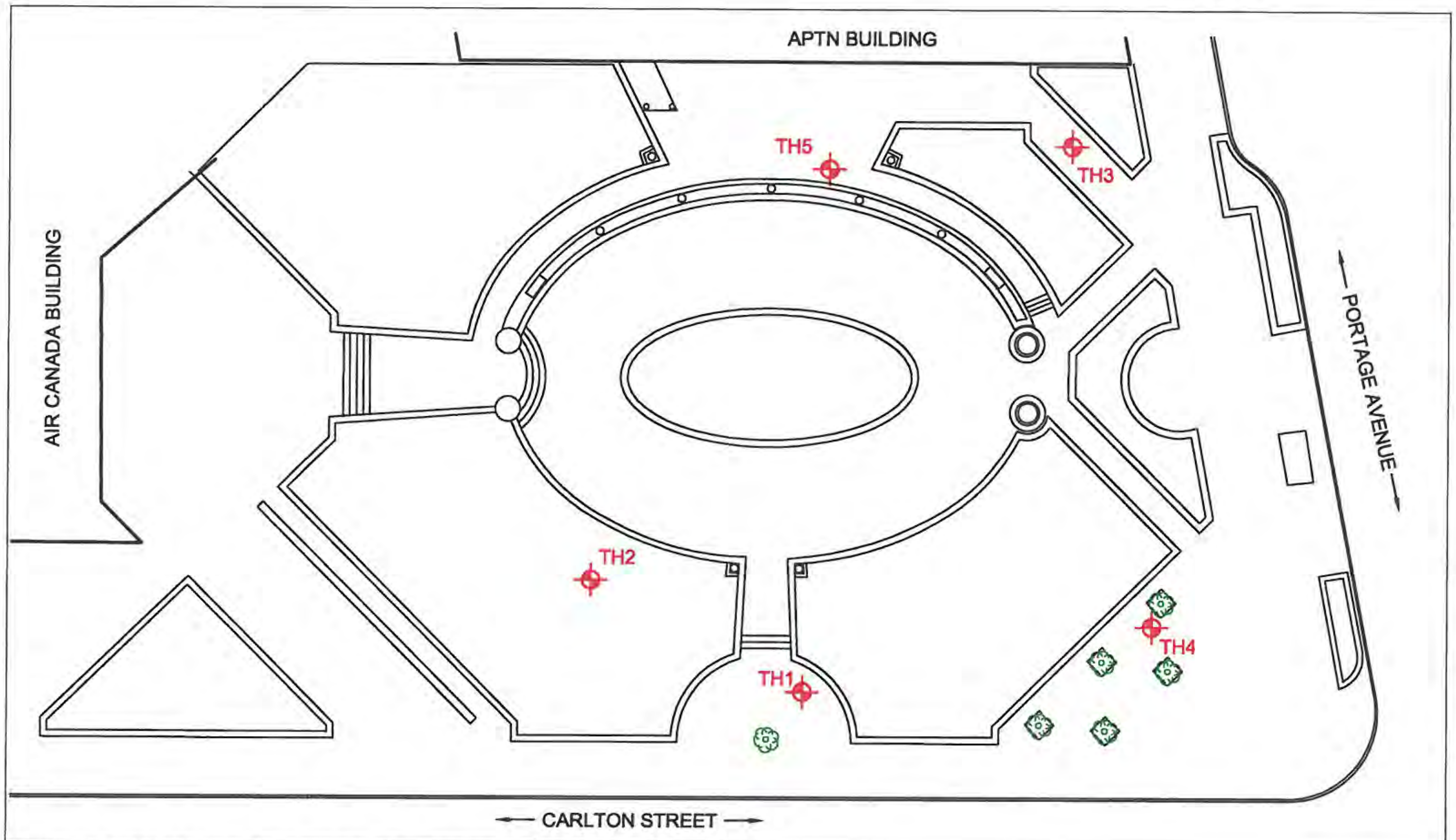
LEGEND

TH1 TEST HOLE

EXISTING TREE

NOTES:

- TREE LOCATIONS ARE APPROXIMATE.
- NOT ALL THE TREES ARE SHOWN IN THE SITE PLAN.



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NO.	DATE	ISSUE / REVISION
0	July 2017	report

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Certificate of Authorization
ENG-TECH Consulting Limited
No.2475

CLIENT: CITY OF WINNIPEG

PROJECT: GEOTECHNICAL INVESTIGATION - AIR CANADA WINDOW PARK, 345 PORTAGE AVENUE, WINNIPEG, MB

DWG DESCRIPTION: SITE AND TEST HOLE LOCATION PLAN

SCALE: NTS

DRAWN BY: JD / AG

DATE: JULY 2017

FILE No.: 17-217-02

CLIENT DWG/FIG. No.:

ENG-TECH DWG/FIG. No.: 1

NO.:

P:\2017\Projects\217(C.O.W)\02(Air Canada Park, Winnipeg, MB)\Drafting\Figure 1 - Site and Test Hole Location Plan 1.dwg

MODIFIED UNIFIED CLASSIFICATION SYSTEM FOR SOILS

MAJOR DIVISION			GROUP SYMBOL	GRAPH SYMBOL	TYPICAL DESCRIPTION	LABORATORY CLASSIFICATION CRITERIA
COARSE GRAINED SOILS (MORE THAN HALF BY WEIGHT LARGER THAN 75 µm)	GRAVELS MORE THAN HALF THE COARSE FRACTION LARGER THAN 4.75 mm	CLEAN GRAVELS (TRACE OR NO FINES)	GW		WELL GRADED GRAVELS, GRAVEL-SAND MIXTURES, LITTLE OR NO FINES	$C_U = \frac{D_{60}}{D_{10}} > 4$; $C_C = \frac{(D_{30})^2}{D_{10} \times D_{60}} = 1$ TO 3
			GP		POORLY GRADED GRAVELS, GRAVEL- SAND MIXTURES, LITTLE OR NO FINES	NOT MEETING ABOVE REQUIREMENTS
		DIRTY GRAVELS (WITH SOME OR MORE FINES)	GM		SILTY GRAVELS, GRAVEL-SAND-SILT MIXTURES	ATTERBERG LIMITS BELOW "A" LINE OR P.I. LESS THAN 4
			GC		CLAYEY GRAVELS, GRAVEL-SAND-CLAY MIXTURES	ATTERBERG LIMITS ABOVE "A" LINE AND P.I. MORE THAN 7
	SANDS MORE THAN HALF THE COARSE FRACTION SMALLER THAN 4.75 mm	CLEAN SANDS (TRACE OR NO FINES)	SW		WELL GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES	$C_U = \frac{D_{60}}{D_{10}} > 6$; $C_C = \frac{(D_{30})^2}{D_{10} \times D_{60}} = 1$ TO 3
			SP		POORLY GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES	NOT MEETING ABOVE REQUIREMENTS
		DIRTY SANDS (WITH SOME OR MORE FINES)	SM		SILTY SANDS, SAND-SILT MIXTURES	ATTERBERG LIMITS BELOW "A" LINE OR P.I. LESS THAN 4
			SC		CLAYEY SANDS, SAND-CLAY MIXTURES	ATTERBERG LIMITS ABOVE "A" LINE AND P.I. MORE THAN 7
FINE GRAINED SOILS (MORE THAN HALF BY WEIGHT SMALLER THAN 75 µm)	SILTS BELOW "A" LINE NEGLIGIBLE ORGANIC CONTENT	LL ≤ 50%	ML		INORGANIC SILTS AND VERY FINE SANDS, ROCK FLOUR, SILTY SANDS OF SLIGHTY PLASTICITY	CLASSIFICATION IS BASED UPON PLASTICITY CHART (SEE BELOW)
		LL > 50%	MH		INORGANIC SILTS, MICACEOUS OR DIATOMACEOUS, FINE SANDY OR SILTY SOILS	
	CLAYS ABOVE "A" LINE NEGLIGIBLE ORGANIC CONTENT	LL ≤ 30%	CL		INORGANIC CLAYS OF LOW PLASTICITY, GRAVELLY, SANDY OR SILTY CLAYS, LEAN CLAYS	
		30% < LL ≤ 50%	CI		INORGANIC CLAYS OF MEDIUM PLASTICITY, SILTY CLAYS	
		LL > 50%	CH		INORGANIC CLAYS OF HIGH PLASTICITY, FAT CLAYS	
	ORGANIC SILTS & CLAYS BELOW "A" LINE	LL < 50%	OL		ORGANIC SILTS AND ORGANIC SILTY CLAYS OF LOW PLASTICITY	
		LL > 50%	OH		ORGANIC CLAYS OF HIGH PLASTICITY	
HIGHLY ORGANIC SOILS			Pt		PEAT AND OTHER HIGHLY ORGANIC SOILS	STRONG COLOUR OR ODOUR, AND OFTEN FIBROUS TEXTURE

ADDITIONAL SYMBOLS

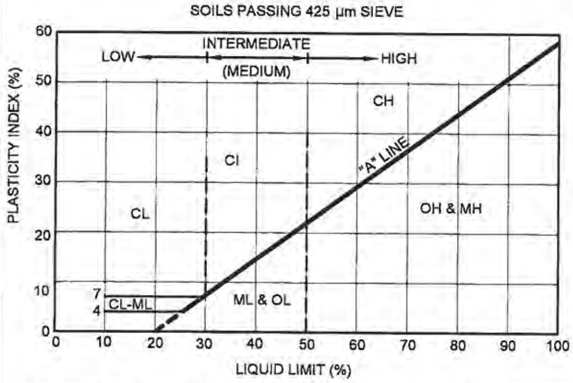
TILL		SANDSTONE	
		GRANITE	
FILL			
TOPSOIL			
CONCRETE			
SHALE			
LIMESTONE			

PLASTIC SOILS

MOISTURE	PLASTICITY	INTRUSIONS	CONSISTENCY	POCKET PEN (TSF)	(N)
DRY	LOW	ROOTLETS	VERY SOFT		< 2
DAMP	MEDIUM	OXIDES	SOFT	0 - 0.5	2 - 4
MOIST	HIGH	MICA	FIRM	0.5 - 1.0	4 - 8
WET		GYPSUM	STIFF	1.0 - 2.0	8 - 15
		ETC.	VERY STIFF	2.0 - 4.0	15 - 30
			HARD	> 4.0	> 30

TSF x 95.8 = kPa (q_U) $S_U = \frac{1}{2} \times q_U$

PLASTICITY CHART FOR SOILS PASSING 425 µm SIEVE



SOIL DESCRIPTIONS

TRACE:	0 - 10%	BOULDERS:	> 200 mm	COARSE SAND:	2 - 4.75 mm
SOME:	10 - 20%	COBBLES:	75 - 200 mm	MEDIUM SAND:	0.425 - 2 mm
WITH:	20 - 35%	COARSE GRAVEL:	19 - 75 mm	FINE SAND:	0.075 - 0.425 mm
AND:	35 - 50%	FINE GRAVEL	4.75 - 19 mm	FINES:	< 0.075 mm

GRANULAR SOILS

MOISTURE	DENSITY	GRADATION	INTRUSIONS	SPT (N)
DRY	VERY LOOSE	POORLY	ROOTLETS	0 - 4
DAMP	LOOSE	WELL	OXIDES	4 - 10
MOIST	MED. DENSE		MICA	10 - 30
WET	DENSE		FINES	30 - 50
	VERY DENSE		ETC.	> 50

DEFINITIONS

LL = LIQUID LIMIT
P.I. = PLASTICITY INDEX
C_U = COEFFICIENT OF UNIFORMITY
q_U = UNCONFINED COMPRESSIVE STRENGTH
S_U = UNDRAINED SHEAR STRENGTH
C_C = COMPRESSION INDEX
PL = PLASTIC LIMIT

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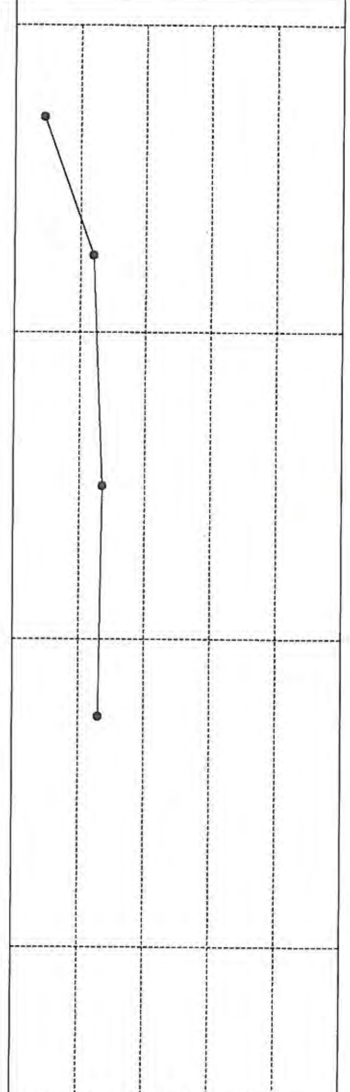
Engineering And Testing Solutions That Work For You

Test Hole #: TH1
Client: City of Winnipeg
Site: See Figure 1
Location: 345 Portage Avenue, Winnipeg, MB
Project: Geotechnical Investigation - Air Canada Window Park

File No.: 17-217-02
Date Drilled: June 1, 2017
Grade Elevation: 100.0 m
Water Elevation: --

SUBSURFACE PROFILE				SAMPLE DATA					SHEAR STRENGTH (kPa)		
Depth (m)	Soil Symbol	Description	Elevation (m)	Sample No.	Sample Type	Moisture Content (%)	Blows/300 mm	Moisture Content (%) PL I---------X---------I LL 20 40 60 80	P. Pen	Torvane	UC
0.0		Ground Surface	100.0								
		Sand and Gravel Fill (300 mm) - light brown, wet, dense, poorly-graded.									
		Clay (CI) - dark brown, moist, stiff, medium plastic, trace gravel.		S1		9					
				S2		24			96		
1.0			99.0								
				S3		27			72		
2.0			98.0								
				S4		26					
		End of Test Hole - end of test hole at 2.7 m below grade. - no seepage encountered. - no sloughing encountered. - test hole backfilled with auger cuttings and bentonite upon completion of drilling.									
3.0			97.0								



ENG- TECH Consulting Limited

Logged by: AG / AN

Reviewed by: CH

Drilled By: Maple Leaf Drilling
Drill Rig: B20L
Auger Size: 125mm Solid Stem

Completion Depth: 2.7 m
Completion Elevation: 97.3 m
Sheet: 1 of 1

SAMPLE TYPE: SPLIT BARREL | SHELBY TUBE | AUGER CUTTINGS | SPLIT SPOON

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Test Hole #: TH2

Client: City of Winnipeg
Site: See Figure 1
Location: 345 Portage Avenue, Winnipeg, MB
Project: Geotechnical Investigation - Air Canada Window Park

File No.: 17-217-02
Date Drilled: June 1, 2017
Grade Elevation: 100.0 m
Water Elevation: --

SUBSURFACE PROFILE

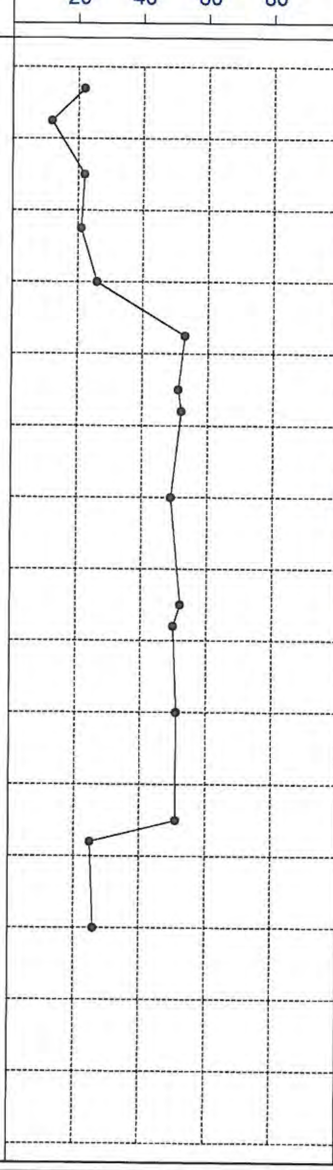
Depth (m)	Description	Elevation (m)
0.0	Ground Surface	100.0
0.0–0.3	**Topsoil (300 mm)** - black, moist, soft, with rootlets and trace organics.	
	Sand and Gravel Fill - light brown, wet, loose, poorly graded.	
	Clay (CH) - light brown, moist, firm, highly plastic, trace to some silt, sand & gravel.	
	Clay (CH) - light brown, wet, soft, highly plastic, trace silt. - below 6.0 m, grey. - below 9.1 m, trace silt.	
	Sand (SP) - brown, moist, loose, poorly-graded, trace gravel.	
	Silt (ML) - light brown, moist to wet, soft, low plastic.	
	End of Test Hole - end of test hole at 12.2 m below grade. - seepage encountered at 2.7 m below grade. - sloughing encountered at 11.7 m below grade. - test hole backfilled with auger cuttings and bentonite upon completion of drilling.	

SAMPLE DATA and SHEAR STRENGTH (kPa)

Sample No.	Sample Type	Moisture Content (%)	Blows/300 mm	P. Pen	Torvane	UC
S1	Auger Cuttings	22				
S2	Auger Cuttings	12				
S3	Auger Cuttings	22		120		
S4	Auger Cuttings	21		36		
S5	Auger Cuttings	26		36		
S6	Auger Cuttings	53		24		
S7	Auger Cuttings	51		12		
S8	Shelby Tube	52		36		
S9	Auger Cuttings	49		24		
S10	Auger Cuttings	52		12		
S11	Shelby Tube	50			30	28
S12	Auger Cuttings	51				
S13	Auger Cuttings	51				
S14	Auger Cuttings	25				
S15	Auger Cuttings	26				

Moisture Content (%)

PL I----------X----------I LL



ENG- TECH Consulting Limited

Logged by: AG / AN
Reviewed by: CH

Drilled By: Maple Leaf Drilling
Drill Rig: B20L
Auger Size: 125 mm Solid Stem

Completion Depth: 12.2 m
Completion Elevation: 87.8 m
Sheet: 1 of 1

SAMPLE TYPE: SPLIT BARREL, SHELBY TUBE, AUGER CUTTINGS, SPLIT SPOON

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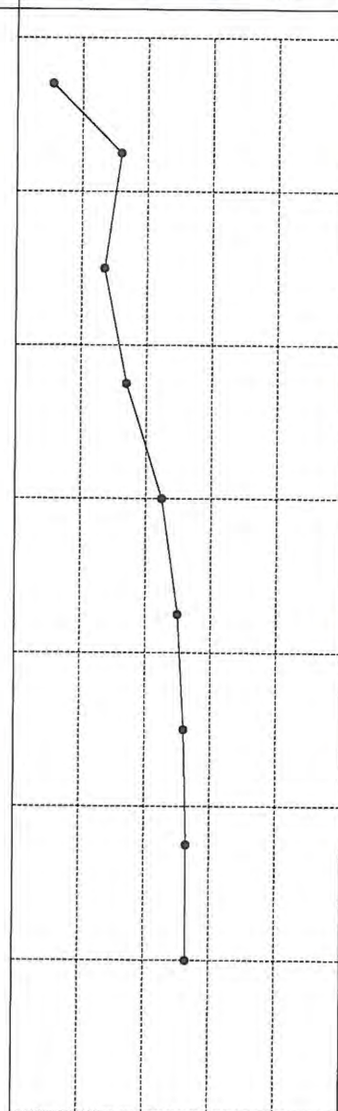
Test Hole #: TH3

Client: City of Winnipeg
Site: See Figure 1
Location: 345 Portage Avenue, Winnipeg, MB
Project: Geotechnical Investigation

File No.: 17-217-02
Date Drilled: June 1, 2017
Grade Elevation: 100.0 m
Water Elevation: --

Depth (m)	Description	Elevation (m)	Sample No.	Sample Type	Moisture Content (%)	Blows/300 mm	P. Pen (kPa)	Torvane	UC
0.0	Ground Surface	100.0							
	Sand and Gravel Fill (300 mm) - light brown, wet, dense, poorly-graded.		S1	Auger cuttings	11				
	Clay (CI-CH) - dark brown, moist, stiff, medium to highly plastic, trace gravel.		S2	Auger cuttings	32		72		
1.0		99.0	S3	Auger cuttings	27		72		
2.0	**Clay (CI)** - light brown, moist, soft, medium plastic, trace silt.	98.0	S4	Auger cuttings	34		36		
3.0	**Clay (CH)** - dark brown, moist, firm, highly plastic. - below 3.0 m, trace silt.	97.0	S5	Auger cuttings	45		36		
			S6	Auger cuttings	50		36		
4.0		96.0	S7	Auger cuttings	52		12		
5.0		95.0	S8	Auger cuttings	53		12		
			S9	Auger cuttings	53		12		
6.0	**End of Test Hole** - end of test hole at 6.0 m below grade. - no seepage encountered. - no sloughing encountered. - test hole backfilled with auger cuttings and bentonite upon completion of drilling.	94.0							
7.0		93.0							



ENG- TECH Consulting Limited

Logged by: AG / AN
Reviewed by:

Drilled By: Maple Leaf Drilling
Drill Rig: B20L
Auger Size: 125mm Solid Stem

Completion Depth: 6.0 m
Completion Elevation: 94.0 m
Sheet: 1 of 1

SAMPLE TYPE: SPLIT BARREL, SHELBY TUBE, AUGER CUTTINGS, SPLIT SPOON

ENG-TECH Consulting Limited

Engineering And Testing Solutions That Work For You

Test Hole #: TH4

Client: City of Winnipeg
Site: See Figure 1
Location: 345 Portage Avenue, Winnipeg, MB
Project: Geotechnical Investigation - Air Canada Window Park

File No.: 17-217-02
Date Drilled: June 7, 2017
Grade Elevation: 100.0 m
Water Elevation: --

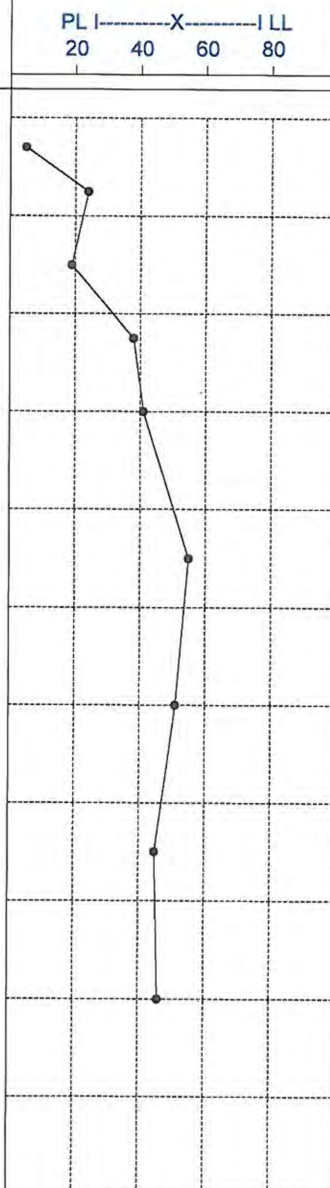
SUBSURFACE PROFILE

Depth (m)	Description	Elevation (m)
0.0	Ground Surface	100.0
0.0–0.3	**Sand and Gravel Fill (300 mm)** - light brown, damp, dense, poorly-graded, with organics & rootlets.	
0.3–9.1	**Clay (CH)** - dark brown, moist, firm, highly plastic, trace gravel. - below 2.1 m, very soft.	
9.1	**End of Test Hole** - end of test hole at 9.1 m below grade. - no seepage encountered. - no sloughing encountered. - test hole backfilled with auger cuttings and bentonite upon completion of drilling.	

SAMPLE DATA

Sample No.	Sample Type	Moisture Content (%)	Blows/300 mm	P. Pen (kPa)	Torvane	UC
S1	Auger Cuttings	5				
S2	Auger Cuttings	24		72		
S3	Auger Cuttings	19		72		
S4	Auger Cuttings	38		24		
S5	Auger Cuttings	41		24		
S6	Auger Cuttings	55		12		
S7	Auger Cuttings	51		12		
S8	Auger Cuttings	45		12		
S9	Auger Cuttings	46		12		

Moisture Content (%)



SHEAR STRENGTH (kPa)

ENG- TECH Consulting Limited

Logged by: AG
Reviewed by: CH

Drilled By: Maple Leaf Drilling
Drill Rig: B20L
Auger Size: 125 mm Solid Stem

Completion Depth: 9.1 m
Completion Elevation: 90.9 m
Sheet: 1 of 1

SAMPLE TYPE: SPLIT BARREL | SHELBY TUBE | AUGER CUTTINGS | SPLIT SPOON

ENG-TECH Consulting Limited

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Test Hole #: TH5

Client: City of Winnipeg
Site: See Figure 1
Location: 345 Portage Avenue, Winnipeg, MB
Project: Geotechnical Investigation - Air Canada Window Park

File No.: 17-217-02
Date Drilled: June 7, 2017
Grade Elevation: 100.0 m
Water Elevation: --

SUBSURFACE PROFILE

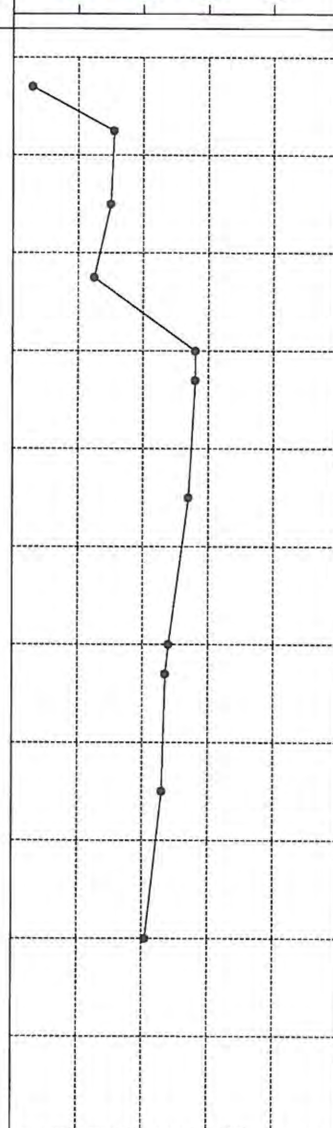
Depth (m)	Description	Elevation (m)
0.0	Ground Surface	100.0
0.0–0.3	***Sand and Gravel Fill (300 mm)*** - light brown, dry, dense, poorly-graded.	
	Clay (CH) - dark brown, moist, firm, highly plastic, trace gravel.	
	Clay (CH) - black, moist, soft, highly plastic, trace rootlets, sand and gravel, odorous.	
	Clay (CH) - dark brown, moist, soft, highly plastic, trace gravel.	
9.1	***End of Test Hole*** - end of test hole at 9.1 m below grade. - no seepage encountered. - no sloughing encountered. - test hole backfilled with auger cuttings and bentonite upon completion of drilling.	

SAMPLE DATA

Sample No.	Sample Type	Moisture Content (%)	Blows/300 mm	P. Pen (kPa)	Torvane (kPa)	UC (kPa)
S1	Auger cuttings	6				
S2	Auger cuttings	31		84		
S3	Auger cuttings	30		108		
S4	Auger cuttings	25		12		
S5	Auger cuttings	56		24		
S6	Shelby tube	56			40	32
S7	Auger cuttings	54				
S8	Auger cuttings	48				
S9	Shelby tube	47			60	86
S10	Auger cuttings	46				
S11	Auger cuttings	41				

Moisture Content (%)

PL I----------X----------I LL



SHEAR STRENGTH (kPa)

ENG- TECH Consulting Limited

Logged by: AG
Reviewed by: [signature]

Drilled By: Maple Leaf Drilling
Drill Rig: B20L
Auger Size: 125 mm Solid Stem

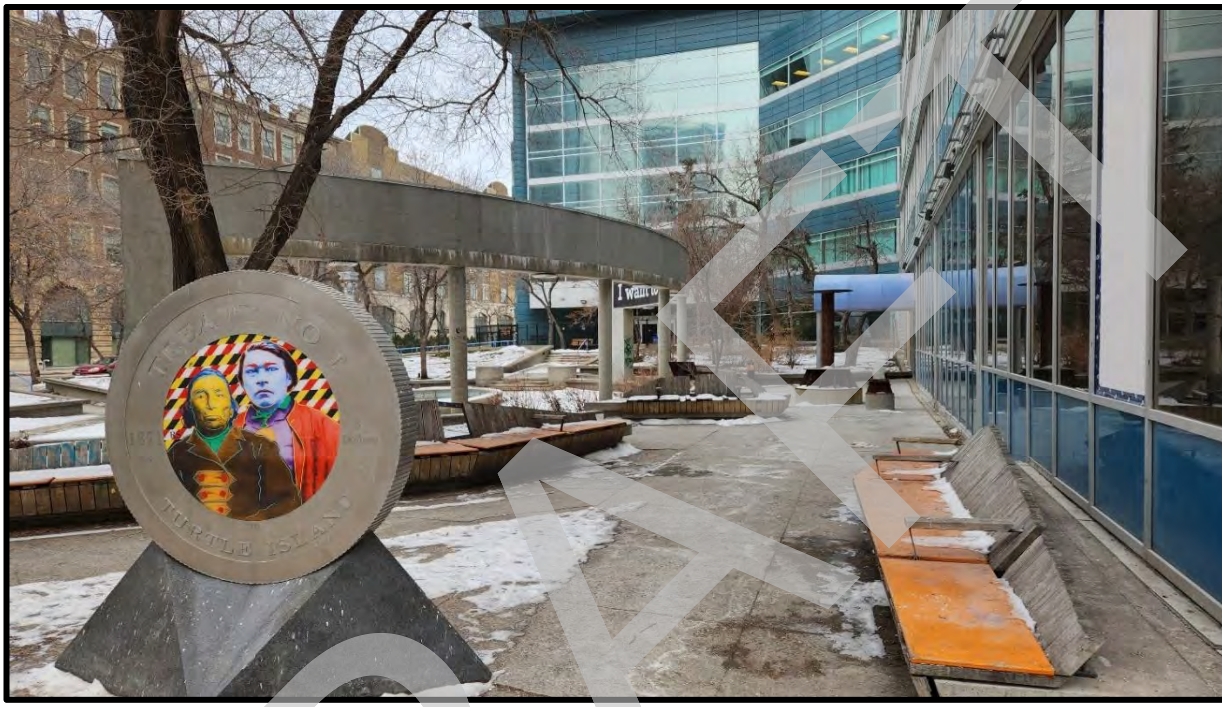
Completion Depth: 9.1 m
Completion Elevation: 91.9 m
Sheet: 1 of 1

SAMPLE TYPE: SPLIT BARREL | SHELBY TUBE | AUGER CUTTINGS | SPLIT SPOON

Submitted to: **City of Winnipeg**

GEOTECHNICAL INVESTIGATION

AIR CANADA WINDOW PARK,
345 PORTAGE AVENUE, WINNIPEG, MANITOBA



MARCH 2024

FILE NO.: 24-217-01

ENG-TECH CONSULTING LIMITED

"Engineering and Testing Solutions That Work for You"

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TABLE OF CONTENTS

PAGE

1.0 INTRODUCTION

ENG-TECH Consulting Limited (ENG-TECH) completed the requested a geotechnical investigation for the proposed redevelopment of Air Canada Window Park at the corner of Portage Avenue and Carlton Street in Winnipeg, Manitoba. The purpose of the investigation is to provide foundation recommendations for steel auger screw piles.

1.1 Scope of Work

ENG-TECH completed the following scope of work:

- A review of any existing information about the site completed by ENG-TECH and information provided by the client.
- Clearance of public underground utility services.
- A test hole drilling and soil sampling program.
- A laboratory testing program.
- An assessment for the use of streel auger screw piles.
- An engineering report outlining the geotechnical investigation and recommendations as outlined in the introduction.

2.0 TEST HOLE DRILLING PROGRAM, SOIL SAMPLING and LABORATORY TESTING

ENG-TECH supervised the drilling of one (1) test hole on February 21, 2024, at the location shown on Figure 1. Air Canada Park is located in downtown Winnipeg and many public and private underground utilities exist in this area. ENG-TECH ensured that the location of test hole maintains a safe distance from any existing underground utility. The test hole was drilled using a B20L drill rig equipped with 125 mm diameter solid stem augers owned and operated by Maple Leaf Drilling. TH1 was drilled on the existing pavement of the park and 150 mm of the concrete had to be cored to perform the drilling. Test hole TH1 was drilled to 7.5 m below existing grade (mbg).

Upon completion of drilling, the test hole was backfilled using the auger soil cuttings and bentonite. In addition, the cored test hole was patched with hot asphalt upon the completion of the drilling. The excess auger cuttings were removed from the work area and the site was cleaned up after drilling.

The soil stratigraphy was visually classified at the time of drilling using the modified Unified Soil Classification System (USCS). Soil samples were collected off the auger flights and by means of Shelby tubes at select depths and retained for testing in ENG-TECH's Winnipeg laboratory. Moisture contents were determined on all soil samples collected, while three (3) unconfined compressive strength tests and soil resistivity tests (2) for the use of steel auger screw piles were completed on select samples. The moisture content and unconfined test results are shown on the test hole summary log, and the resistivity results are outlined in Section 3.0.

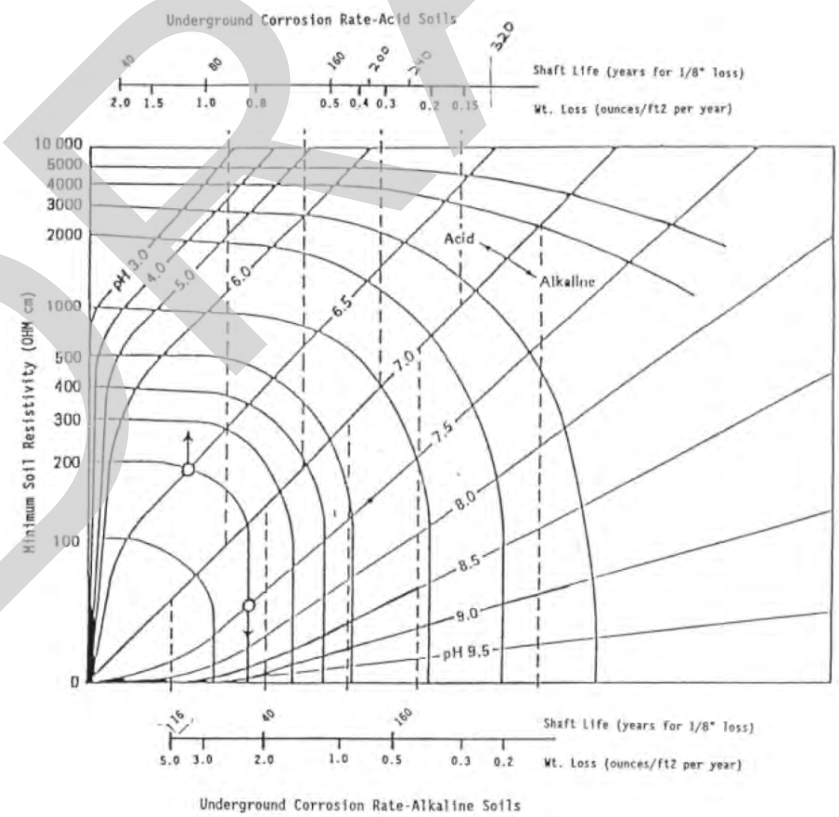
3.0 RESISTIVITY TEST RESULTS

ENG-TECH completed resistivity testing to assess corrosion for the use of steel auger screw piles. Two (2) samples were collected and tested from TH1 at 3.8 mbg and 6.1 mbg on the high plastic clay. The samples were moist and were tested both in as-received and saturated conditions. The results of the tests are as follows:

Test Hole	Sample Depth Below Existing Grade (m)	Trial	Soil Moisture Content	Soil Resistivity Ohms-cm	pH
TH1	3.8	As Received	48.0	368	8.0
	3.8	Saturated	71.0	461	8.0
	6.1	As Received	44.9	430	7.5
	6.1	Saturated	55.3	517	7.5

There are several external environmental factors affecting the corrosion of mild carbon steel foundations. The factors include if the soil is disturbed or undisturbed, soil type, soil resistivity, soil pH, soil moisture, chloride content of soil/water, steel alloy composition, abrasion due to wave action, steel anti-corrosive coatings or cathodic protection and exposure time. In general, the highest metal corrosion rates occur in the first 5 years until a steady state erosion rate is achieved. In terms of underground corrosion, soil resistivity and pH are the two main factors. These factors and all the aforementioned factors affecting the corrosivity of soil can change with time and therefore their effect on the soil corrosivity can be time-dependent.

Corrosion rate losses for uncoated helical screw foundations can generally be estimated from the nomograph presented below (from the British Journal (King, 1977)). Knowing the pH and soil resistivity, an estimate of the service life (defined as 1/8-inch material loss per year) can be determined for acid or alkaline soils.



Nomograph for Estimating the Corrosion Rate

Based on the results of the tests and using the service life nomograph, the screw piles are expected to last more than 75 years without more than 1/8-inch loss of shaft life.

4.0 STRATIGRAPHY

The stratigraphy at the site based on the drilling program is summarized in the following table:

Depth (mbg)		Soil Type
0.0	0.15	Concrete (150 mm).
0.15	2.1	CLAY FILL - brown, moist to damp, some silt, some gravel, some sand.
2.1	7.5	CLAY (CH) - medium brown to brown, moist, firm, high plastic, with silt, trace sand.

No seepage or sloughing were encountered. Detailed stratigraphy descriptions are outlined on the attached test hole summary log.

5.0 RECOMMENDATIONS

5.1 General

The client has expressed interest in using steel auger screw pile for the proposed redevelopment at Air Canada Window Park. Based on the soil conditions observed during drilling, a deep foundation such as steel auger screw piles are a suitable foundation type to limit settlements and differential movements.

5.2 Foundation Recommendations

5.2.1 Screw Piles

The helix screw pile was assessed using the Ultimate Limit State (ULS) and Serviceability Limit State (SLS) values outlined below. The minimum torque as outlined below is required for installing the screw piles, and if not achieved at the design depth, then the piles may have to penetrate deeper until the minimum torque is reached. Other pile sizes could be used and can be assessed upon request.

ULS and SLS Capacities for Steel Screw Piles						
Diameter of Shaft (mm)	Diameter of Helix (mm)	Length of Pile (m)	Number of Helixes	ULS Capacity (kN)	SLS Capacity (kN)	Minimum Installation Torque (kN-m)
89	406	5	1	40	35	4.5
89	406	7.5	1	50	45	5.6
114	305	5	1	30	25	4.1
114	305	7.5	1	45	40	5.9

The following recommendations also pertain to the installation of steel screw piles:

- Steel screw piles are to be CSA grade G40.21 350W (min) or approved equal. The selected steel shaft must have a suitable wall thickness to withstand the minimum installation torque and corrosion to meet the life expectancy of the pile.
- Proper equipment should be available on site to remove any encountered obstructions such as cobbles and boulders while installing the piles.
- Piles in groups shall be installed at a minimum spacing of 2.5 helix diameters apart from each other (center to center). For a two (2) pile group, the design load per pile as outlined above could be used to establish the load of the group.
- Manufactured specifications must be followed for the installation of the screw piles as well as any screw pile shaft modifications in the field at the time of installation.
- A minimum compressible void form of 150 mm must be maintained under all pile caps and any structure supported on piles.
- Documentation and inspection during pile installation should be conducted. The contractor must not establish the final elevation of any piles (cut piles) until the certification is complete.

6.0 INSPECTION AND TESTING

The following inspection and testing by ENG-TECH will aid to ensure quality control during construction and that the recommendations herein are being met:

- Pile Inspection

  Soil conditions can vary with depth; therefore, pile inspection will aid to ensure the soil conditions can carry the loads as outlined herein.

7.0 STATEMENT OF LIMITATIONS AND THIRD-PARTY USE

The geotechnical information provided in this report is in accordance with acceptable engineering principles and practices (Standard of Practice). The findings of this report were based on information provided (field investigation and laboratory testing). Soil conditions are natural deposits that can be highly variable across a site. If sub-surface conditions are different than the conditions previously encountered on-site or those presented here, we should be notified to adjust our findings if necessary.

All information provided in this report is subject to ENG-TECH's standard terms and conditions for engineering services, a copy of which is provided to each of our clients with the original scope of work, or a mutually executed standard engineering services agreement. If these conditions are not attached, and you are not already in possession of such terms and conditions, contact our office and you will be promptly provided with a copy.

The content of this document is not intended for the use of, nor is it intended to be relied upon by any person, firm or corporation, other than the Client and ENG-TECH. ENG-TECH denies any liability whatsoever to other parties for damages or injury suffered by such third party arising from the use of this document by them, without the express written authority of ENG-TECH and the Client. This document is subject to further restrictions imposed by the contract between the Client and ENG-

TECH, and these parties' permission must be sought regarding this document in all other circumstances. ENG-TECH disclaims responsibility for consequential financial effects on transactions or property values, or requirements for follow-up actions and costs.

8.0 CLOSURE

This report was based on the scope of work outlined for the investigation and was prepared by acceptable professional engineering principles and practices. If you have any questions, please contact the undersigned.

Sincerely,
ENG-TECH Consulting Limited

Shah Zeb
Engineering Department

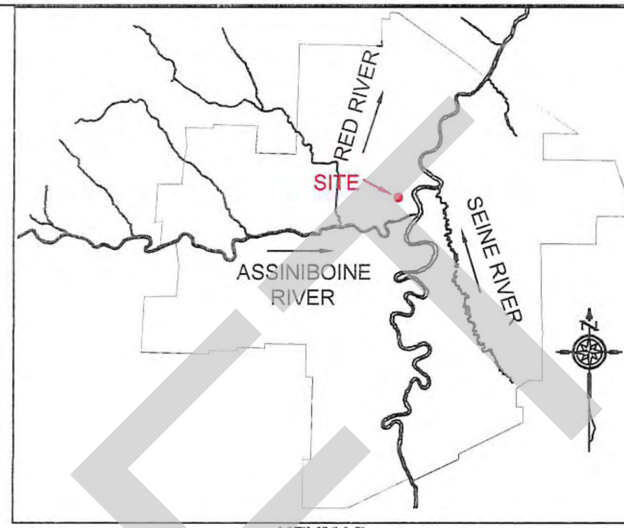
Clark Hryhoruk, M.Sc., P. Eng.
Principal

CDH/sz

ENGINEERS GEOSCIENTISTS MANITOBA
Certificate of Authorization
ENG-TECH Consulting Limited
No.2475

TEST HOLE LOCATION TABLE		
HOLE #	GPS COORDINATES OF TEST HOLES FEBRUARY 21, 2024	
	UTM	14U
TH1	5528410	633190

IMAGE OBTAINED FROM CITY OF WINNIPEG AERIAL MAP WEBSITE



KEYMAP

PHOTOGRAPH 1: FACING NORTH, SHOWING THE LOCATION OF TH1.

PHOTOGRAPH 2: FACING EAST, SHOWING THE TEST HOLE AFTER COMPLETION OF DRILLING.

LEGEND

- TH1 TEST HOLE
- PROPERTY LINE (APPROX.)

NO.	DATE	ISSUE / REVISION
0	MAR. 2024	report

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ENG. STAMP:

ENGINEERS GEOSCIENTISTS MANITOBA
Certificate of Authorization
ENG-TECH Consulting Limited
No.2475

CLIENT:
CITY OF WINNIPEG

PROJECT:
GEOTECHNICAL INVESTIGATION - AIR CANADA WINDOW PARK, 345 PORTAGE AVENUE, WINNIPEG, MANITOBA

DWG DESCRIPTION:
SITE AND TEST HOLE LOCATION PLAN

SCALE:
N.T.S.

DRAWN BY:	DATE:
SZ	MARCH 2024
FILE No.: 24-217-01	CLIENT DWG/FIG. No.:
ENG-TECH DWG/FIG. No.: 1 OF 1	NO.:

P:\2024\217(City of Winnipeg)\01(Air Canada Window Park)\Drawing\Proposed TH location .dwg

MODIFIED UNIFIED CLASSIFICATION SYSTEM FOR SOILS

MAJOR DIVISION			GROUP SYMBOL	GRAPH SYMBOL	TYPICAL DESCRIPTION	LABORATORY CLASSIFICATION CRITERIA
COARSE GRAINED SOILS (MORE THAN HALF BY WEIGHT LARGER THAN 75 μm)	GRAVELS MORE THAN HALF THE COARSE FRACTION LARGER THAN 4.75 mm	CLEAN GRAVELS (TRACE OR NO FINES)	GW		WELL GRADED GRAVELS, GRAVEL-SAND MIXTURES, LITTLE OR NO FINES	$C_U = \frac{D_{60}}{D_{10}} > 4$; $C_C = \frac{(D_{30})^2}{D_{10} \times D_{60}} = 1$ TO 3
			GP		POORLY GRADED GRAVELS, GRAVEL- SAND MIXTURES, LITTLE OR NO FINES	NOT MEETING ABOVE REQUIREMENTS
		DIRTY GRAVELS (WITH SOME OR MORE FINES)	GM		SILTY GRAVELS, GRAVEL-SAND-SILT MIXTURES	ATTERBERG LIMITS BELOW "A" LINE OR P.I. LESS THAN 4
			GC		CLAYEY GRAVELS, GRAVEL-SAND-CLAY MIXTURES	ATTERBERG LIMITS ABOVE "A" LINE AND P.I. MORE THAN 7
	SANDS MORE THAN HALF THE COARSE FRACTION SMALLER THAN 4.75 mm	CLEAN SANDS (TRACE OR NO FINES)	SW		WELL GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES	$C_U = \frac{D_{60}}{D_{10}} > 6$; $C_C = \frac{(D_{30})^2}{D_{10} \times D_{60}} = 1$ TO 3
			SP		POORLY GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES	NOT MEETING ABOVE REQUIREMENTS
		DIRTY SANDS (WITH SOME OR MORE FINES)	SM		SILTY SANDS, SAND-SILT MIXTURES	ATTERBERG LIMITS BELOW "A" LINE OR P.I. LESS THAN 4
			SC		CLAYEY SANDS, SAND-CLAY MIXTURES	ATTERBERG LIMITS ABOVE "A" LINE AND P.I. MORE THAN 7
FINE GRAINED SOILS (MORE THAN HALF BY WEIGHT SMALLER THAN 75 μm)	SILTS BELOW "A" LINE NEGLIGIBLE ORGANIC CONTENT	LL ≤ 50%	ML		INORGANIC SILTS AND VERY FINE SANDS, ROCK FLOUR, SILTY SANDS OF SLIGHTY PLASTICITY	CLASSIFICATION IS BASED UPON PLASTICITY CHART (SEE BELOW)
		LL > 50%	MH		INORGANIC SILTS, MICACEOUS OR DIATOMACEOUS, FINE SANDY OR SILTY SOILS	
	CLAYS ABOVE "A" LINE NEGLIGIBLE ORGANIC CONTENT	LL ≤ 30%	CL		INORGANIC CLAYS OF LOW PLASTICITY, GRAVELLY, SANDY OR SILTY CLAYS, LEAN CLAYS	
		30% < LL ≤ 50%	CI		INORGANIC CLAYS OF MEDIUM PLASTICITY, SILTY CLAYS	
		LL > 50%	CH		INORGANIC CLAYS OF HIGH PLASTICITY, FAT CLAYS	
	ORGANIC SILTS & CLAYS BELOW "A" LINE	LL < 50%	OL		ORGANIC SILTS AND ORGANIC SILTY CLAYS OF LOW PLASTICITY	
		LL > 50%	OH		ORGANIC CLAYS OF HIGH PLASTICITY	
HIGHLY ORGANIC SOILS			Pt		PEAT AND OTHER HIGHLY ORGANIC SOILS	STRONG COLOUR OR ODOUR, AND OFTEN FIBROUS TEXTURE

ADDITIONAL SYMBOLS

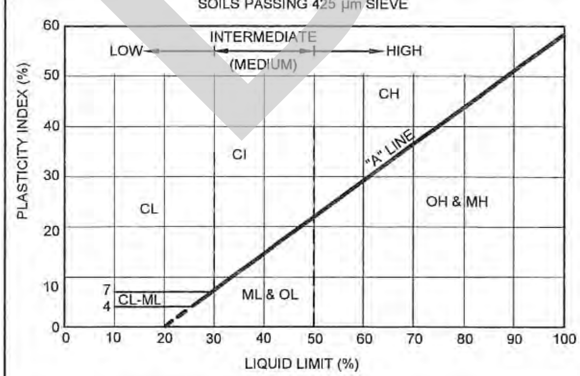
TILL		SANDSTONE	
		GRANITE	
FILL			
TOPSOIL			
CONCRETE			
SHALE			
LIMESTONE			

PLASTIC SOILS

MOISTURE	PLASTICITY	INTRUSIONS	CONSISTENCY	POCKET PEN (TSF)	(N)
DRY	LOW	ROOTLETS	VERY SOFT		< 2
DAMP	MEDIUM	OXIDES	SOFT	0 - 0.5	2 - 4
MOIST	HIGH	MICA	FIRM	0.5 - 1.0	4 - 8
WET		GYPSUM	STIFF	1.0 - 2.0	8 - 15
		ETC.	VERY STIFF	2.0 - 4.0	15 - 30
			HARD	> 4.0	> 30

TSF x 95.8 = kPa (q_u) $S_u = \frac{1}{2} \times q_u$

PLASTICITY CHART FOR SOILS PASSING 425 μm SIEVE



SOIL DESCRIPTIONS

TRACE:	0 - 10%	BOULDERS:	> 200 mm	COARSE SAND:	2 - 4.75 mm
SOME:	10 - 20%	COBBLES:	75 - 200 mm	MEDIUM SAND:	0.425 - 2 mm
WITH:	20 - 35%	COURSE GRAVEL:	19 - 75 mm	FINE SAND:	0.075 - 0.425 mm
AND:	35 - 50%	FINE GRAVEL	4.75 - 19 mm	FINES:	< 0.075 mm

GRANULAR SOILS

MOISTURE	DENSITY	GRADATION	INTRUSIONS	SPT (N)
DRY	VERY LOOSE	POORLY	ROOTLETS	0 - 4
DAMP	LOOSE	WELL	OXIDES	4 - 10
MOIST	MED. DENSE		MICA	10 - 30
WET	DENSE		FINES	30 - 50
	VERY DENSE		ETC.	> 50

DEFINITIONS

LL = LIQUID LIMIT
P.I. = PLASTICITY INDEX
C_U = COEFFICIENT OF UNIFORMITY
q_U = UNCONFINED COMPRESSIVE STRENGTH
S_U = UNDRAINED SHEAR STRENGTH
C_C = COMPRESSION INDEX
PL = PLASTIC LIMIT

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F: \Drafting\SOIL CLASSIFICATIONS\SOIL CLASSIFICATIONS.dwg

ENG-TECH Consulting Limited

Engineering And Testing Solutions That Work For You

Test Hole #: TH1

Client: City of Winnipeg
Site: 345 Portage Avenue, Winnipeg, Manitoba
Location: See Figure 1
Project: Geotechnical Investigation - Air Canada Window Park

File No.: 24-217-01
Date Drilled: February 21, 2024
Grade Elevation: 100.0 m
Water Elevation: --

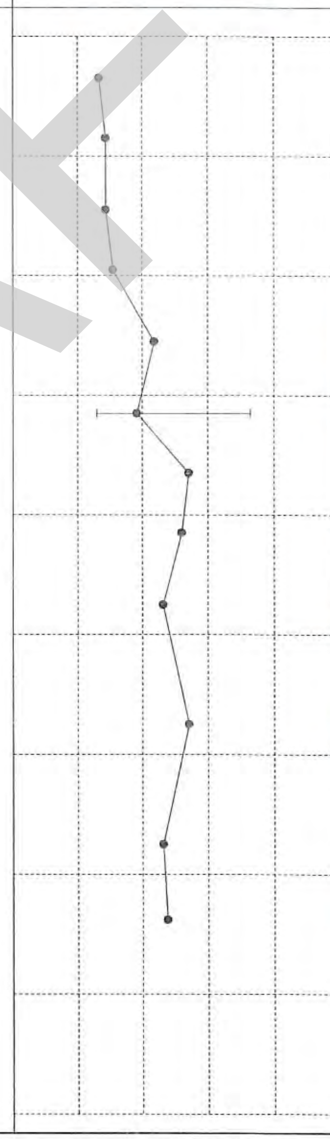
SUBSURFACE PROFILE

Depth (m)	Description	Elevation (m)
0.0	Ground Surface	100.0
0.0 – 0.15	***Concrete (150 mm)***	
0.15 – 2.1	***Clay Fill*** - brown, moist to damp, some silt, some gravel, some sand.	
2.1 – 7.5	***Clay (CH)*** - medium brown to brown, moist, firm, high plastic, with silt, trace sand.	
7.5	***End of Test Hole*** - end of test hole at 7.5 m below grade. - no seepage or sloughing encountered during drilling. - test hole backfilled with auger cuttings and bentonite and patched with hot ashphalt upon completion of drilling.	

SAMPLE DATA / SHEAR STRENGTH (kPa)

Sample No.	Sample Type	Moisture Content (%)	Blows/300 mm	P. Pen	Torvane	UC
S1	Auger Cuttings	26.8				
S2	Auger Cuttings	28.9				
S3	Auger Cuttings	28.9				
S4	Shelby Tube	31.1				92
S5	Auger Cuttings	43.8		48		
S6	Auger Cuttings	38.5		48		
S7	Shelby Tube	54.3				42
S8	Auger Cuttings	52.1		48		
S9	Auger Cuttings	46.4		48		
S10	Auger Cuttings	54.3		48		
S11	Shelby Tube	46.4				60
S12	Auger Cuttings	47.7		48		

Moisture Content (%)



ENG- TECH Consulting Limited

Logged by: SZ
Reviewed by: [signature]

Drilled By: Maple Leaf Drilling Ltd.
Drill Rig: B20L
Auger Size: 125 mm Solid Stem

Completion Depth: 7.5 m
Completion Elevation: 92.5 m
Sheet: 1 of 1

SAMPLE TYPE: SPLIT BARREL | SHELBY TUBE | AUGER CUTTINGS | SPLIT SPOON