Geotechnical Report for
GI Building, Warkworth Institute

Terraspec Project No. 12-6-5542

Prepared by:

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Real Property Professional & Technical Programs/Services
Ontario Region
294 King Street East
Ottawa, Ontario

Re: Geotechnical Report for GI Building, Warkworth Institute
Project # 12-6-5542

Investigation and Soils Data

The project site is located at the Warkworth Institute, on County Road 29 just east of the town of Warkworth. The soil physiography for this area classified as drumlinized till plains, overlying limestone bedrock of the Trenton Group. The bedrock depth at this site is somewhat variable, although bedrock will usually be encountered within 9m of the existing ground surface.

It is proposed that a new building be constructed in between existing buildings WW02, WW03, and WW04. Four exploratory boreholes were placed on site, at the location of the proposed new building, on June 21, 2012. Due to limited access to the site with respect to the entrance gate, the boreholes were placed using a very-compact drilling rig (with comparable power to that of a CME 45), with 130mm solid stem augers. A site plan showing borehole locations has been appended to this report. The borehole logs and laboratory testing data have also been appended to this report.

The underlying native subsoils within the expected new footing elevation generally consisted of a sandy silty clay. This material was typically in a moist, and stiff to very stiff condition, and was considered to be cohesive. The typical undrained apparent cohesion of the sandy silty clay subsoils at the anticipated footing depth was 120-150kPa. The typical SPT N value for this subsoil was 10-14 blows per foot, which for clays, is considered to be a relatively compact condition. The frost susceptibility of the sandy silty clay subsoil was found to be in the low category. Auger refusal was encountered at each of the boreholes. It was inferred that the refusal was due to flat bedrock. Groundwater seepage was generally encountered at a depth of 4 to 5m below existing ground surface.

Methane gas readings were recorded from each open borehole with a methane gas meter.
No methane gas was detected within the boreholes.

The OHSA soil types for excavation and trenching were Type 3 for the native subsoils. These subsoils should be treated as Type 4 for any construction work that would be required below the water table.

An elevation benchmark was created on site, at the following location:
Top of concrete floor slab of main hall, at the north hydro conduit.
The assumed elevation of this benchmark is 100.000m. The original ground elevations of the borehole locations with respect to the benchmark are as follows:

Borehole	Elevation
B1	99.710
B2	99.695
B3	98.315
B4	98.115

Recommendations

1.1 Foundations

Bearing Capacity
The frost protection depth for footings in this area is 1.5m. It is recommended that footings be placed such that the footings will have a minimum 1.5m of soil cover for frost protection.
Spread or strip footings may be placed onto the underlying undisturbed native subsoils, identified as snady silty clay.
Assuming a minimum embedment depth of 1.5m below existing ground surface, the following soil bearing capacities will typically be available at the base of the new footings:

Factored ULS bearing capacity:	180kPa
SLS allowable bearing capacity:	120kPa

This capacity is based on a standard maximum total settlement of 25mm and a maximum differential settlement of 19mm.

For the clay subsoils, it would be advisable to place longitudinal reinforcing steel within the footings.

Due to the difference in elevation of the existing ground on the project site, it may be necessary to place stepped footings towards the south end of the proposed new building.

Subgrade Inspection
The subgrade soils at this location should be carefully reviewed by a geotechnical firm during construction to ensure that the intended soil bearing surface is consistent with this report throughout all proposed footing areas. In the case that fill is required beneath a structure, it is preferable that a lean concrete fill be utilized.

Seismic Parameters
The following seismic design parameters may be utilized:

Warkworth: Sa(0.2)=0.23, Sa(0.5)=0.13, Sa(1.0)=0.067, Sa(2.0)=0.019, PGA=0.12.
Foundation Factor, F=1.0
Site Class = B (average soil properties within top 30m is bedrock)
Soil Shear Wave Average Velocity (m/s) = 760 < Vs < 1500

Geotechnical Parameters
For calculating vertical and lateral earth pressures and other geotechnical parameters, the following unfactored coefficients may be utilized:

native sandy silty clay
phi = 26°
Ka = 0.39, Ko = 0.56, Kp = 2.56
Coefficient of friction for the concrete/clay interface = 0.35
Moist unit weight = 18.30 kN/m3

native silty clay sand with gravel/cobble till
phi = 32°
Ka = 0.31, Ko = 0.47, Kp = 3.25
Coefficient of friction for the concrete/till interface = 0.45
Moist unit weight = 19.81 kN/m3

typical sandy Granular B Type 1 backfill
phi = 32°
Ka = 0.31, Ko = 0.47, Kp = 3.25
Moist unit weight = 22.3 kN/m3

typical gravelly Granular B Type 1 backfill
phi = 35°
Ka = 0.27, Ko = 0.43, Kp = 3.69
Moist unit weight = 23.0 kN/m3

Dewatering
Based on the encountered moisture conditions and groundwater levels, it is not expected that extensive dewatering of the footing excavations will be required, however, dewatering will still be necessary. A continuous pumping operation with conventional sump equipment is expected

to be required for the placement of footings onto the underlying native subsoil.

Stipulate in the contract that all excavations for new footings and roadways must be protected at all times from high moisture levels and/or erosion damage due to rainfall or accumulating groundwater.

Subdrains
It is standard practice to place perimeter sub-drains for new footings, and it is recommended that subdrains be placed for this project. Sub-drain installations should consist of a perforated geotextile-wrapped pipe, placed at the footing depth along the outside perimeter of the footings. The pipe should have a minimum diameter of 150mm and must be graded to a positive outlet away from the foundation. Backfill to the sub-drain trench should consist of OPSS 1004 Clear Stone. A free-draining granular material such as OPSS 1010 Granular B Type 1 should be placed as backfill to the foundation walls.

Reuse of Subsoils
The topsoil encountered on site appeared to be suitable for reuse, although the topsoil layer was relatively thin. The typical topsoil depth on site was 70mm.

The native clay subsoils present on site will not be of much use other than as subgrade fill for landscaped areas. The native soils on site cannot be used as fill beneath any structure footings. Care must to taken to prevent disturbance of this subgrade soil. Similarly, great care must be utilized when compacting this soil if it is intended to be used on site as native backfill beneath roads or parking lots where settlement cannot be tolerated, since these soils are very difficult to fully recompact once disturbed.

The subsoils encountered were observed to be clean and free of contaminants. A soil sample has been sent for chemical testing for landfill disposal criteria. It is not expected that any contaminants will be detected in the soil sample, indicating that excess subsoils from the site may be disposed of at a landfill, if necessary.

Concrete
The frost penetration treatment depth for footings at this site is 1.5m. All concrete placed within the frost penetration treatment depth of 1.5m, or exposed to outside temperature extremes, should generally consist of a 30MPa concrete mix, with adequate (typically 7%) air entrainment.
A soil sample has been sent for chemical testing of sulphate content. It is not expected that a sulphate-resistant concrete will be necessary for the subsoils encountered at this site.

1.2 Slab on Grade

The following minimum requirements are recommended for a standard slab-on-grade floor:

Concrete Slab	150mm
OPSS 1010 Granular A base	150mm
OPSS 1010 Granular B Type 1 subbase	300mm
Over compact existing subgrade soil	

The recommended minimum slab depth is 150mm. It will be desirable to place thicker slabs where the slab will accommodate service vehicle traffic such as fork lifts or other heavy equipment. Consideration can be given to utilizing structural fibre in the concrete floor slab, such as CBM FibreMax, in addition to standard wire mesh. The subgrade soil surface to remain should be proof-rolled to ensure that it is acceptable for placement of the granular base and subbase materials. All granular materials will require compaction as per Section 1.5 of this report. It is recommended that a minimum concrete compressive strength of 20MPa be utilized for floor slabs.

Remove any soft or saturated subsoils from beneath the new floor areas. These subsoils may be replaced as necessary by an acceptable subgrade fill material, such as OPSS 1010 SSM. Allow for subgrade inspections during construction to verify the subsoil conditions and to make recommendations on the need for over-excavation, where necessary.

1.3 Pipe Bedding and Cover

For new underground piping, utilize the following OPSD Standards for pipe installation:

For soil subgrade:			
OPSD 802.010	Flexible Pipe	-	Type 3 Earth Excavation
OPSD 802.031	Rigid Pipe	-	Type 3 Earth Excavation, Class B

Utilize the granular bedding and cover depths as specified in the applicable OPSD standards listed above. OPSS Granular A should be utilized for pipe embedment and pipe cover material for new piping. OPSS Granular B Type 1 material with a maximum particle size of 50mm may be utilized as pipe embedment and cover material for new non-pressurized sewer mains and storm sewer pipe.

Frost protection for underground piping beneath roadways should be utilized as per the following OPSD standards, with a frost treatment depth of k=1.5m:

OPSD 803.030	Frost Penetration Line Below Bedding Grade
OPSD 803.031	Frost Penetration Line Above Bedding Grade

Backfill material for pipe trenches (over the granular cover) may consist of acceptable native

subsoils as indicated above, or alternate cover material may also be used, such as OPSS 1010 SSM. Compaction requirements for OPSD 800 series installations should conform to Section 1.5 of this report.

1.4 Pavement Design

The following minimum pavement designs as per OPSS 1150 specifications are recommended for placement of new asphalt pavement:

Heavy Duty Pavement for Roadways and/or Bus Parking

50mm	HL3 surface course
50mm	HL8 binder course
150mm	OPSS 1010 Granular A base
300mm	OPSS 1010 Granular B Type 1 or Type 2 subbase
	Over compact native subgrade soil

Light Duty Pavement for Parking Lots

50mm	HL3 surface course
150mm	OPSS 1010 Granular A base
300mm	OPSS 1010 Granular B Type 1 subbase
	Over compact native subgrade soil

Asphalt Sidewalks

50mm	HL3 surface course
200mm	OPSS 1010 Granular A base
	Over compact native subgrade soil

The asphalt cement should have a minimum rating of PGAC 58 -34.

Tack-coat the hot mix substrate, as per OPSS.PROV 308, prior to placing the surface course lift of hot mix.

Stipulate in the contract that all hot mix paving operations shall be carried out in strict accordance with OPSS 310 specifications.

The grades for the project site must be designed to ensure positive drainage of the entire pavement structure.

Remove all organic soil from the subgrade surface.
Construct earth grading for roadways as per OPSD 200.01.
Remove boulders (if encountered) from the subgrade surface as per OPSD 204.01.
The subgrade soil to remain should be proof-rolled with heavy compaction equipment to ensure that it is acceptable for placement of the new granular base and granular subbase materials.

1.5 Compaction Requirements

All native soil and granular compaction requirements for the project should conform with OPSS 501, Subsection 501.08.02 - Method A, utilizing soil placement in maximum 300mm lifts and a compaction standard of 100% of Standard Proctor Maximum Dry Density.

1.6 Statement of Limitations

This report is intended for the guidance of the project design team. From a construction standpoint, contractors must make their own assessment of the soil and groundwater conditions and how these will affect their proposed construction techniques and schedules.

The recommendations in this report are based on information determined at the test hole locations. Soils and groundwater conditions beyond the test holes may differ from those encountered at the test hole locations and conditions may become apparent during construction that could not be detected or anticipated at the time of the soils investigation. If this occurs, we recommend that Terraspec be recalled to the site for further consultation, testing, and analysis.

We also recommend that Terraspec be retained to ensure that all subgrade preparation requirements are met, and to confirm that the soil conditions do not deviate materially from those encountered in test holes. In cases where any of our recommendations are not followed, the company's responsibility is limited to interpreting the information from test hole data.

This report is applicable only to this project, constructed substantially in accordance with details of alignment and elevations quoted in the text.

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TERRASPEC ENGINEERING INC.
GEOTECHNICAL ENGINEERS

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Borehole Data
GI Building
Warkworth Institute, Ontario
June 21, 2012

Notes

1. Soil types, strata, and groundwater conditions have been established only at test hole locations.
2. Soils are described according to the MTO Soils Classification System and OPSD 100.06.
3. Dimensions are in millimetres up to 1 metre, then in metres thereafter.

Abbreviations

asph	-	asphalt	&	-	and
blds	-	boulders	w	-	with
blk	-	black	so	-	some
br	-	brown	tr	-	trace
BR	-	bedrock			
cl	-	clay(ey)	s	-	soil sample
cob	-	cobbles	N	-	blowcounts per 0.3m
conc	-	concrete	Su	-	vane shear strength (kPa)
cr	-	crushed	W	-	moisture content (%)
f	-	fine			
gr	-	gravel(ly)			
gry	-	grey			
med	-	medium			
NFP	-	no further progress			
org	-	organics			
RF	-	rock fill			
sa	-	sand(y)			
si	-	silt(y)			
tps	-	topsoil			

B 1

0	-	80	br si tps				
80	-	1.50	br si cl sa -dry to moist, compact				
			s1 at 0.8m	N=10	Su=90		
Soil Sample 1			**Sieve**		**% Passing**		
			4.75mm		100	grain size	
			2.36mm		99.9		
			1.18mm		99.3		
			600um		95.7		
			300um		81.4		
			150um		57.7		
			75um		45.3		
			W		22.2	moisture content	
			ASTM		SC-SM	soil classification	
					18.95	moist unit weight (kN/m3)	
					15.51	dry unit weight (kN/m3)	
1.50	-	4.67	br sa si cl -moist, very stiff				
			s2 at 1.5m	N=12	Su=120		tested for sulphate content
Soil Sample 2			**Sieve**		**% Passing**		
			4.75mm		100	grain size	
			2.36mm		99.9		

			1.18mm	99.5	
			600um	98.3	
			300um	91.3	
			150um	77.8	
			75um	68.4	
			W	28.0	moisture content
			ASTM	CL	soil classification
				18.30	moist unit weight (kN/m3)
				14.30	dry unit weight (kN/m3)

4.67 - 7.56 br si cl sa w gr/cob till -wet, dense
s3 at 5.8m

Soil Sample 3

Sieve	% Passing	
13.2mm	100	grain size
9.50mm	98.3	
4.75mm	94.4	
2.36mm	90.8	
1.18mm	86.9	
600um	82.7	
300um	77.4	
150um	67.6	
75um	54.8	
W	21.0	moisture content
ASTM	CL	soil classification

7.56 NFP, BR, sound BR at 7.56m
- stabilized water level at 3.91m

B 2

0 - 60 br si tps
60 - 1.10 br si cl sa -moist, compact
s5 at 0.8m N=10 tested for disposal criteria

Soil Sample 5

Sieve	% Passing	
4.75mm	100	grain size
2.36mm	99.9	
1.18mm	99.3	
600um	95.1	
300um	79.9	
150um	56.4	
75um	44.1	
W	21.3	moisture content
ASTM	SC-SM	soil classification

1.10 - 3.66 br sa si cl -moist, very stiff
at 1.5m N=14 Su=120
3.66 - 6.25 br si cl sa w gr/cob till -moist, very dense
6.25 NFP, BR, sound BR at 6.25m (1.48MPa pressure applied)
- stabilized water level at 3.91m

B 3

0 - 70 br si tps
70 - 4.72 br sa si cl -moist, very stiff
s6 at 1.5m N=12 Su=140
4.72 - 4.88 br si cl sa w gr/cob till -moist, dense
s7 at 4.8m

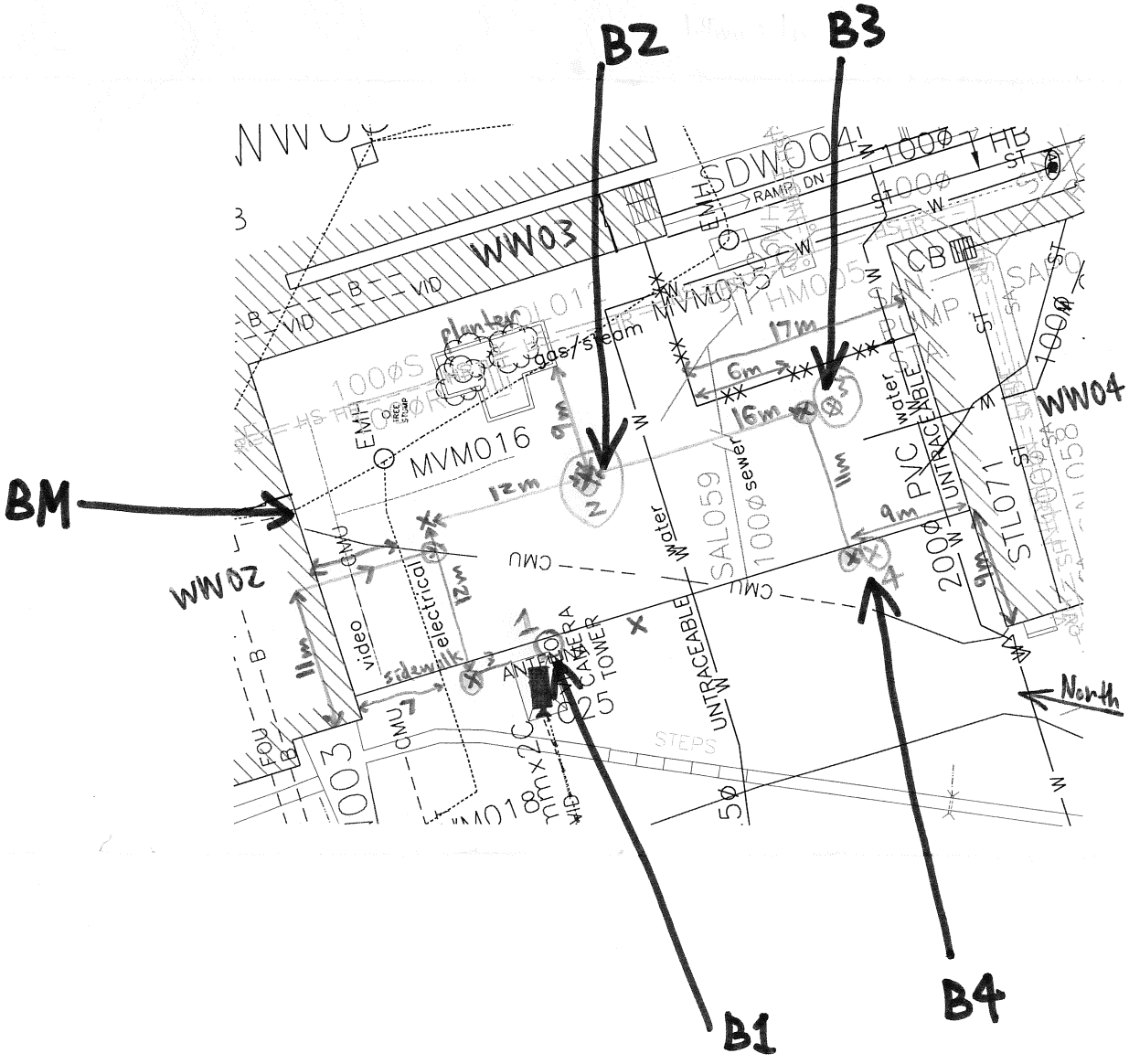
Soil Sample 7

Sieve	% Passing	
19.0mm	100	grain size
13.2mm	94.8	
9.50mm	94.8	
4.75mm	91.0	
2.36mm	85.7	
1.18mm	79.3	
600um	73.3	
300um	66.9	
150um	58.1	
75um	47.8	
W	13.1	moisture content
ASTM	SC-SM	soil classification
	19.81	moist unit weight (kN/m3)
	17.52	dry unit weight (kN/m3)

4.88 - 5.16 dense till/shale BR
5.16 NFP, BR, sound BR at 5.16m
- stabilized water level at 4.88m

B 4

0 - 70 br si tps
70 - 5.03 br sa si cl -moist, very stiff
s8 at 1.5m N=13 Su=150
5.03 - 5.34 br si cl sa w gr/cob till -moist, dense
s9 at 5.1m
5.34 - 5.64 dense till/shale BR
5.64 NFP, BR, sound BR at 5.64m
- stabilized water level at 5.44m


B2
B3
BM
WW02
WW03
WW04
B1
B4
MVM016
MVM015
SDW004
SAL059
STL071
100ø sewer
200ø PVC
UNTRACEABLE
water
gas/steam
electrical
video
sidewalk
planter
ANTENNA
CAMERA
25 TOWER
STEPS
RAMP DN
CB
EMH
North