Peto MacCallum Ltd.
CONSULTING ENGINEERS

FOUNDATION INVESTIGATION AND PRELIMINARY FOUNDATION DESIGN REPORT

for

NEW PATROL YARD
HIGHWAY 69 AT HIGHWAY 637
GWP 5094-06-00
DISTRICT OF SUDBURY, ONTARIO

PETO MacCALLUM LTD.
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PML Ref.: 11KF003
Index No.: 077FIDR
GEOCRES No.: 41I-277
November 11, 2011

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CONSULTING ENGINEERS

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for
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GWP 5094-06-00
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PART A – FOUNDATION INVESTIGATION REPORT

Peto MacCallum Ltd.
CONSULTING ENGINEERS

PART A
FOUNDATION INVESTIGATION REPORT
for
New Patrol Yard
Highway 69 at Highway 637
GWP 5094-06-00
District of Sudbury, Ontario

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1. INTRODUCTION

This report summarises the results of a preliminary foundation investigation carried out for a new Patrol Yard located in the vicinity of the future Highway 69 / Highway 637 interchange within the District of Sudbury, Ontario. The study was conducted for Morrison Hershfield Limited on behalf of the Ministry of Transportation of Ontario (MTO).

Part A of the report provides subsurface information pertaining to a preliminary location of the Patrol Yard building within the proposed site and is considered suitable for planning and preliminary design purposes but should not be used for detail design. A foundation investigation at the final building location may be required.

Information from a preliminary hydrogeological investigation carried out at the site by Peto MacCallum Ltd. (PML), Report Reference No. 07TX045 dated January 6, 2009, GEOCRES No. 41H066 has been used in the preparation of this report.

All elevations in this report are expressed in metres.

2. SITE DESCRIPTION AND GEOLOGY

The site is located to the northwest of the new Highway 69 and Highway 637 interchange, between the new and existing Highway 69 alignments in the Township of Servos, Municipality of Archipelago, Ontario.

The subject site is currently vacant and heavily wooded. The site is located on a well-drained tableland, its central part being relatively flat and sloping down in the east-southeast direction.

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BARRIE, HAMILTON, KITCHENER, TORONTO

A drainage ditch runs along the western boundary of the site parallel to the existing Highway 69. A low-lying swamp area exists along the northwestern part of the site. This site forms part of the Rock Bay drainage area located in the headwaters of the Murdock River (Lovering Lake) watershed.

In general, the mineral soil cover is less than 1 m thick and locally less than 0.2 m thick. There are numerous bedrock outcrops over the area. The site is located within a structural subdivision of the Canadian Precambrian Shield identified as the Grenville Province. In particular, the site is in the Servos Pluton area, where pink and grey gneiss is predominant.

Selected photographs of the site are provided in Appendix A.

3. INVESTIGATION PROCEDURES

The field work for this study was carried out during the period of August 19 to 22, 2011 and comprised 13 boreholes advanced to depths of 0.0 to 3.6 m at the locations shown on Drawing PY-1, attached. Previous boreholes N1, N5D, N5M and N5S were also considered for completeness. Further details are summarised in the following table:

BOREHOLE No.	DEPTH (m)		
	AUGER	ROCK CORE *	TOTAL
F1	0.1	–	0.1
F2	0.0	–	0.0
F3	0.0	3.3	3.3
F4	0.2	–	0.2
F5	0.0	–	0.0
F6	0.4	3.2	3.6
F7	0.4	–	0.4
F8	0.1	–	0.1
F9	0.1	–	0.1
F10	0.0	3.1	3.1
F11	0.8	–	0.8
F12	0.0	3.1	3.1
F13	0.0	–	0.0
N1	0.0	9.3	9.3
N5D	0.1	9.1	9.2
N5M	0.8	6.9	7.7
N5S	0.2	4.5	4.7

* NQ diamond rock coring equipment

The locations of the boreholes were programmed by PML and reviewed by MTO. The actual borehole locations and ground surface elevations at the boreholes were established in the field and provided by Tulloch Geomatics Inc.

The boreholes were advanced using a combination of methods including hand augering, excavating and rotary diamond drilling, powered by a track-mounted CME-850 drill rig supplied and operated by a specialist drilling contractor working under the full-time supervision of a member of our engineering staff. Four boreholes for the current study were extended 3.1 to 3.3 m into bedrock using NQ diamond rock coring equipment.

Soils were identified in the field in accordance with the MTO Soil Classification procedures. All of the recovered soil and rock samples were returned to our laboratory for detailed visual examination and classification. The results of the field investigation are reported on the appended Record of Borehole sheets. A detailed description of the rock cores is given in Table A and in Table CN (Appendix C). Photographs of the rock cores are shown in Appendix B.

The results of four previously drilled boreholes advanced by PML within the proposed building area are included in the PML report No. 07TX045 referenced above. The locations of the boreholes are shown on Drawing PY-1 and their records enclosed in Appendix C.

The groundwater conditions at the borehole locations were assessed during augering or excavating by visual examination of the soil and the sampler as the samples were retrieved and, when appropriate, by measurement of the water level in the open borehole. Upon completion of drilling, the boreholes were backfilled with a bentonite-cement mixture in accordance with the MTO guidelines and Ontario Regulation 903 for borehole abandonment procedures.

4. SUMMARISED SUBSURFACE CONDITIONS

4.1 General

Reference is made to the appended Record of Borehole sheets for details of the subsurface conditions including soil classifications, bedrock descriptions, inferred stratigraphy, boundary elevations and groundwater observations.

The borehole locations and stratigraphic profile prepared from the borehole data are shown on Drawing PY-1. The boundaries between soil strata have been established at the borehole locations only. Between and beyond the boreholes, the boundaries are assumed and may vary.

The subsurface stratigraphy revealed in the boreholes drilled at the site generally comprised exposed bedrock or a surficial topsoil and silty/sandy soils mantling shallow bedrock. Cobbles and boulders were encountered in 2 boreholes. Bedrock was exposed at seven borehole locations at elevation 241.2 to 244.4 and contacted / inferred in the remaining ten boreholes at depths of 0.1 to 0.8 m (elevation 241.0 to 243.6). The strata encountered are summarised below.

4.2 Topsoil

Surficial topsoil was present in boreholes F1, F4, F6 to F9, F11, N5D, N5M and N5S. The silty topsoil was 100 to 200 mm thick and penetrated at elevation 241.6 to 243.9.

4.3 Silt / Silty Sand

Directly beneath the topsoil at depths of 0.1 to 0.2 m (elevation 241.7 to 243.9) in boreholes F4, F6, F7, F11 and N5M was cohesionless silt / silty sand. This unit had a thickness of 100 to 300 mm and was penetrated at depths of 0.2 to 0.4 m (elevation 241.7 to 243.6), with the exception of borehole N5M where the silty sand was 700 mm thick, contained cobbles and boulders and extended to a depth of 0.8 m (elevation 241.0) The moisture content of the silt in borehole F7 was indicative of moist becoming wet conditions just above the bedrock surface (36%).

4.4 Sandy Gravel

A discontinuous layer of sandy gravel was identified below the silt at 0.4 m depth (elevation 243.5) in borehole F11. This layer was 400 mm in thickness and contained cobbles and boulders. The sandy gravel was penetrated at a depth of 0.8 m (elevation 243.1). One grain size analysis carried out on a soil sample indicated a gravel content of 49%, sand content of 39% and silt and clay content of 12%. The water content was 3% indicating dry conditions.

4.5 Bedrock

The depth to and surface elevation of the bedrock identified in the boreholes drilled at the site is summarised in the following table:

BOREHOLE No.	DEPTH TO ROCK (m)	BEDROCK ELEVATION
F1	0.1	241.9
F2	0.0	244.4
F3	0.0*	242.9*
F4	0.2	241.7
F5	0.0	242.7
F6	0.4*	243.6*
F7	0.4	242.8
F8	0.1	242.7
F9	0.1	241.9
F10	0.0*	244.1*
F11	0.8	243.1
F12	0.0*	243.9*
F13	0.0	242.6
N1	0.0*	241.2*
N5D	0.1*	241.7*
N5M	0.8*	241.0*
N5S	0.2*	241.6*

* Confirmed by rock core

Bedrock was exposed at elevation 241.2 to 244.4 in boreholes F2, F3, F5, F10, F12, F13 and N1. In the remaining boreholes, the bedrock surface was confirmed by rock coring or inferred by refusal at depths of 0.1 to 0.8 m (elevation 241.0 to 243.6). The bedrock is generally classified as a grey to dark grey granodiorite gneiss. A detailed description of the rock cores retrieved from boreholes F3, F6, F10 and F12 is given in Table A. For a description of the rock cores retrieved from boreholes N1, N5D, N5M and N5S, refer to Table CN in Appendix C.

The measured core recovery varied between 95 and 100%. The Rock Quality Designation (RQD) determined from the rock cores was in a range of 69 to 100%, locally 50%, indicating a fair to excellent quality rock.

4.6 Groundwater

Groundwater was not observed in any of the current boreholes during or upon completion of drilling. The piezometric water levels in boreholes N1, N5D, N5M and N5S were at depths of 0.9 to 5.2 m below the bedrock surface (elevation 236.0 to 240.3).

Minor seepage of perched water should be locally anticipated at the soil / bedrock interface within depressions in the bedrock surface.

Groundwater levels are subject to seasonal fluctuations and precipitation patterns.

5. MISCELLANEOUS

The field work was carried out under the supervision of Mr. F. Portela, and direction of Mr. G.O. Degil, PhD, P.Eng., Senior Foundation Engineer. The equipment was supplied by Landcore of Chelmsford, Ontario.

The report was prepared by Mr. Grigory O. Degil, PhD, P.Eng., Senior Foundation Engineer and reviewed by Mr. C.M.P. Nascimento, P.Eng., Project Manager. Mr. Brian R. Gray, MEng, P.Eng., MTO Designated Principal Contact carried out an independent review of the report.

TABLE A

ROCK CORE DESCRIPTIONS

CORE RECOVERY					CORE DESCRIPTION	
HOLE NO.	**CORE NO.**	**DEPTH (m)**	**RECOVERY (%)**	**RQD (%)**	**DEPTH (m)**	**DESCRIPTION**
F3	1	0.0 – 1.6	100	94	0.0 – 3.3	GRANODIORITE GNEISS: Grey to dark grey, fine to medium grained, dipping bands, high strength, with 250 mm thick layer of pink pegmatite, coarse crystalline, medium strength, unweathered to slightly weathered, moderate to wide (locally very close to close) spaced flat to dipping cross joints, rough planar, tight to slightly altered with red iron oxide on partings, good to excellent quality.
	2	1.6 – 3.3	95	78		
F6	1	0.4 – 2.0	100	92	0.4 – 3.6	GRANODIORITE GNEISS: Grey to dark grey, fine to medium grained, dipping bands, high strength, unweathered to slightly weathered, close to moderate becoming wide spaced flat to dipping cross joints, rough planar, tight to slightly altered (locally friable) with red iron oxide on partings, minor silt in some joints, excellent quality.
	2	2.0 – 3.6	98	98		
F10	1	0.0 – 1.6	100	90	0.0 – 3.1	GRANODIORITE GNEISS: Grey to dark grey, fine to medium grained, dipping bands, high strength, unweathered to slightly weathered, close to moderate (locally very close) spaced flat to dipping cross joints, rough planar, tight to slightly altered with red iron oxide scale on partings, minor silt in some joints, excellent quality.
	2	1.6 – 3.1	100	100		
F12	1	0.0 – 1.6	100	97	0.0 – 3.1	GRANODIORITE GNEISS: Grey to dark grey, fine to medium grained, dipping bands, high strength, unweathered, close to wide (locally very close) spaced flat to dipping cross joints, rough planar, tight to slightly altered with minor silt in some joints, excellent quality.
	2	1.6 – 3.1	100	96		

NOTE: RQD = Rock Quality Designation

Originated: JFW
Compiled: FP
Checked: GD/ CN

EXPLANATION OF TERMS USED IN REPORT

N VALUE: THE STANDARD PENETRATION TEST (SPT) N VALUE IS THE NUMBER OF BLOWS REQUIRED TO CAUSE A STANDARD 51mm O.D. SPLIT BARREL SAMPLER TO PENETRATE 0.3m INTO UNDISTURBED GROUND IN A BOREHOLE WHEN DRIVEN BY A HAMMER WITH A MASS OF 63.5kg, FALLING FREELY A DISTANCE OF 0.76m. FOR PENETRATIONS OF LESS THAN 0.3m N VALUES ARE INDICATED AS THE NUMBER OF BLOWS FOR THE PENETRATION ACHIEVED. AVERAGE N VALUE IS DENOTED THUS $\bar{N}$.

DYNAMIC CONE PENETRATION TEST: CONTINUOUS PENETRATION OF A CONICAL STEEL POINT (51mm O.D. 60° CONE ANGLE) DRIVEN BY 475 J IMPACT ENERGY ON 'A' SIZE DRILL RODS. THE RESISTANCE TO CONE PENETRATION IS MEASURED AS THE NUMBER OF BLOWS FOR EACH 0.3m ADVANCE OF THE CONICAL POINT INTO THE UNDISTURBED GROUND.

SOILS ARE DESCRIBED BY THEIR COMPOSITION AND CONSISTENCY OR DENSENESS.

COMPOSITION: SECONDARY SOIL COMPONENTS ARE DESCRIBED ON THE BASIS OF PERCENTAGE BY MASS OF THE WHOLE SAMPLE AS FOLLOWS:

PERCENT BY MASS	0 – 10	10 – 20	20 – 30	30 – 40	> 40
	TRACE	*SOME*	*WITH*	*ADJECTIVE (SILTY)*	*AND (AND SILT)*

CONSISTENCY: COHESIVE SOILS ARE DESCRIBED ON THE BASIS OF THEIR UNDRAINED SHEAR STRENGTH (c_u) AS FOLLOWS:

c_u (kPa)	0 - 12	12 - 25	25 - 50	50 - 100	100 - 200	>200
	VERY SOFT	*SOFT*	*FIRM*	*STIFF*	*VERY STIFF*	*HARD*

DENSENESS: COHESIONLESS SOILS ARE DESCRIBED ON THE BASIS OF DENSENESS AS INDICATED BY SPT N VALUES AS FOLLOWS:

N (BLOWS/0.3m)	0 - 5	5 - 10	10 - 30	30 - 50	>50
	VERY LOOSE	*LOOSE*	*COMPACT*	*DENSE*	*VERY DENSE*

ROCKS ARE DESCRIBED BY THEIR COMPOSITION AND STRUCTURAL FEATURES AND / OR STRENGTH.

RECOVERY: SUM OF ALL RECOVERED ROCK CORE PIECES FROM A CORING RUN EXPRESSED AS A PERCENT OF THE TOTAL LENGTH OF THE CORING RUN.

MODIFIED RECOVERY: SUM OF THOSE INTACT CORE PIECES, 100mm+ IN LENGTH EXPRESSED AS A PERCENT OF THE LENGTH OF THE CORING RUN. THE ROCK QUALITY DESIGNATION (R Q D), FOR MODIFIED RECOVERY, IS:

RQD (%)	0 - 25	25 - 50	50 - 75	75 - 90	90 - 100
	VERY POOR	*POOR*	*FAIR*	*GOOD*	*EXCELLENT*

JOINTING AND BEDDING:

SPACING	50mm	50 - 300mm	0.3m - 1m	1m - 3m	>3m
JOINTING	*VERY CLOSE*	*CLOSE*	*MOD. CLOSE*	*WIDE*	*VERY WIDE*
BEDDING	*VERY THIN*	*THIN*	*MEDIUM*	*THICK*	*VERY THICK*

ABBREVIATIONS AND SYMBOLS

FIELD SAMPLING

S S	SPLIT SPOON	T P	THINWALL PISTON
W S	WASH SAMPLE	O S	OSTERBERG SAMPLE
S T	SLOTTED TUBE SAMPLE	R C	ROCK CORE
B S	BLOCK SAMPLE	P H	T W ADVANCED HYDRAULICALLY
C S	CHUNK SAMPLE	P M	T W ADVANCED MANUALLY
T W	THINWALL OPEN	F S	FOIL SAMPLE
F V	FIELD VANE		

STRESS AND STRAIN

u_w	kPa	PORE WATER PRESSURE
r_u	1	PORE PRESSURE RATIO
σ	kPa	TOTAL NORMAL STRESS
σ'	kPa	EFFECTIVE NORMAL STRESS
τ	kPa	SHEAR STRESS
$\sigma_1, \sigma_2, \sigma_3$	kPa	PRINCIPAL STRESSES
ϵ	%	LINEAR STRAIN
$\epsilon_1, \epsilon_2, \epsilon_3$	%	PRINCIPAL STRAINS
E	kPa	MODULUS OF LINEAR DEFORMATION
G	kPa	MODULUS OF SHEAR DEFORMATION
μ	1	COEFFICIENT OF FRICTION

MECHANICAL PROPERTIES OF SOIL

m_v	kPa^{-1}	COEFFICIENT OF VOLUME CHANGE
C_c	1	COMPRESSION INDEX
C_s	1	SWELLING INDEX
C_α	1	RATE OF SECONDARY CONSOLIDATION
c_v	m^2/s	COEFFICIENT OF CONSOLIDATION
H	m	DRAINAGE PATH
T_v	1	TIME FACTOR
U	%	DEGREE OF CONSOLIDATION
σ'_{vo}	kPa	EFFECTIVE OVERBURDEN PRESSURE
σ'_p	kPa	PRECONSOLIDATION PRESSURE
τ_f	kPa	SHEAR STRENGTH
c'	kPa	EFFECTIVE COHESION INTERCEPT
ϕ'	-°	EFFECTIVE ANGLE OF INTERNAL FRICTION
c_u	kPa	APPARENT COHESION INTERCEPT
ϕ_u	-°	APPARENT ANGLE OF INTERNAL FRICTION
τ_R	kPa	RESIDUAL SHEAR STRENGTH
τ_r	kPa	REMOULDED SHEAR STRENGTH
S_t	1	SENSITIVITY = $\frac{c_u}{\tau_r}$

PHYSICAL PROPERTIES OF SOIL

ρ_s	kg/m^3	DENSITY OF SOLID PARTICLES
γ_s	kN/m^3	UNIT WEIGHT OF SOLID PARTICLES
ρ_w	kg/m^3	DENSITY OF WATER
γ_w	kN/m^3	UNIT WEIGHT OF WATER
ρ	kg/m^3	DENSITY OF SOIL
γ	kN/m^3	UNIT WEIGHT OF SOIL
ρ_d	kg/m^3	DENSITY OF DRY SOIL
γ_d	kN/m^3	UNIT WEIGHT OF DRY SOIL
ρ_{sat}	kg/m^3	DENSITY OF SATURATED SOIL
γ_{sat}	kN/m^3	UNIT WEIGHT OF SATURATED SOIL
ρ'	kg/m^3	DENSITY OF SUBMERGED SOIL
γ'	kN/m^3	UNIT WEIGHT OF SUBMERGED SOIL
e	1,%	VOID RATIO
n	1,%	POROSITY
w	1,%	WATER CONTENT
S_r	%	DEGREE OF SATURATION
w_L	%	LIQUID LIMIT
w_P	%	PLASTIC LIMIT
w_S	%	SHRINKAGE LIMIT
I_P	%	PLASTICITY INDEX = $w_L - w_P$
I_L	1	LIQUIDITY INDEX = $\frac{w - w_P}{I_P}$
I_C	1	CONSISTENCY INDEX = $\frac{w_L - w}{I_P}$
DTPL		DRIER THAN PLASTIC LIMIT
APL		ABOUT PLASTIC LIMIT
WTPL		WETTER THAN PLASTIC LIMIT
e_{max}	1,%	VOID RATIO IN LOOSEST STATE
e_{min}	1,%	VOID RATIO IN DENSEST STATE
I_D	1	DENSITY INDEX = $\frac{e_{max} - e}{e_{max} - e_{min}}$
D	mm	GRAIN DIAMETER
D_n	mm	n PERCENT - DIAMETER
C_U	1	UNIFORMITY COEFFICIENT
h	m	HYDRAULIC HEAD OR POTENTIAL
q	m^3/s	RATE OF DISCHARGE
v	m/s	DISCHARGE VELOCITY
i	1	HYDRAULIC GRADIENT
k	m/s	HYDRAULIC CONDUCTIVITY
j	kN/m^3	SEEPAGE FORCE

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Foundation Design

RECORD OF BOREHOLE No F1 1 of 1 METRIC

G.W.P. 5094-06-00 LOCATION Coords: 5 121 095.9 N ; 322 011.1 E ORIGINATED BY G.I.

DIST Sudbury HWY 69 BOREHOLE TYPE Manual Probing COMPILED BY G.D.

DATUM Geodetic DATE August 19, 2011 CHECKED BY C.N.

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa: ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
242.0	Ground Surface										
0.0	Topsoil										
241.9	End of borehole										
0.1	Refusal on probable bedrock										
	Borehole coincides with pavement test hole TH36										
	* Borehole dry										

+7 , ×5 : Numbers refer to Sensitivity

20 / 15 5 / 10 (%) STRAIN AT FAILURE

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RECORD OF BOREHOLE No F2 1 of 1 METRIC

G.W.P. 5094-06-00 LOCATION Coords: 5 121 078.0 N ; 322 030.0 E ORIGINATED BY G.I.

DIST Sudbury HWY 69 BOREHOLE TYPE Manual Probing COMPILED BY G.D.

DATUM Geodetic DATE August 19, 2011 CHECKED BY C.N.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P — NATURAL MOISTURE CONTENT w — LIQUID LIMIT w_L / WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						GR SA SI CL
244.4	Ground Surface										
0.0	Bedrock at surface										
	Borehole coincides with pavement test hole TH42										
	* Borehole dry										

+7, ×5 : Numbers refer to Sensitivity

20 / 15 — 5 / 10 (%) STRAIN AT FAILURE

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RECORD OF BOREHOLE No F3 1 of 1 METRIC

G.W.P. 5094-06-00 LOCATION Coords: 5 121 057.0 N ; 322 048.0 E ORIGINATED BY F.P.

DIST Sudbury HWY 69 BOREHOLE TYPE Rotary Diamond Drilling COMPILED BY G.D.

DATUM Geodetic DATE August 22, 2011 CHECKED BY C.N.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P NATURAL MOISTURE CONTENT w LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	*					GR SA SI CL
242.9	Ground Surface										
0.0	Granodiorite Gneiss bedrock Unweathered to slightly weathered Medium strength Good to excellent quality		1	RC NQ	REC 100%		242				RQD 94%
			2	RC NQ	REC 95%		241				RQD 78%
239.6							240				
3.3	End of borehole										

* Borehole charged with drilling water

+7, ×5 : Numbers refer to Sensitivity

20 / 15 5 / 10 (%) STRAIN AT FAILURE

Ontario

Peto MacCallum Ltd. CONSULTING ENGINEERS

Foundation Design

RECORD OF BOREHOLE No F4 1 of 1 METRIC

G.W.P. 5094-06-00 LOCATION Coords: 5 121 092.0 N ; 321 990.0 E ORIGINATED BY F.P.

DIST Sudbury HWY 69 BOREHOLE TYPE Manual Probing COMPILED BY G.D.

DATUM Geodetic DATE August 19, 2011 CHECKED BY C.N.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						GR SA SI CL
241.9	Ground Surface					*					
241.8 0.0	Topsoil										
241.7 0.2	Silt, some sand Brown Moist End of borehole Refusal on probable bedrock										

* Borehole dry

+7, ×5 : Numbers refer to Sensitivity

20 / 15 5 / 10 (%) STRAIN AT FAILURE

Ontario

Peto MacCallum Ltd. CONSULTING ENGINEERS

Foundation Design

RECORD OF BOREHOLE No F5 1 of 1 METRIC

G.W.P. 5094-06-00 LOCATION Coords: 5 121 081.9 N ; 321 996.9 E ORIGINATED BY G.I.

DIST Sudbury HWY 69 BOREHOLE TYPE Manual Probing COMPILED BY G.D.

DATUM Geodetic DATE August 19, 2011 CHECKED BY C.N.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P — NATURAL MOISTURE CONTENT w — LIQUID LIMIT w_L / WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	*				kN/m³	GR SA SI CL
242.7	Ground Surface										
0.0	Bedrock at surface										
	Borehole coincides with pavement test hole TH37										
	* Borehole dry										

+7, ×5 : Numbers refer to Sensitivity

20 / 15 — 5 / 10 (%) STRAIN AT FAILURE

Ontario

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RECORD OF BOREHOLE No F6 1 of 1 METRIC

G.W.P. 5094-06-00 LOCATION Coords: 5 121 064.9 N ; 322 015.8 E ORIGINATED BY F.P.

DIST Sudbury HWY 69 BOREHOLE TYPE Rotary Diamond Drilling COMPILED BY G.D.

DATUM Geodetic DATE August 22, 2011 CHECKED BY C.N.

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS *	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa: ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
244.0	Ground Surface										
243.9 / 0.1	Topsoil										
243.6 / 0.4	Silty sand, rootlets Red/ brown Moist Granodiorite Gneiss bedrock Unweathered to slightly weathered High strength Excellent quality		1	RC NQ	REC 100%		243				RQD 92%
							242				
			2	RC NQ	REC 98%		241				RQD 98%
240.4 / 3.6	End of borehole										

* Borehole charged with drilling water

+7, ×5 : Numbers refer to Sensitivity

20 / 15 — 5 / 10 (%) STRAIN AT FAILURE

Ontario

Peto MacCallum Ltd. CONSULTING ENGINEERS

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RECORD OF BOREHOLE No F7 1 of 1 METRIC

G.W.P. 5094-06-00 LOCATION Coords: 5 121 045.0 N ; 322 034.0 E ORIGINATED BY G.I.

DIST Sudbury HWY 69 BOREHOLE TYPE Manual Probing COMPILED BY G.D.

DATUM Geodetic DATE August 19, 2011 CHECKED BY C.N.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						GR SA SI CL
243.2	Ground Surface										
243.1 / 0.0	Topsoil										
242.8 / 0.4	Silt trace to some sand Grey to light brown Moist to wet		1	GS	-	*	243		○		
	End of borehole Refusal on probable bedrock										
	Borehole coincides with pavement test hole TH49										
	* Borehole dry										

ON MTO_VER3 NEW LOGO 11KF003.GPJ ON_MOT.GDT 10/11/2011 12:52:19 PM

+7, ×5 : Numbers refer to Sensitivity

20 / 15 — 5 / 10 (%) STRAIN AT FAILURE

Ontario

Peto MacCallum Ltd. CONSULTING ENGINEERS
Foundation Design

RECORD OF BOREHOLE No F8 1 of 1 METRIC

G.W.P. 5094-06-00 LOCATION Coords: 5 121 035.0 N ; 322 039.1 E ORIGINATED BY G.I.

DIST Sudbury HWY 69 BOREHOLE TYPE Manual Probing COMPILED BY G.D.

DATUM Geodetic DATE August 19, 2011 CHECKED BY C.N.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						GR SA SI CL
242.8	Ground Surface					*					
0.0	Topsoil										
242.7	End of borehole										
0.1	Refusal on probable bedrock										
	Borehole coincides with pavement test hole TH51										
	* Borehole dry										

+7, ×5 : Numbers refer to Sensitivity

20 / 15 5 / 10 (%) STRAIN AT FAILURE

Ontario

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RECORD OF BOREHOLE No F9 1 of 1 METRIC

G.W.P. 5094-06-00 LOCATION Coords: 5 121 080.9 N ; 321 979.0 E ORIGINATED BY G.I.

DIST Sudbury HWY 69 BOREHOLE TYPE Manual Probing COMPILED BY G.D.

DATUM Geodetic DATE August 19, 2011 CHECKED BY C.N.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						GR SA SI CL
242.0	Ground Surface					*					
0.0	Topsoil										
241.9	End of borehole										
0.1	Refusal on probable bedrock										
	* Borehole dry										

+7, ×5 : Numbers refer to Sensitivity

20 / 15 5 / 10 (%) STRAIN AT FAILURE

Ontario

Peto MacCallum Ltd. CONSULTING ENGINEERS

Foundation Design

RECORD OF BOREHOLE No F10 1 of 1 METRIC

G.W.P. 5094-06-00 LOCATION Coords: 5 121 066.9 N ; 321 981.9 E ORIGINATED BY F.P.

DIST Sudbury HWY 69 BOREHOLE TYPE Rotary Diamond Drilling COMPILED BY G.D.

DATUM Geodetic DATE August 22, 2011 CHECKED BY C.N.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						GR SA SI CL
244.1	Ground Surface					*					
0.0	Granodiorite Gneiss bedrock Unweathered to slightly weathered High strength Excellent quality		1	RC NQ	REC 100%		244 243				RQD 90%
			2	RC NQ	REC 100%		242 241				RQD 100%
241.0 3.1	End of borehole										

* Borehole charged with drilling water

+7, ×5 : Numbers refer to Sensitivity

20 / 15 5 / 10 (%) STRAIN AT FAILURE

Ontario

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RECORD OF BOREHOLE No F11 1 of 1 METRIC

G.W.P. 5094-06-00 LOCATION Coords: 5 121 049.1 N ; 322 001.1 E ORIGINATED BY G.I.

DIST Sudbury HWY 69 BOREHOLE TYPE Manual Probing COMPILED BY G.D.

DATUM Geodetic DATE August 19, 2011 CHECKED BY C.N.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						GR SA SI CL
243.9	Ground Surface					*					
243.7 0.0	Topsoil										
243.5 0.2	Silt, some gravel trace sand, rootlets										
0.4			1	GS	-				○		49 39 (12)
243.1 0.8	Red/ brown to light brown Moist										
	Sandy gravel, some silt cobbles and boulders										
	Light brown Dry										
	End of borehole										
	Refusal on probable bedrock										
	Borehole coincides with pavement test hole TH44										
	* Borehole dry										

+7 , ×5 : Numbers refer to Sensitivity

20 / 15 5 / 10 (%) STRAIN AT FAILURE

Ontario

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RECORD OF BOREHOLE No F12 1 of 1 METRIC

G.W.P. 5094-06-00 LOCATION Coords: 5 121 038.5 N ; 322 011.2 E ORIGINATED BY F.P.

DIST Sudbury HWY 69 BOREHOLE TYPE Rotary Diamond Drilling COMPILED BY G.D.

DATUM Geodetic DATE August 22, 2011 CHECKED BY C.N.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P NATURAL MOISTURE CONTENT w LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	*					GR SA SI CL
243.9	Ground Surface										
0.0	Granodiorite Gneiss bedrock Unweathered High strength Excellent quality		1	RC NQ	REC 100%		243				RQD 97%
			2	RC NQ	REC 100%		242				RQD 96%
240.8							241				
3.1	End of borehole										

* Borehole charged with drilling water

NOTE: Approximately 200mm of silty topsoil removed by excavator for access purposes.

+7, ×5 : Numbers refer to Sensitivity

(%) STRAIN AT FAILURE

Ontario

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Foundation Design

RECORD OF BOREHOLE No F13 1 of 1 METRIC

G.W.P. 5094-06-00 LOCATION Coords: 5 121 023.0 N ; 322 027.0 E ORIGINATED BY G.I.

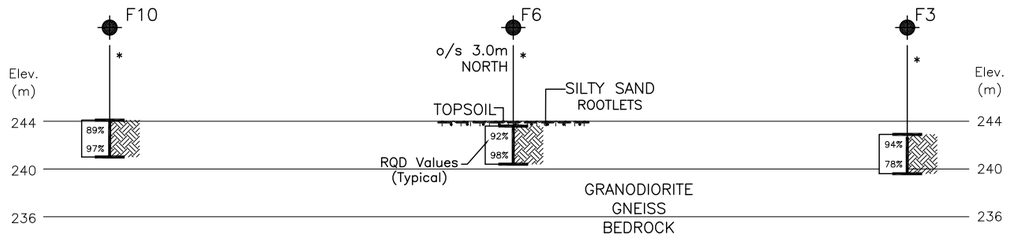
DIST Sudbury HWY 69 BOREHOLE TYPE Manual Probing COMPILED BY G.D.

DATUM Geodetic DATE August 19, 2011 CHECKED BY C.N.

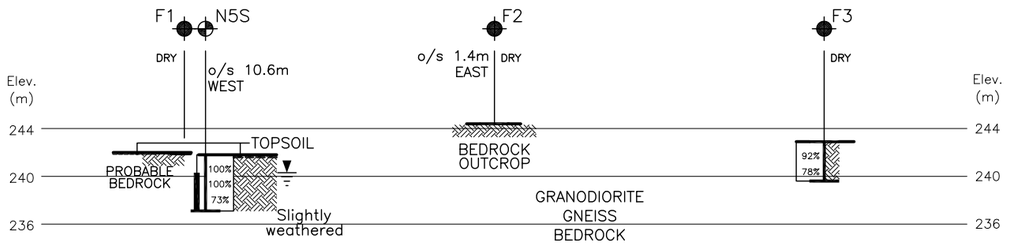
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						GR SA SI CL
242.6	Ground Surface					*					
0.0	Bedrock at surface										
	Borehole coincides with pavement test hole TH52										
	* Borehole dry										

+7 , ×5 : Numbers refer to Sensitivity

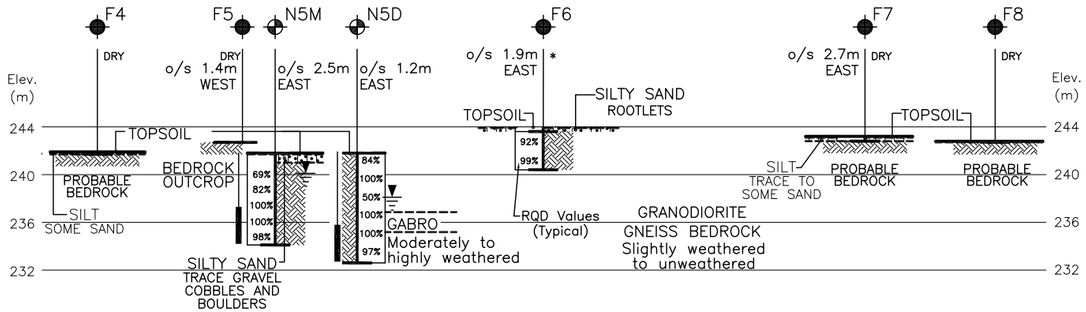
20 / 15 5 / 10 (%) STRAIN AT FAILURE



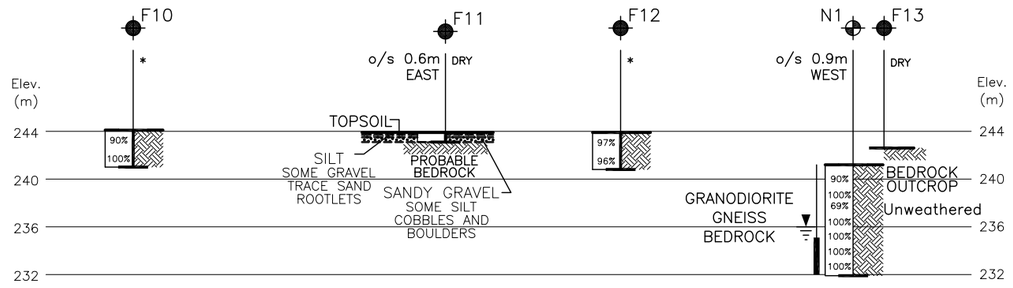
SECTION A–A



SECTION B–B



SECTION C–C



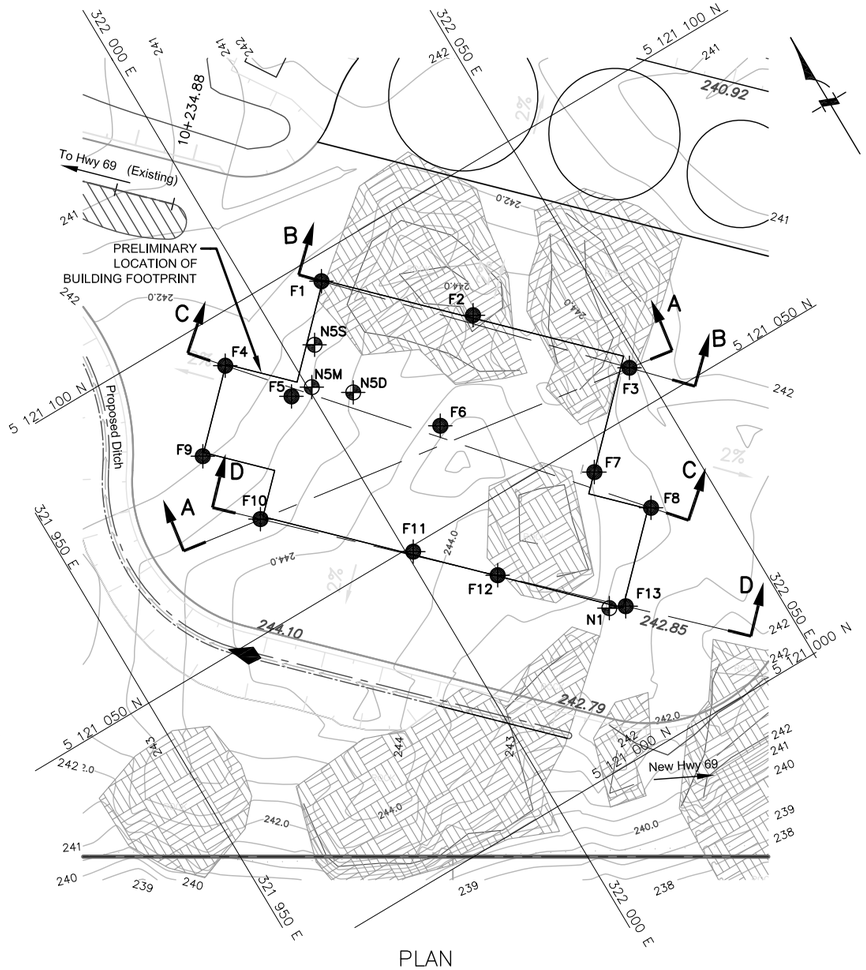
SECTION D–D

SCALE

5 0 5 10m

NOTES:

1. THIS DRAWING SHOULD BE READ IN CONJUCTION WITH THE TEXT AND RECORD OF BOREHOLE LOGS.
2. THIS DRAWING IS FOR SUBSURFACE INFORMATION ONLY. SURFACE DETAILS AND FEATURES ARE FOR CONCEPTUAL ILLUSTRATION.
3. DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN. STATIONS ARE IN KILOMETRES AND METRES.



PLAN

SCALE

10 0 10 20m

(Legend Continued)

BH No	ELEVATION	CO–ORDINATES	
		NORTHINGS	EASTINGS
N1	241.2	5 121 024	322 025
N5D	241.8	5 121 077	322 006
N5M	241.8	5 121 081	322 001
N5S	241.8	5 121 087	322 005

CONT No
GWP No 5094–06–00

NEW PATROL YARD
HIGHWAY 69 AND HIGHWAY 637
BOREHOLE LOCATIONS AND SOIL STRATA

SHEET

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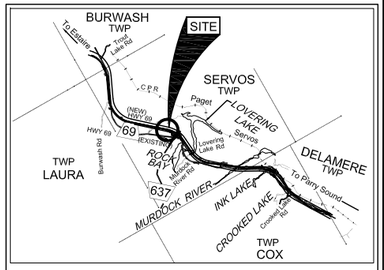
CONSULTING ENGINEERS



KEY PLAN
SCALE
2 0 2 4 6km

LEGEND

- Borehole for present investigation
- Borehole from previous investigation
- N Blows/0.3m (Std. Pen Test, 475 J/blow)
- CONE Blows/0.3m (60° Cone, 475 J/blow)
- WH Penetration due to weight of hammer and rods
- * Water level not established
- W L at time of investigation August 2008 and August 2010
- Head
- ARTESIAN WATER Encountered
- PIEZOMETER

BH No	ELEVATION	CO–ORDINATES	
		NORTHINGS	EASTINGS
F1	242.0	5 121 095.9	322 011.1
F2	244.4	5 121 078.0	322 030.0
F3	242.9	5 121 057.0	322 048.0
F4	241.9	5 121 092.0	321 990.0
F5	242.7	5 121 081.9	321 996.9
F6	244.0	5 121 064.9	322 015.8
F7	243.2	5 121 045.0	322 034.0
F8	242.8	5 121 035.0	322 039.1
F9	242.0	5 121 080.9	321 979.0
F10	244.1	5 121 066.9	321 981.9
F11	243.9	5 121 049.1	322 001.1
F12	243.9	5 121 038.5	322 011.2
F13	242.6	5 121 023.0	322 027.0

(Legend Continues)

REGISTERED PROFESSIONAL ENGINEER
C M P Nascimento
Nov. 11, 2011
PROVINCE OF ONTARIO

REGISTERED PROFESSIONAL ENGINEER
B. R. GRAY
Nov. 11, 11
PROVINCE OF ONTARIO

REFERENCE – MORRISON & HERSHFIELD DRAWINGS:
Conceptual Site Grading Plan for Hwy 69 Patrol Yard.dwg
and topo–11–4504 (H–PLAN 500m).dwg; dated July 2011.

– NOTE –
The boundaries between soil strata have been established only at Borehole locations. Between Boreholes the boundaries are assumed from geological evidence.

REVISIONS			
	DATE	BY	DESCRIPTION

Geocres No. 41I–277

HWY No 69				DIST Sudbury
SUBM'D NA	CHECKED GD	DATE NOV. 11, 2011	SITE ––	
DRAWN NA	CHECKED CN	APPROVED BRG	DWG PY–1	

APPENDIX A

Site Photographs

Photograph 1: General view of the site across from Highway 69 looking northeast.

Photograph 2: Close-up view of the site from Photograph 1 location. Note numerous boulders and rock outcrops amongst the vegetation in the foreground.

Photograph 3: General view of the site. Rock outcrops covered by thin topsoil and loose cobbles are visible throughout.

Photograph 4: Borehole F12, facing west, exposed bedrock under stake and to the south.

APPENDIX B

Rock Core Photographs

Photograph 1: Borehole F3, samples RC-1 and RC-2 from 0.0 to 3.3 m depth. The RQD values were 94 and 78%, indicating good to excellent quality bedrock.

Photograph 2: Borehole F6, samples RC-1 and RC-2 from 0.4 to 3.6 m depth. The RQD values were 92 and 98%, indicating excellent quality bedrock.

Photograph 3: Borehole F10, samples RC-1 and RC-2 from 0.0 to 3.1 m depth. The RQD values were 90 and 100%, indicating excellent quality bedrock.

Photograph 4: Borehole F12, samples RC-1 and RC-2 from 0.0 to 3.1 m depth. The RQD values were 97 and 96%, indicating excellent quality bedrock.

APPENDIX C

Results of Previous Investigation at the Site (GEOCRES No. 41H-66)

- Record of Borehole Sheets
- Table CN – Rock Core Description
- Core Photos 1 to 18
- Drawing 3N - Borehole Locations Plan

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RECORD OF BOREHOLE No N1

1 of 1

METRIC

G.W.P. 5094-06-00 LOCATION Co-ords: 5 121 024 N; 322 025 E ORIGINATED BY F.P.

DIST 54 HWY 69 BOREHOLE TYPE NQ DIAMOND CORING COMPILED BY J.W.

DATUM Geodetic DATE August 20, 2008 CHECKED BY M.A.

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
241.2	Ground Surface										
0.0	Granodiorite Gneiss Bedrock Unweathered High strength Fair to excellent quality		1	RC NQ	REC 100%	*	241				RQD 90%
			2	RC NQ	REC 100%		240				RQD 100%
			3	RC NQ	REC 97%		239				RQD 69%
			4	RC NQ	REC 100%		238				RQD 100%
			5	RC NQ	REC 100%		237				RQD 100%
			6	RC NQ	REC 100%		236				RQD 100%
			7	RC NQ	REC 100%		235				RQD 100%
231.9							234				
9.3	End of borehole						233				
							232				

* Borehole charged with drilling water

PIEZOMETER LEGEND:

- Concrete
- Bentonite seal
- Filter sand
- Screen

Water Level Readings:

Date	Depth (m)	Elev.
08/27/08	5.2	236.0

+7 ,X5 : Numbers refer to Sensitivity

20 / 15 5 / 10 (%) STRAIN AT FAILURE

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RECORD OF BOREHOLE No N2 1 of 1 METRIC

G.W.P. 5094-06-00 LOCATION Co-ords: 5 121 069 N; 321 899 E ORIGINATED BY F.P.

DIST 54 HWY 69 BOREHOLE TYPE NQ DIAMOND CORING COMPILED BY J.W.

DATUM Geodetic DATE August 21, 2008 CHECKED BY M.A.

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
240.7	Ground Surface										
0.0	Topsoil										
0.1	Granodiorite Gneiss Bedrock Slightly weathered High strength Fair to excellent quality		1	RC NQ	REC 100%		240				RQD 86%
			2	RC NQ	REC 100%		239				RQD 65%
			3	RC NQ	REC 100%		238				RQD 80%
			4	RC NQ	REC 100%		237				RQD 89%
			5	RC NQ	REC 100%		236				RQD 100%
232.9			6	RC NQ	REC 100%		235				RQD 100%
7.8	End of borehole						234				
							233				

* Borehole charged with drilling water

PIEZOMETER LEGEND:
- Concrete
- Bentonite seal
- Filter sand
- Screen

Water Level Readings:

Date	Depth (m)	Elev.
08/27/08	2.4	238.3

ON_MOT VER3 07TX045I-N.GPJ ON_MOT.GDT 10/27/2008 7:33:29 AM

$+^{7}$, $\times^{5}$: Numbers refer to Sensitivity

20 / 15 5 / 10 (%) STRAIN AT FAILURE

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Ontario

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RECORD OF BOREHOLE No N3 1 of 1 METRIC

G.W.P. 5094-06-00 LOCATION Co-ords: 5 121 180 N; 321 902 E ORIGINATED BY F.P.

DIST 54 HWY 69 BOREHOLE TYPE NQ DIAMOND CORING COMPILED BY J.W.

DATUM Geodetic DATE August 21, 2008 CHECKED BY M.A.

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
239.6	Ground Surface										
0.0	Granodiorite Gneiss Bedrock Unweathered High strength Excellent quality		2	RC NQ	REC 96%	*	239				RQD 96%
			2	RC NQ	REC 100%						RQD 100%
			3	RC NQ	REC 100%		238 237				RQD 100%
			4	RC NQ	REC 100%		236 235				RQD 100%
			5	RC NQ	REC 100%		234				RQD 100%
			6	RC NQ	REC 100%		233 232				RQD 100%
231.7											
7.9	End of borehole										

* Borehole charged with drilling water

PIEZOMETER LEGEND:
- Concrete
- Bentonite seal
- Filter sand
- Screen

Water Level Readings:

Date	Depth (m)	Elev.
08/27/08	1.4	238.2

$+^{7}$, $\times^{5}$: Numbers refer to Sensitivity

20 / 15 — 5 / 10 (%) STRAIN AT FAILURE

Ministry of Transportation
Ontario

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RECORD OF BOREHOLE No N4 1 of 1 METRIC

G.W.P. 5094-06-00 LOCATION Co-ords: 5 121 104 N; 322 098 E ORIGINATED BY F.P.

DIST 54 HWY 69 BOREHOLE TYPE NQ DIAMOND CORING COMPILED BY J.W.

DATUM Geodetic DATE August 19 and 20, 2008 CHECKED BY M.A.

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT W_P / NATURAL MOISTURE CONTENT W / LIQUID LIMIT W_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
240.4	Ground Surface										
0.0	Granodiorite Gneiss Bedrock Slightly weathered High strength Fair to excellent quality		1	RC NQ	REC 100%	*	240				RQD 70%
			2	RC NQ	REC 95%		239				RQD 85%
			3	RC NQ	REC 100%		238				RQD 100%
			4	RC NQ	REC 98%		237				RQD 91%
			5	RC NQ	REC 98%		236				RQD 97%
233.7							235				
6.7	End of borehole						234				

* Borehole charged with drilling water

PIEZOMETER LEGEND:

- Concrete
- Bentonite seal
- Filter sand
- Screen

Water Level Readings:

Date	Depth (m)	Elev.
08/27/08	6.5	233.9

+7, ×5: Numbers refer to Sensitivity

20 / 15 5 / 10 (%) STRAIN AT FAILURE

Ministry of Transportation
Ontario

Peto MacCallum Ltd.
Foundation Design

RECORD OF BOREHOLE No N5D 1 of 1 METRIC

G.W.P. 5094-06-00 LOCATION Co-ords: 5 121 077 N; 322 006 E ORIGINATED BY F.P.

DIST 54 HWY 69 BOREHOLE TYPE NQ DIAMOND CORING COMPILED BY J.W.

DATUM Geodetic DATE August 18 and 19, 2008 CHECKED BY M.A.

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
241.8	Ground Surface										
0.0	Topsoil										
0.1	Granodiorite Gneiss Bedrock Slightly weathered to unweathered High strength Good to excellent becoming fair quality		1	RC NQ	REC 98%		241				RQD 84%
			2	RC NQ	REC 100%		240				RQD 100%
							239				
			3	RC NQ	REC 100%		238				RQD 50%
							237				
			4	RC NQ	REC 100%		236				RQD 100%
	Gabro Bedrock Moderately to highly weathered Medium to high strength Fair quality		5	RC NQ	REC 100%		235				RQD 100%
	Granodiorite Gneiss Bedrock Slightly weathered to unweathered High strength Excellent quality		6	RC NQ	REC 97%		234				RQD 97%
232.6							233				
9.2	End of borehole										

* Borehole charged with drilling water

PIEZOMETER LEGEND:
- Concrete
- Bentonite seal
- Filter sand
- Screen

Water Level Readings:

Date	Depth (m)	Elev.
08/27/08	3.7	238.1

ON_MOT VER3 07TX045I-N.GPJ ON_MOT.GDT 10/27/2008 7:33:36 AM

+7, ×5: Numbers refer to Sensitivity

15 — 20 / 10 — 5 (%) STRAIN AT FAILURE

Ministry of Transportation
Ontario

Peto MacCallum Ltd.
Foundation Design

RECORD OF BOREHOLE No N5M 1 of 1 METRIC

G.W.P. 5094-06-00 LOCATION Co-ords: 5 121 081 N; 322 001 E ORIGINATED BY F.P.

DIST 54 HWY 69 BOREHOLE TYPE NQ DIAMOND CORING COMPILED BY J.W.

DATUM Geodetic DATE August 15, 2008 CHECKED BY M.A.

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
241.8	Ground Surface										
0.0 / 0.1	Topsoil										
	Silty sand, trace gravel cobble and boulders										
241.0 / 0.8	Granodiorite Gneiss Bedrock Slightly weathered to unweathered High strength Fair to excellent quality		1	RC NQ	REC 98%	*	241				RQD 69%
			2	RC NQ	REC 95%		240				RQD 82%
			3	RC NQ	REC 100%		239				RQD 100%
			4	RC NQ	REC 100%		238				RQD 100%
			5	RC NQ	REC 98%		237				RQD 98%
234.1 / 7.7	End of borehole						236				
							235				

* Borehole charged with drilling water

PIEZOMETER LEGEND:
- Concrete
- Bentonite seal
- Filter sand
- Screen

Water Level Readings:

Date	Depth (m)	Elev.
08/27/08	1.7	240.1

ON_MOT VER3 07TX045I-N.GPJ ON_MOT.GDT 10/27/2008 7:33:38 AM

+7, ×5: Numbers refer to Sensitivity

20 / 15 5 / 10 (%) STRAIN AT FAILURE

Ministry of Transportation
Ontario

Peto MacCallum Ltd.
Foundation Design

RECORD OF BOREHOLE No N5S 1 of 1 METRIC

G.W.P. 5094-06-00 LOCATION Co-ords: 5 121 087 N; 322 005 E ORIGINATED BY F.P.

DIST 54 HWY 69 BOREHOLE TYPE NQ DIAMOND CORING COMPILED BY J.W.

DATUM Geodetic DATE August 19, 2008 CHECKED BY M.A.

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
241.8	Ground Surface										
0.0	Topsoil										
0.2	Granodiorite Gneiss Bedrock Slightly weathered High strength Excellent becoming fair quality		1	RC NQ	REC 100%	*	241				RQD 100%
			2	RC NQ	REC 100%		240				RQD 100%
							239				
			3	RC NQ	REC 98%		238				RQD 73%
237.1											
4.7	End of borehole										

* Borehole charged with drilling water

PIEZOMETER LEGEND:
- Concrete
- Bentonite seal
- Filter sand
- Screen

Water Level Readings:

Date	Depth (m)	Elev.
08/27/08	1.5	240.3

+7, ×5: Numbers refer to Sensitivity

20 / 15 5 / 10 (%) STRAIN AT FAILURE

TABLE CN
ROCK CORE DESCRIPTION

CORE RECOVERY						CORE DESCRIPTION	
MW/BH	**RC**	**DEPTH (m)**	**REC (%)**	**RQD (%)**	**RMR**	**DEPTH (m)**	**DESCRIPTION**
N1	1 2 3 4 5 6 7	0.0 – 1.6 1.6 – 1.9 1.9 – 3.4 3.4 – 4.9 4.9 – 6.4 6.4 – 7.9 7.9 – 9.3	100 100 97 100 100 100 100	90 100 69 100 100 100 100	61 64 52 64 64 64 79	0.0 – 9.3	GRANODIORITE GNEISS: Grey to dark grey, fine to medium grained, dipping bands, with layer of pink pegmatite, high strength, unweathered, close to moderate (locally very closely) spaced flat to dipping cross joints, rough planar, tight to slightly altered with red iron oxide scale on partings, minor silt in some joints, fair to excellent quality.
N2	1 2 3 4 5 6	0.1 – 1.7 1.7 – 3.3 3.3 – 4.7 4.7 – 6.1 6.1 – 7.3 7.3 – 7.8	100 100 100 100 100 100	86 65 80 89 100 100	47 53 56 71 74 74	0.1 – 7.8	GRANODIORITE GNEISS: Pink to grey, medium grained, locally garnetiferous, high strength, slightly weathered, generally moderate to wide spaced (locally very closely to closely spaced) flat to dipping cross joints, rough planar, oxidized (variously with red, green and yellow staining) to slightly altered with silt on some partings. Also with occasional vertical partings, up to 5 mm wide, partially infilled with red and white secondary mineralization and partially voided, fair to excellent quality.
N3	1 2 3 4 5 6	0.0 – 1.3 1.3 – 1.6 1.6 – 3.2 3.2 – 4.8 4.8 – 6.4 6.4 – 7.9	96 100 100 100 100 100	96 100 100 100 100 100	79 79 79 79 79 79	0.0 – 7.9	GRANODIORITE GNEISS: Grey, fine to medium grained, with coarse, pegmatic texture at depth, high strength, unweathered, generally moderate to wide spaced (locally closely to moderately spaced) flat to dipping cross joints, rough planar, tight to slightly altered, with muscovite concentrations at some partings, excellent quality.
N4	1 2 3 4 5	0.0 – 1.6 1.6 – 2.1 2.1 – 3.7 3.7 – 5.2 5.2 – 6.7	100 95 100 98 98	70 85 100 91 97	52 71 50 74 74	0.0 – 6.7	GRANODIORITE GNEISS: Grey, fine to medium grained, high strength, slightly weathered, generally moderate to wide spaced (locally very closely to closely spaced) flat to dipping cross joints, rough planar, oxidized to slightly altered, occasional vertical partings with minor silt on surface, fair to excellent quality.

Notes:

MW/BH = Borehole RC = Core Run REC = Recovery RQD: Rock Quality Designation RMR = Rock Mass Rating

Drilled: August 19, 2008

Logged: September 11, 2008

Originated: FP
Compiled: JFW
Checked: MA

TABLE CN
ROCK CORE DESCRIPTION

CORE RECOVERY						CORE DESCRIPTION	
MW/BH	**RC**	**DEPTH (m)**	**REC (%)**	**RQD (%)**	**RMR**	**DEPTH (m)**	**DESCRIPTION**
N5D	1 2 3 4 5 6	0.0 – 1.6 1.6 – 3.2 3.2 – 4.7 4.7 – 6.1 6.1 – 7.7 7.7 – 9.2	98 100 100 100 100 97	84 100 50 100 100 97	61 74 52 32 74 79	0.0 – 5.6 5.6 – 7.2 7.2 – 9.2	GRANODIORITE GNEISS: Grey, medium grained, high strength, slightly weathered to unweathered, closely to widely spaced dipping cross joints, rough planar, tight to oxidized, locally sandy with brown scale on partings, good to excellent becoming fair quality. GABRO: Black, fine grained, medium to high strength, very closely to moderately spaced dipping partings, oxidized to slightly altered, locally sandy, with 100 mm and 50 mm thick dipping layers of rust brown schist near upper contact, low strength, moderately to highly weathered, red oxidation on partings, fair quality. GRANODIORITE GNEISS: As above, moderately to widely spaced flat to dipping cross joints, rough planar, oxidized to slightly altered, with red or green residue on partings, excellent quality.
N5M	1 2 3 4 5	0.8 – 1.9 1.9 – 3.3 3.3 – 4.6 4.6 – 6.4 6.4 – 7.7	98 95 100 100 98	69 82 100 100 98	38 36 79 64 60	0.8 – 7.7	GRANODIORITE GNEISS: Grey, medium grained, dipping bands, with layers of black gabro, high strength, slightly weathered to unweathered, very closely to closely, becoming moderately to widely spaced dipping cross joints, rough planar, oxidized to slightly altered, with 75 mm thick dipping layer of rust brown schist, low strength, moderately to highly weathered, red oxidation on partings, fair to excellent quality.
N5S	1 2 3	0.2 – 1.7 1.7 – 3.3 3.3 – 4.7	100 100 98	100 100 73	64 50 38	0.2 – 4.7	GRANODIORITE GNEISS: Grey, fine to medium grained, high strength, slightly weathered, closely to moderately spaced (locally very closely spaced) flat to dipping cross joints, rough planar, slightly altered to sandy, locally 1 to 2 mm wide, with red to brown silt residue on partings, excellent becoming fair quality.

Notes:

MW/BH = Borehole RC = Core Run REC = Recovery RQD: Rock Quality Designation RMR = Rock Mass Rating

Drilled: August 19, 2008

Logged: September 11, 2008

Originated: FP
Compiled: JFW
Checked: MA

Core Photo 1: Borehole N1, Run 1 to 4, 0.0 to 4.2 m.

Core Photo 2: Borehole N1, Run 5, 6 and bottom part of Run 4, 4.2 to 7.9 m.

Core Photo 3: Borehole N1, Run 7, 7.9 to 9.3 m.

Core Photo 4: Borehole N2, Run 1 to 3, 0.1 to 4.4 m.

Core Photo 5: Borehole N2, Run 2, Close up view showing vertical partings upto 5 mm wide with secondary mineralization.

Core Photo 6: Borehole N2, Run 4 to 6 and Bottom Part of Run 3, 4.4 to 7.8 m.

Core Photo 7: Borehole N3, Run 1 to 3, 0.0 to 3.2 m.

Core Photo 8: Borehole N3, Run 4 and 5, 3.2 to 6.4 m.

Core Photo 9: Borehole N4, Run 1 to 3, 0.0 to 3.7 m.

Core Photo 10: Borehole N4, Run 4 and 5, 3.7 to 6.7 m.

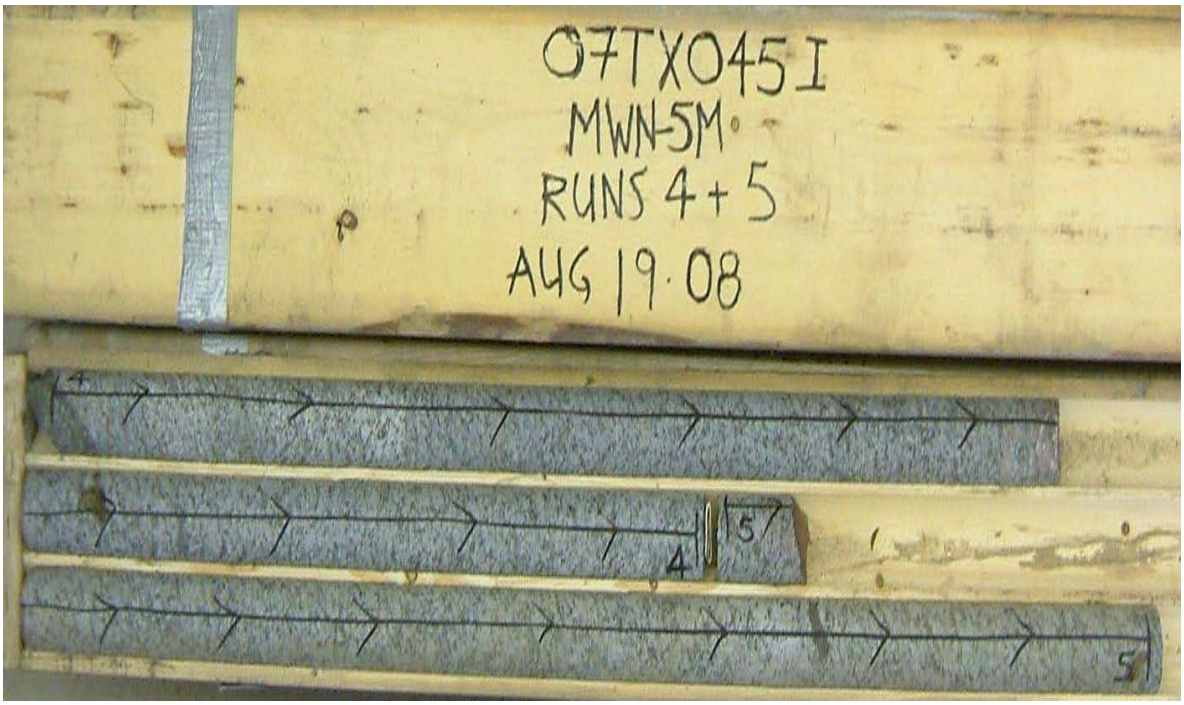
Core Photo 11: Borehole N5D, Run 1 and 2, 0.0 to 3.2 m.

Core Photo 12: Borehole N5D, Run 3 and 4, 3.2 to 6.1 m.

Core Photo 13: Borehole N5D, Run 5 and 6, 6.1 to 9.2 m.

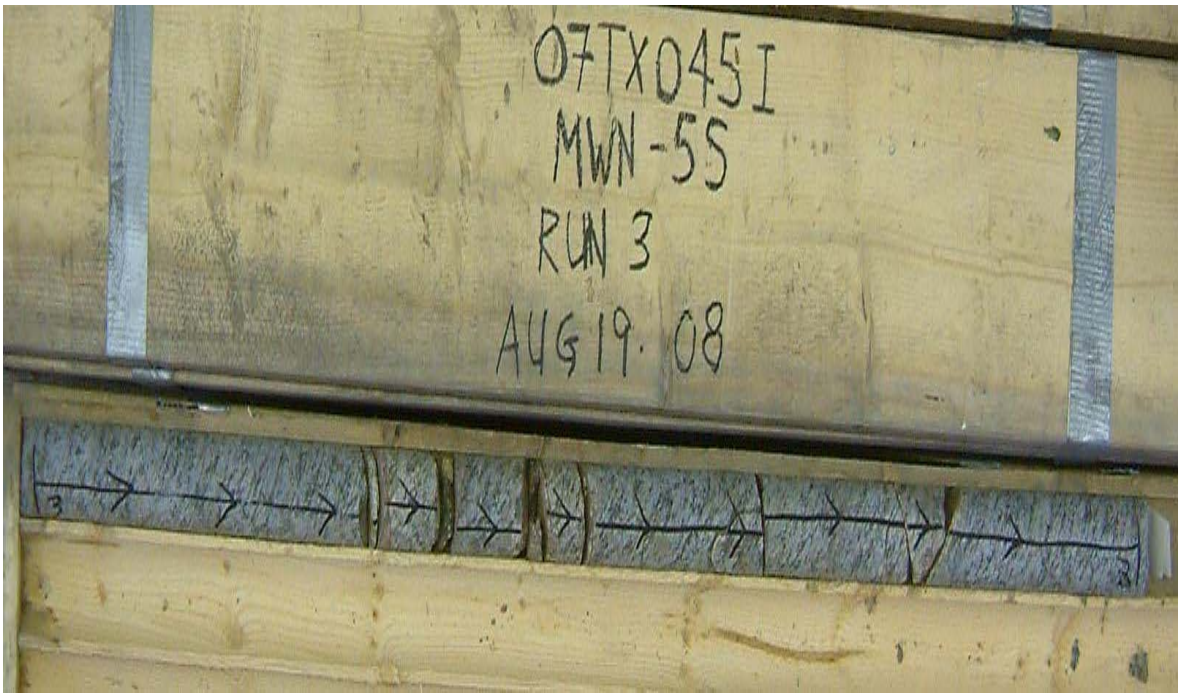
Core Photo 14: Borehole N5M, Run 1 to 3, 0.8 to 4.6 m.

Core Photo 15: Borehole N5M, Close up view of Run 2 showing oxidation and weathering.



Core Photo 16: Borehole N5M, Run 4 and 5, 4.6 to 7.7 m.

Core Photo 17: Borehole N5S, Run 1 and 2, 0.2 to 3.3 m.



Core Photo 18: Borehole N5S, Run 3, 3.3 to 4.7 m.

METRIC

DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN. STATIONS

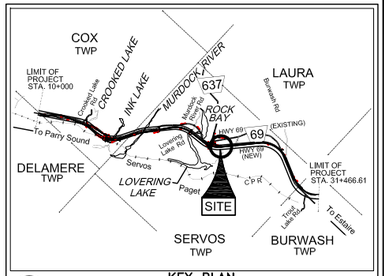
CONT No
GWP No 5094-06-00

HIGHWAY 69

PHASE II ENVIRONMENTAL SITE ASSESSMENT
HIGHWAYS 69 AND 637 – NORTH SITE N2
BOREHOLE AND SOIL SAMPLE LOCATIONS PLAN

SHEET

Peto MacCallum Ltd.
CONSULTING ENGINEERS

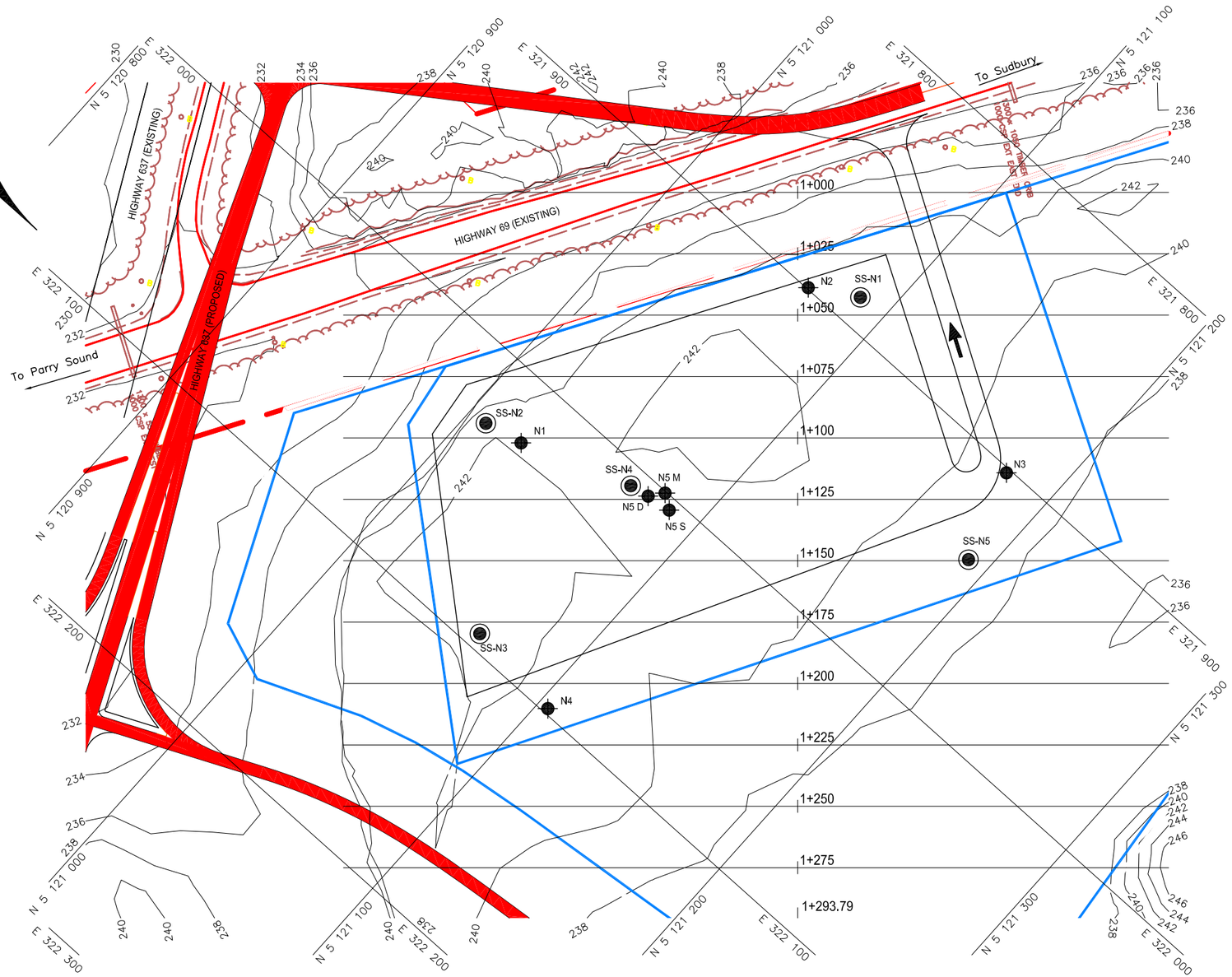


KEY PLAN
SCALE
2 0 2 4 6km

LEGEND

- Borehole with monitoring well
- Surface soil sample location

BH No	ELEVATION	CO-ORDINATES	
		NORTHINGS	EASTINGS
N1	241.2	5 121 024	322 025
N2	240.7	5 121 069	321 899
N3	239.6	5 121 180	321 902
N4	240.4	5 121 104	322 098
N5 M	241.8	5 121 081	322 001
N5 D	241.8	5 121 077	322 006
N5 S	241.8	5 121 087	322 005



PLAN
SCALE
20 0 20 40m

(Legend Continues)

– NOTE –
The boundaries between soil strata have been established only at Borehole locations. Between Boreholes the boundaries are assumed from geological evidence.

NOTE:

1. THIS DRAWING IS FOR SUBSURFACE INFORMATION ONLY. SURFACE DETAILS AND FEATURES ARE FOR CONCEPTUAL ILLUSTRATION..

REF No. STANTEC DRAWINGS:
625_Design_North_Interchange_637_CAN83-12_PIC2.dwg dated July 25, 2008 and North_Contours_Rev.dwg dated August 05, 2008

REGISTERED PROFESSIONAL ENGINEER B. R. GRAY Dec. 18, 2008 PROVINCE OF ONTARIO

LICENSED PROFESSIONAL ENGINEER H. S. MORTAZAVI Dec. 18, 2008 PROVINCE OF ONTARIO

REVISIONS		
DATE	BY	DESCRIPTION

Geocres No. XXX-XXX

HWY No	69			DIST	54
SUBM'D	MA	CHECKED MA	DATE DEC. 18, 2008	SITE	--
DRAWN	NA	CHECKED MHM	APPROVED BRG	DWG	1

PRELIMINARY FOUNDATION DESIGN REPORT

for

NEW PATROL YARD
HIGHWAY 69 AT HIGHWAY 637
GWP 5094-06-00
DISTRICT OF SUDBURY, ONTARIO

PETO MacCALLUM LTD.
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PML Ref.: 11KF003
Index No.: 077FIDR
GEOCRES No.: 41I-277
November 11, 2011

TABLE OF CONTENTS

PART B – PRELIMINARY FOUNDATION DESIGN REPORT

6. ENGINEERING RECOMMENDATIONS

6.1 General

Part B of the report provides preliminary foundation engineering comments and recommendations regarding the design and construction of the building facilities for a new patrol yard located in the vicinity of the future Highway 69 / Highway 637 interchange within the District of Sudbury, Ontario.

The proposed patrol yard is envisaged to accommodate an office building, interior and exterior garages for highway snow plows, a sand and salt storage facility and an equipment and service yard (ref. 'Conceptual Site Grading Plan for Hwy 69 Patrol Yard' drawing prepared by Morrison Hershfield Limited in July 2011). Details of the final proposed facilities were not available at the time of preparation of this report.

The current concept includes an irregular building footprint approximately 40 m wide and 70 m long. It is understood that the design-build team may prepare different concepts including a final site grading resulting in cuts or fills above the existing site elevations.

The recommendations in this report are preliminary and based on PML's interpretation of the factual information obtained from a limited number of boreholes and outlined in Part A of the report. The recommendations are only provided for planning and preliminary design purposes.

All elevations in this report are expressed in metres. A list of the standard specifications referenced in the report is provided in Table 1, attached.

6.2 Foundations

6.2.1 General

Based on the borehole data, supporting the proposed structures on spread footings founded on either bedrock or structural fill is recommended. Use of deep foundations is not considered to be practical due to shallow bedrock at this site.

The building foundations should be checked / designed to resist uplift caused by wind loads.

The floor slab of the building, in particular the salt / sand storage area and the garage areas should be provided with a membrane designed to prevent the migration of salt and hydrocarbon contaminants and allow for their capture and removal if required. The structural design of the floor slab / pavement of the salt / sand storage area will be prepared under the Pavement Engineering scope of work.

The seismic site coefficient for the stratigraphic conditions at this site is 1.0 (Type I soil profile as per clause 4.4.6 of the Canadian Highway Bridge Design Code (CHBDC), CAN/CSA-S6-06, November 2006).

Since there is either exposed bedrock or a soil cover of less than 1 m thickness at the borehole locations, it is considered that liquefaction of the soil and rock is unlikely to occur (refer to clause 4.6.2 of the CHBDC).

6.2.2 Footings

6.2.2.1 General

Use of conventional spread footings founded on either bedrock or structural fill placed directly on bedrock is considered to be the preferred means of supporting the proposed structures at the site.

The bearing resistance for inclined loads should be reduced in accordance with the requirements of clause 6.7.4 of the CHBDC.

All footings subject to frost action should be provided with 2.0 m of earth cover or equivalent thermal insulation. A 25 mm thick layer of polystyrene insulation is thermally equivalent to 600 mm of soil cover. Footings bearing directly on bedrock do not require protection from frost.

Construction of the footings should be performed and monitored in accordance with OPSS 902 to verify the competency of the founding surface.

6.2.2.2 Footings Constructed on Bedrock

Spread footings bearing on the bedrock should be designed using a factored bearing resistance at ultimate limit states (ULS) of 10,000 kPa, subject to geotechnical inspection during construction. Considering the bedrock to be non-yielding, the design will not be governed by settlement criteria since the loading required to produce 25 mm deformation is much larger than the factored capacity at ULS.

The anticipated depths / elevations to bedrock at this site are tabulated in section 4.5. The bedrock surface is variable and ranges from elevation 241.0 to 244.4 at the borehole locations. Mass concrete could be placed to provide a level founding surface for the footings. Alternatively, the rock surface could be "stepped" to follow variations in the bedrock surface elevation, thereby creating a level subgrade by a combination of rock excavation and placement of mass concrete.

Mass concrete could also be employed to raise the subgrade to the design level of the footings. The need to expand the plan area at the base of the mass concrete to provide for stress distribution (2V:1H), place reinforcing steel in the mass concrete and/or use high strength concrete to prevent overstressing will be dictated by the actual thickness of the mass concrete and structural design considerations.

Subject to these comments, the bearing resistance provided for footings bearing on bedrock is considered to be appropriate for mass concrete with an unconfined compressive strength of at least 35 MPa.

Comments concerning excavation of bedrock if required to enable construction of the footings are provided in subsequent sections of the report.

The horizontal force imposed on the foundations will be resisted in part by the friction force developed between the underside of the footing and the bedrock. If the concrete for footings is poured directly on the surface of the bedrock (bedrock surface not roughened by excavation/construction activities), an unfactored friction factor of 0.6 should be employed. A value of 0.7 may be used for a roughened bedrock surface (asperity height of at least 25 mm) created by mechanical means or during rock excavation.

The lateral resistance of footings founded on bedrock could be enhanced by means of a shear key and/or by installing dowels / anchors into the bedrock (SP 999S26). The increased lateral resistance will be provided by the shear strength of steel dowels if used, the horizontal resistance of the bedrock, the horizontal component of tensile forces developed in any inclined anchors and/or a greater frictional resistance between the footing and rock if the anchors are prestressed to increase the vertical pressure. The factored horizontal resistance at ULS of the bedrock is considered to be 5000 kPa.

If anchors are installed for design of uplift resistance, consideration should be given to the presence of dipping cross joints in the bedrock. A factored bond stress at the rock/grout interface of 1.4 MPa at ULS (a resistance factor of 0.4 is applied for a minimum 35 MPa grout) is recommended for design. The anchors should extend a minimum 30 bar diameters into sound bedrock and be spaced at a distance of at least four times the diameter of the anchor hole. The total capacity of a group of closely spaced anchors may be less than the summed capacities of the individual anchors; the impact of anchor interaction should therefore be assessed if the spacing is less than one-fifth of the anchor length. Design, installation and testing of the anchors subjected to tensile stresses should be conducted in accordance with SP 999S26 and clause 6.10.4 of the CHBDC.

6.2.2.3 Footings Constructed on Structural Fill

Spread footings constructed on structural fill placed directly on bedrock could also be employed to support the foundation loads. The structural fill should comprise OPSS Granular A material placed in maximum 200 mm thick lifts, compacted to 100% of the ASTM D-698 (standard Proctor) maximum dry density and extended laterally to a line inclined downwards at 45° to the horizontal originating at least 1 m from the top of the footing.

Minimum frost protection as recommended in section 6.2.2.1 should be provided.

The recommended bearing resistance for spread footings constructed on structural fill (bearing resistance independent of fill thickness due to shallow bedrock at this site) is as follows:

Factored Geotechnical Resistance at ULS	=	900 kPa
Geotechnical Resistance at SLS	=	350 kPa

The geotechnical resistance at SLS normally allows for 25 mm of compression of the founding medium. Differential settlement is expected to be less than 75% of this value. A footing embedment depth of 2.0 m was assumed for computation of the geotechnical resistances.

The horizontal force imposed on the foundations will be resisted in part by the friction developed between the underside of the footing and the structural fill. An unfactored friction factor of 0.7 is recommended for footings on granular fill.

6.3 Slab-on-Grade Considerations

The structural design of the sand / salt storage area will be carried out as a roadway pavement.

Construction of the floor slab as a concrete slab-on-grade for the garage and office areas on the undisturbed native soils / bedrock or an engineered fill pad is considered to be feasible.

It is recommended that topsoil and other deleterious materials be removed from the building footprint. The exposed subgrade should then be prepared in accordance with OPSS 902.

Fill placed under the slab to achieve finished subgrade levels should comprise approved material placed in accordance with OPSS 501 (Method A) and compacted to at least 100% of the standard Proctor maximum dry density.

A minimum 200 mm thick layer of well compacted 19 mm clear crushed stone or equivalent is typically recommended directly beneath concrete floor slabs for bedding purposes and as a vapour barrier. If a moisture sensitive floor finish is to be provided, extra vapour barrier may be necessary. A heavy duty polyethylene (or PVC) sheeting may be installed between the concrete slab and the compacted granular base to act as the vapour barrier. This requirement should be

selected by the Design-Build team considering the specification of the floor finish product and the thickness of concrete floor slab.

If the concrete slab is in an unheated area, it is recommended that the slab-on-grade be placed on a layer of high-density closed-cell insulation or equivalent (such as Styrofoam) with a thickness selected to make up the frost protection requirement previously indicated in this report.

The floor slab should be structurally separated from the foundation walls and columns. Control joints should be provided along column lines and at regular intervals to minimise temperature cracks and to allow for any differential movement of the floor slab.

6.4 Geomembrane Considerations

The Design-Build team should consider the design of the floor slab base material, vapour barrier and environmental membrane. The environmental membrane should extend at least under the sand/salt storage and garage areas. Monitoring wells to verify the future conditions above and below the environmental membrane should be provided in the design.

Details of the remedial measures and monitoring were provided in the Site Selection Study Report prepared by Stantec Consulting Ltd. and dated November 2008, GWP 5094-06-00. For ease of reference, an extract of the document from page 64 is enclosed as Appendix FDR-1. Notwithstanding the recommendations, care should be taken to follow the product manufacturer recommendations for installation to avoid possible warranty conflicts.

6.5 Construction Considerations

6.5.1 Excavation

Excavation for construction of the structure foundations if supported on strip or column footings founded on bedrock will extend locally through silty/sandy soils to depths less than 1 m. Excavation of the native soils is expected to be relatively straightforward. All work should be carried out in accordance with the Occupational Health and Safety Act (OHSA) and local regulations.

The native silty/sandy soils at the site and granular fill materials placed for grading purposes are classified as Type 3 soils according to OHSA (Ontario Regulation 213/91) criteria. Therefore, temporary cut slopes over the full depth of excavation should be inclined at 45° to the horizontal. The need to excavate flatter sideslopes if soft/wet materials or concentrated seepage zones are encountered locally should be considered.

Excavation of bedrock will likely necessitate conventional rock excavation techniques such as blasting (OPSS 120, General Specification for the Use of Explosives, August 1994), machine or manual scaling (SP 299F03 or 299F05), trim or controlled blasting (SP 299F04 or 299F06) and jack-hammering. The actual equipment required and method of excavation within the bedrock is dependent upon the geometry of cut and relative depth of excavation into the bedrock.

It is important that blasting / excavation of the rock is controlled to prevent fracturing and/or disturbance of the bedrock surface on which footings will be founded. A large excavator equipped with a tiger-toothed bucket in conjunction with a jack-hammer or hoe ram is the preferred method of excavation to shallow depths in rock at foundation locations.

Near vertical sidewalls may be utilised for excavations in bedrock if required. Examination of the sidewalls and removal of any loosened rock fragments should be carried out continually for the safety of workmen.

6.5.2 Groundwater Control

Groundwater was not observed in any of the boreholes during or upon completion of drilling. Seepage should be locally anticipated at the soil/bedrock interface within depressions in the bedrock surface. It is considered that seepage of groundwater and surface water run-off into the excavations will be handled by conventional sump pumping techniques.

Groundwater levels are subject to seasonal fluctuations and rainfall patterns.

7. CLOSURE

The report was prepared by Mr. Grigory O. Degil, PhD, P.Eng., Senior Foundation Engineer and reviewed by Mr. C.M.P. Nascimento, P.Eng., Project Manager. Mr. Brian R. Gray, MEng, P.Eng., MTO Designated Principal Contact carried out an independent review of the report.

Sincerely

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TABLE 1

LIST OF STANDARD SPECIFICATIONS REFERENCED IN REPORT

DOCUMENT	TITLE
OPSS 120	General Specification for the Use of Explosives
OPSS 501	Construction Specification for Compacting
OPSS 902	Construction Specification for Excavation and Backfilling – Structures
SP 299F03	Rock Excavation (Machine Scaling)
SP 299F04	Rock Excavation (Trim Blasting)
SP 299F05	Rock Excavation (Manual Scaling)
SP 299F06	Rock Excavation (Controlled Blasting)
SP 999S26	Requirements for Design, Installation and Testing of Temporary and Permanent Pre-Stressed Anchors in Soil and Rock

APPENDIX FDR-1

Recommendations for Remedial Measures and Monitoring
(extracted from "Site Selection Report,
Highway 69 Patrol Yards from Parry Sound to Sudbury")
prepared by Stantec Consulting Ltd., GWP 5094-06-00
dated November 2008

5.5.7.3 Recommendations for Remedial Measures and Monitoring

The remedial measures and monitoring are to be incorporated in the design of the new Patrol Yards to avoid, minimize and/or mitigate the potential environmental impacts.

The preliminary hydrogeological recommendations are based on the key concepts described in the Ministry of Transportation's *Environmental Guide for Patrol Yard Design.*

Remedial Measures

To avoid, minimize and/or mitigate the potential impacts on the groundwater and surface water bodies on the site and in the surrounding areas, the salt-impacted water (drainage, wash water, potential/brine release, or fuel and waste oil leakages/spills) should be contained and properly managed by the following measures:

- The Patrol Yard site, equipment and vehicle repair garage (with oil separators) and fuel storage and dispensing areas will be constructed on pads consisting of:
  - A geomembrane liner placed on a prepared smooth and sloped (for positive drainage) subgrade
  - A free draining (sand) drainage bed about 0.5 m thick should be placed on top of the geomembrane
  - A network of perforated subdrains connected to a solid header pipe should be placed downgradient of the subgrade and above the geomembrane within the sand bed
  - The top of the sand bed where the facilities are to be installed should be paved with positive drainage
- The surface drainage facilities, such as drainage ditches, pipes, and catch basins within the above-noted areas or receiving run-off from those areas will be within the above described pads

Monitoring Wells and Surface Water Sampling Points

After the design is finalized and the site is prepared, monitoring wells and monitoring points will be established in the upstream (upgradient) surrounding areas where remedial measures are to be constructed, and downgradient areas near the site boundaries for seasonal groundwater and surface water sampling and chemical analysis (four times per year). A quarterly monitoring program report should be prepared which will have to include the factual field and laboratory data as well as an assessment of the remedial measures performance objectives.