Peto MacCallum Ltd.
CONSULTING ENGINEERS

FOUNDATION INVESTIGATION AND DESIGN REPORT

for

HIGHWAY 69 / SERVICE ROAD UNDERPASS
W.P. 5131-08-01
MAGNETAWAN FIRST NATION, ONTARIO

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PML Ref.: 09TF042-IC
Index No.: 377FIR and 378FDR
GEOCRES No.: 42H-144
February 4, 2015

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for
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Magnetawan First Nation, Ontario
W.P. 5131-08-01

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1. INTRODUCTION

This report summarises the results of a foundation investigation carried out for the proposed construction of an underpass to carry Service Road traffic over Highway 69 in Magnetawan First Nation, Ontario. The investigation was conducted for AECOM Canada Ltd. (AECOM) on behalf of the Ministry of Transportation of Ontario (MTO).

The underpass is at approximate Station 20+688, Highway 69 chainage, in Magnetawan First Nation (ref. General Arrangement Drawing 1 'Highway 69 NBL / SBL Magnetawan IC Underpass' prepared by AECOM in September 2011).

The report provides subsurface information pertaining to the proposed structure and approaches within about 20 m of the abutments.

All elevations in this report are expressed in meters.

2. SITE DESCRIPTION AND GEOLOGY

The site is situated about 90 km south of Sudbury in a wooded region with open swampy areas. Land use includes limited farming and forestry exploration. Highway 69 is situated on a new alignment and oriented in the south-north direction at the underpass location. The main activity is related to tourism and recreation, especially near the Magnetawan River crossing, with numerous fishing and hunting lodges, camps, marinas and hotels. Site photographs are included in Appendix A.

The study area is located in the physiographic region known as the Georgian Bay Fringe that includes a bedrock plain comprising exposed bedrock knobs, subordinate glacial till moraine and a peat / muck organic terrain over bedrock.

At the site, the topography is irregular in detail with extensive rock outcrops. Soil cover over the rock outcrops is typically less than 1 m. The soils were deposited by glacial Lake Algonquin and later partly by Lake Nipissing. Numerous boulders are present at the site.

Metasedimentary rocks of the Huronian Supergroup and gneisses of the Grenville Province underlie the alignment. The area has undergone considerable folding, intrusive activity, regional metamorphism and faulting. The bedrock in the immediate vicinity of the site is at shallow depths ranging from surface to about 1.5 m.

3. INVESTIGATION PROCEDURES

The field work for this study was carried out during the period of July 25 to August 28, 2013 and comprised 27 boreholes drilled to depths of 0.0 to 4.7 m at the locations shown on Drawing IC-S1, attached. Boreholes IC-7 and IC-8 from the high fill investigation at the west and east approach embankments to the underpass have been used to supplement the subsurface information. Further details are summarised in the following table:

LOCATION	BOREHOLE No.	DEPTH (m)		
		AUGER / CONE	ROCK CORE	TOTAL
West Approach	IC-7	1.8	–	1.8
West Abutment	WA-1	1.5	3.2	4.7
	WA-2	0.9	–	0.9
	WA-3	0.4	3.7	4.1
	WA-4	0.8	–	0.8
	WA-5	0.2	–	0.2
	WA-6	0.8	–	0.8
	WA-7	0.4	3.5	3.9
	WA-8	0.2	–	0.2
	WA-9	0.0	3.1	3.1

LOCATION	BOREHOLE No.	DEPTH (m)		
		AUGER / CONE	ROCK CORE	TOTAL
Pier	CP-1	0.3	3.2	3.5
	CP-2	0.2	–	0.2
	CP-3	0.0	4.7	4.7
	CP-4	0.3	–	0.3
	CP-5	0.1	–	0.1
	CP-6	0.7	–	0.7
	CP-7	0.3	3.4	3.7
	CP-8	0.2	–	0.2
	CP-9	0.1	4.0	4.1
East Abutment	EA-1	0.0	–	0.0
	EA-2	0.0	3.1	3.1
	EA-3	0.0	–	0.0
	EA-4	0.0	3.2	3.2
	EA-5	0.0	–	0.0
	EA-6	0.0	3.5	3.5
	EA-7	0.2	–	0.2
	EA-8	0.0	3.1	3.1
	EA-9	0.0	–	0.0
East Approach	IC-8	0.2	–	0.2

The working points of the structure were staked in the field and surveyed by exp Services Inc. The locations of and ground surface elevations at the boreholes were established in relation to the working points by Peto MacCallum Ltd.

Most boreholes were advanced manually or using continuous flight solid stem augers, powered by a track-mounted D-53 drill rig, supplied and operated by a specialist drilling contractor, working under the full-time supervision of a member of our engineering staff. A total of 12 boreholes (within the foundation elements) were extended 3.1 to 4.7 m into bedrock using NQ diamond rock coring equipment supplemented by wash boring techniques.

Representative samples of the soils were recovered at 0.60 to 0.75 m depth intervals using a conventional split spoon sampler during drilling. Standard penetration tests were conducted simultaneously with the sampling operation to assess the strength characteristics of the substrata. The results of the field tests and observations are reported on the Record of Borehole sheets.

The groundwater conditions at the borehole locations were assessed during drilling by visual examination of the soil, the sampler and drill rods 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 bentonite/cement grout in accordance with the MTO guidelines and MOE Regulation 903 for borehole abandonment procedures.

Soils were identified in the field in accordance with the MTO Soil Classification procedures. The soil samples were returned to our laboratory for detailed visual examination and routine moisture content determination. Laboratory classification tests were not undertaken due to insufficient sample recovery. The surficial soils will be removed to expose bedrock prior to construction of the underpass.

4. SUMMARISED SUBSURFACE CONDITIONS

Reference is made to the appended Record of Borehole sheets for details of the subsurface conditions including soil classifications, bedrock descriptions, inferred stratigraphy, standard and dynamic cone penetration test data and groundwater observations.

The borehole locations, stratigraphic profile and cross-sections prepared from the borehole data are shown on Drawings IC-S1 and IC-S2. 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 surficial peat / topsoil, silty clay / clayey silt and/or sand over bedrock or exposed bedrock. Boulders were encountered in 3 boreholes. The bedrock surface was contacted at depths of 0.0 to 1.8 m (elevation 198.3 to 202.9).

The strata encountered are summarised below.

4.1 Peat / Topsoil

A deposit of peat was present surficially in boreholes WA-1 to WA-8, CP-2, CP-4, CP-5, CP-8 and EA-7. The fine fibrous peat was 100 to 600 mm thick and penetrated at elevation 200.6 to 202.6.

Surficial topsoil was present in boreholes CP-1, CP-9 and IC-8. The sandy/silty topsoil was also identified in boreholes CP-4 and CP-8 below the peat at 0.1 m depth (elevation 202.6 and 201.7). The topsoil was 100 to 300 mm in thickness and penetrated at depths of 0.1 to 0.3 m (elevation 198.3 to 202.4). It is noteworthy that the topsoil contained boulders in borehole CP-1.

4.2 Organic Sand

Covered with 800 mm of snow, ice and water in borehole IC-7 was organic sand. Loose in relative density, this unit was 300 mm thick and penetrated at a depth of 1.1 m (elevation 200.2).

4.3 Silty Clay / Clayey Silt

Overlain by the peat at 0.2 m depth (elevation 201.2 and 201.1) in boreholes WA-1 and WA-2 and by the organic sand at a depth of 1.1 m (elevation 200.2) in borehole IC-7 was a deposit of silty clay / clayey silt. This deposit was 600 to 700 mm in thickness and firm to stiff in consistency, with a moisture content of 32% in one determination. A penetrometer test on a sample of the silty clay indicated a shear strength of about 50 kPa. The deposit was penetrated at depths of 0.8 to 1.8 m (elevation 199.5 to 200.5).

4.4 Sand

Underlying the peat or cohesive deposit at depths of 0.2 to 0.9 m (elevation 200.5 to 201.1) in boreholes WA-1 to WA-4, WA-6 and WA-7 was cohesionless sand. This stratum had a thickness of 100 to 600 mm and was penetrated at depths of 0.4 to 1.5 m (elevation 199.9 to 200.9).

4.5 Boulders

Boulders were present surficially in boreholes CP-1, CP-6, CP-7. A layer of boulders was 300 to 700 mm thick and penetrated at elevation 200.9 to 201.3.

4.6 Bedrock

Bedrock was contacted or inferred by refusal at depths of 0.0 to 1.8 m (elevation 198.3 to 202.9). The bedrock comprises a grey and pink granitic gneiss.

The measured core recovery varied between 80 and 100%. The RQD determined from the rock cores was in a range of 61 to 100%, thus indicating a fair to excellent quality rock. The rock quality was poor (RQD of 48%) in the upper 1.4 m core sample in borehole CP-9.

A detailed description of the rock cores retrieved from boreholes WA-1, WA-3, WA-7, WA-9, CP-1, CP-9 and EA-4 is given in Table A, appended. Photographs of the rock cores are shown in Appendix B.

4.6.1 West Abutment

The bedrock surface was contacted or inferred at depths of 0.0 to 1.5 m (elevation 199.9 to 201.8) in boreholes WA-1 to WA-9. The depth to and surface elevation of the bedrock identified in the boreholes drilled at the west abutment are summarised in the following table:

Location	Borehole No.	Depth to Rock (m)	Bedrock Elevation
West Abutment	WA-1	1.5	199.9*
	WA-2	0.9	200.4
	WA-3	0.4	200.8*
	WA-4	0.8	200.4
	WA-5	0.2	201.1
	WA-6	0.8	200.5
	WA-7	0.4	200.9*
	WA-8	0.2	201.2
	WA-9	0.0	201.8*

* confirmed by rock coring

The bedrock surface has a maximum relief of 1.9 m and slopes at angles of 1 to 7° (up to 17° at the south end of the abutment between boreholes WA-4 and WA-9). The bedrock comprises a grey / dark grey to pink unweathered to slightly weathered high strength granitic gneiss.

The measured core recovery varied between 80 and 100%. The RQD determined from the rock cores was in a range of 61 to 100%, thus indicating a fair to excellent quality rock.

4.6.2 Pier

The bedrock surface was contacted or inferred at depths of 0.0 to 0.7 m (elevation 200.9 to 202.9) in boreholes CP-1 to CP-9. The depth to and surface elevation of the bedrock identified in the boreholes drilled at the pier are summarised in the following table:

Location	Borehole No.	Depth to Rock (m)	Bedrock Elevation
Pier	CP-1	0.3	200.9*
	CP-2	0.2	201.0
	CP-3	0.0	202.9*
	CP-4	0.3	202.4
	CP-5	0.1	201.5
	CP-6	0.7	201.3
	CP-7	0.3	201.3*
	CP-8	0.2	201.6
	CP-9	0.1	202.2*

* confirmed by rock coring

The bedrock surface has a maximum relief of 2.0 m and slopes at angles of 3 to 5° (up to 14° on the south side of the pier between borehole CP-3 and boreholes CP-5 and CP-8). The bedrock comprises a light grey to pink moderately weathered to unweathered high strength granitic gneiss.

The measured core recovery varied between 80 and 100%. The RQD determined from the rock cores was in a range of 80 to 100%, thus indicating a good to excellent quality rock, with the exception of the upper 1.4 m core sample in borehole CP-9 where the rock quality was poor (RQD of 48%).

4.6.3 East Abutment

The bedrock surface was contacted or inferred at depths of 0.0 to 0.2 m (elevation 200.4 to 202.3) in boreholes EA-1 to EA-9. The depth to and surface elevation of the bedrock identified in the boreholes drilled at the east abutment are summarised in the following table:

Location	Borehole No.	Depth to Rock (m)	Bedrock Elevation
East Abutment	EA-1	0.0	201.9
	EA-2	0.0	201.9*
	EA-3	0.0	202.2
	EA-4	0.0	202.3*
	EA-5	0.0	201.4
	EA-6	0.0	200.4*
	EA-7	0.2	200.6
	EA-8	0.0	201.5*
	EA-9	0.0	201.8

* confirmed by rock coring

The bedrock surface has a maximum relief of 1.9 m and slopes at angles of 1 to 7° (up to 21° at the north end of the abutment in the west-east direction). The bedrock comprises a grey slightly weathered high strength granitic gneiss.

The measured core recovery varied between 89 and 100%. The RQD determined from the rock cores was in a range of 81 to 100%, thus indicating a good to excellent quality rock.

4.6.4 Approaches

Bedrock was inferred at 1.8 m depth (elevation 199.5) in borehole IC-7 and a depth of 0.2 m (elevation 198.3) in borehole IC-8 put down at the west and east approaches, respectively**.**

4.7 Groundwater

Water (200 mm deep) was present under snow and ice at 0.6 m depth (elevation 200.7) in borehole IC-7. Groundwater was at a depth of 0.3 m (elevation 201.0) in borehole WA-6 during and upon completion of drilling. The groundwater levels at the site are subject to seasonal fluctuations and precipitation patterns.

5. CLOSURE

The field work was carried out under the supervision of Mr. F. Portela, Senior Technician, and direction of Mr. A. DeSira, MEng, P.Eng., Project Engineer. The equipment was supplied by Walker Drilling Ltd. and Landcore.

This report was prepared by Mr. G.O. Degil, PhD, P.Eng., Senior Foundation Engineer, and reviewed by Mr. B.R. Gray, MEng, P.Eng., MTO Designated Principal Contact. Mr. C.M.P. Nascimento, P.Eng., Project Manager, conducted an independent review of the report.

Yours very truly,

Peto MacCallum Ltd.

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TABLE A
ROCK CORE DESCRIPTIONS

CORE RECOVERY					CORE DESCRIPTION	
HOLE NO.	**CORE NO.**	**DEPTH (m)**	**RECOVERY (%)**	**RQD (%)**	**DEPTH (m)**	**DESCRIPTION**
WA-1	3 4 5	1.5 – 1.9 1.9 – 3.4 3.4 – 4.7	80 100 100	80 100 100	1.5 – 4.7	GRANITIC GNEISS: Dark grey and pink, fine to medium crystalline, garnetiferous banded with occ. black layers (biotite and/or hornblende), high strength, unweathered to slightly weathered, close to moderate spaced flat to dipping partings, rough planar, tight, with dipping to vertical joints, good to excellent quality
WA-3	2 3 4	0.4 – 1.6 1.6 – 2.9 2.9 – 4.1	84 96 100	61 92 100	0.4 – 4.1	GRANITIC GNEISS: Grey and pink, fine to medium crystalline, garnetiferous, banded with occ. black layers (biotite and/or hornblende), banded with occ. dark green layers, high strength, unweathered to slightly weathered, close spaced dipping partings, rough planar, tight to oxidized, with flat to dipping joints, fair to excellent quality
WA-7	2 3 4	0.4 – 1.8 1.8 – 3.3 3.3 – 3.9	86 100 100	73 100 100	0.4 – 3.9	GRANITIC GNEISS: Grey and pink, fine to medium crystalline, garnetiferous, banded with occ. black layers (biotite and/or hornblende), high strength, unweathered to slightly weathered, close to moderate spaced dipping partings, rough planar, tight, with dipping to vertical joints, fair to excellent quality
WA-9	1 2	0.0 – 1.5 1.5 – 3.1	100 95	98 79	0.0 – 3.1	GRANITIC GNEISS: Grey and pink, fine to medium crystalline, garnetiferous, banded with occ. black layers (biotite), high strength, unweathered to slightly weathered, close to moderate spaced flat to dipping partings, rough planar, generally tight, locally oxidized to silty, with dipping to vertical joints, excellent becoming good quality

Originated: JO/SAT
Compiled: FP/SA
Checked: MA/

TABLE A
ROCK CORE DESCRIPTIONS

CORE RECOVERY					CORE DESCRIPTION	
HOLE NO.	**CORE NO.**	**DEPTH (m)**	**RECOVERY (%)**	**RQD (%)**	**DEPTH (m)**	**DESCRIPTION**
CP-1	1 2 3	0.3 – 1.7 1.7 – 3.2 3.2 – 3.5	80 99 100	80 99 100	0.3 – 3.5	GRANITIC GNEISS: Light grey and pink, fine to medium crystalline, garnetiferous banded with occ. black layers (biotite), high strength, slightly weathered to unweathered, close to moderate spaced flat to dipping partings, rough planar, generally tight, locally oxidized to silty, good to excellent quality
CP-9	1 2 3	0.1 – 1.5 1.5 – 3.0 3.0 – 4.1	89 100 100	48 89 100	0.1 – 4.1	GRANITIC GNEISS: Light grey and pink, fine to medium crystalline, garnetiferous banded with occ. black layers (biotite), with occ. dark green layers, high strength, moderately weathered in the first core becoming slightly weathered at depth, close to moderate spaced flat to dipping partings, rough planar, generally tight, locally oxidized to silty, with flat to dipping joints, poor to excellent quality
EA-4	1 2	0.0 – 1.6 1.6 – 3.2	98 97	93 97	0.0 – 3.2	GRANITIC GNEISS: Grey, fine to medium crystalline, garnetiferous, banded with occ. black layers (biotite and/or hornblende), high strength, slightly weathered, close to moderate spaced dipping partings, rough planar, generally tight, locally oxidized to silty, with dipping joints, excellent quality

NOTE: RQD = Rock Quality Designation

Originated: JO/SAT
Compiled: FP/SA
Checked: MA/

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

Ontario

Peto MacCallum Ltd. CONSULTING ENGINEERS

Foundation Design

RECORD OF BOREHOLE No. IC-7 1 of 1 METRIC

ICS Road, Sta. 9+950 CL

G.W.P. 5112-07-00 **LOCATION** Coords: 5 070 096.9 N; 227 749.5 E **ORIGINATED BY** A.L.

DIST Parry Sound **HWY** 69 **BOREHOLE TYPE** 'N' Casing + Wash Boring + Dynamic Cone Penetration Test **COMPILED BY** G.D.

DATUM Geodetic **DATE** February 25, 2013 **CHECKED BY** B.R.G.

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 (%) GR SA SI CL
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						
201.3	Top of Snow/Ice										
0.0	Snow/Ice					▽* ▼*	201				
200.5	Water										
0.8	Organic sand, trace silt rootlets		1	SS	4				○		
200.2	Loose Dark brown Wet						200	■			
1.1											
199.5	Silty clay, trace sand		2	SS	50/8cm						
1.8	Firm to stiff Grey Moist							120/3cm			
	End of borehole										
	Refusal on probable bedrock										
	Sample 2: Sampler bouncing										

* 2013 02 25

▽ Water level observed during drilling

▼ Water level measured after drilling

■ Penetrometer test

ON MTO_VER3 NEW LOGO 09TF042-ICS STRUCTURE.GPJ ON_MOT.GDT 2/5/2015 2:23:40 PM

+7, ×5: Numbers refer to Sensitivity

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

Ontario

Peto MacCallum Ltd. CONSULTING ENGINEERS

Foundation Design

RECORD OF BOREHOLE No. WA-1 1 of 1 METRIC

G.W.P. 5112-07-00 **LOCATION** Coords: 5 070 104.5 N; 227 760.3 E **ORIGINATED BY** F.P.

DIST Parry Sound **HWY** 69 **BOREHOLE TYPE** Continuous Flight Solid Stem Augers + 'N' Casing **COMPILED BY** G.D.

DATUM Geodetic **DATE** July 25, 2013 **CHECKED BY** B.R.G.

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
201.4	Ground Surface										
201.2 / 0.2	Peat, fine fibrous Dark brown		1	SS	1		201				
	Silty clay, trace sand organics										
200.5 / 0.9	Firm Black/ grey Moist		2	SS	9						
	Sand, trace silt						200				
199.9 / 1.5	Compact Brown Wet		3	RC NQ	REC 80%						RQD 80%
	Granitic Gneiss bedrock Unweathered to slightly weathered High strength Good to excellent quality		4	RC NQ	REC 100%		199				RQD 100%
							198				
			5	RC NQ	REC 100%						RQD 100%
196.7 / 4.7	End of borehole						197				

* Borehole charged with drilling water

+7, ×5 : Numbers refer to Sensitivity

(%) STRAIN AT FAILURE

Ontario

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RECORD OF BOREHOLE No. WA-2 1 of 1 METRIC

G.W.P. 5112-07-00 **LOCATION** Coords: 5 070 100.5 N; 227 760.1 E **ORIGINATED BY** F.P.

DIST Parry Sound **HWY** 69 **BOREHOLE TYPE** Continuous Flight Solid Stem Augers **COMPILED BY** G.D.

DATUM Geodetic **DATE** July 26, 2013 **CHECKED BY** B.R.G.

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
201.3	Ground Surface										
201.1 / 0.2	Peat, fine fibrous Dark brown						201				
200.5 / 0.8	Clayey silt, organics Black/grey Moist										
200.4 / 0.9	Sand, trace silt Brown Wet										
	End of borehole										
	Refusal on probable bedrock										
	* Borehole dry										

ON MTO_VER3 NEW LOGO 09TF042-ICS STRUCTURE.GPJ ON_MOT.GDT 2/5/2015 2:18:19 PM

+7, ×5 : Numbers refer to Sensitivity

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

Ontario

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RECORD OF BOREHOLE No. WA-3 1 of 1 METRIC

G.W.P. 5112-07-00 **LOCATION** Coords: 5 070 092.5 N; 227 759.9 E **ORIGINATED BY** F.P.

DIST Parry Sound **HWY** 69 **BOREHOLE TYPE** Continuous Flight Solid Stem Augers + 'N' Casing **COMPILED BY** G.D.

DATUM Geodetic **DATE** July 25, 2013 **CHECKED BY** B.R.G.

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
201.2	Ground Surface										
201.0 / 0.2	Peat, fine fibrous Dark brown		1	SS	-		201				
200.8 / 0.4	Sand, trace silt Brown Wet										
	Granitic Gneiss bedrock Unweathered to slightly weathered High strength Fair to excellent quality		2	RC NQ	REC 84%		200				RQD 61%
			3	RC NQ	REC 96%		199				RQD 92%
			4	RC NQ	REC 100%		198				RQD 100%
197.1 / 4.1	End of borehole * Borehole charged with drilling water										

+7, ×5: Numbers refer to Sensitivity

(%) STRAIN AT FAILURE

Ontario

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RECORD OF BOREHOLE No. WA-4 1 of 1 METRIC

G.W.P. 5112-07-00 **LOCATION** Coords: 5 070 088.6 N; 227 759.8 E **ORIGINATED BY** F.P.

DIST Parry Sound **HWY** 69 **BOREHOLE TYPE** Continuous Flight Solid Stem Augers **COMPILED BY** G.D.

DATUM Geodetic **DATE** July 26, 2013 **CHECKED BY** B.R.G.

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
201.2	Ground Surface										
0.0	Peat, fine fibrous Dark brown						201				
200.6 0.6	Sand, trace silt Brown Wet										
200.4 0.8	End of borehole Refusal on probable bedrock										

* Borehole dry

+7, ×5 : Numbers refer to Sensitivity

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

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RECORD OF BOREHOLE No. WA-5 1 of 1 METRIC

G.W.P. 5112-07-00 **LOCATION** Coords: 5 070 096.5 N; 227 762.5 E **ORIGINATED BY** F.P.

DIST Parry Sound **HWY** 69 **BOREHOLE TYPE** Manual Probing **COMPILED BY** G.D.

DATUM Geodetic **DATE** July 31, 2013 **CHECKED BY** B.R.G.

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
201.3	Ground Surface					*					
201.1 / 0.2	Peat, fine fibrous Dark brown										
	End of borehole										
	Refusal on probable bedrock										
	* Borehole dry										

ON MTO_VER3 NEW LOGO 09TF042-ICS STRUCTURE.GPJ ON_MOT.GDT 2/5/2015 2:18:21 PM

+7, ×5: Numbers refer to Sensitivity

(%) STRAIN AT FAILURE 20 15 5 10

Ontario

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RECORD OF BOREHOLE No. WA-6 1 of 1 METRIC

G.W.P. 5112-07-00 **LOCATION** Coords: 5 070 104.4 N; 227 764.3 E **ORIGINATED BY** F.P.

DIST Parry Sound **HWY** 69 **BOREHOLE TYPE** Manual Probing **COMPILED BY** G.D.

DATUM Geodetic **DATE** July 31, 2013 **CHECKED BY** B.R.G.

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
201.3	Ground Surface										
0.0 / 201.0	Peat, fine fibrous Dark brown		1	BS	-	▽* ▼*	201				
0.3 / 200.5	Sand, trace silt organics		2	BS	-						
0.8	Brown/ grey Wet										
	End of borehole										
	Refusal on probable bedrock										

* 2013 07 31

▽ Water level observed during drilling

▼ Water level measured after drilling

+ , × : Numbers refer to Sensitivity

(%) STRAIN AT FAILURE

Ontario

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RECORD OF BOREHOLE No. WA-7 1 of 1 METRIC

G.W.P. 5112-07-00 **LOCATION** Coords: 5 070 099.9 N; 227 764.1 E **ORIGINATED BY** F.P.

DIST Parry Sound **HWY** 69 **BOREHOLE TYPE** Continuous Flight Solid Stem Augers + 'N' Casing **COMPILED BY** G.D.

DATUM Geodetic **DATE** July 25, 2013 **CHECKED BY** B.R.G.

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
201.3	Ground Surface										
201.1	Peat, fine fibrous		1	SS	5/8cm	*	201				
0.2	Dark brown										
200.9	Sand, trace silt										
0.4	Brown Wet										
	Granitic Gneiss bedrock		2	RC NQ	REC 86%		200				RQD 73%
	Unweathered to slightly weathered										
	High strength										
	Fair to excellent quality						199				
			3	RC NQ	REC 100%						RQD 100%
							198				
197.4			4	RC NQ	REC 100%						RQD 100%
3.9	End of borehole										

* Borehole charged with drilling water

+7, ×5: Numbers refer to Sensitivity

(%) STRAIN AT FAILURE

Ontario

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RECORD OF BOREHOLE No. WA-8 1 of 1 METRIC

G.W.P. 5112-07-00 **LOCATION** Coords: 5 070 092.4 N; 227 764.4 E **ORIGINATED BY** F.P.

DIST Parry Sound **HWY** 69 **BOREHOLE TYPE** Manual Probing **COMPILED BY** G.D.

DATUM Geodetic **DATE** July 31, 2013 **CHECKED BY** B.R.G.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa	PLASTIC LIMIT / NATURAL MOISTURE CONTENT / LIQUID LIMIT	UNIT WEIGHT	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20 40 60 80 100	w_P w w_L	γ	
201.4	Ground Surface							○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE	WATER CONTENT (%) 20 40 60	kN/m³	GR SA SI CL
201.2 / 0.2	Peat, fine fibrous Dark brown										
	End of borehole										
	Refusal on probable bedrock										
	* Borehole dry										

+7, ×5 : Numbers refer to Sensitivity

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

Ontario

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RECORD OF BOREHOLE No. WA-9 1 of 1 METRIC

G.W.P. 5112-07-00 **LOCATION** Coords: 5 070 088.4 N; 227 763.7 E **ORIGINATED BY** F.P.

DIST Parry Sound **HWY** 69 **BOREHOLE TYPE** 'N' Casing **COMPILED BY** G.D.

DATUM Geodetic **DATE** July 26, 2013 **CHECKED BY** B.R.G.

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
201.8 0.0	Ground Surface Granitic Gneiss bedrock Unweathered to slightly weathered High strength Excellent becoming good quality		1	RC NQ	REC 100%		201				RQD 98%
			2	RC NQ	REC 95%		200				RQD 79%
198.7 3.1	End of borehole						199				

* 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. CP-1 1 of 1 METRIC

G.W.P. 5112-07-00 **LOCATION** Coords: 5 070 103.3 N; 227 797.3 E **ORIGINATED BY** F.P.

DIST Parry Sound **HWY** 69 **BOREHOLE TYPE** 'N' Casing **COMPILED BY** G.D.

DATUM Geodetic **DATE** July 30, 2013 **CHECKED BY** B.R.G.

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
201.2	Ground Surface										
0.0 / 200.9	Topsoil, boulders						201				
0.3	Granitic Gneiss bedrock Slightly weathered to unweathered High strength Good to excellent quality		1	RC NQ	REC 80%		200				RQD 80%
			2	RC NQ	REC 99%		199				RQD 99%
197.7			3	RC NQ	REC 100%		198				RQD 100%
3.5	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. CP-2 1 of 1 METRIC

G.W.P. 5112-07-00 **LOCATION** Coords: 5 070 099.3 N; 227 797.1 E **ORIGINATED BY** F.P.

DIST Parry Sound **HWY** 69 **BOREHOLE TYPE** Manual Probing **COMPILED BY** G.D.

DATUM Geodetic **DATE** July 31, 2013 **CHECKED BY** B.R.G.

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
201.2	Ground Surface										
201.0	Peat, fine fibrous										
0.2	Dark brown						201				
	End of borehole										
	Refusal on probable bedrock										
	* Borehole dry										

+7, ×5 : Numbers refer to Sensitivity

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

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RECORD OF BOREHOLE No. CP-3 1 of 1 METRIC

G.W.P. 5112-07-00 **LOCATION** Coords: 5 070 090.3 N; 227 796.8 E **ORIGINATED BY** F.P.

DIST Parry Sound **HWY** 69 **BOREHOLE TYPE** 'N' Casing **COMPILED BY** G.D.

DATUM Geodetic **DATE** July 29, 2013 **CHECKED BY** B.R.G.

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
202.9 0.0	Ground Surface Granitic Gneiss bedrock Moderately weathered to slightly weathered High strength Good to excellent quality		1	RC NQ	REC 100%	*	202				RQD 89%
			2	RC NQ	REC 95%		201				RQD 95%
							200				
198.2 4.7	End of borehole * Borehole charged with drilling water		3	RC NQ	REC 98%		199				RQD 98%

+7, ×5 : Numbers refer to Sensitivity

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

Ontario

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RECORD OF BOREHOLE No. CP-4 1 of 1 METRIC

G.W.P. 5112-07-00 **LOCATION** Coords: 5 070 087.3 N; 227 796.7 E **ORIGINATED BY** F.P.

DIST Parry Sound **HWY** 69 **BOREHOLE TYPE** Manual Probing **COMPILED BY** G.D.

DATUM Geodetic **DATE** July 31, 2013 **CHECKED BY** B.R.G.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa	PLASTIC LIMIT / NATURAL MOISTURE CONTENT / LIQUID LIMIT	UNIT WEIGHT	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20 40 60 80 100	w_P w w_L	γ	
								○ UNCONFINED + FIELD VANE	WATER CONTENT (%)		
								● QUICK TRIAXIAL × LAB VANE	20 40 60		
								20 40 60 80 100			
202.7	Ground Surface									kN/m³	GR SA SI CL
202.6 0.1	Peat, fine fibrous Dark brown										
202.4 0.3	Topsoil										
	End of borehole										
	Refusal on probable bedrock										
	* Borehole dry										

ON MTO_VER3 NEW LOGO 09TF042-ICS STRUCTURE.GPJ ON_MOT.GDT 2/5/2015 2:25:45 PM

+7, ×5: Numbers refer to Sensitivity

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

Ontario

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Foundation Design

RECORD OF BOREHOLE No. CP-5 1 of 1 METRIC

G.W.P. 5112-07-00 **LOCATION** Coords: 5 070 095.2 N; 227 799.5 E **ORIGINATED BY** F.P.

DIST Parry Sound **HWY** 69 **BOREHOLE TYPE** Manual Probing **COMPILED BY** G.D.

DATUM Geodetic **DATE** July 31, 2013 **CHECKED BY** B.R.G.

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
201.6 0.0	Ground Surface					*					
201.5 0.1	Peat, fine fibrous Dark brown										
	End of borehole										
	Refusal on probable bedrock										
	* Borehole dry										

ON MTO_VER3 NEW LOGO 09TF042-ICS STRUCTURE.GPJ ON_MOT.GDT 2/5/2015 2:25:45 PM

+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. CP-6 1 of 1 METRIC

G.W.P. 5112-07-00 **LOCATION** Coords: 5 070 103.2 N; 227 802.3 E **ORIGINATED BY** F.P.

DIST Parry Sound **HWY** 69 **BOREHOLE TYPE** Manual Probing **COMPILED BY** G.D.

DATUM Geodetic **DATE** July 31, 2013 **CHECKED BY** B.R.G.

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
202.0	Ground Surface					*					
0.0	Boulders										
201.3											
0.7	End of borehole Refusal on probable bedrock										

* Borehole dry

+ , × : Numbers refer to Sensitivity

(%) STRAIN AT FAILURE

Ontario

Peto MacCallum Ltd. CONSULTING ENGINEERS

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RECORD OF BOREHOLE No. CP-7 1 of 1 METRIC

G.W.P. 5112-07-00 **LOCATION** Coords: 5 070 098.7 N; 227 802.1 E **ORIGINATED BY** F.P.

DIST Parry Sound **HWY** 69 **BOREHOLE TYPE** 'N' Casing **COMPILED BY** G.D.

DATUM Geodetic **DATE** July 29, 2013 **CHECKED BY** B.R.G.

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
201.6	Ground Surface										
0.0 / 201.3	Boulders										
0.3	Granitic Gneiss bedrock Slightly weathered High strength Excellent quality		1	RC NQ	REC 100%		201				RQD 100%
			2	RC NQ	REC 95%		200 199				RQD 95%
197.9			3	RC NQ	REC 100%		198				RQD 100%
3.7	End of borehole * Borehole charged with drilling water										

+7, ×5 : Numbers refer to Sensitivity

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

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Foundation Design

RECORD OF BOREHOLE No. CP-8 1 of 1 METRIC

G.W.P. 5112-07-00 **LOCATION** Coords: 5 070 091.2 N; 227 801.9 E **ORIGINATED BY** F.P.

DIST Parry Sound **HWY** 69 **BOREHOLE TYPE** Manual Probing **COMPILED BY** G.D.

DATUM Geodetic **DATE** July 31, 2013 **CHECKED BY** B.R.G.

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 (%) GR SA SI CL
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						
201.8	Ground Surface					*					
201.7 0.0	Peat, fine fibrous Dark brown										
0.1	Topsoil										
201.6 0.2	End of borehole										
	Refusal on probable bedrock										
	* Borehole dry										

ON MTO_VER3 NEW LOGO 09TF042-ICS STRUCTURE.GPJ ON_MOT.GDT 2/5/2015 2:25:47 PM

+7, ×5: Numbers refer to Sensitivity

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

Ontario

Peto MacCallum Ltd. CONSULTING ENGINEERS

Foundation Design

RECORD OF BOREHOLE No. CP-9 1 of 1 METRIC

G.W.P. 5112-07-00 **LOCATION** Coords: 5 070 087.2 N; 227 801.7 E **ORIGINATED BY** F.P.

DIST Parry Sound **HWY** 69 **BOREHOLE TYPE** 'N' Casing **COMPILED BY** G.D.

DATUM Geodetic **DATE** July 29, 2013 **CHECKED BY** B.R.G.

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
202.3	Ground Surface										
0.0	Topsoil										
202.2	Granitic Gneiss bedrock						202				
0.1	Moderately weathered to slightly weathered High strength Poor to excellent quality		1	RC NQ	REC 89%						RQD 48%
			2	RC NQ	REC 100%		201				RQD 89%
			3	RC NQ	REC 100%		200				RQD 100%
198.2							199				
4.1	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. EA-1 1 of 1 METRIC

G.W.P. 5112-07-00 **LOCATION** Coords: 5 070 102.0 N; 227 837.7 E **ORIGINATED BY** F.P.

DIST Parry Sound **HWY** 69 **BOREHOLE TYPE** Manual Probing **COMPILED BY** G.D.

DATUM Geodetic **DATE** July 31, 2013 **CHECKED BY** B.R.G.

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 (%) GR SA SI CL
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						
201.9	Ground Surface					*					
0.0	Bedrock at surface										
	* Borehole dry										

ON MTO_VER3 NEW LOGO 09TF042-ICS STRUCTURE.GPJ ON_MOT.GDT 2/5/2015 2:31:13 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. EA-2 1 of 1 METRIC

G.W.P. 5112-07-00 **LOCATION** Coords: 5 070 098.0 N; 227 837.6 E **ORIGINATED BY** F.P.

DIST Parry Sound **HWY** 69 **BOREHOLE TYPE** 'N' Casing **COMPILED BY** G.D.

DATUM Geodetic **DATE** July 30, 2013 **CHECKED BY** B.R.G.

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
201.9 0.0	Ground Surface Granitic Gneiss bedrock Slightly weathered High strength Excellent becoming good quality		1	RC NQ	REC 100%	*	201				RQD 93%
			2	RC NQ	REC 95%		200				RQD 81%
198.8 3.1			3	RC NQ	REC 89%		199				RQD 85%
	End of borehole * Borehole charged with drilling water										

ON MTO_VER3 NEW LOGO 09TF042-ICS STRUCTURE.GPJ ON_MOT.GDT 2/5/2015 2:31:14 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. EA-3 1 of 1 METRIC

G.W.P. 5112-07-00 **LOCATION** Coords: 5 070 090.0 N; 227 837.3 E **ORIGINATED BY** F.P.

DIST Parry Sound **HWY** 69 **BOREHOLE TYPE** Manual Probing **COMPILED BY** G.D.

DATUM Geodetic **DATE** July 31, 2013 **CHECKED BY** B.R.G.

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
202.2	Ground Surface					*					
0.0	Bedrock at surface										
	* 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. EA-4 1 of 1 METRIC

G.W.P. 5112-07-00 **LOCATION** Coords: 5 070 086.0 N; 227 837.2 E **ORIGINATED BY** F.P.

DIST Parry Sound **HWY** 69 **BOREHOLE TYPE** 'N' Casing **COMPILED BY** G.D.

DATUM Geodetic **DATE** July 30, 2013 **CHECKED BY** B.R.G.

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
202.3 0.0	Ground Surface Granitic Gneiss bedrock Slightly weathered High strength Excellent quality		1	RC NQ	REC 98%	*	202				RQD 93%
			2	RC NQ	REC 97%		201 200				RQD 97%
199.1 3.2	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. EA-5 1 of 1 METRIC

G.W.P. 5112-07-00 **LOCATION** Coords: 5 070 093.9 N; 227 839.0 E **ORIGINATED BY** F.P.

DIST Parry Sound **HWY** 69 **BOREHOLE TYPE** Manual Probing **COMPILED BY** G.D.

DATUM Geodetic **DATE** July 31, 2013 **CHECKED BY** B.R.G.

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
201.4	Ground Surface					*					
0.0	Bedrock at surface										
	* Borehole dry										

ON MTO_VER3 NEW LOGO 09TF042-ICS STRUCTURE.GPJ ON_MOT.GDT 2/5/2015 2:31:16 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. EA-6 1 of 1 METRIC

G.W.P. 5112-07-00 **LOCATION** Coords: 5 070 101.8 N; 227 841.7 E **ORIGINATED BY** F.P.

DIST Parry Sound **HWY** 69 **BOREHOLE TYPE** Hilti **COMPILED BY** G.D.

DATUM Geodetic **DATE** August 28, 2013 **CHECKED BY** B.R.G.

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
200.4	Ground Surface										
0.0	Granitic Gneiss bedrock Slightly weathered High strength Excellent quality		1	RC NQ	REC 100%		200				RQD 100%
			2	RC NQ	REC 100%						RQD 100%
			3	RC NQ	REC 92%		199				RQD 92%
			4	RC NQ	REC 100%		198				RQD 100%
			5	RC NQ	REC 100%						RQD 100%
196.9							197				
3.5	End of borehole										

* Borehole charged with drilling water

+7, ×5: Numbers refer to Sensitivity

(%) STRAIN AT FAILURE

Ontario

Peto MacCallum Ltd. CONSULTING ENGINEERS

Foundation Design

RECORD OF BOREHOLE No. EA-7 1 of 1 METRIC

G.W.P. 5112-07-00 **LOCATION** Coords: 5 070 097.8 N; 227 841.6 E **ORIGINATED BY** F.P.

DIST Parry Sound **HWY** 69 **BOREHOLE TYPE** Manual Probing **COMPILED BY** G.D.

DATUM Geodetic **DATE** July 31, 2013 **CHECKED BY** B.R.G.

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
200.8	Ground Surface					*					
200.6 / 0.2	Peat, fine fibrous Dark brown										
	End of borehole										
	Refusal on probable bedrock										
	* Borehole dry										

ON MTO_VER3 NEW LOGO 09TF042-ICS STRUCTURE.GPJ ON_MOT.GDT 2/5/2015 2:31:17 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. EA-8 1 of 1 METRIC

G.W.P. 5112-07-00 **LOCATION** Coords: 5 070 089.8 N; 227 841.3 E **ORIGINATED BY** F.P.

DIST Parry Sound **HWY** 69 **BOREHOLE TYPE** 'N' Casing **COMPILED BY** G.D.

DATUM Geodetic **DATE** July 30, 2013 **CHECKED BY** B.R.G.

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
201.5	Ground Surface										
0.0	Granitic Gneiss bedrock Slightly weathered High strength Excellent quality		1	RC NQ	REC 100%		201				RQD 100%
			2	RC NQ	REC 98%		200 199				RQD 93%
198.4											
3.1	End of borehole * Borehole charged with drilling water										

ON MTO_VER3 NEW LOGO 09TF042-ICS STRUCTURE.GPJ ON_MOT.GDT 2/5/2015 2:31:18 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. EA-9 1 of 1 METRIC

G.W.P. 5112-07-00 **LOCATION** Coords: 5 070 085.8 N; 227 841.2 E **ORIGINATED BY** F.P.

DIST Parry Sound **HWY** 69 **BOREHOLE TYPE** Manual Probing **COMPILED BY** G.D.

DATUM Geodetic **DATE** July 31, 2013 **CHECKED BY** B.R.G.

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
201.8 / 0.0	Ground Surface Bedrock at surface										
	* Borehole dry										

ON MTO_VER3 NEW LOGO 09TF042-ICS STRUCTURE.GPJ ON_MOT.GDT 2/5/2015 2:31:18 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. IC-8 1 of 1 METRIC

ICS Road, Sta. 10+050 CL

G.W.P. 5112-07-00 **LOCATION** Coords: 5 070 093.5 N; 227 849.5 E **ORIGINATED BY** A.L.

DIST Parry Sound **HWY** 69 **BOREHOLE TYPE** Manual Probing **COMPILED BY** G.D.

DATUM Geodetic **DATE** February 01, 2013 **CHECKED BY** B.R.G.

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
198.5	Ground Surface					*					
198.3	Topsoil										
0.2	End of borehole										
	Refusal on probable bedrock										
	* Borehole dry										

+7, ×5 : Numbers refer to Sensitivity

(%) STRAIN AT FAILURE 20 15 10 5

CONT No
WP No 5131-08-01

INTERCHANGE SERVICE ROAD UNDERPASS HIGHWAY 69 NBL/SBL

BOREHOLE LOCATIONS AND SOIL STRATA

SHEET

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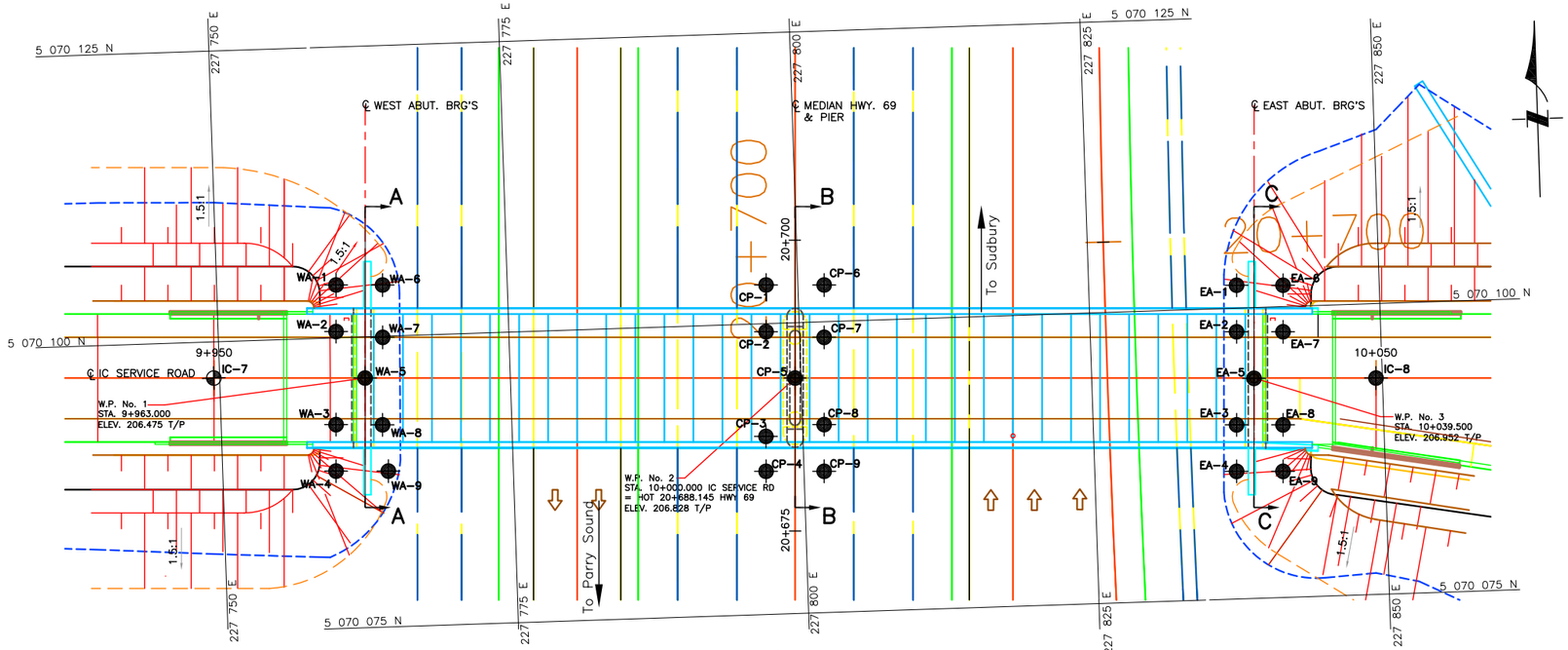
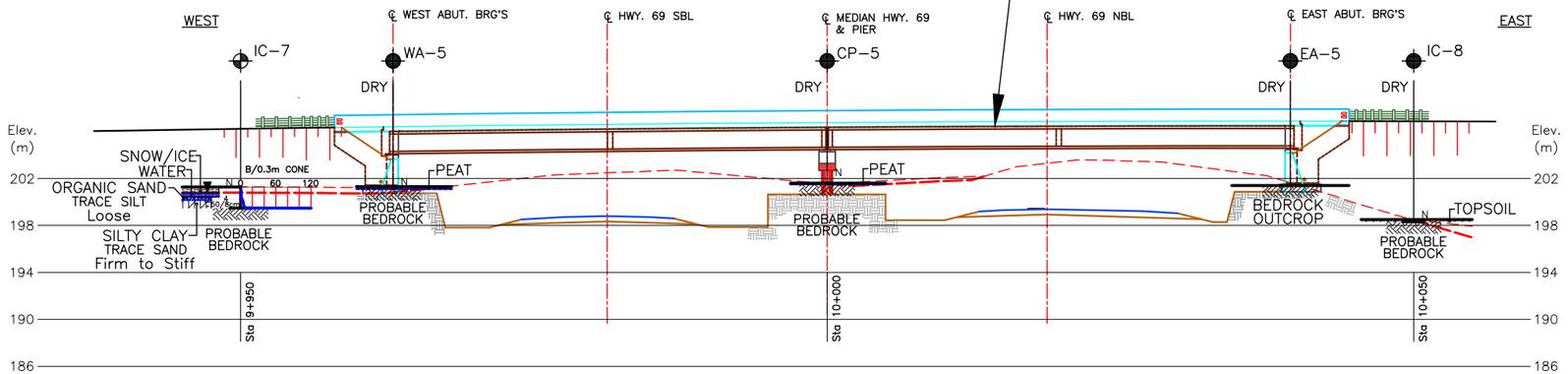
CONSULTING ENGINEERS



PLAN
SCALE
5 0 5 10m



PROFILE ALONG ℄ IC SERVICE ROAD
SCALE
5 0 5 10m

(Legend Continued)

BH No	ELEVATION	CO-ORDINATES NORTHINGS	EASTINGS
CP-1	201.2	5 070 103.3	227 797.3
CP-2	201.2	5 070 099.3	227 797.1
CP-3	202.9	5 070 090.3	227 796.8
CP-4	202.7	5 070 087.3	227 796.7
CP-5	201.6	5 070 095.2	227 799.5
CP-6	202.0	5 070 103.2	227 802.3
CP-7	201.6	5 070 098.7	227 802.1
CP-8	201.8	5 070 091.2	227 801.9
CP-9	202.3	5 070 087.2	227 801.7
EA-1	201.9	5 070 102.0	227 837.7

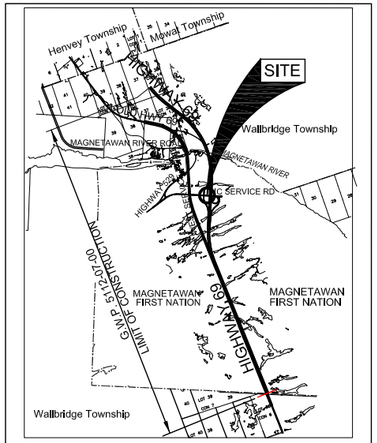
(Legend Continues)

(Legend Continued)

BH No	ELEVATION	CO-ORDINATES NORTHINGS	EASTINGS
EA-2	201.9	5 070 098.0	227 837.6
EA-3	202.2	5 070 090.0	227 837.3
EA-4	202.3	5 070 086.0	227 837.2
EA-5	201.4	5 070 093.9	227 839.0
EA-6	200.4	5 070 101.8	227 841.7
EA-7	200.8	5 070 097.8	227 841.6
EA-8	201.5	5 070 089.8	227 841.3
EA-9	201.8	5 070 085.8	227 841.2
IC-8	198.5	5 070 093.5	227 849.5

NOTES:

1. DRAWINGS IC-S1 AND IC-S2 SHOULD BE READ IN CONJUNCTION WITH THE TEXT AND RECORD OF BOREHOLE LOGS.
2. REFER TO DRAWING IC-S2 FOR SECTIONS A-A, B-B AND C-C.
3. THIS DRAWING IS FOR SUBSURFACE INFORMATION ONLY. SURFACE DETAILS AND FEATURES ARE FOR CONCEPTUAL ILLUSTRATION.
4. DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN. STATIONS ARE IN KILOMETRES AND METRES.



KEY PLAN
SCALE
1.0 0 1.0 2.0 km

LEGEND

- Borehole
- Dynamic Cone Penetration Test (Cone)
- Borehole & Cone
- 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 rods and hammer
- WL at time of investigation Feb. & July 2013
- Head
- ARTESIAN WATER Encountered
- PIEZOMETER

BH No	ELEVATION	CO-ORDINATES NORTHINGS	EASTINGS
IC-7	201.3	5 070 096.9	227 749.5
WA-1	201.4	5 070 104.5	227 760.3
WA-2	201.3	5 070 100.5	227 760.1
WA-3	201.2	5 070 092.5	227 759.9
WA-4	201.2	5 070 088.6	227 759.8
WA-5	201.3	5 070 096.5	227 762.5
WA-6	201.3	5 070 104.4	227 764.3
WA-7	201.3	5 070 099.9	227 764.1
WA-8	201.4	5 070 092.4	227 764.4
WA-9	201.8	5 070 088.4	227 763.7

(Legend Continues)

– 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

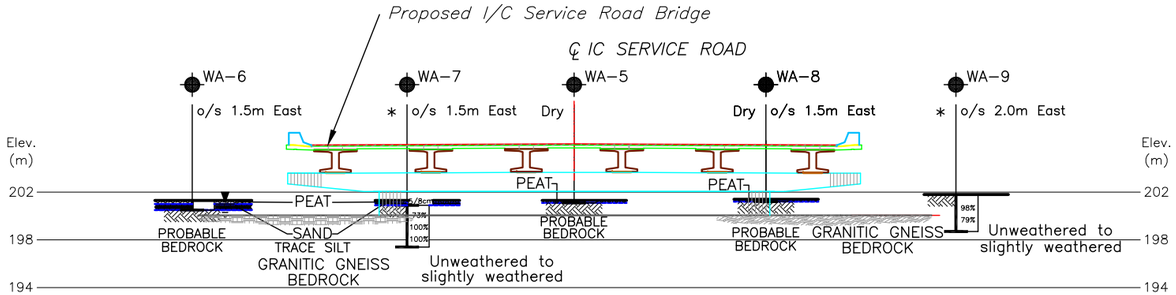
REGISTERED PROFESSIONAL ENGINEER
B. R. GRAY
Feb. 04, 2015
PROVINCE OF ONTARIO

REGISTERED PROFESSIONAL ENGINEER
C M P Nascimento
PROVINCE OF ONTARIO

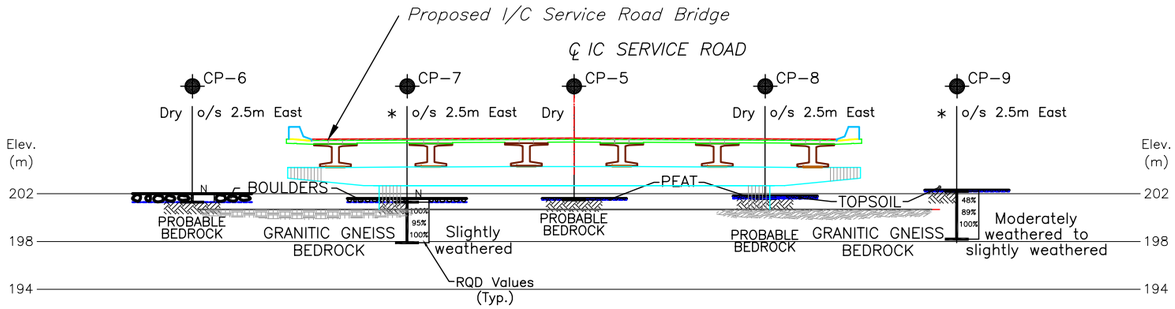
REF. AECOM Drawing: 60143751-IC-UNDERPASS_1_GA.dwg; dated Sept.2011

Geocres No. 42H-144

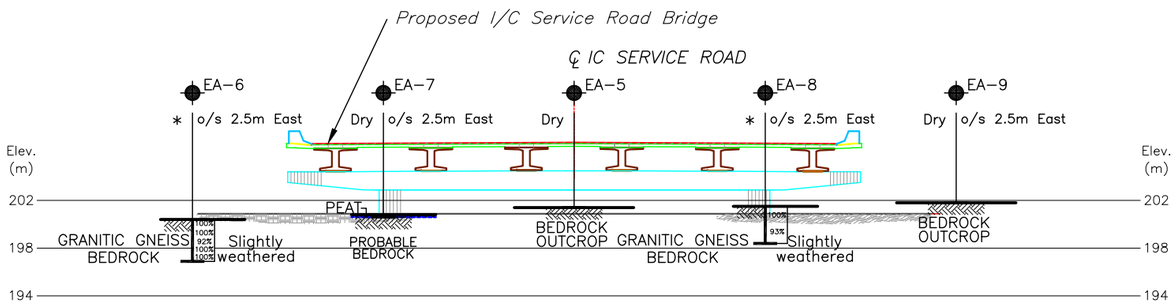
HWY No	69			DIST	54
SUBM'D	NA	CHECKED	GD	SITE	44-455
DRAWN	NA	CHECKED	BRG	DWG	IC-S1
		APPROVED	CN	DATE	FEB. 04, 2015



SECTION A–A



SECTION B–B



SECTION C–C

SCALE

HORIZONTAL

1.25 0 1.25 2.5m

VERTICAL

5 0 5 10m

NOTES:

1. DRAWINGS IC–S1 AND IC–S2 SHOULD BE READ IN CONJUNCTION WITH THE TEXT AND RECORD OF BOREHOLE LOGS.
2. REFER TO DRAWING IC–S1 FOR BOREHOLE LOCATIONS PLAN AND CENTRELINE PROFILE.
3. THIS DRAWING IS FOR SUBSURFACE INFORMATION ONLY. SURFACE DETAILS AND FEATURES ARE FOR CONCEPTUAL ILLUSTRATION.
4. DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN. STATIONS ARE IN KILOMETRES AND METRES.

REF. AECOM Drawing: 60143751-IC-UNDERPASS_1_GA.dwg; dated Sept.2011

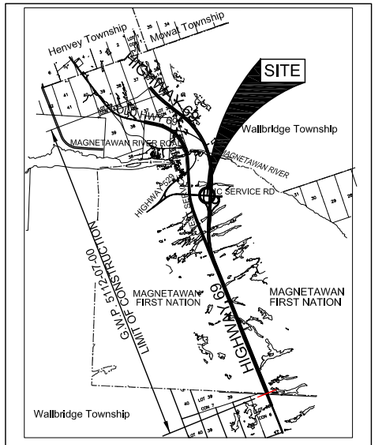
CONT No

WP No 5131–08–01

INTERCHANGE SERVICE ROAD UNDERPASS
HIGHWAY 69 NBL/SBL
SOIL STRATA

SHEET

Peto MacCallum Ltd.
CONSULTING ENGINEERS



KEY PLAN
SCALE
1.0 0 1.0 2.0 km

LEGEND

- Borehole
- Dynamic Cone Penetration Test (Cone)
- Borehole & Cone
- 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 rods and hammer
- WL at time of investigation Feb. & July 2013
- Head ARTESIAN WATER Encountered
- PIEZOMETER

BH No	ELEVATION	CO–ORDINATES NORTHINGS	EASTINGS

FOR DETAILS, REFER TO DRAWING IC–S1

– 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

REGISTERED PROFESSIONAL ENGINEER B. R. GRAY Feb. 04, 2015 PROVINCE OF ONTARIO

REGISTERED PROFESSIONAL ENGINEER C. M. P. Nascimento Feb. 04, 2015 PROVINCE OF ONTARIO

Geocres No. 42H–144

HWY No	69			DIST	54
SUBM'D	NA	CHECKED GD	DATE FEB. 04, 2015	SITE	44–455
DRAWN	NA	CHECKED BRG	APPROVED CN	DWG	IC–S2

APPENDIX A

Site Photographs

Photograph 1: Borehole WA-7, facing west.

Photograph 2: Borehole WA-9, facing south.

Photograph 3: Borehole CP-1, facing south.

Photograph 4: Fractured surface rock at the location of borehole CP-3.

Photograph 5: Surface boulders at the location of borehole CP-7.

Photograph 6: Facing north from W.P. No. 3 (east abutment).

Photograph 7: Facing south from W.P. No. 3 (east abutment). The drill rig is at borehole EA-4.

Photograph 8: Facing east from W.P. No. 3 (east abutment).

APPENDIX B

Rock Core Photographs

Photograph 1: Cores retrieved from borehole WA-1. Rock cores 3 to 5 from 1.5 to 4.7 m depth. RQD values ranged from 80 to 100%, indicating good to excellent rock quality.

Photograph 2: Cores retrieved from borehole WA-3. Rock cores 2 to 4 from 0.4 to 4.1 m depth. RQD values ranged from 61 to 100%, indicating fair to excellent rock quality

Photograph 3: Cores retrieved from borehole WA-7. Rock cores 2 to 4 from 0.4 to 3.9 m depth. RQD values ranged from 73 to 100%, indicating fair to excellent rock quality.

Photograph 4: Cores retrieved from borehole WA-9. Rock cores 1 and 2 from 0.0 to 3.1 m depth. RQD values were 98 and 79%, indicating excellent becoming good rock quality.

Photograph 5: Cores retrieved from borehole CP-1. Rock cores 1 to 3 from 0.3 to 3.5 m depth. RQD values ranged from 80 to 100%, indicating good to excellent rock quality.

Photograph 6: Cores retrieved from borehole CP-9. Rock cores 1 to 3 from 0.1 to 4.1 m depth. RQD values ranged from 48 to 100%, indicating poor to excellent rock quality.

Photograph 7: Cores retrieved from borehole EA-4. Rock cores 1 and 2 from 0.0 to 3.2 m depth. RQD values were 93 and 97%, indicating excellent rock quality.

Peto MacCallum Ltd.
CONSULTING ENGINEERS

FOUNDATION DESIGN REPORT

for

HIGHWAY 69 / SERVICE ROAD UNDERPASS
W.P. 5131-08-01
MAGNETAWAN FIRST NATION, ONTARIO

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PML Ref.: 09TF042-IC
Index No.: 378FDR
GEOCRES No.: 42H-144
February 4, 2015

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Peto MacCallum Ltd.
CONSULTING ENGINEERS

FOUNDATION DESIGN REPORT
for
Highway 69 / Service Road Underpass
Magnetawan First Nation, Ontario
W.P. 5131-08-01

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1. INTRODUCTION

This report provides foundation engineering comments and recommendations regarding design and construction of the foundations and approach embankments for the proposed construction of an underpass to carry Service Road traffic over Highway 69 in Magnetawan First Nation, Ontario. The investigation was conducted for AECOM Canada Ltd. (AECOM) on behalf of the Ministry of Transportation of Ontario (MTO).

The underpass is at approximate Station 20+688, Highway 69 chainage, in Magnetawan First Nation, about 90 km south of Sudbury. The underpass is proposed to be a 2-span structure with a total length of 76.5 m and width of 12 m (ref. General Arrangement Drawing 1 'Highway 69 NBL / SBL Magnetawan IC Underpass' prepared by AECOM in September 2011).

The road grade on Interchange Service Road at the underpass location is planned to be at elevation 206.5 at the west abutment and elevation 207.0 at the east abutment. The approach embankments to the structure are envisaged to be 5 m high at the west abutment and 7 to 9 m high at the east abutment (interpolated from ground surface elevations and the proposed road grade). The road grade on Highway 69 is planned to be at elevation 199.0 to 199.5.

In summary, the site is located on a rock outcrop where the subsurface stratigraphy revealed in the boreholes generally comprised relatively thin layers of surficial peat / topsoil, silty clay / clayey silt and/or sand over bedrock or exposed bedrock. Boulders were encountered in 3 boreholes. The bedrock surface was contacted at depths of 0.0 to 1.8 m (elevation 198.3 to 202.9).

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

Location	Borehole No.	Depth to Rock (m)	Bedrock Elevation
West Approach	IC-7	1.8	199.5
West Abutment	WA-1	1.5	199.9*
	WA-2	0.9	200.4
	WA-3	0.4	200.8*
	WA-4	0.8	200.4
	WA-5	0.2	201.1
	WA-6	0.8	200.5
	WA-7	0.4	200.9*
	WA-8	0.2	201.2
	WA-9	0.0	201.8*
Pier	CP-1	0.3	200.9*
	CP-2	0.2	201.0
	CP-3	0.0	202.9*
	CP-4	0.3	202.4
	CP-5	0.1	201.5
	CP-6	0.7	201.3
	CP-7	0.3	201.3*
	CP-8	0.2	201.6
	CP-9	0.1	202.2*
East Abutment	EA-1	0.0	201.9
	EA-2	0.0	201.9*
	EA-3	0.0	202.2
	EA-4	0.0	202.3*
	EA-5	0.0	201.4
	EA-6	0.0	200.4*
	EA-7	0.2	200.6
	EA-8	0.0	201.5*
	EA-9	0.0	201.8
East Approach	IC-8	0.2	198.3

* confirmed by rock coring

In view of the very small depth of the bedrock below the ground surface and the planned grades of the underpass deck, it is considered that integral abutments will require deep trenches or coring of large diameter deep holes to install the piles and this is not economical. The structure may be designed with semi-integral or conventional abutments.

The "red flag" issues outlined in the preceding paragraphs and the recommended methods of overcoming these issues noted in the following sections of the report are intended to alert and aid the designer and the contractor. These comments and recommendations are based on the conditions revealed during the investigations and no responsibility is assumed by the consultants or the MTO for alerting the contractor to all critical issues for each foundation alternative. The requirements to deliver acceptable construction quality remain the responsibility of the contractor.

2. FOUNDATIONS

2.1 General

The design road grade at the underpass location is at elevation 206.5 to 207.0, about 5 to 7 m above the ground surface at the west abutment, pier and east abutment.

It is recommended that the abutment and pier foundations be supported by spread footings founded on bedrock.

Spread footings founded on bedrock are considered to be the preferred foundation system due to the shallow depth to bedrock at the locations of both abutments and the pier (less than 2 m). It is noteworthy that boulders present at the site should be removed prior to placing the footings or fill.

The seismic coefficient for the 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-S6-00). The zonal acceleration ratio is 0.05. The bridge site is located in Seismic Performance Zone 1.

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. In addition, a rock engineering specialist should be retained to examine the integrity and/or impact on bedrock below the footings, should blasting be required near the bridge foundations.

Further comments and recommendations for design of the foundations are provided in the following sections. A summary of the advantages, disadvantages and the preferred foundation type from a foundation engineering perspective is given in Table 1. The standard specifications referenced in this report are listed in Table 2.

2.2 Spread Footings

As discussed in section 2.1, the foundations for the abutments and pier may be constructed as footings on bedrock. The anticipated depth and elevation to bedrock at each borehole location are tabulated in section 1.0. The bedrock surface level within the footprints of the foundation elements ranges from elevation 199.9 to 201.8 at the west abutment, from elevation 200.9 to 202.9 at the pier and from elevation 200.4 to 202.3 at the east abutment. The inferred surface of the bedrock generally slopes down to the northwest at inclinations of 1 to 7° at the west abutment, to the north at angles of 3 to 5° at the pier and to the northeast at inclinations of 1 to 7° at the east abutment, locally dipping at maximum angles of 17°, 14° and 21° respectively.

The bedrock generally comprises a slightly weathered high strength granitic gneiss and is classified as fair to excellent quality (RQD of 61 to 100%) with a core recovery in excess of 80%. Poor quality rock was only identified in the upper 1.4 m core sample in borehole CP-9. It is considered that the rock is capable of adequately supporting the foundation loads.

Footings bearing on the high strength bedrock should be designed using a factored geotechnical bearing resistance of 10 MPa at ultimate limit states (ULS). The geotechnical reaction at serviceability limit states (SLS) allows for 25 mm compression of the founding medium. 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 would be much larger than the factored geotechnical resistance at ULS. Consequently the geotechnical reaction at SLS should be taken the same as the factored geotechnical resistance at ULS for computation purposes. The geotechnical bearing resistance for inclined loads should be reduced in accordance with the requirements of clause 6.7.4 of the CHBDC.

Mass concrete could be placed to provide a level founding surface for the footings where required. 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 structural design considerations including the actual thickness of the mass concrete.

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. If the actual bearing pressure is less than 8 MPa, the unconfined compressive strength of the concrete could be reduced in direct linear proportion to the actual bearing stress to a minimum of 25 MPa.

Comments concerning excavation of bedrock to enable construction of the footings are provided in section 5 of this 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. An unfactored friction factor of 0.7 is recommended for footings constructed on rough bedrock surfaces (asperity height of at least 25 mm).

The need to install anchors / dowels to resist sliding if the slope of the bedrock surface referred to previously is unfavourably inclined relative to the direction of the force imposed by the foundation loads should be considered by the structural engineer. 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.

A NSSP should be included in the tender documents for inspection of the footing subgrade by a specialist rock mechanics engineer. Based on the inspection, rock bolts or grouting and/or local scaling may be required.

The lateral resistance of footings founded on bedrock could be increased by means of a shear key and/or by installing 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 dowels into concrete are employed, a NSSP should be included in the tender documents to provide specific direction for the contractor during installation and testing of the dowels.

If anchors are installed, 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 at least 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 be assessed if the spacing is less than one-fifth of the anchor length.

2.3 Piles

Taking into account the shallow depth to bedrock at the locations of both abutments and the pier (less than 2 m), use of steel H-piles driven to bedrock through the embankment fill is not considered to be a suitable method of supporting the west and east abutment foundations. Based on the proposed abutment grades, it is very likely that local bedrock excavation or large diameter coring to provide for the structurally required minimum 3 to 5 m free pile length for integral abutments would be necessary as well. It is therefore not recommended to use steel H-piles to support the foundation loads at the site.

3. ABUTMENT WALLS

The abutment walls should be designed to resist the unbalanced lateral earth pressure imposed by the backfill adjacent to the wall. The lateral earth pressure may be computed using the equivalent fluid pressure diagrams presented in Section 6.9 of the CHBDC or employing the following equation, assuming a triangular pressure distribution:

$$p = K(\gamma h + q) + Cp + Cs$$

where K = coefficient of lateral earth pressure (dimensionless)
γ = unit weight of free-draining granular material, kN/m^3
h = depth below final grade, m
q = surcharge load, kPa, if present

Cp = compaction pressure, kPa (refer to clause 6.9.3 of CHBDC)
Cs = earth pressure induced by seismic events, kPa (refer to clause 4.6.4 of CHBDC)
where Ø = angle of internal friction of retained soil (35º for Granular B Type II)
δ = angle of friction between the soil and wall (23.5º for Granular B Type II)

The seismic site coefficient and zonal acceleration ratio for the conditions at this site were provided in section 2.1.

Free-draining granular material or rockfill should be used as backfill behind the walls. The following parameters are recommended for design:

Parameters	Granular A or Granular B Type II	Rockfill
Angle of Internal Friction, degrees	35	42
Unit Weight, kN/m^3	22.8	18.0
Coefficient of Active Earth Pressure K_a	0.27	0.20
Coefficient of Earth Pressure At-Rest K_o	0.43	0.33
Coefficient of Passive Earth Pressure K_p	3.69	5.04

The coefficient of earth pressure at-rest should be used for design of rigid and unyielding walls, the active earth pressure coefficient for unrestrained structures. The earth pressure coefficients should be reviewed if the slope of the backfill exceeds 10° to the horizontal. Alternatively, the material above the top of the wall could be treated as a surcharge load (q in the preceding equation).

A weeping tile system (OPSS 405 and OPSD 3190.100) should be installed to minimise the build-up of hydrostatic pressure behind the walls. The weeping tiles should be surrounded by a properly designed granular filter or geotextile to prevent migration of fines into the system. The drainage pipe should be placed on a positive grade and lead to a frost-free outlet.

Backfilling adjacent to retaining structures should be carried out in conformance to Ontario Provincial Standards specifications for granular or rock backfill at abutments (OPSD 3101.150 and 3101.200).

Operation of compaction equipment adjacent to retaining structures should be restricted to limit the compaction pressure noted in clause 6.9.3 of the CHBDC. Refer to OPSS 501 for additional information in this regard.

4. APPROACH EMBANKMENTS

The height of fill embankments will be 5 m at the west approach and 7 to 9 m at the east approach. It is anticipated that the approach embankments will be constructed with earth borrow, granular material or rockfill. Construction of the fill on bedrock is considered to be feasible.

The peat / topsoil identified at the abutment locations and along the alignment of the approach fills within 20 m of the abutments should be stripped prior to placement of the embankment fill. All loose boulders should be removed from each approach embankment footprint.

The embankments should be constructed in accordance with OPSD 201.020, 202.010 and OPSS 206. The side slopes of the approach embankments should be inclined no steeper than 2H: 1V for earth fill and 1.25H: 1V for rockfill. A 2 m wide mid-height bench should be provided to limit the height of uninterrupted slopes to maximum 8 m for earth fill embankments and 10 m for rockfill embankments (OPSD 202.010).

Where slope flattening is proposed, a drainage gap should be provided in accordance with OPSD 202.020. Where slopes are flattened to eliminate the need for a guiderail, a granular infilled drainage gap should be provided in accordance with the Northeastern Region Pavement Design Practices and Guidelines as shown in Figure 1, appended. OPSS Granular B Type II should be used for the drainage gaps.

Where the bedrock surface slopes in the direction transverse to the roadway alignment, it should be benched in accordance with OPSD 208.010 to provide stable conditions.

It is considered that the approach embankments constructed in accordance with these recommendations will be stable. Settlement of the road surface will only be governed by

'consolidation' of the newly placed fill (settlement of the embankment fill due to consolidation of the bedrock at both embankments is negligible).

The backfill placed adjacent to the abutments will be about 5 to 7 m thick. The magnitude of 'consolidation' of this fill will be dependent on the workmanship employed by the contractor and, if placed in 200 to 300 mm thick lifts compacted to 100% of the standard Proctor maximum dry density in accordance with the requirements of OPSS 902 and OPSS 501 (Method A), should be in the order of 15 mm at the west abutment and about 20 mm at the east abutment. The settlement of the approach fill surface near the abutments should be essentially complete within 2 to 3 months after placement of the fill.

The settlement of the approach embankments made up of rockfill if used beyond the granular fill zone at the abutments is estimated to be 40 to 45 mm at the west approach and 60 to 75 mm at the east approach. The settlement remaining after 6 and 12 months following fill placement is 10 to 15 mm and 5 to 10 mm respectively. These values have been assessed using “Post-construction rock fill settlement and guidelines for estimating rock fill quantity” approved by MTO on April 12, 2010.

The embankment platform founded on bedrock should be widened by 1 m in accordance with the Northeastern Region Engineering Directive (NRE 98-200).

Earth fill slopes where employed should be protected against surface erosion by sodding and suitable vegetation. Refer to OPSS 803 or 804 for time constraints and the type of seed and mulch required.

5. EXCAVATION AND GROUNDWATER CONTROL

It is expected that excavation for construction of spread footings founded on bedrock will extend through the clayey soils and/or sand to a depth not exceeding 2 m at both abutments and the pier.

The typically firm to stiff silty clay / clayey silt and loose to compact sand are classified as Type 3 soils according to the Occupational Health and Safety Act (Ontario Regulation 213/91) criteria.

Temporary cut slopes in earth over the full depth of excavation should therefore be inclined at an angle of 45° to the horizontal. The need to excavate flatter sideslopes if excessively soft/wet materials or concentrated seepage zones are encountered locally during construction should be considered.

Bedrock is classified as Type 1 soil. Near vertical sidewalls (up to 10V:1H) may be utilised for temporary excavations in bedrock. Examination of the sidewalls and removal of any loosened rock fragments should be carried out continually for the safety of workmen.

Mechanical means such as 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 scaling at foundation locations (OPSS.PROV 202). Conventional rock excavation techniques such as blasting (OPSS 120), controlled blasting (OPSS.PROV 202) and trim blasting (OPSS.PROV 202) are likely to be required as well. The actual equipment required and method of excavation within the bedrock will be dependent upon the geometry of cut and the relative depth of excavation into the bedrock. Mass concrete could be employed to level minor variations in the bedrock surface.

If blasting is required, a NSSP should be prepared to provide specific direction to the contractor to control the blasting / rock excavation activities to prevent fracturing and/or disturbance of the bedrock surface on which footings will be founded; require that a blasting specialist be retained to establish the charge to minimise overbreak; advise the contractor that any overblasting / overexcavation will be the sole responsibility of the contractor and require that loosened rock resulting from blasting operations be removed by mechanical means.

Groundwater was at a depth of 0.3 m (elevation 201.0) in borehole WA-6 during and upon completion of drilling. Water (200 mm deep) was also present under snow and ice at 0.6 m depth (elevation 200.7) in borehole IC-7. It is anticipated that conventional sump pumping techniques will be sufficient to control seepage of groundwater into the foundation excavations. Groundwater levels are subject to seasonal fluctuations and precipitation patterns.

All work should be carried out in accordance with the Occupational Health and Safety Act (Ontario Regulation 213/91) and with local/MTO regulations.

6. CLOSURE

This report was prepared by Mr. G.O. Degil, PhD, P.Eng., Senior Foundation Engineer, and reviewed by Mr. B.R. Gray, MEng, P.Eng., MTO Designated Principal Contact. Mr. C.M.P. Nascimento, P.Eng., Project Manager, conducted an independent review of the report.

Yours very truly,

Peto MacCallum Ltd.

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TABLE 1

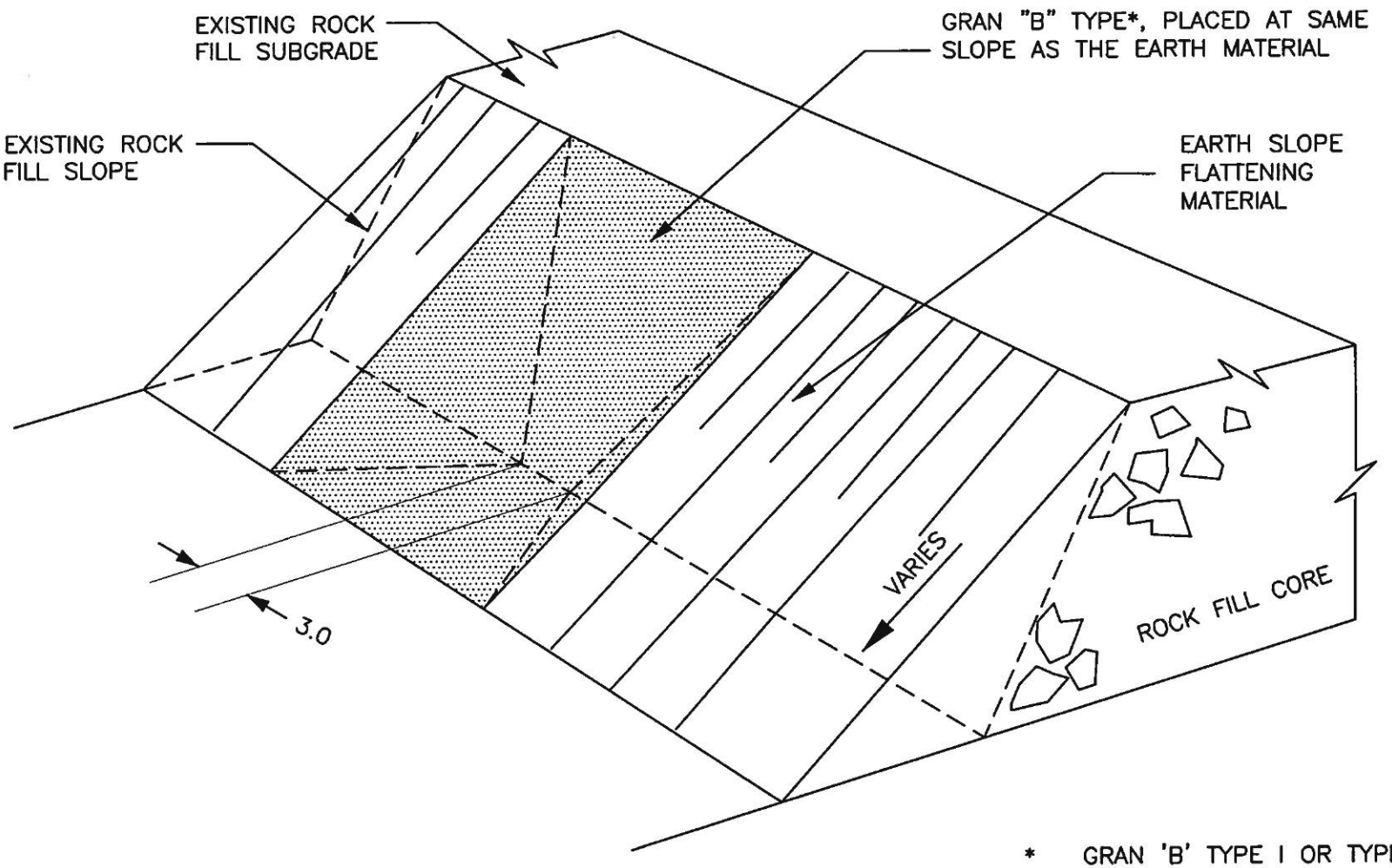
SUMMARY OF ADVANTAGES, DISADVANTAGES AND RECOMMENDED FOUNDATIONS

FOUNDATION TYPE	ADVANTAGES	DISADVANTAGES	RECOMMENDED FOUNDATION TYPE
WEST AND EAST ABUTMENTS			
Spread footings on rock	• Ease of construction • Minimal requirement for rock excavation • No requirement to provide erosion protection	• Need to place mass concrete to provide a level surface	Spread footings
Spread footings on engineered fill pad	Not appropriate		
Driven piles	• High capacity	• Too short piles; would require rock trenches or large diameter drilled holes • High cost relative to footings	
Caissons	• High capacity	• Special construction methods on sloping bedrock • High cost relative to other alternatives	

TABLE 2

LIST OF STANDARD SPECIFICATIONS REFERENCED IN REPORT

DOCUMENT	TITLE
OPSS 120	General Specification for the Use of Explosives
OPSS 206	Construction Specification for Grading
OPSS 405	Construction Specification for Pipe Subdrains
OPSS 501	Construction Specification for Compacting
OPSS 803	Construction Specification for Sodding
OPSS 804	Construction Specification for Seed and Cover
OPSS 902	Construction Specification for Excavation and Backfilling - Structures
OPSS.PROV 202	Rock Removal by Manual Scaling, Machine Scaling, Trim Blasting, or Controlled Blasting
SP 999S26	Requirements for Design, Installation and Testing of Temporary and Permanent Pre-Stressed Anchors in Soil and Rock
OPSD 201.020	Rock Grading-Divided Rural
OPSD 202.010	Slope Flattening Using Excess Material on Earth or Rock Embankment
OPSD 202.020	Drainage Gap for Slope Flattening on Rock or Granular Embankment
OPSD 208.010	Benching of Earth Slopes
OPSD 3101.150	Minimum Granular Backfill Requirements - Abutments
OPSD 3101.200	Walls Abutment, Backfill Rock
OPSD 3190.100	Retaining Wall and Abutment Wall Drain Detail
NRE 98-200	Northeastern Region Directive - Platform Widening



* GRAN 'B' TYPE I OR TYPE II AS RECOMMENDED FOR PROJECT.

FIGURE 1: ROCK FILL DRAINAGE IN SLOPE FLATTENED AREAS

NOT TO SCALE