PML Peto MacCallum Ltd.
CONSULTING ENGINEERS

FOUNDATION INVESTIGATION AND DESIGN REPORT

For

STEPHENSON ROAD 1 UNDERPASS
WP 5039-00-01, SITE 42-326
HIGHWAY 11
TOWNSHIP OF STEPHENSON / TOWNSHIP OF MACAULEY
MTO HUNTSVILLE AREA

PETO MacCALLUM LTD.
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PML Ref.: 04TF006-SR1
Index No.: 081FIR and 082FDR
Geocres No.: 31E-232
June 22, 2005

Peto MacCallum Ltd.
CONSULTING ENGINEERS

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For

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for
Stephenson Road 1 Underpass
WP 5039-00-01, Site 42-326
Highway 11
MTO Huntsville Area

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1. INTRODUCTION

This report summarizes the results of the foundation investigation carried out for the proposed construction of an underpass to be located at Stephenson Road 1 and Highway 11 some 15 km south of Huntsville, Ontario. The investigation was conducted for McCormick Rankin Corporation (MRC) on behalf of the Ontario Ministry of Transportation.

The report provides subsurface information pertaining to the proposed underpass structure and approaches within about 20 m of the abutments. Relevant data from the preliminary foundation investigation carried out by Golder Associates Limited (GAL) reference No. 011-1104 dated April 2001, is provided in this report.

2. SITE DESCRIPTION AND GEOLOGY

Stephenson Road 1 will be realigned and pass over Highway 11 at approximate Station 24+465, Highway 11 chainage, in the Geographic Township of Macauley, Town of Bracebridge, District Municipality of Muskoka (ref. Drawing 1 'Hwy 11 - Stephenson Road 1 Underpass. Preliminary General Arrangement' prepared by MRC September, 2004). Stephenson Road 1 is the boundary road between the Geographic Township of Stephenson, now located in the Town of Huntsville, and the Geographic Township of Macauley, now located in the Town of Bracebridge. The realigned roadway and new structure will be located approximately 50 m south of the existing Stephenson Road 1 and Highway 11 intersection.

Numerous rock exposures are visible along Highway 11 near the site. The vegetation cover is generally dense with mature trees and brush. A few residences and one commercial building (Wegner Furniture) exist near the site. Approximately 150 m to the west of the site is an existing high voltage electric corridor. The corridor crosses Stephenson Road 1 at an angle and crosses Highway 11, about 250 m north of Stephenson Road 1.

The structure to be erected will carry Stephenson Road 1 traffic over Highway 11. Highway 11 is designated as a south-north road. Therefore, the alignment of the underpass is considered to extend west-east. Photographs of the site are included in Appendix A.

The project site physiography comprises mainly sands and silts within a narrow strip of land that extends from Gravenhurst to North Bay ("The Physiography of Southern Ontario", Chapman and Putnam, 1984). Highway 11 roughly follows the alignment of this physiographic unit. The topography is irregular but typically undulating and dotted with areas of wet ground separated by steep rock ridges.

The site is located within the Central Gneiss Belt (Geologic Map 2544, Ministry of Northern Development and Mines) that comprises Precambrian rock formations. The typical rock types in the project area are migmatites, gneisses and felsic igneous rocks, such as granite. The soil/bedrock interface is at variable depths ranging from the surface to over 35 m, with the bedrock levels exhibiting locally sharp changes along the alignment.

3. INVESTIGATION PROCEDURES

The field work for this study was carried out during the period of October 23 to 25, 2004 and comprised 28 boreholes drilled to depths of 0.0 to 4.6 m at the locations shown on Drawing 1, appended. Further details are summarized in the following table:

LOCATION	BOREHOLE No.	DEPTH (m)		
		AUGER	ROCK CORE$^{(1)}$	TOTAL
West Approach	1-107	0.4	--	0.4
West Abutment	1-101	0.5	4.0	4.5
	1-102	0.8	--	0.8
	1-103	0.0	--	0.0
	1-104	0.1	3.9	4.0
	1-105	0.0	--	0.0
	1-106	0.0	--	0.0
	1-108	0.6	--	0.6
	1-109	0.6	4.0	4.6
	1-110	0.0	--	0.0

LOCATION	BOREHOLE No.	DEPTH (m)		
		AUGER	ROCK CORE[1]	TOTAL
Central Pier	1-111	0.2	--	0.2
	1-112	0.7	3.3	4.0
	1-113	0.2	--	0.2
	1-114	0.3	--	0.3
	1-115	0.2	3.0	3.2
	1-116	0.0	--	0.0
	1-117	0.9	--	0.9
	1-118	0.0	--	0.0
East Abutment	1-119	0.0	--	0.0
	1-120	0.0	--	0.0
	1-121	0.2	3.0	3.2
	1-122	0.0	3.1	3.1
	1-123	0.1	--	0.1
	1-124	0.8	--	0.8
	1-125	0.0	--	0.0
	1-126	0.3	3.0	3.3
	1-127	0.1	--	0.1
East Approach	1-128	0.0	--	0.0

(1) NQ diamond rock coring equipment

We also refer to Appendix B for the logs of previous boreholes drilled by GAL. The boreholes are identified as 1-1, 1-2, 1-3, 1-4, 1-5. These boreholes extended to depths ranging from 0.1 to 4.0 m, including the core depth.

The working points (WP) at the structure location were staked in the field by M.F. Tulloch Inc. The positions of the boreholes around the working points were selected by Peto MacCallum Ltd. The locations of and ground surface elevations at the boreholes were also determined by Peto MacCallum Ltd. based upon the elevation provided at each WP by M.F. Tulloch Inc.

The following temporary benchmarks (TBM) established on existing ground level at the working points (WP) for each of the foundation units were provided by M.F. Tulloch Inc.

TBM	DESCRIPTION	ELEVATION
TBM1	Existing ground at West Abutment, WP1	334.34
TBM2	Existing ground at Centre Pier, WP2	332.90
TBM3	Existing ground at East Abutment, WP3	332.64

The boreholes were advanced by hand (shovel) or using continuous flight hollow stem augers, powered by a track-mounted CME-55 Bombardier drill rig, supplied and operated by a specialist drilling contractor, working under the full-time supervision of a member of our engineering staff. Three boreholes at each abutment and two boreholes at the Centre Pier were extended 3.0 to 4.0 m into bedrock using NQ diamond rock coring equipment. The boreholes previously advanced by others included one bedrock core at each foundation element.

Due to shallow bedrock, only two samples of overburden material was obtained (in boreholes 1-1 and 1-112). In borehole 1-1, the material was a silty sand with organic inclusions while in borehole 1-112 the material was a fine fiberous peat followed by a sand, trace of silt.

The groundwater conditions at the borehole locations were assessed during drilling by visual examination of soil, the sampler and drill rods as the samples were retrieved and, when appropriate, by measurement of the water level in the open boreholes. Boreholes were backfilled with a bentonite/cement mixture in accordance with the MTO guidelines for borehole abandonment procedures.

4. SUMMARIZED SUBSURFACE CONDITIONS

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

The borehole locations and stratigraphic cross-sections prepared from the borehole data are presented on the appended Drawings 1, 2 and 3.

The subsurface stratigraphy revealed in the boreholes drilled at the site generally comprised a surficial topsoil or peat layer sometimes followed by a thin sand/silt deposit mantling shallow bedrock. Bedrock was exposed at 11 borehole locations and contacted/inferred in the remaining boreholes at depths of 0.1 to 0.9 m (elevation 329.5 to 334.4). The strata encountered are summarized below.

4.1 Topsoil/Peat

A surficial topsoil layer was encountered in boreholes 1-3, 1-5, 1-104, 1-111, 1-113, 1-114, 1-117, 1-123, 1-124 and 1-127. The topsoil had a thickness of 100 to 300 mm and was penetrated at elevation 329.5 to 334.1. Similarly, a deposit of peat was present surficially in boreholes 1-101, 1-102, 1-107, 1-108, 1-109, 1-112, 1-115, 1-121 and 1-126. The peat had a thickness of 200 to 500 mm and was penetrated at elevation 332.2 to 334.1.

4.2 Sand/Silt

A cohesionless deposit of sand and silt of various granulometric composition (sandy silt, silty sand, sand trace silt and sand and gravel) was encountered surficially in boreholes 1-1, 1-2, and 1-4 or directly beneath the topsoil or peat at elevation 334.1 to 332.1 in boreholes 1-101, 1-102, 1-107, 1-108, 1-109, 1-112, 1-117 and 1-124. This unit was 200 to 700 mm thick and penetrated at depths of 0.4 to 0.9 m (elevation 331.5 to 333.7).

Cobbles and boulders were encountered within the sand and gravel stratum in borehole 1-2.

4.3 Bedrock

Bedrock was exposed at elevation 331.3 to 334.4 in boreholes 1-103, 1-105, 1-106, 1-110, 1-116, 1-118, 1-119, 1-120, 1-122, 1-125 and 1-128. In the remaining boreholes, the bedrock surface was confirmed by rock coring or inferred by refusal at depths of 0.1 to 0.9 m (elevation 329.5 to 334.1). The bedrock comprises a granitic gneiss. The gneiss was dark grey to pink in colour, medium to coarse crystalline, moderate to slight banding.

A detailed description of the rock cores retrieved from boreholes 1-101, 1-104, 1-109, 1-112, 1-115, 1-121, 1-122 and 1-126 is provided in Table A, appended. Photographs of the cores taken from selected boreholes are shown in Appendix A. Descriptions of the rock cores retrieved by others in boreholes 1-1, 1-2, and 1-3 are provided on the respective drill logs.

The measured core recovery typically varied between 93 and 100% (81% in one sample from borehole 1-101). The RQD determined from the rock cores was in a typical range of 72 to 100%, indicating a fair to excellent quality rock. The upper rock cores in boreholes 1-104, 1-109, 1-122 and 1-126 exhibited an RQD of 49 to 67% (poor to fair quality rock). The rock is classified as medium to high strength. In general, the rock mass rating is described as good to excellent.

4.4 Groundwater

Groundwater was not observed in any of the boreholes during or upon completion of augering. However, minor seepage should be anticipated locally at the soil/bedrock interface within depressions in the bedrock surface.

Groundwater levels 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. E.A. Gonneau, MBA, P.Eng., Senior Engineer. The equipment was supplied by Marathon Drilling Co. Ltd.

The report was prepared by Mr. Eric A. Gonneau, MBA, P.Eng., and reviewed by Mr. Dennis W. Kerr, MEng, P.Eng., Chief Foundation Engineer. Mr. Brian R. Gray, MEng, P.Eng., MTO Designated Foundations Contact, carried out an independent review of the report.

Sincerely

Peto MacCallum Ltd.

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Registered Professional Engineer
D. W. KERR
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MTO Designated Foundations Contact

EAG/DWK/BRG:jlb

TABLE A

ROCK CORE DESCRIPTION

CORE RECOVERY					CORE DESCRIPTION	
HOLE NO.	CORE NO.	DEPTH (m)	RECOVERY (%)	RQD (%)	DEPTH (m)	DESCRIPTION
1-101	1	0.5 - 2.0	100	78	0.5 - 4.5	GRANITIC GNEISS: Grey to dark grey, medium crystalline, moderate banding with occasional concentrations of feldspar, becoming slightly banded to granite like, high strength, unweathered, close to moderate spaced flat to dipping partings, rough planar, tight to oxidized, good quality.
	2	2.0 - 3.6	97	90		
	3	3.6 - 4.5	81	81		
1-104	1	0.1 - 1.4	100	67	0.1 - 4.0	GRANITIC GNEISS: Light grey to pink, medium to coarse crystalline, with slight banding, high strength, unweathered, close to moderate spaced flat to dipping partings, rough planar, oxidized or slightly altered becoming tight below 2.3 m, fair to excellent quality.
	2	1.4 - 2.9	93	90		
	3	2.9 - 4.0	98	98		
1-109	1	0.6 - 2.2	100	49	0.6 - 4.6	GRANITIC GNEISS: Light grey to pink, medium crystalline, with slight banding, with layer of pink, coarse crystalline pegmatite, medium to high strength, slightly weathered to unweathered, close to moderate spaced flat to dipping partings, rough planar, oxidized to tight, numerous vertical partings with brown to rust coloured encrustation on surface, poor to excellent quality.
	2	2.2 - 3.7	100	100		
	3	3.7 - 4.6	97	83		

Originated: FP
Compiled: JFW
Checked: CN

TABLE A

ROCK CORE DESCRIPTION

CORE RECOVERY					CORE DESCRIPTION	
HOLE NO.	CORE NO.	DEPTH (m)	RECOVERY (%)	RQD (%)	DEPTH (m)	DESCRIPTION
1-112	2	0.7 - 2.1	100	100	0.7 - 4.0	GRANITIC GNEISS: Light grey to pink, medium crystalline, with slight banding, high strength, unweathered, close to moderate spaced flat to dipping partings, rough planar, oxidized to tight, good to excellent quality.
	3	2.1 - 3.6	97	78		
	4	3.6 - 4.0	100	75		
1-115	1	0.2 - 1.7	93	72	0.2 - 3.2	GRANITIC GNEISS: Light grey to pink, medium crystalline, with slight banding, high strength, slightly weathered to unweathered, very close to close spaced flat to dipping partings, occasional vertical parting, rough planar, oxidized to tight, fair to excellent quality.
	2	1.7 - 3.2	100	92		
1-121	1	0.2 - 1.7	100	83	0.2 - 3.2	GRANITIC GNEISS: Light grey to pink, medium to coarse crystalline, banded, occasional biotite concentrations, high strength, unweathered, close to moderate spaced flat partings, rough planar, generally tight, root hairs in parting at 1.1 m, fair to good quality.
	2	1.7 - 3.2	100	73		
1-122	1	0.0 - 1.5	100	67	0.0 - 3.1	GRANITIC GNEISS: Light grey to pink, medium crystalline, banded, with thin layers of muscovite, medium to high strength, slightly weathered to unweathered, close to moderate spaced flat partings, rough planar, slightly altered to oxidized to tight, fair to good, quality.
	2	1.5 - 3.1	98	85		
1-126	1	0.3 - 1.8	98	53	0.3 - 3.3	GRANITIC GNEISS: Light grey to pink, medium crystalline, slight banding, occasional thin layers of muscovite, medium to high strength, slightly weathered to unweathered, close spaced flat partings, rough planar, slightly altered to oxidized to tight, occasional schist like / friable on some partings, fair to good quality.
	2	1.8 - 3.3	98	90		

RQD: Rock Quality Designation

Originated: FP
Compiled: JFW
Checked: 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.

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/0.3 m)	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:

R Q D (%)	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

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		CONSISTENCY INDEX $= \frac{w_L - w}{I_p}$
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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RECORD OF BOREHOLE No 1-101

1 of 1 **METRIC**

G.W.P. 62-86-00
LOCATION Co-ords. 5 001 799 N; 319 582 E
ORIGINATED BY F.P.
DIST 52 HWY 11
BOREHOLE TYPE Shovel - NQ Rock Coring
COMPILED BY F.P.
DATUM Geodetic
DATE October 23, 2004
CHECKED BY

SOIL PROFILE			SAMPLES								
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS *	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 SHEAR STRENGTH kPa O 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
334.1	Ground Surface										
0.0	Peat, fine fibrous Dark brown						334				
0.2 333.6	Sandy silt Brown Moist										
0.5	Granitic Gneiss Bedrock High strength Unweathered Refer to table A for detailed description		1	RC NQ	REC 100%		333				RQD 78%
			2	RC NQ	REC 97%		332				RQD 90%
			3	RC NQ	REC 81%		331 330				RQD 81%
329.6 4.5	End of borehole										

* Borehole charged with drilling water

ON_MOT VER3 04TF006_SR1.GPJ ON_MOT.GDT 12/7/04 3:29:35 PM

+^{3}, ×^{3} : Numbers refer to Sensitivity

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

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RECORD OF BOREHOLE No 1-102

1 of 1 **METRIC**

G.W.P. 62-86-00
LOCATION Co-ords. 5 001 815 N; 319 582 E
ORIGINATED BY F.P.
DIST 52 HWY 11
BOREHOLE TYPE Hollow Stem Augers
COMPILED BY F.P.
DATUM Geodetic
DATE October 23, 2004
CHECKED BY

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	*					
334.2	Ground Surface										
0.0	Peat, fine fibrous Dark brown						334				
0.3 333.4	Sandy silt, organics inclusions Brown										
0.8	End of borehole Auger refusal on probable bedrock * Borehole dry on completion of drilling										

ON_MOT VER3 04TF006_SR1.GPJ ON_MOT.GDT 12/7/04 3:30:32 PM

$+^{3}, \times^{3}$: Numbers refer to Sensitivity

(%) STRAIN AT FAILURE

Ministry of Transportation
Ontario

Peto MacCallum Ltd.
Foundation Design

RECORD OF BOREHOLE No 1-103

1 of 1 **METRIC**

G.W.P. 62-86-00
LOCATION Co-ords. 5 001 800 N; 319 534 E
ORIGINATED BY F.P.
DIST 52 HWY 11
BOREHOLE TYPE Shovel
COMPILED BY F.P.
DATUM Geodetic
DATE October 23, 2004
CHECKED BY

SOIL PROFILE		SAMPLES						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	GROUND WATER CONDITIONS *	ELEVATION SCALE				
334.1	Ground Surface										
0.0	Bedrock at surface										
	* Borehole dry										

$+^3, \times^3$: Numbers refer to Sensitivity

(%) STRAIN AT FAILURE

Ministry of Transportation
Ontario

Peto MacCallum Ltd.
Foundation Design

RECORD OF BOREHOLE No 1-104

1 of 1 **METRIC**

G.W.P. 62-36-00
LOCATION Co-ords. 5 001 816 N; 319 584 E
ORIGINATED BY [illegible]
DIST 52 HWY 11
BOREHOLE TYPE Shovel + NQ Rock Coring
COMPILED BY [illegible]
DATUM Geodetic
DATE October 22, 2004
CHECKED BY

SOIL PROFILE			SAMPLES								
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"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
334.2	Ground Surface										
0.0	Topsoil						334				
0.1	Granitic Gneiss Bedrock High strength Unweathered Refer to Table A for detailed description		1	RC NQ	REC 100%		333				RQD 67%
			2	RC NQ	REC 93%		332				RQD 90%
			3	RC NQ	REC 98%		331				RQD 98%
330.2 4.0	End of borehole										

* Borehole charged with drilling water

ON_MOT VER3 04TF006_SR1.GPJ ON_MOT.GDT 12/7/04 3:30:39 PM

+3, ×3: Numbers refer to Sensitivity

(%) STRAIN AT FAILURE

Ministry of Transportation
Ontario

Peto MacCallum Ltd.
Foundation Design

RECORD OF BOREHOLE No 1-105

1 of 1 **METRIC**

G.W.P. 62-86-00
LOCATION Co-ords. 5 001 801 N; 319 587 E
ORIGINATED BY F.P.
DIST 52 HWY 11
BOREHOLE TYPE Shovel
COMPILED BY F.P.
DATUM Geodetic
DATE October 23, 2004
CHECKED BY

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
333.4	Ground Surface													
0.0	Bedrock at surface													
	* Borehole dry													

CN_MOT LINES OVER BDRY C4TF006_SR1.GPJ ON_MOT.GDT 12/7/04 3:36:17 PM

$+^3, \times^3$: Numbers refer to Sensitivity

(%) STRAIN AT FAILURE

Ministry of Transportation
Ontario

Peto MacCallum Ltd.
Foundation Design

RECORD OF BOREHOLE No 1-106

1 of 1 **METRIC**

G.W.P. 62-36-00
DIST 52 HWY 11
DATUM Geodetic
LOCATION Co-ords. 5 001 917 N; 339 587 E
BOREHOLE TYPE Shovel
DATE October 23, 2004
ORIGINATED BY F.P.
COMPILED BY F.P.
CHECKED BY

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	*					
334.4	Ground Surface										
0.0	Bedrock at surface										

* Borehole dry

+³, ×³: Numbers refer to Sensitivity

20
15 ─○─ 5 (%) STRAIN AT FAILURE
10

Ministry of Transportation
Ontario

Peto MacCallum Ltd.
Foundation Design

RECORD OF BOREHOLE No 1-107

1 of 1 **METRIC**

G.W.P. 62-36-00
LOCATION Co-ords. 5 001 [illegible] N; [illegible] 565 E
ORIGINATED BY P.P.
DIST 52 HWY 11
BOREHOLE TYPE Shovel
COMPILED BY P.P.
DATUM Geodetic
DATE October 23, 2004
CHECKED BY

SOIL PROFILE			SAMPLES									
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"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	
333.4	Ground Surface											
0.0	Peat, fine fibrous Dark brown											
0.2												
333.0 0.4	Sandy silt, organics inclusions Brown						333					
	End of borehole Refusal on probable bedrock											
	* Borehole dry											

ON_MOT VER3 04TF006_SR1 GPJ ON_MOT GDT 12/7/04 3:33:54 PM

+³, ×³: Numbers refer to Sensitivity

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

Ministry of Transportation Ontario

Peto MacCallum Ltd.
Foundation Design

RECORD OF BOREHOLE No 1-108

1 of 1

METRIC

G.W.P. 62-86-00
LOCATION Co-ords. 5 001 807 N; 319 582 E
ORIGINATED BY S.P.
DIST 52 HWY 11
BOREHOLE TYPE Hollow Stem Augers
COMPILED BY S.P.
DATUM Geodetic
DATE October 23, 2004
CHECKED BY

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	*					
334.3	Ground Surface										
0.0	Peat, fine fibrous										
0.2	Dark brown						334				
333.7 0.6	Sandy silt, organics inclusions Brown End of borehole Auger refusal on probable bedrock										

* Borehole dry on completion of drilling

CN_MOT VER3 04TF006_SR1.GPJ CN_MOT.GDT 12/7/04 3:31:21 PM

+ , × : Numbers refer to Sensitivity

10 (%) STRAIN AT FAILURE

Ministry of Transportation
Ontario

Peto MacCallum Ltd.
Foundation Design

RECORD OF BOREHOLE No 1-109

1 of 1 **METRIC**

G.W.P. 62-66-00 LOCATION Co-ord. 5 001 808 N; 319 534 E ORIGINATED BY F.P.
DIST 52 HWY 11 BOREHOLE TYPE Hollow Stem Augers + NQ Rock Coring COMPILED BY F.P.
DATUM Geodetic DATE October 23, 2004 CHECKED BY

SOIL PROFILE			SAMPLES					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	GROUND WATER CONDITIONS *	ELEVATION SCALE				
334.3	Ground Surface										
0.0	Peat, fine fibrous Dark brown						334				
0.2	Sandy silt Brown Moist										
333.7 0.6	Granitic Gneiss Bedrock Medium to high strength Slightly weathered to unweathered Refer to Table A for detailed description		1	RC NQ	REC 100%		333				RQD 49%
			2	RC NQ	REC 100%		332 331				RQD 100%
			3	RC NQ	REC 97%		330				RQD 83%
329.7 4.6	End of borehole										
	* Borehole charged with drilling water										

$+^3, \times^3$: Numbers refer to Sensitivity

(%) STRAIN AT FAILURE

Ministry of Transportation
Ontario

Peto MacCallum Ltd.
Foundation Design

RECORD OF BOREHOLE No 1-110

1 of 1 **METRIC**

G.W.P.	62-86-00	LOCATION	Co-ords. 5 001 809 N; 313 587 E	ORIGINATED BY	P.P.
DIST 5_	HWY 11	BOREHOLE TYPE	Shovel	COMPILED BY	P.P.
DATUM	Geodetic	DATE	October 23, 2004	CHECKED BY	

SOIL PROFILE			SAMPLES						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	GROUND WATER CONDITIONS *	ELEVATION SCALE					
333.2	Ground Surface											
0.0	Bedrock at surface											
	* Borehole dry											

CN_MOT LINES OVER FDRY 04TF006_SR1.GPJ CN_MOT.GDT 12/7/04 3:26:24 PM

+ , ×³ ⁾ Numbers refer to Sensitivity

(%) STRAIN AT FAILURE

Ministry of Transportation
Ontario

Peto MacCallum Ltd.
Foundation Design

RECORD OF BOREHOLE No 1-111

1 of 1 **METRIC**

G.W.P. 62-86-00 LOCATION Co-ords. 5 001 811 N; 319 618 E ORIGINATED BY F.P.
DIST 52 HWY 11 BOREHOLE TYPE Shovel COMPILED BY F.P.
DATUM Geodetic DATE October 25, 2004 CHECKED BY

SOIL PROFILE			SAMPLES											
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"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
332.7	Ground Surface													
0.0	Topsoil	~~												
0.2	End of borehole													
	Refusal on probable bedrock													
	* Borehole dry													

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

1 —○— 5 10 (%) STRAIN AT FAILURE

Ministry of Transportation
Ontario

Peto MacCallum Ltd.
Foundation Design

RECORD OF BOREHOLE No 1-112

1 of 1

METRIC

G.W.P. 62-56-00
LOCATION Co-ords. 5 001 827 N; 319 617 E
ORIGINATED BY F.P.
DIST 52 HWY 11
BOREHOLE TYPE Hollow Stem Augers + NQ Rock Coring
COMPILED BY F.P.
DATUM Geodetic
DATE October 25, 2004
CHECKED BY

SOIL PROFILE			SAMPLES								
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"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
332.9	Ground Surface										
0.0 332.4 0.5	Peat, fine fibrous Dark brown		1	SS	11						
332.2 0.7	Sand trace silt Moist										
	Granitic Gneiss Bedrock High strength Unweathered Refer to Table A for detailed description		2	RC NQ	REC 100%		332 331				RQD 100%
			3	RC NQ	REC 97%		330				RQD 78%
328.9 4.0			4	RC NQ	REC 100%		329				RQD 75%
	End of borehole										

* Borehole charged with drilling water

+³, ×³: Numbers refer to Sensitivity
(%) STRAIN AT FAILURE

Ministry of Transportation
Ontario

Peto MacCallum Ltd.
Foundation Design

RECORD OF BOREHOLE No 1-113

1 of 1 **METRIC**

G.W.P. 62-56-00	LOCATION Co-ords. 5 001 912 N; 319 619 E		ORIGINATED BY F.P.
DIST 52	HWY 11	BOREHOLE TYPE Shovel	COMPILED BY F.P.
DATUM Geodetic	DATE October 15, 2004		CHECKED BY

SOIL PROFILE			SAMPLES					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	GROUND WATER CONDITIONS	ELEVATION SCALE				GR	SA	SI	CL
332.8	Ground Surface					*								
0.0	Topsoil	≈												
0.2	End of borehole Refusal on probable bedrock * Borehole dry													

+³, ×³: Numbers refer to Sensitivity

20 15 10 5 (%) STRAIN AT FAILURE

Ministry of Transportation
Ontario

Peto MacCallum Ltd.
Foundation Design

RECORD OF BOREHOLE No 1-114

1 of 1 **METRIC**

G.W.P. 62-36-00
LOCATION Co-ords. 5 001 828 N; 319 619 E
ORIGINATED BY P.P.
DIST 52 HWY 11
BOREHOLE TYPE Shovel
COMPILED BY P.P.
DATUM Geodetic
DATE October 25, 2004
CHECKED BY

SOIL PROFILE			SAMPLES					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	GROUND WATER CONDITIONS	ELEVATION SCALE				
333.0	Ground Surface					*					
0.0	Topsoil Dark brown	≈≈									
0.3	End of borehole Refusal on probable bedrock										

* Borehole dry

$+^3$, $\times^3$: Numbers refer to Sensitivity

(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 1-115

1 of 1

METRIC

G.W.P. 62-86-00
LOCATION Co-ords. 5 001 813 N; 319 422 E
ORIGINATED BY F.P.
DIST 52 HWY 11
BOREHOLE TYPE Hollow Stem Augers - NQ Rock Coring
COMPILED BY F.P.
DATUM Geodetic
DATE October 15, 2004
CHECKED BY

SOIL PROFILE			SAMPLES								
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"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
332.4	Ground Surface										
0.0	Peat, fine fibrous Dark brown										
0.2	Granitic Gneiss Bedrock High strength Slightly weathered to unweathered Refer to Table A for detailed description		1	RC NQ	REC 93%		332 331				RQD 72%
			2	RC NQ	REC 100%		330				RQD 92%
329.2 3.2	End of borehole										

* Borehole charged with drilling water

+³, ×³: Numbers refer to Sensitivity

(%) STRAIN AT FAILURE

Ministry of Transportation
Ontario

Peto MacCallum Ltd.
Foundation Design

RECORD OF BOREHOLE No 1-116

1 of 1 **METRIC**

G.W.P. 62-66-00
LOCATION Co-ords. 5 001 628 N; 319 622 E
ORIGINATED BY P.P.
DIST 52 HWY 11
BOREHOLE TYPE Shovel
COMPILED BY P.P.
DATUM Geodetic
DATE October 25, 2004
CHECKED BY

SOIL PROFILE			SAMPLES								
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"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
332.4	Ground Surface										
0.0	Bedrock at surface										
	* Borehole dry										

+3, ×3: Numbers refer to Sensitivity

(%) STRAIN AT FAILURE

Ministry of Transportation
Ontario

Peto MacCallum Ltd.
Foundation Design

RECORD OF BOREHOLE No 1-117

1 of 1 **METRIC**

G.W.P. 62-86-00
LOCATION Co-ords. 5 001 8_9 N; 319 617 E
ORIGINATED BY P.P.
DIST 52 HWY 11
BOREHOLE TYPE Hollow Stem Augers
COMPILED BY P.P.
DATUM Geodetic
DATE October 25, 2004
CHECKED BY

SOIL PROFILE			SAMPLES					DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 SHEAR STRENGTH kPa O UNCONFINED + FIELD VANE ● QUICK TRIAXIAL X 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	GROUND WATER CONDITIONS *	ELEVATION SCALE				
332.9	Ground Surface										
0.0	Topsoil										
0.2	Sandy silt Brown Moist										
332.0 0.9	End of borehole Refusal on probable bedrock						332				
	* Borehole dry										

CN_MOT VER3 04TF006_CR1 GPJ CN_MOT GDT 12.7.04 3 32 06 PM

+ , X : Numbers refer to Sensitivity

(%) STRAIN AT FAILURE

Ministry of Transportation
Ontario

Peto MacCallum Ltd.
Foundation Design

RECORD OF BOREHOLE No 1-118

1 of 1

METRIC

G.W.P. 62-86-00
LOCATION Co-ords. 5 001 821 N; 319 622 E
ORIGINATED BY P.P.
DIST 52 HWY 11
BOREHOLE TYPE Shovel
COMPILED BY P.P.
DATUM Geodetic
DATE October 25, 2004
CHECKED BY

SOIL PROFILE			SAMPLES					DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 SHEAR STRENGTH kPa O UNCONFINED + FIELD VANE ● QUICK TRIAXIAL X 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	GROUND WATER CONDITIONS *	ELEVATION SCALE				
332.2	Ground Surface										
0.0	Bedrock at surface										
	* Borehole dry										

+ , X : Numbers refer to Sensitivity

(%) STRAIN AT FAILURE

Ministry of Transportation
Ontario

Peto MacCallum Ltd.
Foundation Design

RECORD OF BOREHOLE No 1-119

1 of 1

METRIC

G.W.P. 62-56-00
LOCATION Co-ords. 5 001 611 N; 319 652 E
ORIGINATED BY F.P.
DIST 52 HWY 11
BOREHOLE TYPE Shovel
COMPILED BY F.P.
DATUM Geodetic
DATE October 24, 2004
CHECKED BY

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	*					
331.0	Ground Surface										
0.0	Bedrock at surface										
	* Borehole dry										

ON_MOT LINES OVER BDRY 04TF006_SR1 GPJ ON_MOT GDT 12 7 04 3 36 46 PM

+ 3, ×3: Numbers refer to Sensitivity

(%) STRAIN AT FAILURE

Ministry of Transportation
Ontario

Peto MacCallum Ltd.
Foundation Design

RECORD OF BOREHOLE No 1-120

1 of 1 **METRIC**

G.W.P. 62-36-00
LOCATION Co-ords. 5 001 339 N; 319 652 E
ORIGINATED BY F.P.
DIST 52 HWY 11
BOREHOLE TYPE Shovel
COMPILED BY F.P.
DATUM Geodetic
DATE October 24, 2004
CHECKED BY

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	*					
332.5	Ground Surface										
0.0	Bedrock at surface										
	* Borehole dry										

+³, ×³: Numbers refer to Sensitivity

(%) STRAIN AT FAILURE

Ministry of Transportation Ontario

Peto MacCallum Ltd.
Foundation Design

RECORD OF BOREHOLE No 1-121

1 of 1 **METRIC**

G.W.P. 22-86-00
LOCATION Co-ords. 5 001 824 N; 319 654 E
ORIGINATED BY F.P.
DIST 52 HWY 11
BOREHOLE TYPE Hollow Stem Augers + NQ Rock Coring
COMPILED BY F.P.
DATUM Geodetic
DATE October 24, 2004
CHECKED BY

SOIL PROFILE			SAMPLES					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	GROUND WATER CONDITIONS *	ELEVATION SCALE				
332.4	Ground Surface										
0.0	Peat, coarse fibrous Dark brown										
0.2	Granitic Gneiss Bedrock High strength Unweathered Refer to Table A for detailed description		1	RC NQ	REC 100%		332 331				RQD 83%
			2	RC NQ	REC 100%		330				RQD 73%
329.2 3.2	End of borehole										

* Borehole charged with drilling water

CN_MOT VER3 04TF006_SR1.GPJ CN_MOT.GDT 12/7/04 3:32:16 PM

$+^{3}$, $\times^{3}$: Numbers refer to Sensitivity

1 —○— 3 (%) STRAIN AT FAILURE, 15

Ministry of Transportation
Ontario

Peto MacCallum Ltd.
Foundation Design

RECORD OF BOREHOLE No 1-122

1 of 1 **METRIC**

G.W.P. 62-66-00
LOCATION Co-ords. 5 001 639 N; 319 654 E
ORIGINATED BY F.P.
DIST 52 HWY 11
BOREHOLE TYPE Hollow Stem Augers + NQ Rock Coring
COMPILED BY M.P.
DATUM Geodetic
DATE October 24, 2004
CHECKED BY

DYNAMIC CONE PENETRATION RESISTANCE PLOT: 20, 40, 60, 80, 100
SHEAR STRENGTH kPa: ○ UNCONFINED; + FIELD VANE; ● QUICK TRIAXIAL; X 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

SOIL PROFILE			SAMPLES								
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS *	ELEVATION SCALE	DYNAMIC CONE PENETRATION / SHEAR STRENGTH kPa	WATER CONTENT (%)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
332.6	Ground Surface										
0.0	Granitic Gneiss Bedrock Medium to high strength Slightly weathered to unweathered Refer to Table A for detailed description	▨	1	RC NQ	REC 100%		332				RQD 67%
		▨	2	RC NQ	REC 98%		331 330				RQD 85%
329.5 3.1											

* Borehole charged with drilling water

$+^3$, $\times^3$: Numbers refer to Sensitivity

(%) STRAIN AT FAILURE

Ministry of Transportation
Ontario

Peto MacCallum Ltd.
Foundation Design

RECORD OF BOREHOLE No 1-123

1 of 1 **METRIC**

G.W.P.	62-86-00	LOCATION	Co-ords. 5 001 825 N; 319 657 E	ORIGINATED BY	P.P.
DIST 52	HWY 11	BOREHOLE TYPE	Shovel	COMPILED BY	P.P.
DATUM	Geodetic	DATE	October 24, 2004	CHECKED BY	

SOIL PROFILE			SAMPLES					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	GROUND WATER CONDITIONS *	ELEVATION SCALE				
332.2	Ground Surface										
0.0	Topsoil										
0.1	End of borehole Refusal on probable bedrock * Borehole dry										

+³, ×³: Numbers refer to Sensitivity

(%) STRAIN AT FAILURE

Ministry of Transportation
Ontario

Peto MacCallum Ltd.
Foundation Design

RECORD OF BOREHOLE No 1-124

1 of 1 **METRIC**

G.W.P. 62-96-00
LOCATION Co-ords. 5 001 840 N; 319 657 E
ORIGINATED BY F.P.
DIST 52 HWY 11
BOREHOLE TYPE Hollow Stem Augers
COMPILED BY F.P.
DATUM Geodetic
DATE October 24, 2004
CHECKED BY

SOIL PROFILE			SAMPLES					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	GROUND WATER CONDITIONS *	ELEVATION SCALE				
332.3	Ground Surface										
0.0	Topsoil										
0.2	Silty sand Brown Moist						332				
331.5 0.8	End of borehole Auger refusal on probable bedrock										

* Borehole dry

CN_MOT VER3 04TF006_SR1.GPJ ON_MOT.GDT 12/7/04 3:32:16 PM

+³, ×³: Numbers refer to Sensitivity

(%) STRAIN AT FAILURE

Ministry of Transportation
Ontario

Peto MacCallum Ltd.
Foundation Design

RECORD OF BOREHOLE No 1-125

1 of 1 **METRIC**

G.W.P. 62-86-00
LOCATION Co-ords. 5 001 831 N; 319 651 E
ORIGINATED BY F.P.
DIST 52 HWY 11
BOREHOLE TYPE Shovel
COMPILED BY F.P.
DATUM Geodetic
DATE October 24, 2004
CHECKED BY

SOIL PROFILE		SAMPLES						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	GROUND WATER CONDITIONS	ELEVATION SCALE				
332.5	Ground Surface										
0.0	Bedrock at surface * Borehole dry										

CN_MOT LINES OVER BDRY 04TF006_SR1.GPJ CN_MOT.GDT 12/7/04 3:36:57 PM

$+^{7}$, $\times^{3}$: Numbers refer to Sensitivity

(%) STRAIN AT FAILURE

Ministry of Transportation
Ontario

Peto MacCallum Ltd.
Foundation Design

RECORD OF BOREHOLE No 1-126

1 of 1 **METRIC**

G.W.P. 62-86-00
LOCATION Co-ords. 5 001 832 N; 319 654 E
ORIGINATED BY P.P.
DIST 52 HWY 11
BOREHOLE TYPE Hollow Stem Augers + NQ Rock Coring
COMPILED BY P.P.
DATUM Geodetic
DATE October 24, 2004
CHECKED BY

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	*					
332.6	Ground Surface										
0.0	Peat, coarse fibrous Dark brown										
0.3	Granitic Gneiss Bedrock Medium to high strength Refer to Table A for deatiled description		1	RC NQ	REC 96%		332 331				RQD 53%
			2	RC NQ	REC 93%		330				RQD 90%
329.3 3.3	End of borehole										

* Borehole charged with drilling water

ON_MOT VER3 04TF006_SR1.GPJ ON_MOT.GDT 12/7/04 3:32:42 PM

+³, ×³ : Numbers refer to Sensitivity

(%) STRAIN AT FAILURE

Ministry of Transportation
Ontario

Peto MacCallum Ltd.
Foundation Design

RECORD OF BOREHOLE No 1-127

1 of 1 **METRIC**

G.W.P. 62-86-00
LOCATION Co-ords. 5 001 832 N; 313 657 E
ORIGINATED BY F.P.
DIST 52 HWY 11
BOREHOLE TYPE Shovel
COMPILED BY F.P.
DATUM Geodetic
DATE October 24, 2004
CHECKED BY

SOIL PROFILE			SAMPLES					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	GROUND WATER CONDITIONS *	ELEVATION SCALE				
332.2	Ground Surface										
0.0	Topsoil										
0.1	End of borehole Refusal on probable bedrock * Borehole dry										

+^{3}, ×^{5}: Numbers refer to Sensitivity

$\overset{20}{15\text{—}\circ\text{—}5}\underset{10}{}$ (%) STRAIN AT FAILURE

Ministry of Transportation
Ontario

Peto MacCallum Ltd.
Foundation Design

RECORD OF BOREHOLE No 1-128

1 of 1 **METRIC**

G.W.P. 57-86-00
LOCATION Co-ords. 5 001 336 N; 319 673 E
ORIGINATED BY F.P.
DIST 52 HWY 11
BOREHOLE TYPE Shovel
COMPILED BY F.P.
DATUM Geodetic
DATE October 24, 2004
CHECKED BY

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	*					
331.3	Ground Surface										
0.0	Bedrock at surface										
	* Borehole dry										

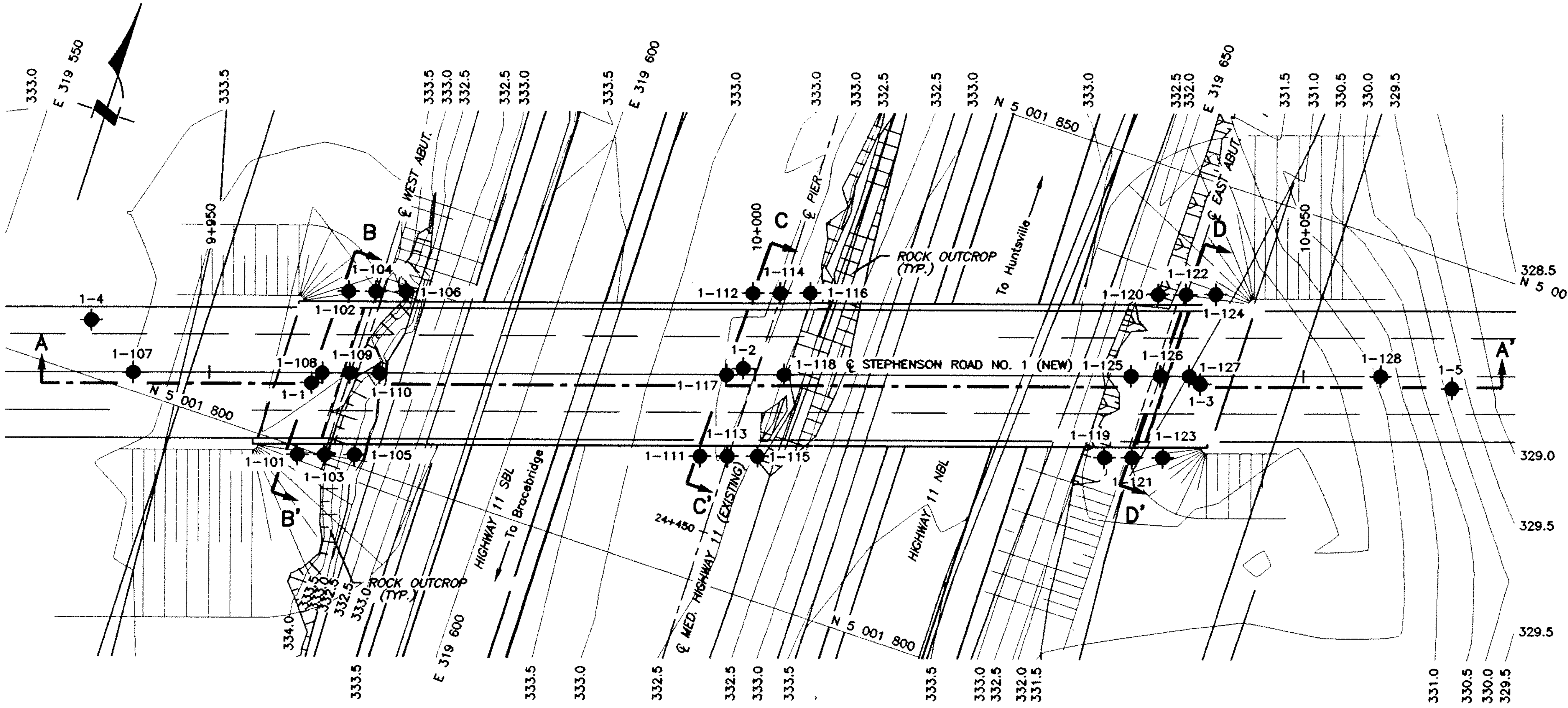
ON_MOT LINES OVER BDRY 04TF006_SR1.GPJ ON_MOT.GDT 12/7/04 3:37:05 PM

+³ , ×³ : Numbers refer to Sensitivity

(%) STRAIN AT FAILURE

(Legend Continued)

BH No	ELEVATION	CO-ORDINATES NORTH	EAST
1-106	334.4	5 001 817	319 587
1-107	333.4	5 001 802	319 565
1-108	334.3	5 001 807	319 582
1-109	334.3	5 001 808	319 584
1-110	333.2	5 001 809	319 587
1-111	332.7	5 001 811	319 618
1-112	332.9	5 001 827	319 617
1-113	332.8	5 001 812	319 619
1-114	333.0	5 001 828	319 619
1-115	332.4	5 001 813	319 622
1-116	332.4	5 001 828	319 622
1-117	332.9	5 001 819	319 617
1-118	332.2	5 001 821	319 622
1-119	331.9	5 001 823	319 652
1-120	332.5	5 001 839	319 652
1-121	332.4	5 001 824	319 654
1-122	332.6	5 001 839	319 654
1-123	332.2	5 001 825	319 657
1-124	332.3	5 001 840	319 657
1-125	332.5	5 001 831	319 652
1-126	332.6	5 001 832	319 654
1-127	332.2	5 001 832	319 657
1-128	331.3	5 001 838	319 673



PLAN
SCALE
5 0 5 10m

METRIC

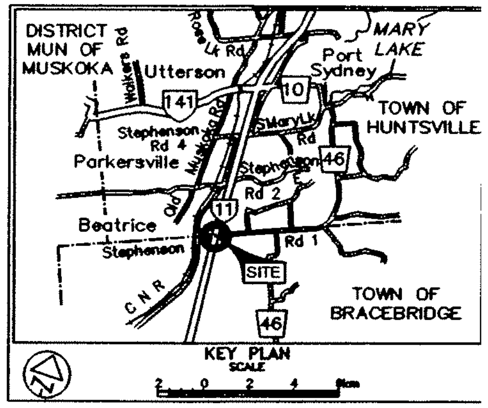
DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN. STATIONS IN KILOMETRES + METRES

CONT No
WP No 5039-00-01

HIGHWAY 11
STEPHENSON ROAD No. 1 UNDERPASS
BOREHOLE LOCATIONS

SHEET

Peto MacCallum Ltd.
CONSULTING ENGINEERS



KEY PLAN
SCALE

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)

▼ W L at time of investigation Oct 2004

▽ Head
ARTESIAN WATER
Encountered

BH No	ELEVATION	CO-ORDINATES NORTH	EAST
1-1	334.7	5 001 806	319 581
1-2	333.0	5 001 820	319 618
1-3	332.5	5 001 832	319 658
1-4	333.2	5 001 805	319 560
1-5	329.6	5 001 839	319 680
1-101	334.1	5 001 799	319 582
1-102	334.2	5 001 815	319 582
1-103	334.1	5 001 800	319 584
1-104	334.2	5 001 816	319 584
1-105	333.4	5 001 801	319 587

(Legend Continues)

- NOTE -

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

NOTES:

1. BOREHOLES 1-1 TO 1-5 WERE DRILLED BY GOLDER ASSOCIATES; REPORT REFERENCE NO. 011-1104 DATED APRIL 2001
2. REFER TO DRAWING NO. 2 AND 3 FOR SECTIONS A-A' TO D-D'.

E. A. GONNEAU

D. W. KERR

B. R. GRAY

REF No E-S5568-310GA001.dwg; h5568xB1.dwg; h5568xB2.dwg; October, 2004

REVISIONS DATE	BY	DESCRIPTION

Geocres No. 31E-232

HWY No 11			DIST 52
SUBM'D FP	CHECKED EG	DATE JUNE 17, 2005	SITE 42-328
DRAWN NA/MM	CHECKED BRG	APPROVED DWK	DWG 1

METRIC

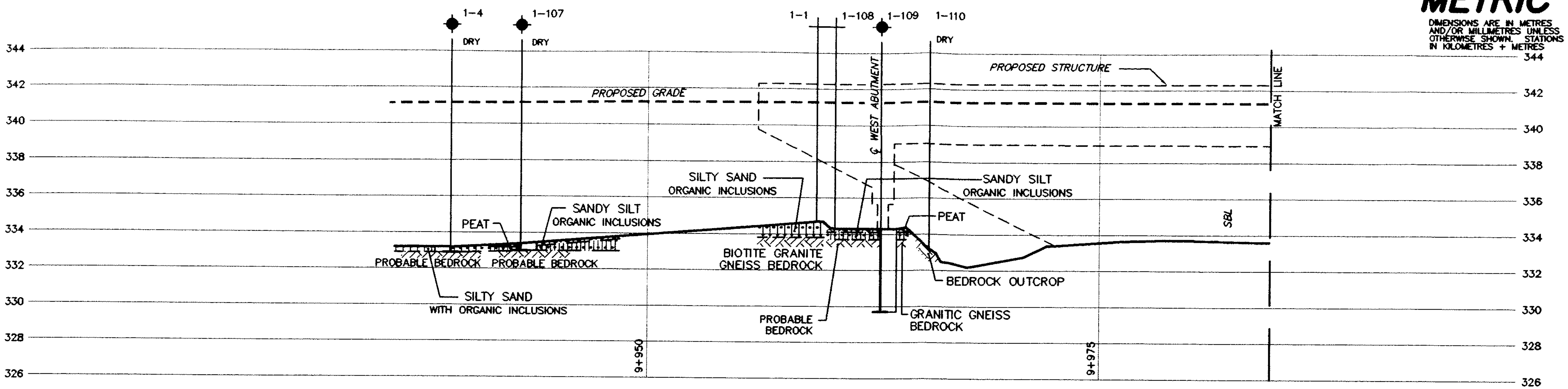
DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN. STATIONS IN KILOMETRES + METRES

CONT No
WP No 5039-00-01

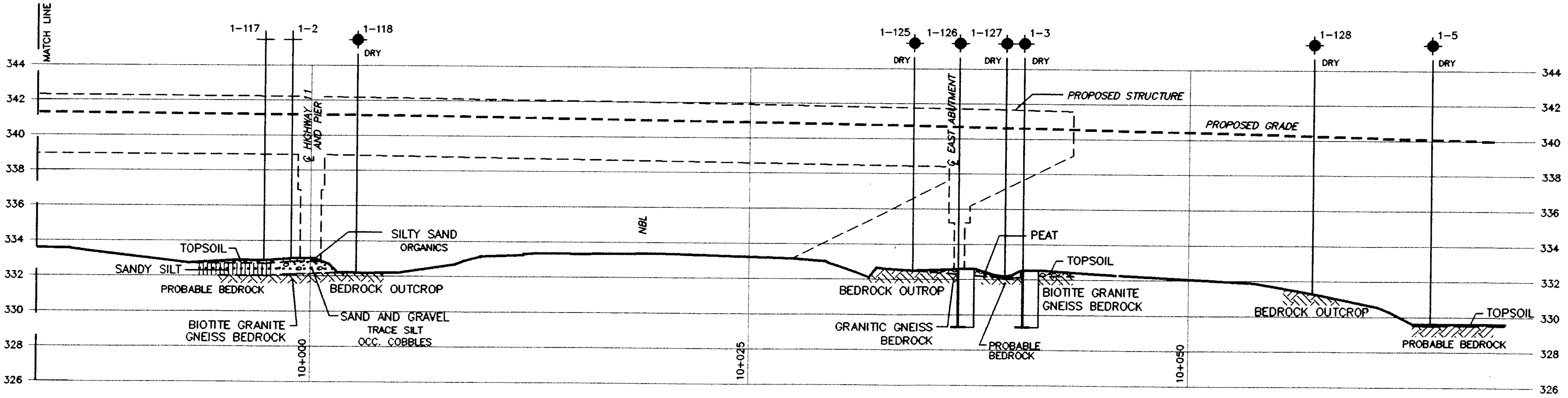
HIGHWAY 11
STEPHENSON ROAD No. 1 UNDERPASS
SOIL STRATA

SHEET

Peto MacCallum Ltd.
CONSULTING ENGINEERS

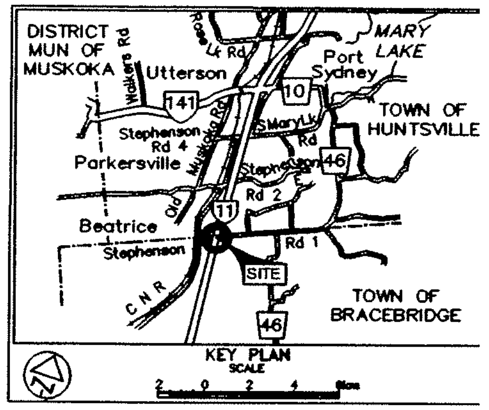


SECTION A–A'



SECTION A–A' (Continued)

SCALE
2.5 0 2.5 5m



KEY PLAN
SCALE
2 0 2 4 6km

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)
▼	W L at time of investigation Oct 2004
▽	Head ARTESIAN WATER Encountered

BH No	ELEVATION	CO-ORDINATES NORTH	CO-ORDINATES EAST
Refer to drawing 1 for co-ordinates			

NOTES:

1. BOREHOLES 1-1 TO 1-5 WERE DRILLED BY GOLDER ASSOCIATES; REPORT REFERENCE NO. 011-1104 DATED APRIL 2001
2. REFER TO DRAWING NO. 1 AND 3 FOR PLAN AND SECTIONS B-B' TO D-D'.
3. SECTIONS ARE PROVIDED SOLELY FOR ILLUSTRATIVE PURPOSES. REFER TO RECORD OF BOREHOLES FOR DETAILED DESCRIPTION OF SUBSURFACE CONDITIONS, IN-SITU TEST DATA AND LABORATORY TEST RESULTS.

E. A. GONNEAU

D. W. KERR

R. R. GRAY

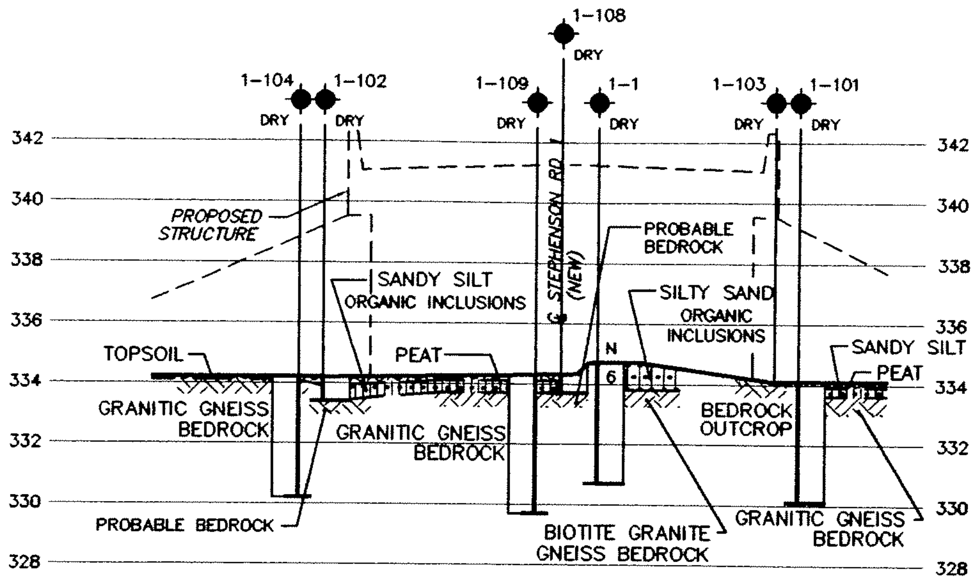
– NOTE –
The boundaries between soil strata have been established only at Borehole locations. Between Boreholes the boundaries are assumed from geological evidence.

REVISIONS DATE	BY	DESCRIPTION

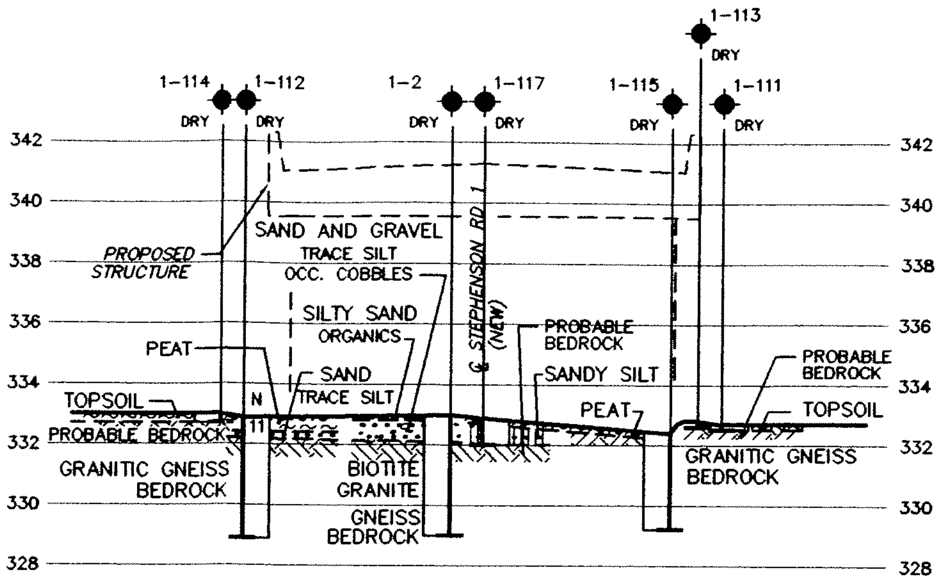
Geocres No. 31E-232

HWY No 11			DIST 52
SUBM'D FP	CHECKED EG	DATE JUNE 17, 2005	SITE 42-328
DRAWN NA/MM	CHECKED BRG	APPROVED DWK	DWG 2

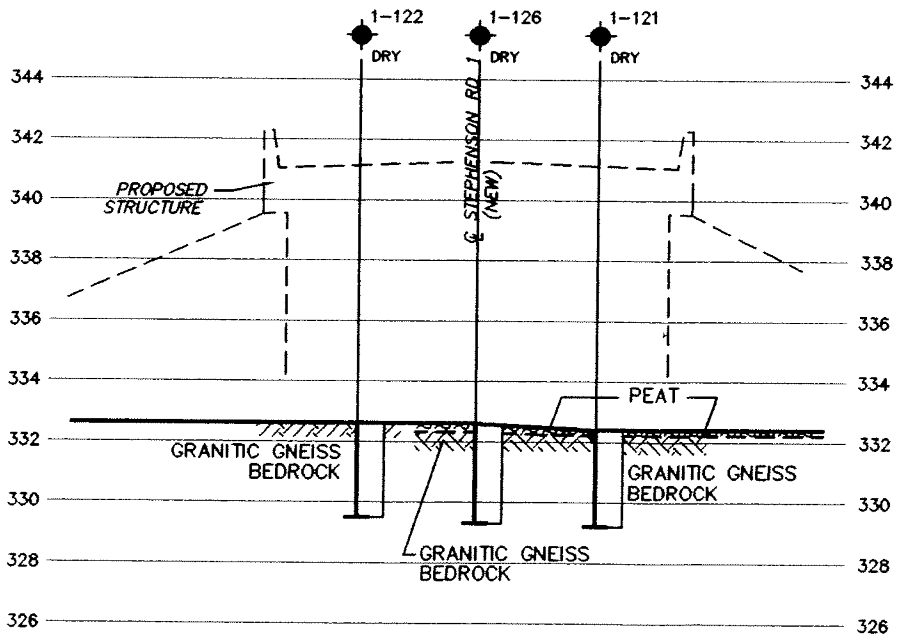
REF No E-S5568-310GA001.dwg; h5568xB1.dwg; h5568xB2.dwg; October, 2004



B–B'



C–C'



D–D'

SECTIONS

SCALE
2.5 0 2.5 5m

NOTES:

BOREHOLES 1-1 TO 1-5 WERE DRILLED BY GOLDER ASSOCIATES; REPORT REFERENCE NO. 011-1104 DATED APRIL 2001

REFER TO DRAWING NO. 1 AND 2 FOR PLAN AND SECTION A-A'.

SECTIONS ARE PROVIDED SOLELY FOR ILLUSTRATIVE PURPOSES. REFER TO RECORD OF BOREHOLES FOR DETAILED DESCRIPTION OF SUBSURFACE CONDITIONS, IN-SITU TEST DATA AND LABORATORY TEST RESULTS.

E. A. CORNEAU

D. W. KERR

B. R. GRAY

REF No E-S5568-310GA001.dwg; h5568xB1.dwg; h5568xB2.dwg; October, 2004

METRIC

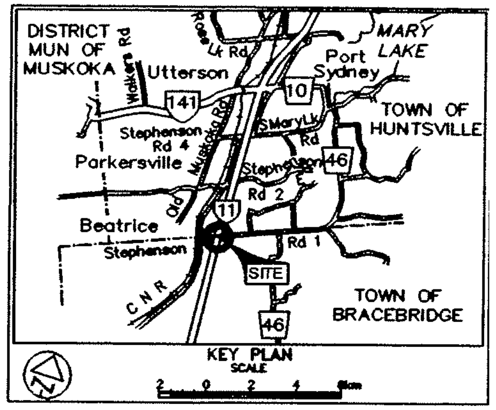
DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN. STATIONS IN KILOMETRES + METRES

CONT No
WP No 5039-00-01

HIGHWAY 11
STEPHENSON ROAD No. 1 UNDERPASS
SOIL STRATA

SHEET

Peto MacCallum Ltd.
CONSULTING ENGINEERS



KEY PLAN
SCALE

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)
- ▽ W L at time of investigation Oct 2004
- ▽ Head
- ARTESIAN WATER Encountered

BH No	ELEVATION	CO-ORDINATES NORTH	CO-ORDINATES EAST
	Refer to drawing 1 for co-ordinates		

– 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. 31E-232

HWY No 11			DIST 52
SUBM'D FP	CHECKED EG	DATE JUNE 17, 2005	SITE 42-326
DRAWN NA/MM	CHECKED BRG	APPROVED DWK	DWG 3

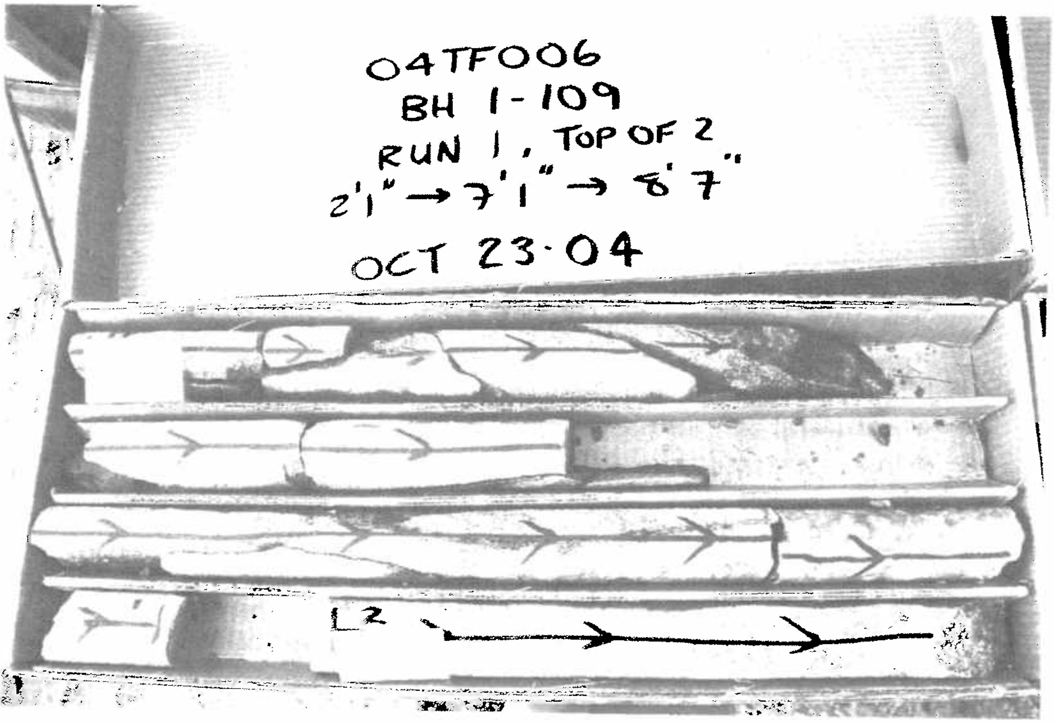
APPENDIX A

Photographs

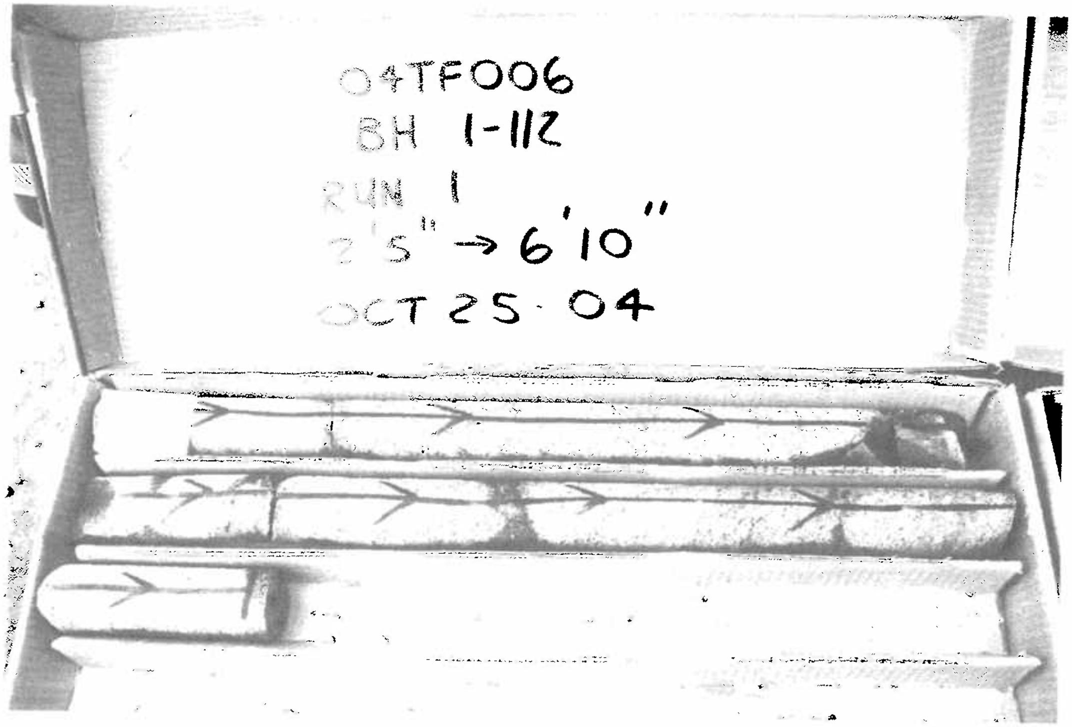
Photograph 1: Stephenson Road 1 west abutment, facing north

Photograph 2: Stephenson Road 1 centre pier, facing south to pier location

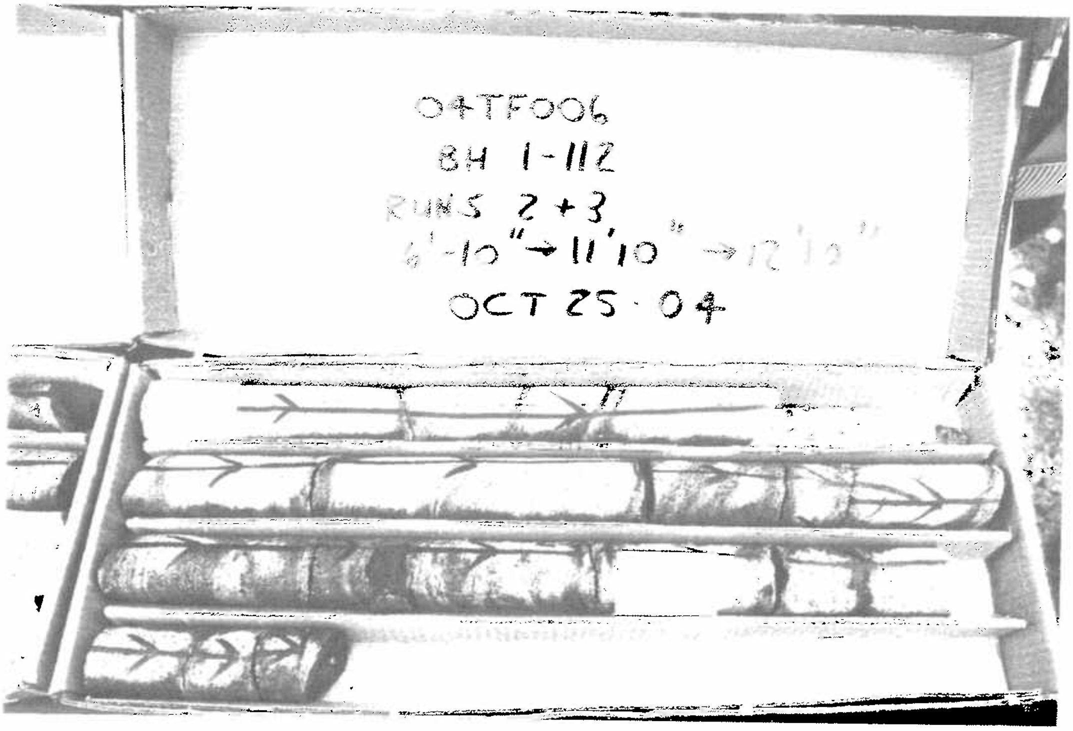
Photograph 3: Stephenson Road 1, East abutment, facing East at working point stake



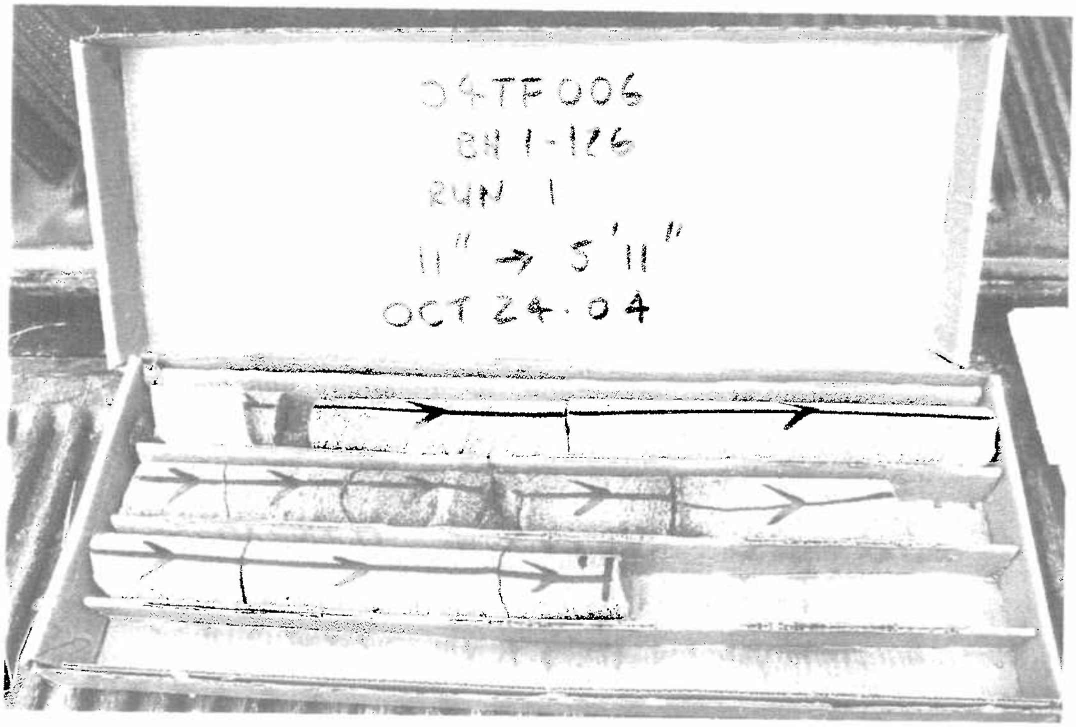
Photograph 4



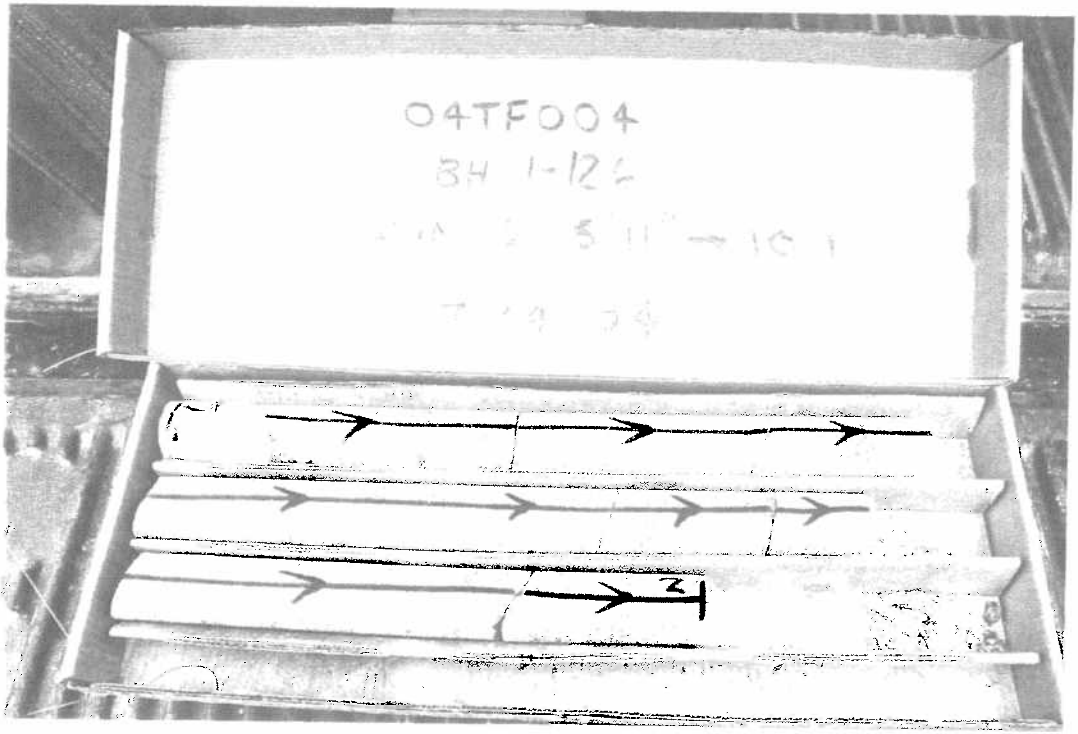
Photograph 5



Photograph 6



Photograph 7



Photograph 8

APPENDIX B

Borehole Logs from Preliminary Design Report

Ministry of Transportation
Ontario

RECORD OF BOREHOLE No 1-1

1 OF 1

METRIC

PROJECT [illegible]
W.P. [illegible]
DIST 52 HWY 11
DATUM Geodetic
LOCATION N 5301906, E 31[illegible]581
BOREHOLE TYPE Portable Tripod
DATE Feb 5,01
ORIGINATED BY [illegible]B
COMPILED BY [illegible]KB
CHECKED BY [illegible]SP

ELEV DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	"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 × REMOULDED 20 40 60 80 100	PLASTIC LIMIT w_P, NATURAL MOISTURE CONTENT w, LIQUID LIMIT w_L / WATER CONTENT (%) 10 20 30	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
334.7	GROUND SURFACE										
0.0	Silty Sand with rootlets and organics Loose Black sh brown Moist		1	SS	6		334				
333.8 0.9	Biotite granite GNEISS Dark grey-black with white speckles and streaks, foliated Slightly weathered to fresh Medium jointed, coarse to very coarse grained, very to extremely strong Occasional pink, very coarse grained zones Bedrock cored from 0.9m to 4.0m depth. For bedrock coring details refer to Record of Drillhole 1-1						333 332 331				
330.7 4.0	END OF HOLE Note: Water used during coring operations; water level on completion of drilling not representative of groundwater conditions										

PROJECT 011 1104

RECORD OF DRILLHOLE: 1-1

SHEET 2 OF 2

LOCATION N 5001306 E 319581

DRILLING DATE February 5 2001

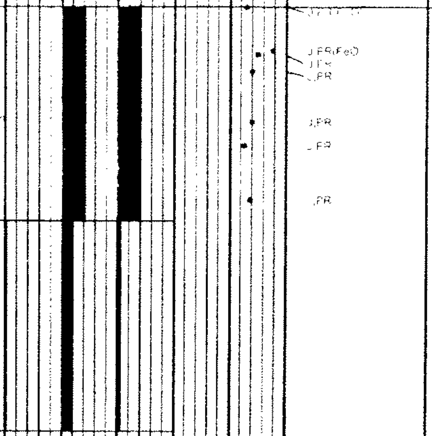
DATUM Geodetic

INCLINATION -90 AZIMUTH —

DRILL RIG Portable Tripod

DRILLING CONTRACTOR Marathon Drilling

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. / DEPTH (m)	RUN No.	NOTES WATER LEVELS INSTRUMENTATION
1	Rotary Drilling NQ	Biotite granite GNEISS Dark grey-black with white speckles and streaks, foliated Slightly weathered to fresh Medium jointed, coarse to very coarse grained, very to extremely strong Occasional pink, very coarse grained zones			1	
3				350.74 3.96	2	
4		END OF HOLE				



DEPTH SCALE
1 : 50

LOGGED JB
CHECKED

Ministry of Transportation
Ontario

RECORD OF BOREHOLE No 1-2

1 OF 1

METRIC

PROJECT [illegible]
W P [illegible]
DIST 52 HWY 11
DATUM Geodetic
LOCATION N 5001320 E 31[illegible]
BOREHOLE TYPE Portable Tripod
DATE Feb 5/01
ORIGINATED BY [illegible]B
COMPILED BY DKB
CHECKED BY [illegible]SP

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 × REMOULDED 20 40 60 80 100	PLASTIC LIMIT w_P — NATURAL MOISTURE CONTENT w — LIQUID LIMIT w_L WATER CONTENT (%) 10 20 30	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						
333.0	GROUND SURFACE										
0.0	Silty Sand with roots/organics Blackish brown Moist										
0.2	Sand and Gravel, trace silt, occ. cobbles, grinding on boulder at 0.2m depth										
332.1 0.9	Biotite granite GNEISS Dark grey-black with white speckles and streaks, foliated Slightly weathered to fresh Medium jointed, coarse to very coarse grained, very to extremely strong Occasional pink, very coarse grained zones. Bedrock cored from 0.9m to 4.0m depth. For bedrock coring details refer to Record of Drillhole 1-2						332 331 330				
329.0 4.0	END OF HOLE Note: Water used during coring operations, water level on completion of drilling not representative of groundwater conditions.						329				

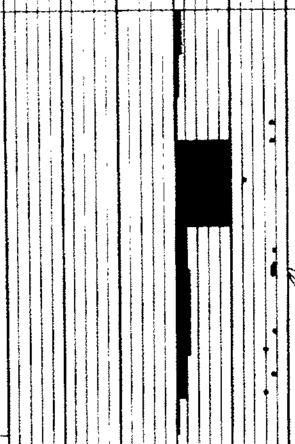
RECORD OF DRILLHOLE: 1-2

PROJECT: 011-1104
LOCATION: N 5031820, E 319618
INCLINATION: -90° AZIMUTH: —

DRILLING DATE: February 5, 2001
DRILL RIG: Portable Tripod
DRILLING CONTRACTOR: Marathon Drilling

SHEET 2 OF 2
DATUM: Geodetic

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. DEPTH (m)	RUN No.	PENETRATION RATE		DISCONTINUITY DATA TYPE AND SURFACE DESCRIPTION	NOTES WATER LEVELS INSTRUMENTATION
3	Rotary Drilling NQ Core	Biotite granite GNEISS Dark grey-black with white speckles and streaks, foliated Slightly weathered to fresh Medium jointed, coarse to very coarse grained, very to extremely strong Occasional pink, very coarse grained zones.		129.04 3.96				J,UE J,PR [illegible] J,PR J,PR J,PR J,PR J,PR J,PR J,UE J,PR J,PR	
		END OF HOLE							



DEPTH SCALE

LOGGED: TB
CHECKED: [illegible]

Golder Associates

RECORD OF BOREHOLE No 1-3

1 OF 1 **METRIC**

PROJECT 011-1104
W.P. [illegible]6-00
DIST 52 HWY 11
DATUM Geodetic
LOCATION N 5301802 E 371458
BOREHOLE TYPE Portable Tripod
DATE Feb 6/01
ORIGINATED BY JB
COMPILED BY DKB
CHECKED BY ASP

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 × REMOULDED 20 40 60 80 100	PLASTIC LIMIT w_P NATURAL MOISTURE CONTENT w LIQUID LIMIT w_L WATER CONTENT (%) 10 20 30	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						
332.5	GROUND SURFACE										
0.0 332.2	Topsoil										
0.3 329.3	Biotite granite GNEISS Dark grey-black with white speckles and streaks, foliated Slightly weathered to fresh Medium jointed, coarse to very coarse grained, very to extremely strong Occasional pink, very coarse grained zones Bedrock cored from 0.3m to 3.2m depth. For bedrock coring details refer to Record of Drillhole 1-3						332 331 330				
3.2	END OF HOLE Note: Water used during coring operations: water level on completion of drilling not representative of groundwater conditions.										

PROJECT: 01?-1?04

LOCATION: N 5001831, E 31?658

INCLINATION: 90°   AZIMUTH: —

RECORD OF DRILLHOLE: 1-3

DRILLING DATE: February 6, 2001

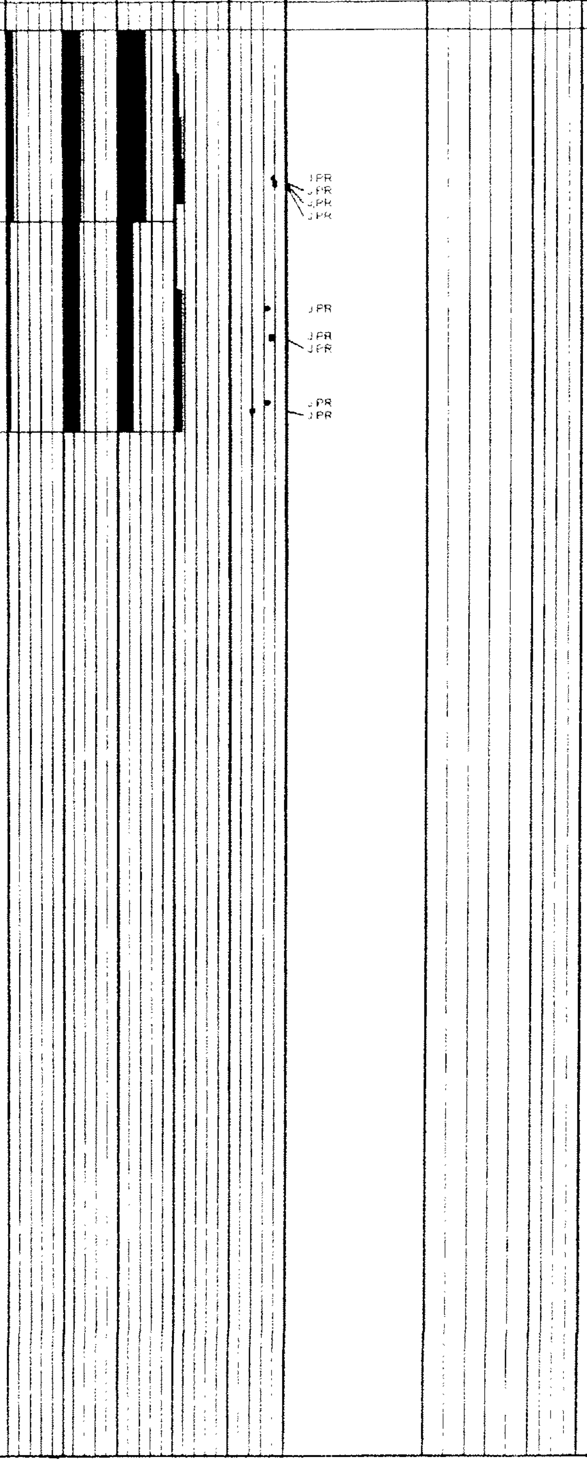
DRILL RIG: Portable Tripod

DRILLING CONTRACTOR: Marathon Drilling

SHEET 2 OF 2

DATUM: Geodetic

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. / DEPTH (m)	RUN No.	NOTES WATER LEVELS INSTRUMENTATION
				[illegible]		
1 2 3	Rotary Drilling NQ Size	Biotite granite GNEISS Dark grey black with white speckles and streaks, foliated Slightly weathered to fresh Medium jointed, coarse to very coarse grained, very to extremely strong Occasional pink very coarse grained zones.	▨	[illegible]	1 2	
				329.30 3.20		
4 5 6 7 8 9 10		END OF HOLE				



DEPTH SCALE
1 : 50

LOGGED: SB
CHECKED: FDG

RECORD OF BOREHOLE No 1-4

1 OF 1

METRIC

PROJECT 011-1-04
W.P 6[illegible]-95-00
DIST 52 HWY 11
DATUM Geodetic

LOCATION N 5001 65 E 1 480
BOREHOLE TYPE Portable Tripod
DATE Feb 8,01

ORIGINATED BY JB
COMPILED BY DKB
CHECKED BY RSP

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 × REMOULDED 20 40 60 80 100	PLASTIC LIMIT w_P NATURAL MOISTURE CONTENT w LIQUID LIMIT w_L WATER CONTENT (%) 10 20 30	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						
333.2	GROUND SURFACE										
0.0 332.9 0.3	Silty Sand with roots, organics Black Moist						333				
	END OF BOREHOLE Refusal to further auger penetration, probable bedrock Note: Open borehole dry upon completion of drilling.										

+ 3, × 3: Numbers refer to Sensitivity
○ 3% STRAIN AT FAILURE

RECORD OF BOREHOLE No 1-5

1 OF 1 **METRIC**

PROJECT [illegible]11-1104

W.P [illegible]

LOCATION N [illegible] E [illegible]

ORIGINATED BY [illegible]

DIST 52 HWY 11

BOREHOLE TYPE Portable Tripod

COMPILED BY DKB

DATUM Geodetic

DATE Feb 6 01

CHECKED BY ASP

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 × REMOULDED 20 40 60 80 100	PLASTIC LIMIT W_P NATURAL MOISTURE CONTENT W LIQUID LIMIT W_L WATER CONTENT (%) 10 20 30	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						
329.6	GROUND SURFACE										
329.3 0.3	Topsoil										
	END OF BOREHOLE Refusal to further auger penetration, probable bedrock Note: Open borehole dry upon completion of drilling.						329				

+3, ×3: Numbers refer to Sensitivity

○ 3% STRAIN AT FAILURE

PML Peto MacCallum Ltd.
CONSULTING ENGINEERS

FOUNDATION DESIGN REPORT

For

STEPHENSON ROAD 1 UNDERPASS
WP 5039-00-01, SITE 42-326
HIGHWAY 11
TOWNSHIP OF STEPHENSON / TOWNSHIP OF MACAULEY
MTO HUNTSVILLE AREA

PETO MacCALLUM LTD.
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1 cc: PML Toronto
1 cc: PML Barrie

PML Ref.: 04TF006-SR1
Index No.: 082FDR
Geocres No.: 31E-232
June 22, 2005

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FOUNDATION DESIGN REPORT
for
Stephenson Road 1 Underpass
WP 5039-00-01, Site 42-326
Highway 11
MTO Huntsville Area

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1. INTRODUCTION

This report provides foundation engineering comments and recommendations regarding design and construction of the foundations, abutments and approach embankments for the proposed underpass to be constructed at Stephenson Road 1 and Highway 11 located some 15 km south of Huntsville, Ontario. The investigation was conducted for McCormick Rankin Corporation (MRC) on behalf of the Ontario Ministry of Transportation (MTO).

Stephenson Road 1 will pass over Highway 11 at approximate Station 24+465 centreline of Highway 11 chainage, and Station 10+000, centreline of Stephenson Road 1. The proposed underpass will be a two span structure with a span length of 37.0 m and width of about 13.1 m (ref. Drawing 1 'Hwy 11 – Stephenson Road 1 Underpass. Preliminary General Arrangement' prepared by MRC in September 2004).

The road grade on Highway 11 at the underpass location is planned to be at approximately elevation 333.5. The Stephenson Road 1 grade will be near elevation 341.0 at the west and east abutments. The approach embankments to the structure are envisaged to be some 6 to 8 m high (interpolated from ground surface elevations at borehole locations and the road grade shown on the MRC drawing referred to above). No cut or fill is anticipated at the centre pier foundation that is planned on the existing Highway 11 median.

The subsurface stratigraphy revealed in the boreholes drilled at the site generally comprised a surficial topsoil or peat sometimes followed by a thin sand/silt deposit mantling shallow bedrock. Bedrock was exposed at eleven borehole locations, confirmed by rock coring in 11 boreholes and inferred in the remaining boreholes at depths of 0.1 to 0.9 m (elevation 329.5 to 334.1).

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

LOCATION	BOREHOLE NO.	DEPTH TO ROCK (m)	BEDROCK ELEVATION
West Approach	1-4	0.3	332.9
	1-107	0.4	333.0
West Abutment	1-1 (1)	0.9 (2)	333.8
	1-101	0.5 (2)	333.6
	1-102	0.8	333.4
	1-103	0.0	334.1
	1-104	0.1 (2)	334.1
	1-105	0.0	333.4
	1-106	0.0	334.4
	1-108	0.6	333.7
	1-109	0.6 (2)	333.7
	1-110	0.0	333.2
Central Pier	1-2 (1)	0.9 (2)	332.1
	1-111	0.2	332.5
	1-112	0.7 (2)	332.2
	1-113	0.2	332.6
	1-114	0.3	332.7
	1-115	0.2 (2)	332.2
	1-116	0.0	332.4
	1-117	0.9	332.0
	1-118	0.0	332.2
East Abutment	1-3 (1)	0.3 (2)	332.2
	1-119	0.0	331.9
	1-120	0.0	332.5
	1-121	0.2 (2)	332.2
	1-122	0.0 (2)	332.6
	1-123	0.1	332.1
	1-124	0.8	331.5
	1-125	0.0	332.5
	1-126	0.3 (2)	332.3
	1-127	0.1	332.1
East Approach	1-5 (1)	0.1	329.5
	1-128	0.0	331.3

(1) Completed by others during preliminary design, February 2001.

(2) Confirmed by rock core

2. FOUNDATIONS

2.1 General

The design road grade at both abutments is near elevation 341, about 6 to 8 m above the bedrock surface.

The system employed to support the structure will be subject to structural design consideration, economic considerations and construction constraints. Spread footings constructed on bedrock or a pad of engineered fill as well as piles driven to bedrock are considered to be feasible means of supporting the foundation loads. Construction of integral abutments may require excavation of a trench into bedrock to accommodate the minimum pile length called for in MTO Report 50-96-01.

A summary of the advantages and disadvantages of each foundation system are provided in the following table:

FOUNDATION TYPE	ADVANTAGES	DISADVANTAGES
Spread Footings on Rock	• Ease of construction • Lower cost than deep foundations • High bearing resistance	• Need to remove rock to foundation elevation • Needs mass concrete to achieve a level bearing surface
Spread Footings on Structural Fill	• Ease of construction • Lower cost than pile foundation • Level bearing surface • No need for rock excavation	• Requires the construction of a structure fill pad • Low bearing resistances • Needs erosion protection
Piles on Bedrock	• Technique and specialized construction equipment to drive piles is available in the industry • High bearing resistance	• Requires construction of a fill pad ahead of the approach embankment construction • Higher installation cost than spread footings

From a foundation engineering perspective, use of spread footings constructed on bedrock is the preferred foundation system.

Further comments and recommendations for design of the foundations are provided in the following sections.

A list of the MTO documents used in subsequent sections of the report is provided on Table 1 for your reference.

2.2 Seismic Analysis and Liquefaction Potential

Since bedrock was exposed at the bridge site and the soil cover at the borehole locations is less than 1 m, it is considered that liquefaction of the soil and rock is unlikely to occur (refer to clause 4.6.2 of the (CHBDC), CAN/CSA-S6-00).

The seismic site coefficient for the stratigraphic conditions at this site is 1.0 [soil profile Type I, Canadian Highway Bridge Design Code (CHBDC) clause 4.4.6, CAN/CSA-S6-00].

2.3 Spread Footings

2.3.1 General

Construction of the footings should be performed and monitored in accordance with SP 902S01 to verify the competency of the founding surface. All fractured rock should be removed from the founding surface to expose sound rock. 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 structure foundations.

All footings or pile caps subject to frost action should be provided with 1.8 m of earth cover or equivalent thermal insulation. A 25 mm thick layer of polystyrene insulation is thermally equivalent to 0.6 m of soil cover. Footings bearing directly on bedrock do not require protection from frost.

2.3.2 Footings Constructed on Bedrock

Provided all loose fractured rock is removed from the foot print, footings bearing on the sound bedrock should be designed using a factored bearing resistance at ULS of 10,000 kPa. 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 bearing resistance for inclined loads should be reduced in accordance with the requirements of clause 6.7.4 of the CHBDC.

The anticipated depths/elevations to bedrock at this site are indicated in the table provided in section 1.0 of the report. The bedrock surface elevation ranges from 333.2 to 334.4 at the west abutment, 332.0 to 332.7 at the centre pier and 331.5 to 332.6 at the east abutment. 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 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 footings are 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 since this bedrock surface is relatively smooth, presumably as a result of weathering and/or glaciation. If excavation of the bedrock is required, an unfactored friction factor of 0.7 could be used.

The lateral resistance of footings founded on bedrock could be increased by means of a shear key, sockets 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.

Given the hardness of the bedrock, sockets and keys will likely be impractical. Developing adequate resistance against sliding of spread footings founded on the sloping bedrock will likely require dowels. If dowels 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 rod/grout interface of 1.4 MPa at ULS (a resistance factor of 0.4 is applied for a minimum 35 MPa grout) and at the grout/rock interface of 800 kPa is recommended for design. The anchors should have a minimum bond length into sound bedrock of 3.0 m according to clause 6.10.2.3 of the CHBDC 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. 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.

2.3.3 Footings Constructed on Structural Fill

Footings constructed on structural fill placed in the approach embankments could also be employed to support the foundation loads, provided that all loose soil and boulders are removed and the structural fill pad is constructed on the exposed bedrock (west abutment elevation 333.2

to 334.4; east abutment elevation 331.5 to 332.6). The structural fill should comprise OPSS Granular A material placed in maximum 200 mm thick lifts, compacted to 100% Standard Proctor maximum dry density as determined by the MTO test method LS-706 (Standard Proctor) and extended laterally to a line inclined downwards at 45° to the horizontal originating at least 1 m from the top of the footing. The limits of the fill pad should be surveyed in the field and clearly marked for the contractor. This scheme is illustrated in Figure 2, appended.

Footings should <u>not</u> be constructed on rock fill. However, rock fill may be placed adjacent to the Granular A core noted in Figure 2.

The recommended bearing resistance for 2.5 m wide footings constructed on structural fill (bearing resistance independent of fill thickness due to shallow bedrock at this site) is as follows:

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

The 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 1.8 m was assumed for computation of the ULS resistance.

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

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 structural fill. An unfactored friction factor of 0.7 is recommended for footings on granular fill.

2.4 Piles

The piles should be driven to refusal on bedrock anticipated at the depths/elevations indicated in the table provided in Section 1.0 and/or the base of the trench excavation, if required to accommodate integral abutments, whichever is greater.

The depth of excavation of the trench required for construction of integral abutments will be dictated by design details. The excavation width should be at least 1 m wider than the plan area of the piles; side slopes could be excavated near vertical. The excavation should be backfilled with Granular material (maximum particle size <75 mm), following the procedures outlined in the section titled "Approach Embankments". Further comments concerning bedrock excavation are provided in the section titled "Excavation and Groundwater Control".

Placement of concrete in the trench could also be employed to temporarily support the piles during construction. Refer to Figure 1 for a typical trench configuration. The piles, must however be set on the bedrock surface directly or as designed by the structural engineer.

The compacted granular fill pad placed as a working platform for construction equipment during installation of the abutment piles, and the embankment fill within the limits of the pile foundation, including the trench excavated to accommodate integral abutments, should comprise OPSS Granular A material to allow installation of the abutment piles without damage. Alternative granular materials could be employed provided the maximum particle size does not exceed 75 mm.

The recommended factored axial resistance at ultimate limit states (ULS) for three pile sections is as follows:

	Factored Axial Resistance at ULS, kN
HP 310 x 110	2000
HP 310 x 132	2400
HP 310 x 174	3200

The resistance at serviceability limit states (SLS) normally allows for 25 mm of compression of the pile and founding medium. Considering the bedrock to be a non-yielding material, the design is not expected to be governed by settlement criteria since the loading required to produce an appreciable deformation of the pile and/or bedrock is much larger than the factored resistance at ULS.

The soil adjacent to the upper portion of the piles is expected to comprise well-compacted approach fill material (Granular B type II). The thin veneer of sand and silt should be excavated prior to placement of the granular fill. To accommodate movement of the integral abutment system, two concentric CSPs that extend at least 3 m below the bottom of the abutment should be placed around the pile to create an annular space. The inner CSP should be filled with sand meeting the gradation requirements of Granular B Type I. Alternatively, a single CSP filled with loose uniform sand meeting the requirements shown in Table 1 may be used. Refer to MTO Report SO-96-01 for further details.

The type of equipment required to drive the piles will be somewhat dictated by the design capacity. Cognizant of the pile length, the soil characteristics and the presence of cobbles/boulders at the site, it is considered, based on our extensive experience with pile driving under similar conditions, that a hammer transferring about 40 kJ of energy to the pile should be employed to drive the piles. The rated energy of the hammer should therefore be 50 to 55 kJ, depending on the type of equipment employed. Since the piles will set on rock, a specific set for this project is not provided.

The piles will set on or into bedrock and should be equipped with "Rock Points" to minimize the potential for damage to the pile tip. Clause 3.1.2 and 3.3.1-6 of the Structural Manual (Division 1 - Exceptions to the Canadian Highway Bridge Design Code) and SP 903S01 call for the use of Oslo Point (OPSD 3304) or Titus H Bearing Pile Points Rock Injector Model (Titus Point). The Titus Point should be used to minimize the potential for damage to the pile toe when driving through cobbles/boulders overlying bedrock at the site.

The piles should be installed and monitored in accordance with the requirements of SP 903501. This should involve confirmation of the founding elevation, alignment, plumbness, uniformity of set and quality of splices and should be done on a full-time basis by experienced geotechnical personnel.

Resistance to lateral loads may be provided in part by mobilization of passive resistance along the pile below the annular space. The lateral resistance recommended for the pile sections is as follows:

	Granular Backfill
Factored Lateral Resistance at ULS, kN	120
Lateral Resistance at SLS, kN	50

The assessed values of lateral resistance assume that the piles are driven through compacted granular materials placed as recommended in the section titled "Approach Embankments". If greater resistance is required, batter piles could be installed.

The coefficient of horizontal subgrade reaction, k_s, for the granular fill backfill placed within the limits of the driven piles as recommended earlier should be computed using the following equation to evaluate the point of contraflexture:

$k_s = n_h z/b$

where n_h = coefficient related to soil density, MN/m^3;
= $10\ MN/m^3$ for granular backfill;
z = depth, m;
b = pile width, m

3. ABUTMENT WALLS

3.1 General

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, p (kPa) may be computed using the equivalent fluid pressure diagrams presented in Section 6.9 of the CHBDC or employing the following equation.

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

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 (35° for Granular A or Granular B Type II)
δ = angle of friction between the soil and wall (23.5° for Granular A or Granular B Type II)

The seismic coefficient for the conditions at this site was provided in Section 2.1.

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

PARAMETERS	GRANULAR A	GRANULAR B TYPE II	ROCK FILL
Angle of Internal Friction, degrees	35	35	42
Unit weight, kN/m^3	22.8	22.8	18.0
Coefficient of Active Earth Pressure K_a	0.27	0.27	0.20
Coefficient of Earth Pressure At Rest K_o	0.43	0.43	0.33
Coefficient of Passive Earth Pressure K_p	3.69	3.69	5.04

3.2 Abutments

Refer to MTO report S0-96-11 for procedures to determine the earth pressure coefficient to be employed in design of integral abutments. 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 10º to the horizontal. Alternatively, the material above the top of the wall could be treated as a surcharge load (q in the preceding equation).

The magnitude of the passive resistance and active pressure is dependent on the actual lateral movement of the structure toward and away from the adjacent soil. We refer to Figure C6.9.1(a) of the CHBDC for this computation. The subsoil should be considered medium dense sand for the project.

A weeping tile system (SP 405F03) and/or weep holes should be installed to minimise the build-up of hydrostatic pressure behind the wall. 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 with Ontario Provincial Standards specifications for granular or rock backfill at abutments (OPSD 3501 and 3505).

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 SP 105S10 for additional information in this regard.

3.3 Retained Soil System

A retained soil system (RSS) could also be employed, (high performance, high appearance rated). The design, supply and construction of the RSS wall should conform to SP 599S22.

All material (shallow depths of topsoil, peat, and sand) should be stripped to bare bedrock and removed from the RSS footprint. The founding material is expected to comprise bedrock or granular engineered fill.

The bearing resistance recommended previously for footings founded on bedrock (at levels ranging from elevations 333.2 to 334.4 for the west abutment and 331.5 to 332.6 for the east abutment) or structural fill is considered to be suitable for the anticipated 1 m wide footings required to support the RSS.

The earth pressure coefficients provided previously are also considered to be appropriate for the RSS wall.

The horizontal force at the base of the RSS will be resisted in part by the friction force developed through the granular backfill or along the interface between the granular backfill and the founding soil, subject to site specific design details. An unfactored friction factor of 0.7 is considered to be appropriate for both situations at this site.

The RSS supplier should be responsible for specifying the type of backfill material employed, taking into consideration the engineering properties of the proprietary product, the design life of the structure, the pullout resistance required, drainage requirements.

The supplier of the RSS should also be responsible for design of the structure (backfill, reinforcement, internal and external stability) and provide drawings to show pertinent information such as location, length, height, elevations, performance level, appearance etc.

Since the RSS wall, if employed, will be constructed on cohesionless soils, or bedrock, it is considered that an adequate factor safety for global stability will exist (F > 1.5).

4. APPROACH EMBANKMENTS

4.1 General

It is anticipated that the approach embankments will be constructed with earth borrow/granular materials or rock fill. Both the east and west approach fill embankments will be about 6 to 8 m high. Construction of the fill on the sand and/or bedrock that underlies a surficial deposit of topsoil or peat is considered to be feasible.

The topsoil or peat identified in boreholes 1-101, 1-102, 1-104, 1-106, 1-107, 1-108 and 1-109 to depths of 0.1 to 0.3 m (elevation 333.2 to 334.1) at the west abutment and in boreholes 1-3, 1-121, 1-123, 1-124, 1-126 and 1-127 to depths of 0.1 to 0.3 m (elevation 332.5 to 332.1) at the east abutment should be stripped prior to placement of the embankment fill.

4.2 Embankment Design and Construction Considerations

The width of the embankment platforms should be widened by a minimum of 1 m in accordance with the Northeastern Region Engineering Directive (NRE 98-200) (embankments constructed on bedrock). The widening is required to allow for geotechnical considerations such as settlement of the embankment and native soils and for future pavement overylays.

Earth fill slopes where employed should be protected against surface erosion by sodding and suitable vegetation. Refer to OPSS 571 or 572 for time constraints and the type of seed and mulch required.

The embankments should be constructed in accordance with OPSD 201.010, 201.020, 202.010 and SP 206S03. The side slopes of the approach embankments should be inclined no steeper than 2H:1V for earth fill and 1.25H:1V for rock fill. The 2 m wide mid-height berm called for in OPSD 202.010 should be incorporated for earth embankments higher than 8 m and rock fill embankments higher than 10 m.

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 guide rail, a granular infilled drainage gap should be provided in accordance with Northeastern Region Pavement Design Practices and Guidelines as shown in Figure 3, appended. OPSS Granular B Type II should be used for the drainage gaps.

It is considered that approach embankments constructed in accordance with the recommendations in this report on the cohesionless native soils less than 0.9 m thick, or directly on bedrock will be stable (computed factor of safety greater than 1.4).

4.3 Approach Embankment Settlements

Settlement of the embankment platform is expected as a result of two mechanisms, consolidation of the native soil below the embankment fill and consolidation of the new fill.

Settlement of the embankment fill surface due to consolidation of the thin layer of underlying native soil (where present) is computed to be less than 10 mm and completed within one month following placement of the fill.

Where the embankments are constructed with rock fill, some settlement of the embankment fill surface, both during and following completion of construction, due to "consolidation" of the rockfill is likely to occur. The magnitude of total settlement is estimated to be 0.5% of the rockfill height (40 mm to 30 mm). About 50% of these settlements should occur during the first year and 50% during the ten year period following completion of construction.

Some settlement of the road surface adjacent to the abutments should also be expected due to "consolidation" of the granular backfill.

The backfill placed adjacent to the abutments will be up to 8 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 98% of Standard Proctor maximum dry density in accordance with the requirements of SP 206S03 and OPSS 501 (Method A), should be less than 20 mm.

Consequently, total settlement of the approach fill surface near the abutments should be less than 20 mm and be essentially complete within 2 to 4 months after placement of the fill.

5. EXCAVATION AND GROUNDWATER CONTROL

Excavation for construction of the structure foundations if supported on spread footings founded on bedrock will extend through sandy soils to depths of up to 0.9 m. Excavation of the native soils is expected to be relatively straightforward.

The soil at the site is classified as Type 3 soil according to Occupational Health and Safety Act (Ontario Regulation 213/91) criteria. Therefore, temporary cut slopes over the full depth of the excavation should be inclined at 45° to the horizontal. The need to excavate flatter sideslopes if excessively soft/wet materials or concentrated seepage zones are encountered locally should not be overlooked.

Excavation of bedrock will be more difficult and necessitate conventional rock excavation techniques such as blasting (OPSS 120, General Specification for the Use of Explosives, and jack-hammering). The actual equipment required and method of excavation within the bedrock will be dependent upon the geometry of cut and relative depth of excavation into the bedrock. Preshearing and prespilitting to control the overbreak should be used to excavate the narrow trench in the rock required for the abutment pile foundation in the integral abutment alternative.

Mechanical means should be employed to excavate the loosened rock at the footing. Mass concrete could be employed to level minor variations in the bedrock surface. The footing founding area should be inspected and approved by a rock engineering specialist.

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 minimize overbreak; advise the contractor that any overblasting/over excavation will be the sole responsibility of the contractor; and require that loosened rock resulting from blasting operations be removed by mechanical means.

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

Groundwater was not observed in any of the boreholes during or upon completion of drilling. However, minor seepage should be anticipated locally at the soil/bedrock interface within depressions in the bedrock surface. It is anticipated that conventional sump pumping techniques will be sufficient to control seepage of groundwater into the excavations. Groundwater levels are subject to seasonal fluctuations and rainfall 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

The report was prepared by Mr. Eric A. Gonneau, MBA, P.Eng. Senior Engineer, and reviewed by Mr. Dennis W. Kerr, MEng, P.Eng., Chief Foundation Engineer. Mr. Brian R. Gray, MEng, P.Eng., MTO Designated Foundations Contact, carried out an independent review of the report.

Sincerely

Peto MacCallum Ltd.

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EAG/DWK/BRG:jlb

TABLE 1

LIST OF STANDARD SPECIFICATIONS REFERENCED IN REPORT

TITLE	NO.	DATE
General Specification for the Use of Explosives	OPSS 120	November 2003
Construction Specification for Compacting	OPSS 501	February 1996
Construction Specification for Sodding	OPSS 571	November 2001
Construction Specification for Seed and Cover	OPSS 572	November 2003
Rock Grading-Undivided Highway	OPSD 201.010	April 1999
Rock Grading-Divided Highway	OPSD 201.020	April 1999
Embankment Construction Using Excess Material Outside of Earthfill or Rockfill	OPSD 202.010	March 1, 1998
Drainage Gap for Slope Flattening on Rock or Granular Embankment	OPSD 202.020	March 1, 1998
Minimum Granular Backfill Requirements - Abutments	OPSD 3501.000	April 1999
Rock Backfill Requirements - Abutments	OPSD 3505.000	November 2001
Construction Specification for Compaction	SP 105S10	November 2004
Construction Specification for Grading	SP 206S03	January 2004
Construction Specification for Pipe Subdrains	SP 405F03	May 2004
Requirements for The Design, Supply and Construction of Retaining Soil Systems (RSS)	SP 599S22	March 2001
Construction Specification for Piling	SP 903S01	September 2004
Requirements for Design, Installation and Testing of Temporary and Permanent Pre-Stressed Anchors in Soil and Rock	SP 999S26	July 2004
Northeastern Region Directive - Platform Widening	NRE 98-200	October 28, 1998
Dowels Into Concrete	NSSP	December 2002

TABLE 2

Gradation Specification for Sand Fill in Pre-Augered Holes at Integral Abutments

MTO SIEVE DESIGNATION	PERCENTAGE PASSING BY MASS
2 mm #10	100
600 µm#30	80 – 100
425 µm#40	40 – 80
250 µm#60	5 – 25
150 µm#100	0 – 6

From MTO Report S0-96-01, Revision 1 – July, 1996.

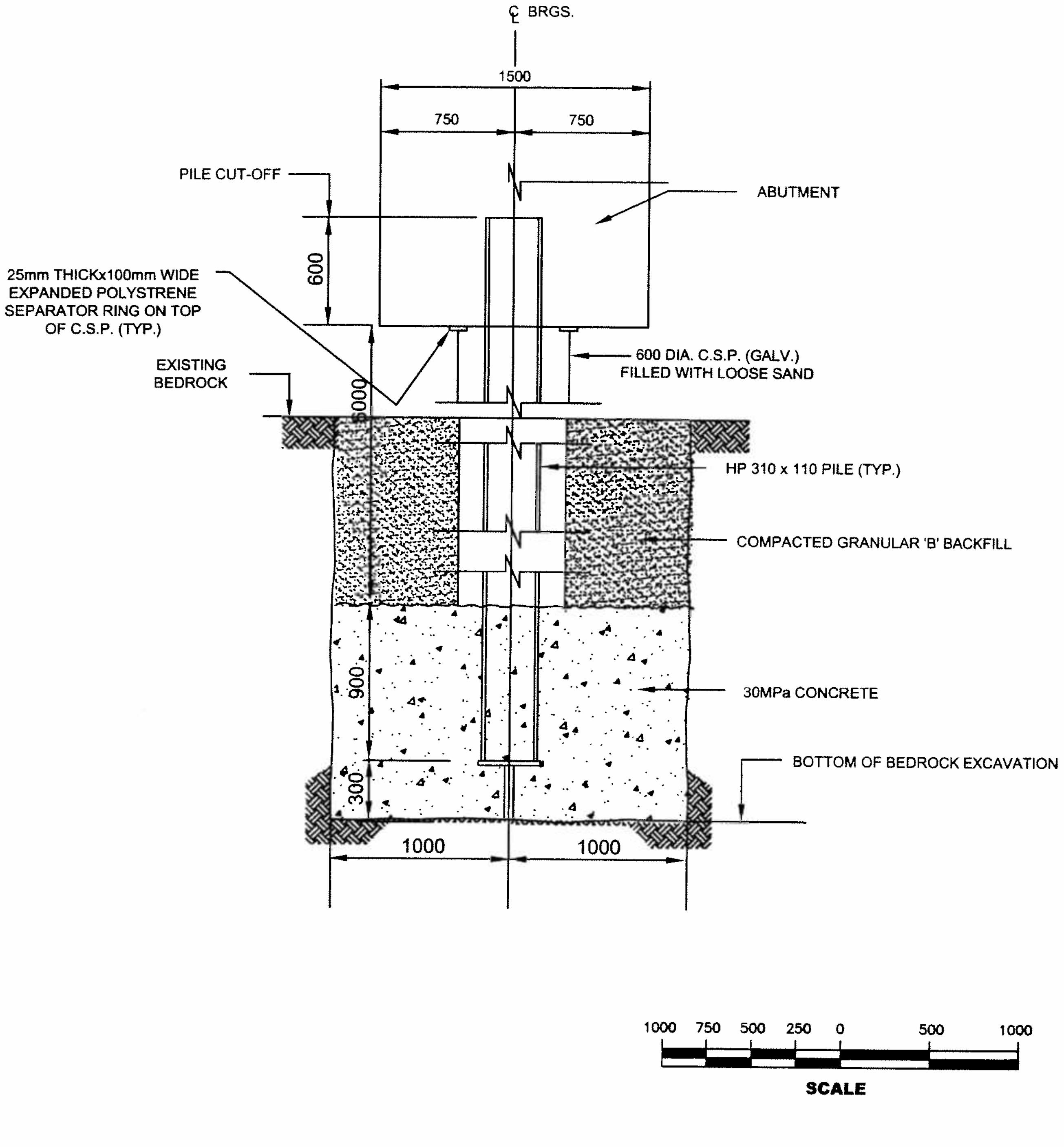
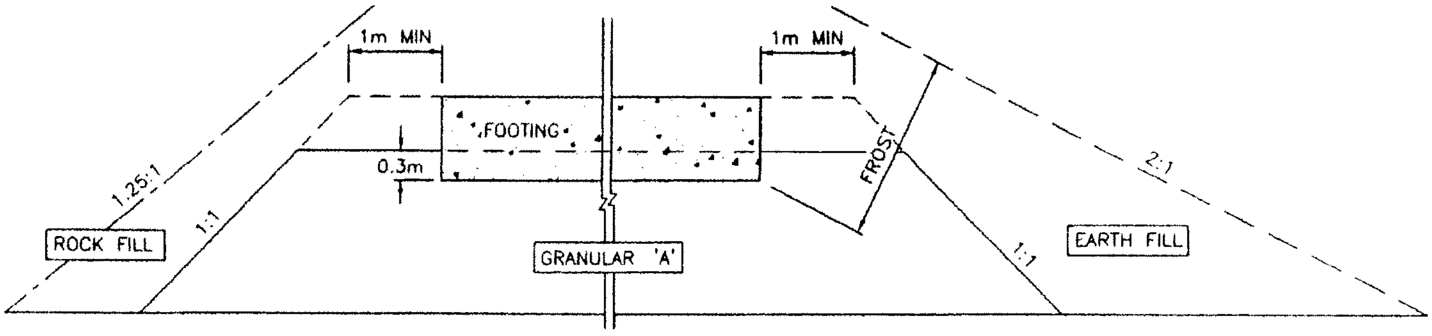


FIGURE 1: ALTERNATIVE PILE INSTALLATION SCHEME (INTEGRAL ABUTMENTS)

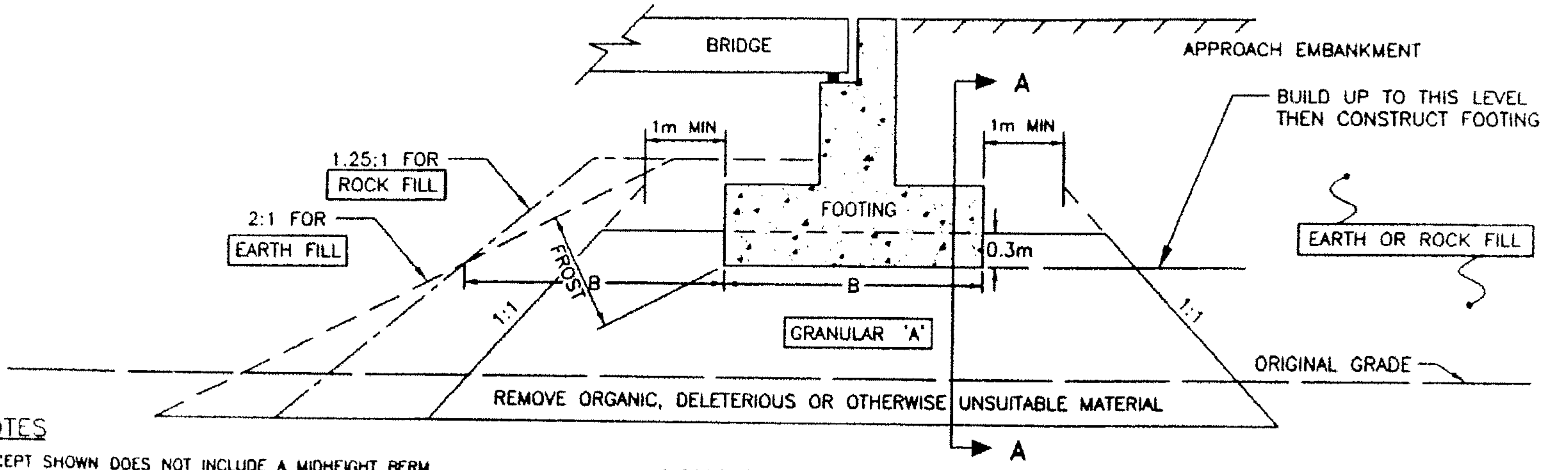
REFERENCE:
SKETCH PROVIDED BY McCORMICK RANKIN CORP. (MAY 2005)

SCALE: AS SHOWN
DIMENSIONS IN MILLIMETRES



CROSS SECTION A-A

NOT TO SCALE



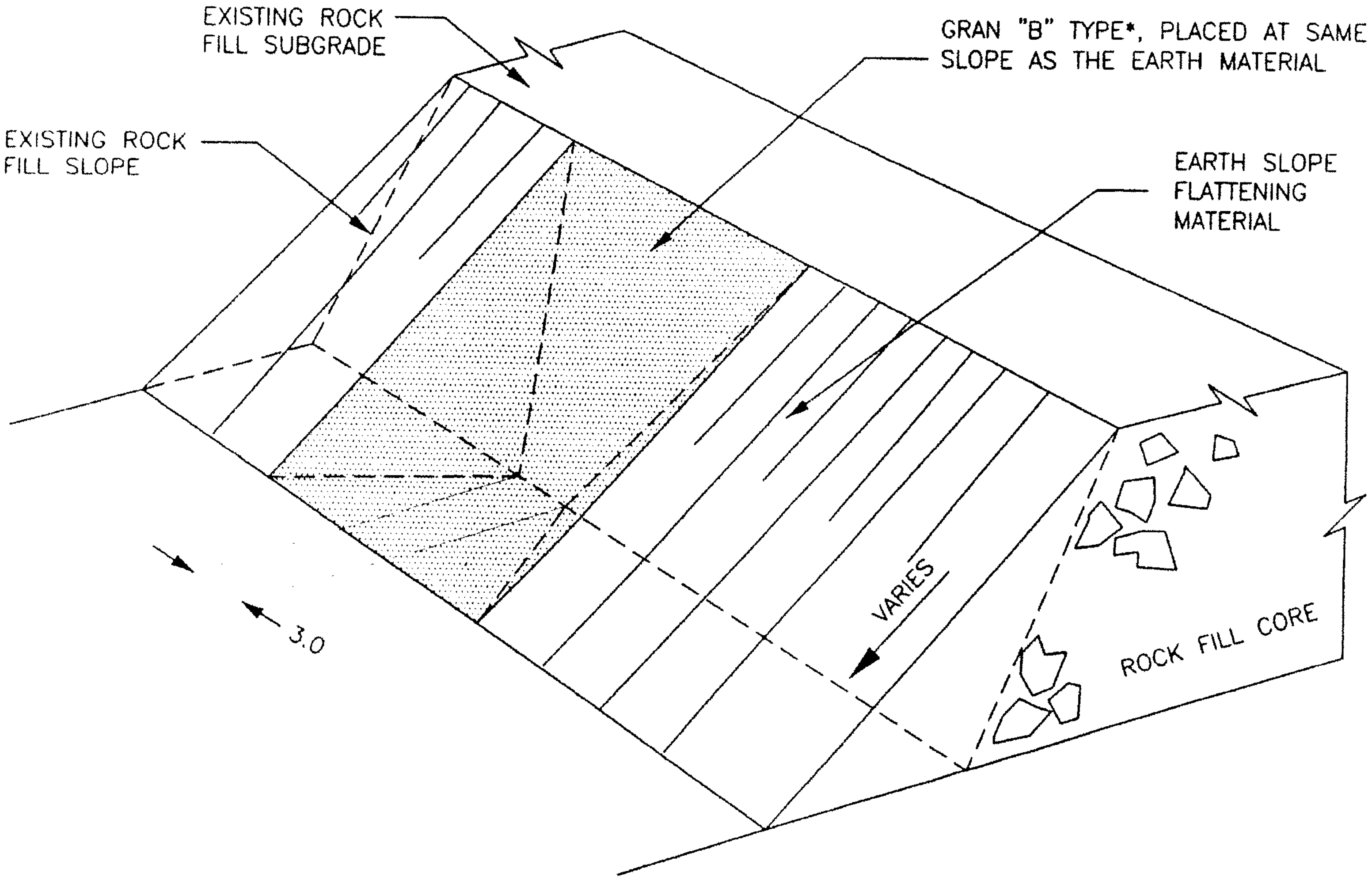
LONGITUDINAL SECTION

NOT TO SCALE

NOTES

1. CONCEPT SHOWN DOES NOT INCLUDE A MIDHEIGHT BERM.
2. LIMITS OF GRANULAR 'A' CORE TO BE DEFINED BY A SITE SPECIFIC SURVEY.
3. REMOVE ORGANIC, DELETERIOUS OR OTHERWISE UNSUITABLE MATERIAL UNDER AREA OF COMPACTED GRANULAR 'A' AND EARTH OR ROCK FILL AS NOTED IN TEXT OF REPORT.
4. PLACE GRANULAR 'A' AND EARTH OR ROCK FILL ON APPROVED SUBGRADE TO BOTTOM OF FOOTING LEVEL, COMPACTED ACCORDING TO CURRENT M.T.O. STANDARDS.
5. CONSTRUCT CONCRETE FOOTING.
6. PLACE REMAINDER OF GRANULAR 'A' AND EARTH OR ROCK FILL INCLUDING MIDHEIGHT BENCHES, AS REQUIRED.
7. REFER TO TEXT OF REPORT FOR FROST DEPTH.

FIGURE 2: ABUTMENT ON COMPACTED FILL SHOWING GRANULAR 'A' CORE



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

FIGURE 3: ROCK FILL DRAINAGE IN SLOPE FLATTENED AREAS

NOT TO SCALE