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DIST. 52 REGION

W.P. No. 399-97-01
GWP: 290-97-00

CONT. No.

W. O. No.

STR. SITE No. 42-321

HWY. No. 69

LOCATION Tower Rd. Underpass

No of PAGES -

OVERSIZE DRAWINGS TO BE INCLUDED WITH THIS REPORT.

REMARKS:

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CONSULTING ENGINEERS

FOUNDATION INVESTIGATION REPORT
FOR
TOWER ROAD UNDERPASS
W.P. 399-97-01
G.W.P. 290-97-00, SITE 42-321
HIGHWAY 69, DISTRICT 52
HUNTSVILLE, ONTARIO

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Job No. 97TF088A
Geocres No. 31E-134

August, 1999

PetoMacCallum Ltd.
CONSULTING ENGINEERS

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Peto MacCallum Ltd.
CONSULTING ENGINEERS

FOUNDATION INVESTIGATION REPORT
For
Tower Road Underpass
W.P. 399-97-01
G.W.P. 290-97-00, Site 42-321
Highway 69, District 52, Huntsville

INTRODUCTION

This report summarizes the results of the foundation investigation carried out for construction of the underpass to carry Tower Road over the proposed four-lane Highway 69 (Station 13+593 Highway 69 chainage).

The report pertains to the proposed bridge structure and approaches within about 20 m of the abutments, between approximate stations 9+940 and 10+060, Tower Road chainage.

SITE DESCRIPTION

The site is located about 2.5 km southwest of MacTier and about 400 m west of the existing Tower Road/Highway 69 intersection. At the underpass, the Tower Road structure will run east-west.

The bridge location is presently a wooded/brush-covered area located immediately west of a trailer park. Partially tree covered bedrock outcrops exist immediately to the north and south of the bridge site.

The report area is part of the Precambrian Laurentian peneplane. Although the general surface of the country is relatively flat the topography is quire irregular in detail and the area is dotted with many small lakes separated by rocky ridges. The overburden in the region is typically shallow, but can vary substantially in thickness over short distances. Swamp environments have developed in areas of poor drainage.

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BARRIE, BRAMPTON, HAMILTON, KITCHENER, TORONTO

The bedrock formations are of Precambrian age and are largely composed of veined, banded, and homogeneous pink and grey gneisses produced by injection and granitization of metamorphic gneisses of various types.

INVESTIGATION PROCEDURES

The fieldwork was carried out on March 3 and 4, 1998 and comprised 10 boreholes drilled at the locations shown on Drawing 1.

The boreholes were drilled to refusal on bedrock/inferred bedrock at depths of 0.0 to 2.6 m. Three of the boreholes were extended an additional 2.5 to 2.9 m into the bedrock using NQ rock coring equipment.

The boreholes were advanced using continuous flight hollow stem augers, powered by a track-mounted CME-75 drillrig, supplied and operated by a specialist drilling contractor, working under the full-time supervision of a member of our engineering staff.

Where an appreciable overburden thickness was encountered, samples were recovered using a conventional split spoon sampler as well as from the auger cuttings. Standard penetration tests were conducted simultaneously with the sampling operation to assess the strength characteristics of the substrata. The groundwater conditions in the boreholes were closely monitored during the course of the fieldwork.

All of the recovered samples were returned to our laboratory for detailed visual examination, classification and routine moisture content determinations. Samples of the recovered rock core were subjected to unconfined compressive strength tests.

SUMMARIZED SUBSURFACE CONDITIONS

Reference is made to the appended Log of Borehole sheets for details of the subsurface conditions including soil classifications, inferred stratigraphy, standard penetration test "N" values, rock core descriptions, groundwater observations and the results of laboratory moisture content determinations. Stratigraphic profiles prepared from the borehole data are presented on Drawing 1.

The stratigraphy revealed in the boreholes generally comprised a surficial sand and gravel fill and/or sand layer overlying bedrock. The strata encountered are summarized below.

Sand and Gravel Fill

A surficial layer of sand and gravel fill was encountered in boreholes 321-1, 2, 4, 6, 8 and 10. A 25 mm thick layer of tar and chip overlying sand and gravel fill was contacted surficially in borehole 321-9. The fill was 80 to 760 mm thick and generally comprised crushed stone and/or sand and gravel.

Sand

A discontinuous layer of native sand was encountered surficially in boreholes 321-3 and 7 and beneath the sand and gravel fill in testhole 321-10. The sand layer was 1.0 to 1.1 m thick and consisted of fine to medium sand. Some organics were noted in this deposit in borehole 321-3.

Bedrock

Bedrock or inferred bedrock was contacted surficially in borehole 321-5, beneath the fill and/or sand in boreholes 321-1 to 4 and 321-6 to 10 at depths of 0.0 to 2.6 m (elevation 243.5 to 248.2).

A description of the rock cores recovered from boreholes 321-3, 6 and 7 is presented on Table I. The bedrock consists of granite gneiss and migmatite. Core recovery ranged from 75 to 100% (average 93%) and the RQD typically ranged from 50 to 100% (average 86%). The rock was described as fair to excellent quality, locally very poor quality in the upper 330 mm of borehole 321-3.

The unconfined compressive strength of selected core samples were as follows:

Borehole No.	Depth (m)	Unconfined Compressive Strength (MPa)
321-3	1.32	96.4
321-6	0.91	131.5
321-7	1.52	115.2

Groundwater

Standing water was present at the location of testhole 321-3, drilled in a roadside ditch. Free water was not observed in the remaining boreholes during the course of the fieldwork.

CLOSURE

The fieldwork was carried out under the supervision of M. Rapsey, Senior Drillrig Supervisor. The equipment was supplied by All-Terrain Drilling Limited.

The report was written by M.R. Anderson, P.Eng., Project Engineer, and reviewed by D.W. Kerr, P.Eng., Manager of Geotechnical and Geo-Environmental Services, Hamilton.

Yours very truly

Peto MacCallum Ltd.

Dennis W. Kerr, M.Eng., P.Eng.
Manager Geotechnical and
Geo-Environmental Services

Brian R. Gray, M.Eng., P.Eng.
Vice-President
Geotechnical and
Geo-Environmental Services

MRA:mma

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Our Ref: 97TF088A

TABLE I

ROCK CORE DESCRIPTION
W.P. 399-97-01
GWP 290-97-00, Site No. 42-321

CORE RECOVERY					CORE DESCRIPTION	
BOREHOLE	**CORE NO.**	**DEPTH (m)**	**RECOVERY (%)**	**RQD (%)**	**DEPTH (m)**	**DESCRIPTION**
321-3	1	0.99 - 1.32	100	0	0.99 - 1.30	**GRANITIC GNEISS**, pink, fine crystalline with concentrations of biotite mica, medium to high strength, unweathered; very close to close spaced discontinuities; very poor quality
	2	1.32 - 2.84	90	90		
	3	2.84 - 3.95	100	100		
					1.30 - 3.45	**MIGMATITE**, grey and black heterogeneous biotite migmatite, high strength, unweathered; moderate to wide spaced partings; excellent quality
321-6	1	0.76 - 1.47	93	79	0.76 - 2.05	**MIGMATITE**, light grey and pink banded biotite migmatite; close to moderate spaced partings; high strength
	2	1.47 - 3.00	100	67		
	3	3.00 - 3.66	100	100	2.05 - 2.74	**MIGMATITE**, homogeneous hornblende migmatite, high strength; close to moderate spaced discontinuities; oblique partings with silt infilling at 2.4 m
					2.74 - 3.66	**GRANITIC GNEISS**, pink, fine crystalline, high strength; moderate spaced discontinuities; excellent quality
321-7	1	1.04 - 1.65	75	50	1.04 - 3.76	**GRANITIC GNEISS**, pink, fine crystalline with biotite mica, high strength, unweathered; close to moderate spaced discontinuities; fair to excellent quality
	2	1.65 - 3.15	76	100		
	3	3.15 - 3.76	100	100		

RQD = Rock Quality Designation

Logged by J. Wright

LIST OF ABBREVIATIONS

PENETRATION RESISTANCE

STANDARD PENETRATION RESISTANCE 'N', - THE NUMBER OF BLOWS REQUIRED TO ADVANCE A STANDARD SPLIT SPOON SAMPLER 0.3m INTO THE SUBSOIL. DRIVEN BY MEANS OF A 63.5kg HAMMER FALLING FREELY A DISTANCE OF 0.76m.

DYNAMIC PENETRATION RESISTANCE : - THE NUMBER OF BLOWS REQUIRED TO ADVANCE A 51mm, 60 DEGREE CONE, FITTED TO THE END OF DRILL RODS, 0.3m INTO THE SUBSOIL. THE DRIVING ENERGY BEING 475 J PER BLOW.

DESCRIPTION OF SOIL

THE CONSISTENCY OF COHESIVE SOILS AND THE RELATIVE DENSITY OR DENSENESS OF COHESIONLESS SOILS ARE DESCRIBED IN THE FOLLOWING TERMS :-

CONSISTENCY	'N' BLOWS/0.3 m	c kPa	DENSENESS	'N' BLOWS/0.3 m
VERY SOFT	0 - 2	0 - 12	VERY LOOSE	0 - 4
SOFT	2 - 4	12 - 25	LOOSE	4 - 10
FIRM	4 - 8	25 - 50	COMPACT	10 - 30
STIFF	8 - 15	50 - 100	DENSE	30 - 50
VERY STIFF	15 - 30	100 - 200	VERY DENSE	> 50
HARD	> 30	> 200		

W.T.P.L. WETTER THAN PLASTIC LIMIT D.T.P.L. DRIER THAN PLASTIC LIMIT

A.P.L. ABOUT PLASTIC LIMIT

TYPE OF SAMPLE

S.S	SPLIT SPOON	T.W.	THINWALL OPEN
W.S.	WASHED SAMPLE	T.P.	THINWALL PISTON
S.B.	SCRAPER BUCKET SAMPLE	O.S.	OESTERBERG SAMPLE
A.S.	AUGER SAMPLE	F.S	FOIL SAMPLE
C.S.	CHUNK SAMPLE	R.C	ROCK CORE
S.T	SLOTTED TUBE SAMPLE		

P.H SAMPLE ADVANCED HYDRAULICALLY

P.M. SAMPLE ADVANCED MANUALLY

SOIL TESTS

Qu	UNCONFINED COMPRESSION	L.V	LABORATORY VANE
Q	UNDRAINED TRIAXIAL	F.V	FIELD VANE
Qcu	CONSOLIDATED UNDRAINED TRIAXIAL	C	CONSOLIDATION
Qd	DRAINED TRIAXIAL		

▲,△ - Undisturbed and remoulded shear strength determined from in situ vane test.

■ - Undrained shear strength determined from pocket penetrometer test.

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LOG OF BOREHOLE NO. 321-1

N 4 996 236
E 282 175

PROJECT W.P. 399-97-01, HIGHWAY 69, DISTRICT 52, HUNTSVILLE
SITE Tower Road Underpass, Site 42-321
LOCATION Station 9+945.5 (Tower Road) 5.5m Lt.
BORING METHOD Continuous Flight Solid Stem Augers
BORING DATE March 3, 1998

OUR PROJECT 97TF088A
ENGINEER A. D. Vanin
TECHNICIAN M. Rapsey

DEPTH in METRES	DESCRIPTION	LEGEND	ELEVATION	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: BLOWS/0.3m N-VALUES	SHEAR STRENGTH C_u ▲ / DYNAMIC CONE PENETRATION x / STANDARD PENETRATION TEST ● BLOWS/0.3M (20 40 60 80)	LIQUID LIMIT W_L / PLASTIC LIMIT W_P / WATER CONTENT W (W_P W W_L) WATER CONTENT % (10 20 30)	GROUNDWATER OBSERVATIONS AND REMARKS
0	GROUND ELEVATION 248.23								
0.10	SAND AND GRAVEL FILL: 50mm crushed stone over 50mm sand and gravel		248						Upon completion of augering, no free water, no cave.
	BOREHOLE TERMINATED UPON REFUSAL TO AUGER AT 0.10m. BEDROCK ASSUMED.								
1.5									
3.0									
4.5									
6.0									
7.5									
9.0									
10.5									
12.0									
13.5									
15.0									
16.5									

NOTES:

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LOG OF BOREHOLE NO. 321-2

N 4 996 226
E 282 179

PROJECT W.P. 399-97-01, HIGHWAY 69, DISTRICT 52, HUNTSVILLE
SITE Tower Road Underpass, Site 42-321
LOCATION Station 9+945.5 (Tower Road) 5.5m Rt.
BORING METHOD Continuous Flight Solid Stem Augers
BORING DATE March 3, 1998
OUR PROJECT 97TF088A
ENGINEER A. D. Vanin
TECHNICIAN M. Rapsey

DEPTH in METRES	DESCRIPTION	LEGEND	ELEVATION	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: BLOWS/0.3m N-VALUES	SHEAR STRENGTH C_u ▲ / DYNAMIC CONE PENETRATION x / STANDARD PENETRATION TEST ● BLOWS/0.3M (20 40 60 80)	LIQUID LIMIT W_L / PLASTIC LIMIT W_P / WATER CONTENT W — WATER CONTENT % (10 20 30)	GROUNDWATER OBSERVATIONS AND REMARKS
0	GROUND ELEVATION 248.25								
0.08	**SAND AND GRAVEL FILL** : 75mm crushed stone		248						Upon completion of augering, no free water, no cave.
	BOREHOLE TERMINATED UPON REFUSAL TO AUGER AT 0.08m. BEDROCK ASSUMED.								
1.5									
3.0									
4.5									
6.0									
7.5									
9.0									
10.5									
12.0									
13.5									
15.0									
16.5									

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LOG OF BOREHOLE NO. 321–3

N 4 996 243
E 282 194

PROJECT W.P. 399–97–01, HIGHWAY 69, DISTRICT 52, HUNTSVILLE
SITE Tower Road Underpass, Site 42–321
LOCATION Station 9+965.5 (Tower Road) 5.5m Lt.
BORING METHOD Continuous Flight Solid Stem Augers & NQ Rock Coring
BORING DATE March 4, 1998

OUR PROJECT 97TF088A
ENGINEER A. D. Vanin
TECHNICIAN M. Rapsey

DEPTH in METRES	DESCRIPTION	LEGEND	ELEVATION	NUMBER	TYPE	BLOWS/0.3m N - VALUES	SHEAR STRENGTH C_u ▲ / DYNAMIC CONE PENETRATION x / STANDARD PENETRATION TEST ● BLOWS/0.3M (20 40 60 80)	RUN (mm)	RECOVERY (%)	RQD (%)	DRILL WATER RETURN (%)	LIQUID LIMIT W_L / PLASTIC LIMIT W_P / WATER CONTENT W (W_P W W_L) / WATER CONTENT % (10 20 30)	GROUNDWATER OBSERVATIONS AND REMARKS
0	GROUND ELEVATION 247.43												
	SAND : Black to dark brown silty sand, saturated, low organic		247										Borehole located in ditch. Free water at surface.
0.99													
1.30	**BEDROCK** : Granitic Gneiss		246				330	100	0	100			
1.5	Biotite Migmatite												
			245				1524	90	90	100			
3.0													
3.45			244				610	100	100	100			
	BOREHOLE TERMINATED AT 3.45m												
4.5			243										
6.0													
7.5													
9.0													
10.5													
12.0													
13.5													
15.0													
16.5													

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LOG OF BOREHOLE NO. 321-4

PROJECT W.P. 399-97-00, HIGHWAY 69, DISTRICT 52, HUNTSVILLE
SITE Tower Road Underpass, Site 42-321
LOCATION Station 9+965.5 (Tower Road) 5.5m Rt.
BORING METHOD Continuous Flight Solid Stem Augers

OUR PROJECT 97TF088A
BORING DATE March 3, 1998
ENGINEER A. D. Vanin
TECHNICIAN M. Rapsey

DEPTH in METRES	DESCRIPTION	LEGEND	ELEVATION	NUMBER	TYPE	BLOWS/0.3m N - VALUES	SHEAR STRENGTH C_u ▲ / DYNAMIC CONE PENETRATION x / STANDARD PENETRATION TEST ● BLOWS/0.3M (20 40 60 80)	LIQUID LIMIT W_L / PLASTIC LIMIT W_P / WATER CONTENT W (W_P W W_L) WATER CONTENT % (10 20 30)	GROUNDWATER OBSERVATIONS AND REMARKS
0	GROUND ELEVATION 247.73								
0.18	SAND AND GRAVEL FILL: 75mm crushed stone over 100mm dark brown silty, fine to coarse sand		247						Upon completion of augering, no free water, no cave.
	BOREHOLE TERMINATED UPON REFUSAL TO AUGER AT 0.18m. BEDROCK ASSUMED.								
1.5									
3.0									
4.5									
6.0									
7.5									
9.0									
10.5									
12.0									
13.5									
15.0									
16.5									

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LOG OF BOREHOLE NO. 321-5

N 4 996 256
E 282 227

PROJECT W.P. 399-97-01, HIGHWAY 69, DISTRICT 52, HUNTSVILLE
SITE Tower Road Underpass, Site 42-320
LOCATION Station 10+000.0 (Tower Road) 5.5m Lt.
BORING METHOD Continuous Flight Solid Stem Augers
BORING DATE March 3, 1998
OUR PROJECT 97TF088A
ENGINEER A. D. Vanin
TECHNICIAN M. Rapsey

DEPTH in METRES	DESCRIPTION	LEGEND	ELEVATION	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: BLOWS/0.3m N - VALUES	SHEAR STRENGTH C_u ▲ / DYNAMIC CONE PENETRATION x / STANDARD PENETRATION TEST ● BLOWS/0.3M (20 40 60 80)	LIQUID LIMIT W_L / PLASTIC LIMIT W_P / WATER CONTENT W (W_P W W_L) WATER CONTENT % (10 20 30)	GROUNDWATER OBSERVATIONS AND REMARKS
	GROUND ELEVATION 248.10								
0	BEDROCK		248						Upon completion of augering, no free water, no cave.
1.5									
3.0									
4.5									
6.0									
7.5									
9.0									
10.5									
12.0									
13.5									
15.0									
16.5									

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LOG OF BOREHOLE NO. 321-6

N 4 996 245
E 282 230

PROJECT W.P. 399-97-01, HIGHWAY 69, DISTRICT 52, HUNTSVILLE
SITE Tower Road Underpass, Site 42-321
LOCATION Station 10+000.0 (Tower Road) 5.5m Rt.
BORING METHOD Continuous Flight Solid Stem Augers & NQ Rock Coring
BORING DATE March 4, 1998

OUR PROJECT 97TF088A
ENGINEER A. D. Vanin
TECHNICIAN M. Rapsey

DEPTH in METRES	DESCRIPTION	LEGEND	ELEVATION	NUMBER	TYPE	BLOWS/0.3m N - VALUES	SHEAR STRENGTH C_u ▲ / DYNAMIC CONE PENETRATION x / STANDARD PENETRATION TEST ● BLOWS/0.3M (20 40 60 80)	LIQUID LIMIT W_L / PLASTIC LIMIT W_P / WATER CONTENT W (W_P W W_L) WATER CONTENT % (10 20 30)	GROUNDWATER OBSERVATIONS AND REMARKS
	GROUND ELEVATION 247.31								
0	SAND AND GRAVEL FILL : 75mm crushed stone over sand and gravel		247						Upon completion of augering, no free water, no cave.
0.76	BEDROCK : Biotite Migmatite		246				711 93 79 100		
1.5									
2.05	Hornblende Migmatite		245				1524 100 67 *		* Lost drill water at 2.45m.
2.74	Granitic Gneiss								
3.0			244				660 100 100 100		
3.66	BOREHOLE TERMINATED AT 3.66m						RUN (mm) / RECOVERY (%) / RQD (%) / DRILL WATER RETURN (%)		
4.5			243						
6.0									
7.5									
9.0									
10.5									
12.0									
13.5									
15.0									
16.5									

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LOG OF BOREHOLE NO. 321-7

N 4 996 267
E 282 259

PROJECT W.P. 399-97-01, HIGHWAY 69, DISTRICT 52, HUNTSVILLE
SITE Tower Road Underpass, Site 42-321
LOCATION Station 10+034.5 (Tower Road) 5.5m Lt.
BORING METHOD Continuous Flight Solid Stem Augers & NQ Rock Coring
BORING DATE March 4, 1998

OUR PROJECT 97TF088A
ENGINEER A. D. Vanin
TECHNICIAN M. Rapsey

DEPTH in METRES	DESCRIPTION	LEGEND	ELEVATION	NUMBER	TYPE	BLOWS/0.3m N - VALUES	SHEAR STRENGTH C_u ▲ / DYNAMIC CONE PENETRATION x / STANDARD PENETRATION TEST ● BLOWS/0.3M (20 40 60 80)	LIQUID LIMIT W_L / PLASTIC LIMIT W_P / WATER CONTENT W (W_P W W_L) WATER CONTENT % (10 20 30)	GROUNDWATER OBSERVATIONS AND REMARKS
	GROUND ELEVATION 246.28								
0	**SAND** : Dark brown to brown, silty fine to medium sand		246						Upon completion of augering, no free water, no cave.
1.04									
1.5	**BEDROCK** : Granitic Gneiss		245				610 75 50 100		
			244				1499 76 100 100		
3.0			243				610 100 100 100		
3.76									
4.5	**BOREHOLE TERMINATED AT 3.76m**		242				RUN (mm) / RECOVERY (%) / RQD (%) / DRILL WATER RETURN (%)		
6.0									
7.5									
9.0									
10.5									
12.0									
13.5									
15.0									
16.5									

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LOG OF BOREHOLE NO. 321-8

N 4 996 257
E 282 262

PROJECT W.P. 399-97-01, HIGHWAY 69, DISTRICT 52, HUNTSVILLE
SITE Tower Road Underpass, Site 42-321
LOCATION Station 10+034.5 (Tower Road) 5.5m Rt.
BORING METHOD Continuous Flight Solid Stem Augers
BORING DATE March 3, 1998

OUR PROJECT 97TF088A
ENGINEER A. D. Vanin
TECHNICIAN M. Rapsey

DEPTH in METRES	DESCRIPTION	LEGEND	ELEVATION	NUMBER	TYPE	BLOWS/0.3m VALUES N	SHEAR STRENGTH C_u ▲ / DYNAMIC CONE PENETRATION × STANDARD PENETRATION TEST ● BLOWS/0.3M (20 40 60 80)	LIQUID LIMIT W_L / PLASTIC LIMIT W_P / WATER CONTENT W (W_P — W — W_L) WATER CONTENT % (10 20 30)	GROUNDWATER OBSERVATIONS AND REMARKS
	GROUND ELEVATION 246.89								
0									Upon completion of augering, no free water, no cave.
0.46	SAND AND GRAVEL FILL: Brown, fine to coarse sand and gravel, trace of silt		246						
	BOREHOLE TERMINATED UPON REFUSAL TO AUGER AT 0.46m. BEDROCK ASSUMED.								
1.5									
3.0									
4.5									
6.0									
7.5									
9.0									
10.5									
12.0									
13.5									
15.0									
16.5									

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LOG OF BOREHOLE NO. 321-9

N 4 996 274
E 282 277

PROJECT W.P. 399-97-01, HIGHWAY 69, DISTRICT 52, HUNTSVILLE
SITE Tower Road Underpass, Site 42-321
LOCATION Station 10+054.5 (Tower Road) 5.5m Lt.
BORING METHOD Continuous Flight Solid Stem Augers
BORING DATE March 3, 1998
OUR PROJECT 97TF088A
ENGINEER A. D. Vanin
TECHNICIAN M. Rapsey

DEPTH in METRES	DESCRIPTION	LEGEND	ELEVATION	SAMPLES NUMBER	SAMPLES TYPE	BLOWS/0.3m N - VALUES	GROUNDWATER OBSERVATIONS AND REMARKS
	GROUND ELEVATION 246.07						
0.03	TAR AND CHIP : 25mm						Upon completion of augering, no free water, no cave.
0.56	SAND AND GRAVEL FILL : 75mm crushed stone over brown, gravelly, fine to medium sand, trace of silt		245				
	SAND : Compact, rusty-brown to brown fine sand, trace of silt, damp to moist		244	1	SS	12	
2.62	BOREHOLE TERMINATED UPON REFUSAL TO AUGER AT 2.62m. BEDROCK ASSUMED.		243				

SHEAR STRENGTH C_u ▲
DYNAMIC CONE PENETRATION ×
STANDARD PENETRATION TEST ●
BLOWS/0.3M 20 40 60 80

LIQUID LIMIT ____ W_L
PLASTIC LIMIT ____ W_P
WATER CONTENT ____ W
W_P W W_L
WATER CONTENT % 10 20 30

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LOG OF BOREHOLE NO. 321–10

N 4 996 264
E 282 281

PROJECT W.P. 399–97–01, HIGHWAY 69, DISTRICT 52, HUNTSVILLE
SITE Tower Road Underpass, Site 42–321
LOCATION Station 10+054.5 (Tower Road) 5.5m Rt.
BORING METHOD Continuous Flight Solid Stem Augers
BORING DATE March 3, 1998
OUR PROJECT 97TF088A
ENGINEER A. D. Vanin
TECHNICIAN M. Rapsey

DEPTH in METRES	DESCRIPTION	LEGEND	ELEVATION	NUMBER	TYPE	BLOWS/0.3m N - VALUES
	GROUND ELEVATION 246.10					
0						
0.46	SAND AND GRAVEL FILL : 150mm crushed stone over dark brown, fine sand, some gravel and silt, damp		245			
1.5				1	SS	72*
1.55	SAND : Compact, rusty brown to brown, fine sand, trace of silt, damp		244			
	BOREHOLE TERMINATED UPON REFUSAL TO AUGER AT 1.55m. BEDROCK ASSUMED.					
3.0						
4.5						
6.0						
7.5						
9.0						
10.5						
12.0						
13.5						
15.0						
16.5						

SHEAR STRENGTH C_u ▲
DYNAMIC CONE PENETRATION x
STANDARD PENETRATION TEST ●
BLOWS/0.3M
20 40 60 80

LIQUID LIMIT ____ W_L
PLASTIC LIMIT ____ W_P
WATER CONTENT ____ W
W_P W W_L
WATER CONTENT %
10 20 30

GROUNDWATER OBSERVATIONS AND REMARKS

Upon completion of augering, no free water, no cave.

* 22 for 300mm, then 50 for 25mm and bouncing

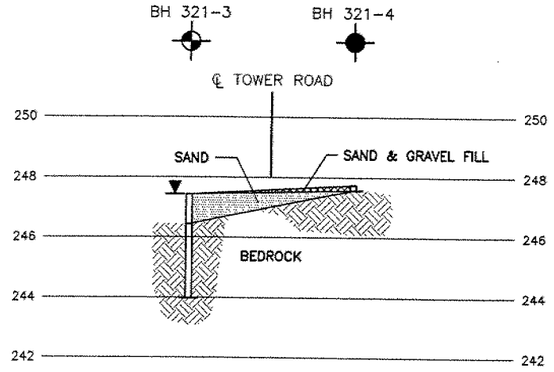
NOTES:

CHECKED BY:

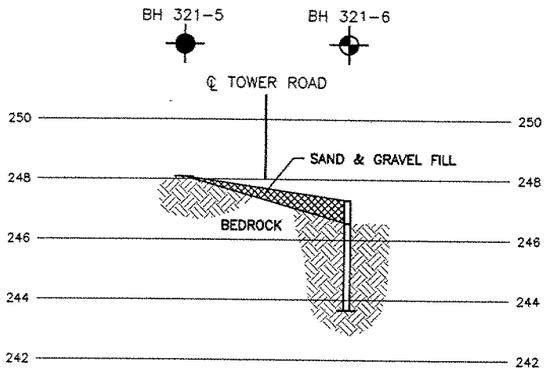
PLATE No 790-69/69-0

METRIC

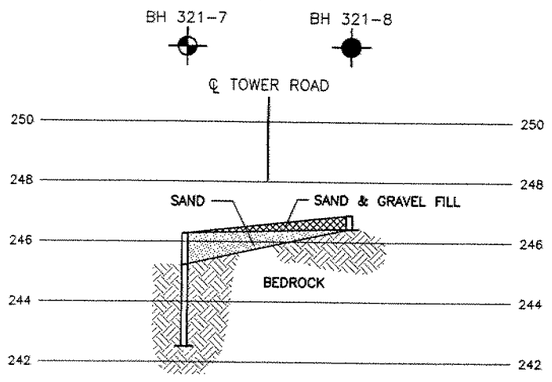
DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN



SECTION B - B

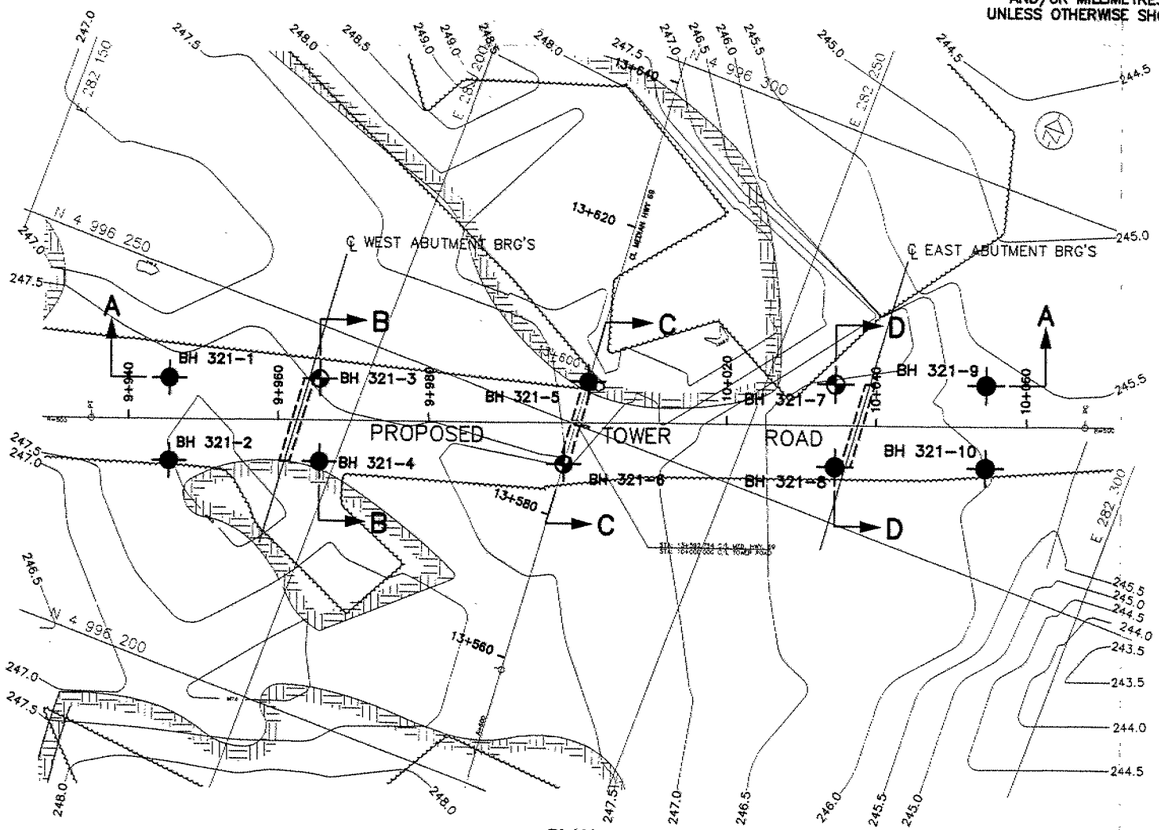


SECTION C - C



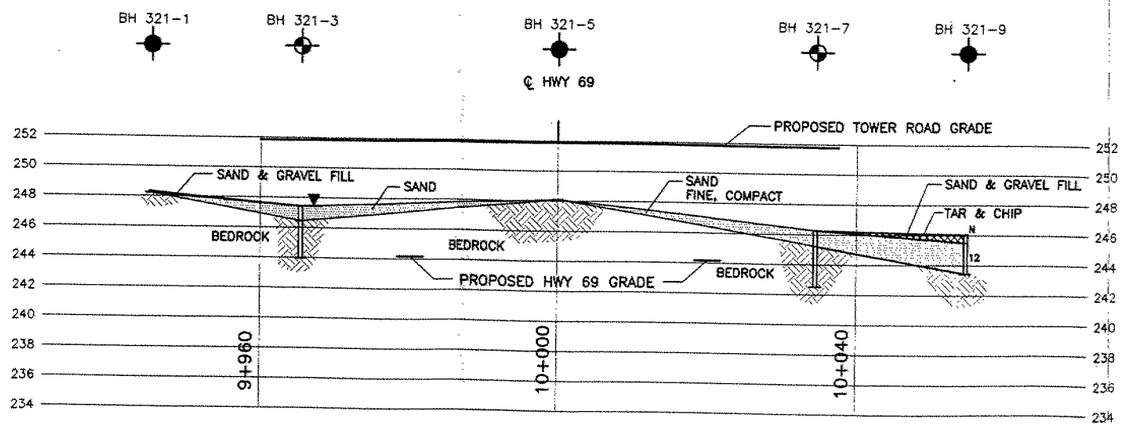
SECTION D - D

4m 2m 0 4m HOR.
2m 1m 0 2m VERT.



PLAN

8m 4m 0 8m



SECTION A - A

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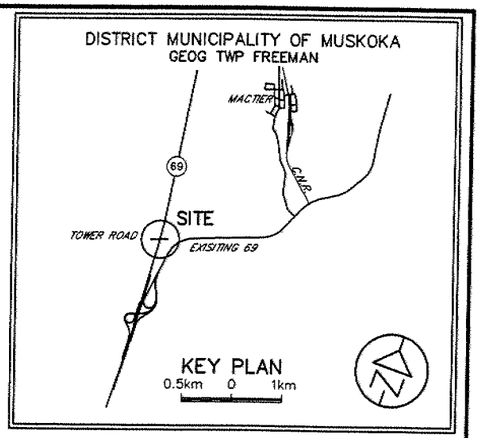
4m 2m 0 4m VERT.



BOREHOLE	NORTHING	EASTING	ELEVATION
BH 321-1	N 4 996 236	E 282 175	248.23
BH 321-2	N 4 996 226	E 282 179	248.25
BH 321-3	N 4 996 243	E 282 194	247.43
BH 321-4	N 4 996 233	E 282 198	247.73
BH 321-5	N 4 996 256	E 282 227	248.10
BH 321-6	N 4 996 245	E 282 230	247.31
BH 321-7	N 4 996 267	E 282 259	246.28
BH 321-8	N 4 996 257	E 282 262	246.89
BH 321-9	N 4 996 274	E 282 277	246.07
BH 321-10	N 4 996 264	E 282 281	246.10

LEGEND

- BOREHOLE
- BOREHOLE & ROCK CORE
- OBSERVED WATER LEVEL (DURING OR UPON COMPLETION OF DRILLING)

NOTE

1. REFER TO LOG OF BOREHOLE SHEETS FOR DETAILED SUBSURFACE CONDITIONS.
2. THE BOUNDARIES BETWEEN SOIL STRATA HAVE BEEN ESTABLISHED ONLY AT BOREHOLE LOCATIONS. BETWEEN BOREHOLES, THE BOUNDARIES ARE ASSUMED FROM GEOLOGICAL EVIDENCE.

PROPOSED CROSSING
AT
TOWER ROAD
AND
KING'S HIGHWAY 69
DISTRICT MUNICIPALITY OF MUSKOKA

LOT 9 GEOG TWP FREEMAN
CON 5 TWP OF GEORGIAN BAY

SCALE	DISTRICT	REGION
AS SHOWN	52 HUNTSVILLE	NORTHERN
WP/WO 399-97-01	PROFILE C-790-69-070	PLAN B-790-69-017

SURVEY 97 12 PLAN 97 12

SITE 42-321 PLAN E-790-69-069

Peto MacCallum Ltd.
CONSULTING ENGINEERS
45 BURFORD ROAD, HAMILTON, ONTARIO L8E 3C6

DRAWN	CB	DATE	SCALE	JOB NO.	DRAWING NO.
CHECKED	MRA	AUGUST 1999	AS SHOWN	97TF088A	1
APPROVED	DWK				

BOREHOLE LOCATION PLAN AND SOIL PROFILES

PetoMacCallum Ltd.
CONSULTING ENGINEERS

FOUNDATION DESIGN REPORT
FOR
TOWER ROAD UNDERPASS
W.P. 399-97-01
G.W.P. 290-97-00, SITE 42-321
HIGHWAY 69, DISTRICT 52
HUNTSVILLE, ONTARIO

Distribution:
13 cc: Highway 69 Joint Venture c/o McCormick Rankin Corporation for distribution to MTO
1 cc: Highway 69 Joint Venture c/o McCormick Rankin Corporation
1 cc: Highway 69 Joint Venture c/o Totten Sims Hubicki Associates
1 cc: PML Hamilton
1 cc: PML Toronto
1 cc: PML Barrie

Job No. 97TF088A
Geocres No. 31E-134

August, 1999

TABLE OF CONTENTS

Peto MacCallum Ltd.
CONSULTING ENGINEERS

FOUNDATION DESIGN REPORT
For
Tower Road Underpass
W.P. 399-97-01
G.W.P. 290-97-00, Site 42-321
Highway 69, District 52, Huntsville

INTRODUCTION

This report provides geotechnical comments and recommendations regarding design and construction of foundations, abutments and approaches at the proposed Highway 69 underpass at Tower Road.

Construction of a two span underpass structure is planned. At the underpass location, the proposed four-lane Highway 69 will be constructed in a cut of about 3 to 4 m (road grade at elevation 244.2). Road grades on Tower Road over the structure will be near elevation 251.7, some 4 to 5 m above existing grade (based on General Arrangement drawing dated February 1999 and existing ground surface elevations determined at the borehole locations).

The subsurface stratigraphy revealed at the bridge site generally comprised a thin surficial layer of sand and gravel fill and/or native sand mantling bedrock.

Bedrock/inferred bedrock was contacted at depths of 0.0 to 2.6 m.

FOUNDATIONS

Integral Abutments on Piles

The preliminary profile drawings indicate that road grades along Tower Road at the underpass location will be some 4 to 5 m above existing grade. Bedrock was contacted at depths of 0.0 to 1.0 m. Construction of integral abutments supported on steel H-piles is therefore not considered feasible at this site.

45 Burford Road, Hamilton, Ontario L8E 3C6
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E-mail: ham@petomac.on.ca
BARRIE, BRAMPTON, HAMILTON, KITCHENER, TORONTO

Spread Footings

Based on the borehole information, it is considered that the structure may be supported on conventional spread footings founded on bedrock.

Foundations bearing on the sound bedrock at elevations 245.2 to 248.1 may be designed using a factored bearing resistance of 10,000 kPa at the ultimate limit state.

The capacity at serviceability limit states normally allows for 25 mm of compression of the founding medium. Considering the bedrock to be non-yielding, the design is not expected to be governed by settlement since the loading required to produce deformation will be much larger than the factored capacity at ULS.

The bedrock cut for construction of Highway 69 will be some 2.7 to 3.9 m adjacent to the west abutment, 3.3 to 4.8 m at the centre pier, and 2.0 to 3.2 m adjacent to the east abutment. Current plans call for an approximate 10 m wide rock ridge along the centre median to be unexcavated.

The abutment footings should be founded below a line inclined upwards at 1:2 (H:V) from the toe of the Highway 69 cut. Footings for the centre pier may be constructed on the rock "ridge" along the median provided they are founded below a line inclined upwards at 1:1 from the toe of the excavation and the edge of footing is at least 2.0 m from the rock excavation face.

The bedrock surface at the abutments slopes up from the north to south at an inclination of about 7° to the horizontal, about 12° south to north at the centre pier. Mass concrete could be placed to provide a level founding surface for the abutment footings. It is anticipated that bedrock excavation will be required to lower the founding level at the centre pier; the excavation should be carried out in a manner which provides a level founding surface.

It is important that blasting/excavation of the rock along the northbound and southbound lanes of the highway in the vicinity of the pier is controlled to prevent disturbance to the rock. The excavation specifications should call for the contractor to retain a blasting specialist to establish blast criteria/ procedures to prevent disturbance. It should be stipulated that payment will be limited to excavation

to the limits shown on the drawing, overblasting/excavation will be the responsibility of the contractor, and all loosened rock is to be removed.

Mechanical means should be employed to excavate the loosened rock at the pier footing. A large excavator equipped with a "tiger tooth" bucket in conjunction with a jackhammer or hoe ram is the preferred method of excavation to shallow depths in rock.

Alternatively, spread footings could be constructed on structural fill placed in the approaches. The engineered fill should comprise OPSS Granular "A" material placed in maximum 200 mm thick lifts, compacted to 100% standard Proctor maximum dry density, and extended laterally to a line inclined outwards at 1:1 (H:V) originating at least 1 m from the top of footing. This scheme is illustrated on Figure 1. The fill should be placed directly on bedrock.

The recommended bearing resistances for footings constructed on structural fill are as follows:

Assumed Footing Width (m)	Factored Bearing Resistance at ULS (kPa)	Bearing Resistance at SLS (kPa)
2	920	250
3	1110	250

The recommended capacity at SLS allows for 25 mm of total settlement; 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 capacities.

All footings subject to frost action should be provided with the normal 1.8 m of earth cover or equivalent thermal insulation. A 25 mm thick layer of polystyrene insulation is thermally equivalent to 600 mm of soil cover. Footings bearing on sound bedrock should not require protection from frost.

Prior to placement of structural concrete, all foundation excavations should be examined by qualified geotechnical personnel to verify the competency of the founding surface.

ABUTMENT WALLS

The abutment walls should be designed to resist the unbalanced lateral earth pressure imposed by the backfill adjacent to the wall. The lateral earth pressure, p, may be computed using the equivalent fluid pressures presented in Section 6-7.4 of the Ontario Highway Bridge Design Code (OHBDC, 3rd Edition, 1991) or employing the following equation, assuming a triangular pressure distribution:

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

where K = coefficient of lateral earth pressure

γ = unit weight of free-draining granular material (kN/m^3)

h = depth below final grade (m)

q = surcharge load (kPa), if present

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

	Granular "A"	Granular "B"	Rock Fill
Angle of Internal Friction (degrees)	35	32	35
Unit Weight (kN/m^3)	22.8	21.2	18.0
Active Earth Pressure Coefficient (K_a)	0.27	0.31	0.27
At Rest Earth Pressure Coefficient (K_o)	0.43	0.47	0.43
Passive Earth Pressure Coefficient (K_p)	3.69	3.25	3.69

A weeping tile system and/or weeping holes should be installed to minimize 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.

The horizontal force will be resisted in part by the friction force developed between the underside of footing and the bedrock/structural fill. Unfactored friction factors of 0.6 and 0.45 are recommended for footings on bedrock and granular fill, respectively. A value of 0.7 may be used for a roughened bedrock surface (asperity height of at least 25 mm) created by mechanical means or during rock excavation.

The lateral resistance of footings founded on bedrock could be increased by installing anchors into the bedrock. The increased lateral resistance will be provided by the shear strength of the steel dowels, the horizontal component of tensile forces developed in any inclined anchors, and/or increased frictional resistance between the footing and rock if the anchors are prestressed to increase the vertical pressure.

A factored rock-grout bond stress of 1.4 MPa at the ultimate limit state (resistance factor of 0.4 applied, minimum 35 MPa grout) is recommended for design. The anchors should extend a minimum 30 bar diameters into sound bedrock and be spaced 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.

APPROACH FILL

Backfilling adjacent to the structure should be carried out in conformance with Ontario Provincial Standards specifications for granular or rock backfill.

The approaches on Tower Road will require up to about 5 m of fill.

The investigation indicates the proposed fill sections will generally be founded on a thin layer of sand and gravel fill and/or sand overlying bedrock.

It is anticipated that embankments will be constructed with soil or rockfill material generated from sections cut through bedrock along the project. The embankment fill should be constructed in accordance with OPSD 200.01, 200.02, 201.01, 201.02 and 202.010. The side slopes of approach

fills should be inclined no steeper than 2:1 (H:V) for earth fill and 1.25:1 for rock fill. For high rock fill embankments, provide 2.0 m wide berms so that no uninterrupted rock slope is greater than 6 m high in accordance with the Northern Region Pavement Design Practices and Guidelines.

Where slope flattening is proposed, a drainage gap should be provided in accordance with OPSD 202.02. Where slopes are flattened to eliminate the need for a guide rail, a granular infilled drainage gap should be provided in accordance with Northern Region practice, refer to sketch provided.

EXCAVATION AND GROUNDWATER CONTROL

Excavation for construction of footings is expected to be carried out primarily within the approach fill, locally sand and gravel fill and/or sand, and into bedrock. Excavation of the approach fill is expected to be relatively straightforward. The fill would be classified as a Type 3 soil according to Occupational Health and Safety Act (Ontario Regulation 213/91) criteria.

Excavation of the rock will be more difficult requiring standard methods of rock excavation such as blasting 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.

The rock excavation should be carried out in a manner that minimizes fracturing of the bedrock surface on which the proposed foundations will bear.

Free water was not observed in the boreholes during the course of the fieldwork. Seepage or surface water which enters the excavation should be readily handled by conventional sump pumping techniques.

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

CLOSURE

This report was written by M.R. Anderson, P.Eng., Project Engineer. It was reviewed by D.W. Kerr, P.Eng., Manager of Geotechnical and Geo-Environmental Services, Hamilton.

Yours very truly

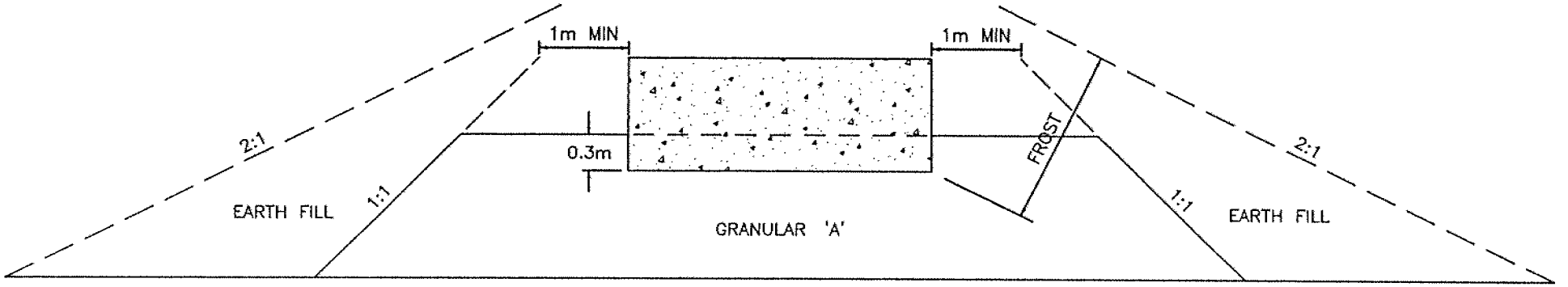
Peto MacCallum Ltd.

Dennis W. Kerr, M.Eng., P.Eng.
Manager Geotechnical and
Geo-Environmental Services

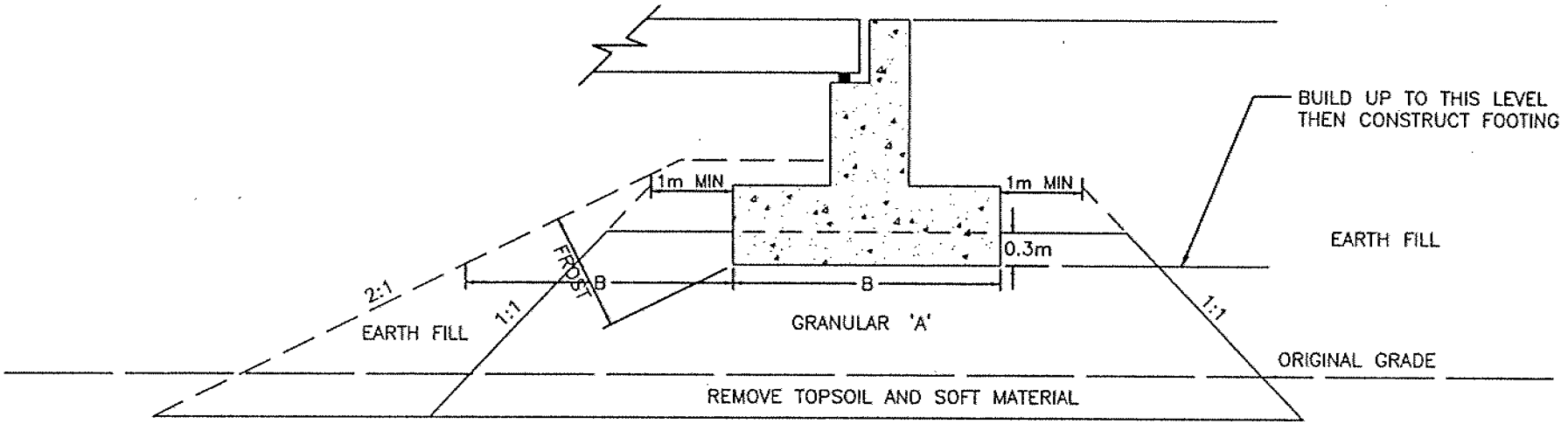
Brian R. Gray, M.Eng., P.Eng.
Vice-President
Geotechnical and
Geo-Environmental Services

MRA:mma

ABUTMENT ON COMPACTED FILL SHOWING GRANULAR 'A' CORE



CROSS SECTION



LONGITUDINAL SECTION

NOTES

1. REMOVE TOPSOIL AND/OR SOFT SUBSOIL UNDER AREA OF COMPACTED GRANULAR 'A' AND EARTH FILL.
2. PLACE GRANULAR 'A' AND EARTH FILL TO BOTTOM OF FOOTING LEVEL, COMPACTED ACCORDING TO CURRENT M.T.O. STANDARDS.
3. CONSTRUCT CONCRETE FOOTING
4. PLACE REMAINDER OF GRANULAR 'A' AND EARTH FILL AS REQUIRED
5. REFER TO TEXT OF REPORT FOR FROST DEPTH

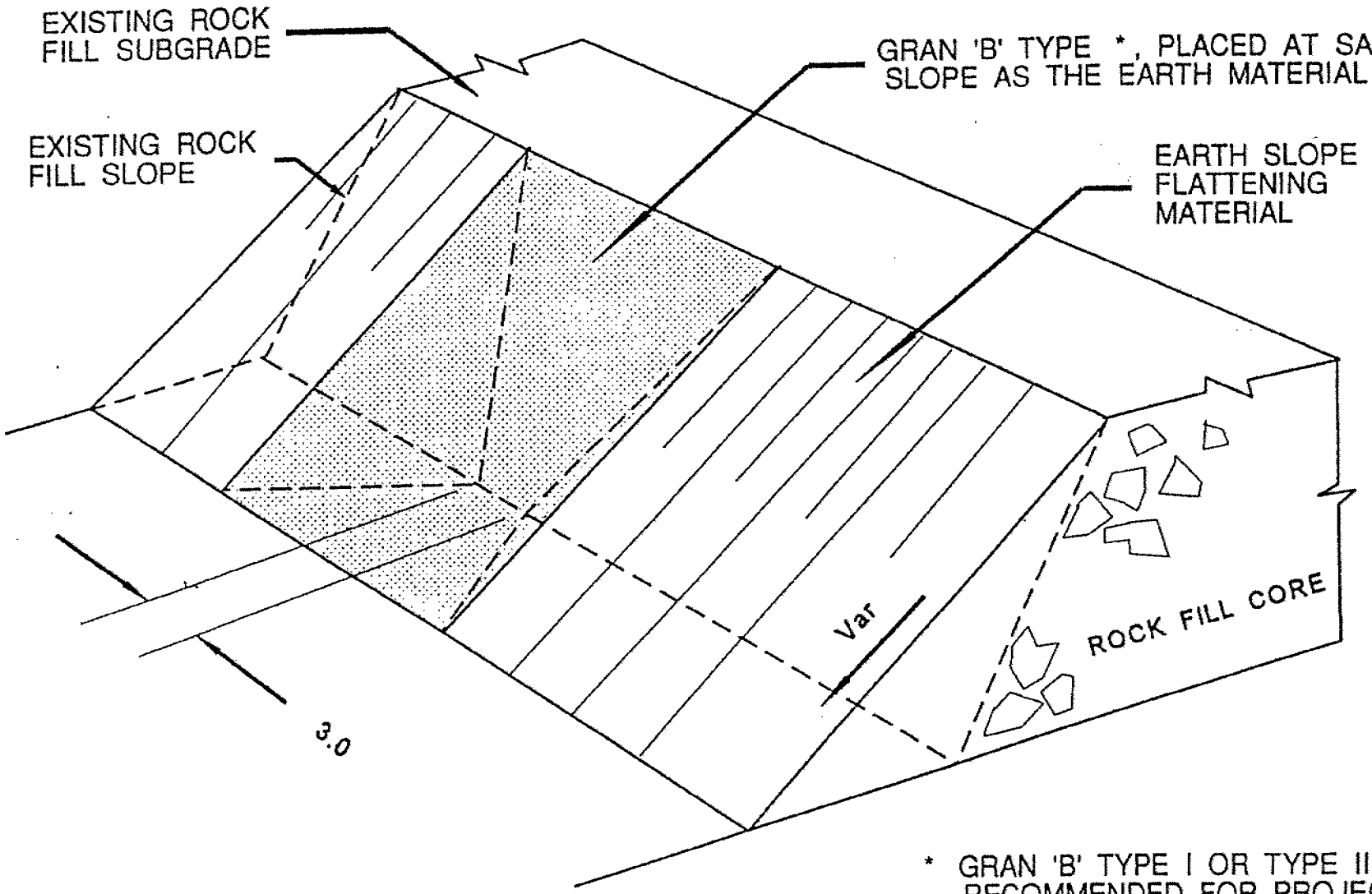
Peto MacCallum Ltd.
CONSULTING ENGINEERS
45 BURFORD ROAD, HAMILTON, ONTARIO L8E 3C6
Tel: (905) 561-2231 Fax (905) 561-6363

DATE	SCALE	JOB NO.	FIGURE NO.
MAR. 1998	NTS	–	1

APPENDIX A

ROCKFILL DRAINAGE
IN SLOPE FLATTENED AREAS

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



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

ROCK FILL DRAINAGE IN SLOPE FLATTENED AREAS

NOT TO SCALE

Ontario

memorandum

To: Mike Pearsall, P. Eng. 1999 10 20
Senior Project Manager
Planning & Design Section
Northern Region

From: Pavements and Foundation Section
Room 232, Central Building
Downsview, Ontario

Re: Final Foundation Investigation Reports
Hwy 69 - Four Laning From Tower Rd. Northerly 26.5 km to North of Hwy 141
Blackstone/Crane Lake Underpass, W.P. 408-97-01, Site 44-383
CNR Overhead, W.P. 405/406-97-01, Site 44-381 N&S
Healey Lake Road Underpass, W.P. 400-97-01, Site 44-377
Tower Road Underpass, W.P. 399-97-00, Site 44-321
Airport Road Underpass, W.P. 407-97-01, Site 44-382
G.W.P. 290-97-00, Hwy 69, District 52, Huntsville

We have conceptually reviewed the final Foundation reports for the above projects, dated August 1999 produced by Peto MacCallum Ltd. Consulting Engineers for McCormick Rankin Corporation to determine the consultant's performance in providing the deliverables as would be required by MTO for similar consultant assignments. The accuracy of the subsurface information and the adequacy and technical aspects of the recommendations remain the responsibility of the consultant. The Ministry assumes no responsibility or liability for these aspects of the reports. These aspects will be reviewed in order to assess the consultant's performance in this assignment upon implementation of the recommendation in the design and upon review of the performance of the foundations for the completed project.

Most of the comments made in the preliminary foundation report review are incorporated in the final report. However, following are our comments:

Healey Lake Road Underpass, Site 44-377; Section II, Page 8, Second Paragraph: The phrase "earth rock" should be changed to "earth fill".

Blackstone/Crane Lake Underpass, Site 44-383: It should be noted in the report that for excavation below water table, an NSSP for dewatering should be included in the contract.

CNR Overhead, Site 44-381 N&S: The following comments were made in our previous memo dated May 26, 1999, but not incorporated in the final report:

"at this location piles will be driven through the engineered fill. It should be specified in the Foundation report that the engineered fill will be constructed prior to pile driving. In order to drive the piles through the engineered fill, the fill should be constructed of granular material. It should also be specified that the particle size of the granular fill should not be larger than 75 mm for H-piles and 50 mm for pipe piles driving."

If you have any other questions, please advise.

K. Ahmad, P. Eng.
Foundation Engineer
For
T.C. Kim, P. Eng.
Senior Foundation Engineer

cc: T. Kazmierowski

file: c:\ken\2909700.mik.doc

Ontario

memorandum

To: Bruce Sedgwick, P. Eng.
Senior Project Engineer
Planning and Design Section
Northern Region

1999 05 26

From: Pavements and Foundations Section
Room 232, Central Building
Downsview, Ontario

Re: Draft Foundation Investigation Reports
Highway 69 - Four Laning
From Tower Road Northerly 26.5 km to 2 km North of Hwy 141
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General Comments for all projects

1. MTO has established the frost depth for the Huntsville District as 1.8m. The frost depth in all the Foundation reports for this project should be specified as1.8 m.

2. Recommendation should be given for the side slopes of the approach fills.

3. The Key Plan, northing and easting and the stations shown on the plan are very small. After the drawings are reproduced to include in the contract package, they would not be legible.

4. The cross sections are very small (some of them are thumb size) and should be enlarged. These cross sections will be included in the contract package. When they are reproduced for the contract package, they would not be legible. The plan is produced in 1:500 scale. The cross sections are normally 100 percent larger than the plans to show the details. But in the report the cross sections are 50 percent reduced. Ideally the cross sections should be in true scale, i.e. same horizontal and vertical scales. If the true scale is not feasible, then the ratio of horizontal and vertical scales should be 2. The ratio of the horizontal and vertical scale in the foundation reports are 5. The cross sections, therefore, are very distorted. All the cross sections do not have to fit on one drawing. Cross sections can be produced on more than one drawings. A sample copy of the standard drawing can be obtained from the Pavements and Foundations office.

5. A bar scale, similar to the one provided on the plan should also be provided on the cross sections

6. The Pavements and Foundations Section has assigned Geocres Numbers for these projects. The Consultant should provide the Geocres numbers on the Final Reports. The Geocres number shall be shown on the lower left corner of the Title Page of the Foundation reports.

Blackstone/Crane Lake Road, Site 44-383

1 Page 2 (Section II): The recommended pile resistance on bedrock is conservative and should be revised. Due to the high grade steel of the H-Piles, The pile resistance on sound bedrock has been increased. For example the pile resistance at ULS for HP 310X110 piles is 2000 kN. The term "Pile Capacity" is not used any more in OHBDC. The Consultant should refer to the OHBDC 91, 3rd Edition.

2 The Geocres Number for this project is 31E-131.

CNR Overhead, Site 44-381, N&S

1 Page 2 (Section II): We understand that at this location piles will be driven through the engineered fill. It should be specified in the Foundation report that the engineered fill will be constructed prior to pile driving. In order to drive the piles through the engineered fill, the fill should be constructed of granular material. It should also be specified that the particle size of the granular fill should not be larger than 75 mm for H-piles and 50 mm for pipe piles.

2 Page 2 (Section II): The recommended pile resistance on bedrock is conservative and should be revised. Due to the high grade steel of the H-Piles, The pile resistance on sound bedrock has been increased. For example the pile resistance at ULS for HP 310X110 piles is 2000 kN. The term "Pile Capacity" is not used any more in OHBDC. The Consultant should refer to the OHBDC 91, 3rd Edition.

3 The Geocres Number for this project is 31E-132.

Healey Lake Rd. Underpass, Site 44-377

1 Page 1 (Section II): The proposed abutment and pier locations are underlain by peat. The report did recommend removing peat from these locations. It should also be mentioned in the report that the engineered fill should be constructed prior to pile driving. In order to drive the piles through the engineered fill, the fill should be constructed of granular material. It should be specified that the particle size of the granular fill should not be larger than 75 mm for H-piles and 50 mm for pipe piles.

2 Page 2 (Section II): The recommended pile resistance on bedrock is conservative and should be revised. Due to the high grade steel of the H-Piles, The pile resistance on sound bedrock has been increased. For example the pile resistance at ULS for HP 310X110 piles is 2000 kN. The term "Pile Capacity" is not used any more in OHBDC. The Consultant should refer to the OHBDC 91, 3rd Edition.

3 The Geocres Number for this project is 31E-133.

Tower Road Underpass, Site 44-321

1 The Geocres Number for this project is 31E-134.

Airport Road Underpass, Site 44-382

1 The Geocres Number for this project is 31E-135.

If you have any questions, please advise.

K. Ahmad, P. Eng
Foundation Engineer

For

T.C. Kim, P. Eng.
Senior Foundation Engineer

cc: P. Furst
W. Roy
D. Yeo
I. Hussain
T. Kazmierowski

file: c:\data\wpwin60\2909700.brc3.wpd