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W.P. No. 404-91-00

CONT. No. 94-51

W. O. No.

STR. SITE No. 29-003

HWY. No. 17

LOCATION Bisset Creek

No of PAGES -

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OVERSIZE DRAWINGS TO BE INCLUDED WITH THIS REPORT.

REMARKS:

FOUNDATION INVESTIGATION REPORT

CONTRACT NO. 94-51



Ministry of
Transportation

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Note: For purposes of the contract, this report supersedes all other Foundation Reports prepared by, or for the Ministry in connection with the above mentioned project.

EXPLANATION OF TERMS USED IN REPORT

2

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/0.3m)	0 - 5	5 - 10	10 - 30	30 - 50	> 50
	VERY LOOSE	LOOSE	COMPACT	DENSE	VERY DENSE

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

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

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

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

JOINTING AND BEDDING:

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

ABBREVIATIONS AND SYMBOLS

FIELD SAMPLING

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

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

FOUNDATION INVESTIGATION REPORT
for
Bissett Creek Detour Bridge
Rehabilitation of Existing Bridge, Highway 17
W.P.404-91-00, Site No. 29-003
District 13, North Bay

INTRODUCTION

This report summarizes the information obtained from the foundation investigation carried out at the above noted site. The investigation was carried out at the request of the Northern Region Structural Section for a detour bridge required due to the proposed rehabilitation of the existing Bissett Creek Bridge at Highway 17. The field work, carried out between 93 06 01 and 93 06 05, consisted of four (4) sampled boreholes along the proposed detour bridge alignment.

SITE DESCRIPTION

The site is located to the south of Highway 17 at Bissett Creek, approximately 50 km east of Mattawa in the Township of Maria, County of Renfrew. According to the Northern Ontario Engineering Geology Terrain Study published by the Ministry of Natural Resources, the site is an Alluvial or Glaciofluvial outwash plain. The material typically comprises sand and gravel.

The existing crossing at Bissett Creek is a three span steel plate girder, with a C.P.R. bridge crossing over it at an angle. The existing highway embankment is about 8 m high on the east side of the creek; and maximum of about 3 m high on the west side tapering off at Sta. 20+120 approximately.

The existing embankment and approach slopes are barren to sparsely vegetated. The slope is typically composed of silty sand material, standing at an angle of 2H:1V to 2.5H:1V approximately. Some erosion gullies can be seen on slope. At the east abutment location, broken concrete blocks are found on the slope surface.

The existing pavement around the bridge location appears to be in fair conditions. No sign of distress was noted except some minor transverse cracks. However, during the time of the investigation, a 4 \pm m diameter sink hole was found on slope at about Sta. 20+262. The sink hole is about 2 m below the top of the slope and it is circular in shape and about 1 m deep.

Rip-raps are found along the banks of Bissett Creek. On the east side of the creek at the proposed detour location, they are in small sizes and partly covered with soil. At the time

of the investigation, water in the creek was flowing rapidly.

INVESTIGATION PROCEDURES

Soil data and inherent properties were obtained by in-situ and laboratory testing. The procedures employed are discussed below.

Field

The field work for the investigation was carried out between 93 06 01 and 93 06 05 and consisted of four (4) sampled boreholes advanced to depths of 1.2 to 13.5 m.

The boreholes were advanced using conventional hollow stem augering supplemented by washboring and coring techniques in boulders/bedrock with a track mounted continuous flight auger machine. The sampling program consisted of split spoon samples collected in the overburden. Disturbed subsoil samples were retrieved by split spoon sampler in accordance with Standard Penetration Test (ASTM D1586). All subsoil samples were identified in the field and returned to the laboratory for further examination and appropriate testing. Conventional rock coring techniques were applied in retrieving rock core samples in bedrock. Rock coring was carried out in BH 2 and BH 3. Coring techniques were used to advance through the boulders in BH 4.

Groundwater levels were measured in each borehole and in the watercourse. All boreholes were backfilled upon completion of the field work.

Surveying required to ascertain borehole locations and elevations was carried out by the Northern Region Surveys and Plans Section.

Laboratory

The laboratory testing on selected soil samples consisted of the following:

- Grain Size Distribution
- Natural Moisture Content Determination

Laboratory results are given in the following section of this report and are illustrated on Record of Borehole sheets included in the Appendix.

SUBSURFACE CONDITIONS

General

The Record of Borehole sheets in the Appendix illustrate the subsurface conditions at the borehole locations. The locations and elevations of the boreholes together with a stratigraphy profile are shown in Dwg. No. 4049100-A. *

The predominant soil stratum encountered in the boreholes typically consisted of silty sand/sandy silt fill overlying non-cohesive bouldery glacial till. Bedrock was encountered at 3.9 and 10.9 m depth in BH 2 and BH 3 respectively. The glacial till stratum is absent in BH 1. Augering at BH 1 reached refusal on probable bedrock at 1.2 m.

Following are the specific descriptions of the materials encountered in the investigation:

Silty Sand/Sandy Silt (Fill)

This non-cohesive material is typically described as silty sand or sandy silt, trace to some gravel. Numerous cobbles and boulders were encountered in BH 2 and occasional organic inclusions were found in BH 1. This material is believed to be the fill placed during construction of the existing highway. It extends from the ground surface to bedrock at 1.2 m depth and to the glacial till stratum in BH 2 to BH 4 at 1.8 to 3.0 m. The Standard Penetration Resistance 'N' values recorded range from 0 to 65 blows/0.23 m but typically between 12 and 27 blows/0.3 m indicating compact state of denseness. The high blowcount of 65 blows/0.23 m was due to the sampler being driven on rock and hence does not represent the denseness of the material.

Heterogeneous Mixture of Sand, Gravel, Trace to Some Silt, Numerous Cobbles and Boulders (Glacial Till)

This glacial till stratum is the major native deposit in the area. It underlies the fill layer in BH 2 to BH 4 and extends to bedrock. The material is generally described as a heterogeneous mixture of sand and gravel, trace to some silt with numerous cobbles and boulders. The Standard Penetration Resistance 'N' values recorded range from 22 blows/0.3 m to 108 blows/0.15 m indicating compact to very dense state of denseness. Layers of boulders were cored in BH 3 and BH 4. Core recovery and Rock Quality Designation values range from 15.5 to 82% and 0 to 65% respectively.

* Sheet 43-1 of the Contract Drawings.

Typical properties of the material, as determined by laboratory tests on representative soil samples may be summarized as follows:

<u>Property</u>	<u>Range</u>	<u>No. of Test</u>
Natural Moisture Content (w%)	5.0-17.5	6
Grain Size Distribution(%)		6
-Gravel	35-54	
-Sand	37-54	
-Silt	5-12	
-Clay	1-2	

Bedrock

Bedrock was encountered at depths of 1.2 to 10.9 m depths. It dips gently from El. 157.8 m in BH 1 to El. 144.6 m in BH 3. Bedrock outcrops can be found at Sta. 20+075 to 20+115. Bedrock was cored in BH 2 and BH 3. The rock cores obtained are used for rock quality determination and classification. Detailed descriptions of the rock are attached in the Appendix.

Bedrock is Amphibolite and Pegmatite of the Grenville Province. Core recoveries and Rock Quality Designations range from 86 to 100% and 37.5 to 65% respectively. The rock is considered strong.

Groundwater

The groundwater level measured in the boreholes varies from El. 152.2 to 153.3 m as the location of the borehole moves further away from the creek. During the time of the investigation, the water level in the creek was at El. 152.0 m.

Groundwater levels are subject to seasonal fluctuations and hence may vary from the elevations given in this report.

MISCELLANEOUS

The fieldwork for this investigation was carried out under the supervision of D. Kwok, Project Foundation Engineer using the equipment owned and operated by Master Soil Investigation Ltd. Bedrock was classified by MTO petrographer D. Williams.

The project was carried out by D. Kwok under the general supervision of B. Iyer, Senior Foundation Engineer. The report was written by D. Kwok, reviewed by B. Iyer, and approved by M. Devata, Chief Foundation Engineer.



P. Payer
P. Payer, P.Eng.
Senior Foundation Engineer



D. Dundas
D. Dundas, P.Eng.
Chief Foundation Engineer
(Acting)

APPENDIX

RECORD OF BOREHOLE No 1

1 OF 1

METRIC

W.P. 404-91-00 LOCATION Ste 20+134, o/s 17 m RT CL Hwy 17 ORIGINATED BY DK
DIST 13 HWY 17 BOREHOLE TYPE Hollow Stem Auger COMPILED BY DT
DATUM Geodetic DATE 93 06 05 CHECKED BY BI

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC NATURAL LIQUID LIMIT MOISTURE CONTENT			UNIT WEIGHT	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100	W _p	W	W _L		
159.0	Ground Surface																
0.0	Sandy Silt, some Gravel occasional Organic Inclusions Dark Brown (Fill)					*											
157.8			1	SS	65	/23cm	158										
1.2	End of Borehole * Bore Hole Dry	Probable Bedrock															

METRIC

+3, x5: Numbers refer to Sensitivity

RECORD OF BOREHOLE No 3

1 OF 1

METRIC

W.P. 404-91-00 LOCATION Ste 20+219.0, o/s 24.4m RT CL Hwy 17 ORIGINATED BY DK
DIST 13 HWY 17 BOREHOLE TYPE Hollow Stem Auger COMPILED BY DT
DATUM Geodetic DATE 93 06 03 CHECKED BY BI

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT 7 kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
155.5	Ground Surface																
0.0	Silty Sand Trace Gravel Occasional Cobbles and Boulders Brown Compact (Fill)		1	AS	-		155										
			2	SS	15		154										
153.2			3	SS	38	/23cm	153										51 40 7 2
2.3	Heterogeneous Mixture of Sand & Gravel Trace Silt Numerous Cobbles & Boulders Greenish Gray Dense to Very Dense (Glacial Till)		4	RC	REC 82%		152										RQD 65%
			5	RC	REC	70%	151										RQD 0%
			6	SS	42		150										49 45 5 1
			7	RC	REC 31%		149										RQD 15%
			8	RC	REC	50%	148										RQD 0%
			9	RC	REC 57.5%		147										RQD 30%
			10	SS	108	/15cm	146										RQD 0%
			11	RC	REC 15.5%		145										
144.6			12	WS	-		144										RQD 65%
10.9	Pegmatite Bedrock		13	RC	REC 86%		143										RQD 63%
			14	RC	REC 97.5%		142										
142.0																	
13.5	End of Borehole																

RECORD OF BOREHOLE No 4

1 OF 1

METRIC

W.P. 404-91-00 LOCATION Sta 20+244.6, o/s 25.5m RT CL Hwy 17 ORIGINATED BY DK
DIST 13 HWY 17 BOREHOLE TYPE Hollow Stem Auger, Rock Core COMPILED BY DT
DATUM Geodetic DATE 93 06 01 CHECKED BY BI

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT 7 kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
155.8	Ground Surface																
0.0	Silty Sand Occasional Cobbles and Boulders Trace Gravel & Rootlets Brown Very Loose to Compact (Fill)		1	AS	—		155										
			2	SS	0												
154.0			3	SS	27		154										
1.8	Heterogeneous Mixture of Sand & Gravel Some Silt Numerous Cobbles & Boulders Brown & Grey Dense to Very Dense (Glacial Till)		4	RC	REC 71%		153										RQD 19%
			5	SS	33		152										37 49 12 2
			6	SS	56		151										35 54 10 1
			7	RC	REC 32%		150										RQD 0%
			8	RC	REC 47%		149										RQD 32%
			9	RC	REC 52%		148										RQD 0%
			10	RC	REC 55%		147										RQD 27%
146.0																	
9.8	End of Borehole																
	• 93 06 01																

ROCK CORE DESCRIPTION
WP 404-91-00

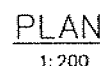
Page 1 of 1

CORE RECOVERY					CORE DESCRIPTION	
BH#	RC#	DEPTH (m)	% CR*	% RQD*	DEPTH (m)	DESCRIPTION
2	4	3.89-5.41	100	53	3.89-6.93	AMPHIBOLITE (garnetiferous), greyish black to medium light grey, with interlayered moderate reddish brown to medium light grey PEGMATITE (31%); coarse to medium grained; strong; unweathered to slightly weathered; fractures moderate to extremely close spaced, near vertical to dipping, undulating to planar, smooth to rough.
	5	5.41-6.93	100	38		
3	4	2.92-4.44	82	65	2.92-10.87 10.87-13.51	OVERBURDEN (till). PEGMATITE (biotite- and pyrite-bearing), moderate orange pink to light grey to black; coarse grained; strong; unweathered to slightly weathered; fractures wide to very close spaced, dipping, undulating, rough to smooth.
	5	5.64-5.77	70	0		
	7	6.71-7.37	31	15		
	8	7.60-7.82	56	0		
	9	7.82-8.84	58	30		
	11	9.30-10.36	16	0		
	13	10.69-11.99	90	65		
	14	11.99-13.51	98	63		
4	4	1.98-2.59	71	19	1.98-9.75	OVERBURDEN (till).
	7	6.10-6.81	32	0		
	8	6.81-8.25	47	32		
	9	8.25-8.97	52	0		
	10	8.97-9.75	55	27		

*CR = CORE RECOVERY

*RQD = ROCK QUALITY DESIGNATION

Note: Depths are approximated where core recovery is less than 100%
Logged by: DAW, Soils and Aggregates Section



T/FTG - TOP OF FOOTING

- R1. GENERAL ARRANGEMENT
- R2. EAST ABUTMENT
- R3. WEST ABUTMENT
- R4. WINGWALLS
- R5. PIERS - I
- R6. PIERS - II
- R7. STRUCTURAL STEEL - I
- R8. STRUCTURAL STEEL - II
- R9. STRUCTURAL STEEL - III
- R10. BEARINGS
- R11. DECK DETAILS
- R12. DECK REINFORCING - I
- R13. DECK REINFORCING - II
- R14. JOINT ANCHORAGE AND ARMOURING
- R15. EXPANSION JOINT DRAINS
- R16. BARRIER WALL W/O RAILING - NORTH
- R17. BARRIER WALL W/O RAILING - SOUTH
- R18. 6000 mm APPROACH SLAB
- R19. STANDARD DETAILS
- R20. QUANTITIES - STRUCTURE I
- R21. QUANTITIES - STRUCTURE II


- B1. ACROW BRIDGE
- B2. ACROW BRIDGE DETAILS
- B3. PILE DRIVING - STEAM AND DIESEL HAMMERS

OPSD - 4010.00 GUIDE RAIL AND CHANNEL ANCHORAGE
OPSD - 918.01 CONCRETE BARRIER TRANSITION TO STRUCTURES

Tablet in S.E. Abut. of Bridge
6.4 RT - 20+210.4
QUAD 46078 BISSETT

2 NEW
1:100

DRAWING NOT TO BE SCALED
FOR use ON ORIGINAL DRAWING

[illegible]

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Ministry
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Transportation

FOUNDATION DESIGN SECTION

**foundation
investigation and
design report**

ENGINEERING MATERIALS OFFICE
FOUNDATION DESIGN SECTION

CONT 94-51

WP 404-91-00

DIST 13

HWY 17

STR SITE 29-003

Bissett Creek Detour Bridge
Rehabilitation of Existing Bridge

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FOUNDATION INVESTIGATION REPORT
for
Bissett Creek Detour Bridge
Rehabilitation of Existing Bridge, Highway 17
W.P.404-91-00, Site No. 29-003
District 13, North Bay

INTRODUCTION

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SITE DESCRIPTION

The site is located to the south of Highway 17 at Bissett Creek, approximately 50 km east of Mattawa in the Township of Maria, County of Renfrew. According to the Northern Ontario Engineering Geology Terrain Study published by the Ministry of Natural Resources, the site is an Alluvial or Glaciofluvial outwash plain. The material typically comprises sand and gravel.

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of the investigation, water in the creek was flowing rapidly.

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Following are the specific descriptions of the materials encountered in the investigation:

Silty Sand/Sandy Silt (Fill)

This non-cohesive material is typically described as silty sand or sandy silt, trace to some gravel. Numerous cobbles and boulders were encountered in BH 2 and occasional organic inclusions were found in BH 1. This material is believed to be the fill placed during construction of the existing highway. It extends from the ground surface to bedrock at 1.2 m depth and to the glacial till stratum in BH 2 to BH 4 at 1.8 to 3.0 m. The Standard Penetration Resistance 'N' values recorded range from 0 to 65 blows/0.23 m but typically between 12 and 27 blows/0.3 m indicating compact state of denseness. The high blowcount of 65 blows/0.23 m was due to the sampler being driven on rock and hence does not represent the denseness of the material.

Heterogeneous Mixture of Sand, Gravel, Trace to Some Silt, Numerous Cobbles and Boulders (Glacial Till)

This glacial till stratum is the major native deposit in the area. It underlies the fill layer in BH 2 to BH 4 and extends to bedrock. The material is generally described as a heterogeneous mixture of sand and gravel, trace to some silt with numerous cobbles and boulders. The Standard Penetration Resistance 'N' values recorded range from 22 blows/0.3 m to 108 blows/0.15 m indicating compact to very dense state of denseness. Layers of boulders were cored in BH 3 and BH 4. Core recovery and Rock Quality Designation values range from 15.5 to 82% and 0 to 65% respectively.

Typical properties of the material, as determined by laboratory tests on representative soil samples may be summarized as follows:

<u>Property</u>	<u>Range</u>	<u>No. of Test</u>
Natural Moisture Content (w%)	5.0-17.5	6
Grain Size Distribution(%)		6
-Gravel	35-54	
-Sand	37-54	
-Silt	5-12	
-Clay	1-2	

Bedrock

Bedrock was encountered at depths of 1.2 to 10.9 m depths. It dips gently from El. 157.8 m in BH 1 to El. 144.6 m in BH 3. Bedrock outcrops can be found at Sta. 20+075 to 20+115. Bedrock was cored in BH 2 and BH 3. The rock cores obtained are used for rock quality determination and classification. Detailed descriptions of the rock are attached in the Appendix.

Bedrock is Amphibolite and Pegmatite of the Grenville Province. Core recoveries and Rock Quality Designations range from 86 to 100% and 37.5 to 65% respectively. The rock is considered strong.

Groundwater

The groundwater level measured in the boreholes varies from El. 152.2 to 153.3 m as the location of the borehole moves further away from the creek. During the time of the investigation, the water level in the creek was at El. 152.0 m.

Groundwater levels are subject to seasonal fluctuations and hence may vary from the elevations given in this report.

DISCUSSION AND RECOMMENDATIONS

General

The project comprises construction of a detour bridge at Bissett Creek. It is required to carry the traffic during rehabilitation of the existing crossing. The proposed alignment runs on the slope to the south of Highway 17 with an offset of 17 m from the centreline of the existing highway. Span arrangements and footing locations have not been determined.

Foundation

Based on the proposed profile of the detour alignment and our discussion with the Regional Structural Section, it is considered more cost effective to design for a three span bridge. The proposed centreline chainages of the piers and abutments are as follows:

West Abutment	20+140	West Pier	20+165
East Abutment	20+230	East Pier	20+205

East Abutment and Piers -

Based on the results of the foundation investigation, the subsurface stratigraphy typically comprises a loose to compact non-cohesive fill layer overlying a bouldery non-cohesive glacial till stratum. For conventional footing construction on the existing slope, it will involve major subexcavation of the existing slope. Shoring may also be required to support the existing highway. It is therefore considered economically unfeasible. Two other methods of foundation support have been considered as follows.

Option A -

The detour structure can be supported by steel H-piles driven to refusal into the competent non-cohesive glacial till or possibly to bedrock in the case of the West Pier. The following pile capacities should be employed in the design as per O.H.B.D.C :

	<u>HP 310X79</u>	<u>HP 310X110</u>
Factored Axial Capacity at U.L.S.	900 kN/pile	1300 kN/pile
Axial Capacity at S.L.S. Type II	650 kN/pile	900 kN/pile

Pile driving should be controlled by the Hiley Formula as per MTO Standards SS103-10 or SS103-11, assuming ultimate capacities as indicated below:

Ultimate Capacities for Hiley Formula

<u>HP310X79</u>	<u>HP310X110</u>
2670kN/pile 1950 kN	3450kN/pile 2700 kN

For preliminary design purpose, the estimated pile tip elevations are as follows:

Estimated Pile Tip Elevation

East Abutment (Sta 20+230)	151.5 m
East Pier (Sta 20+205)	151.0 m
West Pier (Sta 20+165)	150.8 m

The field investigation has revealed layers of boulders and cobbles in the fill and glacial till strata. Piles should be equipped with reinforced pile tips in accordance with OPSD-3301.00. Rock points are not required. If piles are driven through new fill, the grain size of the fill should be less than 75 mm under the pile locations. Considerations should be given to pile bent construction. This would minimize excavation on the existing slope. Depending on the location and elevation of the pile caps, temporary cuts and/or shoring may still be required for the construction of the pile caps on or close to the existing slopes.

For piling construction, the details of the existing foundations (Bissett Creek crossing and CPR bridge) have to be carefully reviewed to ensure that the piling operation will have no adverse effects on the existing foundations. Please forward the proposed foundation layout together with the existing foundation details to our office for review once they are available.

Option B -

For Bailey bridge construction, it is envisaged that a relatively larger differential settlement in the longitudinal as well as transverse directions may be tolerable. In this case, foundation support can be provided by means of rock filled timber cribs. For footing elements located on slope, the existing slope should be benched to receive the timber cribs. For preliminary estimating purpose, the following bearing capacities in accordance with O.H.B.D.C. may be used:

Factored Bearing Capacity at U.L.S.	= 400 kPa
Bearing Capacity at SLS Type II	= 250 kPa

If this option is adopted, further consultation with our office is required.

West Abutment -

Based on the results of the foundation investigation, bedrock is expected to be at shallow depth around the proposed West Abutment location. In fact, bedrock outcrops can be found by the side of the highway at Sta 20+110 approximately. Construction of the abutment should be straight forward with standard front spill slope and footing founded on bedrock. For preliminary design purpose, the estimated founding elevation is $156.3 \pm$ m. When the size and location of the footing element are determined, further investigation should be carried out to delineate the bedrock profile at the footing location.

For footings founded on bedrock, the following bearing capacities are recommended:

Factored Bearing Capacity at U.L.S.	= 10,000 kPa
Bearing Capacity at SLS Type II	does not govern in the design of the foundation

Sliding resistance between concrete and bedrock should be in accordance with O.H.B.D.C. Section 6-8.4.3 assuming an unfactored angle of internal friction of 30° . If the bedrock surface is roughened by chiselling grooves, the unfactored angle of internal friction may be increased to 35° . If necessary, the sliding resistance may be supplemented by dowelling into bedrock. Please contact our office for design details.

Frost Protection

All pile caps should have a minimum earth cover of 2.0 m or equivalent insulation for frost protection. Frost cover is not required for footings on rock.

Earth Pressure

Backfill to abutments should consist of granular material in accordance with MTO Standard Special Provision No. 109F03.

Computation of earth pressures should be in accordance with Section 6.7 of the O.H.B.D.C. The active case will govern earth pressure design for the yielding condition while the at-rest case will govern for unyielding condition. For design purposes, the following properties for backfill are recommended:

<u>Material</u>	<u>ϕ</u>	<u>γ</u>	<u>K_o</u>	<u>K_a</u>
Granular A	35°	22.8 kN/m ³	0.43	0.27
Granular B	30°	21.2 kN/m ³	0.50	0.33
Rock fill	35°	18.0 kN/m ³	0.43	0.27

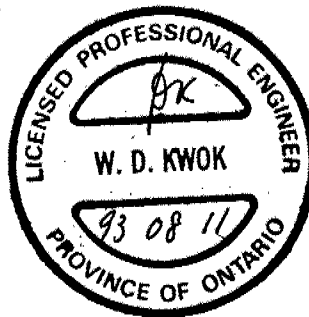
Embankment Slopes


Approach embankment slopes may be safely constructed at a gradient of 2H:1V or flatter up to a maximum height of 7.0 m. If rock fill is used, slopes may be formed at 1.5H:1V up to 7 m. Surficial organic material should be removed prior to filling. The existing slope should be benched to receive new fill in accordance with OPSD 208.01.

MISCELLANEOUS

The fieldwork for this investigation was carried out under the supervision of D. Kwok, Project Foundation Engineer using the equipment owned and operated by Master Soil Investigation Ltd. Bedrock was classified by MTO petrographer D. Williams.

The project was carried out by D. Kwok under the general supervision of B. Iyer, Senior Foundation Engineer. The report was written by D. Kwok, reviewed by B. Iyer, and approved by M. Devata, Chief Foundation Engineer.




D. Kwok, P. Eng.
Project Foundation Engineer




M. Devata, P. Eng.
Chief Foundation Engineer

APPENDIX

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/0.3m)	0 - 5	5 - 10	10 - 30	30 - 50	> 50
	VERY LOOSE	LOOSE	COMPACT	DENSE	VERY DENSE

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

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

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

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

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 = $\frac{c_u}{\tau_r}$

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

PHYSICAL PROPERTIES OF SOIL

ρ_s	kg/m^3	DENSITY OF SOLID PARTICLES	e	1, %	VOID RATIO	e_{\min}	1, %	VOID RATIO IN DENSEST STATE
γ_s	KN/m^3	UNIT WEIGHT OF SOLID PARTICLES	n	1, %	POROSITY	I_D	1	DENSITY INDEX = $\frac{e_{\max} - e}{e_{\max} - e_{\min}}$
ρ_w	kg/m^3	DENSITY OF WATER	w	1, %	WATER CONTENT	D	mm	GRAIN DIAMETER
γ_w	KN/m^3	UNIT WEIGHT OF WATER	S_r	%	DEGREE OF SATURATION	D_n	mm	n PERCENT - DIAMETER
ρ	kg/m^3	DENSITY OF SOIL	w_L	%	LIQUID LIMIT	C_u	1	UNIFORMITY COEFFICIENT
γ	KN/m^3	UNIT WEIGHT OF SOIL	w_p	%	PLASTIC LIMIT	h	m	HYDRAULIC HEAD OR POTENTIAL
ρ_d	kg/m^3	DENSITY OF DRY SOIL	w_s	%	SHRINKAGE LIMIT	q	m^3/s	RATE OF DISCHARGE
γ_d	KN/m^3	UNIT WEIGHT OF DRY SOIL	I_p	%	PLASTICITY INDEX = $w_L - w_p$	v	m/s	DISCHARGE VELOCITY
ρ_{sat}	kg/m^3	DENSITY OF SATURATED SOIL	I_L	1	LIQUIDITY INDEX = $\frac{w - w_p}{I_p}$	i	1	HYDRAULIC GRADIENT
γ_{sat}	KN/m^3	UNIT WEIGHT OF SATURATED SOIL	I_C	1	CONSISTENCY INDEX = $\frac{w_L - w}{I_p}$	k	m/s	HYDRAULIC CONDUCTIVITY
ρ'	kg/m^3	DENSITY OF SUBMERGED SOIL	e_{\max}	1, %	VOID RATIO IN LOOSEST STATE	j	KN/m^2	SEEPAGE FORCE
γ'	KN/m^3	UNIT WEIGHT OF SUBMERGED SOIL						

RECORD OF BOREHOLE No 1

1 OF 1

METRIC

W.P. 404-91-00 LOCATION Sta 20+134, o/s 17 m RT CL Hwy 17 ORIGINATED BY DK
DIST 13 HWY 17 BOREHOLE TYPE Hollow Stem Auger COMPILED BY OT
DATUM Geodetic DATE 93 06 05 CHECKED BY BI

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC NATURAL LIQUID LIMIT MOISTURE CONTENT LIMIT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100	W _P	W	W _L		
159.0	Ground Surface																
0.0	Sandy Silt, some Gravel occasional Organic inclusions Dark Brown (Fill)																
157.8			1	SS	65	/23cm	158										
1.2	End of Borehole Probable Bedrock																

RECORD OF BOREHOLE No 2

1 OF 1

METRIC

W.P. 404-91-00 LOCATION Sta 20+160.1, e/s 17.2m RT CL Hwy 17 ORIGINATED BY DK
DIST 13 HWY 17 BOREHOLE TYPE Hollow Stem Auger COMPILED BY DT
DATUM Geodetic DATE 93 06 05 CHECKED BY BI

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _P	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
155.2	Ground Surface																
0.0	Silty Sand with Gravel, Trace Organics Numerous Cobbles & Boulders, Dark Grey Compact (Fill)		1	SS	20												
			2	SS	12												
152.2			3	SS	22												
3.0	Heterogeneous mixture of Sand & Gravel Trace Silt Greenish Grey Compact (Glacial Till)																54 37 7 2
151.3	Amphibolite Bedrock		4	RC	REC 100%												RQD 53%
3.9			5	RC	REC 100%												RQD 37.5%
148.3																	
6.9	End of Borehole • 93 06 05																

RECORD OF BOREHOLE No 3

1 OF 1

METRIC

W.P. 404-91-00 LOCATION Site 20+219.0, o/s 24.4m RT CL Hwy 17 ORIGINATED BY DK
DIST 13 HWY 17 BOREHOLE TYPE Hollow Stem Auger COMPILED BY DT
DATUM Geodetic DATE 93 06 03 CHECKED BY BI

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT 7 KN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES		20	40	60	80	100		
155.5	Ground Surface												
0.0	Silty Sand Trace Gravel Occasional Cobbles and Boulders Brown Compact (Fill)		1	AS	-	155							
153.2			2	SS	15	154							
2.3			3	SS	38	153							51 40 7 2
			4	RC	REC 82%	152							RQD 65%
			5	RC	REC 70%	151							RQD 0%
			6	SS	42	149							49 45 5 1
			7	RC	REC 31%	148							RQD 15%
			8	RC	REC 50%	147							RQD 0%
			9	RC	REC 57.5%	146							RQD 30%
			10	SS	108	145							RQD 0%
			11	RC	REC 15.5%	144							RQD 0%
			12	WS	-	143							RQD 65%
144.6			13	RC	REC 86%	142							RQD 63%
10.9			14	RC	REC 97.5%								
142.0													
13.5	End of Borehole												

RECORD OF BOREHOLE No 4

1 OF 1

METRIC

W.P. 404-91-00 LOCATION Sta 20+244.6, o/s 25.5m RT CL Hwy 17 ORIGINATED BY DK
DIST 13 HWY 17 BOREHOLE TYPE Hollow Stem Auger, Rock Core COMPILED BY DT
DATUM Geodetic DATE 93 06 01 CHECKED BY BI

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES		20	40	60	80	100					
155.8	Ground Surface															
0.0	Silty Sand Occasional Cobbles and Boulders Trace Gravel & Rootlets Brown Very Loose to Compact (Fill)		1	AS	-											
			2	SS	0											
154.0			3	SS	27											
1.8	Heterogeneous Mixture of Sand & Gravel Some Silt Numerous Cobbles & Boulders Brown & Grey Dense to Very Dense (Glacial Till)		4	RC	REC 71%											RQD 19%
			5	SS	33											37 49 12 2
			6	SS	56											35 54 10 1
			7	RC	REC 32%											RQD 0%
			8	RC	REC 47%											RQD 32%
			9	RC	REC 52%											RQD 0%
			10	RC	REC 55%											RQD 27%
146.0																
9.8	End of Borehole															
	▲ 93 06 01															

+3, x5: Numbers refer to
Sensitivity

20
15-5 (%) STRAIN AT FAILURE
10

ROCK CORE DESCRIPTION WP 404-91-00

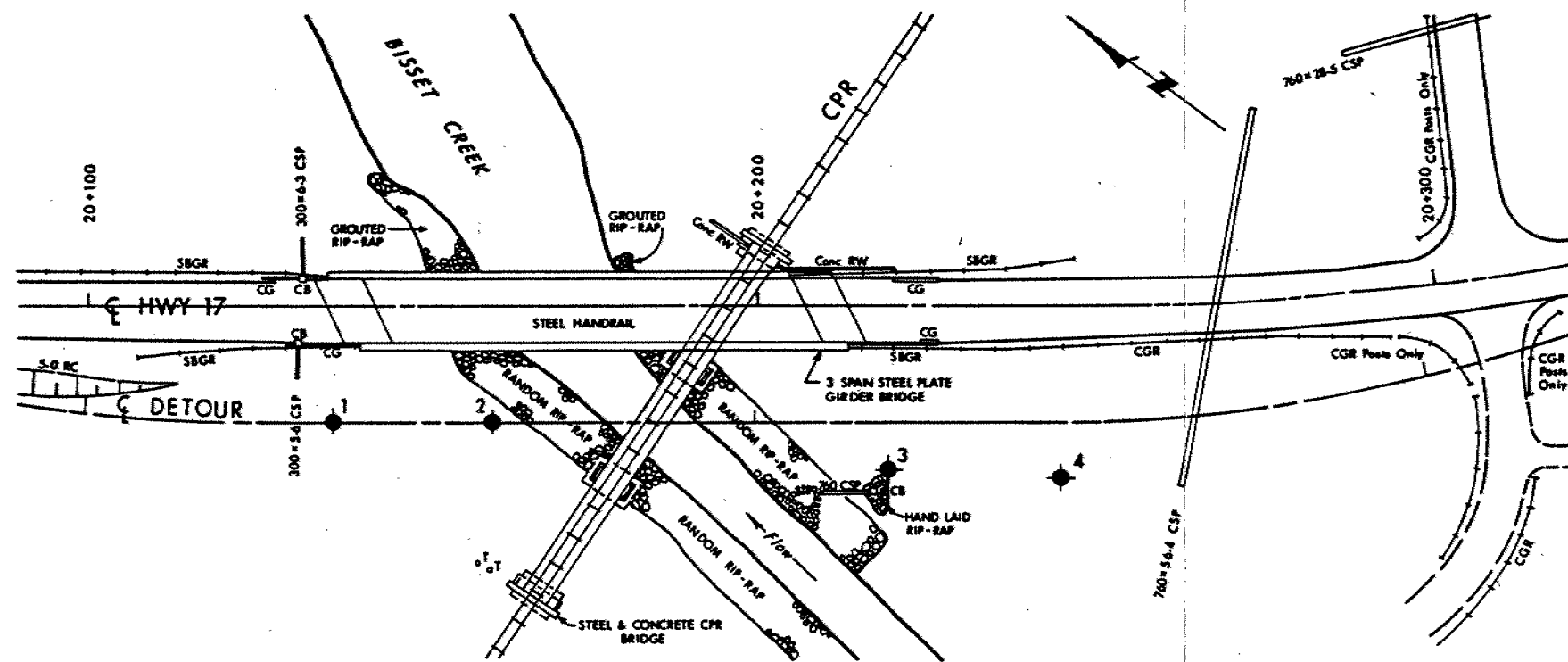
Page 1 of 1

CORE RECOVERY					CORE DESCRIPTION	
BH#	RC#	DEPTH (m)	% CR*	% RQD*	DEPTH (m)	DESCRIPTION
2	4	3.89-5.41	100	53	3.89-6.93	AMPHIBOLITE (garnetiferous), greyish black to medium light grey, with interlayered moderate reddish brown to medium light grey PEGMATITE (31%); coarse to medium grained; strong; unweathered to slightly weathered; fractures moderate to extremely close spaced, near vertical to dipping, undulating to planar, smooth to rough.
	5	5.41-6.93	100	38		
3	4	2.92-4.44	82	65	2.92-10.87 10.87-13.51	OVERBURDEN (till). PEGMATITE (biotite- and pyrite-bearing), moderate orange pink to light grey to black; coarse grained; strong; unweathered to slightly weathered; fractures wide to very close spaced, dipping, undulating, rough to smooth.
	5	5.64-5.77	70	0		
	7	6.71-7.37	31	15		
	8	7.60-7.82	56	0		
	9	7.82-8.84	58	30		
	11	9.30-10.36	16	0		
	13	10.69-11.99	90	65		
	14	11.99-13.51	98	63		
4	4	1.98-2.59	71	19	1.98-9.75	OVERBURDEN (till).
	7	6.10-6.81	32	0		
	8	6.81-8.25	47	32		
	9	8.25-8.97	52	0		
	10	8.97-9.75	55	27		

*CR = CORE RECOVERY

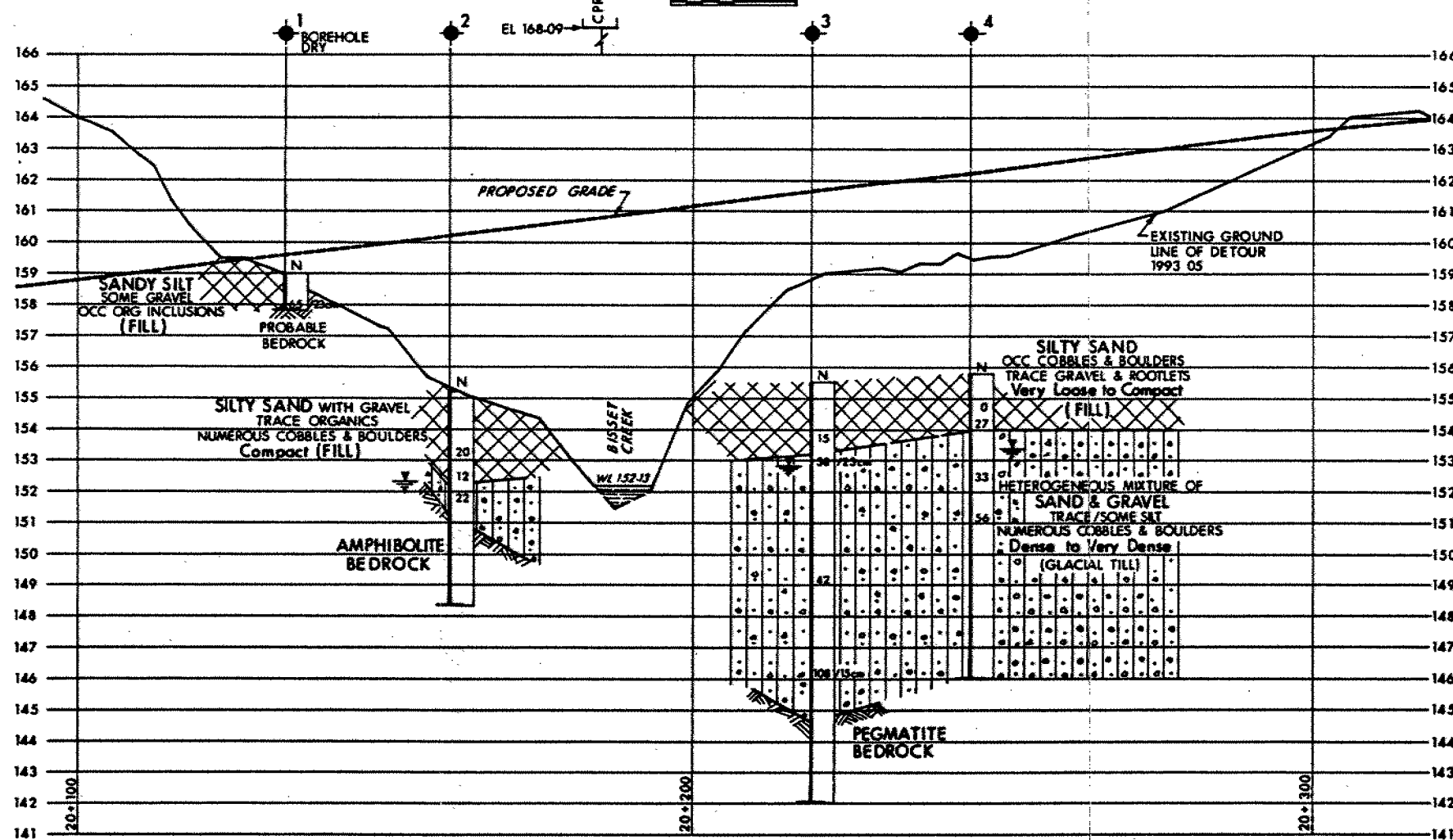
*RQD = ROCK QUALITY DESIGNATION

Note: Depths are approximated where core recovery is less than 100%
Logged by: DAW, Soils and Aggregates Section



PLAN

SCALE



PROFILE HWY 17 DETOUR



METRIC

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

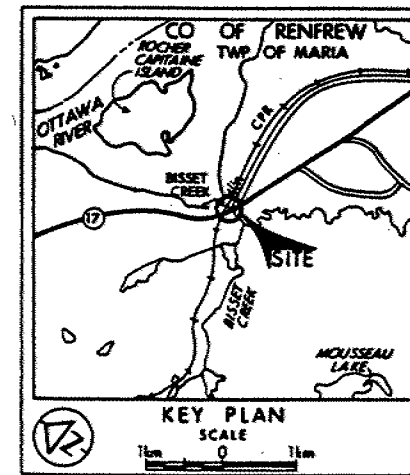
CONT No
WP No 404-91-00

BISSET CREEK

BORE HOLE LOCATIONS & SOIL STRATA



SHEET



LEGEND

- ◆ Bore Hole
- ⊕ Dynamic Cone Penetration Test (Cone)
- ⊕ Bore Hole & 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 1993 06

No	ELEVATION	STATION	OFFSET
1	159.0	20+134.0	17.0m Rt
2	155.2	20+160.1	17.2m Rt
3	155.5	20+219.0	24.4m Rt
4	155.8	20+244.6	25.5m Rt

NOTE

The boundaries between soil strata have been established only at Bore Hole locations. Between Bore Holes the boundaries are assumed from geological evidence.

NOTE: The complete foundation investigation and design report for this project and other related documents may be examined at the Engineering Materials Office, Downsview. Information contained in this report and related documents is specifically excluded in accordance with the conditions of Section GC 2.01 of OPS Gen Cond.



DATE	BY	DESCRIPTION
1993 08 16	W. B. KWOK	DATE 1993 08 16 SITE 29-003
1993 08 16	W. B. KWOK	DWG 4049100-A