

FOUNDATION INVESTIGATION REPORT

CONTRACT NO 84-212



Ministry of
Transportation and
Communications

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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

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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_f	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

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For

W.P. 24-82-01, Site 47-9

Blanche River Bridge at Kenogami

Hwy. 11, District 14, New Liskeard

INTRODUCTION:

This report summarizes the results of the foundation investigation required for the proposed bridge replacement at this site.

The fieldwork was conducted during the period from 82 06 02 - 13 utilizing a modified diamond drill equipped with BW casing, and AX and BX core barrels.

This work consisted of 7 sampled boreholes/dynamic core penetration tests, plus an additional 6 dynamic cone penetration tests. Bedrock was cored at all 7 borehole locations.

SITE DESCRIPTION

The site is located on the Hwy. 11 crossing of the Blanche River at Kenogami (Grenfell Twp., District of Timiskaming).

Physiographically, the site lies in the Canadian Shield. The relatively shallow bedrock is covered by fluvial deposits.

SUBSURFACE CONDITIONS

General

The Record of Borehole Sheets (Appendix) illustrate the conditions at the borehole locations. The locations and elevations of the boreholes, and stratigraphical profiles based on the borehole data are shown on Drawing No. 2 of the contract drawings.

At the borehole locations, the overburden thickness ranges from 1.7 to 5.5 m. The overburden generally consists of silty sand to silt containing occasional silty clay. Occasional boulders were encountered across the site, generally near the bedrock.

Silty Sand to Silt

In general the overburden consists of silty sand to silt, containing occasional silty clay, gravel and boulders and traces of organics. The denseness of this material ranges from very loose to very dense.

Silt to Silty Clay

At the northeast portion of the site (BH No. 6), the overburden consists of very soft to firm silt to silty clay, containing organics near the surface.

Bedrock

The bedrock is metasedimentary - fragments of igneous/metamorphic rock in a matrix of slate-like material.



D. H. Dundas

D. H. Dundas, P. Eng.
Foundations Engineer

K. G. Selby

K. G. Selby, P. Eng.
Chief Foundations Engineer

APPENDIX

RECORD OF BOREHOLE No 1

METRIC

6

W P 24-82-02 LOCATION Sta. 10 + 110.9 7.2 m Rt. of Hwy. 11
DIST 14 HWY 11 BOREHOLE TYPE BW Casing, BX Core Barrel
DATUM Geodetic DATE 82 06 02
ORIGINATED BY D.D.
COMPILED BY D.D.
CHECKED BY D.D.

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 SHEAR STRENGTH ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE	PLASTIC LIMIT W _p NATURAL MOISTURE CONTENT W LIQUID LIMIT W _L WATER CONTENT (%)	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE						
303.7	Water Surface									
0.0	Water									
301.9	River Bottom									
1.8	Silty Sand to Silt* Very loose to very dense occ. gravel and boulders		1	SS	2					
			2	SS	60					
			3	RC	55%					
299.5	Bedrock		4	RC	81%					
4.2	Sound metasedimentary									
298.6										
5.1	End of Borehole * occ. Silty Clay, trace organics									

+3, x5: Numbers refer to
Sensitivity
20
15
10
5 (%) STRAIN AT FAILURE



RECORD OF BOREHOLE No 2

METRIC

7

W P 24-82-02 LOCATION Sta. 10 + 117.0 10.4 m Rt. of Hwy. 11 ORIGINATED BY PC
DIST 14 HWY 11 BOREHOLE TYPE Dynamic Cone Penetration Test COMPILED BY DD
DATUM Geodetic DATE 82 06 03 CHECKED BY DD

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 SHEAR STRENGTH ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE	PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES								
303.7	Water Surface												
0.0	Water												
301.6	River Bottom						302						
2.1	Probable Silty Sand to Silt, occ. Silty Clay Trace Organics occ. gravel and boulders						300						
299.3													
4.4	Probable Bedrock End of Cone Test												

+3, x5: Numbers refer to
Sensitivity

20
15
10
5 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 3

METRIC 8

W P 24-82-02 LOCATION Sta. 10 + 100.8 9.8 m Rt. g Hwy. 11 ORIGINATED BY PC
DIST 14 HWY 11 BOREHOLE TYPE BW Casing, BX Core Barrel COMPILED BY DD
DATUM Geodetic DATE 82 06 03 CHECKED BY DD

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 Y	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80					
303.7	Water Surface															
302.6	River Bottom															
1.1	Silty Sand to Silt occ. Silty Clay occ. Gravel and boulders very loose to very dense		1	SS	63											37 57 5 1
299.1																
4.6	Bedrock		2	RC	80%											
297.1	sound metasedimentary		3	RC	100%											
6.6	End of Borehole															

+3, x5: Numbers refer to
Sensitivity

20
15 \pm 5 (%) STRAIN AT FAILURE
10

RECORD OF BOREHOLE No 4

METRIC

9

W P 24-82-02 LOCATION Sta. 10 + 126.2 6.6 m Rt. of Hwy. 11 ORIGINATED BY DD
DIST 14 HWY 11 BOREHOLE TYPE BW Casing, BX and AX Core Barrels COMPILED BY DD
DATUM Geodetic DATE 82 06 03-04 CHECKED BY DD

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 (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			'N' VALUES	20 40 60 80 100					
303.7	Water Surface												
0.0	Water												
302.2	River Bottom												
1.5	Silty Sand to silt occ. Silty Clay, Trace Organics, occ. Gravel and boulders		1	SS	2								
300.0	Very loose to compact		2	SS	12								
3.7	Bedrock		3	RC	50%								
298.3	Sound metasedimentary		4	RC	100%								
5.4	End of Borehole												

OFFICE REPORT ON SOIL EXPLORATION

+3, x5: Numbers refer to
Sensitivity

20
15 5 (%) STRAIN AT FAILURE
10

RECORD OF BOREHOLE No 5

METRIC 10

W P 24-82-02 LOCATION Sta. 10 + 134.2 6.8 m Rt. of Hwy. 11 ORIGINATED BY DD
DIST 14 HWY 11 BOREHOLE TYPE Dynamic Cone Penetration Test COMPILED BY DD
DATUM Geodetic DATE 82 06 04 CHECKED BY DD

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 SHEAR STRENGTH ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE	PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT Y	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES								
303.7	Water Surface												
0.0	Water												
302.9	River Bottom												
0.8	Probable Silty Sand to Silt												
	Occ. Silty Clay, Trace Organics												
	Occ. Gravel and Boulders												
298.8													
4.9	Probable Bedrock												
	End of Cone Test												

OFFICE REPORT ON SOIL EXPLORATION



RECORD OF BOREHOLE No 6

METRIC 11

W P 24-82-02 LOCATION Sta. 10 + 147.4 15.0 m Rt. of Hwy. 11 ORIGINATED BY DD
DIST 14 HWY 11 BOREHOLE TYPE BW Casing, AX Core Barrel COMPILED BY dd
DATUM Geodetic DATE 82 06 04 CHECKED BY dd

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 SHEAR STRENGTH ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE	PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE								
303.7	Water Surface											
303.1	River Bottom											
0.6	with organics Silty Clay to Clay		1	SS	2							0 35 60 5
	Silt to Silty Clay Very soft to firm		2	SS	2							
298.5			3	SS	6							0 0 94 6
5.2	Bedrock											
297.1	Sound metasedimentary		4	RC	95%							
6.6	End of Borehole											

+3, x⁵: Numbers refer to
Sensitivity

20
15
10
5 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 7

METRIC

12

W P 24-82-02 LOCATION Sta. 10 + 150.4 16.6 m Lt. of Hwy. 11 ORIGINATED BY EC
 DIST 14 HWY 11 BOREHOLE TYPE Dynamic Cone Penetration Test COMPILED BY DD
 DATUM Geodetic DATE 82 06 07 CHECKED BY DD *DD*

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 (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100	SHEAR STRENGTH					
0.0	Water Surface													
303.7	River Bottom													
0.6	Probable Silt to Silty Clay													
	Occ. organics													
	Occ. Gravel and Boulders													
297.6	Probable Bedrock													
6.1	End of Borehole													

OFFICE REPORT ON SOIL EXPLORATION

+3, x5: Numbers refer to Sensitivity

20
15-5 (%) STRAIN AT FAILURE
10

RECORD OF BOREHOLE No 8

METRIC

13

W P 24-82-02

LOCATION Sta. 10 + 133.6 6.8 m Lt. of Hwy. 11

ORIGINATED BY FC

DIST 14 HWY 11

BOREHOLE TYPE BW Casing, BX Core Barrel

COMPILED BY DD

DATUM Geodetic

DATE 82 06 07-13

CHECKED BY DD

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 Y	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES								
303.7	Water Surface												
0.0	Water												
302.8	River Bottom												
0.9	Silty Sand to Silt Occ. Silty Clay Trace organics Occ. Gravel and Boulders												
	Very loose to very dense		1	SS	40								
297.9	Bedrock		2	RC	90%								
5.8	Sound metasedimentary		3	RC	90%								
295.9													
7.8	End of Borehole												

OFFICE REPORT ON SOIL EXPLORATION

+3, x5: Numbers refer to Sensitivity

20
15
10
5 (% STRAIN AT FAILURE



RECORD OF BOREHOLE No 9

METRIC

14

W P 24-82-02 LOCATION Sta. 10 + 126.2 7.8 m Lt. of Hwy. 11 ORIGINATED BY EC
DIST 14 HWY 11 BOREHOLE TYPE Dynamic Cone Penetration Test COMPILED BY DD
DATUM Geodetic DATE 82 06 13 CHECKED BY DD *h*

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 (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			'N' VALUES	SHEAR STRENGTH					
303.7	Water Surface												
0.0	Water												
302.3	River Bottom												
1.4	Probable Silty Sand to Silt, occ. Silty Clay, trace organics Occ. Gravel and Boulders					302							
299.7						300							
4.0	Probable Bedrock End of Borehole												

OFFICE REPORT ON SOIL EXPLORATION

+³, x⁵: Numbers refer to
Sensitivity

20
15
10
5
0
5
10
15
20
(%) STRAIN AT FAILURE



RECORD OF BOREHOLE No 10

METRIC

15

W P 24-82-02 LOCATION Sta. 10 + 119.0 10.5mLt. 6 Hwy. 11 ORIGINATED BY EC
DIST 14 HWY 11 BOREHOLE TYPE BW Casing, BX Core Barrel COMPILED BY DD
DATUM Geodetic DATE 82 06 12-13 CHECKED BY DD

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 (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			VALUES	20 40 60 80 100					
303.7	Water Surface												
0.0	Water												
301.7	River Bottom					302							
2.0	Silty Sand to Silt Occ. Silty Clay, Trace organics Occ. Gravel and Boulders		1	SS	1								
			2	SS	60	300							
	Very loose to very Dense		3	SS	60								
298.0	Bedrock		4	RC	84%	298							
	Sound metasedimentary		5	RC	92%								
			6	RC	86%	296							
295.5													
8.2	End of Borehole												



RECORD OF BOREHOLE No 11

METRIC

16

W P 24-82-02 LOCATION Sta. 10 + 110.9 7.0 m Lt. of Hwy. 11 ORIGINATED BY EC
DIST 14 HWY 11 BOREHOLE TYPE Dynamic Cone Penetration Test COMPILED BY DD
DATUM Geodetic DATE 82 06 08 CHECKED BY DD

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 SHEAR STRENGTH ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE	PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES								
303.7	Water Surface												
0.0	Water												
302.2	River Bottom												
1.5	Probable Silty Sand to Silt, occ. Silty Clay Trace organics Occ. Gravel & Boulders						302						
299.9							300						
3.8	Probable Bedrock End of Borehole												

+3, x5 : Numbers refer to
Sensitivity

20
15
10
5 (% STRAIN AT FAILURE



RECORD OF BOREHOLE No 12

METRIC

17

W P 24-82-02 LOCATION Sta. 10 + 107.3 7.8 m Lt. of Hwy. 11 ORIGINATED BY EC
DIST 14 HWY 11 BOREHOLE TYPE Dynamic Cone Penetration Test COMPILED BY DD
DATUM Geodetic DATE 82 06 08 CHECKED BY DD

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 (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			'N' VALUES	20					
303.7	Water Surface												
0.0	Water												
301.9	River Bottom												
1.8	Probable Silty Sand to Silt, occ. Silty Clay, Trace organics												
300.2	Occ. Gravel & Boulders												
3.5	Probable Bedrock												
	End of Borehole												

+3, x5: Numbers refer to
Sensitivity

20
15 5 (%) STRAIN AT FAILURE
10



RECORD OF BOREHOLE No 13

METRIC

18

W P 24-82-02 LOCATION Sta. 10 + 099.4 12.0 m E. of Hwy. 11 ORIGINATED BY PC
DIST 14 HWY 11 BOREHOLE TYPE BW Casing, BX Core Barrel COMPILED BY mn
DATUM Geodetic DATE 82 06 07-08 CHECKED BY DD

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 SHEAR STRENGTH ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE	PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES								
303.7	Water Surface												
0.0	Water												
302.5	River Bottom												
1.2	Silty Sand to Silt Occ. Silty Clay, Trace Organics, Occ. Gravel & Boulders *		1	SS	2		302						
300.7	Weathered		2	SS	60								
3.0	Bedrock		3	RC	88%		300						
299.1	Sound metasedimentary			BX									
4.6	End of Borehole * Very loose to dense												

+³, x⁵: Numbers refer to
Sensitivity

20
15
10
5 (%) STRAIN AT FAILURE

ENGINEERING MATERIALS OFFICE
PAVEMENT & FOUNDATION DESIGN SECTION

WP 24-82-02 DIST 14
HWY 11 STR SITE 47-009

Blanche River Bridge at Kenogami

DISTRIBUTION

S. McCombie
S.G. Wilson
G. Ricker
D.J. Armatage (2)
C. Grebski
B.J. Giroux
R. Hore

L. Argo (Cover Only)
T.J. Kovich (Cover Only)

FOUNDATION INVESTIGATION REPORT

For

W.P. 24-82-02, Site 47-009

Blanche River Bridge at Kenogami

Hwy. 11, District 14, New Liskeard

INTRODUCTION:

This report summarizes the results of the foundation investigation required for the proposed bridge replacement at this site.

The fieldwork was conducted during the period from 82 06 02 - 13 utilizing a modified diamond drill equipped with BW casing, and AX and BX core barrels.

This work consisted of 7 sampled boreholes/dynamic core penetration tests, plus an additional 6 dynamic cone penetration tests. Bedrock was cored at all 7 borehole locations.

SITE DESCRIPTION

The site is located on the Hwy. 11 crossing of the Blanche River at Kenogami (Grenfell Twp., District of Timiskaming).

Physiographically, the site lies in the Canadian Shield. The relatively shallow bedrock is covered by fluvial deposits.

SUBSURFACE CONDITIONS

General

The Record of Borehole Sheets (Appendix) illustrate the conditions at the borehole locations. The locations and elevations of the boreholes, and stratigraphical profiles based on the borehole data are shown on Drawing No. 248202-A.

At the borehole locations, the overburden thickness ranges from 1.7 to 5.5 m. The overburden generally consists of silty sand to silt containing occasional silty clay. Occasional boulders were encountered across the site, generally near the bedrock.

Silty Sand to Silt

In general the overburden consists of silty sand to silt, containing occasional silty clay, gravel and boulders and traces of organics. The denseness of this material ranges from very loose to very dense.

Silt to Silty Clay

At the northeast portion of the site (BH No. 6), the overburden consists of very soft to firm silt to silty clay, containing organics near the surface.

Bedrock

The bedrock is metasedimentary - fragments of igneous/metamorphic rock in a matrix of slate-like material.

DISCUSSION AND RECOMMENDATIONS

Foundation Alternatives

The foundation alternative which leads to the least expensive design should be adopted.

For the pier foundations, spread footings on sound bedrock are recommended.

For the abutment foundations, spread footings on sound bedrock, and perched abutments on steel H-piles or rock fill should be considered.

Design Data

Embankments

If the existing approach embankments are to be lengthened or widened, all loose or soft material under the eventual embankments should be removed.

Structure Foundations

ALTERNATIVE 1 - SPREAD FOOTINGS ON SOUND BEDROCK

All loose or soft surficial deposits at the footing locations should be removed in accordance with current MTC practices and standards. The approximate elevations of sound bedrock are illustrated on Drawing No. 248202-A.

A de-watering scheme will be required if the footings and piers are to be constructed in dry conditions. For this purpose, a cofferdam may be constructed using either sheeting or a prefabricated box. However, due to the uneven surface of the bedrock, developing a seal between the bedrock and the cofferdam may be difficult. Therefore, in this case it would be advantageous to construct at least a portion (i.e. at least enough to

balance the hydrostatic head) of the footing by employing tremie concrete techniques. The remainder of the footing and the pier or abutment should be constructed in dry conditions.

For sliding safety of the footings, to achieve resistance to lateral forces:

a) Key into bedrock a minimum of 0.3 m

or

b) Dowel into bedrock a minimum of 1.0 m. As a design example a 5 cm diameter dowel installed as recommended will provide a shearing resistance of approximately 45 kN.

or

c) Use friction coefficient of 0.6 between bedrock and footing.

Earth pressures should be computed as per Subsection 6.6.1.2.2 of the O.H.B.D.C. assuming a non-yielding foundation condition with $K_0 = 0.5$ for granular backfill.

Settlements of the structure will be negligible.

For bearing capacity, net safe pressure = 4800 kPa.

For the purposes of the O.H.B.D.C.

- Factored Bearing Capacity at U.L.S. = 7500 kPa
- Bearing Capacity at S.L.S. Type II will not govern design

ALTERNATIVE 2 - PERCHED ABUTMENT ON STEEL H-PILES

For this alternative, the front and side slopes of the approach embankments in the immediate vicinity of the abutment should be 2 horizontal to 1 vertical. All loose or soft surficial deposits beneath the approach

embankments in the vicinity of the abutments should be removed. Particle sizes of the fill directly beneath the pile locations should not exceed 75 mm - to facilitate pile driving.

The H-piles should be equipped with reinforced tips and driven to bedrock. Refer to Drawing No. 248202-A for approximate bedrock elevations.

Earth pressures should be computed as per Subsection 6.6.1.2.2 of the O.H.B.D.C. assuming a non-yielding foundation condition with $K_0 = 0.5$ for granular backfill.

For frost protection, cover should be greater than 2.1 m.

Settlements of the abutments will be negligible.

For pile capacity

HP 310 x 110, safe capacity = up to 1150 kN per pile
HP 310 x 79, safe capacity = up to 820 kN per pile

For the purpose of the O.H.B.D.C.

- Factored Capacity at U.L.S.

HP 310 x 110 = 1600 kN per pile
HP 310 x 79 = 1150 kN per pile

- Capacity at S.L.S. Type II

HP 310 x 110 = 1150 kN per pile
HP 310 x 79 = 820 kN per pile

ALTERNATIVE 3 - PERCHED ABUTMENT ON ROCK FILL

All loose or soft surficial deposits beneath the approach embankments in the vicinity of the abutments should be removed.

The surface of the rock fill at the footing locations should be chinked with low slump concrete to prevent washout of the foundation materials.

For slope stability of the rock fill;

- forward slopes at 1.5:1
- side slopes from abutments to 15 m behind C/L brg. of abutments at 1.5:1
- remaining slopes within rock fills at 1.25:1 or flatter

Earth pressures should be computed as per Subsection 6.6.1.2.2 of the O.H.B.D.C. assuming a yielding foundation condition with $K_a = 0.33$ for granular backfill.

For sliding safety of footing;

- friction coefficient between rock fill and footing = $\tan 30^\circ$.

For frost protection, cover should be greater than 2.1 m.

For settlement;

- small settlements will occur within the rock fill
- therefore a simply-supported design for the approach spans is recommended
- to reduce future settlements within the rock fill it may be advantageous to surcharge above the footing location
- this can be accomplished by constructing the fill to profile grade and re-excavating to the footing elevation
- for easier excavation, the material above the footing location should be earth material, perhaps separated from the rock by a fabric barrier.

For Bearing Capacity;

- net safe pressure = up to 240 kPa

For the purposes of the O.H.B.D.C.

- Factored Bearing Capacity at U.L.S. = 580 kPa
- Bearing Capacity at S.L.S. Type II = 240 kPa

MISCELLANEOUS

The fieldwork for this project was carried out under the supervision of Mr. F. Colozza (student field technician). The report was written by Mr. D. H. Dundas, Project Foundations Engineer, and reviewed by Mr. K. G. Selby, Senior Foundations Engineer. The equipment used was owned and operated by Morton & Partners Ltd.



D. H. Dundas

D. H. Dundas, P. Eng.
Project Foundations Engineer

K. G. Selby

K. G. Selby, P. Eng.
Senior Foundations Engineer

APPENDIX



Ministry of
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RECORD OF BOREHOLE No 1

METRIC

W P 24-82-02 LOCATION Sta. 10 + 110.9 7.2 m Rt. of Hwy. 11 ORIGINATED BY D.D.
DIST 14 HWY 11 BOREHOLE TYPE BW Casing, BX Core Barrel COMPILED BY D.D.
DATUM Geodetic DATE 82 06 02 CHECKED BY D.D.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 SHEAR STRENGTH ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE	PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES								
303.7	Water Surface												
0.0	Water												
301.9	River Bottom												
1.8	Silty Sand to Silt* Very loose to very dense		1	SS	2								
			2	SS	60								
	occ. gravel and boulders		3	RC	55%								
299.5	Bedrock		4	RC	81%								
298.6	Sound metasedimentary												
5.1	End of Borehole * occ. Silty Clay, trace organics												

+³, x⁵: Numbers refer to
Sensitivity

20
15 5 (%) STRAIN AT FAILURE
10



RECORD OF BOREHOLE No 2

METRIC

W P 24-82-02 LOCATION Sta. 10 + 117.0 10.4 m Rt. of Hwy. 11 ORIGINATED BY FC
DIST 14 HWY 11 BOREHOLE TYPE Dynamic Cone Penetration Test COMPILED BY DD
DATUM Geodetic DATE 82 06 03 CHECKED BY DD

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 SHEAR STRENGTH ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE	PLASTIC LIMIT W _p NATURAL MOISTURE CONTENT W LIQUID LIMIT W _L WATER CONTENT (%)	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES						
303.7	Water Surface										
0.0	Water										
301.6	River Bottom										
2.1	Probable Silty Sand to Silt, occ. Silty Clay Trace Organics occ. gravel and boulders										
299.3	Probable Bedrock										
4.4	End of Cone Test										

+3, x5 : Numbers refer to
Sensitivity

20
15
10
5 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 3

METRIC

W P 24-82-02 LOCATION Sta. 10 + 100.8 9.8 m Rt. g Hwy. 11 ORIGINATED BY FC
DIST 14 HWY 11 BOREHOLE TYPE BW Casing, BX Core Barrel COMPILED BY DD
DATUM Geodetic DATE 82 06 03 CHECKED BY DD

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 (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			'N' VALUES	SHEAR STRENGTH ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE					
303.7	Water Surface												
302.6	Water River Bottom												
1.1	Silty Sand to Silt occ. Silty Clay occ. Gravel and boulders very loose to very dense		1	SS	63								37 57 5 1
299.1	Bedrock		2	RC	80%								
297.1	sound metasedimentary		3	RC	100%								
6.6	End of Borehole												

+3, x5: Numbers refer to Sensitivity
20
15 \pm 5 (%) STRAIN AT FAILURE
10



RECORD OF BOREHOLE No 4

METRIC

W P 24-82-02 LOCATION Sta. 10 + 126.2 6.6 m Rt. of Hwy. 11 ORIGINATED BY DD
DIST 14 HWY 11 BOREHOLE TYPE BW Casing, BX and AX Core Barrels COMPILED BY DD
DATUM Geodetic DATE 82 06 03-04 CHECKED BY DD

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100	PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES								
303.7	Water Surface												
0.0	Water												
302.2	River Bottom												
1.5	Silty Sand to Silt occ. Silty Clay, Trace Organics, occ. Gravel and boulders		1	SS	2		302						
			2	SS	12								
300.0	Very loose to compact		3	RC	50%		300						1 71 27 1
3.7	Bedrock		4	RC	100%								
298.3	Sound metasedimentary												
5.4	End of Borehole												



RECORD OF BOREHOLE No 5

METRIC

W P 24-82-02 LOCATION Sta. 10 + 134.2 6.8 m Rt. of Hwy. 11 ORIGINATED BY DD
DIST 14 HWY 11 BOREHOLE TYPE Dynamic Cone Penetration Test COMPILED BY DD
DATUM Geodetic DATE 82 06 04 CHECKED BY DD

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 SHEAR STRENGTH ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE	PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES								
303.7	Water Surface												
0.0	Water												
302.9	River Bottom												
0.8	Probable Silty Sand to Silt												
	Occ. Silty Clay, Trace Organics												
	Occ. Gravel and Boulders												
298.8													
4.9	Probable Bedrock												
	End of Cone Test												



RECORD OF BOREHOLE No 6

METRIC

W P 24-82-02 LOCATION Sta. 10 + 147.4 15.0 m Rt. of Hwy. 11 ORIGINATED BY DD
DIST 14 HWY 11 BOREHOLE TYPE BW Casing, AX Core Barrel COMPILED BY DD
DATUM Geodetic DATE 82 06 04 CHECKED BY DD

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT <div>20 40 60 80 100</div>	PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT Y	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES								
303.7	Water Surface												
0.0	Water												
303.1	River Bottom												
0.6			1	SS	2								0 35 60 5
	with organics												
	Silty Clay to Clay		2	SS	2								
	Silt to Silty Clay												
	Very soft to firm		3	SS	6								0 0 94 6
298.5													
5.2	Bedrock												
297.1	Sound metasedimentary		4	RC	95%								
6.6	End of Borehole												

+3, x5: Numbers refer to
Sensitivity

20
15 5 (%) STRAIN AT FAILURE
10



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RECORD OF BOREHOLE No 7

METRIC

W P 24-82-02 LOCATION Sta. 10 + 150.4 16.6 m Lt. of Hwy. 11 ORIGINATED BY EC
DIST 14 HWY 11 BOREHOLE TYPE Dynamic Cone Penetration Test COMPILED BY DD
DATUM Geodetic DATE 82 06 07 CHECKED BY DD 10

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 (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			'N' VALUES	SHEAR STRENGTH								
							20	40	60	80	100					
303.7	Water Surface															
0.0	Water															
303.1	River Bottom															
0.6	Probable Silt to Silty Clay															
	Occ. organics															
	Occ. Gravel and Boulders															
297.6																
6.1	Probable Bedrock															
	End of Borehole															

+3, x5 : Numbers refer to Sensitivity 20 15 10 5 (%) STRAIN AT FAILURE



RECORD OF BOREHOLE No 8

METRIC

W P 24-82-02 LOCATION Sta. 10 + 133.6 6.8 m Lt. E Hwy. 11 ORIGINATED BY FC
DIST 14 HWY 11 BOREHOLE TYPE BW Casing, BX Core Barrel COMPILED BY DD
DATUM Geodetic DATE 82 06 07-13 CHECKED BY DD

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 SHEAR STRENGTH ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE	PLASTIC LIMIT W _p NATURAL MOISTURE CONTENT W LIQUID LIMIT W _L WATER CONTENT (%) 40 80 120	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES						
303.7	Water Surface										
0.0	Water										
302.8	River Bottom										
0.9	Silty Sand to Silt Occ. Silty Clay Trace organics Occ. Gravel and Boulders										
	Very loose to very dense		1	SS	40						
297.9	Bedrock		2	RC	90%						
	Sound metasedimentary		3	RC	90%						
295.9											
7.8	End of Borehole										



RECORD OF BOREHOLE No 9

METRIC

W P 24-82-02 LOCATION Sta. 10 + 126.2 7.8 m Lt. of Hwy. 11 ORIGINATED BY FC
DIST 14 HWY 11 BOREHOLE TYPE Dynamic Cone Penetration Test COMPILED BY DD
DATUM Geodetic DATE 82 06 13 CHECKED BY DD

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 (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			'N' VALUES	20 40 60 80 100					
303.7	Water Surface												
0.0	Water												
302.3	River Bottom												
1.4	Probable Silty Sand to Silt, occ. Silty Clay, trace organics Occ. Gravel and Boulders					302							
299.7						300							
4.0	Probable Bedrock End of Borehole												



RECORD OF BOREHOLE No 10

METRIC

W P 24-82-02 LOCATION Sta. 10 + 119.0 10.5mLt. # Hwy. 11 ORIGINATED BY EC
DIST 14 HWY 11 BOREHOLE TYPE BW Casing, BX Core Barrel COMPILED BY DD
DATUM Geodetic DATE 82 06 12-13 CHECKED BY DD

SOIL PROFILE		STRAT PLOT	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 (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION		NUMBER	TYPE			'N' VALUES	20 40 60 80 100					
303.7	Water Surface												
0.0	Water												
301.7	River Bottom					302							
2.0	Silty Sand to Silt Occ. Silty Clay, Trace organics Occ. Gravel and Boulders		1	SS	1								
			2	SS	60	300							
			3	SS	60								
298.0	Very loose to very Dense					298							
5.7	Bedrock		4	RC	84%								
	Sound metasedimentary		5	RC	92%								
			6	RC	86%	296							
295.5													
8.2	End of Borehole												

+3, x5: Numbers refer to
Sensitivity

20
15
10

5 (%) STRAIN AT FAILURE



RECORD OF BOREHOLE No 11

METRIC

W P 24-82-02 LOCATION Sta. 10 + 110.9 7.0 m Lt. of Hwy. 11 ORIGINATED BY FC
DIST 14 HWY 11 BOREHOLE TYPE Dynamic Cone Penetration Test COMPILED BY DD
DATUM Geodetic DATE 82 06 08 CHECKED BY DD

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 SHEAR STRENGTH ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE	PLASTIC LIMIT W _p NATURAL MOISTURE CONTENT W LIQUID LIMIT W _L WATER CONTENT (%)	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES						
303.7	Water Surface										
0.0	Water										
302.2	River Bottom										
1.5	Probable Silty Sand to Silt, occ. Silty Clay Trace organics Occ. Gravel & Boulders						302				
299.9							300				
3.8	Probable Bedrock End of Borehole										

+3, x5: Numbers refer to
Sensitivity

20
15 5 (%) STRAIN AT FAILURE
10



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RECORD OF BOREHOLE No 12

METRIC

W P 24-82-02 LOCATION Sta. 10 + 107.3 7.8 m Lt. of Hwy. 11 ORIGINATED BY EC
DIST 14 HWY 11 BOREHOLE TYPE Dynamic Cone Penetration Test COMPILED BY DD
DATUM Geodetic DATE 82 06 08 CHECKED BY DD

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 (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			'N' VALUES	20					
303.7	Water Surface												
0.0	Water												
301.9	River Bottom												
1.8	Probable Silty Sand to Silt, occ. Silty Clay, Trace organics												
300.2	Occ. Gravel & Boulders												
3.5	Probable Bedrock												
	End of Borehole												

+3, x5 : Numbers refer to
Sensitivity

20
15
10
5 (%) STRAIN AT FAILURE



RECORD OF BOREHOLE No 13

METRIC

W P 24-82-02 LOCATION Sta. 10 + 099.4 12.0 m Lt. of Hwy. 11 ORIGINATED BY EC
DIST 14 HWY 11 BOREHOLE TYPE BW Casing, BX Core Barrel COMPILED BY DD
DATUM Geodetic DATE 82 06 07-08 CHECKED BY DD

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 SHEAR STRENGTH ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE	PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES								
303.7	Water Surface												
0.0	Water												
302.5	River Bottom												
1.2	Silty Sand to Silt Occ. Silty Clay, Trace Organics, Occ. Gravel & Boulders *		1	SS	2		302						
300.7	Weathered		2	SS	60								
3.0	Bedrock		3	RC	88%		300						
299.1	Sound metasedimentary			BX									
4.6	End of Borehole * Very loose to dense												

EXPLANATION OF TERMS USED IN REPORT

N VALUE: THE STANDARD PENETRATION TEST (SPT) N VALUE IS THE NUMBER OF BLOWS REQUIRED TO DRIVE 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_i	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						

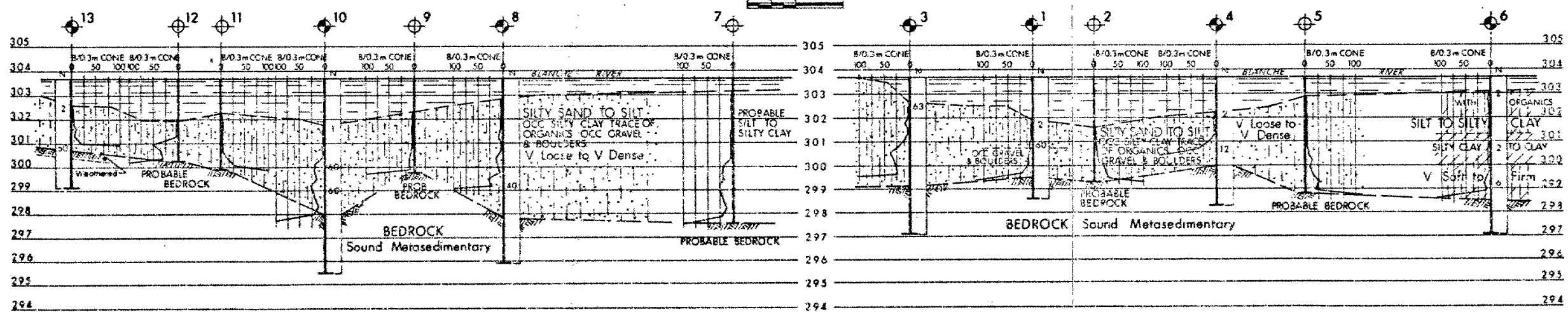
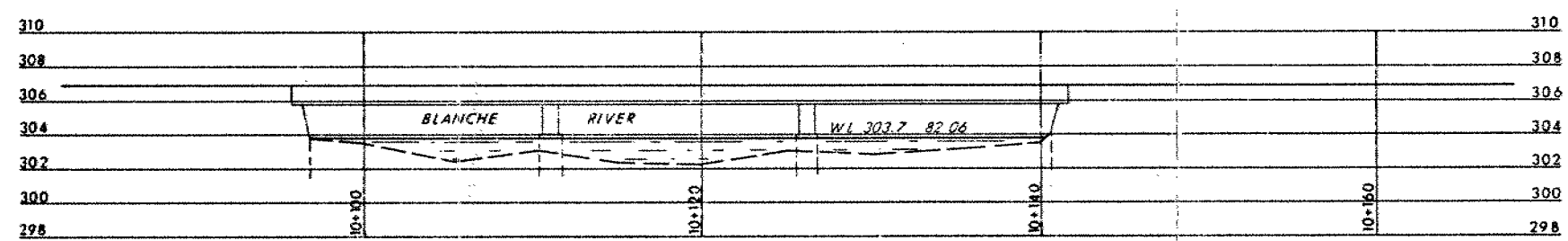
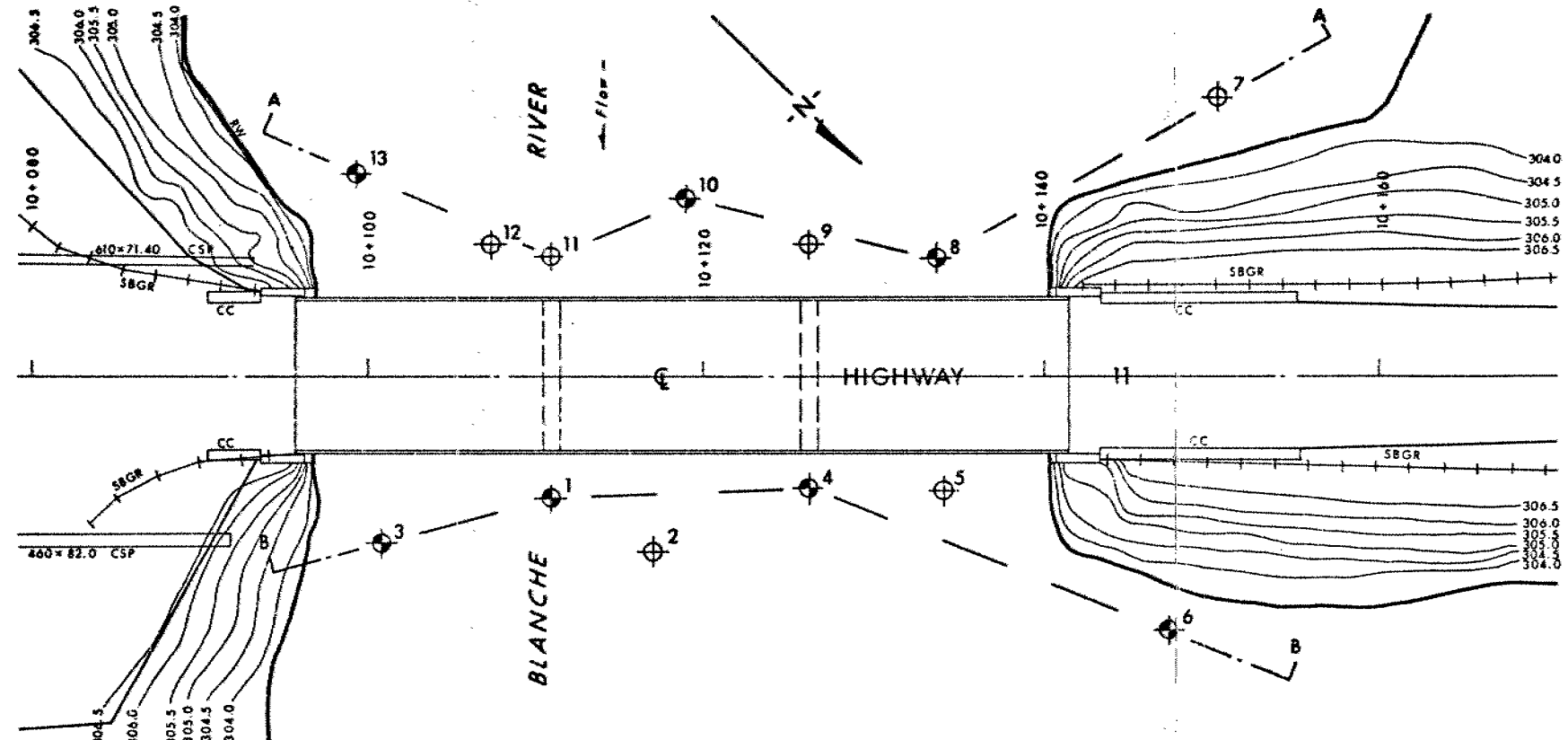
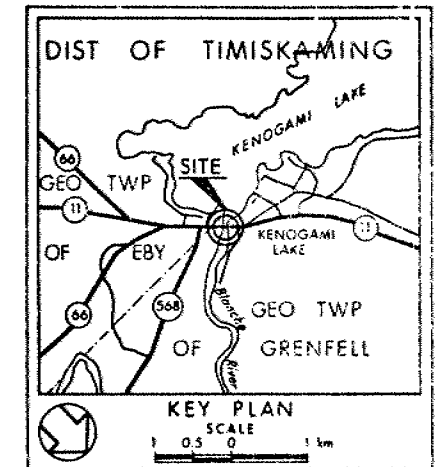
METRIC
DIMENSIONS ARE IN METRES
AND/OR MILLIMETRES UNLESS
OTHERWISE SHOWN. STATIONS
IN KILOMETRES - METRES

CONT No
WP No 24-82-02

BLANCHE RIVER

SHEET

BORE HOLE LOCATIONS & SOIL STRATA



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 82.06

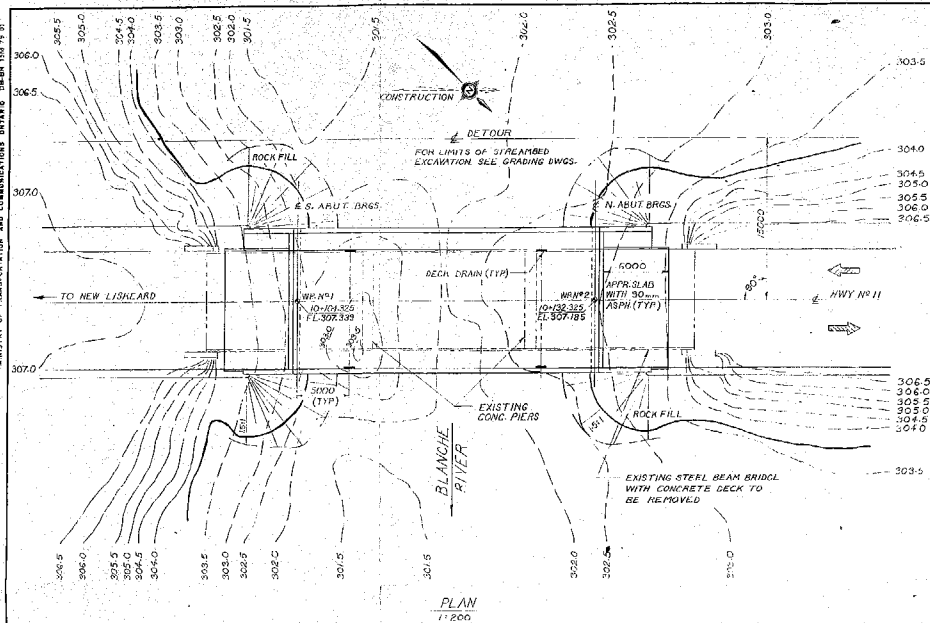
No	ELEVATION	STATION	OFFSET
1	303.7	10+110.9	7.2 m RT
2	303.7	10+117.0	10.4 m RT
3	303.7	10+100.8	9.8 m RT
4	303.7	10+126.2	6.6 m RT
5	303.7	10+134.2	6.8 m RT
6	303.7	10+147.4	15.0 m RT
7	303.7	10+150.4	16.6 m LT
8	303.7	10+133.6	6.8 m LT
9	303.7	10+126.2	7.8 m LT
10	303.7	10+119.0	10.5 m LT
11	303.7	10+110.9	7.0 m LT
12	303.7	10+107.3	7.8 m LT
13	303.7	10+099.4	12.0 m LT

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

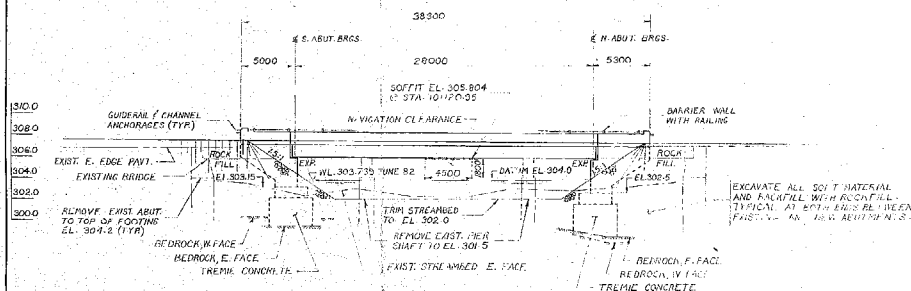
NOTE: The complete foundation investigation and design report for this project and other related documents may be examined at the Engineering Materials Office, Downsview. Information contained in this report and related documents is specifically excluded in accordance with the conditions at Section 102-2 of Form 100.

DATE	BY	DESCRIPTION
82.10.06	DATE	82.10.06
82.10.06	CHECKED	82.10.06
82.10.06	DRAWN	82.10.06

Geocres No 42 A-34
HWY No 11
SUBD DD
DRAWN SQ



PLAN
1:200



LAST ELEVATION

BM 307.220
GEODETIC DATUM
C.C. ON CONC. SLAB
N.W. CORNER S1 S5
19-24 RT. STA 10+065.20

DHO- BM 275-70
EL 325-029
TABLET SET VERTICALLY
IN RK ROUTE 69

METRIC

DIMENSIONS ARE IN MILLIMETRES
UNLESS OTHERWISE SHOWN.
ELEVATIONS, COORDINATES, CURVE
AND ALIGNMENT DATA ARE IN METRES.
STATIONS ARE IN KILOMETRES + METRES.

DIST. 14 HWY. 11
CONT No
WP No 24-82-01



BLANCHE RIVER BRIDGE
AT KENOGAMI
GENERAL ARRANGEMENT

NOTES

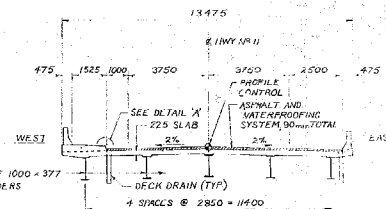
CLASS OF CONCRETE	
FOOTINGS & APPROACH SLABS	20 MPa
REMAINDER	30 MPa

REINFORCING STEEL SHALL BE GRADE 400 MPa BARS MARKED WITH THE SUFFIX 'C' SHALL BE COATED BARS.

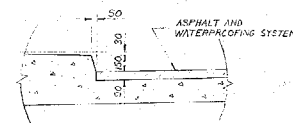
CLEAR COVER TO REINFORCING STEEL

FOOTINGS	100 ± 25 mm
ABUTMENTS / WINGWALLS (FRONT FACE)	80 ± 20 mm
CHEEK - TOP	70 ± 20 mm
- BOTTOM	40 ± 10 mm
REMAINDER (UNLESS OTHERWISE NOTED)	70 ± 20 mm

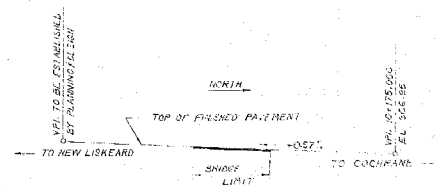
CONSTRUCTION NOTES
THE CONTRACTOR SHALL FINISH THE BEARING SEAT
DEAD LEVEL TO THE SPECIFIED ELEVATIONS TO
A TOLERANCE OF ± 3 mm. NO CONCRETE SHALL
BE PLACED ABOVE THE ABUTMENT BEARING
SEATS UNTIL THE CONCRETE IN THE DECK
HAS BEEN PLACED.



TYPICAL DECK SECTION
1:100



CURB DETAIL 'A'
1:20



PROPOSED PROFILE @ E HWY NO. 11
N.T.S.

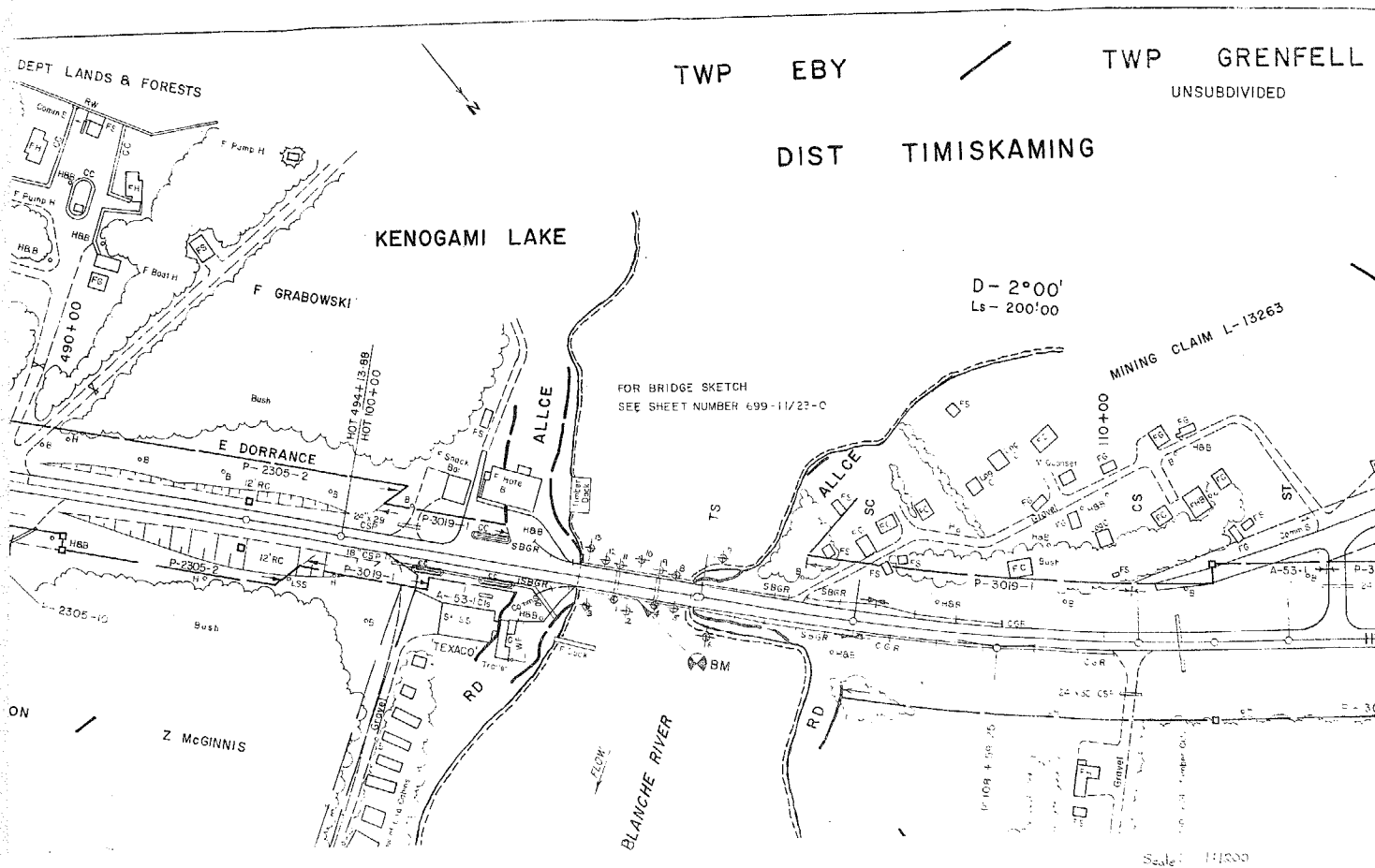


DRAWING NOT TO BE SCALED
100 mm ON ORIGINAL DRAWING

REVISIONS				
	DATE	BY	DESCRIPTION	
	DESIGN OK	CHECK	LOADING OHBNC-8-79	DATE 03/7
	CHALRAMEL EVC	CHECK OK	SITE No 47-009	DWG P-1

WP 24-82-02

FIGURE 1



Scale: 1:1000