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GEOCRES No. 52E-21

DIST. 20 REGION

W.P. No. 18-77-18

CONT. No. 88-450

W. O. No.

STR. SITE No. 41S-133

HWY. No. 807

LOCATION Gibson Creek & Hwy 807
(Bending Lake Rd)

No of PAGES - —

OVERSIZE DRAWINGS TO BE INCLUDED WITH THIS REPORT.

REMARKS:

FOUNDATION INVESTIGATION REPORT

CONTRACT NO 88 - 450

Ontario

Ministry of
Transportation and
Communications

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

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:

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
γ_s	kN/m^3	UNIT WEIGHT OF SOLID PARTICLES
ρ_w	kg/m^3	DENSITY OF WATER
γ_w	kN/m^3	UNIT WEIGHT OF WATER
ρ	kg/m^3	DENSITY OF SOIL
γ	kN/m^3	UNIT WEIGHT OF SOIL
ρ_d	kg/m^3	DENSITY OF DRY SOIL
γ_d	kN/m^3	UNIT WEIGHT OF DRY SOIL
ρ_{sat}	kg/m^3	DENSITY OF SATURATED SOIL
γ_{sat}	kN/m^3	UNIT WEIGHT OF SATURATED SOIL
ρ'	kg/m^3	DENSITY OF SUBMERGED SOIL
γ'	kN/m^3	UNIT WEIGHT OF SUBMERGED SOIL

e	1, %	VOID RATIO
n	1, %	POROSITY
w	1, %	WATER CONTENT
S_r	%	DEGREE OF SATURATION
w_L	%	LIQUID LIMIT
w_p	%	PLASTIC LIMIT
w_S	%	SHRINKAGE LIMIT
I_p	%	PLASTICITY INDEX = $w_L - w_p$
I_L	1	LIQUIDITY INDEX = $\frac{w - w_p}{I_p}$
I_C	1	CONSISTENCY INDEX = $\frac{w_L - w}{I_p}$
e_{max}	1, %	VOID RATIO IN LOOSEST STATE

e_{min}	1, %	VOID RATIO IN DENSEST STATE
I_D	1	DENSITY INDEX = $\frac{e_{max} - e}{e_{max} - e_{min}}$
D	mm	GRAIN DIAMETER
D_n	mm	n PERCENT - DIAMETER
C_U	1	UNIFORMITY COEFFICIENT
h	m	HYDRAULIC HEAD OR POTENTIAL
q	m^3/s	RATE OF DISCHARGE
v	m/s	DISCHARGE VELOCITY
i	1	HYDRAULIC GRADIENT
k	m/s	HYDRAULIC CONDUCTIVITY
j	kN/m^3	SEEPAGE FORCE

FOUNDATION INVESTIGATION REPORT
For
W.P. 18-77-18, Site #41S-133
Gibson Creek Culvert
Highway #807, (Bending Lake Road)
District #20, Kenora

INTRODUCTION

This report contains the information obtained from a foundation investigation carried out at the above-noted site.

The fieldwork for this project was carried out during the period from 86 05 26 to 86 05 30 utilizing a diamond drill equipped with 60 mm I.D. B-Casing. The investigation consisted of 8 sampled boreholes which ranged in depth from 0.9 m to 3.6 m. BX-size (41 mm) rock core was recovered from all 8 boreholes to prove bedrock.

SITE DESCRIPTION

The site is located approximately 33.4km south of Highway #17 on proposed Bending Lake Road, Highway #807. Due to the isolated nature of the site, it was accessible only from Snoke Bay Road (a Great Lakes Paper Company Road) which intersects Highway #17 approximately 9 km west of Borups Corners, Gibson Creek is located approximately 66 km south west of Highway #17 along Snake Bay Road.

The topography of the site is gently rolling with some hills in the vicinity. Gibson Creek is a fairly small shallow creek with rapidly flowing water; it runs in a north west direction and drains Gibson Lake located to the east of the site. The area is extensively forested; there is a logging camp located approximately 500 m north along Snake Bay Road. The Ministry right-of-way is visible to the north where trees have been cleared for the road.

The existing bridge, built by the paper company, is a small structure suppored by timber cross-braces and logs embedded into each embankment. It is sufficient strong to support fully loaded logging trucks which cross it several times each day. The approaches to the bridge consist of up to 2 m of sand, gravel, and boulder fill material.

SUBSURFACE CONDITIONS

General

Bedrock was very close to the surface at all borehole locations as illustrated by the Record of Borehole Sheets (Appendix, BH #1 to BH #8). Overburden consisted mainly of boulders, cobbles and gravel with silty sand interstitial material. The locations and elevations of the boreholes are shown on Sheet No. 2 of the Contract Drawings.

Overburden

The overburden at this site is very dense, consisting of a thin layer (0.15 to 0.6 m) of boulders, cobbles, gravel and sand.

Bedrock

The bedrock was proved at each borehole location. The upper portion of the granite type bedrock was found to be moderately weathered. The rock core samples were examined by Mr. E.R. Magni, Geologist and his description is appended to this report.

Groundwater Conditions

No groundwater level observations were carried out in Borehole No. 1,2,5 and 6. For construction purposes the groundwater level may be assumed to be at the same level as the prevailing water surface in the creek.

P. Payer

P. Payer, P. Eng.
Sr. Foundations Engineer

K. G. Selby

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

APPENDIX

DESCRIPTION OF ROCK CORE - W.P. 18-77-18

BOREHOLE NUMBER	DEPTH (m)	% CR*	% RQD*	CORE DESCRIPTION	
				DEPTH (m)	DESCRIPTION
1	0.30 - 1.30 1.30 - 2.06 2.06 - 3.58	77 97 98	18 80 78	0.30 - 0.63 0.63 - 1.12 1.12 - 3.58	GRANITE, pink mottled black, moderately weathered, very closely spaced GRANITE, grey mottled pink, slightly weathered, closely spaced joints GRANITE, grey mottled pink, unweathered, medium spaced joints
2	0.15 - 0.76 0.76 - 1.37	83 96	21 0	0.15 - 1.37	GRANITE, white mottled black and pink, slightly weathered, closely to medium spaced joints, near vertical oxidized joint from 0.15 to 0.38
3	0.30 - 1.22 1.22 - 1.98	64 93	0 50	0.30 - 0.94 0.94 - 1.98	GRANITE, grey mottled pink, moderately weathered, very closely spaced joints GRANITE, grey mottled pink, unweathered, medium spaced joints
4	0.08 - 0.76	100	100	0.08 - 0.23 0.23 - 0.76	BOULDER GRANITE, white mottled black, unweathered, medium spaced joints
5	0.46 - 0.76 0.76 - 1.52 1.52 - 1.98	100 93 94	0 37 67	0.46 - 0.76 0.76 - 1.98	GRANITE, pink mottled black, medium weathered, very closely spaced joints GRANITE, pink mottled black, unweathered, medium spaced joints (1.83 - 1.98 very closely spaced joints)
6	0.46 - 0.91 0.91 - 1.37 1.37 - 1.83 1.83 - 2.59	89 94 100 90	0 89 94 57	0.46 - 0.61 0.61 - 0.91 0.91 - 2.59	BOULDERS GRANITE, white mottled black, medium weathered, very closely spaced joints GRANITE, white mottled black, unweathered, medium spaced joints

* CR = CORE RECOVERY ; RQD = ROCK QUALITY DESIGNATION

DESCRIPTION OF ROCK CORE - W.P. 18-77-18

BOREHOLE NUMBER	DEPTH (m)	% CR*	% RQD*	CORE DESCRIPTION	
				DEPTH (m)	DESCRIPTION
7	0.15 - 0.91	77	0	0.15 - 0.46	GRANITE, white mottled black and brown, slightly weathered, vertical joint along length of core
				0.46 - 0.91	GRANITE, white mottled black and pink, unweathered, vertical joint along length of core, closely spaced joints
8	0.23 - 0.84	92	50	0.23 - 0.84	GRANITE, white mottled pink,unweathered, closely spaced joints

* CR = CORE RECOVERY ; RQD = ROCK QUALITY DESIGNATION

86 06 05

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RECORD OF BOREHOLE No 1

METRIC

W P 18-77-18 LOCATION STA. 36 + 534.0 °/s 5.9 m Rt. ORIGINATED BY W.D.

DIST 20 HWY 807 BOREHOLE TYPE Washboring, BXL Rock Coring COMPILED BY W.D.

DATUM Geodetic DATE 86 05 27 CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE)	PLASTIC LIMIT Wp / NATURAL MOISTURE CONTENT W / LIQUID LIMIT Wl — WATER CONTENT (%)	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES						
411.9	Ground Level										
411.6 0.0	Boulders with Sand, Trace Silt, cobbles, gravel										
0.3	Weathered					*					
	Sound		1	RC BXL	77%		411				RQD 18%
	Bedrock										
	Granite		2	RC BXL	97%		410				RQD 80%
			3	RC BXL	98%		409				
408.3											RQD 78%
3.6	End of Borehole						408				

* WL Not Observed

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RECORD OF BOREHOLE No 2

METRIC

W P 18-77-18 LOCATION STA. 36 + 534.5 o/s 9.0 m Lt. ORIGINATED BY W.D.

DIST 20 HWY 807 BOREHOLE TYPE Washboring, BQ Rock Coring COMPILED BY W.D.

DATUM Geodetic DATE 86 05 29 CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH (o UNCONFINED, + FIELD VANE, ● QUICK TRIAXIAL, x LAB VANE)	PLASTIC LIMIT Wp / NATURAL MOISTURE CONTENT W / LIQUID LIMIT WL — WATER CONTENT (%)	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES						
411.8	Ground Level										
411.65	cobbles with Sand Some Silt										
0.15	Weathered		1	RC BQ	80%	*	411				RQD 21%
	Bedrock Sound Granite		2	RC BQ	96%						
410.4											RQD 0%
1.4	End of Borehole						410				

* WL Not Observed

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RECORD OF BOREHOLE No 3

METRIC

W P 18-77-18 LOCATION STA. 36 + 542.3 °/s 6.8 m Rt. ORIGINATED BY W.D.

DIST 20 HWY 807 BOREHOLE TYPE Washboring, BXL Rock Coring COMPILED BY W.D.

DATUM Geodetic DATE 86 05 27 CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × 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						
411.5	Creek Water Level										
411.3	Creek Bottom										
0.2											
410.9	Boulders, cobbles, gravel						411				
0.5	Weathered										
	Bedrock Sound Granite		1	RC BXL	64%		410				RQD 0%
			2	RC BXL	93%						RQD 50%
409.3											
2.2	End of Borehole						409				

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RECORD OF BOREHOLE No 4

METRIC

W P 18-77-18 LOCATION STA. 36 + 543.5 o/s 7.0 m Lt. ORIGINATED BY W.D.

DIST 20 HWY 807 BOREHOLE TYPE Washboring, BXL Rock Coring COMPILED BY W.D.

DATUM Geodetic DATE 86 05 29 CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE)	PLASTIC LIMIT Wp / 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						
410.9	Creek Water Level										
410.7	Creek Bottom										
0.2 410.5	Boulders, cobbles, gravel										
0.4 409.9	Bedrock Sound Granite		1	RC BXL	100%		410				RQD 100%
1.0	End of Borehole						409				

Ministry of Transportation and Communications
Ontario

RECORD OF BOREHOLE No 5

METRIC

W P 18-77-18 LOCATION STA. 36 + 550.0 °/s 8.2 m Rt. ORIGINATED BY W.D.

DIST 20 HWY 807 BOREHOLE TYPE Washboring, BXL Rock Coring COMPILED BY W.D.

DATUM Geodetic DATE 86 05 27 CHECKED BY

SOIL PROFILE ELEV/DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES 'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE)	PLASTIC LIMIT Wp / NATURAL MOISTURE CONTENT W / LIQUID LIMIT WL — WATER CONTENT (%)	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
411.9	Ground Level										
0.0	Boulders, cobbles gravel with Sand					*					
411.45											
0.45	Weathered		1	RC BXL	100%						RQD 0%
	Sound						411				
	Bedrock Granite		2	RC BXL	93%						RQD 37%
409.9			3	RC BXL	94%						RQD 67%
							410				
2.0	End of Borehole										
	* WL Not Observed						409				

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Ontario

RECORD OF BOREHOLE No 6

METRIC

W P 18-77-18 LOCATION STA. 36 + 553.1 °/s 5.4 m Lt. ORIGINATED BY W.D.

DIST 20 HWY 807 BOREHOLE TYPE Washboring, BXL Rock Coring COMPILED BY W.D.

DATUM Geodetic DATE 86 05 28 CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE)	PLASTIC LIMIT Wp / 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						
410.9	Ground Level										
0.0	Boulders, cobbles gravel with Sand Trace Silt					*					
410.3											
0.6	Weathered		1	RC BXL	89%		410				RQD 0%
	Sound		2	RC BXL	94%						RQD 89%
	Bedrock Granite		3	RC BXL	100%		409				RQD 94%
408.3			4	RC BXL	90%						RQD 57%
2.6	End of Borehole						408				

* WL Not Observed

Ministry of Transportation and Communications
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RECORD OF BOREHOLE No 7

METRIC

W P 18-77-18 LOCATION STA. 36 + 547.0 °/s 7.3 m Lt. ORIGINATED BY W.D.

DIST 20 HWY 807 BOREHOLE TYPE Washboring, BXL Rock Coring COMPILED BY W.D.

DATUM Geodetic DATE 86 05 29 CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE)	PLASTIC LIMIT Wp / NATURAL MOISTURE CONTENT W / LIQUID LIMIT WL — WATER CONTENT (%)	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES						
410.9	Creek Water Level										
410.7	Creek Bottom										
0.2	cobbles, and gravel										
0.3	Bedrock										
	Granite Weathered		1	RC BXL	77%		410				RQD 0%
409.8	Sound										
1.1	End of Borehole						409				

Ministry of Transportation and Communications
Ontario

RECORD OF BOREHOLE No 8

METRIC

W P 18-77-18 LOCATION STA. 36 + 539.3 °/s 6.5 m Rt. ORIGINATED BY W.D.

DIST 20 HWY 807 BOREHOLE TYPE Washboring, BQ Rock Coring COMPILED BY W.D.

DATUM Geodetic DATE 86 05 30 CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE)	PLASTIC LIMIT Wp / 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						
411.4	Creek Water Level										
~~411.3~~ 411.1	~~Creek Bottom~~ cobbles, and gravel										
0.3	Bedrock — Weathered — Sound		1	RC BQ	92%		411				
410.5	Granite										RQD 50%
0.9	End of Borehole						410				

ENGINEERING MATERIALS OFFICE
FOUNDATION DESIGN SECTION

WP 18-77-18 DIST 20

HWY 807 STR SITE 41S-133

Gibson Creek Bridge

Highway #807

(Bending Lake Road)

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FOUNDATION INVESTIGATION REPORT
For
W.P. 18-77-18, Site #41S-133
Gibson Creek Bridge, Highway #807 (Bending Lake Road)
District #20, Kenora

INTRODUCTION

This report contains the information obtained from a foundation investigation carried out at the above-noted site, together with recommendations for design and construction of a new structure and approaches.

The fieldwork for this project was carried out during the period from 86 05 26 to 86 05 30 utilizing a diamond drill equipped with 60 mm I.D. B-Casing. The investigation consisted of 8 sampled boreholes which ranged in depth from 0.9 m to 3.6 m. BX-size (41 mm) rock core was recovered from all 8 boreholes to prove bedrock.

SITE DESCRIPTION

The site is located approximately 33.4 km south of Highway #17 on proposed Bending Lake Road, Highway #807. Due to the isolated nature of the site, it was accessible only from Snake Bay Road (a Great Lakes Paper Company Road) which intersects Highway #17 approximately 9 km west of Borups Corners; Gibson Creek is located approximately 66 km south west of Highway #17 along Snake Bay Road.

The topography of the site is gently rolling with some hills in the vicinity. Gibson Creek is a fairly small shallow creek with rapidly flowing water; it runs in a north west direction and drains Gibson Lake located to the east of the site. The area is extensively forested; there is a logging camp located approximately 500 m north along Snake Bay Road. The Ministry right-of-way is visible to the north where trees have been cleared for the road.

The existing bridge, built by the paper company, is a small structure supported by timber cross-braces and logs embedded into each embankment. It is sufficiently strong to support fully loaded logging trucks which cross it several times each day. The approaches to the bridge consist of up to 2 m of sand, gravel, and boulder fill material.

SUBSURFACE CONDITIONS

General

Bedrock was very close to the surface at all borehole locations as illustrated by the Record of Borehole Sheets (Appendix, BH #1 to BH #8). Overburden consisted mainly of boulders, cobbles and gravel with silty sand interstitial material. The locations and elevations of the boreholes and the bedrock elevations are shown on Drawing No. 187718-A.

Overburden

The overburden at this site is very dense, consisting of a thin layer (0.15 m to 0.6 m) of boulders, cobbles, gravel and sand.

Bedrock

The bedrock is moderately weathered to unweathered, precambrian granite.

Groundwater

At the time of the field investigation, the groundwater elevation was at the creek surface (elev. 411.5 m on 86 05 27 at the south side of the bridge and elev. 410.9 m on 86 05 27 at the north side of the bridge).

DISCUSSION AND RECOMMENDATIONS

The region has proposed to replace the timber structure at this location with one of the following alternatives:

a. 6.1 m span concrete culvert

b. Twin 3.048 m C.S.P.'s

c. 18 m single span bridge

The new grade will be at el. 413.8 m, which is 0.6 m above the existing bridge deck and 2.8 m above the creek bed.

18 m Single Span Bridge

For the 18 m single span bridge, the abutments should be constructed on sound bedrock.

A safe bearing pressure of up to 5 MPa may be assumed for design purposes.

The east abutment should be constructed at or below elev. 410.3 m and the west abutment at or below elev. 411.3 m because of the slightly higher bedrock surface. Please refer to Drawing No. 187718-A for bedrock elevations of the borehole locations. For estimation purposes, bedrock elevations have been interpolated between these points.

The following design values are recommended, for purposes of the O.H.B.D.C.:

FACTORED BEARING CAPACITY AT ULS-10,000 kPa
BEARING CAPACITY AT SLS TYPE II - Not Applicable

Lateral earth pressures should be computed in accordance with Section 6-6.1.2 of the O.H.B.D.C. the 'at rest' condition should be assumed to apply for granular backfill for which the following properties are applicable:

Gran 'A': γ = 22.8 kN/m^3, ϕ = 35°, K_o = 0.43
Gran 'B': γ = 21.1 kN/m^3, ϕ = 30°, K_o = 0.50

A coefficient of friction of TAN 35° may be assumed to apply between the base of footings and sound granite bedrock.

Differential settlements will be negligible for foundations mounted on solid bedrock.

Frost protection is not required.

Dewatering should not pose any problems.

6.1 m Span Concrete Culvert

For the 6.1 m span concrete culvert, footings should be constructed on sound bedrock at or below el. 410.3 m.

Safe bearing pressures up to 5 MPa may be assumed for design purposes.

The following design values are recommended, for purposes of the O.H.B.D.C.:

FACTORED BEARING CAPACITY AT ULS - 10,000 kPa
BEARING CAPACITY AT SLS TYPE II - Not Applicable

Lateral earth pressures should be computed in accordance with Section 6-6.1.2 of the O.H.B.D.C. The 'at rest' condition should be assumed to apply for granular backfill for which the following properties are applicable:

Gran 'A': γ = 22.8 kN/m^3, ϕ = 35°, K_o = 0.43
Gran 'B': γ = 21.1 kN/m^3, ϕ = 30°, K_o = 0.50

A coefficient of friction of TAN 35° may be assumed to apply between the base of footings and sound granite bedrock.

Bedding and backfilling should be in accordance with the appropriate Ministry Standards.

Differential settlements will be negligible.

Frost protection is not required.

Dewatering should not pose any problems.

Twin 3.048 m C.S.P.'s

Twin 3.048 m C.S.P.'s may be used at this site if they are large enough to perform in spring flooding. Bedding and backfill should be in accordance with the appropriate Ministry Standards.

MISCELLANEOUS

The drilling portion of the fieldwork for this project was carried out under the supervision of Mr. W. Dumanski, Student Engineer.

The report was written by Mr. Dumanski, and reviewed by Mr. K.G. Selby, Chief Foundations Engineer.

The drilling equipment used was owned and operated by N. Morissette Drilling Co. Ltd..

W.M. Dumanski
Project Foundations Engineer

K.G. Selby, P.Eng.
Chief Foundations Engineer
(West)

APPENDIX

Ministry of Transportation and Communications
Ontario

RECORD OF BOREHOLE No 1

METRIC

W P 18-77-18 LOCATION STA. 36 + 534.0 °/s 5.9 m Rt. ORIGINATED BY W.D.

DIST 20 HWY 807 BOREHOLE TYPE Washboring, BXL Rock Coring COMPILED BY W.D.

DATUM Geodetic DATE 86 05 27 CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × 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						
411.9	Ground Level										
0.0 / 411.6	Boulders with Sand, Trace Silt, cobbles, gravel										
0.3	Weathered										
	Sound		1	RC BXL	77%		411				RQD 18%
	Bedrock										
	Granite		2	RC BXL	97%		410				RQD 80%
			3	RC BXL	98%		409				
408.3											RQD 78%
3.6	End of Borehole						408				

RT ON SOIL EXPLORATION

Ministry of Transportation and Communications
Ontario

RECORD OF BOREHOLE No 2

METRIC

W P 18-77-18 LOCATION STA. 36 + 534.5 o/s 9.0 m Lt. ORIGINATED BY W.D.

DIST 20 HWY 807 BOREHOLE TYPE Washboring, BQ Rock Coring COMPILED BY W.D.

DATUM Geodetic DATE 86 05 29 CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH o UNCONFINED + FIELD VANE • QUICK TRIAXIAL × 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						
411.8	Ground Level										
411.65 / 0.15	cobbles with Sand Some Silt										
	Weathered		1	RC BQ	80%		411				RQD 21%
	Sound Bedrock Granite		2	RC BQ	96%						
410.4											RQD 0%
1.4	End of Borehole						410				

T ON SOIL EXPLORATION

Ministry of Transportation and Communications
Ontario

RECORD OF BOREHOLE No 3

METRIC

W P 18-77-18 LOCATION STA. 36 + 542.3 °/s 6.8 m Rt. ORIGINATED BY W.D.

DIST 20 HWY 807 BOREHOLE TYPE Washboring, BXL Rock Coring COMPILED BY W.D.

DATUM Geodetic DATE 86 05 27 CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE)	PLASTIC LIMIT Wp / 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						
411.5	Creek Water Level										
411.3	Creek Bottom										
0.2 / 410.9	Boulders, cobbles, gravel						411				
0.5	Weathered										
	Bedrock Sound Granite		1	RC BXL	64%		410				RQD 0%
			2	RC BXL	93%						RQD 50%
409.3											
2.2	End of Borehole						409				

RT ON SOIL EXPLORATION

Ministry of Transportation and Communications
Ontario

RECORD OF BOREHOLE No 4

METRIC

W P 18-77-18 LOCATION STA. 36 + 543.5 O/S 7.0 m Lt. ORIGINATED BY W.D.

DIST 20 HWY 807 BOREHOLE TYPE Washboring, BXL Rock Coring COMPILED BY W.D.

DATUM Geodetic DATE 86 05 29 CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE)	PLASTIC LIMIT Wp / NATURAL MOISTURE CONTENT W / LIQUID LIMIT WL — WATER CONTENT (%)	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES						
410.9	Creek Water Level										
410.7	Creek Bottom										
0.2 / 410.5	Boulders, cobbles, gravel										
0.4 / 409.9	Bedrock Sound Granite		1	RC BXL	100%		410				RQD 100%
1.0	End of Borehole						409				

RT ON SOIL EXPLORATION

Ministry of Transportation and Communications
Ontario

RECORD OF BOREHOLE No 5

METRIC

W P 18-77-18 LOCATION STA. 36 + 550.0 °/s 8.2 m Rt. ORIGINATED BY W.D.

DIST 20 HWY 807 BOREHOLE TYPE Washboring, BXL Rock Coring COMPILED BY W.D.

DATUM Geodetic DATE 86 05 27 CHECKED BY

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 × 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						
411.9	Ground Level										
0.0 411.45	Boulders, cobbles gravel with Sand										
0.45	Weathered Sound		1	RC BXL	100%						RQD 0%
	Bedrock Granite		2	RC BXL	93%		411				RQD 37%
409.9			3	RC BXL	94%		410				RQD 67%
2.0	End of Borehole						409				

RT ON SOIL EXPLORATION

Ministry of Transportation and Communications
Ontario

RECORD OF BOREHOLE No 6

METRIC

W P 18-77-18 LOCATION STA. 36 + 553.1 °/s 5.4 m Lt. ORIGINATED BY W.D.

DIST 20 HWY 807 BOREHOLE TYPE Washboring, BXL Rock Coring COMPILED BY W.D.

DATUM Geodetic DATE 86 05 28 CHECKED BY

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 × LAB VANE	PLASTIC LIMIT Wp / NATURAL MOISTURE CONTENT W / LIQUID LIMIT WL — WATER CONTENT (%)	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES						
410.9	Ground Level										
0.0 410.3	Boulders, cobbles gravel with Sand Trace Silt										
0.6	Weathered Sound		1	RC BXL	89%		410				RQD 0%
	Bedrock Granite		2	RC BXL	94%						RQD 89%
			3	RC BXL	100%		409				RQD 94%
408.3			4	RC BXL	90%						RQD 57%
2.6	End of Borehole						408				

RT ON SOIL EXPLORATION

Ministry of Transportation and Communications
Ontario

RECORD OF BOREHOLE No 7

METRIC

W P 18-77-18 LOCATION STA. 36 + 547.0 °/s 7.3 m Lt. ORIGINATED BY W.D.

DIST 20 HWY 807 BOREHOLE TYPE Washboring, BXL Rock Coring COMPILED BY W.D.

DATUM Geodetic DATE 86 05 29 CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) SHEAR STRENGTH: o UNCONFINED, + FIELD VANE, ● QUICK TRIAXIAL, × 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						
410.9	Creek Water Level										
410.7	Creek Bottom										
0.2	cobbles, and gravel										
0.3	Bedrock Granite Weathered		1	RC BXL	77%		410				RQD 0%
409.8	Sound										
1.1	End of Borehole						409				

RT ON SOIL EXPLORATION

Ministry of Transportation and Communications
Ontario

RECORD OF BOREHOLE No 8

METRIC

W P 18-77-18 LOCATION STA. 36 + 539.3 °/s 6.5 m Rt. ORIGINATED BY W.D.

DIST 20 HWY 807 BOREHOLE TYPE Washboring, BQ Rock Coring COMPILED BY W.D.

DATUM Geodetic DATE 86 05 30 CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) SHEAR STRENGTH (o UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB VANE)	PLASTIC LIMIT Wp / NATURAL MOISTURE CONTENT W / LIQUID LIMIT WL — WATER CONTENT (%)	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES						
411.4	Creek Water Level										
~~411.3~~	~~Creek Bottom~~										
411.1	cobbles, and gravel ~~weathered~~										
0.3	Bedrock ~~Sound~~		1	RC	92%		411				
410.5	Granite			BQ							RQD 50%
0.9	End of Borehole						410				

T ON SOIL EXPLORATION

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 (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

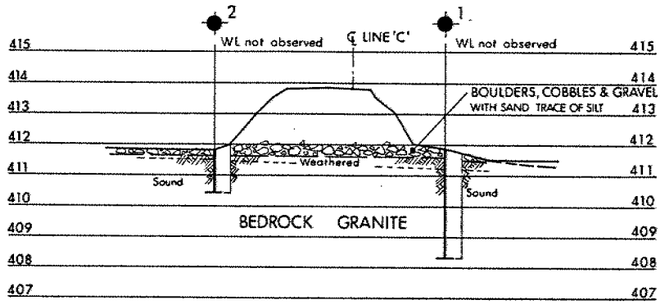
m_v	kPa^{-1}	COEFFICIENT OF VOLUME CHANGE
C_c	1	COMPRESSION INDEX
C_s	1	SWELLING INDEX
C_α	1	RATE OF SECONDARY CONSOLIDATION
c_v	m^2/s	COEFFICIENT OF CONSOLIDATION
H	m	DRAINAGE PATH
T_v	1	TIME FACTOR
U	%	DEGREE OF CONSOLIDATION
σ'_{vo}	kPa	EFFECTIVE OVERBURDEN PRESSURE
σ'_p	kPa	PRECONSOLIDATION PRESSURE
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

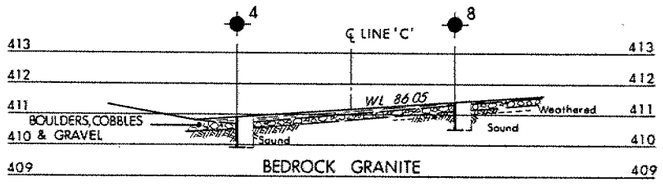
ρ_s	kg/m^3	DENSITY OF SOLID PARTICLES
γ_s	kN/m^3	UNIT WEIGHT OF SOLID PARTICLES
ρ_w	kg/m^3	DENSITY OF WATER
γ_w	kN/m^3	UNIT WEIGHT OF WATER
ρ	kg/m^3	DENSITY OF SOIL
γ	kN/m^3	UNIT WEIGHT OF SOIL
ρ_d	kg/m^3	DENSITY OF DRY SOIL
γ_d	kN/m^3	UNIT WEIGHT OF DRY SOIL
ρ_{sat}	kg/m^3	DENSITY OF SATURATED SOIL
γ_{sat}	kN/m^3	UNIT WEIGHT OF SATURATED SOIL
ρ'	kg/m^3	DENSITY OF SUBMERGED SOIL
γ'	kN/m^3	UNIT WEIGHT OF SUBMERGED SOIL

e	1,%	VOID RATIO
n	1,%	POROSITY
w	1,%	WATER CONTENT
S_r	%	DEGREE OF SATURATION
w_L	%	LIQUID LIMIT
w_p	%	PLASTIC LIMIT
w_s	%	SHRINKAGE LIMIT
I_p	%	PLASTICITY INDEX = $w_L - w_p$
I_L	1	LIQUIDITY INDEX = $\frac{w - w_p}{I_p}$
I_C	1	CONSISTENCY INDEX = $\frac{w_L - w}{I_p}$
e_{max}	1,%	VOID RATIO IN LOOSEST STATE
e_{min}	1,%	VOID RATIO IN DENSEST STATE
I_D	1	DENSITY INDEX = $\frac{e_{max} - e}{e_{max} - e_{min}}$
D	mm	GRAIN DIAMETER
D_n	mm	n PERCENT - DIAMETER
C_U	1	UNIFORMITY COEFFICIENT
h	m	HYDRAULIC HEAD OR POTENTIAL
q	m^3/s	RATE OF DISCHARGE
v	m/s	DISCHARGE VELOCITY
i	1	HYDRAULIC GRADIENT
k	m/s	HYDRAULIC CONDUCTIVITY
j	kN/m^3	SEEPAGE FORCE

MINISTRY OF TRANSPORTATION AND COMMUNICATIONS, ONTARIO PH-D-207 82 04



A-A



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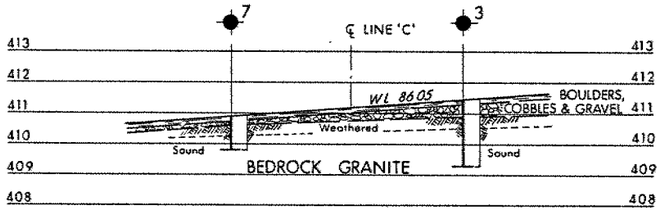

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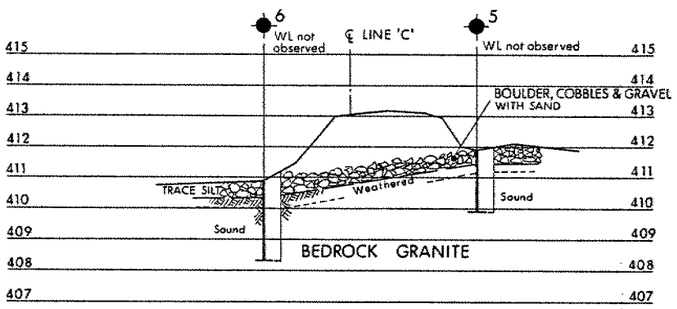


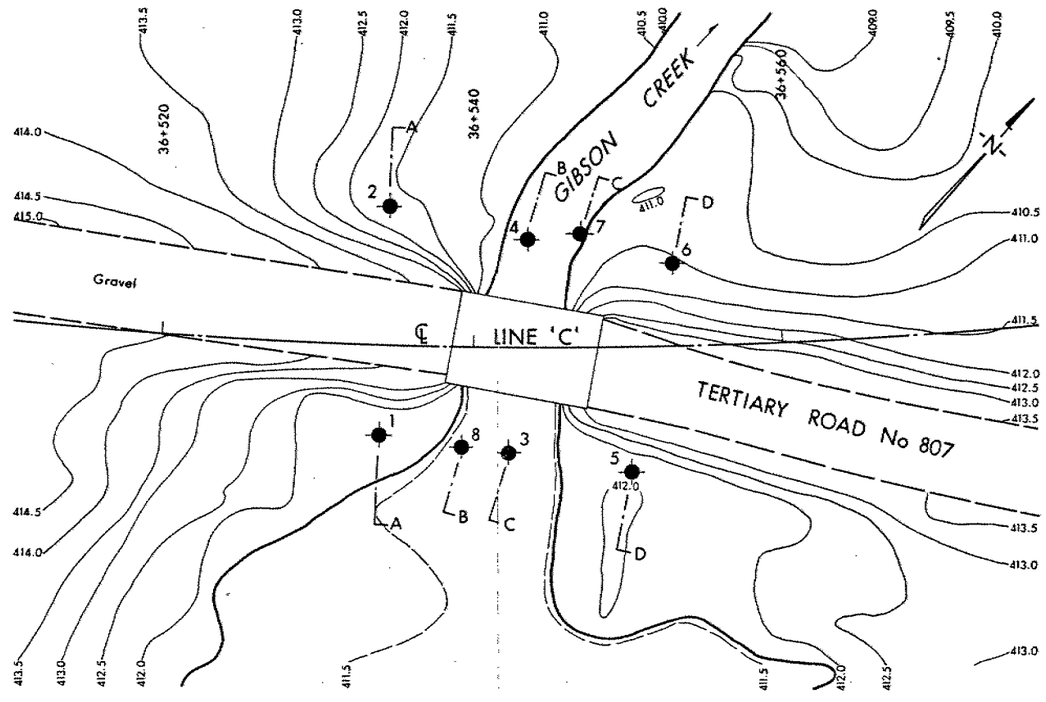
D-D

SECTIONS

SCALE

4m 2 0 4m Hor

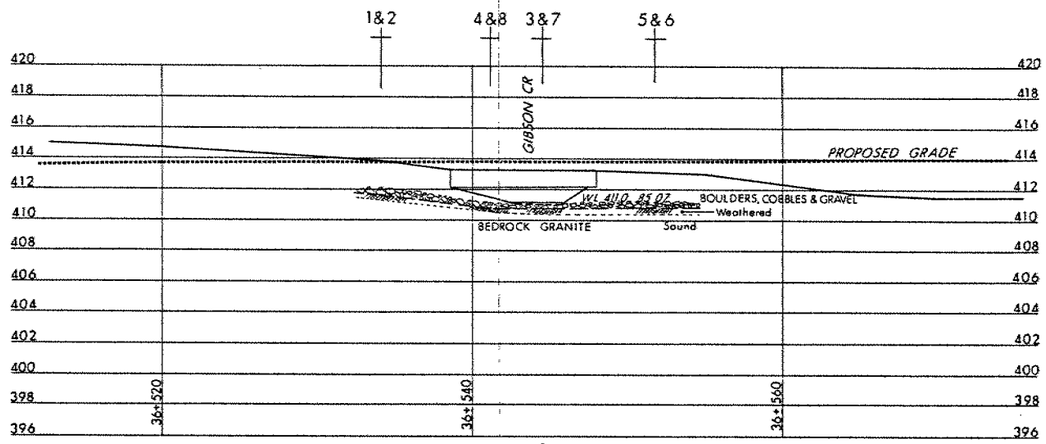
2m 1 0 2m Vert



PLAN

SCALE

4m 2 0 4m



℄ PROFILE LINE 'C'

SCALE

4m 2 0 4m

METRIC

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

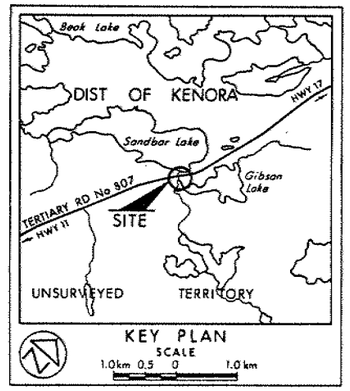
CONT No

WP No 18-77-18

GIBSON CREEK

BORE HOLE LOCATIONS & SOIL STRATA

SHEET



KEY PLAN

SCALE

1.0km 0.5 0 1.0 km

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)
- WL at time of investigation 1986 05
  WL not observed in BHs 1, 2, 5 & 6

No	ELEVATION	STATION	OFFSET
1	411.9	36+534.0	5.9 m RT
2	411.8	36+534.5	9.0 m LT
3	411.5	36+542.3	6.8 m RT
4	410.9	36+543.5	7.0 m LT
5	411.9	36+550.0	8.2 m RT
6	410.9	36+553.1	5.4 m LT
7	410.9	36+547.0	7.3 m LT
8	411.4	36+539.3	6.5 m 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 102-2 of Form 100.

REV.	DATE	BY	DESCRIPTION

Geocres No 52E-21

HWY No TERTIARY RD No 807			DIST 20
SUBM'D WD	CHECKED	DATE 1986 08 12	SITE 41S-133
DRAWN SO	CHECKED	APPROVED	DWG 187718-A

REF No E-8060-1 85 07

DOCUMENT MICROFILMING IDENTIFICATION

G.I.-30 SEPT. 1976

GEOCRES No. 52E-21

DIST. 20 REGION

W.P. No.

CONT. No.

W. O. No. 78-12003

STR. SITE No.

HWY. No. LOC.

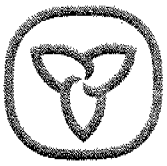
LOCATION 5.0 MILES NORTH OF KENORA - ANDERSON ROAD BRIDGE

No OF PAGES - 2

OVERSIZE DRAWINGS TO BE INCLUDED WITH THIS REPORT.

REMARKS:

FILE COPY



Ontario

Ministry of
Transportation and
Communications

foundation investigation and design report

ENGINEERING MATERIALS OFFICE
SOIL MECHANICS SECTION

WO 78-12003 DIST 20

HWY Mun. STR SITE 41S-26

Anderson Road Bridge

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GEOCRES 52E-21 DATE FEB 28 1979

MUNICIPAL FOUNDATION INVESTIGATION REPORT

For

Anderson Road Bridge
W.O. 78-12003, Site 41S-26
District 20, Kenora

INTRODUCTION

This report contains the results of a foundation investigation which was carried out at the site of the above mentioned project during the period of January 20-24, 1979. The fieldwork was done by utilizing a conventional diamond drilling equipment using NX (3 inch I.D.) and BX (2 3/8 inch I.D.) size casings.

SITE DESCRIPTION

The proposed bridge replacement site is situated at the crossing of Anderson Road and Winnipeg River system, approximately 3.1 miles northwest of the junction of Secondary Hwy. 666 and Anderson Road in the Township of Melick. The junction of Anderson Road and Secondary Hwy. 666 is located some 1.2 miles north of Kenora's Townline. The structure site is located in a relatively steeply sloping (2:1) valley having a width of about 70 feet measured along the existing river water level (elev. 66±). Frequent rock outcrops with a vertical or near vertical face are visible adjacent to the crossing. The immediate vicinity of the site is covered with trees. Residential dwellings in a scattered pattern were observed along Anderson Road.

SUBSURFACE CONDITIONS

In general the overburden in the borings was found to consist of a surficial deposit of organic silt to a maximum thickness of about 5 feet below the existing river bed level. The consistency of this stratum (when it is not frozen) is estimated to be in the very soft state. Below the organic silt, a compact to dense gravelly sand with some silt was encountered to varying depths, the maximum thickness being about 19 feet at the approximate

centre of the valley. Partially weathered, pink coloured, friable, gneiss type bedrock was found to underlie the overburden.

References should be made to the Record of Borehole Sheets and Drawing No. 7812003-A contained in the Appendix of this report for the different subsoil boundaries and also for the locations and elevations of the individual borings. The groundwater is assumed to be the same as the existing river water level at a given time.

DISCUSSION AND RECOMMENDATIONS

General

It is proposed to replace the existing 8 span, approximately 115 foot long single lane timber bridge supported on pile bents. Some of these bents have moved towards the river. The flow in the river is minimal at this location. Design requirements for the structure replacement are as follows:

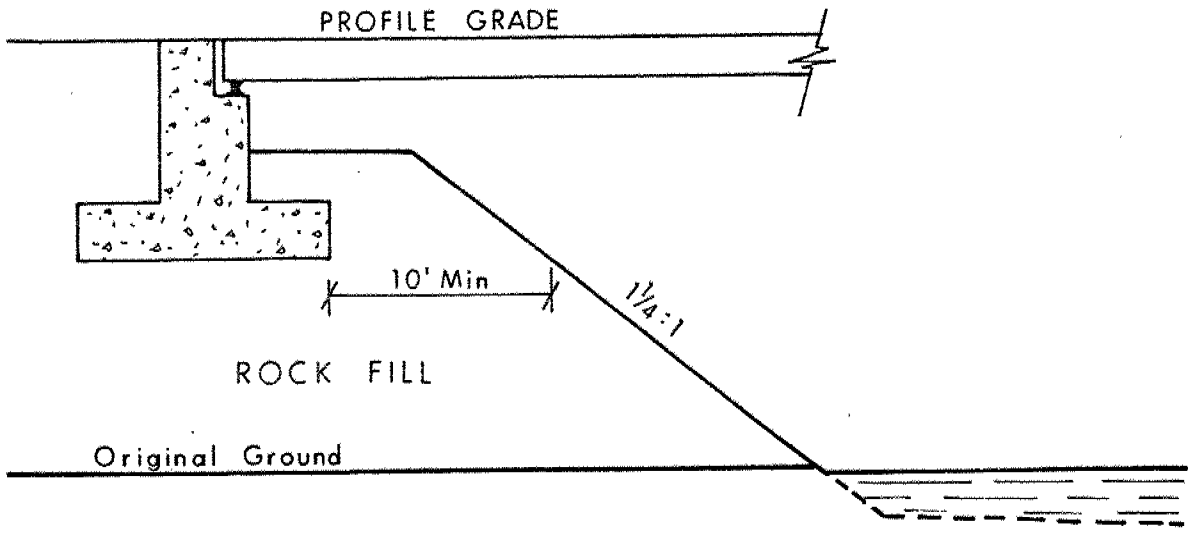
Horizontal Alignment: as existing

Vertical Alignment: Up to 4 feet grade raise over the existing

Navigational Clearance: 6 feet vertical by 8 feet horizontal. The 6 feet vertical clearance should be taken from an average H.W.L. of Elev. 71±.

Structure Foundations

In view of the site conditions and the proposed design criteria, the most practical type of solution appears to be the erection of C.S.P. culvert or culverts. According to the information of Northwestern Region's Structural Section, the Federal Ministry of Transport would not approve the construction of C.S.P. culvert (s). As an alternative, the abutments of the proposed structure may be founded on spread footings placed within rock fill approach embankments. Design pressures up to 2 tsf may be assumed. The footings should be placed so as to have at least 8 feet of cover to provide for frost protection. The rock fill approach embankments should be built initially to profile grade with 1¼:1 side and forward slopes at the structure location, then excavated for the structure foundation as shwon on the sketch below.



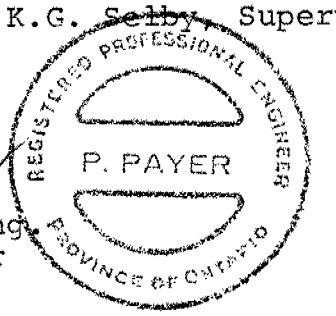
N T S

It would be advantageous to provide for shimming up the bridge deck to accommodate settlements which may occur after completion of the project. The encountered very soft organic silt deposit should be removed from toe to toe and at least 10 feet in front of the forward slopes to its full vertical extent prior to the placement of the rock fill approach embankments.

As a second alternative the abutments may be founded on the bedrock some 10 feet behind the rock face. The footings should be keyed into the bedrock for a minimum distance of about 1 foot. Should a multi-span structure be considered at this location, it is recommended that steel 'H' pile bents be constructed. This will eliminate the dewatering problems which arise if the pile caps would be formed below the prevailing river water level. The steel 'H' piles should be driven to bedrock in which case the maximum allowable load for the particular steel section adopted may be used for design purposes. Due to the steeply sloping nature of the bedrock and the shallow overburden at some locations within the construction area, it is recommended that the piles be fitted with Oslo points (SS3-4) and keyed into the rock to safeguard against sliding.

MISCELLANEOUS

The supervision of the fieldwork, together with the preparation of this report, was carried out by Mr. P. Payer, Senior Engineer. Equipment was owned and operated by Morton and Partners, Ltd., Thunder Bay. The report was reviewed by Mr. K.G. Selby, Supervising Engineer.



P. Payer, P. Eng.
Senior Engineer

K.G. Selby, P. Eng.
Supervising Engineer

APPENDIX

Ministry of Transportation and Communications
Ontario

HIGHWAY ENGINEERING DIVISION - ENGINEERING MATERIALS OFFICE - SOIL MECHANICS SECTION

OFFICE REPORT ON SOIL EXPLORATION

RECORD OF BOREHOLE No 1

W O 78-12003 LOCATION Sta. 13+39; ℄ Anderson Road ORIGINATED BY PP
DIST 20 HWY Loc. BOREHOLE TYPE Washbore-NX Casing COMPILED BY PP
DATUM Assumed DATE January 20-21, 1979 CHECKED BY [illegible]

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES 'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE)	PLASTIC LIMIT Wp / NATURAL MOISTURE CONTENT W / LIQUID LIMIT WL — WATER CONTENT (%)	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
65.9	Ice Level										
0.0 / 62.3	River Bed										
3.6 / 56.9	Organic Silt Very Soft		1	SS	2		60				
9.0	Gravelly Sand Some Silt Compact to Dense		2	SS	33						
			3	SS	18		50				
			4	SS	33						
37.6							40				
28.3	Refusal Probable Bedrock End of Borehole										

RECORD OF BOREHOLE No 2

W O 78-12003 LOCATION Sta. 13+08; ℄ Anderson Road ORIGINATED BY PP
DIST 20 HWY Loc. BOREHOLE TYPE Probehole-NX Casing COMPILED BY PP
DATUM Assumed DATE January 21, 1979 CHECKED BY [illegible]

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES 'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE)	PLASTIC LIMIT Wp / NATURAL MOISTURE CONTENT W / LIQUID LIMIT WL — WATER CONTENT (%)	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
65.8	Ice and Frozen Ground Level										
0.0 / 60.8	Organic Silt (Frozen)						60				
5.0 / 56.1	Gravelly Sand										
9.7	Refusal Probable Bedrock End of Hole										

+3, ×5 : Numbers refer to Sensitivity

20
15 ◇ 5 (%) STRAIN AT FAILURE
10

Ministry of Transportation and Communications
Ontario

HIGHWAY ENGINEERING DIVISION - ENGINEERING MATERIALS OFFICE - SOIL MECHANICS SECTION

OFFICE REPORT ON SOIL EXPLORATION

RECORD OF BOREHOLE No 3

WO 78-12003 LOCATION Sta. 13+70; ℄ Anderson Road ORIGINATED BY PP
DIST 20 HWY Loc. BOREHOLE TYPE Probehole-NX Casing COMPILED BY PP
DATUM Assumed DATE January 21, 1979 CHECKED BY

SOIL PROFILE ELEV/DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES 'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH (○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB VANE)	PLASTIC LIMIT Wp / NATURAL MOISTURE CONTENT W / LIQUID LIMIT WL — WATER CONTENT (%)	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
66.6	Ground (Frozen) Level										
0.0 / 63.6	Organic Silt (Frozen)										
3.0 / 57.1	Gravelly Sand						60				
9.5	Refusal Probable Bedrock End of Hole Note: Water Level Not Established										

RECORD OF BOREHOLE No 4

WO 78-12003 LOCATION Sta. 14+02; o/s 10' Lt. ℄ Anderson Road ORIGINATED BY PP
DIST 20 HWY Loc. BOREHOLE TYPE BXL Rock Coring COMPILED BY PP
DATUM Assumed DATE January 22, 1979 CHECKED BY

SOIL PROFILE ELEV/DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES 'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH (○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB VANE)	PLASTIC LIMIT Wp / NATURAL MOISTURE CONTENT W / LIQUID LIMIT WL — WATER CONTENT (%)	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
77.2	Ground Level										
0.0 / 73.1	Gravelly Sand (Frozen)										
4.1 / 68.2	Gneiss Bedrock Partially Weathered		1	RC BXL	Rec. 75%		70				
			2	RC BXL	Rec. 85%						
9.0	End of Borehole Note: Water Level Not Observed										

+3, ×5 : Numbers refer to Sensitivity

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

Ministry of Transportation and Communications
Ontario

HIGHWAY ENGINEERING DIVISION - ENGINEERING MATERIALS OFFICE - SOIL MECHANICS SECTION

OFFICE REPORT ON SOIL EXPLORATION

RECORD OF BOREHOLE No 5

W O 78-12003 LOCATION Sta. 12+50; o/s 14' Rt. ℄ Anderson Road ORIGINATED BY PP
DIST 20 HWY Loc. BOREHOLE TYPE Rock Coring-BX Casing COMPILED BY PP
DATUM Assumed DATE January 23, 1979 CHECKED BY GP.

SOIL PROFILE ELEV/DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES 'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH (o UNCONFINED, • QUICK TRIAXIAL, + FIELD VANE, × LAB VANE)	PLASTIC LIMIT Wp / NATURAL MOISTURE CONTENT W / LIQUID LIMIT W_L — WATER CONTENT (%)	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
79.9	Ground Level										
0.0	Sand and Organic										
74.6	Recovered 4.8' of Gneiss Bedrock Sound										
5.3	End of Borehole Note: Water Level Not Established Drilled With BX Casing						70				

RECORD OF BOREHOLE No 6

W O 78-12003 LOCATION Sta. 14+12; o/s 11' Rt. ℄ Anderson Road ORIGINATED BY PP
DIST 20 HWY Loc. BOREHOLE TYPE BXL Rock Coring COMPILED BY PP
DATUM Assumed DATE January 23, 1979 CHECKED BY GP.

SOIL PROFILE ELEV/DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES 'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH (o UNCONFINED, • QUICK TRIAXIAL, + FIELD VANE, × LAB VANE)	PLASTIC LIMIT Wp / NATURAL MOISTURE CONTENT W / LIQUID LIMIT W_L — WATER CONTENT (%)	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
78.3	Ground Level										
0.0	Gravelly Sand										
74.1	(Frozen)										
4.2	Gneiss Bedrock		1	RC BXL	Rec. 97%						
70.6	Sound										
7.7	End of Borehole Note: Water Level Not Established						70				

+3, ×5 : Numbers refer to Sensitivity

20
15 ◇ 5 (%) STRAIN AT FAILURE
10

Ministry of Transportation and Communications
Ontario

DIAMOND DRILL RECORD

HOLE NO. _____ SHEET NO. _____

PROPERTY W.O. 78-12003
LOCATION
LATITUDE
DEPARTURE
BEARING

DIP 90°
TOTAL FOOTAGE

ELEV. COLLAR
DATUM
DATE STARTED
DATE COMPLETED
DRILLED BY
LOGGED BY

FOOTAGE FROM	FOOTAGE TO	FORMATION	SAMPLE NUMBER			REMARKS
		Hole #4				
4.1'	9.0'	Gneiss, pink colour, medium texture, hard				lost core 0.9' during #1 run - core broken, joints weathered
		4.1' to 4.7' weathered, friable				
		5.3' to 5.5' weathered, friable				
		6.2' to 7.3' weathered, friable				
		Hole #6				
4.8'	7.7'	Gneiss, pink, hard to medium hard, medium texture, partially weathered, friable				core broken into small sections 2" to 4"

DATE OF EXAMINATION February 1st, 1979

B.K.Glassford

OB-MT-113

EXPLANATION OF TERMS USED IN REPORT

'N' VALUE: AN INDICATOR OF SUBSOIL QUALITY. IT IS OBTAINED FROM THE STANDARD PENETRATION TEST (CSA STD. A119.1). SPT 'N' VALUE IS THE NUMBER OF BLOWS REQUIRED TO CAUSE A STANDARD 2 INCH O.D. SPLIT-BARREL SAMPLER TO PENETRATE 12 INCHES INTO UNDISTURBED GROUND IN A BOREHOLE WHEN DRIVEN BY A HAMMER WEIGHING 140 POUNDS, FALLING FREELY A DISTANCE OF 30 INCHES. FOR PENETRATIONS OF LESS THAN 12 INCHES 'N' VALUES ARE INDICATED AS THE NUMBER OF BLOWS FOR THE PENETRATION ACHIEVED. 'N' VALUES CORRECTED FOR OVERBURDEN PRESSURE ARE DENOTED THUS $\overline{N}$.

DYNAMIC CONE PENETRATION TEST (CSA STD. A119.3): CONTINUOUS PENETRATION OF A CONICAL STEEL POINT (2" O.D. 60 CONE ANGLE) DRIVEN BY 350 FT-LB IMPACTS ON 'A' SIZE DRILL RODS. THE RESISTANCE TO CONE PENETRATION IS MEASURED AS THE NUMBER OF BLOWS FOR EACH 12 INCH ADVANCE OF THE CONICAL POINT INTO THE UNDISTURBED GROUND.

SOIL QUALITY: SOILS ARE DESCRIBED BY THEIR COMPOSITION AND CONSISTENCY OR DENSITY.

CONSISTENCY: COHESIVE SOILS ARE DESCRIBED ON THE BASIS OF THEIR UNDRAINED SHEAR STRENGTH AS FOLLOWS:

S_u (PSF)	0 - 250	250 - 500	500 - 1000	1000 - 2000	2000 - 4000	> 4000
	VERY SOFT	*SOFT*	*FIRM*	*STIFF*	*VERY STIFF*	*HARD*

DENSENESS: COHESIONLESS SOILS ARE DESCRIBED ON THE BASIS OF SPT 'N' VALUES AS FOLLOWS:

'N' (BLOW/FT)	0 - 5	5 - 10	10 - 30	30 - 50	> 50
	VERY LOOSE	*LOOSE*	*COMPACT*	*DENSE*	*VERY DENSE*

ROCK QUALITY: 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 DRILLED IN THAT CORING RUN.

MODIFIED RECOVERY: SUM OF THOSE NATURALLY FRACTURED CORE PIECES, 4"+ 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	2"	2" - 12"	1' - 3'	3' - 10'	> 10'
JOINTING	*VERY CLOSE*	*CLOSE*	*MOD. CLOSE*	*WIDE*	*VERY WIDE*
BEDDING	*VERY THIN*	*THIN*	*MEDIUM*	*THICK*	*VERY THICK*

ABBREVIATIONS & SYMBOLS

LABORATORY TESTING

TRIAXIAL TESTS ARE DESCRIBED IN TERMS OF WHETHER THEY ARE CONSOLIDATED (C) OR NOT (U) ISOTROPICALLY (I) OR NOT (A) AND SHEARED DRAINED (D) OR UNDRAINED (U) WITH PORE PRESSURE MEASUREMENTS (BAR OVER SYMBOLS)
EG. $\overline{CIU}$ = CONSOLIDATED ISOTROPIC UNDRAINED TRIAXIAL WITH PORE PRESSURE MEASUREMENT
UNLESS OTHERWISE SPECIFIED IN REPORT ALL TESTS ARE IN COMPRESSION

FIELD SAMPLING

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

EARTH PRESSURE TERMS

μ	COEFFICIENT OF FRICTION
δ	ANGLE OF WALL FRICTION
k_o	COEFFICIENT OF EARTH PRESSURE AT REST
k_A	COEFFICIENT OF ACTIVE EARTH PRESSURE
k_p	COEFFICIENT OF PASSIVE EARTH PRESSURE
i	ANGLE OF INCLINATION OF SURCHARGE
w	SLOPE ANGLE-BACKFACE OF WALL
β	ANGLE OF SLOPE
N_γ, N_q, N_c	BEARING CAPACITY FACTORS
D_f	DEPTH OF FOOTING
B,L	FOOTING DIMENSIONS

INDEX PROPERTIES

γ	UNIT WEIGHT OF SOIL (BULK DENSITY)
γ_w	UNIT WEIGHT OF WATER
γ_d	UNIT DRY WEIGHT OF SOIL (DRY DENSITY)
γ'	UNIT WEIGHT OF SUBMERGED SOIL
G_s	SPECIFIC GRAVITY OF SOLIDS
e	VOIDS RATIO
e_o	INITIAL VOIDS RATIO
e_{max}	e IN LOOSEST STATE
e_{min}	e IN DENSEST STATE
D_r	RELATIVE DENSITY = $\frac{e_{max} - e}{e_{max} - e_{min}}$
n	POROSITY
w	WATER CONTENT
w_L	LIQUID LIMIT
w_p	PLASTIC LIMIT
w_s	SHRINKAGE LIMIT
I_p	PLASTICITY INDEX = $w_L - w_p$
I_L	LIQUIDITY INDEX = $\frac{w - w_p}{I_p}$
I_c	CONSISTENCY INDEX = $\frac{w_L - w}{I_p}$
A_c	ACTIVITY = $\frac{I_p \text{ of soil}}{\%< 2\mu m \text{ Soil Fraction}}$
Om	ORGANIC MATTER CONTENT
S_r	DEGREE OF SATURATION
S	SENSITIVITY = $\frac{S_u \text{ (undisturbed)}}{S_u \text{ (remoulded)}}$

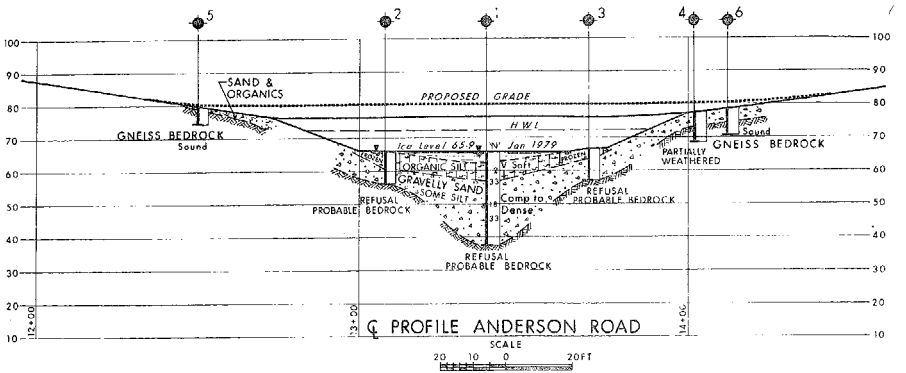
STRENGTH PARAMETERS

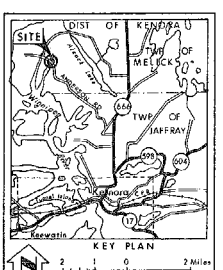
ϕ	ANGLE OF SHEARING RESISTANCE
τ_f	PEAK SHEAR STRENGTH
τ_R	RESIDUAL SHEAR STRENGTH
c	COHESION INTERCEPT
$\sigma_1, \sigma_2, \sigma_3$	NORMAL PRINCIPAL STRESSES
u	PORE WATER PRESSURE
u_e	EXCESS u
r_u	PORE PRESSURE RATIO
q_u	UNCONFINED COMPRESSIVE STRENGTH
s_u	UNDRAINED SHEAR STRENGTH
ϵ	LINEAR STRAIN
γ	SHEAR STRAIN
ν	POISSON'S RATIO
E	MODULUS OF ELASTICITY
G	MODULUS OF SHEAR DEFORMATION
k_s	MODULUS OF SUBGRADE REACTION
m,n	STABILITY COEFFICIENTS
A,B	PORE PRESSURE COEFFICIENTS

NOTE: EFFECTIVE STRESS PARAMETERS ARE DENOTED BY USE OF APOSTROPHE ABOVE THE SYMBOL, THUS: ϕ' = EFFECTIVE ANGLE OF SHEARING RESISTANCE; σ' = EFFECTIVE NORMAL STRESS

HYDRAULIC TERMS

h	HYDRAULIC HEAD OR POTENTIAL
q	RATE OF DISCHARGE
v	VELOCITY OF FLOW
i	HYDRAULIC GRADIENT
j	SEEPAGE FORCE PER UNIT VOLUME
η	COEFFICIENT OF VISCOSITY
k	COEFFICIENT OF HYDRAULIC CONDUCTIVITY
k_h	k IN HORIZONTAL DIRECTION
k_v	k IN VERTICAL DIRECTION
m_v	COEFFICIENT OF VOLUME CHANGE
c_v	COEFFICIENT OF CONSOLIDATION
C_c	COMPRESSION INDEX
C_r	RECOMPRESSION INDEX
d	DRAINAGE PATH DISTANCE
T_v	TIME FACTOR
U	DEGREE OF CONSOLIDATION
OCR	OVERCONSOLIDATION RATIO (OCR)





NOTE:

BENCH MARK ORIGIN
ASSUMED B.M.#1, ELEVATION 100-00
PAINT MARK ON ROCK; STA 0+17, 9/3 32' RT

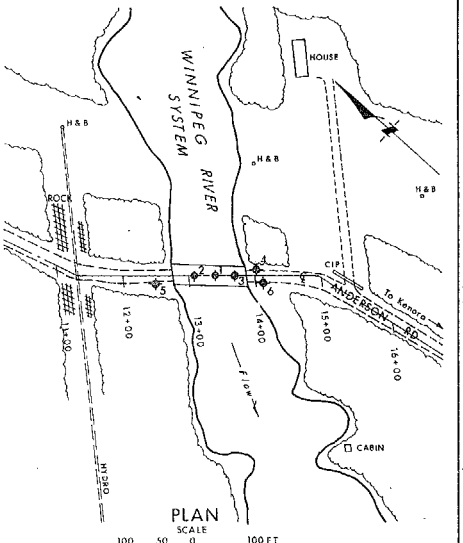
ASSUMED B.M.#2, ELEVATION 76-55
PAINT MARK ON ROCK; STA 12+73, 0/5 20' RT

LEGEND

Bore Hole

WATER LEVEL NOT OBSERVED in BH°3, 4, 5 & 6

No	ELEVATION	STATION	OFFSET
1	65·9	13+35	℄
2	65·8	13+08	℄
3	66·6	13+70	℄
4	77·2	14+02	10' LT
5	79·9	12+50	14' RT
6	78·3	14+12	11' RT



Geocres No 52E-21

Ministry of Transportation and Communications
Ontario

ANDERSON RD & WINNIPEG RIVER SYSTEM

DIST OF KENORA - MUN OF JAFFRAY & MELICK - TWP OF MELICK
CON T LOT 17 SITE 41S-26 DIST 20

DATE Feb 12, 1979 | WO 78-12003 | Dwg No 7812003-A