

SAMPLE DISPOSITION NOTICE		
TYPE	DISCARD AFTER	RECOMM. BY
JARS	79-12-20	Wes
TUBES	79-12-20	Wes
ROCK CORES	79-12-20	Wes

ENGINEERING MATERIALS OFFICE
PAVEMENT & FOUNDATION DESIGN SECTION

WP 1-75-06 DIST 20
HWY Sec.Hwy.542 STR SITE 41S-118
Marchington Lake Road, Line 'D'
Marchington River Structure

DISTRIBUTION

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APPENDIX

FOUNDATION INVESTIGATION REPORT
FOR

Marchington Lake Road, Line 'D'
Marchington River Structure
41 km North of Sec. Hwy. #542
W.P. 1-75-06, Site 41S-118
District #20, Kenora, Ontario

INTRODUCTION

This report contains the results of the foundation investigation carried out at the above mentioned site. The field work which consisted of four sampled boreholes and six Dynamic Cone Penetration tests was carried out during the period of 79-09-27 to 79-10-15. The boreholes were advanced with conventional Diamond Drilling equipment adapted for soil sampling purposes using NX (76.2 mm I.D.) casing. For borings located in the river the aforementioned Diamond Drill was mounted on a raft. A Continuous Flight Auger machine mounted on a muskeg vehicle and equipped with 82 mm I.D. Hollow Stem Augers was utilized to drill Borehole #1.

SITE DESCRIPTION

The site is located at the crossing of the proposed realigned and upgraded Marchington Lake Road Line 'D' and Marchington River, some 41 km North of Sec. Hwy. #542. The nearest settlement is the Town of Sioux Lookout. The surrounding terrain is undulating and bush covered. The vegetation consists of Birch and Evergreen (spruce) species. At the present time, a road side park and a boat launch is situated at the west end of the proposed structure. Rock outcrops are visible north of the site. The width of the river along the proposed alignment is about 40 metres and up to 5 metres in depth. The direction of the flow is from north to south.

SUBSURFACE CONDITIONS

Apart from the surficial topsoil and organics east of the river and the bouldery sand and gravel fill material on the west side, the subsoil at this site was found to consist of silty clay and slightly plastic silt followed by bedrock. In Borehole #4 an approx. 0.8 m thick sand layer was observed below the silt zone. The depths of the different soil types vary. Reference should be made to the Record of Borehole Sheets which are contained in the Appendix of this report. The sheets contain the extent and the descriptions of the soil and bedrock types encountered and also, in summarized form, the results of all field and laboratory tests performed.

The stratigraphical profile shown on Drawing No. 17506-A is based on this information. The drawing also shows the locations and elevations of the borings. Detailed description of the various strata are given below.

Bouldery Sand and Gravel - Fill Material

This fill material, consisting of sand, gravel and boulders was placed on the original subsoil to provide access to the boat launch ramp. The thickness is in the order of 0.5 m.

Topsoil

A shallow layer of topsoil (0.5 m) was encountered at ground level on the east side of the river at the proposed structure and approach location. The material consists of silt, sand with decayed and undecayed organic substances. The colour of the deposit is dark brown to black.

Stratified Silty Clay, Trace of Sand

Beneath the above described surficial deposits of fill material and topsoil is a stratum consisting of alternating layers of clays having low and intermediate plasticity. Overall, the deposit ranged in thickness from 1.2 to 3.5 metres with the individual layers varying from 4 to 20 mm in thickness.

Physical properties of the material as determined from field and laboratory tests are summarized as follows:

	<u>Range:</u>
Natural Moisture Content (%)	18 - 32
Liquid Limit (%)	17 - 43
Plastic Limit (%)	16 - 19
Bulk Density (t/m^3)	1.92 - 1.99
Undrained Shear Strength (kPa)	
Unconfined	48 - 64
Field Vane	17 - 65
Sensitivity	2 - 7

Grain size distribution curves are presented on Figure 1 of the Appendix.

The consistency of the overall deposit may be described as soft to stiff. For design purposes an undrained shear strength value (C_u) of 30 kPa is recommended.

Silt Traces of Sand and Clay

Below the silty clay stratum a deposit of slightly plastic silt was found in every borehole. The thickness of this silt zone varied from 0.5 to 5.5 metres. The material is composed of silt, traces of sand and clay. The natural moisture is in the order of 23%. The results of the grain size distribution tests are plotted on Figure 2 of the Appendix.

Standard Penetration Tests 'N' values ranged from 4 to 10 blows per 0.3 m.

Sand Trace of Silt

An approx. 0.8 m thick layer of loose sand with traces of silt was encountered below the silt layer in Borehole #4.

Bedrock

Very hard granite and Gneiss bedrock was encountered at the following elevations:

B.H. #1	EL. 363.9
" #2	EL. 363.1
" #3	EL. 368.8
" #4	EL. 368.4

Refer to the Diamond Drill Record Sheet for a complete description of the rock cores obtained.

Groundwater Conditions

The groundwater level was observed by measuring in the open boreholes after completion of the investigation. The water level in Marchington River at the time of the investigation was at elevation 370.5. The groundwater level was found to vary from EL. 367.2 to EL. 370.0. The groundwater levels are shown on the Record of Borehole Sheets, as well as on Drawing No. 17506-A.

DISCUSSION AND RECOMMENDATIONS

General

As part of the reconstruction of Marchington Lake Road on a new alignment a structure will be required to cross Marchington River. At this time, a three-span (20 m - 40 m - 20 m) structure is proposed by the Regional Structural Section.

The proposed profile grade of Marchington Lake Road at the west end of the structure is set at EL. 375.5 and on the east side is at EL. 376.0, thus necessitating the construction of approach fills 2 m and 2.5 m respectively.

The borings have indicated that the overburden consists of up to 9.5 m stratified silty clay and silt, followed by sound bedrock at various elevations.

Structure Foundations

Due to the overburden conditions and the position of the bedrock observed at this location it is necessary to found the proposed structure differently from the west portion to the east.

West Portion (Abutment and Pier)

The encountered subsoil conditions (low bearing capacity and settlement considerations) do not favour spread footing type foundations. Also, the relatively deep bedrock and position of the ground and river water levels would make it economically unfeasible. Therefore a piled foundation is recommended for this portion of the proposed structure. The best solution appears to found the abutment and pier on end bearing piles driven to bedrock (EL. 363 - EL. 364). For steel tubes, 323.9 mm O.D. @ 49.73 kg/m or HP 310 x 110 Steel 'H' piles with reinforced tips, the maximum permissible load is 1100 kN. If tube piles are selected, it is recommended that the driving energy for final 2 metres does not exceed 40 000 Joules/blow, to prevent pile damage on contact with bedrock. A suitable

note should be provided on the design drawings. The pile caps should be protected against frost action with a minimum of 2.6 m of earth cover.

East Portion (Abutment and Pier)

At this side, the surface of the competent granite and Gneiss bedrock is at a relatively shallow depth. Therefore, it is recommended that the abutment and pier be founded on spread footings placed on the sound bedrock. Safe pressures up to 5000 kPa may be used for design purposes.

Approach Embankments

Fills up to 2.5 m are required to attain the proposed profile grade of Marchington Lake Road at this crossing. No stability problems are anticipated for fills of this height provided 2:1 slopes are constructed. The fill should consist of well compacted acceptable materials. Care should be taken to ensure that no material larger than 50 mm is placed at locations where piles may have to be driven.

The settlement of the subsoil, caused by the superimposed 2.5 m high fill, is estimated to be in the order of 100 mm and will take place over a long period of time.

OTHER CONSIDERATIONS

If excavations are below the water level, a dewatering scheme will be required to form the pile caps and to place the concrete for the spread footings in dry.

The removal of the topsoil and soft surficial organic material should be in accordance with current MTC practices and standards.

In order to prevent the pile tips from damages it is recommended that the encountered surficial bouldery sand and gravel fill material on the west side be removed to its full vertical and horizontal extent within the confines of the proposed footings.

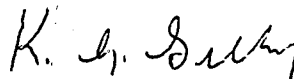
MISCELLANEOUS

The field work for this investigation was carried out under the supervision of Mr. R. Riske, Student Technician. The rock cores were examined by Mrs. Z. Koniuszy, Geologist. This report was written by Mr. P. Payer and reviewed by Mr. K.G. Selby.

The equipment used was owned and operated by Morton and Partners Ltd. from Thunder Bay, Ontario.

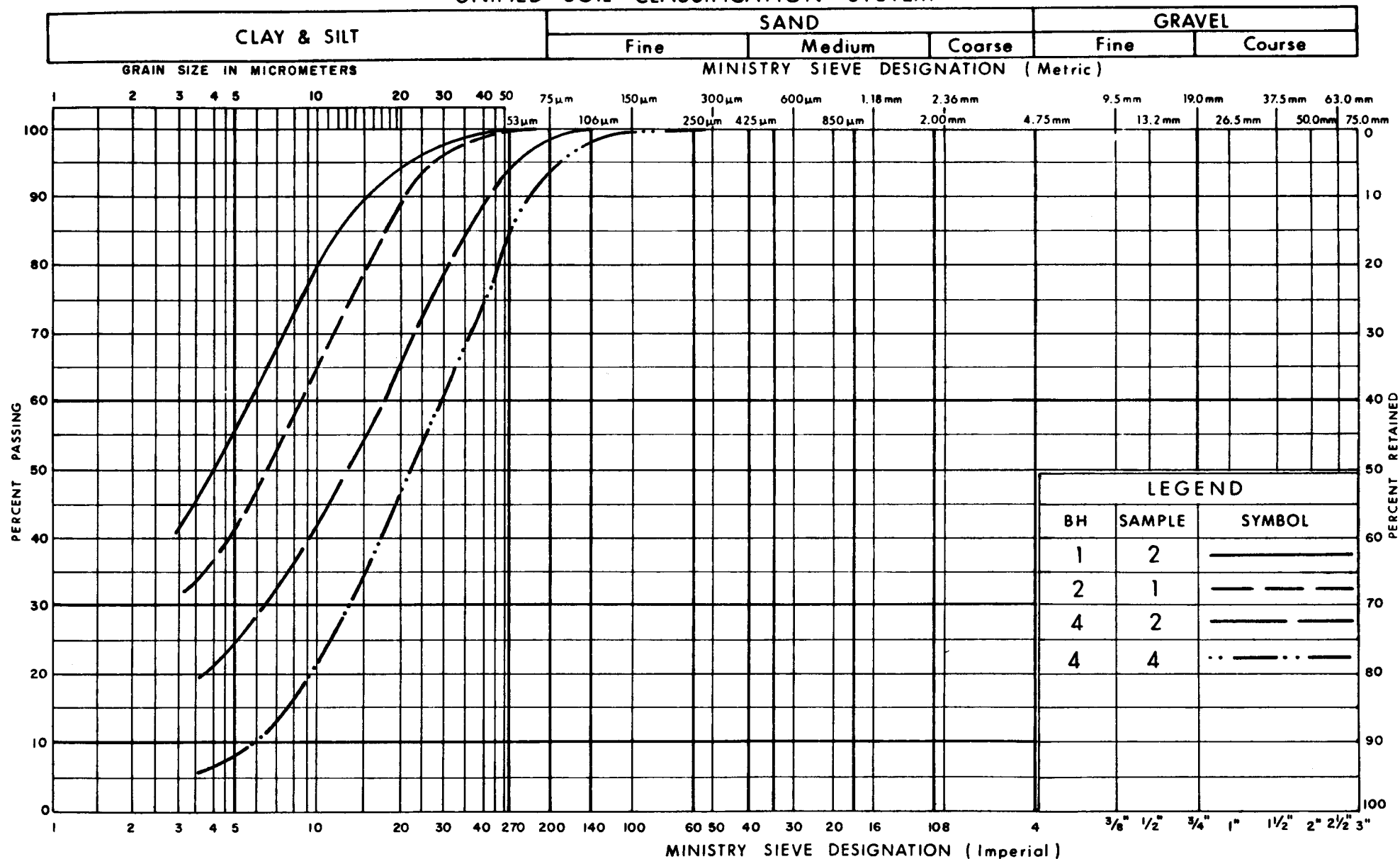


P. Payer, P. Eng.
Foundations Engineer



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

UNIFIED SOIL CLASSIFICATION SYSTEM



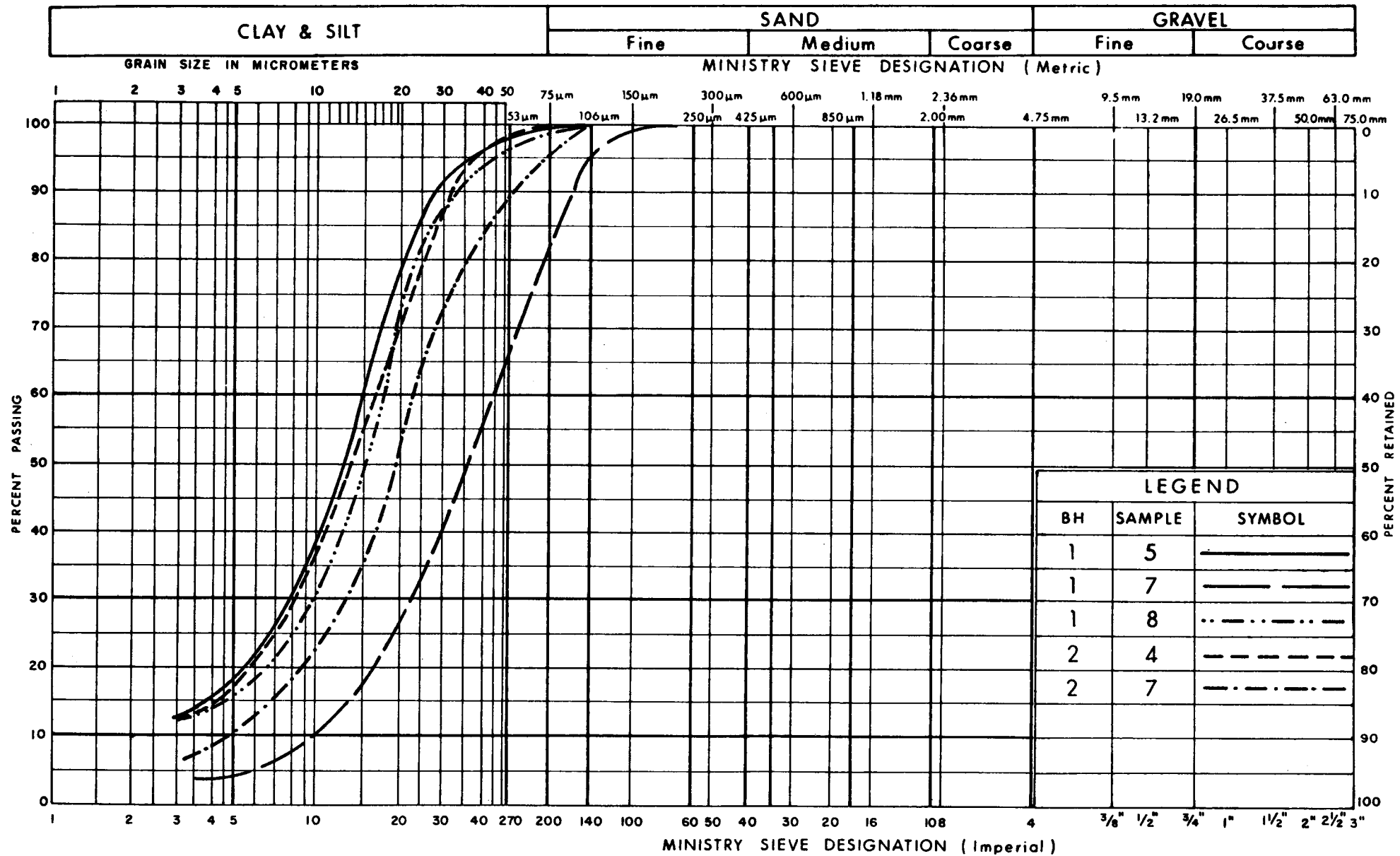
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**GRAIN SIZE DISTRIBUTION
STRATIFIED SILTY CLAY
TRACE OF SAND**

FIG No 1

W P 1-75-06

UNIFIED SOIL CLASSIFICATION SYSTEM



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GRAIN SIZE DISTRIBUTION
SILT
TRACE OF SAND & CLAY

FIG No 2

W P 1-75-06



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HIGHWAY ENGINEERING DIVISION-ENGINEERING MATERIALS OFFICE-SOIL MECHANICS SECTION

RECORD OF BOREHOLE No 1

METRIC

W P 1-75-06 LOCATION 10-470, E ORIGINATED BY RR
DIST 20 HWY Acc. Rd. BOREHOLE TYPE Hollow Stem Augers, BX Rock Core and Cone Test COMPILED BY RR
DATUM Geodetic DATE 79 09 27 CHECKED BY _____

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	NUMBER	TYPE	'N' VALUES								
373.3	Ground Level											
0.0	Sa. & Gr. Fill material											
0.5	Silty clay Trace of sand Stratified Firm Grey - Brown	1	SS	9								
		2	SS	9								
		3	Tw	PH								
		4	SS	3								
369.3												
4.0	Silt Some sand Trace of clay Loose Grey coloured	5	SS	4								
		6	SS	8								
		7	SS	7								
		8	SS	9								
363.8		9	SS	0								
9.5	Granite bedrock Sound	10	BX RC	90% REC								
362.3												
11.0	End of Borehole											

+3, x5: Numbers refer to
Sensitivity

20
15
10
5 (%) STRAIN AT FAILURE

OFFICE REPORT ON SOIL EXPLORATION



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HIGHWAY ENGINEERING DIVISION-ENGINEERING MATERIALS OFFICE-SOIL MECHANICS SECTION

RECORD OF BOREHOLE No 2

METRIC

W P I-75-06 LOCATION 10490, E ORIGINATED BY RR
DIST 20 HWY Acc. Rd. BOREHOLE TYPE NW Casing and BX Rock Core COMPILED BY RR
DATUM Geodetic DATE 79 09 29 CHECKED BY _____

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										WATER CONTENT (%)		
								○ UNCONFINED		+ FIELD VANE		● QUICK TRIAXIAL						x LAB VANE		
								20	40	60	80	100								
370.6	Ground Level																			
0.0	Sa. & Gr. Fill material																			
0.3	Silty clay Trace of sand Stratified Soft to firm Grey coloured		1	SS	2												0 0 72 28			
			2	TW	PM															
367.6			3	SS	7															
3.0	Silt Traces of sand and clay Loose Grey coloured		4	SS	10												0 1 89 10			
			5	SS	9															
			6	SS	7												0 4 92 4			
			7	SS	8															
			8	SS	5															
363.1			9	BX RC	80% REC															
7.50	Granite bedrock Sound																			
361.6																				
9.00	End of Borehole																			

+3, x5: Numbers refer to Sensitivity

20
15
10
5 (%) STRAIN AT FAILURE

OFFICE REPORT ON SOIL EXPLORATION



RECORD OF BOREHOLE No 2A										METRIC			
W P		1-75-06		LOCATION		10+494.6, E		ORIGINATED BY		RR			
DIST		20		HWY		Acc. Rd.		BOREHOLE TYPE		Cone Test Only			
DUM		Geodetic		DATE		79 10 01		COMPILED BY		RR			
								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 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								
370.4	River Water Level												
369.8	Water River Bottom												
0.6	Probable silty clay and silt												
360.6													
9.78	End of Cone Test Probable bedrock												

+³, x⁵: Numbers refer to
Sensitivity

20
15
10
5 (%) STRAIN AT FAILURE

OFFICE REPORT ON SOIL EXPLORATION



METRIC

W P 1-75-06 LOCATION 10+530, E ORIGINATED BY RR
DIST 20 HWY Acc. Rd. BOREHOLE TYPE NW Casing and BX Rock Core COMPILED BY RR
DATUM Geodetic DATE 79 10 02 CHECKED BY _____

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT	PLASTIC LIMIT	NATURAL MOISTURE CONTENT	LIQUID LIMIT	UNIT WEIGHT Y	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100	W _p	W	W _L		
								SHEAR STRENGTH					
								○ UNCONFINED + FIELD VANE					
								● QUICK TRIAXIAL x LAB VANE					
370.5	Ground Level												
0.0	Topsoil												
369.1	Silty clay . Trace of sand. Firm		1	SS	7								
368.7	Silt - Loose		2	SS	157.08								
1.8	Granite bedrock Sound		3	BX RC	100% REC								
			4	BX RC	71% REC								
365.8			5	BX RC	100% REC								
4.7	End of Borehole			RC	REC								

+3, x5 : Numbers refer to Sensitivity

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

OFFICE REPORT ON SOIL EXPLORATION

RECORD OF BOREHOLE No 3A

METRIC

W P 1-75-06 LOCATION 10+525, E ORIGINATED BY RR
 DIST 20 HWY Acc.Rd. BOREHOLE TYPE Cone Test Only COMPILED BY RR
 DATUM Geodetic DATE 79 10 01 CHECKED BY

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			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	Wp	W	W _L		
370.4	River Water Level												
369.8	Water River Bottom												
0.60	Probable silty clay and silt												
367.2													
3.20	End of Cone Test Probable bedrock												

OFFICE REPORT ON SOIL EXPLORATION

RECORD OF BOREHOLE No 3B

METRIC

W P 1-75-06 LOCATION 10+532, E ORIGINATED BY RR
DIST 20 HWY Acc.Rd. BOREHOLE TYPE Cone Test Only COMPILED BY RR
DATUM Geodetic DATE 79 10 15 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 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						
370.9	Ground Level										
0.0	Probable silty clay and silt						370				
368.7							368				
2.20	End of Cone Test Probable bedrock								120/0.5m		

OFFICE REPORT ON SOIL EXPLORATION

RECORD OF BOREHOLE No 4

METRIC

W P 1-75-06 LOCATION 10+550 E ORIGINATED BY RR
 DIST 20 HWY Acc. Rd. BOREHOLE TYPE NW Casing, AXL Rock Core COMPILED BY RR
 DATUM Geodetic DATE 1979 10 14 CHECKED BY _____

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE			20	40	60	80	100		
373.5	Ground Level												
0.0	Topsoil - Organics												
0.5	Silty clay		1	TW	PH							1.92	
	Trace of sand												
	Stratified		2	SS	17								
371.3	Stiff												
2.2	Silt		3	SS	16								0 1 87 12
	Traces of sand and		4	SS	10								
	clay												
	Loose		5	SS	10								0 6 90 4
369.1													
4.4	Sand - Loose		6	SS	10								
368.4													
5.1	Gneiss bedrock		8	AXL	94% RC REC								0 98 2
	Sound		9	AXL	100% RC REC								
365.4			10	AXL	100% RC REC								
8.1	End of Borehole												

+3, x5: Numbers refer to
Sensitivity

20
15
10
5 (%) STRAIN AT FAILURE

OFFICE REPORT ON SOIL EXPLORATION



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HIGHWAY ENGINEERING DIVISION-ENGINEERING MATERIALS OFFICE-SOIL MECHANICS SECTION

RECORD OF BOREHOLE No 4A												METRIC		
W P		1-75-06		LOCATION		10+548, E		ORIGINATED BY		RR				
DIST		20 HWY Acc. Rd.		BOREHOLE TYPE		Cone Test Only		COMPILED BY		RR				
DATUM		Geodetic		DATE		1979 10 14		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 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									
373.3	Ground Level													
0.0	Probable silty clay and silt						370							
							368							
366.3							366							
5.0	End of Cone Test Probable bedrock								120/	.15m				

+³, x⁵: Numbers refer to
Sensitivity

20
15
10
5 (%) STRAIN AT FAILURE

OFFICE REPORT ON SOIL EXPLORATION

RECORD OF BOREHOLE No 4B

METRIC

W P 1-75-06 LOCATION 10+552 o/s .8m N E ORIGINATED BY RR
 DIST 20 HWY Acc. Rd. BOREHOLE TYPE Cone Test Only COMPILED BY RR
 DATUM Geodetic DATE 1979 10 15 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 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						
373.6	Ground Level										
0.0	Probable silty clay and silt						370				
							368				
							366				
368.2	End of Cone Test							120/	.18m		
5.4	Probable bedrock										

OFFICE REPORT ON SOIL EXPLORATION

+³, x⁵: Numbers refer to Sensitivity

20
15 ϕ 5 (%) STRAIN AT FAILURE
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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

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

STRESS AND STRAIN

u_w	kPa	PORE WATER PRESSURE
r_u	1	PORE PRESSURE RATIO
σ	kPa	TOTAL NORMAL STRESS
σ'	kPa	EFFECTIVE NORMAL STRESS
τ	kPa	SHEAR STRESS
$\sigma_1, \sigma_2, \sigma_3$	kPa	PRINCIPAL STRESSES
ϵ	%	LINEAR STRAIN
$\epsilon_1, \epsilon_2, \epsilon_3$	%	PRINCIPAL STRAINS
E	kPa	MODULUS OF LINEAR DEFORMATION
G	kPa	MODULUS OF SHEAR DEFORMATION
μ	1	COEFFICIENT OF FRICTION

PHYSICAL PROPERTIES OF SOIL

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

METRIC

NOTE: DIMENSIONS ARE IN METERS
AND/OR MILLIMETERS UNLESS
OTHERWISE SHOWN. STATIONS
IN KILOMETERS + METERS

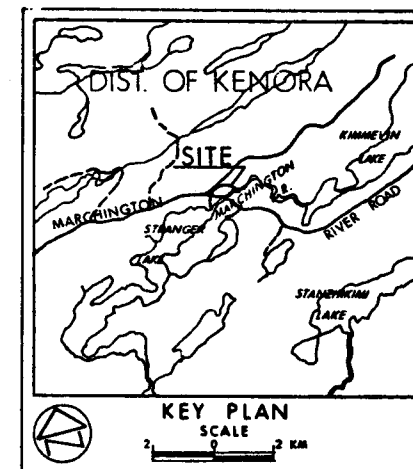
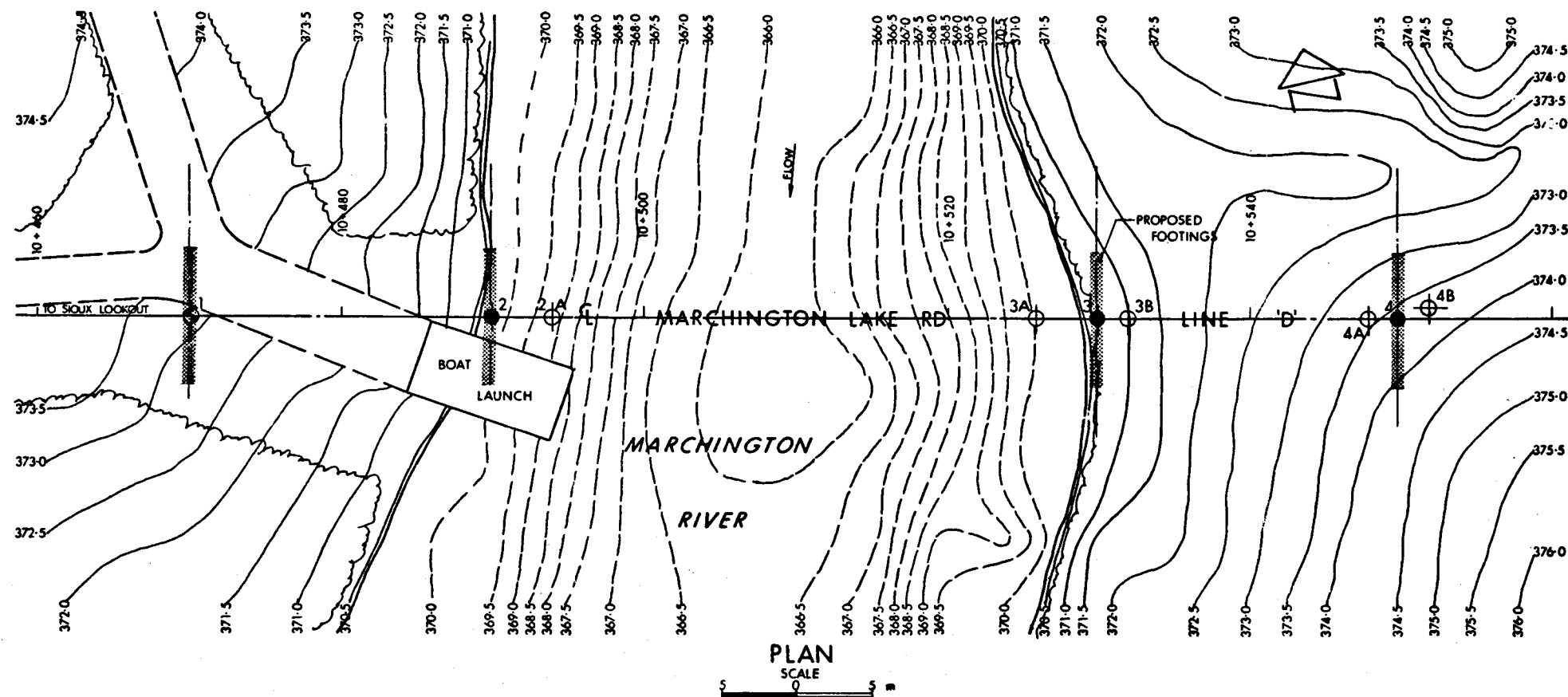
CONT No
WP No 1-75-06

MARCHINGTON LAKE RD. &
MARCHINGTON RIVER STRUCTURE

BORE HOLE LOCATIONS & SOIL STRATA

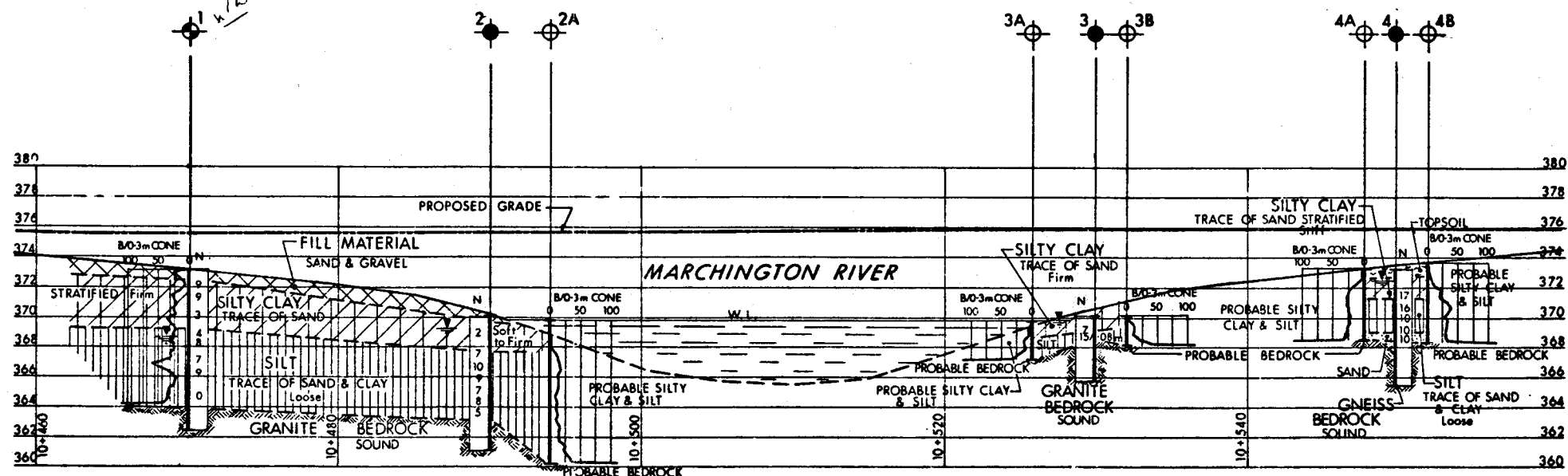


SHEET



LEGEND

- ◆ Bore Hole
- ⊕ Dynamic Cone Penetration Test (Cone)
- ⊕ Bore Hole & Cone
- N Blows/0.3m (Std Pen Test, 475 J/blow)
- CONE Blows/0.3m (60° Cone, 475 J/blow)
- W L at time of investigation 79 09 29



PROFILE MARCHINGTON RD. LINE 'D'

No	ELEVATION	STATION	OFFSET
1	373.3	10+470.0	℄
2	370.6	10+490.0	℄
2A	370.4	10+494.6	℄
3	370.5	10+530.0	℄
3A	370.4	10+526.0	℄
3B	370.9	10+532.0	℄
4	373.5	10+550.0	℄
4A	373.3	10+548.0	℄
4B	373.6	10+552.0	0.8 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.

REVISIONS	DATE	BY	DESCRIPTION

Geocres No 521-6

HWY No MARCHINGTON RD	DIST 20
SUBMD F. P. CHECKED DATE 79 12 05	SITE
DRAWNO J. CHECKED	DWG 17506-A

FOUNDATION INVESTIGATION REPORT

CONTRACT NO 82-459



Ministry of
Transportation and
Communications



INDEX

<u>Page No.</u>	<u>Description</u>
1	Index
2	Abbreviations & Symbols
3	Soil Classification System
4-19	Foundation Investigation Report Marchington Lake Road, Line 'D' (Highway 516) W.P. 1-75-06

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.

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
U		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		COEFFICIENT OF FRICTION

MECHANICAL PROPERTIES OF SOIL

m_v	kPa ⁻¹	COEFFICIENT OF VOLUME CHANGE
C_c		COMPRESSION INDEX
C_s		SWELLING INDEX
C_α		RATE OF SECONDARY CONSOLIDATION
c_v	m ² /s	COEFFICIENT OF CONSOLIDATION
H	m	DRAINAGE PATH
T_v		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		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		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		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		LIQUIDITY INDEX = $\frac{w - w_p}{I_p}$	i		HYDRAULIC GRADIENT
γ_{sat}	kN/m ³	UNIT WEIGHT OF SATURATED SOIL	I_C		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						

EXTENDED CASAGRANDE SOIL CLASSIFICATION SYSTEM

EXTENDED CASAGRANDE SOIL CLASSIFICATION SYSTEM										
FIELD IDENTIFICATION PROCEDURES (EXCLUDING PARTICLES LARGER THAN 75mm (3 INCHES) AND BASED ON FRACTIONS ON ESTIMATED MASS)					GRP SYMP	TYPICAL NAMES	INFORMATION REQUIRED FOR DESCRIBING SOILS	LABORATORY CLASSIFICATION CRITERIA		
COARSE GRAINED SOILS MORE THAN HALF OF MATERIAL IS LARGER THAN 75µm (NO. 200 SIEVE SIZE) (MORE THAN HALF OF MATERIAL IS LARGER THAN 75µm (NO. 200 SIEVE SIZE) TO THE NAKED EYE)	GRAVELS MORE THAN HALF OF COARSE FRACTION IS LARGER THAN 5mm (NO. 4 SIEVE)	CLEAN GRAVELS (LITTLE OR NO FINES)	WIDE RANGE IN GRAIN SIZE & SUBSTANTIAL AMOUNTS OF ALL INTERMEDIATE PARTICLE SIZE		GW	WELL GRADED GRAVELS, GRAVEL-SAND MIXTURES, LITTLE OR NO FINES.	GIVE TYPE NAME, IF NECESSARY, INDICATE APPROX. % OF SAND & GRAVEL, MAX. SIZE, ANGULARITY, SURFACE CONDITION, & HARDNESS OF THE COARSE GRAINS; LOCAL OR GEOLOGIC NAME & OTHER PERTINENT DESCRIPTIVE INFORMATION, & SYMBOL IN PARENTHESIS. FOR UNDISTURBED SOILS ADD INFORMATION ON STRATIFICATION, DEGREE OF COMPACTNESS, CEMENTATION, MOISTURE CONDITIONS & DRAINAGE CHARACTERISTICS.	USE GRAIN SIZE CURVE IN IDENTIFYING THE FRACTIONS AS GIVEN UNDER FIELD IDENTIFICATION DETERMINE PERCENTAGES OF GRAVEL & SAND FROM GRAIN SIZE CURVE, DEPENDING ON PERCENTAGE OF FINES (FRACTION SMALLER THAN 75µm (NO. 200 SIEVE) COARSE GRAINED SOILS ARE CLASSIFIED AS FOLLOWS: LESS THAN 5% 5% TO 12% 12% TO 17% 17% TO 29% 29% TO 49% 49% TO 69% 69% TO 89% 89% TO 100% BORDERLINE CASES REQ. USE OF DUAL SYMBOLS C _u = $\frac{D_{60}}{D_{10}}$ GREATER THAN 6 C _c = $\frac{(D_{30})^2}{D_{10} \cdot D_{60}}$ BETWEEN ONE AND 3 NOT MEETING ALL GRADATION REQUIREMENTS FOR GW ATTERBERG LIMITS BELOW A-LINE, OR I _p LESS THAN 4 ABOVE A-LINE WITH I _p BETWEEN 4 AND 7 ARE BORDERLINE CASES REQUIRING USE OF DUAL SYMBOLS C _u = $\frac{D_{60}}{D_{10}}$ GREATER THAN 6 C _c = $\frac{(D_{30})^2}{D_{10} \cdot D_{60}}$ BETWEEN ONE AND 3 NOT MEETING ALL GRADATION REQUIREMENTS FOR SW ATTERBERG LIMITS BELOW A-LINE OR I _p LESS THAN 4 ABOVE A-LINE WITH I _p BETWEEN 4 AND 7 ARE BORDERLINE CASES REQUIRING USE OF DUAL SYMBOLS		
			PREDOMINANTLY ONE SIZE OR A RANGE OF SIZES WITH SOME INTERMEDIATE SIZES MISSING		GP	POORLY GRADED GRAVELS, GRAVEL-SAND MIXTURES, LITTLE OR NO FINES				
		GRAVEL WITH FINES (APPRECIABLE AMOUNT OF FINES)	NON-PLASTIC FINES (FOR IDENTIFICATION PROCEDURES SEE ML BELOW)		GM	SILTY GRAVELS, POORLY GRADED GRAVEL-SAND-SILT MIXTURES				
			PLASTIC FINES (FOR IDENTIFICATION PROCEDURES SEE CL BELOW)		GC	CLAYEY GRAVELS, POORLY GRADED GRAVEL-SAND-CLAY MIXTURES				
	SANDS MORE THAN HALF OF COARSE FRACTION IS SMALLER THAN 5mm (NO. 4 SIEVE)	CLEAN SANDS (LITTLE OR NO FINES)	WIDE RANGE IN GRAIN SIZES & SUBSTANTIAL AMOUNTS OF ALL INTERMEDIATE PARTICLE SIZES		SW	WELL GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES				
			PREDOMINANTLY ONE SIZE OR A RANGE OF SIZES WITH SOME INTERMEDIATE SIZES MISSING		SP	POORLY GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES				
		SANDS WITH FINES (APPRECIABLE AMOUNT OF FINES)	NON-PLASTIC FINES (FOR IDENTIFICATION PROCEDURES SEE ML BELOW)		SM	SILTY SANDS, POORLY GRADED SAND-SILT MIXTURES				
			PLASTIC FINES (FOR IDENTIFICATION PROCEDURES SEE CL BELOW)		SC	CLAYEY SANDS, POORLY GRADED SAND-CLAY MIXTURES				
			IDENTIFICATION PROCEDURES ON FRACTION SMALLER THAN 425µm (NO. 40 SIEVE SIZE)							
			FINE GRAINED SOILS MORE THAN HALF OF MATERIAL IS SMALLER THAN 75µm (NO. 200 SIEVE SIZE) (75µm IS ABOUT THE SMALLEST PARTICLE VISIBLE TO THE NAKED EYE)	SILTS AND CLAYS	LIQUID LIMIT LESS THAN 35%	DRY STRENGTH (CRUSHING CHARACTERISTICS)	DILATANCY (REACTION TO SHAKING)		TOUGHNESS (CONSISTENCY NEAR PLASTIC LIMIT)	ML
NONE	QUICK	NONE				CL	CLAYEY SILTS (INORGANIC), GRAVELLY CLAYS, SANDY CLAYS, LEAN CLAYS			
MEDIUM TO HIGH	NONE TO VERY SLOW	MEDIUM				OL	ORGANIC SILT OF LOW PLASTICITY, ORGANIC SANDY SILTS			
SLIGHT TO MEDIUM	SLOW	SLIGHT				MI	INORGANIC COMPRESSIBLE SILTS OR SILTY FINE SANDS WITH SOME CLAY OF MEDIUM PLASTICITY (BELOW A-LINE)			
NONE TO SLIGHT	SLOW TO QUICK	SLIGHT				CI	SILTY CLAYS (INORGANIC) OF MEDIUM PLASTICITY			
HIGH	NONE	MEDIUM TO HIGH				OI	ORGANIC SILTY CLAYS OF MEDIUM PLASTICITY			
LIQUID LIMIT BETWEEN 35% AND 50%	NONE TO SLIGHT	SLOW TO QUICK			SLIGHT	MH	INORGANIC SILTS, HIGHLY COMPRESSIBLE MICACEOUS OR DIATOMACEOUS FINE SANDY, OR SILTY SOILS, ELASTIC SILTS			
	HIGH	NONE			MEDIUM TO HIGH	CH	CLAYS (INORGANIC) OF HIGH PLASTICITY, FAT CLAYS			
	SLIGHT TO MEDIUM	VERY SLOW			SLIGHT	OH	ORGANIC CLAYS OF HIGH PLASTICITY			
	SLIGHT TO MEDIUM	SLOW TO NONE			MEDIUM					
	HIGH TO VERY HIGH	NONE			HIGH					
	MEDIUM TO HIGH	NONE TO VERY SLOW			SLIGHT TO MEDIUM					
LIQUID LIMIT GREATER THAN 50%										
HIGHLY ORGANIC SOILS					PT	PEAT & OTHER HIGHLY ORGANIC SOILS				

USE GRAIN SIZE CURVE IN IDENTIFYING THE FRACTIONS AS GIVEN UNDER FIELD IDENTIFICATION

DETERMINE PERCENTAGES OF GRAVEL & SAND FROM GRAIN SIZE CURVE, DEPENDING ON PERCENTAGE OF FINES (FRACTION SMALLER THAN 75µm (NO. 200 SIEVE) COARSE GRAINED SOILS ARE CLASSIFIED AS FOLLOWS:

LESS THAN 5%
5% TO 12%
12% TO 17%
17% TO 29%
29% TO 49%
49% TO 69%
69% TO 89%
89% TO 100%

BORDERLINE CASES REQ. USE OF DUAL SYMBOLS

C_u = $\frac{D_{60}}{D_{10}}$ GREATER THAN 6
C_c = $\frac{(D_{30})^2}{D_{10} \cdot D_{60}}$ BETWEEN ONE AND 3

NOT MEETING ALL GRADATION REQUIREMENTS FOR GW

ATTERBERG LIMITS BELOW A-LINE, OR I_p LESS THAN 4
ABOVE A-LINE WITH I_p BETWEEN 4 AND 7 ARE BORDERLINE CASES
REQUIRING USE OF DUAL SYMBOLS

C_u = $\frac{D_{60}}{D_{10}}$ GREATER THAN 6
C_c = $\frac{(D_{30})^2}{D_{10} \cdot D_{60}}$ BETWEEN ONE AND 3

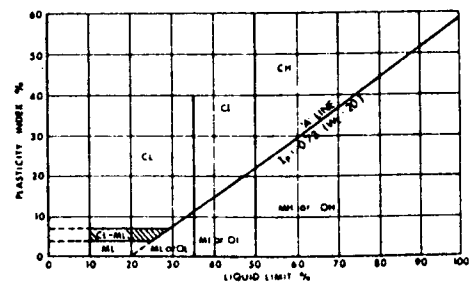
NOT MEETING ALL GRADATION REQUIREMENTS FOR SW

ATTERBERG LIMITS BELOW A-LINE OR I_p LESS THAN 4
ABOVE A-LINE WITH I_p BETWEEN 4 AND 7 ARE BORDERLINE CASES REQUIRING USE OF DUAL SYMBOLS

PLASTICITY CHART FOR LABORATORY CLASSIFICATION OF FINE GRAINED SOILS

USE GRAIN SIZE CURVE IN IDENTIFYING THE FRACTIONS AS GIVEN UNDER FIELD IDENTIFICATION

DETERMINE PERCENTAGES OF GRAVEL & SAND FROM GRAIN SIZE CURVE, DEPENDING ON PERCENTAGE OF FINES (FRACTION SMALLER THAN 75 μm (NO. 200 SIEVE) COARSE GRAINED SOILS ARE CLASSIFIED AS FOLLOWS:



PLASTICITY CHART
FOR LABORATORY CLASSIFICATION OF FINE GRAINED SOILS

BOUNDARY CLASSIFICATIONS: SOILS POSSESSING CHARACTERISTICS OF TWO GROUPS ARE DESIGNATED BY COMBINATIONS OF GROUP SYMBOLS. FOR EXAMPLE GW-GC, WELL GRADED GRAVEL-SAND MIXTURE WITH CLAY BINDER

FOUNDATION INVESTIGATION REPORT
FOR
Marchington Lake Road, Line 'D' (Hwy. 516)
Marchington River Structure
41 km North of Sec. Hwy. #642
W.P. 1-75-06, Site 41S-118
District #20, Kenora, Ontario

INTRODUCTION

This report contains the results of the foundation investigation carried out at the above mentioned site. The field work which consisted of four sampled boreholes and six Dynamic Cone Penetration tests was carried out during the period of 79-09-27 to 79-10-15. The boreholes were advanced with conventional Diamond Drilling equipment adapted for soil sampling purposes using NX (76.2 mm I.D.) casing. For borings located in the river the aforementioned Diamond Drill was mounted on a raft. A Continuous Flight Auger machine mounted on a muskeg vehicle and equipped with 82 mm I.D. Hollow Stem Augers was utilized to drill Borehole #1.

SITE DESCRIPTION

The site is located at the crossing of the proposed realigned and upgraded Marchington Lake Road Line 'D' and Marchington River, some 41 km North of Sec. Hwy. #642. The nearest settlement is the Town of Sioux Lookout. The surrounding terrain is undulating and bush covered. The vegetation consists of Birch and Evergreen (spruce) species. At the present time, a road side park and a boat launch is situated at the west end of the proposed structure. Rock outcrops are visible north of the site. The width of the river along the proposed alignment is about 40 metres and up to 5 metres in depth. The direction of the flow is from north to south.

SUBSURFACE CONDITIONS

Apart from the surficial topsoil and organics east of the river and the bouldery sand and gravel fill material on the west side, the subsoil at this site was found to consist of silty clay and slightly plastic silt followed by bedrock. In Borehole #4 an approx. 0.7 m thick sand layer was observed below the silt zone. The depths of the different soil types vary. Reference should be made to the Record of Borehole Sheets which are contained in the Appendix of this report. The sheets contain the extent and the descriptions of the soil and bedrock types encountered and also, in summarized form, the results of all field and laboratory tests performed.

The stratigraphical profile shown on Contract Drawing No. 2 is based on this information. The drawing also shows the locations and elevations of the borings. Detailed description of the various strata are given below.

Bouldery Sand and Gravel - Fill Material

This fill material, consisting of sand, gravel and boulders was placed on the original subsoil to provide access to the boat launch ramp. The thickness is in the order of 0.5 m.

Topsoil

A shallow layer of topsoil (0.5 m) was encountered at ground level on the east side of the river at the proposed structure and approach location. The material consists of silt, sand with decayed and undecayed organic substances. The colour of the deposit is dark brown to black.

Stratified Silty Clay, Trace of Sand

Beneath the above described surficial deposits of fill material and topsoil is a stratum consisting of alternating layers of clays having low and intermediate plasticity. Overall, the deposit ranged in thickness from 1.2 to 3.5 metres with the individual layers varying from 4 to 20 mm in thickness.

Physical properties of the material as determined from field and laboratory tests are summarized as follows:

	<u>Range:</u>
Natural Moisture Content (%)	18 - 32
Liquid Limit (%)	17 - 43
Plastic Limit (%)	16 - 19
Bulk Density (t/m^3)	1.92 - 1.99
Undrained Shear Strength (kPa)	
Unconfined	48 - 64
Field Vane	17 - 65
Sensitivity	2 - 7

Grain size distribution curves are presented on Figure 1 of the Appendix.

The consistency of the overall deposit may be described as soft to stiff.

Silt Traces of Sand and Clay

Below the silty clay stratum a deposit of slightly plastic silt was found in every borehole. The thickness of this silt zone varied from 0.5 to 5.5 metres. The material is composed of silt, traces of sand and clay. The natural moisture is in the order of 23%. The results of the grain size distribution tests are plotted on Figure 2 of the Appendix.

Standard Penetration Tests 'N' values ranged from 4 to 10 blows per 0.3 m.

Sand Trace of Silt

An approx. 0.7 m thick layer of loose sand with traces of silt was encountered below the silt layer in Borehole #4.

Bedrock

Very hard granite and Gneiss bedrock was encountered at the following elevations:

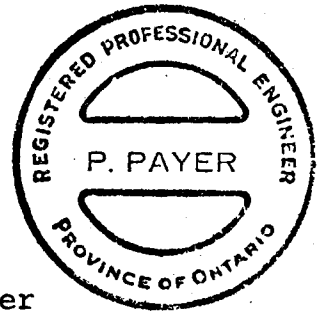
B.H.	#1	EL. 363.8
"	#2	EL. 363.1
"	#3	EL. 368.7
"	#4	EL. 368.4

Groundwater Conditions

The groundwater level was observed by measuring in the open boreholes after completion of the investigation. The water level in Marchington River at the time of the investigation was at elevation 370.5. The groundwater level was found to vary from EL. 367.2 to EL. 370.0. The groundwater levels are shown on the Record of Borehole Sheets, as well as on Contract Drawing No. 2.

P. Payer

P. Payer, P. Eng.
Foundations Engineer



K.G. Selby

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

APPENDIX



RECORD OF BOREHOLE No. 1

METRIC

W P 1-75-06 LOCATION 10+470.0 ORIGINATED BY RR
DIST 20 HWY 516 BOREHOLE TYPE Hollow Stem Augers, BX Rock Core and Cone Test COMPILED BY RR
DATUM Geodetic DATE 79 09 27 CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100		
373.3	Ground Level													
0.0	Sa.6Gr. Fill material													
0.5	Silty clay Trace of sand Stratified Firm Grey - Brown		1	SS	9		372						1.99	0 0 70 30
			2	SS	9									0 1 83 16
			3	TW	PH									0 0 56 44
369.3			4	SS	3		370							
4.0	Silt Some sand Trace of clay Loose Grey coloured		5	SS	4									0 1 90 9
			6	SS	8		368							0 17 79 4
			7	SS	7									
			8	SS	9		366							0 3 87 10
363.8			9	SS	0									
9.5	Granite bedrock Sound		10	BX RC	90% REC		364							
362.3														
11.0	End of Borehole													

*3, *5: Numbers refer to
Sensitivity

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

OFFICE REPORT ON SOIL EXPLORATION

RECORD OF BOREHOLE No 2

METRIC

W P 1-75-06 LOCATION 10+490, E ORIGINATED BY RR
 DIST 20 HWY 516 BOREHOLE TYPE NW Casing and BX Rock Core COMPILED BY RR
 DATUM Geodetic DATE 79 09 29 CHECKED BY _____

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
370.6	Ground Level																
0.0	Sa. Gr. Fill material																GR SA SI CL
0.3	Silty clay Trace of sand Stratified Soft to firm Grey coloured		1	SS	2		370										0 0 72 28
			2	TW	PM		368										
			3	SS	7												
367.6	Silt Traces of sand and clay Loose Grey coloured		4	SS	10		366										0 1 89 10
3.0			5	SS	9												
			6	SS	7												0 4 92 4
			7	SS	8		364										
			8	SS	5												
363.1	Granite bedrock Sound		9	BX RC	80% REC		362										
7.50																	
361.6	End of Borehole																
9.00																	

OFFICE REPORT ON SOIL EXPLORATION

+³, x⁵: Numbers refer to
Sensitivity

20
15
10
5 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 2A

METRIC

W P 1-75-06 LOCATION 10+494.6, E ORIGINATED BY RR
DIST 20 HWY 516 BOREHOLE TYPE Cone Test Only COMPILED BY RR
DATUM Geodetic DATE 79 10 01 CHECKED BY

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					
370.4	River Water Level												
369.8	Water River Bottom												
0.6	Probable silty clay and silt												
360.6													
9.78	End of Cone Test Probable bedrock												

+3, x5 : Numbers refer to
Sensitivity

20
15 5 (%) STRAIN AT FAILURE
10

OFFICE REPORT ON SOIL EXPLORATION

RECORD OF BOREHOLE No 3

METRIC

W P 1-75-06 LOCATION 10+530, E ORIGINATED BY RR
DST 20 HWY 516 BOREHOLE TYPE NW Casing and BX Rock Core COMPILED BY RR
DATUM Geodetic DATE 79 10 02 CHECKED BY _____

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			20	40	60	80	100					
370.5	Ground Level															
0.0	Topsoil															
369.1	Silty clay . Trace of sand. Firm		1	SS	7											
368.7	Silt - Loose		2	SS	157.08											
1.8	Granite bedrock Sound		3	BX RC	100% REC											
			4	BX RC	71% REC											
365.8			5	BX RC	100% REC											
4.7	End of Borehole															

OFFICE REPORT ON SOIL EXPLORATION

+3, x5: Numbers refer to
Sensitivity

20
15 5 (%) STRAIN AT FAILURE
10

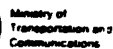
RECORD OF BOREHOLE No 3A

METRIC

W P 1-75-06 LOCATION 10+525, E ORIGINATED BY RR
DIST 20 HWY 516 BOREHOLE TYPE Cone Test Only COMPILED BY RR
DATUM Geodetic DATE 79 10 01 CHECKED BY _____

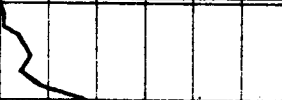
SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			'N' VALUES	20	40	60	80					
370.4	River Water Level															
369.8	Water River Bottom					370										
0.60	Probable silty clay and silt					368										
367.2																
3.20	End of Cone Test Probable bedrock															

OFFICE REPORT ON SOIL EXPLORATION



METRIC

WP 1-75-06 LOCATION 10+532, E ORIGINATED BY RR
DIST 20 HWY 516 BOREHOLE TYPE Cone Test Only COMPILED BY RR
DATUM Geodetic DATE 79 10 15 CHECKED BY _____

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			WATER CONTENT (%)						
						○ UNCONFINED ● QUICK TRIAXIAL				+ FIELD VANE x LAB VANE					
370.9	Ground Level								20 40 60 80 100						
0.0	Probable silty clay and silt						370								
368.7							368								
2.20	End of Cone Test Probable bedrock														
</															

+3, x5 : Numbers refer to Sensitivity

20
15 ϕ 5 (%) STRAIN AT FAILURE
10

OFFICE REPORT ON SOIL EXPLORATION



RECORD OF BOREHOLE No 4

METRIC

W P 1-75-06 LOCATION 10+550 E
DIST 20 HWY 516 BOREHOLE TYPE NW Casing, AXI Rock Core
DATUM Geodetic DATE 1979 10 14
ORIGINATED BY RR
COMPILED BY RR
CHECKED BY

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 (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			20	40	60	80	100					
373.5	Ground Level															
0.0	Topsoil - Organics															
0.5	Silty clay		1	TW	PM										1.92	
	Trace of sand															
	Stratified		2	SS	17											0 1 87 12
371.3	Stiff															
2.2	Silt		3	SS	16											
	Traces of sand and															
	clay		4	SS	10											0 6 90 4
	Loose		5	SS	10											
369.1																
4.4	Sand - Loose		6	SS	10											0 98 2
368.4																
5.1	Gneiss bedrock		8	AXI	94% RC REC											
	Sound															
			9	AXI	100% RC REC											
365.4			10	AXI	100% RC REC											
8.1	End of Borehole															

*3, x5: Numbers refer to
Sensitivity

20
15
10
5 (%) STRAIN AT FAILURE

OFFICE REPORT ON SOIL EXPLORATION



RECORD OF BOREHOLE No 4A

METRIC

W P 1-75-06 LOCATION 10+548, E ORIGINATED BY RR
DIST 20 HWY 516 BOREHOLE TYPE Cone Test Only COMPILED BY RR
DATUM Geodetic DATE 1979 10 14 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 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						
373.3	Ground Level										
0.0	Probable silty clay and silt						370				
							368				
368.3							366				
5.0	End of Cone Test Probable bedrock								120/.15m		

OFFICE REPORT ON SOIL EXPLORATION

+3, x5 : Numbers refer to
Sensitivity

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



RECORD OF BOREHOLE No 4B

METRIC

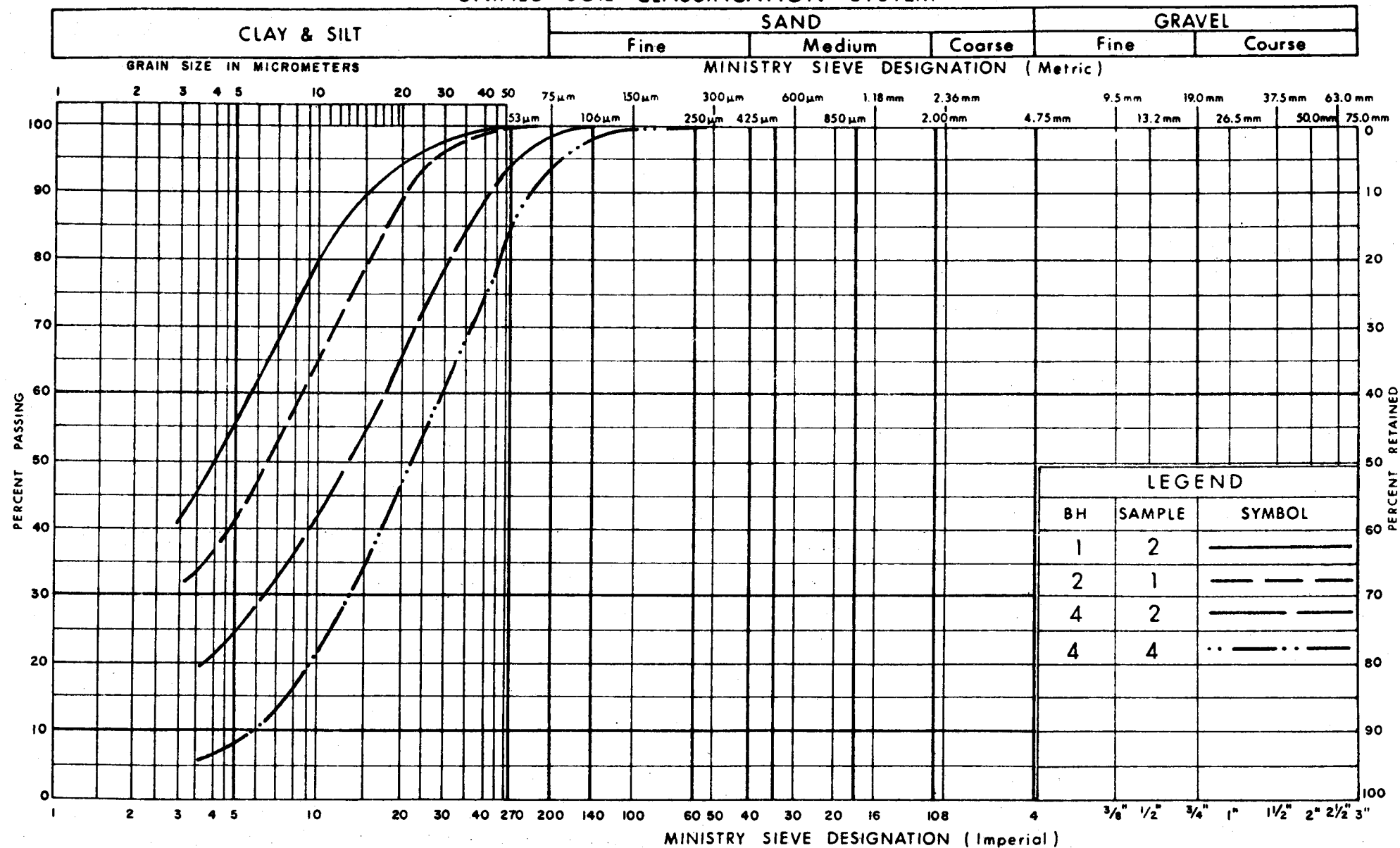
W P 1-75-06 LOCATION 10+552 o/s .8m N E ORIGINATED BY RR
DIST 20 HWY 516 BOREHOLE TYPE Cone Test Only COMPILED BY RR
DATUM Geodetic DATE 1979 10 15 CHECKED BY _____

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 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								
373.6	Ground Level												
0.0	Probable silty clay and silt						370						
							368						
368.2							366						
5.4	End of Cone Test Probable bedrock												

+3, x5: Numbers refer to
Sensitivity

20
15
10
5 (%) STRAIN AT FAILURE

UNIFIED SOIL CLASSIFICATION SYSTEM



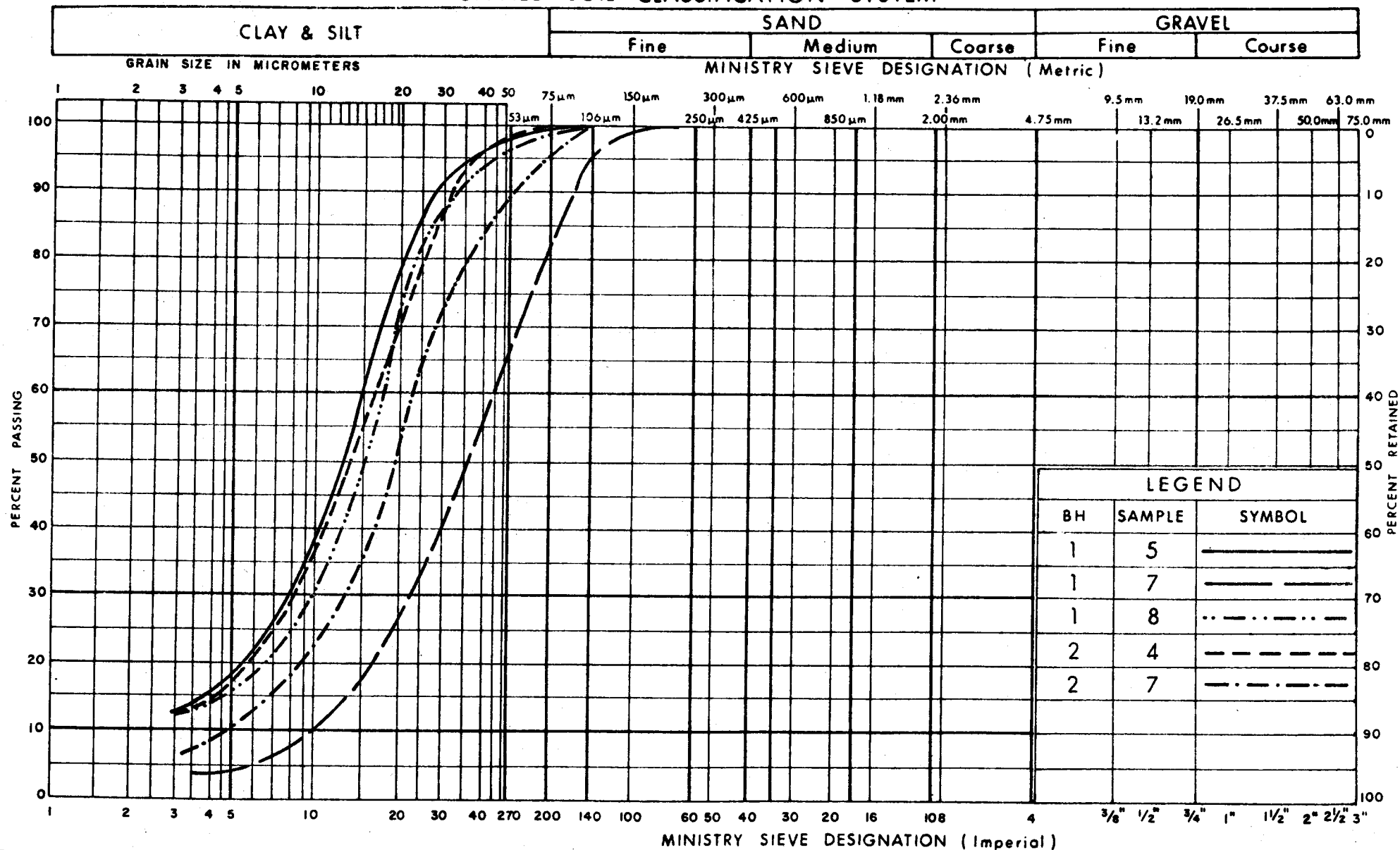
Ministry of
Transportation and
Communications

GRAIN SIZE DISTRIBUTION
STRATIFIED SILTY CLAY
TRACE OF SAND

FIG No 1

W P 1-75-06

UNIFIED SOIL CLASSIFICATION SYSTEM



Ontario

 Ministry of
Transportation and
Communications

GRAIN SIZE DISTRIBUTION
SILT
TRACE OF SAND & CLAY

FIG No 2

W P 1-75-06



Memorandum

To: Mr. W. W. Kulmattickas,
Head,
Structural Office,
Northwestern Region.

Attention:

From: Pav't. & Foundation Design Section
Engineering Materials Office,
Room 315, Central Building,
Downsview, Ontario.

Date: 79 10 24

Our File Ref.

In Reply to

Subject:

Re: Foundation Recommendations
For
Proposed New Crossing at
Marchington River and
Marchington Road, Line 'D',
W.P. 1-75-06, Site:
District 20, Kenora.

After lengthy delays, caused by breakdowns of the hired drilling equipment, we have completed the field investigation at this location.

Based on the recent telephone conversations with you, this project is considered to be extremely urgent. Therefore, we submit our summarized findings and preliminary recommendations which should be sufficient for design purposes.

The borings at the proposed footing locations (Drawing No. E-5645-1) indicate that the overburden consists of about 1.5 m to 9.5 m thick stratified clays and silts. Bedrock was encountered at the following elevations:

Sta. 10+470	Elevation 363.6	(B.H. #1)
Sta. 10+490	Elevation 362.8	(B.H. #2)
Sta. 10+530	Elevation 370.5	(B.H. #3)
Sta. 10+550	Elevation 368.4	(B.H. #4)

The following groundwater levels were observed:

B.H. #1	Elevation 366.5
B.H. #2	Elevation 369.4
B.H. #3	Elevation 370.5 (River water level)
B.H. #4	Elevation 373.0

Recommendations:

West Abutment and West Pier

End bearing piles driven to bedrock. For steel tubes, 323.9 mm O.D. @ 49.73 kg/m or HP 310 x 110 steel 'H' piles with reinforced tips, the maximum permissible load is 1100 kN.

East Abutment and East Pier

Spread footings placed on sound bedrock. Recommended design load: up to 5000 kPa.

If excavations are below the water level, a dewatering scheme will be required to form the pile caps and to place the concrete for the spread footings in the dry. No stability problems are anticipated for the proposed 2.5 m high approaches, provided with 2:1 slopes.

No bouldery fill should be placed at locations where piles are to be driven.

The complete Foundation Investigation and Design Report will be submitted at a later date.

Should further information be required however, please contact our office.

PP/cy

c.c. A. Radkowski
N. Maluzinsky
Files



P. Payer
Foundation Engineer.