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W.P. No. 277-85-01

CONT. No. 87-213

W. O. No.

STR. SITE No. 385-20

HWY. No. 556

LOCATION Little Garden River Crossing #1

No. of PAGES -

OVERSIZE DRAWINGS TO BE INCLUDED WITH THIS REPORT.

REMARKS:

FOUNDATION INVESTIGATION REPORT

CONTRACT NO 87-213

Ontario

Ministry of
Transportation and
Communications

I N D E X

NOTE: For the purposes of this contract, these Foundation Investigation Reports supersede all other reports prepared by or for the Ministry in connection with the above-noted projects.

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
Little Garden River Crossing No. 1
W.P. 277-85-01, Site No: 38S-20
District 18, Sault Ste. Marie

INTRODUCTION

Terraprobe Limited was authorized by the Hon. E. Fulton, Minister, on behalf of the Ministry of Transportation and Communications (MTC), to undertake a foundation investigation for a proposed bridge structure on Hwy. 556, near Sault St. Marie, Ontario.

The purpose of the investigation was to determine subsurface conditions at the site and provide engineering recommendations for the goetechnical aspects of design for foundations and approach embankments, including comments on the anticipated construction conditions.

The field investigation for the project was conducted between January 25 to February 2, 1986, when four borings (BH 1 to BH 4) were drilled to depths of 6.1 to 8.8 m below ground surface at the locations shown on Dwg. 2. the borings were put down at the proposed bridge abutment locations. The details of the field work procedures are fully presented in Appendix A of this report.

Subsequent to the investigation carried out by Terraprobe Ltd., the Foundation Design Section advanced an additional boring (BH 5) at this site. The findings from this additional borehole are discussed in an addendum on Page 7 of this report.

SITE AND GEOLOGY

The site is located on Hwy. 556, approximately 50 km northwest of Sault St. Marie (Ref. Dwg. 2 in the Contract Drawings - Borehole Location and Soil Strata) at the Little Garden River. Hwy. 556 is a gravel surfaced two lane road. A timber bridge structure currently crosses the Little Garden River.

In the vicinity of the site the Garden River is situated in a broad meandering channel of about 4 m depth and 30 m width. At the time of our investigation (January-February 1985) the river was not frozen, and the depth of water was about 0.3 m. The areas surrounding the site are generally undeveloped rural Crown Land which is covered by dense bush.

Based on a review of selected geologic references, the site is located in an area underlain by overburden materials consisting of coarse grained glacial outwash. The bedrock in the vicinity of the site is described as early Precambrian granitic material.

SUBSURFACE CONDITIONS

Details of the subsurface conditions encountered at the site are summarized below, and are also presented on the accompanying Borehole Logs and stratigraphical sections on Dwg. 2 of the Contract Drawings.

In summary, the borings indicate that the site is underlain by dense gravel, sand and boulders. This stratum was fully penetrated by one of the borings at a depth of 5.8 m, where granitic bedrock was encountered. The remaining borings were terminated in the overburden at depths of 6.1 to 7.6 m.

It should be noted that the subsurface conditions are confirmed at the borehole locations only, and may vary at other locations. The boundaries between the various strata as shown on the logs and sections are based on non-continuous sampling. These boundaries represent an inferred transition between the various strata, rather than a precise plane of change.

The following describes the soils encountered at this site.

Topsoil

Topsoil was encountered at the ground surface in BH 2 and 3, to depths of 0.3 to 0.6 m. The topsoil was generally black in colour, and contained numerous roots and forest litter such as leaves and wood pieces.

Fill Materials

Fill materials were encountered in BH 1 and 4, from the ground surface to depths of 0.5 to 0.9 m respectively. The fill materials consisted of loose native gravel, sand and boulders which were placed for construction of the drill access road. The fill contained traces of topsoil, roots and other organic matter as a result of the site clearing operations.

Gravel, Sand and Boulders

This stratum was encountered in all of the borings from immediately beneath the topsoil or fill materials. It was encountered to the bottom of BH 1, 2 and 4, at depths of up to 7.6 m. It was fully penetrated in BH 3 only at a depth of about 5.8 m, where the bedrock surface was encountered.

This stratum appears to consist of coarse cobbles and gravel with a matrix of sand with a trace to some silt. Due to the coarse grained nature of the soil, it was not possible to obtain fully representative samples using a 50 mm diameter split spoon. Therefore, the soil descriptions are based on the observed resistance to penetration during drilling, as well as the appearance of the spoon samples. The results of grain size distribution of the split spoon samples are presented on Figure 1, and indicate that the samples generally consisted of sand gravel, with trace to some silt. The range of gravel, sand and silt and clay fraction in the samples analysed as noted below:

Gravel	Sand	Silty and Clay
19 to 62%	30 to 62%	4 to 22%

However, based on the rate of advance of the drilling, it appears that cobbles and boulders of 150 to 800 mm diameter are present throughout the deposit, and the split spoon samples are more representative of the matrix between the cobbles and boulders.

It is also noted that the drilling technique (rotary bicone and casing) would tend to wash some of the fines from the soil matrix, hence the spoon samples may contain less silt and fine sand fraction than is actually present in the soil.

At the base of BH 1 and 4, the material appeared to consist of cobbles with very little sand or gravel matrix. The samples obtained from the base of the borings were wash samples of the drill cuttings. It is possible that these 'boulders' may be the top of the bedrock surface, however the drill casing could not be lowered to permit coring of the material to verify this.

The penetration resistance of the stratum ranged from 46 to over 100 blows per 0.3 m. The extremely high penetration resistance of the soil is attributed to the large percentage of particles in excess of 50 mm diameter. Based on the resistance to penetration during drilling, the material is considered to be dense.

Granitic Bedrock

The bedrock surface was encountered beneath the gravel and boulder stratum in BH 3 only, at a depth of about 5.8 m. It was penetrated to the base of the boring at about 8.8 m depth. As noted previously, it is possible that the bedrock surface was encountered near the base of BH 1 and 4 at depths of 5.6 and 5.9 m, respectively, although the borings could not be advanced to permit further sampling.

The bedrock consisted of medium grained pink to brown granite-gneiss. While the total core recoveries were generally good, the rock was broken to highly fractured, and the Rock Quality Designation (RQD) determined for the core was zero throughout. Total core recoveries ranged from 0 to 100%, but most runs obtained recoveries in excess of 70 percent.

The degree of fracturing did not decrease with depth. The material was slightly weathered on fracture surfaces.

GROUNDWATER

The borings caved at depths of 1.2 to 2 m after withdrawal of the casing, as noted on the Borehole logs. The water levels measured in the standpipes on February 2, 1985, some 1 to 6 days following their installation, are noted below:

Borehole No.	Groundwater Depth/Elevation (m)
2	2.7 / 343.3
3	2.7 / 343.2
4	4.4 / 343.5

The elevation of the water in the river was approximately 345 m on February 2, 1986.

The difference in the groundwater level compared to the river water level suggests that the soil does not have a high permeability.

ADDENDUM (BH 7)

As mentioned in the Introduction of this report, one additional borehole (BH 5) was advanced at this site. The borehole was advanced using hollow stem augers and washboring techniques between 87 01 18 and 87 01 20. The borehole was advanced to bedrock (Elev. 339.9), approximately 5.9 m below the ground surface. 2.1 m of rock core was also obtained. A core penetration test accompanied the borehole. Dwg. 2 of the Contract Drawings indicates, in plan, the location of the borehole.

The following is a description of the subsurface conditions encountered in BH 5. The Record of Borehole sheet for this borehole is included in the Appendix.

Extending from the ground surface (Elev. 345.8) down to a depth of 0.7 m is a surficial deposit of peat. The peat is generally black in colour and contains numerous roots, with decaying wood and leaves.

Underlying the peat and extending to a depth of 5.9 m below the ground surface is a cohesionless deposit consisting of sand with/and gravel, trace silt. From the drilling, frequent cobbles and boulders may be inferred to be present within this deposit.

Grain size distribution tests were carried out on 4 samples of this cohesionless material. The following is a summary of the results.

	Range
Gravel	28 - 57 %
Sand	39 - 63 %
Silt and Clay	4 - 7 %

Fig. 2 in the Appendix illustrates the results in envelope form.

Based on the interpretation of Standard Penetration Test 'N' values, this deposit can be considered to generally be in a dense to very dense state. It should be noted that the upper surface of this deposit consists of a fine silty sand. It should also be noted that this non-cohesive stratum may 'boil' or be 'disturbed' when subjected to an unbalanced hydrostatic pressure.

Bedrock was proven in BH 5 by obtaining 2.1 m of BX rock core. Bedrock at this specific location is described as a Granitic Fault Breccia slightly weathered. The surface of the bedrock was found at a depth of 5.9 m below the ground surface, corresponding to Elev. 339.9.

A description of the recovered core was prepared by E. Magni, MTC Geologist, and is included in the table attached.

The groundwater level across the site is governed by the prevailing creek level. At the time of the investigation the creek level was at Elev. 345.4. The stabilized groundwater level may be expected to be at the same elevation.

MISCELLANEOUS

As previously noted, BH 1 to 4 were carried out by Terraprobe Ltd. The soil descriptions pertaining to these 4 boreholes were also prepared by Terraprobe Ltd.

BH 5 was carried out by the MTC Foundation Design Section subsequent to the investigation carried out by the consultant. The summary of the findings of BH 5 was prepared by L. Politano, Project Foundations Engineer.

L. Politano, P. Eng.
Project Foundations Engineer

REGISTERED PROFESSIONAL ENGINEER
87-03-27
L. R. POLITANO
PROVINCE OF ONTARIO

M. Devata, P. Eng.
Chief Foundations Engineer (East)

APPENDIX

Ministry of Transportation and Communications
Ontario

RECORD OF BOREHOLE No 1 — METRIC

W P 277-85-01 LOCATION Sta. 10 + 606 offset 5m LT ORIGINATED BY R.M.
DIST 18 HWY 556 BOREHOLE TYPE Hollow Stem Auger, NX, BX Casing & Cone Test COMPILED BY P.B.
DATUM Geodetic DATE 1986 01 25 and 26 CHECKED BY M.T.

SOIL PROFILE ELEV/DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	'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 W_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA (SI CL)
347.1	Ground Surface						347				
0.0 / 346.6	Fill, sand, gravel and cobbles, loose										
0.5	Gravel, sand and boulders		1	SS	50/13 cm	▼	346		o		
	Dense to very Dense		2	SS	50/10 cm		345		o		40 56 (4)
			3	SS	76/25 cm		344		o		
			4	SS	52				o		22 56 (22)
			5	SS	65/20 cm		343		o		
341.5			6	SS	50/8 cm		342				
5.6 / 340.1	Boulders, some sand matrix		7	WS	-		341				
			8	WS	-						
7.0	End of Borehole Borehole caving at 1.4 m depth as casing withdrawn Water level in hole at 1.1 m depth on completion										

$+^3$, $\times^5$: Numbers refer to Sensitivity

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

OFFICE REPORT ON SOIL EXPLORATION

Ministry of Transportation and Communications
Ontario

RECORD OF BOREHOLE No 2 METRIC

W P 277-85-01 LOCATION Sta 10 + 579 offset 5m RT ORIGINATED BY R.M.

DIST 18 HWY 556 BOREHOLE TYPE Hollow Stem Auger, NX, BX Casing & Cone Test COMPILED BY P.B.

DATUM Geodetic DATE 1986 01 26 to 29 CHECKED BY M.T.

SOIL PROFILE ELEV/DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	'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 W_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA (SI CL)
346.0	Ground Surface										
0.0 345.7	Topsoil, silty, numerous roots, black		1	SS	4		346				
0.3	Gravel, sand and boulders		2	SS	56		345				59 33 (8)
			3	SS	34/15cm		344				
	Dense to very Dense		4	SS	50/5cm		343				
			5	SS	48	Piezometer	342				
			6	SS	50/8cm		341				43 51 (6)
339.9			7	SS	60		340				
6.1	End of Borehole Borehole caving at 2.0 m depth as casing withdrawn Water level in standpipe at 2.7 m depth on Feb. 2, 1986		8	SS	-						

OFFICE REPORT ON SOIL EXPLORATION

+3, ×5 : Numbers refer to Sensitivity

15 20 10 5 (%) STRAIN AT FAILURE

Ministry of Transportation and Communications
Ontario

RECORD OF BOREHOLE No 3 METRIC

W P 277-85-01 LOCATION Sta 10 + 585 offset 4m LT ORIGINATED BY R.M.
DIST 18 HWY 556 BOREHOLE TYPE Hollow Stem Auger, NX, BX Casing & Cone Test COMPILED BY P.B.
DATUM Geodetic DATE 1986 01 29 to 31 CHECKED BY M.T.

SOIL PROFILE ELEV/DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / 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)
345.9	Ground Surface										
0.0 / 345.3	Topsoil, numerous roots leaves, black		1	SS	17		346				
0.6	Gravel, sand and Boulders Dense to Very Dense		2	SS	50/ 8cm		345				
			3	SS	60/15cm		344				27 58 (15)
			4	SS	98						
			5	SS	87	▼	343				
			6	SS	46		342				
			7	SS	72		341				
340.1			8	SS	50/6cm						
5.8	Granite bedrock, highly fractured to broken. Slight weatherin on fracture surfaces		9	B RC	rec 83%	Piezometer	340				
			10	B RC	rec 100%						
			11	B RC	rec 100%		339				
			12	B RC	rec 100%						
			13	B RC	rec 71%		338				
337.1			14	B RC	rec 53%						
			15	B/RC	0%						
8.8	End of Borehole Borehole caving at 1.2 m depth as casing withdrawn Water level in stand-pipe at 2.7 m depth on Feb. 2, 1986										

$+^3$, $\times^5$: Numbers refer to Sensitivity

$15 \overset{20}{\diamond} 5$ (%) STRAIN AT FAILURE
10

OFFICE REPORT ON SOIL EXPLORATION

Ministry of Transportation and Communications
Ontario

RECORD OF BOREHOLE No 4 METRIC

W P 277-85-01 LOCATION Sta 10 + 597 offset 4m RT ORIGINATED BY R.M.

DIST 18 HWY 556 BOREHOLE TYPE Hollow Stem Auger, NX, BX, Casing & Cone Test COMPILED BY P.B.

DATUM Geodetic DATE 1986 01 31 and 86 02 02 CHECKED BY M.T.

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 (%) 20 40 60	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES						
347.9	Ground Surface										
0.0 / 347.0	Fill, sand, gravel, cobbles, loose		1	SS	9						
0.9	Gravel, sand and boulders, Dense to very dense		2	SS	46		347				GR 5A (SI CL)
			3	SS	50/13cm						62 30 (8)
							346				
			4	SS	92						
							345				
			5	SS	93/28cm						
							344				
343.2			6	SS	80/13cm	▼					
4.7	Sand and gravel, some silt (Till Like)						343				
342.0	Dense Brown		7	SS	46						19 62 (19)
5.9	Gravel and Boulders, some sand matrix						342				
			8	SS	90/22cm						
							341				
340.3			9	WS	-	Piezometer					
7.6	End of Borehole										

Borehole caving at 1.7 m depth as casing withdrawn

Water level in standpipe at 4.4 m depth on Feb. 2, 1986

+3, ×5 : Numbers refer to Sensitivity

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

OFFICE REPORT ON SOIL EXPLORATION

Ministry of Transportation and Communications
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RECORD OF BOREHOLE No 5 METRIC

W P 277-85-01 LOCATION Sta. 10 + 567.5 ℄ HWY 556 ORIGINATED BY M.J.
DIST 18 HWY 556 BOREHOLE TYPE H.S. Auger, BW Casing, Cone Pen. Test COMPILED BY L.P.
DATUM Geodetic DATE 1987 01 18/20 CHECKED BY

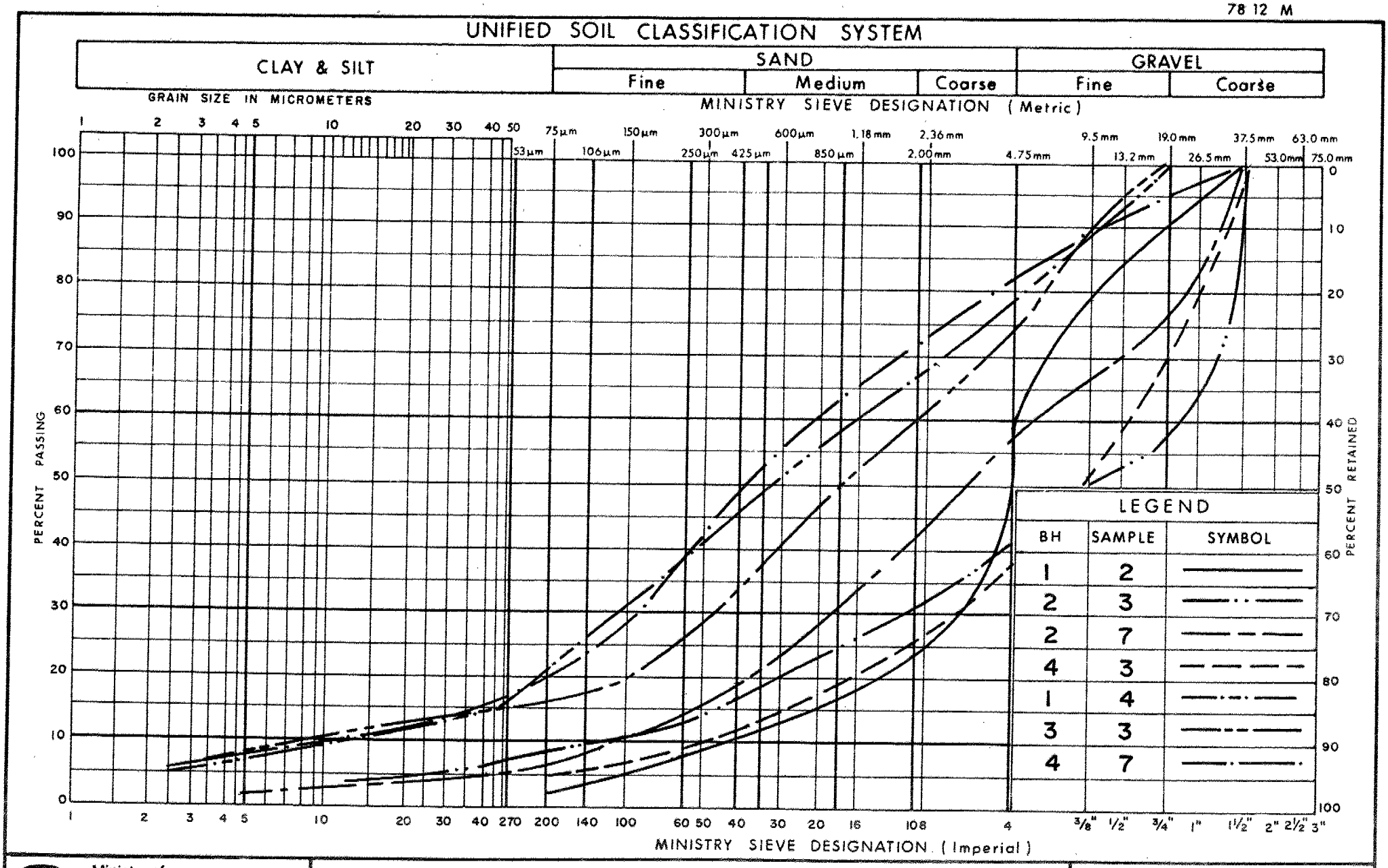
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES 'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE)	PLASTIC LIMIT Wp / NATURAL MOISTURE CONTENT W / LIQUID LIMIT W_L — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
345.8	Ground Surface										
0.0 / 345.1	Peat		1	SS	7		345				
0.7	Fine silty sand		2	SS	20						
	Sand with/and gravel trace silt		3	SS	30		344		○		28 63 (9)
	(Sand well-graded)		4	SS	125	▽ *	343		○		57 39 (4)
	Occ. cobbles and boulders		5	SS	82				○		42 51 7 0
			6	SS	38		342		○		34 61 (5)
	Dense to Very Dense		7	SS	26		341				
			8	SS	70/8 cm						
339.9	Boulders		9	RC	REC 63%		340				RQD=47%
5.9	Bedrock		10	RC	REC 75%						RQD=0
	Granitic Fault Breccia Slightly weathered		11	RC	REC 90%		339				RQD=13%
337.8			12	RC	REC 71%		338				RQD= 0%
8.0	End of Borehole										

* Groundwater level measured at end of day within open borehole. May not be stabilized

OFFICE REPORT ON SOIL EXPLORATION

+3, ×5 : Numbers refer to Sensitivity

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



Ministry of Transportation and Communications
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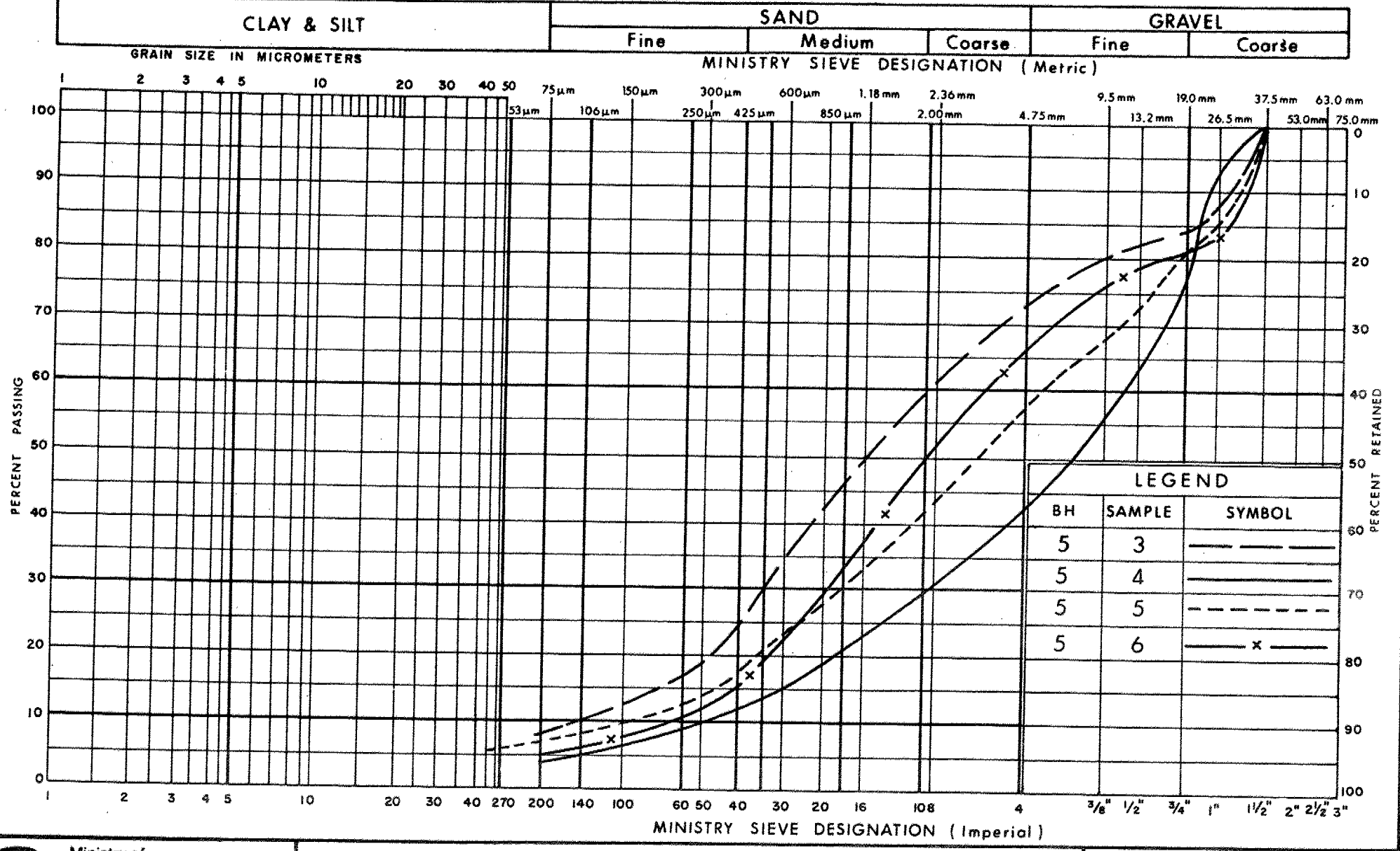
GRAIN SIZE DISTRIBUTION
GRAVEL AND BOULDERS IN A MATRIX OF SAND, TRACE TO SOME SILT

FIG No 1
WP 277-85-01

UNIFIED SOIL CLASSIFICATION SYSTEM



Ministry of Transportation and Communications
Ontario

GRAIN SIZE DISTRIBUTION

SAND WITH / AND GRAVEL , TRACE SILT

FIG No 2

W P 277-85-01

76

BOREHOLE 5

DEPTH (m)	% CR*	% RQD*	DEPTH (m)	DESCRIPTION
5.49-6.25	63	47	5.49-5.92	**BOULDERS**
6.25-6.76	75	0	5.92-7.95	**GRANITIC FAULT BRECCIA ***, slightly weathered with a moderately weathered zone at 6.50 to 6.76 m and a highly weathered zone from 7.80 to 7.95 m, closely spaced joints.
6.76-7.77	90	13		Rock intersected by very closely spaced microgractures due to brecciated (faulted) nature of rock.
7.77-7.95	71	0		
				*** FAULT BRECCIA - rock distrubed and microfractured by faulting then recemented.**

* CR = CORE RECOVERY; RQD = ROCK QUALITY DESIGNATION

FOUNDATION INVESTIGATION REPORT
For
Little Garden River Bridge #2 - Hwy. 556
Site No: 38S-21 W.P. 277-85-02
District 18, Sault Ste. Marie

INTRODUCTION

The Foundation Design Section of the Ministry of Transportation and Communications retained the services of C. Mirza Engineering Inc. to carry out a subsoil investigation at the above-noted site. The investigation involved four boreholes identified as BH1 to BH4. This report summarizes the findings of the investigation. The fieldwork for this project was carried out between 86 02 05 and 86 02 07.

Subsequent to the investigation carried out by C. Mirza Engineering Inc., the Foundation Design Section advanced an additional 3 sampled borings at this site. The borings are identified as BH 11, 12, and 13. The findings from the additional boreholes are included as an addendum on Page22 of this report.

SITE AND GEOLOGY

The site is located on the extension of Secondary Highway 556 to Ranger Lake in Hughes Township, District of Algoma, approximately 100 km northeast of Sault Ste. Marie. A key map of the site is shown on Dwg. No. 2778502-A (Dwg. 2) in the Contract Drawings.

The geology of this area has been mapped by the Ontario Geological Survey (Mineral Potential Map Series P.1513). Near the bridge site the terrain is shown as an ice-contact deposit area, comprising chiefly of glacio-fluvial deposits, with very low mineral potential. There are no major bedrock outcrops mapped for this area. The bedrocks of the area belong to the Abitibi Belt of the Superior Province of the Precambrian Shield and consist primarily of granite and granitic types of rock.

The terrain at the site and immediate vicinity is relatively flat. Till-ice contact drift "hills" are visible some 500 m to the northwest and to the southeast about 1 km away. Vegetation is mostly cedar with some pine and fir. Many trees along the river bank at the site are leaning into the river, indicating active erosion of the banks.

The existing structure is a timber bridge. The river is about 10 m wide and flows sluggishly towards the west. At the time of investigation, the water in the river was 250 to 400 mm deep. The central portion of the stream was unfrozen.

The timber structure rests on sawn "railway tie size" lumber and is entirely constructed of sawn lumber. The clearance between the road surface at deck and the water at the time of investigation was just over one metre.

SUBSURFACE CONDITIONS

General

The soil conditions across the site are fairly uniform. Beneath a surficial cover of peat there is a compact to very dense deposit of sand and gravel extending to the final depth of the investigation which was a maximum of just over 11 metres in a borehole and just over 20 metres in a cone hole. No cohesive soils were encountered in either the bore or cone holes. The water table was found to correspond to the river level.

The boundaries between the various soil types, in-situ and laboratory test results, as well as groundwater levels are shown on the Record of Borehole Sheets in the Appendix. The location of each borehole is shown in plan on Dwg. 2 of the Contract Drawings.

Peat

Under a cover of snow at the time of the investigation, the soil along the river banks at the proposed crossing location consists of a surficial cover of dark brown peat, mixed with some sand. The peat grades into the underlying sand and gravel deposit at a depth of 700 mm. Therefore the thickness of the peat deposit is about 700 mm. At the time of the investigation, this organic layer was completely frozen. In the unfrozen state, the consistency of the peat is likely to be very soft, since it is quite fibrous and shows no root mat.

Sand and Gravel

The surficial peat deposit is directly underlain by a 3 to 4 metre thick deposit of sand and gravel. From the drilling, cobbles are inferred to be present within this upper non-cohesive stratum. The sand is of reddish brown colour and the gravel is subangular to sub-rounded, indicating the origin of the sand to be glacial-fluvial, and of granitic parent materials.

The moisture content of this stratum was found to range between 12 and 22 percent, the lower values being obtained in samples containing a larger percentage of gravel. Typical grain size distribution curves are given in Figure 1. The gravel content is just under 50 percent.

The 'N' values in this stratum ranged from lows of 13 to an isolated high of 72 blows/0.3 m, indicating the density of the stratum to be generally compact to dense, being occasionally very dense. The 'N' values below 20 blows/0.3 m were measured just below the peat stratum, and it is suspected that both the peat and perhaps unbalanced hydrostatic heads in the hollow stem augering may have caused a boiling of the sand, leading to the lower 'N' values. Below the first sample taken in this deposit, the auger stem was kept filled with water to prevent unbalanced hydrostatic uplift, and the 'N' values were generally in the dense range (over 30 blows/0.3 m). The field experience shows that even such a dense deposit can boil under unbalanced hydrostatic heads.

Sand with Some Gravel

Below the upper sand and gravel deposit, at about Elev. 348, a deep deposit of sand with some gravel was encountered, and was found to extend to the maximum depth of the borehole. The sand is of reddish brown colour generally, becoming greyish below about Elev. 343. The sand particle sizes range from medium to coarse, and are generally subangular. The material is typical of glacial outwash deposits. From the augering, boulders and cobbles are inferred to be present in this deposit at random throughout its depth. At the location of BH 4, the augers began to tilt, indicating a boulder had been encountered at that depth (8.1 m). Hence the borehole was terminated at that depth.

This sand deposit is inferred to extend below the sampled depth of 12 metres in BH 1 on the basis of the dynamic cone penetration tests carried out both within BH 1 and at the location of Cone holes 2 and 3. Upon completion of the tests, no clay was found on any of the A rods used to drive the cone tip. However, in BH 4, a lens of fine gray silty sand was encountered between Elev. 346 and 347. Such lenses are also inferred to be present throughout the deposit in a random fashion. The moisture content of the sand is about 15 percent on average.

Grain size distribution curves for the sand deposit are given in Figure 2 and for the silty sand lens in Figure 3. In Figure 3, the presence of occasional gravel has distorted the curve. However, the lens consists of essentially a

fine sand matrix, which is non-cohesive.

The 'N' values in the sand deposit ranged between 11 and 68 blow/0.3 m, indicating the deposit to be of compact to very dense relative density. However, some of the higher 'N' values may represent cobbles and boulders which have been pushed aside in the sampling process. Thus, the overall denseness of the deposit is more likely to be compact. However, care is required in excavations to ensure the sand does not boil under unbalanced hydrostatic heads.

GROUNDWATER CONDITIONS

The groundwater conditions were observed in the open boreholes and were found to correspond to the river level prevailing at the time of the investigation, being generally within 500 mm of the ground level or Elev. 351.0 at BH 4 and 351.1 at BH 1.

Since the sandy deposits at the site are totally cohesionless, the sand was found to be entering the hollow stem augers when a depth of 1.5 to 2 m below grade was reached, due to unbalanced hydrostatic heads. Since the boreholes were located only 2 to 4 m from the edge of the river, the hydraulic gradient through the deposit is in the order of unity.

ADDENDUM (BH 11, 12, 13)

As mentioned in the Introduction of this report, three additional boreholes (BH 11, 12, 13) were advanced at this site. The borings were advanced using hollow-stem augers and washboring techniques between 87 01 13 and 87 01 17 and were extended to depths ranging between 6.1 and 20.1 m below the ground surface. A dynamic cone penetration test accompanied one of the boreholes.

The locations of the borings are shown on Dwg. 2778502-A (Dwg. 2) of the Contract Drawings. The Record of Borehole Sheets are included in the Appendix.

The following is a brief description of the subsurface conditions encountered in these 3 borings.

Peat

A surficial deposit of dark brown peat was encountered in each of the 3 boreholes. The thickness of this organic deposit was found to vary between 0.7 and 0.9 m in the 3 boreholes sampled. The peat is fibrous in texture and shows no root mat.

Sand some/and Gravel, trace silt

Underlying the organic deposit is a non-cohesive stratum of sand, some/and gravel, trace silt. The thickness of this deposit was found to range between 3.8 and 12.5 m. From the drilling, occasional cobbles are inferred to be present within this deposit.

Grain size distribution tests were carried out on 8 samples of this cohesionless material. The results are shown in envelope form on Figure 4 in the Appendix and can be summarized as follows:

	Range
Gravel	31 - 55 %
Sand	40 - 66 %
Silt and Clay	3 - 8 %

Based on the interpretation of Standard Penetration Test 'N' values ranging between 9 and 37 blows/0.3 m, this deposit is considered to be in loose to dense state. Generally, the deposit is in a compact to dense state, with the loose zone encountered below Elev. 348.7 in BH 12.

In BH 12, the sand and gravel deposit just described was interrupted at Elev. 345.9 by a 2.2 m thick seam of fine to medium sand. Underlying the fine to medium sand is a deposit of sand with gravel trace of silt. This lower deposit of sand with gravel was found to extend to a minimum Elev. of 333.3, and was found to be in a dense state throughout. Occasional cobbles can be anticipated.

It should be noted that when this cohesionless material is subjected to a unbalanced hydrostatic pressure, 'boiling' or basal disturbance will result.

Fine to Medium Sand

A deposit of fine to medium sand was encountered in each borehole at depths ranging between 3.8 and 12.5 m below the ground surface. In BH 11, the minimum thickness of this deposit was found to be 2.3 m. However, the full thickness was not established since the boring was terminated at a depth of 6.1 m below the ground surface. In BH 12, the thickness of this deposit was found to be a minimum of 5.2 m.

A grain size distribution test was carried out on a sample (BH 11, #8) of this cohesionless material. The test indicates that this typical sample consists of 2% gravel, 95% sand, and 3% silt and clay. The results are graphically shown on Figure 5 in the Appendix.

Based on the interpretation of Standard Penetration Test 'N' values, this deposit is considered to be in a compact to dense state.

From the drilling, it is inferred that occasional cobbles are present within this deposit.

It should be noted that this material will experience 'boiling' when subjected to an unbalanced hydrostatic pressure.

GROUNDWATER CONDITIONS

The groundwater conditions were observed in the open boreholes and the levels were found to correspond to the creek level prevailing at the time. At the time of the investigation (Jan. 1987), the groundwater level was measured at Elev. 351.3±.

MISCELLANEOUS

As previously noted, BH 1 to 4 were carried out by C. Mirza Engineering. The soil descriptions pertaining to these 4 boreholes were also prepared by C. Mirza Engineering.

BH 11, 12, 13 were carried out by the MTC Foundation Design Section subsequent to the investigation carried out by the Consultant. The summary of these 3 borings was prepared by L. Politano, Project Foundations Engineer.

L. Politano, P. Eng.
Project Foundations Engineer

M. Devata, P. Eng.
Chief Foundations Engineer (East)

APPENDIX

Ministry of Transportation and Communications, Ontario

RECORD OF BOREHOLE No 1 — METRIC

W P 277-85-02 — LOCATION Station 12 + 163 o/s 4.6 Rt. ℄ Hwy 556, Line 'C' — ORIGINATED BY BP

DIST 18 HWY 556 — BOREHOLE TYPE Hollow Stem Auger and Dynamic Cone Penetration — COMPILED BY BP

DATUM Geodetic — DATE 1986 02 13 — CHECKED BY CM

OFFICE REPORT ON SOIL EXPLORATION

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES 'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
351.6	Ground Surface							
0.0	PEAT		1	ss	2	▼	351	W.L on 1986 02 16
350.9	Dk. Brown Trace of Sand							
0.7	SAND & GRAVEL		2	ss	13			
	Brown Compact to V. Dense		3	ss	72		350	46 53 (1)
	occ. Cobbles		4	ss	46		349	
347.9			5	ss	27			43 55 (2)
3.7							348	
	SAND with some Gravel Brown Medium to Coarse Compact occ. Cobbles & Boulders		6	ss	19			21 77 (2)
			7	ss	11		347	
			8	ss	13		346	
			9	ss	20		345	
343.0							344	7 91 (2)
8.6	Grey Dense occ. lens of fine Sand		10	ss	49		343	
340.5			11	ss	25		342	27 68 (5)
11.1	End of Borehole. Start of Dynamic Cone Penetration Test						341	
							340	
							339	
							338	
							337	

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 (%) — 10 20 30

UNIT WEIGHT γ

Continued

+3, ×5 : Numbers refer to Sensitivity

15 20 5 (%) STRAIN AT FAILURE

Ministry of Transportation and Communications
Ontario

RECORD OF BOREHOLE No 1 Contd. METRIC

W P 277-85-02 LOCATION Station 12+163 o/s 4.6 Rt. ℄ Hwy 556, Line 'C' ORIGINATED BY BP

DIST 18 HWY 556 BOREHOLE TYPE Hollow Stem Auger and Dynamic Cone Penetration COMPILED BY BP

DATUM Geodetic DATE 1986 02 13 CHECKED BY CM

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, 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						
336.6											
15.0							336				
							335				
							334				
333.3											
18.3	End of Dynamic Cone Penetration Test										

+3, x5 : Numbers refer to Sensitivity

15 20 10 5 (%) STRAIN AT FAILURE

OFFICE REPORT ON SOIL EXPLORATION

Ministry of Transportation and Communications
Ontario

OFFICE REPORT ON SOIL EXPLORATION

RECORD OF BOREHOLE No 2 METRIC

W P 277-85-02 LOCATION Station 12+163 o/s 4.4 Lt. ℄ Hwy 556, Line 'C' ORIGINATED BY BP
DIST 18 HWY 556 BOREHOLE TYPE Dynamic Cone Penetration Resistance Test COMPILED BY SQA
DATUM Geodetic DATE 1986 02 14 CHECKED BY CM

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: 'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE
351.6	Ground Surface						351
0.0 / 350.9	Probable PEAT						350
0.7	Probable SAND & GRAVEL						349
347.9 / 3.7	Probable SAND with some Gravel						348 347 346 345 344 343 342 341 340 339 338 337

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

Continued

$+^3$, $\times^5$: Numbers refer to Sensitivity

$15 \frac{20}{10} 5$ (%) STRAIN AT FAILURE

Ministry of Transportation and Communications
Ontario

RECORD OF BOREHOLE No 2 Contd. METRIC

W P 277-85-02 LOCATION Station 12+163 o/s 4.4 Lt. ℄ Hwy 556, Line 'C' ORIGINATED BY BP
DIST 18 HWY 556 BOREHOLE TYPE Dynamic Cone Penetration Resistance Test COMPILED BY SQA
DATUM Geodetic DATE 1986 02 14 CHECKED BY CM

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						
336.6											
15.0							336				
							335				
							334				
							333				
							332				
331.1								Hammer Bouncing			
20.5	End of Cone Penetration Test Practical Refusal										

OFFICE REPORT ON SOIL EXPLORATION

$+^3$, $\times^5$: Numbers refer to Sensitivity

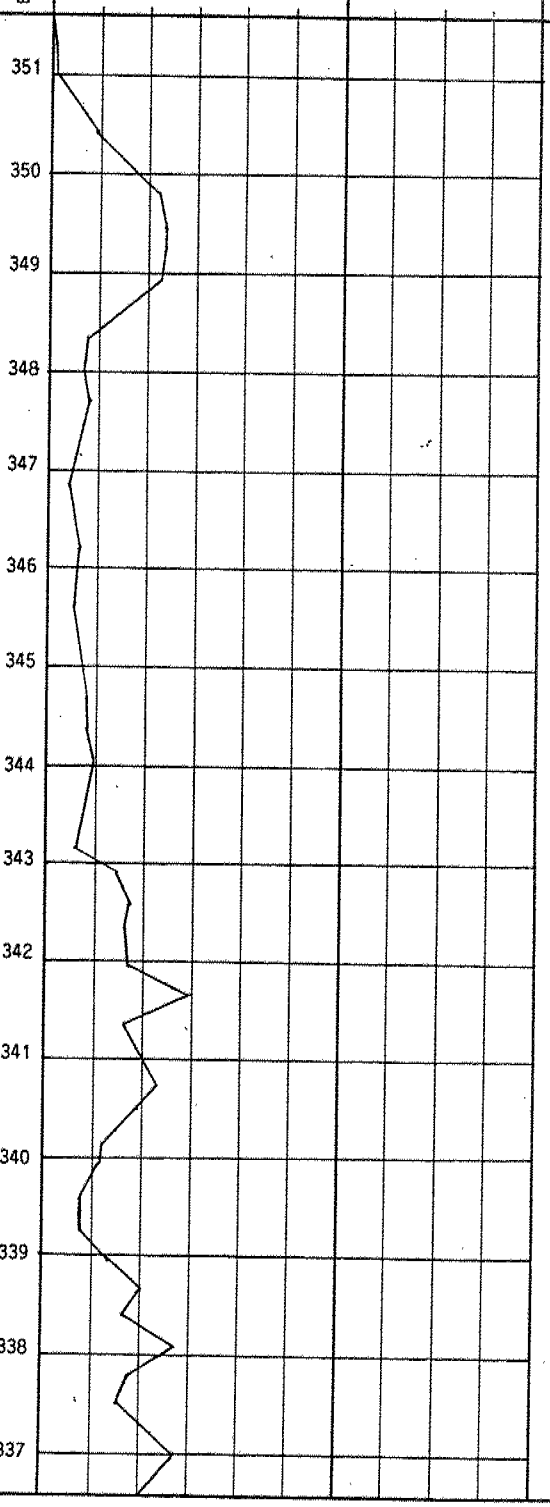
20
15 ◇ 5 (%) STRAIN AT FAILURE
10

Ministry of Transportation and Communications
Ontario

RECORD OF BOREHOLE No 3 METRIC

W P 277-85-02 LOCATION Station 12+139 o/s 6.8 Rt. ℄ Hwy 556 , Line 'C' ORIGINATED BY BP
DIST 18 HWY 556 BOREHOLE TYPE Dynamic Cone Penetration Resistance Test COMPILED BY BP
DATUM Geodetic DATE 1986 02 14 CHECKED BY CM

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
351.6	Ground Surface										
0.0	Probable PEAT										
350.9											
0.7	Probable SAND & GRAVEL										
348.2											
3.4	Probable SAND with some Gravel										
336.6											
15.0	End of Cone Penetration Test										



$+^3$, $\times^5$: Numbers refer to Sensitivity

20
15 ⊹ 5 (%) STRAIN AT FAILURE
10

OFFICE REPORT ON SOIL EXPLORATION

Ministry of Transportation and Communications
Ontario

OFFICE REPORT ON SOIL EXPLORATION

RECORD OF BOREHOLE No 4 METRIC

W P 277-85-02 LOCATION Station 12+141 o/s 4.4 Lt. ℄ Hwy 556, Line 'C' ORIGINATED BY BP
DIST 18 HWY 556 BOREHOLE TYPE Hollow Stem Auger COMPILED BY BP
DATUM Geodetic DATE 1986 02 14 CHECKED BY CM

SOIL PROFILE ELEV/DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	'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 (%) 10 20 30	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
351.3	Ground Surface										
0.0	PEAT Dk. Brown		1	ss	2	▽	351				W.L. on 1986 02 16
350.6	Trace of Sand										
0.7	SAND & GRAVEL Brown Compact to Dense occ. Cobbles		2	ss	17		350		○		
			3	ss	45						
			4	ss	42		349		○		
348.3											
3.0	SAND with some Gravel Fine Sand lens Brown Medium to Coarse Compact to V. Dense occ. Cobbles & Boulders		5	ss	19		348				18 81 (1)
			6	ss	15		347				
			7	ss	68				○		18 65 07 10
			8	ss	33		346				
							345				
							344				
			9	ss	63				○		
343.2											
8.1	End of Borehole										

$+^3$, $\times^5$: Numbers refer to Sensitivity

15 20/10 5 (%) STRAIN AT FAILURE

Ministry of Transportation and Communications
Ontario

RECORD OF BOREHOLE No 11 METRIC

W P 277-85-02 LOCATION Sta. 12 + 143 O/S 4.5 RT ℄ Hwy 556 Line 'C' ORIGINATED BY LP/MJ
DIST 18 HWY 556 BOREHOLE TYPE Hollow stem Auger COMPILED BY LP
DATUM Geodetic DATE 1987 01 13 CHECKED BY

SOIL PROFILE ELEV/DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	'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 W_L WATER CONTENT (%) 10 20 30	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
351.4	Ground Surface										
0.0	Peat		1	SS	0		351				
350.6	Trace, sand, gravel										
0.8	Sand, some gravel, trace silt		2	SS	11		350				
			3	SS	35						38 59 (3)
	Occasional cobbles.		4	SS	22		349				44 52 (4)
			5	SS	37	*1					31 66 (3)
	Compact to Dense		6	SS	16	*2	348				
347.6											
3.8	Fine to medium Sand, trace silt		7	SS	17	*3	347				
			8	SS	12						2 95 (3)
	Compact						346				
345.3						*4					
6.1	End of Borehole						345				

Notes

*1 After augering to Elev. 348.4, sand came up augers to Elev. 349.2±. Hole washed back down to Elev. 348.4. 'N' value may not be representative.

*2 After augering to Elev. 347.6, sand came up augers to Elev. 248.2±. Hole washed back down to Elev. 347.6. 'N' value may not be representative.

*3 After augering to Elev. 346.8±, sand came up augers to Elev. 347.8±. Hole washed back down to Elev. 346.8. 'N' value may not be representative.

*4 After augering to Elev. 345.3, sand came up augers to Elev. 346.8±.

Borehole was terminated.

+3, ×5 : Numbers refer to Sensitivity

20
15 ◇ 5 (%) STRAIN AT FAILURE
10

OFFICE REPORT ON SOIL EXPLORATION

Ministry of Transportation and Communications
Ontario

RECORD OF BOREHOLE No 12 METRIC

W P 277-85-02 LOCATION Sta. 12 + 143 4.5 LT ℄ Hwy. 556 Line 'C' ORIGINATED BY LP/MJ
DIST 18 HWY 556 BOREHOLE TYPE N-Casing, Washboring, Cone Penetration Test COMPILED BY LP
DATUM Geodetic DATE 1987 01 13 to 16 CHECKED BY [illegible]

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES 'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE
351.4	Ground Surface						351
0.0	Peat (probable)						
350.5							350
0.9	Sand and Gravel trace silt						
	Occ. cobbles		1	SS	31		349
	Dense		2	SS	37		
	Loose		3	SS	9		348
			4	SS	9		
345.9			5	SS	28		347
5.5	Fine to Med. Sand trace silt		6	SS	34		346
	Compact to Dense		7	WS	-		345
344.1							
7.3	Sand with gravel, trace silt		8	SS	35		344
			9	SS	39		343
	Occ. cobbles						342
			9A	SS	33		341
							340
							339
			10	SS	31		338
	Dense						337
336.8							
14.6	CONTINUED ON SHEET 2						

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 (%) 10 20 30

Cone 'bouncing' several times

UNIT WEIGHT γ

REMARKS & GRAIN SIZE DISTRIBUTION (%)

GR	SA	SI	CL	
48	45	7	0	
36	56			(8)

$+^3$, $\times^5$: Numbers refer to Sensitivity

20
15 ◇ 5 (%) STRAIN AT FAILURE
10

OFFICE REPORT ON SOIL EXPLORATION

Ministry of Transportation and Communications
Ontario

RECORD OF BOREHOLE No 12 Cont

METRIC

W P 277-85-02 LOCATION Sta. 12 - 143 O/S 4.5 Lt ℄ Hwy. 556 Line 'C' ORIGINATED BY LP/MJ

DIST 18 HWY 556 BOREHOLE TYPE N-Casing, Washboring, Cone Penettation Test COMPILED BY LP

DATUM Geodetic DATE 1987 01 13/16 CHECKED BY [illegible]

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						
336.8	Continued										
14.6	Sand with gravel Trace silt		11	SS	*		336				
	Occ. cobbles						335				
			12	SS	30		334				
333.3	Dense							Refusal			
18.1	End of Borehole Refusal to casing advancement and tricone * Spoon bouncing, probable cobble or boulder						333				

+3, ×5 : Numbers refer to Sensitivity

20
15 ◇ 5 (%) STRAIN AT FAILURE
10

OFFICE REPORT ON SOIL EXPLORATION

Ministry of Transportation and Communications
Ontario

RECORD OF BOREHOLE No 13 METRIC

W P 277-85-02 LOCATION Sta. 12 + 159 at ℄ Hwy. 556 ORIGINATED BY MJ
DIST 18 HWY 556 BOREHOLE TYPE Hollow stem Augers, N & B Casing, Washboring, cone Test COMPILED BY LP
DATUM Geodetic DATE 1987 01 16 and 17 CHECKED BY [illegible]

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'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 (%) (10 20 30)	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
351.3	Ground Surface										
0.0 / 350.6	Peat with sand		1	SS	4		351				
0.7	Sand and gravel, trace silt		2	SS	19				○		50 45 (5)
			3	SS	35		350		○		53 43 (4)
	Occ. cobbles		4	SS	36		349		○		55 40 (5)
			5	SS	10		348				
			6	SS	15		347				
							346				
							345				
							344				
			7	SS	23		343				
	Compact to Dense						342				
							341				
			8	SS	77	*	340				
338.8 / 12.5							399				
	Fine to Med. sand Some silt, trace gravel						338				
	Occ. cobbles		9	SS	5	**	337				
336.2 / 15.1											

+3, ×5 : Numbers refer to Sensitivity

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

OFFICE REPORT ON SOIL EXPLORATION

RECORD OF BOREHOLE No 13 Cont METRIC

W P 277-85-02 LOCATION Sta. 12 + 159 at ℄ Hwy. 556 Line 'C' ORIGINATED BY MJ

DIST 18 HWY 556 BOREHOLE TYPE Hollow Stem Augers, N & B Casing, Washboring, Cone Test COMPILED BY LP

DATUM Geodetic DATE 1987 01 16 and 17 CHECKED BY [illegible]

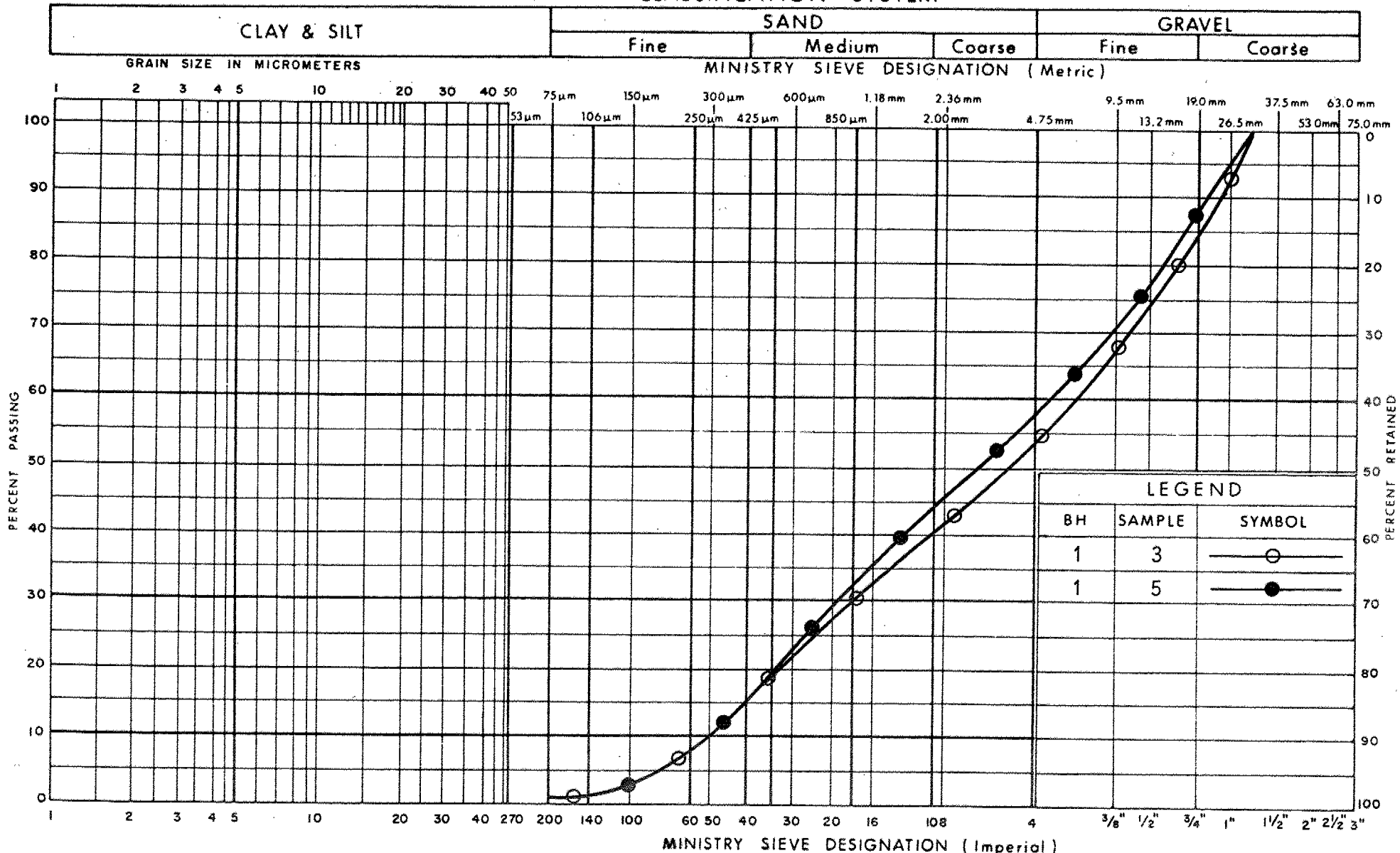
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: 'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE)	PLASTIC LIMIT Wp / NATURAL MOISTURE CONTENT W / LIQUID LIMIT W_L — WATER CONTENT (%)	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
336.2	CONTINUED										
15.1	Fine to Med. Sand Some silt, trace gravel Occ. cobbles						336 335				
336.6	Dense		10	SS	38		334				
17.7	End of Borehole						333 332	Refusal			
331.2											
20.1	End of Cone Test Refusal to Cone * Spoon bouncing probable cobble ** Sample probably disturbed due to unbalanced hydrostatic pressure.										

+3, ×5 : Numbers refer to Sensitivity

15 20 10 5 (%) STRAIN AT FAILURE

OFFICE + REPORT ON SOIL EXPLORATION

UNIFIED SOIL CLASSIFICATION SYSTEM



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Ontario

GRAIN SIZE DISTRIBUTION

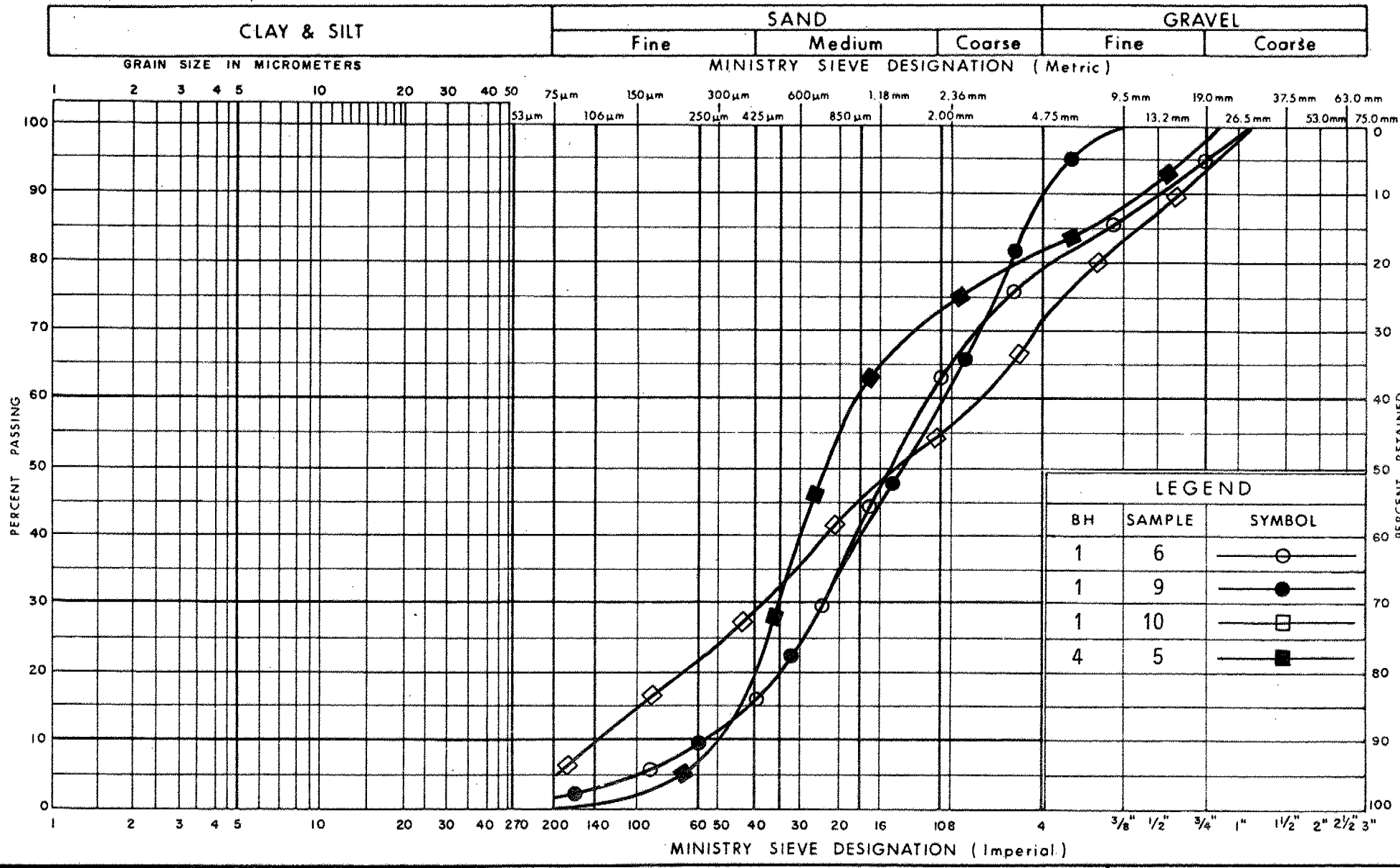
SAND & GRAVEL

FIG No 1

W P 277-85-02

37

UNIFIED SOIL CLASSIFICATION SYSTEM



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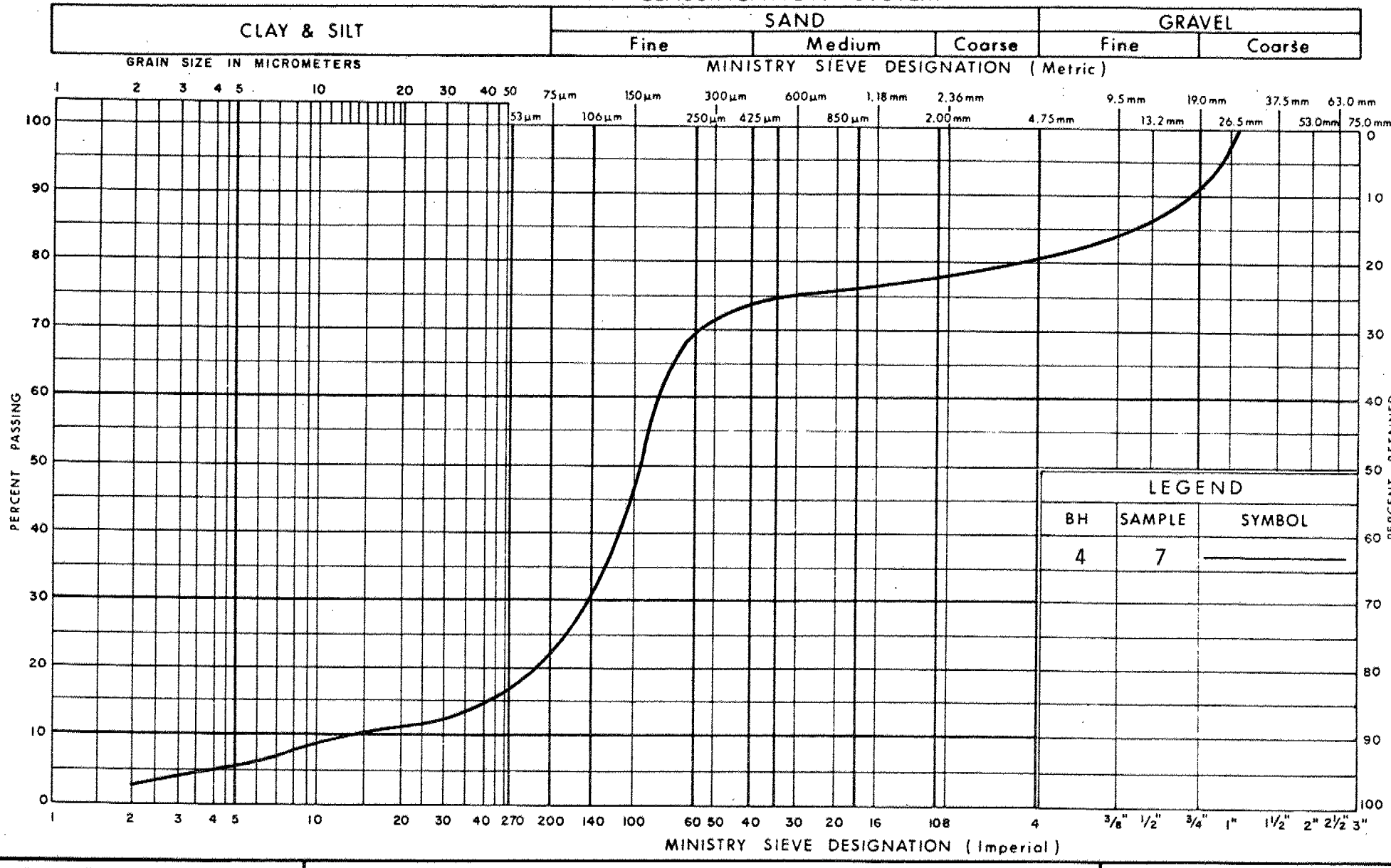
GRAIN SIZE DISTRIBUTION

Medium SAND
with Gravel

FIG No 2
W P 277-85-02

UNIFIED SOIL CLASSIFICATION SYSTEM



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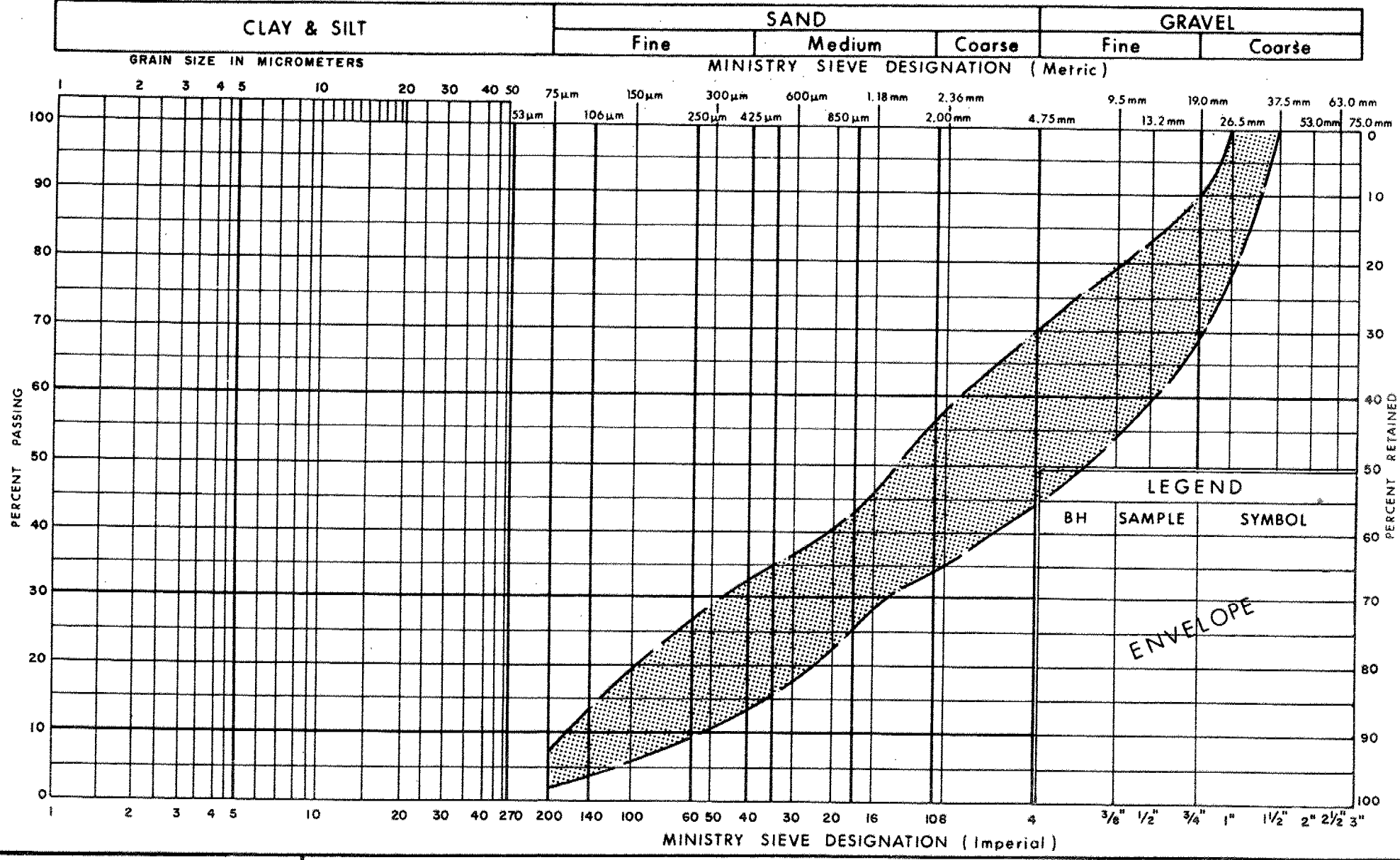
GRAIN SIZE DISTRIBUTION

Fine SAND
with Gravel, and a trace of Silt & Clay

FIG No 3
W P 277-85-02

UNIFIED SOIL CLASSIFICATION SYSTEM



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GRAIN SIZE DISTRIBUTION

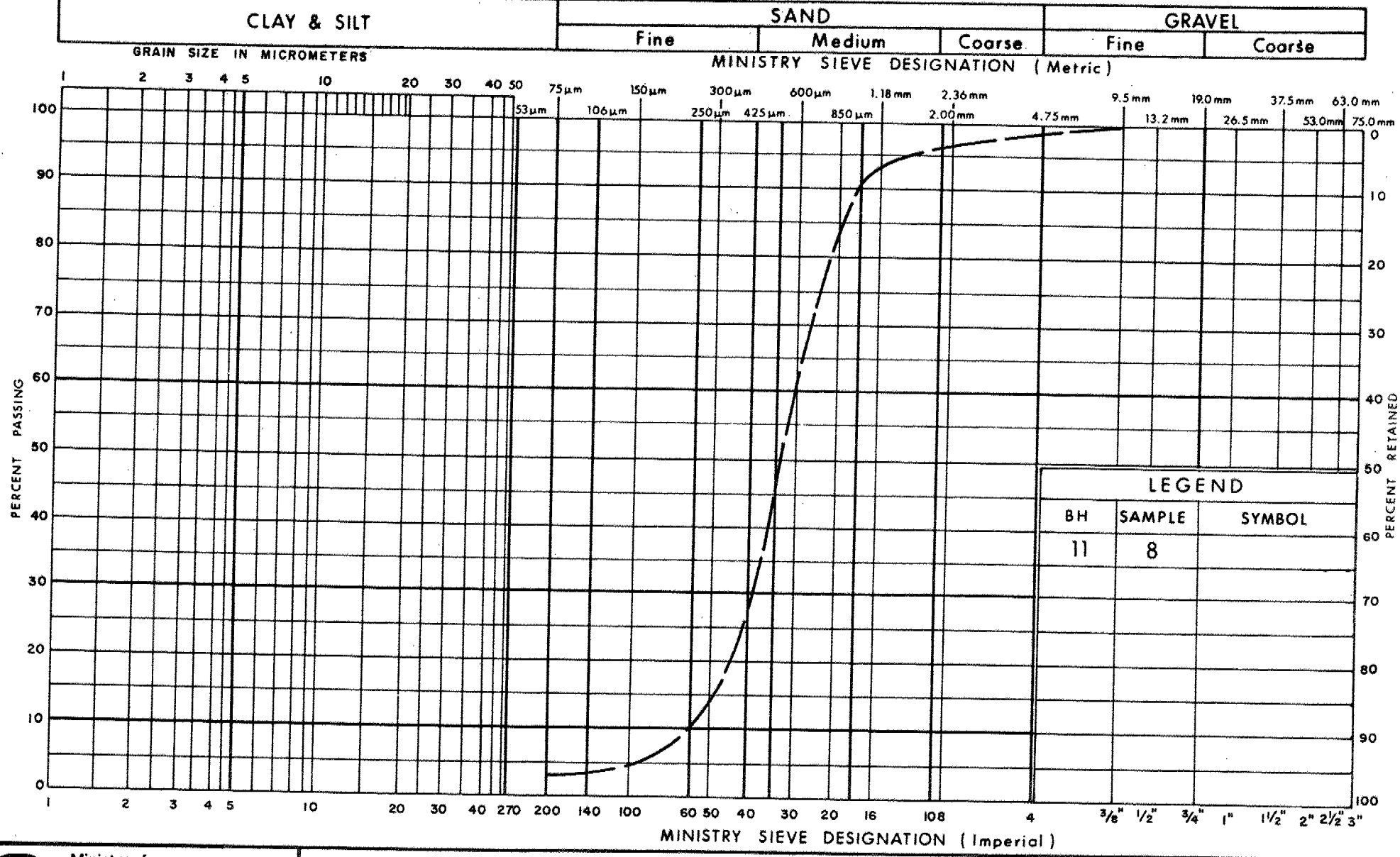
SAND SOME / AND GRAVEL , TRACE SILT

FIG No 4

W P 277-85-02

40

UNIFIED SOIL CLASSIFICATION SYSTEM



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GRAIN SIZE DISTRIBUTION
Fine - Med SAND

FIG No 5
W P 277-85-02

FOUNDATION INVESTIGATION REPORT
For
W.P. 278-85-01, Kinnihan Creek
Hwy. 556, Site 38S-22
District 18, Sault Ste. Marie

INTRODUCTION

Peto MacCallum Ltd. was retained by the Ministry of Transportation and Communications (MTC), to carry out a foundation investigation for the proposed Kinnihan Creek Structure on Hwy. 556 in the District of Sault St. Marie, Ontario.

The purpose of the investigation was to determine detailed subsurface soil and groundwater conditions at the site.

The fieldwork involved 9 boreholes (BH 1 to BH 9) ranging in depths from 0.6 to 8 m below the ground surface. Three of the boreholes were accompanied by dynamic cone penetration tests.

Dwg. 2 in the Contract Drawings indicates in plan the location of each borehole, together with 2 stratigraphical sections.

The fieldwork for this project was carried out between 86 02 03 and 86 02 05 utilizing a CME-55 Bombadier-mounted drill rig equipped with continuous flight hollow stem augers.

Subsequent to the investigation carried out by Peto MacCallum Ltd., the Foundation Design Section advanced an additional 3 sampled boreholes (BH 10, 11, 12) and 2 independent cone penetration tests (BH 13, 14) at this site. The findings from this additional fieldwork are discussed in an addendum on Page 43 of this report.

SITE DESCRIPTION

The Kinnihan Creek is approximately 5 m wide in the vicinity of the proposed structure and the water was flowing at about 0.5 m depth at the time of the fieldwork.

The creek channel is about 1.0 m deep and flows through a flood plain which is approximately 50 to 60 m wide. The flood plain is vegetated with small bushes whereas the ground to the east and west of the flood plain is vegetated with mature deciduous and coniferous trees.

SUBSURFACE CONDITIONS

We refer to the appended Record of Borehole sheets in the Appendix, for details of the fieldwork including soil classifications inferred stratigraphy, standard penetration 'N' values, dynamic cone penetration tests, groundwater observations in the open boreholes during and upon completion of drilling and laboratory moisture content determination test results.

The summarized subsurface conditions are presented on sections and profiles included on the appended plan.

The stratigraphy at the creek crossing generally comprises either topsoil or peat overlying major fluvial deposits of gravelly sand and sandy gravel.

Topsoil/Peat

Boreholes 2, 4 and 8 put down on the east and west sides of the flood plain encountered 150 to 300 mm of dark brown sandy silt topsoil.

Elsewhere boreholes 1, 3, 5, 6, 7 and 9 drilled within the flood plain environment encountered shallow peat deposits extending to depths between 1.0 and 2.1 m. The peat deposits were thickest to the north of the proposed road centreline.

Gravelly Sand/Sandy Gravel

Underlying the surficial peat and topsoil, the boreholes encountered major deposits of gravelly sand and sandy gravel to the termination depths. Grain size distribution analyses carried out on split spoon samples are illustrated on Figures 1, 2 and 3. It should be noted that the sampling procedures exclude particles larger than about 40 mm and consequently the gravel contents in the field are higher than indicated by the laboratory tests. The deposits typically contain numerous cobbles and boulders.

The granular soils are generally loose to very dense with depth based on standard penetration 'N' values and dynamic cone penetration tests ranging from 3 to in excess of 100 blows per 0.3 m. The native soils are generally saturated below depths of about 1.0 m and may boil when subjected to an unbalanced hydrostatic head.

GROUNDWATER

The groundwater observations carried out in the open boreholes during and upon completion of drilling indicate that the stabilized groundwater level at the site presently matches the water level in the creek which is at about elevation 351.9. The groundwater levels would be expected to fluctuate seasonally with the creek level.

Two (2) chemical analysis conducted on samples of the groundwater are summarized on Table 1 and indicate pH values of 7.4 and 7.5 with sulphate contents as SO_4 of 58 and 96 ppm.

ADDENDUM (BH 10, 11, 12, 13, 14)

As mentioned in the Introduction of this report 3 additional sampled boreholes and 2 independent dynamic cone penetration tests were carried out at this site. The location of the additional borings are shown on Dwg. 2 of the Contract Drawings. The Record of Borehole Sheets for these borings are included in the Appendix.

The fieldwork for this additional work was carried out on 87 01 20. The sampled boreholes (BH 10, 11, 12) were advanced to a depth of 4.4 m below the ground surface.

The following is a brief description of the subsurface conditions encountered in BH 10, 11 and 12.

BH 10

Extending from the ground surface down to a depth of 2.1 m is a deposit of peat. The peat is generally black in colour and contains numerous roots, with decaying wood and leaves.

Underlying the surficial organic deposit is a deposit of fine sand with silt. A grain size distribution test carried out on a sample of this material (BH 10, #5) indicates that the sample consisted of 1% gravel, 60% sand and 39% silt and clay. The results are shown on Fig. 4 in the Appendix. Based on the interpretation of Standard Penetration Test 'N' values of 6 blows/0.3 m, this deposit is considered to be in a loose state within the zone investigated. The full depth of this cohesionless deposit was not established as the borehole was terminated at 4.4 m below the ground surface.

It should be noted that 'boiling' will result when this deposit is subjected to an unbalanced hydrostatic pressure.

BH 11

A surficial cover of peat was found for a depth of 0.8 m below the ground surface. The peat is generally black in colour and contains numerous roots, with decaying wood and leaves.

Underlying the organic deposit is a cohesionless deposit consisting of medium to coarse sand, trace/some gravel, trace silt. This deposit has a thickness of 2.2 m. Two grain size distribution tests were carried out on samples of this material. The following are the results:

	#3	#4
Gravel	6	26
Sand	90	71
Silt and Clay	4	3

The results of these two tests are shown on Fig. 4 in the Appendix.

Based on the interpretation of Standard Penetration Test 'N' values of 5 blow/0.3 m, this deposit is considered to be in a loose state.

It should be noted that when subjected to an unbalanced hydrostatic pressure, the base of an excavation will be disturbed and the fines may experience 'boiling'.

Underlying the medium to coarse sand deposit, is a non-cohesive stratum of fine sand with silt. The full extent of this loose deposit was not established as the borehole was terminated at a depth of 4.4 m below the ground surface.

BH 13, 14

These two boreholes consisted only of dynamic cone penetration tests. The results of these tests are shown on the Record of Borehole Sheets for these two holes.

GROUNDWATER CONDITIONS (BH 10 to 14)

At the time of the investigation, (Jan. 1987) the groundwater level was found to be at Elev. 351.8±.

MISCELLANEOUS

As previously noted, BH 1 to 9 were carried out by Peto McCallum Ltd. The soil descriptions pertaining to the boreholes were also prepared by Peto McCallum Ltd.

BH 10 to 14 were carried out by the MTC Foundation Design Section subsequent to the investigation carried out by the consultant. The summary of the soil conditions in these boreholes were prepared by L. Politano, Project Foundation Engineer.

L. Politano, P. Eng.
Project Foundations Engineer

M. Devata, P. Eng.
Chief Foundations Engineer (East)

APPENDIX

Ministry of Transportation and Communications
Ontario

OFFICE REPORT ON SOIL EXPLORATION

RECORD OF BOREHOLE No 1

METRIC

W P 278-85-01 LOCATION Sta. 12 + 420 o/s 13m Rt. ℄ Line 'C' ORIGINATED BY PC

DIST 18 HWY 556 BOREHOLE TYPE Hollow Stem Auger, Wash Boring & Cone Test COMPILED BY GM

DATUM Geodetic DATE 1986 02 04 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 (%) (20 40 60)	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES						
352.39	Ground Level										GR SA SI CL
0.00	Peat		1	SS	14*		352			172	*Frozen
351.19	Very Soft Dark Brown		2	SS	2						
1.20	Gravelly fine to medium sand, trace silt, numerous cobbles		3	SS	10		350				8 88 (4)
	Loose to Compact		4	SS	8						
348.39	Brown		5	SS	10						
4.00	Sandy gravel, trace silt, numerous cobbles and boulders		6	SS	25		348				
	Compact to Very Dense		7	SS	56		346				
344.34	Brown		8	SS	50						
8.05	End of Borehole										

$+^3$, $\times^5$: Numbers refer to Sensitivity

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

Ministry of Transportation and Communications
Ontario

RECORD OF BOREHOLE No 2 METRIC

W P 278-85-01 LOCATION Sta. 12 + 417 ℄ Line 'C' ORIGINATED BY PC
DIST 18 HWY 556 BOREHOLE TYPE Hollow Stem Auger, Cone Test COMPILED BY GM
DATUM Geodetic DATE 1986 02 04 CHECKED BY GM

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 W_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
352.54	Ground Level										
352.24 / 0.30	Topsoil dark brown		1	SS	19	▼	352				
	Sandy gravel, trace silt, numerous cobbles and boulders		2	SS	33						51 41 (8)
	Compact to Very Dense		3	SS	55						
			4	SS	15		350				
	Brown		5	SS	68						
			6	SS	28		348				
			7	SS	23		346				
345.19			8	SS	13						
7.35	End of Borehole										

OFFICE REPORT ON SOIL EXPLORATION

+3, ×5 : Numbers refer to Sensitivity

15 20 10 5 (%) STRAIN AT FAILURE

Ministry of Transportation and Communications
Ontario

RECORD OF BOREHOLE No 3 METRIC

W P 278-85-01 LOCATION Sta. 12 + 434 o/s 7m Lt. ℄ Line 'C' ORIGINATED BY PC
DIST 18 HWY 556 BOREHOLE TYPE Hollow Stem Auger, Wash Boring & Cone Test COMPILED BY GM
DATUM Geodetic DATE 1986 02 04 CHECKED BY GM

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 (%) 20 40 60	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
352.52	Ground Level										
0.00	Peat		1	SS	4		352			○ 111	
	Very Soft Dark Brown		2	SS	2/450mm					○ 83	
350.37			3	SS	2/450mm					○ 93	
2.15	Gravelly fine to coarse sand, trace silt, numerous cobbles and boulders		4	SS	7		350		○		
348.87			5	SS	13				○		
3.65	Loose to Compact Brown										
	Sandy gravel, trace silt, numerous cobbles and boulders		6	WS			348	100/130 mm	○		
346.42	Compact Brown										
6.10	Gravelly fine to coarse sand, trace silt, numerous cobbles		7	SS	17		346		○		12 73 (15)
344.47	Compact Brown		8	SS	23				○		
8.05	End of Borehole										

+3, ×5 : Numbers refer to Sensitivity

15 20 5 (%) STRAIN AT FAILURE 10

OFFICE REPORT ON SOIL EXPLORATION

Ministry of Transportation and Communications
Ontario

RECORD OF BOREHOLE No 4 METRIC

W P 278-85-01 LOCATION Sta. 12 + 408 ℄ Line 'C' ORIGINATED BY PC
DIST 18 HWY 556 BOREHOLE TYPE Hollow Stem Auger COMPILED BY GM
DATUM Geodetic DATE 1986 02 04 CHECKED BY GM

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 (%) 20 40 60	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
352.67	Ground Level										
352.49 0.18	Topsoil dark brown										
	Sandy gravel, trace silt, numerous cobbles and boulders		1	SS	11				○		
			2	SS	26		352		○		42 52 (6)
			3	SS	50/50mm	*					
	Compact to Dense		4	SS	49				○		
349.42	Brown						350				
3.25	End of Borehole		5	SS	55/200mm	*			○		

*Note: High "N" value due to presence of boulders and cobbles.

OFFICE REPORT ON SOIL EXPLORATION

+3, ×5 : Numbers refer to Sensitivity

20
15 ⊹ 5 (%) STRAIN AT FAILURE
10

Ministry of Transportation and Communications
Ontario

RECORD OF BOREHOLE No 5 METRIC

W P 278-85-01 LOCATION Sta. 12 + 448 o/s 1m Lt. ℄ Line 'C' ORIGINATED BY PC
DIST 18 HWY 556 BOREHOLE TYPE Hollow Stem Auger COMPILED BY GM
DATUM Geodetic DATE 1986 02 03 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 (%) (20 40 60)	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES						
352.68	Ground Level										
	Peat		1	SS	2/490mm						
	Sand layers below 0.60m						352				
351.48	Very Soft Dark Brown		2	SS	15				o		
1.20	Sandy gravel, trace silt, numerous cobbles and boulders		3	SS	10				o		
349.63	Compact to Loose Grey		4	SS	8		350		o		
3.05	End of Borehole									o 82	

+3, ×5 : Numbers refer to Sensitivity

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

OFFICE REPORT ON SOIL EXPLORATION

Ministry of Transportation and Communications
Ontario

RECORD OF BOREHOLE No 6 METRIC

W P 278-85-01 LOCATION Sta. 12 + 432.5 ℄ Line 'C' ORIGINATED BY PC
DIST 18 HWY 556 BOREHOLE TYPE Hollow Stem Auger COMPILED BY GM
DATUM Geodetic DATE 1986 02 05 CHECKED BY GK

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 (%) (20 40 60)	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
352.51	Ground Level										
0.00	Peat						352				
351.01	Very Soft Dark Brown		1	SS	2/600mm				o		
1.50	Sandy gravel, trace silt, numerous cobbles and boulders										
350.36	Very Loose Brown		2	SS	3				o		
2.15	End of Borehole										

OFFICE REPORT ON SOIL EXPLORATION

+3, ×5 : Numbers refer to Sensitivity

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

Ministry of Transportation and Communications
Ontario

RECORD OF BOREHOLE No 7 METRIC

W P 278-85-01 LOCATION Sta. 12 + 455 ℄ Line 'C' ORIGINATED BY PC
DIST 18 HWY 556 BOREHOLE TYPE Hollow Stem Auger COMPILED BY GM
DATUM Geodetic DATE 1986 02 06 CHECKED BY

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 W_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
352.69	Ground Level										
0.00	Peat										
	Very Soft Dark Brown						352				
351.64											
351.29	Sandy gravel, trace silt, numerous cobbles and boulders		1	SS	4/450mm				○		
1.40	Very Loose Brown										
	End of Borehole										

OFFICE REPORT ON SOIL EXPLORATION

+3, ×5 : Numbers refer to Sensitivity

15 20/10 5 (%) STRAIN AT FAILURE

Ministry of Transportation and Communications
Ontario

RECORD OF BOREHOLE No 8 METRIC

W P 278-85-01 LOCATION Sta. 12 + 456 Ø Line 'C' ORIGINATED BY PC
DIST 18 HWY 556 BOREHOLE TYPE Hollow Stem Auger COMPILED BY GM
DATUM Geodetic DATE 1986 02 05 CHECKED BY GM

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 (%) (20 40 60)	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES						
352.62	Ground Level										
352.52 0.10	Topsoil Dark Brown										
351.97 0.65	Sandy gravel, trace silt, numerous cobbles and boulders Dark Brown to Brown		1	AS			352				
	End of Borehole (Refusal to auger on boulder)										
	Note: No water encountered during drilling.										

OFFICE REPORT ON SOIL EXPLORATION

+3, ×5 ; Numbers refer to Sensitivity

20
15 ◇ 5 (%) STRAIN AT FAILURE
10

Ministry of Transportation and Communications
Ontario

RECORD OF BOREHOLE No 9 METRIC

W P 278-85-01 LOCATION Sta. 12 + 445 o/s 8m Lt. ℄ Line 'C' ORIGINATED BY PC
DIST 18 HWY 556 BOREHOLE TYPE Hollow Stem Auger COMPILED BY GM
DATUM Geodetic DATE 1986 02 05 CHECKED BY

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 W_L — WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
352.51	Ground Level										
0.00	Peat						352				
	Very Soft Dark Brown		1	SS	2/600mm	▼			○		
351.01											
1.50	Sandy gravel, trace silt, numerous cobbles and boulders		2	SS	5				○		
350.36											
2.15	Loose Brown										
	End of Borehole										

OFFICE REPORT ON SOIL EXPLORATION

+3, ×5 : Numbers refer to Sensitivity

20
15 ◇ 5 (%) STRAIN AT FAILURE
10

Ministry of Transportation and Communications
Ontario

RECORD OF BOREHOLE No 10 METRIC

W P 278-85-01 LOCATION Sta. 12 + 446 O/S 12.5 Lt ℄ Hwy 556 ORIGINATED BY MJ

DIST 18 HWY 556 BOREHOLE TYPE Hollow Stem Auger, Cone Test COMPILED BY LP

DATUM Geodetic DATE 1987 01 20 CHECKED BY

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 (%) (10 20 30)	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
352.3	Ground Surface										
0.0	Peat		1	SS	1	▼	352				
			2	SS	0						
			3	SS	0						
350.2			4	SS	2		350				1 60 (39)
2.1	some gravel										
	Fine sand with silt sand becoming finer with depth		5	SS	6				○		
347.9	Loose		6	SS	6		348				
4.4	End of Borehole										
345.9							346				
6.4	End of Cone Test										

$+^{3}$, $\times^{5}$: Numbers refer to Sensitivity

20
15 ⊹ 5 (%) STRAIN AT FAILURE
10

OFFICE REPORT ON SOIL EXPLORATION

Ministry of Transportation and Communications
Ontario

RECORD OF BOREHOLE No 11 METRIC

W P 278-85-01 LOCATION Sta. 12 + 445 at ℄ Hwy. 556 ORIGINATED BY MJ
DIST 18 HWY 556 BOREHOLE TYPE Hollow Stem Auger, Cone Test COMPILED BY LP
DATUM Geodetic DATE 1987 01 20 CHECKED BY [illegible]

SOIL PROFILE ELEV/DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	'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 (%) (10 20 30)	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
352.5	Ground Surface										
0.0 / 351.7	Peat		1	SS	0	▼	352				
0.8	Med. Coarse Sand, trace/some gravel, trace silt		2	SS	6						
			3	SS	5						6 90 (4)
349.5	Loose		4	SS	5		350				26 71 (3)
3.0	Fine sand with silt		5	SS	4						
348.1	Loose		6	SS	6		348				0 61 (39)
4.4 / 346.1	End of Borehole										
6.4	End of Cone Test						346				

OFFICE REPORT ON SOIL EXPLORATION

+3, ×5 : Numbers refer to Sensitivity

20
15 ◇ 5 (%) STRAIN AT FAILURE
10

Ministry of Transportation and Communications
Ontario

RECORD OF BOREHOLE No 12

METRIC

W P 278-85-01 LOCATION Sta. 12 + 444 O/S 11.5 RT ℄ Hwy. 556 ORIGINATED BY MJ

DIST 18 HWY 556 BOREHOLE TYPE Hollow Stem Auger and Cone Test COMPILED BY LP

DATUM Geodetic DATE 1987 01 20 CHECKED BY LP

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 (%) (10 20 30)	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
352.5	Ground Surface										
0.0 / 351.6	Peat	≈≈≈	1	SS	1	▼	352				
			2	SS	11						
0.9	Sand, trace/some silt gravel (well-graded)	⋰⋱	3	SS	17				○		33 63 (4)
			4	SS	2		350				
	Loose to Compact		5	SS	9				○		1 85 14
348.1	fine sand		6	SS	11		348				
4.4 / 346.4	End of Borehole										
6.1	End of Cone Test						346				

+3, ×5 : Numbers refer to Sensitivity

15 20 10 5 (%) STRAIN AT FAILURE

OFFICE REPORT ON SOIL EXPLORATION

Ministry of Transportation and Communications
Ontario

RECORD OF BOREHOLE No 13

METRIC

W P 278-85-01 LOCATION Sta. 12 + 445 O/S 6 RT ℄ Hwy. 556 ORIGINATED BY MJ

DIST 18 HWY 556 BOREHOLE TYPE Cone Test COMPILED BY LP

DATUM Geodetic DATE 1987 01 20 CHECKED BY [illegible]

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						
352.5	Ground Surface										
0.0							352				
							350				
							348				
346.1											
6.4	End of Cone Test										

+3, ×5 : Numbers refer to Sensitivity

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

OFFICE REPORT ON SOIL EXPLORATION

Ministry of Transportation and Communications
Ontario

RECORD OF BOREHOLE No 14

METRIC

W P 278-85-01 LOCATION Sta. 12 + 445 O/S 6 LT ℄ Hwy. 556 ORIGINATED BY MJ

DIST 18 HWY 556 BOREHOLE TYPE Cone Test COMPILED BY LP

DATUM Geodetic DATE 1987 01 20 CHECKED BY

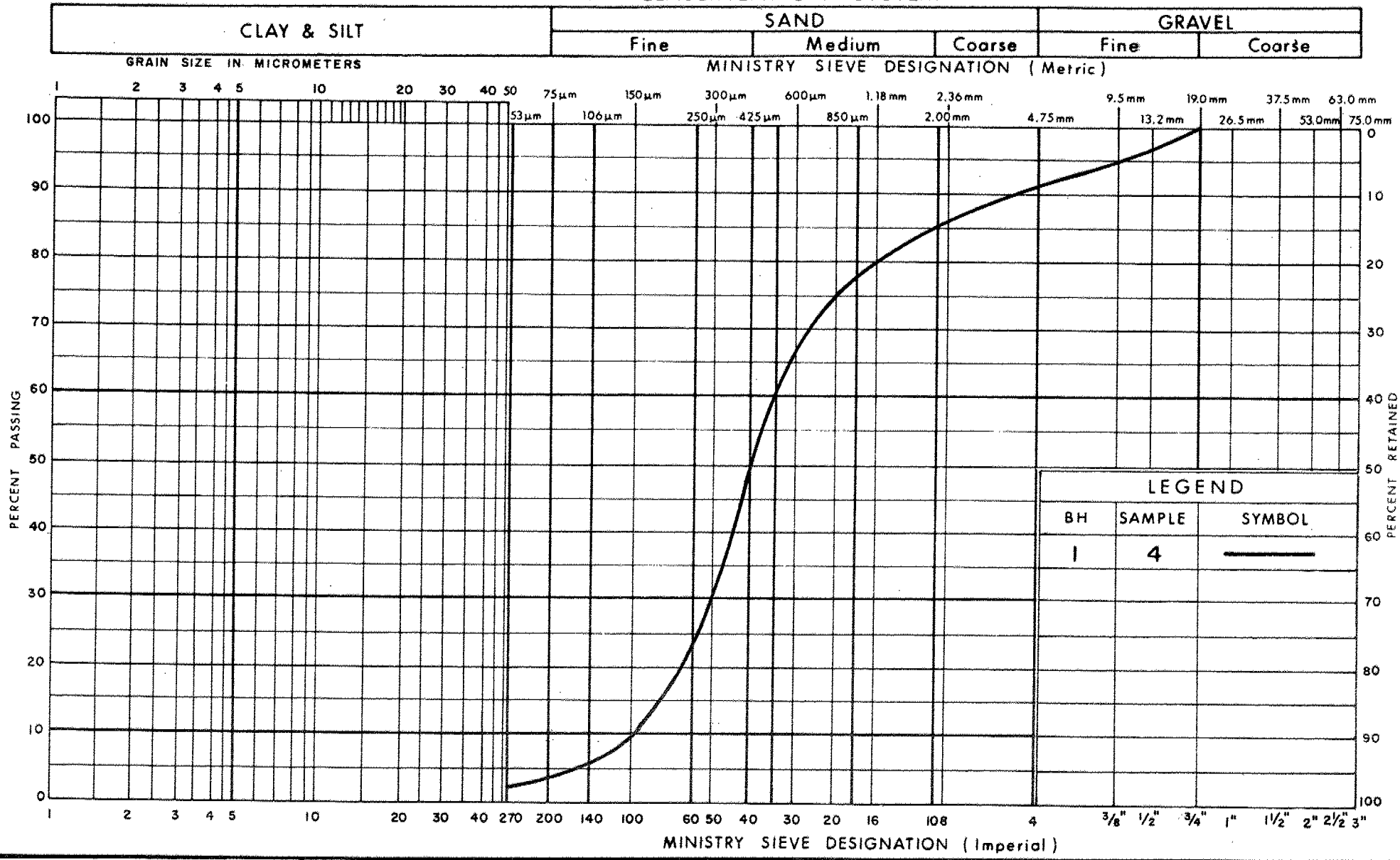
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) SHEAR STRENGTH ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE	PLASTIC LIMIT W_P — NATURAL MOISTURE CONTENT W — LIQUID LIMIT W_L WATER CONTENT (%)	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES						
352.5											
0.0							352				
							350				
							348				
346.1											
6.4	End of Cone Test										

OFFICE REPORT ON SOIL EXPLORATION

$+^3$, $\times^5$: Numbers refer to Sensitivity

20
15 ⊹ 5 (%) STRAIN AT FAILURE
10

UNIFIED SOIL CLASSIFICATION SYSTEM



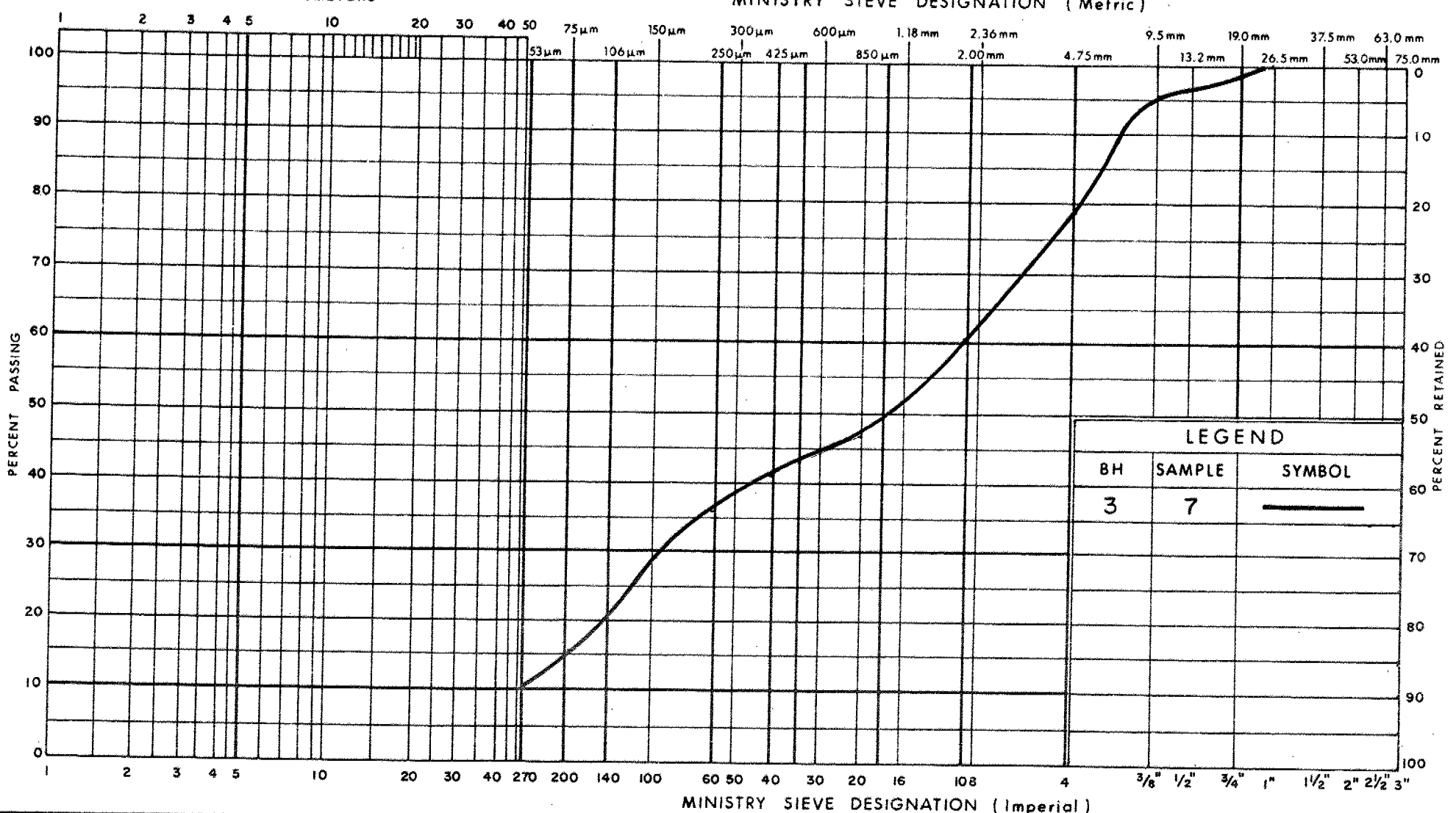
Ministry of Transportation and Communications
Ontario

GRAIN SIZE DISTRIBUTION
GRAVELLY FINE TO MEDIUM SAND
TRACE SILT, NUMEROUS COBBLES

FIG No 1
WP 278-85-01

UNIFIED SOIL CLASSIFICATION SYSTEM

CLAY & SILT	SAND			GRAVEL	
	Fine	Medium	Coarse	Fine	Coarse

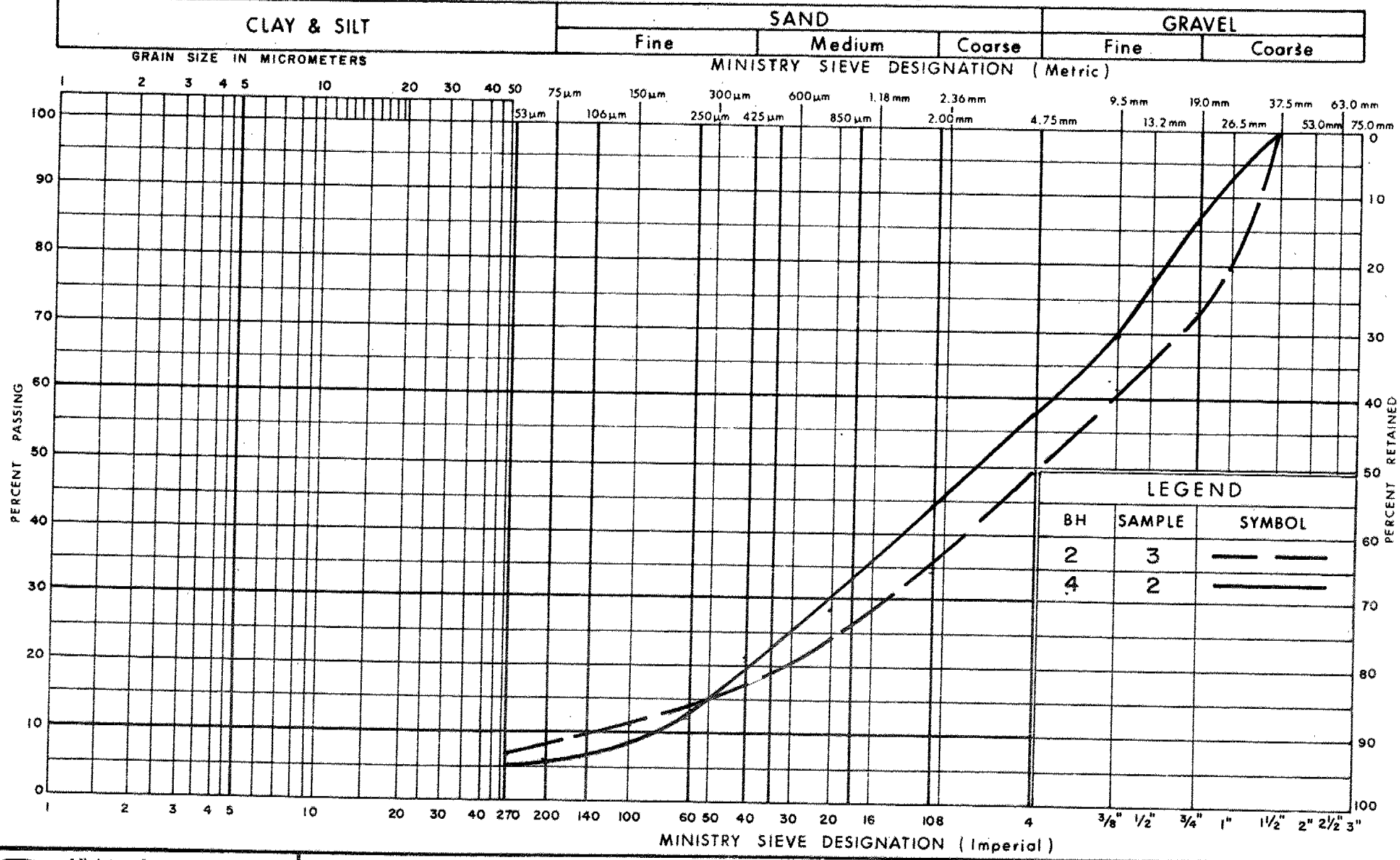


Ministry of Transportation and Communications
Ontario

GRAIN SIZE DISTRIBUTION
GRAVELLY FINE TO COARSE SAND
TRACE SILT, NUMEROUS COBBLES

FIG No 2
W P 278 - 85 - 01

UNIFIED SOIL CLASSIFICATION SYSTEM

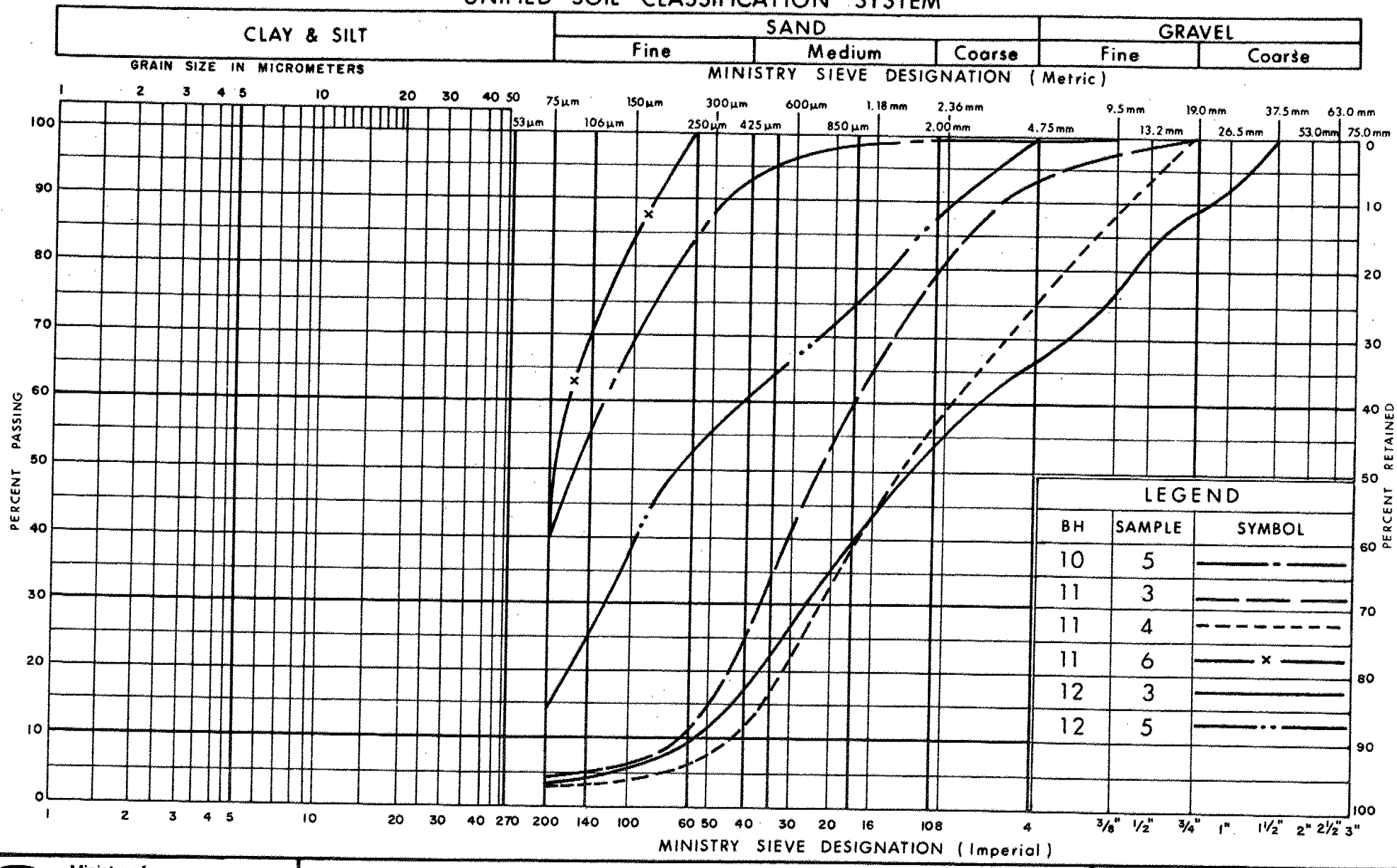


Ministry of Transportation and Communications
Ontario

GRAIN SIZE DISTRIBUTION
SANDY GRAVEL
TRACE SILT, NUMEROUS COBBLES & BOULDERS

FIG No 3
W P 278 - 85 - 01

UNIFIED SOIL CLASSIFICATION SYSTEM



Ministry of Transportation and Communications
Ontario

GRAIN SIZE DISTRIBUTION

FIG No 4
W P 278-85-01

JOB NO. 86 F 11
Feb. 26, 1986

TABLE I

pH VALUE AND SULPHATE CONTENT OF WATER SAMPLES

KINNIHAN CREEK STRUCTURE
HIGHWAY 556
DISTRICT OF SAULT STE. MARIE

BOREHOLE NO.	DEPTH (m)	pH VALUE	SULPHATE CONTENT ppm as SO_4	RELATIVE DEGREE SULPHATE ATTACK ON CONCRETE
4	1.0	7.5	96	Negligible
2	1.0	7.4	58	Negligible

PETO MacCALLUM LTD.

memorandum

Ontario

To: Mr. O. E. Ramakko
Head, Structural Section
Northwestern Region-Thunder Bay

Date: 1986 03 21

From: Engineering Materials Office
Foundation Design Section
Central Building, Room 315

Re: Foundation Investigation Report
W.P. 277-85-01, Site No. 38S-20
Hwy 556, Little Garden River Crossing No. 1

Terraprobe Limited was retained by this section to carry out a foundation investigation at the above-noted site and provide recommendations for the design and construction of the proposed structure and the associated fills.

During the progress of the project, this section reviewed a draft of the report for technical content. Attached, please find a copy of the final report.

If you have any questions, please contact the undersigned.

L. Politano
Project Foundations Engineer

for M. Devata
Chief foundations Engineer
(East)

LP:gp

cc: FILE

memorandum

Ontario

Tel: 7101

To: O. Ramakko
Head, Structural Section
Northwestern Region

Date: 1987 02 20

From: Foundation Design Section
Room 315, Central Building

RE: Additional Boring at
Little Garden River Crossing #1
W.P. 277-85-01, Site 38S-20, Hwy. 55
District 18 - Sault Ste. Marie

As discussed in our memorandum dated 86 11 07, this Section has advanced an additional borehole at the above-noted site. The additional boring was necessary because the proposed single span structure was relocated some 15 m west subsequent to the original foundation investigation.

The additional borehole (B.H. 5) was advanced using hollow stem augers and washboring techniques between 87 01 18 and 87 01 20. The borehole was advanced to bedrock (Elev. 339.9), approximately 5.9 m below the ground surface. 2.1 m of rock core was also obtained. A cone penetration test also accompanied the borehole. The attached plan indicates the location of all the borings carried out at this site including the four boreholes (B.H. 1 to B.H. 4) advanced for the original investigation in February, 1986.

The following is a brief description of the subsurface conditions encountered in B.H. 5. A draft version of the Record of Borehole Sheets is attached for your information.

South Abutment (B.H. 5)

Extending from the ground surface (Elev. 345.8) down to a depth of 0.7 m is a deposit of peat. The peat was generally black in colour and contained numerous roots and decaying wood and leaves.

Underlying the peat and extending to a depth of 5.2 m below the ground surface is cohesionless deposit consisting of sand, some silt, some gravel. From the drilling, frequent cobbles and boulders may be inferred to be present within this deposit. Based on the interpretation of Standard Penetration Test 'N' values, this deposit can be considered to generally be in a dense to very dense state. It should be noted that the upper surface of this deposit consists of a fine silty sand. It should be noted that this non-cohesive stratum may 'boil' or be 'disturbed' when subjected to an unbalanced hydrostatic pressure. No laboratory test results of samples of this material are available at this time.

Underlying the sand previously described is a mixture of very dense sand and gravel. The thickness of this stratum was found to 0.7.m. It is anticipated that cobbles and boulders may be encountered within this cohesionless deposit.

.....2

Bedrock was proven in B.H. 5 by obtaining 2.1 m of BX rock core. Bedrock at this specific location is described as a Granitic Fault Breccia, slightly weathered. The surface of the bedrock was found at a depth of 5.9 m below the ground surface, corresponding to Elev. 339.9.

The groundwater level across the site is governed by the prevailing creek level. At the time of the investigation the creek level was at Elev. 345.4. The stabilized groundwater level may be expected to be at the same elevation.

Recommendations

Recommendations pertaining to the design and construction of the foundations for this project were presented in the 1986 report prepared for this Section by Terraprobe Limited. Generally, the recommendations in this report are still valid. However, in view of the findings of B.H. 5, the south abutment, if founded at Elev. 342.9 can be designed for 1000 kPa U.L.S., and 400 kPa, S.L.S. Type II.

I would request that you append this memorandum to your copy of the foundation report for future reference. If you have any questions or require clarification, please do not hesitate to contact the undersigned.

L. Politano
Project Foundations Engineer

for

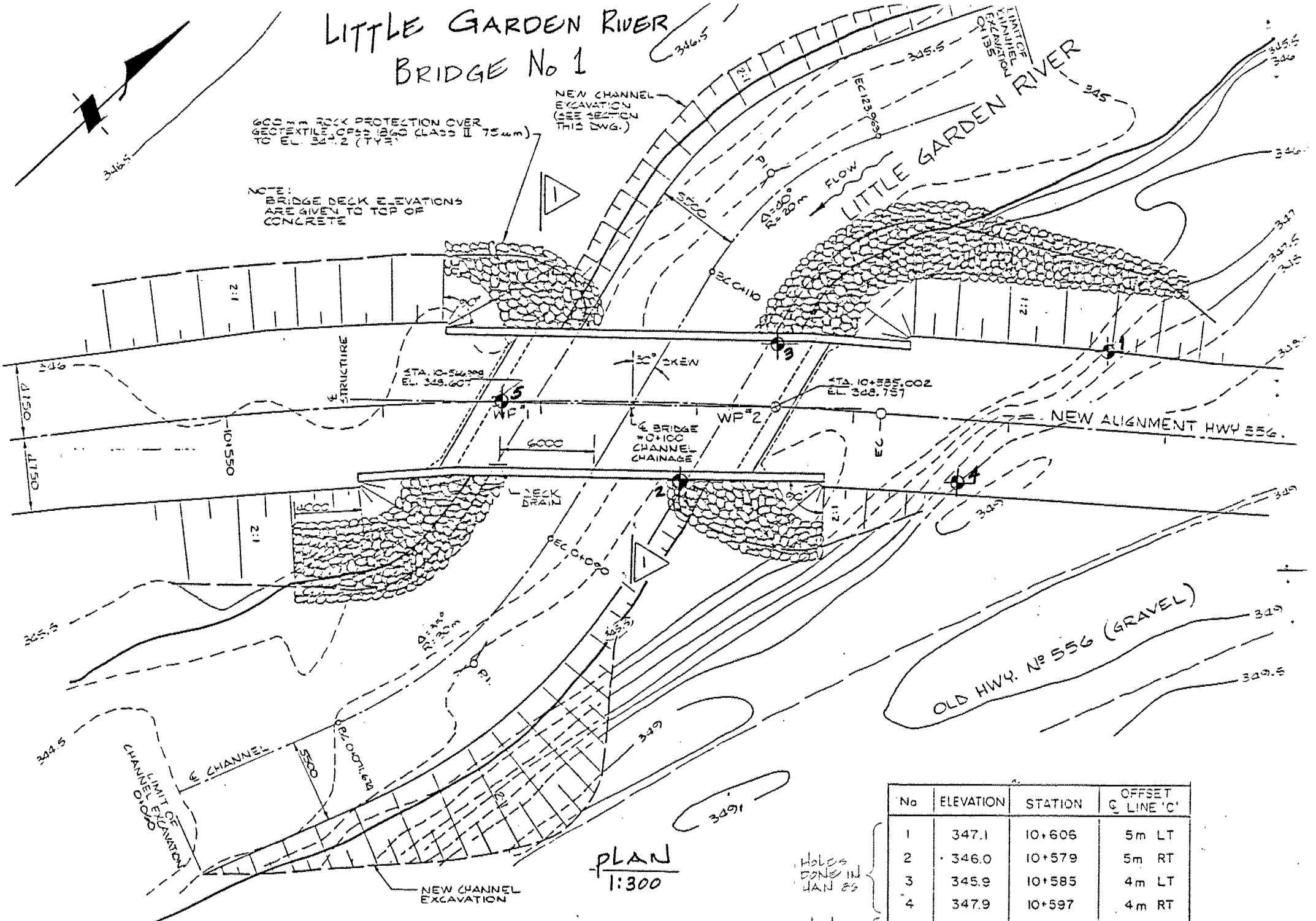
M. Devata
Chief Foundations Engineer
(East)

LP/MD/mmj

Attachs.

c.c. - J.B. MacMaster
G.D. Newell
C.E. Pritchard
K. Bassi
J.H. Peer

LITTLE GARDEN RIVER
BRIDGE No 1



PLAN
1:300

	No	ELEVATION	STATION	OFFSET ℄ LINE 'C'
Holes done in Jan 85	1	347.1	10+606	5m LT
	2	346.0	10+579	5m RT
	3	345.9	10+585	4m LT
	4	347.9	10+597	4m RT
Jan 87	5		10+567.5	℄

REMOVE EXISTING TIMBER BRIDGE DOWNSTREAM.

277-85-01 LOCATION Sta. 10+567.5 3.5 DESIGNATED BY M.J.

DIST 18 HWY 556 BOREHOLE TYPE H.S. Auger, BW Casing, Cone Pen Test COMPILED BY L.P.

DATUM GEODETIC DATE 87-01-15/20 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						
345.8	Ground Surface										
0.0	Peat		1	SS	7						
345.1											
0.7	Fine silty sand		2	SS	20		345				
	Sand, some silt, gravel		3	SS	30		344				
	(sand well-graded)		4	SS	125	▼	343				
	Occ. cobbles and boulders		5	SS	82	*					
			6	SS	38		342				
	Dense to Very Dense		7	SS	76		341				
340.1											
5.7	Sand and gravel, some silt, Occ. boulders		8	SS	70/8cm						
335.8	V. Dense Boulders						340				REC = 63 % RQD = 47 %
10.0	Bedrock		9	RC							
	Granitic Fault Breccia		10	RC			339				REC = 75 % RQD = 0 %
	Slightly weathered										REC = 90 % RQD = 13 %
337.8			11	RC			338				
8.0	End of Borehole		12	RC							REC = 71 % RQD = 0 %

*Groundwater level measured at end of temporary standpipe installation in borehole. May not be stabilized.

1, 2, 3 ... Numbers refer to Sensitivity

(20) 15.4-5 (%) STRAIN AT FAILURE

Terraprobe Limited

211 Wilkinson Road
Brampton, Ontario
L6T 4M2
(416) 453-6761

• GEOTECHNICAL INVESTIGATIONS • ENGINEERING GEOLOGY
• WATER RESOURCES AND CONTAMINANT HYDROGEOLOGY • MATERIALS AND CONSTRUCTION INSPECTION AND TESTING

FOUNDATION INVESTIGATION

PROPOSED LITTLE GARDEN RIVER CROSSING NO. 1

W.P. 277-85-01, SITE NO. 38S-20

DISTRICT 18 REGION N-W

Geocres 41J - 43

PREPARED FOR : Ministry of Transportation and
Communications
Foundation Design Section
1201 Wilson Ave.
Central Building
Downsview, Ontario
M3M 1J8

March, 1986

DISTRIBUTION OF REPORT

11 copies - Ministry of Transportation and Communications

1 copy - Terraprobe Limited

Terraprobe File No. 85293

TABLE OF CONTENTS

ABSTRACT

Terraprobe Limited was authorized by the Hon. E. Fulton, Minister, on behalf of the Ministry of Transportation and Communications (MTC), to undertake a foundation investigation for a proposed bridge structure on Highway 556, near Sault Ste. Marie, Ontario.

The field investigation for the project was conducted between January 25 and February 2, 1986 when 4 boreholes were advanced to depths of about 6.1 to 8.8 m below ground surface at the proposed bridge abutment locations.

The borings indicate that the site is underlain by dense GRAVEL, SAND AND BOULDERS. This stratum was fully penetrated by one of the borings at a depth of 5.8 m, where GRANITE BEDROCK was encountered. The remaining borings were terminated in the overburden at depths of 6.1 to 7.6 m.

In summary, it is considered that the bridge could be founded on spread footings placed on the dense gravel and boulder stratum. Deep foundations carried to the bedrock are not considered feasible due to the difficulty in penetrating the gravel and boulder materials. It is expected that foundation excavations will require the use of heavy equipment. Groundwater control will be required for excavations below the water table.

1 INTRODUCTION

Terraprobe Limited was authorized by the Hon. E. Fulton, Minister, on behalf of the Ministry of Transportation and Communications (MTC), to undertake a foundation investigation for a proposed bridge structure on Highway 556, near Sault Ste. Marie, Ontario.

The details of the project were provided in our proposal letter of December 13, 1986, addressed to Mr. L. Politano, P.Eng. of MTC, and in Consultant's Agreement No. 4238-9085-135.

The purpose of the investigation was to determine subsurface conditions at the site and provide engineering recommendations for the geotechnical aspects of design for foundations and approach embankments, including comments on the anticipated construction conditions.

The field investigation for the project was conducted between January 25 to February 2, 1986, when four borings were drilled to depths of 6.1 to 8.8 m below ground surface at the locations shown on Sheet 1. The borings were put down at the proposed bridge abutment locations. The details of the field work procedures are fully presented in Appendix A of this report.

2 SITE AND GEOLOGY

The site is located on Highway 556, approximately 50 km north west of Sault Ste. Marie (ref. Sheet 1 - Borehole Location and Soil Strata) at the Little Garden River. Highway 556 is a gravel surfaced two lane road. A timber bridge structure currently crosses the Little Garden River.

In the vicinity of the site, the Garden River is situated in a broad meandering channel of about 4 m depth and 30 m width. At the time of our investigation (January-February) the river was not frozen, and the depth of water was about 0.3 m. The areas surrounding the site are generally undeveloped rural Crown Land which is covered by dense bush.

Based on a review of selected geologic references, the site is located in an area underlain by overburden materials consisting of coarse grained glacial outwash. The bedrock in the the vicinity of the site is described as early Precambrian granitic material.

3 SUBSURFACE CONDITIONS

Details of the subsurface conditions encountered at the site are summarized below, and are also presented on the accompanying Borehole Logs and and cross sections on Sheet 1.

In summary, the borings indicate that the site is underlain by dense GRAVEL, SAND AND BOULDERS. This stratum was fully penetrated by one of the borings at a depth of 5.8 m, where GRANITIC BEDROCK was encountered. The remaining borings were terminated in the overburden at depths of 6.1 to 7.6 m.

It should be noted that the subsurface conditions are confirmed at the the borehole locations only, and may vary at other locations. The boundaries between the various strata as shown on the logs and sections are based on non-continuous sampling. These boundaries represent an inferred transition between the various strata, rather than a precise plane of change.

The following describes the soils encountered at this site:

Topsoil

Topsoil was encountered at the ground surface in Boreholes 2 and 3, to depths of 0.3 to 0.6 m. The topsoil was generally black in colour, and contained numerous roots and forest litter such as leaves and wood pieces.

Fill Materials

Fill materials were encountered in Boreholes 1 and 4, from the ground surface to depths of 0.5 to 0.9 m respectively. The fill materials consisted of loose native gravel, sand and boulders which were placed for construction of the drill access road. The fill contained traces of topsoil, roots, and other organic matter as a result of the site clearing operations.

Gravel, Sand and Boulders

This stratum was encountered in all of the borings from immediately beneath the topsoil or fill materials. It was encountered to the bottom of Boreholes 1, 2, and 4, at depths of up to 7.6 m. It was fully penetrated in Borehole 3 only at a depth of about 5.8 m, where the bedrock surface was encountered.

This stratum appears to consist of coarse cobbles and gravel with a matrix of sand with a trace to some silt. Due to the coarse grained nature of the soil, it was not possible to obtain fully representative samples using a 50 mm diameter split spoon. Therefore, the soil descriptions are based on the observed resistance to penetration during drilling, as well as the appearance of the spoon samples. The results of grain size distribution of the split spoon samples are presented on Figure 1, and indicate that the samples generally consisted of sandy gravel, with trace to

some silt. The range of gravel, sand, and silt and clay fraction in the samples analysed is noted below :

Gravel	Sand	Silt and Clay
19 to 62 %	30 to 62 %	4 to 22 %

However, based on the rate of advance of the drilling, it appears that cobbles and boulders of 150 to 800 mm diameter are present throughout the deposit, and the split spoon samples are more representative of the matrix between the cobbles and boulders.

It is also noted that the drilling technique (rotary bicone and casing) would tend to wash some of the fines from the soil matrix, hence the spoon samples may contain less silt and fine sand fraction than is actually present in the soil.

At the base of Boreholes 1 and 4, the material appeared to consist of cobbles with very little sand or gravel matrix. The samples obtained from the base of the borings were wash samples of the drill cuttings. It is possible that these 'boulders' may be the top of the bedrock surface, however the drill casing could not be lowered to permit coring of the material to verify this.

The penetration resistance of the stratum ranged from 46 to over 100 blows per 0.3 m. The extremely high penetration resistance of the soil is attributed to the large percentage of particles in excess of 50 mm diameter. Based on the resistance to penetration during drilling, the material is considered to be dense.

Granitic Bedrock

The bedrock surface was encountered beneath the gravel and boulder stratum in in Borehole 3 only, at a depth of about 5.8 m. It was penetrated to the base of the boring at about 8.8 m depth. As noted previously, it is possible that the bedrock surface was encountered near the base of Boreholes 1 and 4 at depths of 5.6 and 5.9 m, respectively although the borings could not be advanced to permit further sampling.

The bedrock consisted of medium grained pink to brown granite-gneiss. While the total core recoveries were generally good, the rock was broken to highly fractured, and the Rock Quality Designation (RQD) determined for the core was zero throughout. Total core recoveries ranged from 0 to 100 %, but most runs obtained recoveries in excess of 70 per cent.

The degree of fracturing did not decrease with depth. The material was slightly weathered on fracture surfaces.

Groundwater

The borings caved at depths of 1.2 to 2 m after withdrawal of the casing, as noted on the Borehole logs. The water levels measured

in the standpipes on February 2, some 1 to 6 days following their installation, are noted below:

Borehole No.	Groundwater Depth/Elevation (m)
2	2.7 / 343.3
3	2.7 / 343.2
4	4.4 / 343.5

The elevation of the water in the river was approximately 345 m on February 2, 1986.

The difference in the groundwater level compared to the river water level suggests that the soil does not have a high permeability.

4 DISCUSSION AND RECOMMENDATIONS

The following discussions and recommendations are based on the factual data obtained from the boreholes, and are presented for the guidance of the design engineer only. Contractors bidding on or conducting work associated with this project should review the factual information to assess their effect on proposed construction methods and scheduling.

It is our understanding that it is proposed to replace the existing timber bridge with a 22 m single span concrete structure. The proposed structure would be located about 15 m west of the existing bridge, and the roadway would be realigned as required. The approach fills for the roadway would be up to 4 m in height at the bridge location. The channel of the Garden River would be realigned about 10 m to the east of its present location, to flow beneath the proposed bridge.

4.1 Bridge Foundations

Based on the ground conditions encountered in the borings, it is considered that the proposed bridge could be founded on spread footings placed on the dense gravel and boulder stratum; or on end bearing piles carried down to the bedrock surface. However due to the large boulder content of the overburden materials, it would be necessary to install the piles in pre-augered holes in order to reach the bedrock surface. This would be a difficult and costly procedure, hence the use of spread footings is recommended.

It is recommended that spread footings for the bridge be placed on the dense to very dense gravel and boulder stratum, at 0.5 m or more below the top of the stratum. This corresponds to the following maximum founding elevations at the borehole locations:

Borehole	Maximum Founding Elevation (m)
1	346.1
2	345.8
3	344.8
4	346.5

All foundations should be provided with a minimum soil cover of 1.8 m or equivalent insulation for frost protection purposes.

Since the bearing capacity of coarse gravel and boulder soils cannot be predicted by classical bearing capacity methods, the design foundation bearing pressures were estimated by assuming that the soil behaves as a dense sand. The following assumptions were made in the calculations:

- average penetration resistance of soil - 40 blows/0.3 m
- minimum footing width - 2 m
- minimum footing depth below final grade - 1.8 m
- water table at base of footing

Using these assumptions, the recommended bearing capacities at the Serviceability Limit States (SLS) and Ultimate Limit States (ULS) based on the Ontario Highway Bridge Code (OHBC) are as noted below:

Factored bearing capacity at ULS (qf) = 700 kPa

Bearing capacity at SLS Type II (qs) = 400 kPa

The estimated maximum total and differential settlements at the SLS Type II are 25 mm and 10 mm respectively.

In all cases, foundations should be placed on undisturbed native soil, which has been cleaned of topsoil, loosened material, and debris. The base of all footings should be inspected by a qualified geotechnical engineer prior to pouring concrete, to ensure that the exposed soil conditions are in accordance with the design assumptions.

4.2 Excavations

Foundation excavations at the site are expected to encounter a thin layer of fill or topsoil, followed by dense native gravel and boulder soils. Temporary unbraced excavations through these soils are expected to remain stable at inclinations of about 1 to 1. Excavations carried below the groundwater table may slough to slightly flatter angles if seepage results in loss of fines or matrix material.

Temporary shoring or a trench box could be used in lieu of the above side slopes, if required to minimize the extent of the excavation.

Where workmen must enter excavations carried deeper than 1.2 m, the trench excavations should be suitably sloped and/or braced.

It is expected that the base of the foundation excavations will generally be carried to about elevation 342 to 343 m, in order to provide sufficient frost cover to the footings and scour protection in the river channel. At this elevation, the base of the excavations will be less than about 1 m below the measured groundwater table. In this case, it is likely that groundwater control can be accomplished by pumping from an open sump in the base of the excavation, without creating excessive heave or loosening of the soil.

In the event that excavations are carried more than about 1 m below the groundwater level (ie, below elevation 342 m), it may be necessary to permit flooding of the base of the excavation. This would prevent an unbalanced head and minimize loosening of the soil by upward seepage. Concrete could then be placed below the water by tremie methods. The use of well points, sheet piling or similiar groundwater control methods are not considered feasible due to the difficulty in advancing through the cobbles and boulders.

It is expected that the base of the excavations will be somewhat uneven as the result of protruding boulders and cobbles. In order to provide a level working base, and more uniform contact pressure with the footings, it is recommended that a thin pad of Granular 'A' material be placed in the base of the excavation. The granular material should be compacted in thin lifts to a minimimum 100 per cent of the Standard Proctor Maximum Dry Density (SPMDD). If water in the base of the excavation precludes the placement and compaction of fill, then a level base may be provided with mass concrete.

Heavy machinery will be required to excavate the dense gravel and boulder soils. The presence of large boulders may necessitate splitting or blasting to permit their excavation.

It will be necessary to divert the creek flow away from the foundation excavations so that construction operations may proceed in the dry. This may be accomplished by means of a cofferdam or other temporary diversion scheme.

4.3 Backfill

The native gravel and boulder soils encountered in the borings will be suitable for use as general fill for the approach embankments. Care should be exercised to minimize segregation of the materials during placement, and 'nesting' of cobbles and boulders. It is recommended that select fill materials be used adjacent to the bridge abutments, since the native soils contain large boulders and cobbles.

Select, free-draining granular fill, such as MTC Granular 'A' or 'B', should be used as backfill behind the bridge abutments. The select fill should be placed in a wedge shaped zone extending from 1.2 m behind the base of the wall and up at a 45 degree angle, as per the OHBC. Heavy compaction equipment should not be used behind the wall within a lateral distance equal to the current height of fill above the wall footing, in order to minimize deflection or possible damage of the wall.

Provided the above backfill criteria are satisfied, the following parameters may be used in calculation lateral earth pressures, in accordance with the OHBC:

	Unfactored Angle of Friction	Unit weight (kN/cu.m.)
Granular 'A'	35	22.0
Granular 'B'	30	21.2

It should be noted that the mobilization of the active earth pressure behind the wall will require an outward deflection of up to 0.5 per cent of the wall height, as measured at the top of the wall. If the bridge is a rigid frame structure, and the abutments are constrained so that this deflection cannot occur, then the at-rest earth pressure should be used in design.

The angle of friction between the foundation of the abutment and the native gravel and boulder soil may be assumed as 30 degrees, hence the coefficients of friction at the ultimate and serviceability limits may be taken as 0.46 and 0.57 respectively.

The effect of possible loss of soil at the toe of the abutment as the result of scour or erosion should be considered when calculating the passive earth resistance in this area.

A series of weep holes or other drainage system should be provided at the base of the abutments, to permit drainage of water from the backfill.

All new or additional fill materials placed beneath the roadway area, and in the footing trenches should should be compacted to a minimum 95 per cent of the SPMDD in lifts not exceeding 200 mm. It is important to achieve adequate compaction to minimize future settlement behind the abutments, and to prevent erosion or scour of the backfill in the river channel.

4.4 Embankment Stability

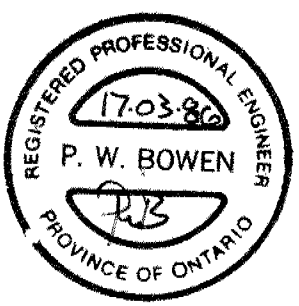
The dense gravel and boulder soils are considered suitable for support of the proposed approach embankment fills. No embankment foundation stability problems are forseen.

The area beneath the embankments should be prepared by stripping all topsoil or loose surficial materials. The embankment fill should consist of a clean, non-organic earth fill which can be readily compacted to 95 per cent of the SPMDD.

Respectfully Submitted,

TERRAPROBE LIMITED

Paul W. Bowen, P.Eng.



Michael Tanos, P.Eng.

APPENDIX A

TERRAPROBE LIMITED

APPENDIX A

FIELD WORK

The field investigation for the project was conducted between January 25 to February 2, 1986 when 4 boreholes were advanced to depths of about 6.1 to 8.8 m below existing grades, at the locations shown on Sheet 1.

The drilling was conducted with machinery operated by Master Soil Investigation Limited of Weston, Ontario. The drilling operations were directed and supervised by Mr. R. Moore, CET,from Terraprobe Limited.

The boreholes were put down in the vicinity of the abutments for the proposed bridge.

In order to permit access to the borehole locations, a local contractor was retained to clear brush and provide an access road for the drilling equipment.

The borings were put down using a bombarier mounted CME 55 power auger. Difficult drilling conditions were encountered due to the presence of cobble and boulder size materials. The borings were advanced to practical refusal with hollow stem augers, and were then continued by coring and /or rotary triconing through the boulders with 'N' and 'B' casing and equipment. Boreholes 1, 2, and 4 were advanced in this fashion until wear or damage of the casing shoe prevented further penetration.

Split spoon samples of the overburden materials were obtained at regular intervals using a conventional 50 mm diameter split barrel sampler. All samples obtained in the investigation were sealed into glass jars, and transported to our laboratory for detailed inspection and testing.

In Borehole 3, the boring was advanced to the bedrock surface. The bedrock was cored for approximately 3 m in 'B' size with a diamond core barrel.

Standpipe type piezometers were sealed into 3 selected borings, in order to permit observation of groundwater levels. The standpipes comprised 12 mm I.D. CPVC tubing, which was saw-slotted near the base, and fitted with a sand filter and bentonite seal as shown on the accompanying borehole logs.

The field was supervised throughout by Mr. R. Moore, CET from Terraprobe Limited, who directed the drilling and sampling operations, and transported the samples to our laboratory.

The locations of the borings were determined by relative to a survey baseline which had been established in the field by MTC personnel.

The elevations of the borings were determined relative to a local geodetic benchmark by MTC personnel.

LABORATORY WORK

All of the soil and bedrock samples obtained in the investigation were examined in detail by the project engineer, and classified by visual and tactile methods.

Since all of the samples were non-cohesive, the laboratory testing was limited to determination of water content and grain size distribution of selected samples. The results of the testing are presented on Figure 1 and the Borehole logs.

Terraprobe Limited

ABBREVIATIONS, TERMINOLOGY, AND GENERAL INFORMATION

SAMPLING METHOD

SS - split spoon
ST - Shelby tube
AS - auger sample
RC - rock core

PENETRATION RESISTANCE

Standard Penetration Resistance ('N' values) is defined as the number of blows by a hammer of 63.5 kg. mass (140 lbs.) falling freely for a distance of 0.76 m (30 inches) required to advance a standard 50 mm (2 inch) diameter split spoon sampler for a distance of 0.3 m (12 inches).

Dynamic Cone Penetration Resistance is defined as the number of blows by a hammer of 63.5 kg. mass (140 lbs.) falling freely for a distance of 0.76 m (30 inches)required to advance a conical steel point of 50 mm diameter and with 60 degree sides on 'A' size drill rods for a distance of 0.3 m (12 inches).

SOIL DESCRIPTION

Cohesionless Soils

Relative Density	'N' value
very loose	< 4
loose	4 - 10
compact	10 - 30
dense	30 - 50
very dense	> 50

Cohesive Soils

Consistency	Undrained Shear Strength (kPa)	'N'
very soft	< 12	< 2
soft	12 - 25	2 - 4
firm	25 - 50	4 - 8
stiff	50 - 100	8 - 16
very stiff	100 - 200	16 - 32
hard	> 200	> 32

SOIL COMPOSITION

	% by weight
'trace' (eg. trace silt)	< 10
'some' (eg. some gravel)	10 - 20
adjective (eg. sandy)	20 - 35
'and' (eg. sand and gravel)	35 - 50

GENERAL INFORMATION

The recommendations provided in this report are based on the factual information obtained from the boreholes and on the general information provided for the proposed project.

Site investigation by means of boreholes and/or test pits identifies subsurface conditions at the location and time of sampling only. Ground conditions at locations away from the boreholes and test pits may vary.

Recommendations are made by interpretation of this factual data for specific conditions such as size, configuration and location of the proposed project. Changes in project conditions should be reviewed by the geotechnical consultant as they may affect the recommendations provided.

In order to identify possible changes in ground conditions between the sample locations and their effect on the project, it is recommended that site inspections be carried out during construction by qualified geotechnical personnel.

Ministry of Transportation and Communications
Ontario

RECORD OF BOREHOLE No 1

METRIC

W P 277-85-01 LOCATION Sta. 10 + 606 offset 5m LT ORIGINATED BY R.M.

DIST 18 HWY 556 BOREHOLE TYPE Hollow Stem Auger, NX, BX Casing & Cone Test COMPILED BY P.B.

DATUM Geodetic DATE 1986 01 25 and 26 CHECKED BY M.T.

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 W_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
347.1	Ground Surface						347				
0.0 / 346.6	Fill, sand, gravel and cobbles, loose										
0.5	Gravel, sand and boulders		1	SS	50/13 cm	▼	346		○		
			2	SS	50/10 cm		345		○		40 56 (4)
	Dense to very Dense		3	SS	76/25 cm		344		○		
			4	SS	52		343		○		22 56 (22)
			5	SS	65/20 cm		342		○		
341.5			6	SS	50/8 cm						
5.6	Boulders, some sand matrix		7	WS	-		341				
340.1			8	WS	-						
7.0	End of Borehole Borehole caving at 1.4 m depth as casing withdrawn Water level in hole at 1.1 m depth on completion										

$+^3$, $\times^5$: Numbers refer to Sensitivity

20
15 ⊹ 5 (%) STRAIN AT FAILURE
10

Ministry of Transportation and Communications
Ontario

RECORD OF BOREHOLE No 2 METRIC

W P 277-85-01 LOCATION Sta 10 + 579 offset 5m RT ORIGINATED BY R.M.
DIST 18 HWY 556 BOREHOLE TYPE Hollow Stem Auger, NX, BX Casing & Cone Test COMPILED BY P.B.
DATUM Geodetic DATE 1986 01 26 to 29 CHECKED BY M.T.

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 (%) (20 40 60)	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA (SI CL)
346.0	Ground Surface										
0.0 / 345.7	Topsoil, silty, numerous roots, black		1	SS	4		346				
0.3	Gravel, sand and boulders		2	SS	56		345				59 33 (8)
			3	SS	50/15cm						
			4	SS	50/5cm		344				
	Dense to very Dense		5	SS	48	Piezometer	343				
			6	SS	50/8cm		342				
			7	SS	60		341				43 51 (6)
339.9			8	SS	-		340				
6.1	End of Borehole										

Borehole caving at 2.0 m depth as casing withdrawn

Water level in standpipe at 2.7 m depth on Feb. 2, 1986

+3, ×5 : Numbers refer to Sensitivity

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

Ministry of Transportation and Communications
Ontario

RECORD OF BOREHOLE No 3 METRIC

W P 277-85-01 LOCATION Sta 10 + 585 offset 4m LT ORIGINATED BY R.M.

DIST 18 HWY 556 BOREHOLE TYPE Hollow Stem Auger, NX, BX Casing & Cone Test COMPILED BY P.B.

DATUM Geodetic DATE 1986 01 29 to 31 CHECKED BY M.T.

SOIL PROFILE ELEV/DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	'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 W_P / NATURAL MOISTURE CONTENT W / LIQUID LIMIT W_L / WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA (SI CL)
345.9	Ground Surface										
0.0 / 345.3	Topsoil, numerous roots leaves, black		1	SS	17		346		○		
0.6	Gravel, sand and Boulders Dense to Very Dense		2	SS	50/8cm		345		○		
			3	SS	60/15cm				○		27 58 (15)
							344				
			4	SS	98				○		
			5	SS	87		343		○		
			6	SS	46		342		○		
			7	SS	72				○		
340.1			8	SS	50/5cm		341				
5.8	Granite bedrock, highly fractured to broken. Slight weatherin on fracture surfaces		9	B RC	rec 83%	Piezometer	340				
			10	B RC	rec 100%						
			11	B RC	rec 100%		339				
			12	B RC	rec 100%						
			13	B RC	rec 71%		338				
337.1			14	B RC	rec 53%						
			15	B/RC	0%						
8.8	End of Borehole Borehole caving at 1.2 m depth as casing withdrawn Water level in stand-pipe at 2.7 m depth on Feb. 2, 1986										

$+^3$, $\times^5$: Numbers refer to Sensitivity

$\frac{20}{15 \diamond 5}$ (%) STRAIN AT FAILURE
10

Ministry of Transportation and Communications
Ontario

RECORD OF BOREHOLE No 4 METRIC

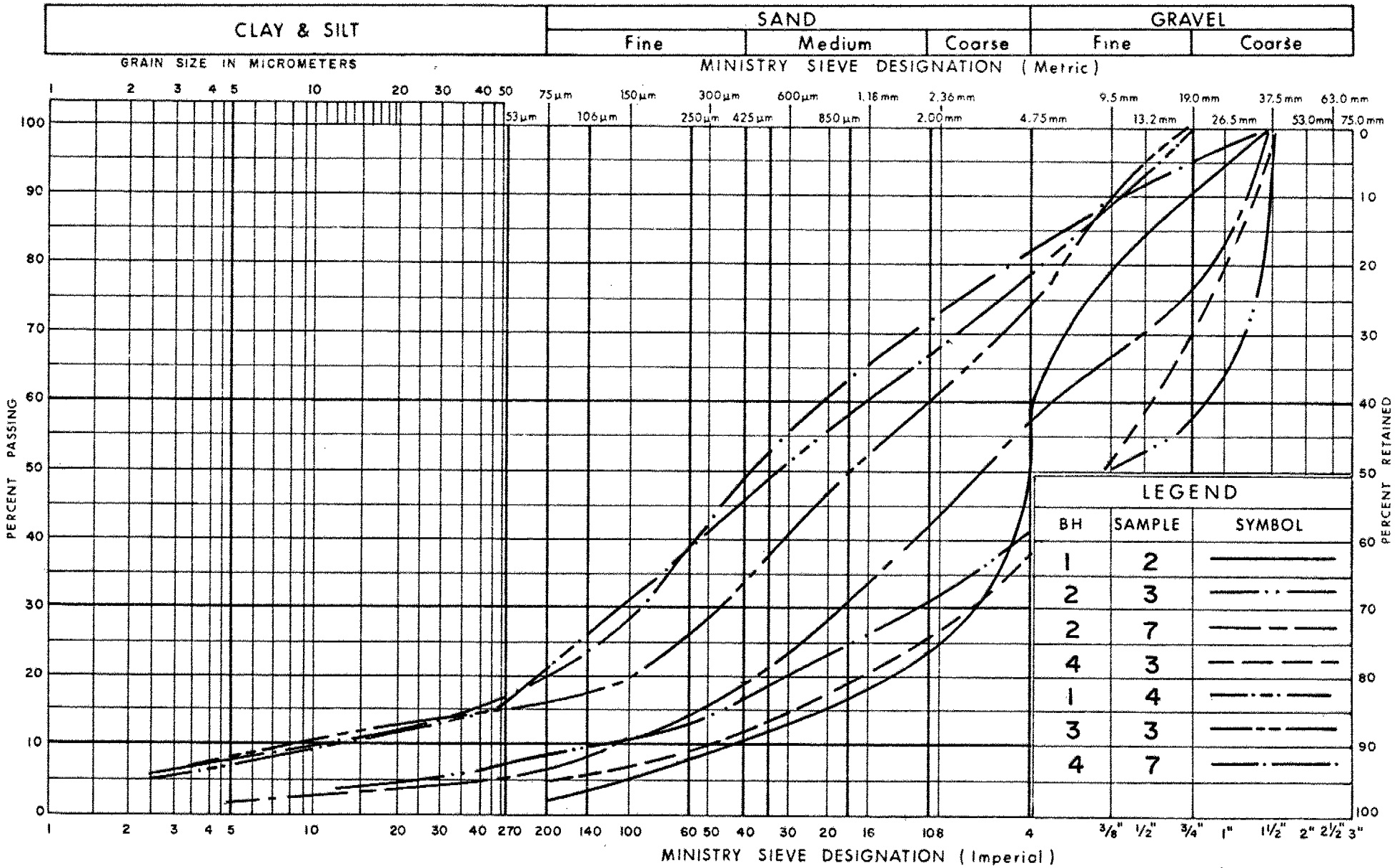
W P 277-85-01 LOCATION Sta 10 + 597 offset 4m RT ORIGINATED BY R.M.
DIST 18 HWY 556 BOREHOLE TYPE Hollow Stem Auger, NX, BX, Casing & Cone Test COMPILED BY P.B.
DATUM Geodetic DATE 1986 01 31 and 86 02 02 CHECKED BY M.T.

SOIL PROFILE ELEV/DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	'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 (%) 20 40 60	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA (SI CL)
347.9	Ground Surface										
0.0 347.0	Fill, sand, gravel, cobbles, loose		1	SS	9				○		
0.9	Gravel, sand and boulders, Dense to very dense		2	SS	46		347		○		62 30 (8)
			3	SS	50/12cm		346		○		
			4	SS	92		345		○		
			5	SS	93/28cm		344		○		
343.2			6	SS	80/13cm						
4.7 342.0	Sand and gravel, some silt (Till like) Dense Brown		7	SS	46		343		○		19 62 (19)
5.9	Gravel and Boulders, some sand matrix		8	SS	90/22cm		342				
340.3			9	WS	-	Piezometer	341				
7.6	End of Borehole Borehole caving at 1.7 m depth as casing withdrawn Water level in standpipe at 4.4 m depth on Feb. 2, 1986										

+3, ×5 : Numbers refer to Sensitivity

20
15 ⊹ 5 (%) STRAIN AT FAILURE
10

UNIFIED SOIL CLASSIFICATION SYSTEM



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GRAIN SIZE DISTRIBUTION
GRAVEL AND BOULDERS IN A MATRIX OF SAND, TRACE TO SOME SILT

FIG No 1
W P 277-85-01

Ministry of Transportation and Communications
Ontario

RECORD OF BOREHOLE No 5

METRIC

W P 277-85-01 LOCATION Sta. 10 + 567.5 ℄ HWY 556 ORIGINATED BY M.J.

DIST 18 HWY 556 BOREHOLE TYPE H.S. Auger, BW Casing, Cone Pen. Test COMPILED BY L.P.

DATUM Geodetic DATE 1987 01 18/20 CHECKED BY

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
345.8	Ground Surface							
0.0 / 345.1	Peat		1	SS	7			
0.7	Fine silty sand		2	SS	20		345	
	Sand with/and gravel trace silt		3	SS	30		344	28 63 (9)
	(Sand well-graded)		4	SS	125	▼ *		57 39 (4)
	Occ. cobbles and boulders		5	SS	82		343	42 51 7 0
			6	SS	38		342	34 61 (5)
	Dense to Very Dense		7	SS	26		341	
			8	SS	70/8 cm			
339.9	Boulders		9	RC	REC 63%		340	RQD=47%
5.9	Bedrock		10	RC	REC 75%			RQD=0
	Granitic Fault Breccia Slightly weathered		11	RC	REC 90%		339	RQD=13%
337.8			12	RC	REC	71%	338	RQD= 0%
8.0	End of Borehole							

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 (%) 10 20 30

UNIT WEIGHT γ

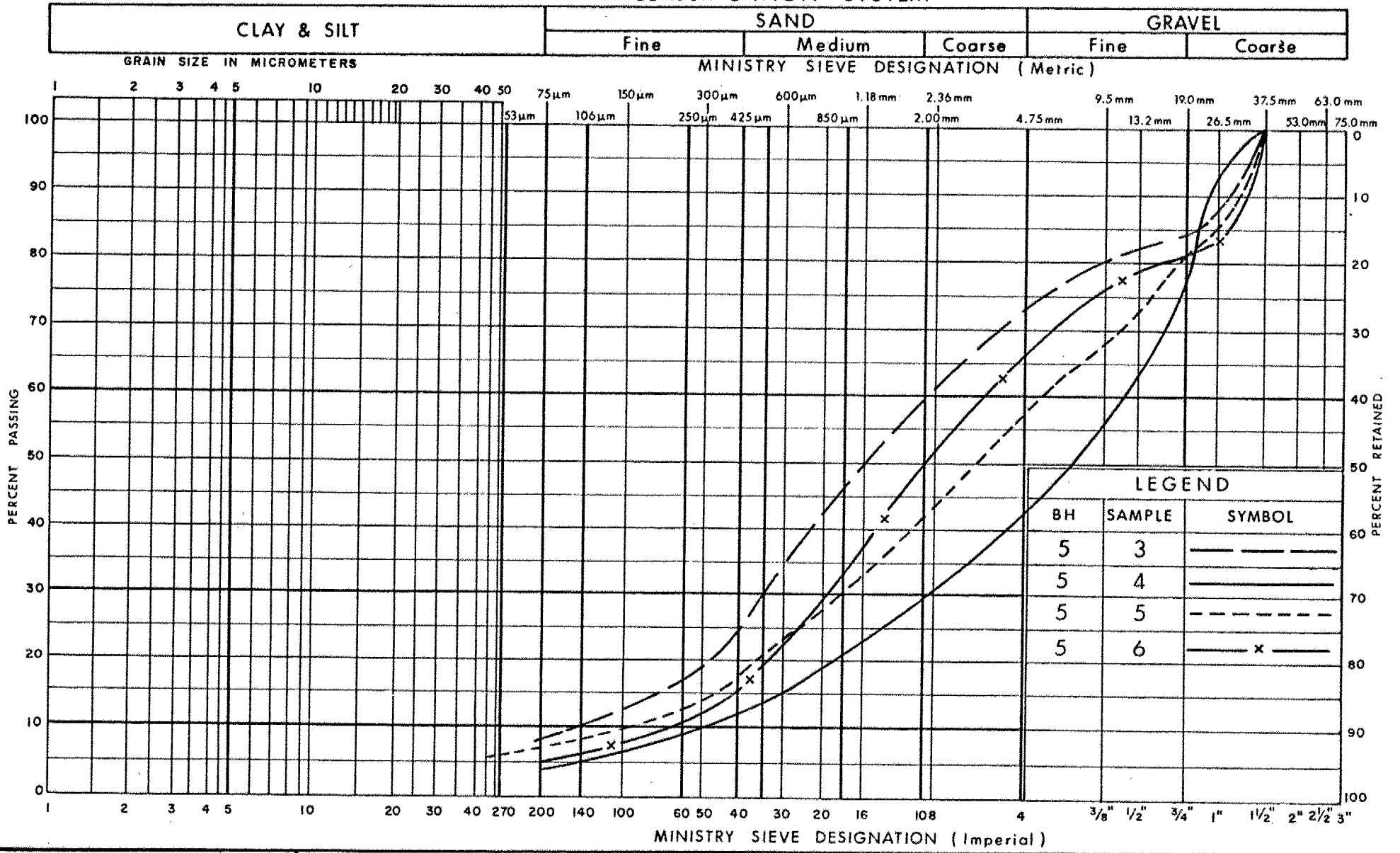
* Groundwater level measured at end of day within open borehole. May not be stabilized

$+^3$, $\times^5$: Numbers refer to Sensitivity

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

OFFICE REPORT ON SOIL EXPLORATION

UNIFIED SOIL CLASSIFICATION SYSTEM



Ministry of Transportation and Communications
Ontario

GRAIN SIZE DISTRIBUTION

SAND WITH / AND GRAVEL, TRACE SILT

FIG No 2

W P 277-85-01

MINISTRY OF TRANSPORTATION AND COMMUNICATIONS, ONTARIO PR-01-207 (Formerly 08-MT-308M 78-06)

CONT No
WP No 277-85-01

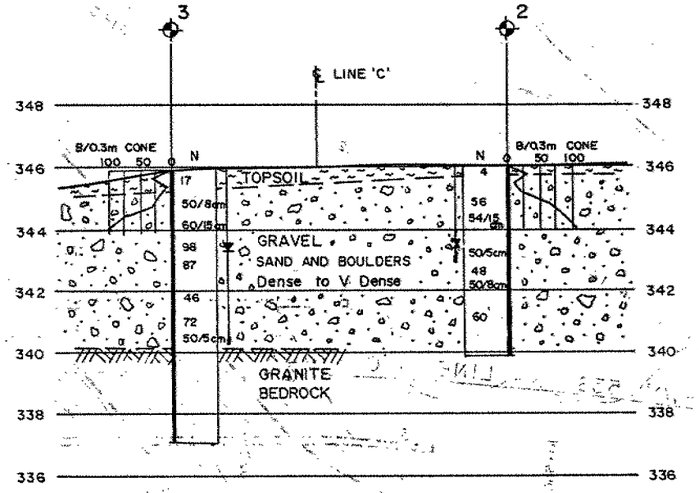
SHEET

LITTLE GARDEN RIVER
(CROSSING No 1)
BORE HOLE LOCATIONS & SOIL STRATA

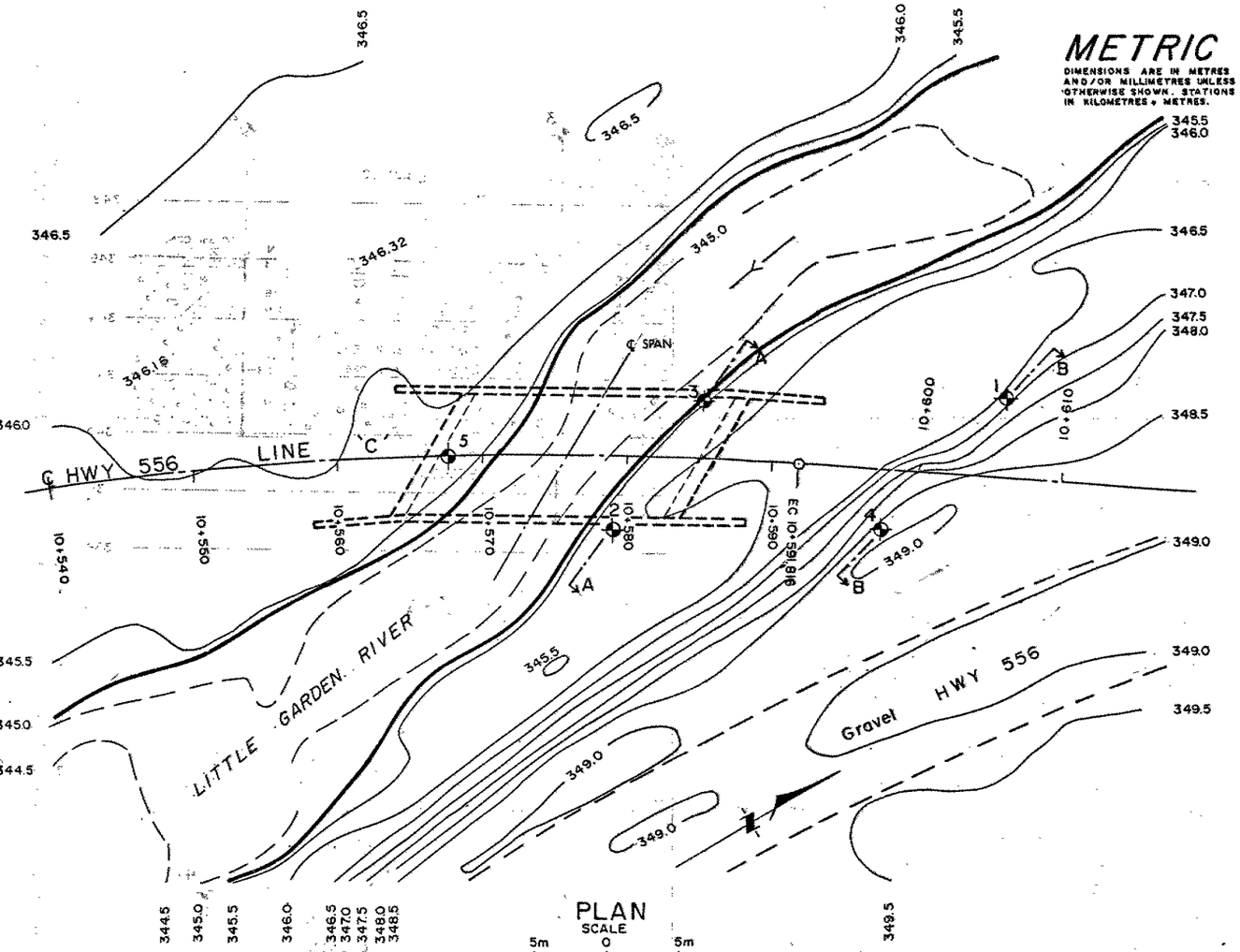
TERRAPROBE LIMITED

METRIC

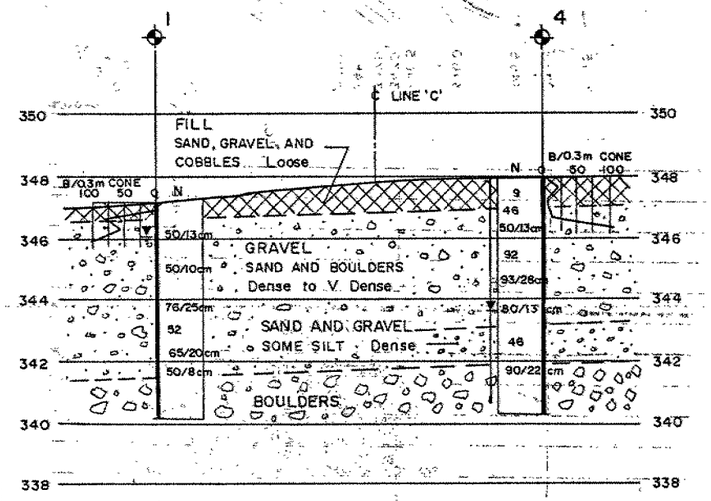
DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN. STATIONS IN KILOMETRES + METRES.



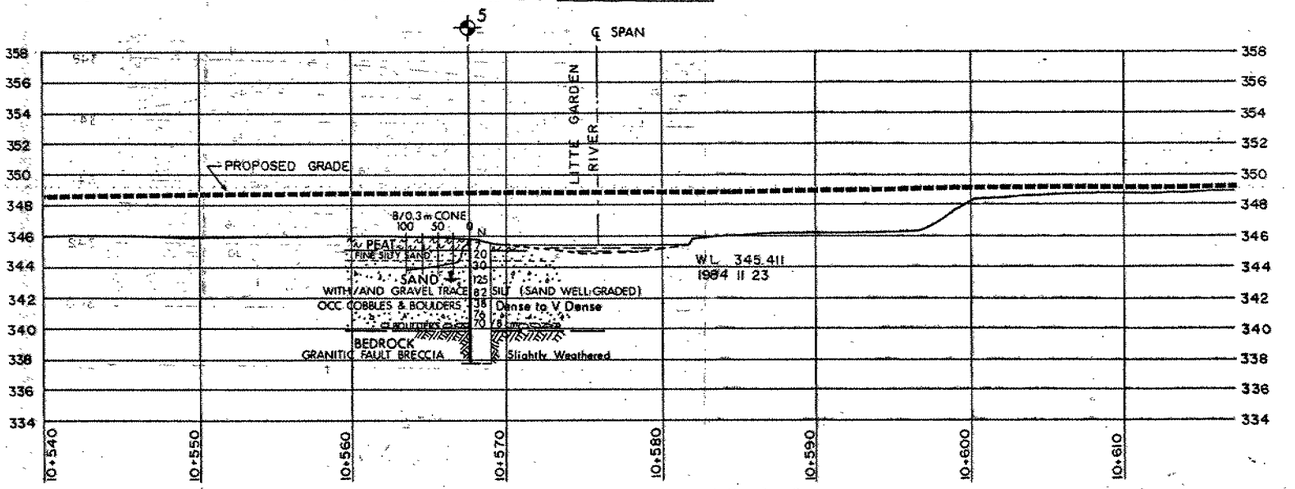
A-A



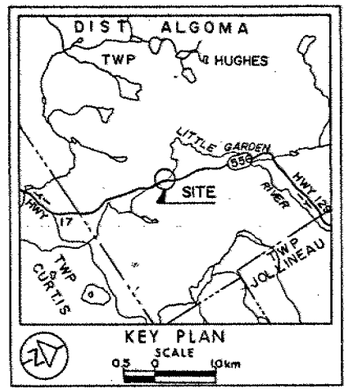
PLAN
SCALE
5m 0 5m



B-B
SECTIONS
SCALE
5m 0 5m



PROFILE OF LINE 'C'
SCALE
5m 0 5m



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 1986 01 and 1986 02 & 1987 01
- Piezometer

No	ELEVATION	STATION	OFFSET ℄ LINE 'C'
1	347.1	10+606	5m LT
2	346.0	10+579	5m RT
3	345.9	10+585	4m LT
4	347.9	10+597	4m RT
87 01 H-TC 5	345.8	10+567.5	℄

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.

REVISIONS		
870226	SO	BORE HOLE 5 ADDED
DATE	BY	DESCRIPTION

Geocres No 41J-43

HWY No 556			DIST 18
SUBMD PB	CHECKED	DATE 1986 02 13	SITE 38S-20
DRAWN JM	CHECKED	APPROVED	DWG 2

MINISTRY OF TRANSPORTATION AND COMMUNICATIONS, ONTARIO PR-D-207 (Formerly 08-MT-3088M 78-06)

METRIC

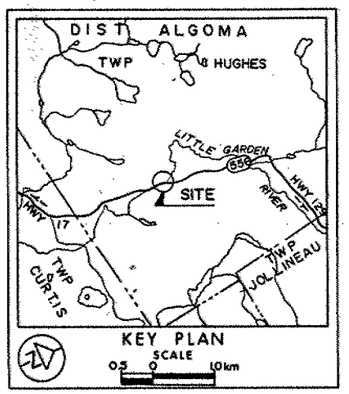
DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN. STATIONS IN KILOMETRES + METRES.

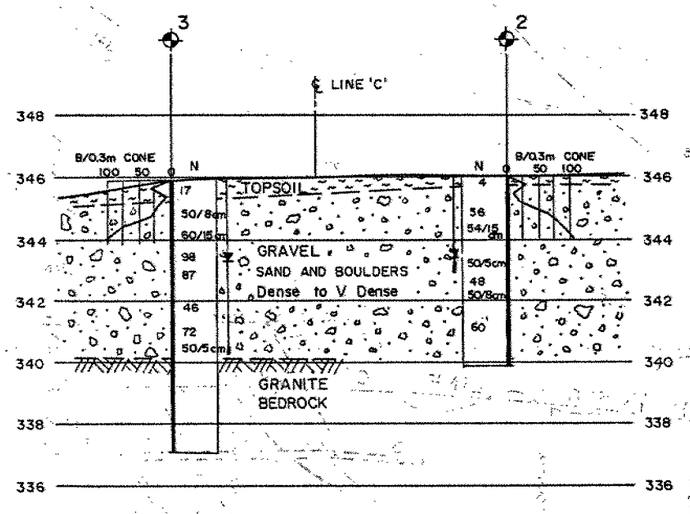
CONT No
WP No 277-85-01

SHEET

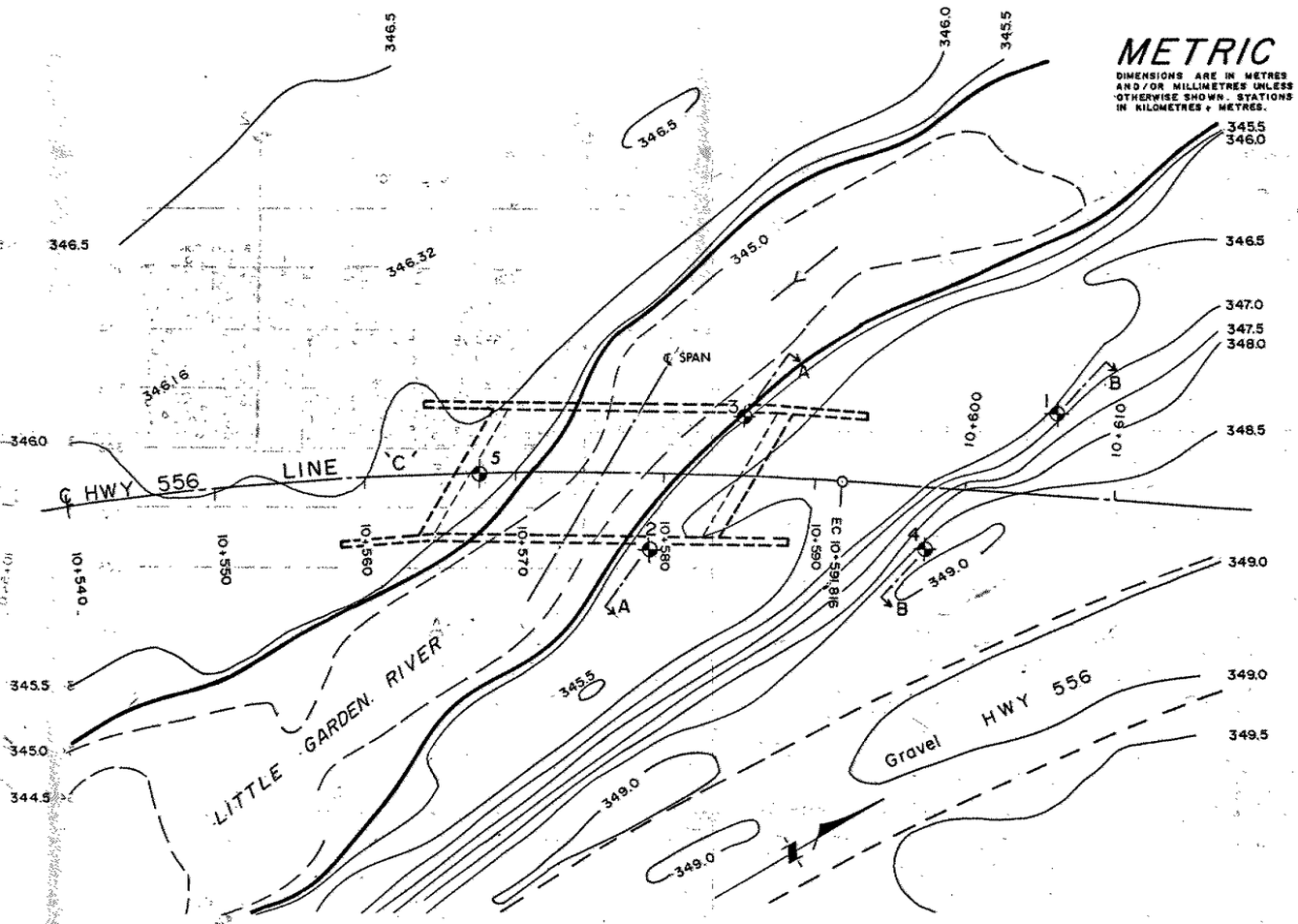
LITTLE GARDEN RIVER
(CROSSING No 1)
BORE HOLE LOCATIONS & SOIL STRATA

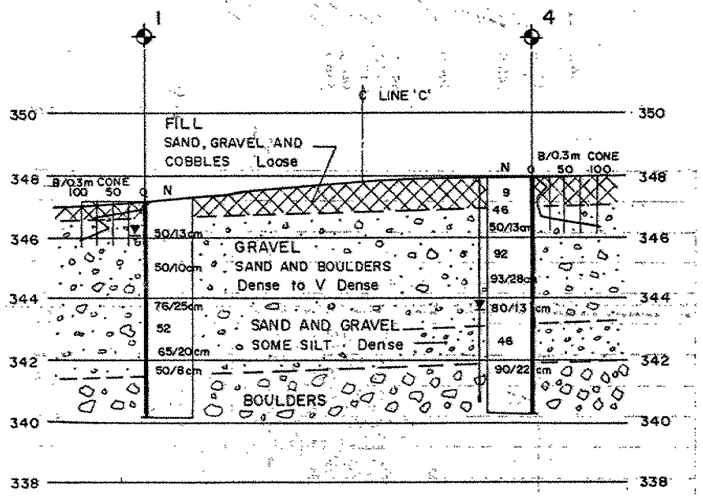
TERRAPROBE LIMITED



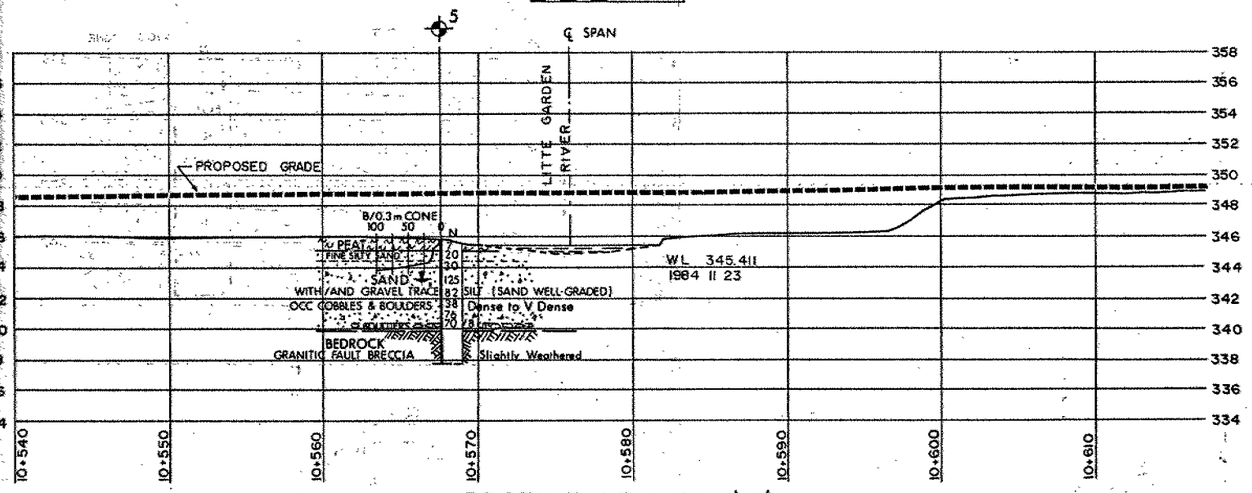


A-A





B-B
SECTIONS
SCALE
5m 0 5m



PROFILE OF LINE 'C'
SCALE
5m 0 5m

No	ELEVATION	STATION	OFFSET ℄ LINE 'C'
1	347.1	10+606	5m LT
2	346.0	10+579	5m RT
3	345.9	10+585	4m LT
4	347.9	10+597	4m RT
87 01 H-TC 5	345.8	10+567.5	℄

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 1986 01 and 1986 02 & 1987 01
- Piezometer

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REVISIONS		
870226	SO	BORE HOLE 5 ADDED
DATE	BY	DESCRIPTION

Geocres No 41J-43

HWY No 556			DIST 18
SUBM'D PB	CHECKED	DATE 1986 02 13	SITE 38S-20
DRAWN AB	CHECKED	APPROVED	DWG 2

OVERSIZE DRAWING

OVERSIZE DRAWING

memorandum

Ontario

Tel: 3731

To: O. Ramakko
Head, Structural Section
Northwestern Region

Date: 1987 02 25

Atten: R. Krisciunas

RE: W.P. 277-85-01, Hwy. 556
Little Garden River Crossing No. 2 1
District 18 - Sault Ste. Marie

We have reviewed the final Drawing 1 and Drawing 3 (dated September/86) for the above-noted structure. We have the following comments:

1. In areas where fill is required, peat and other surficial organic material should be completely subexcavated to at least 1 m beyond the plan limits of the embankment. All fill placed below 0.3 m above the prevailing groundwater level should consist of granular material.

2. In view of the generally well graded natural granular material across the site, geotextile is not required under the rock protection.

3. The contractor should be informed through a Special Provision of the occasional to frequent cobbles and boulders which exist across the site and that a dewatering scheme will be necessary for the construction of the structure footings. The contractor should be required to submit a dewatering scheme for M.T.C. approval. In addition, the S.P. should include a provision indicating that if sheet piles are to be used, they are to be left permanently in place.

If you have any questions or require additional details, please do not hesitate to contact this Section.

L. Politano
Project Foundations Engineer

for

M. Devata
Chief Foundations Engineer
(East)

LP/MD/mmj

c.c. - K. Bassi

memorandum

Ontario

Tel: 7101

To: O. Ramakko
Head, Structural Section
Northwestern Region

Date: 1987 02 20

From: Foundation Design Section
Room 315, Central Building

RE: Additional Boring at
Little Garden River Crossing #1
W.P. 277-85-01, Site 38S-20, Hwy. 55
District 18 - Sault Ste. Marie

As discussed in our memorandum dated 86 11 07, this Section has advanced an additional borehole at the above-noted site. The additional boring was necessary because the proposed single span structure was relocated some 15 m west subsequent to the original foundation investigation.

The additional borehole (B.H. 5) was advanced using hollow stem augers and washboring techniques between 87 01 18 and 87 01 20. The borehole was advanced to bedrock (Elev. 339.9), approximately 5.9 m below the ground surface. 2.1 m of rock core was also obtained. A cone penetration test also accompanied the borehole. The attached plan indicates the location of all the borings carried out at this site including the four boreholes (B.H. 1 to B.H. 4) advanced for the original investigation in February, 1986.

The following is a brief description of the subsurface conditions encountered in B.H. 5. A draft version of the Record of Borehole Sheets is attached for your information.

South Abutment (B.H. 5)

Extending from the ground surface (Elev. 345.8) down to a depth of 0.7 m is a deposit of peat. The peat was generally black in colour and contained numerous roots and decaying wood and leaves.

Underlying the peat and extending to a depth of 5.2 m below the ground surface is cohesionless deposit consisting of sand, some silt, some gravel. From the drilling, frequent cobbles and boulders may be inferred to be present within this deposit. Based on the interpretation of Standard Penetration Test 'N' values, this deposit can be considered to generally be in a dense to very dense state. It should be noted that the upper surface of this deposit consists of a fine silty sand. It should be noted that this non-cohesive stratum may 'boil' or be 'disturbed' when subjected to an unbalanced hydrostatic pressure. No laboratory test results of samples of this material are available at this time.

Underlying the sand previously described is a mixture of very dense sand and gravel. The thickness of this stratum was found to 0.7.m. It is anticipated that cobbles and boulders may be encountered within this cohesionless deposit.

.....2

Bedrock was proven in B.H. 5 by obtaining 2.1 m of BX rock core. Bedrock at this specific location is described as a Granitic Fault Breccia, slightly weathered. The surface of the bedrock was found at a depth of 5.9 m below the ground surface, corresponding to Elev. 339.9.

The groundwater level across the site is governed by the prevailing creek level. At the time of the investigation the creek level was at Elev. 345.4. The stabilized groundwater level may be expected to be at the same elevation.

Recommendations

Recommendations pertaining to the design and construction of the foundations for this project were presented in the 1986 report prepared for this Section by Terraprobe Limited. Generally, the recommendations in this report are still valid. However, in view of the findings of B.H. 5, the south abutment, if founded at Elev. 342.9 can be designed for 1000 kPa U.L.S., and 400 kPa, S.L.S. Type II.

I would request that you append this memorandum to your copy of the foundation report for future reference. If you have any questions or require clarification, please do not hesitate to contact the undersigned.

L. Politano
Project Foundations Engineer

for

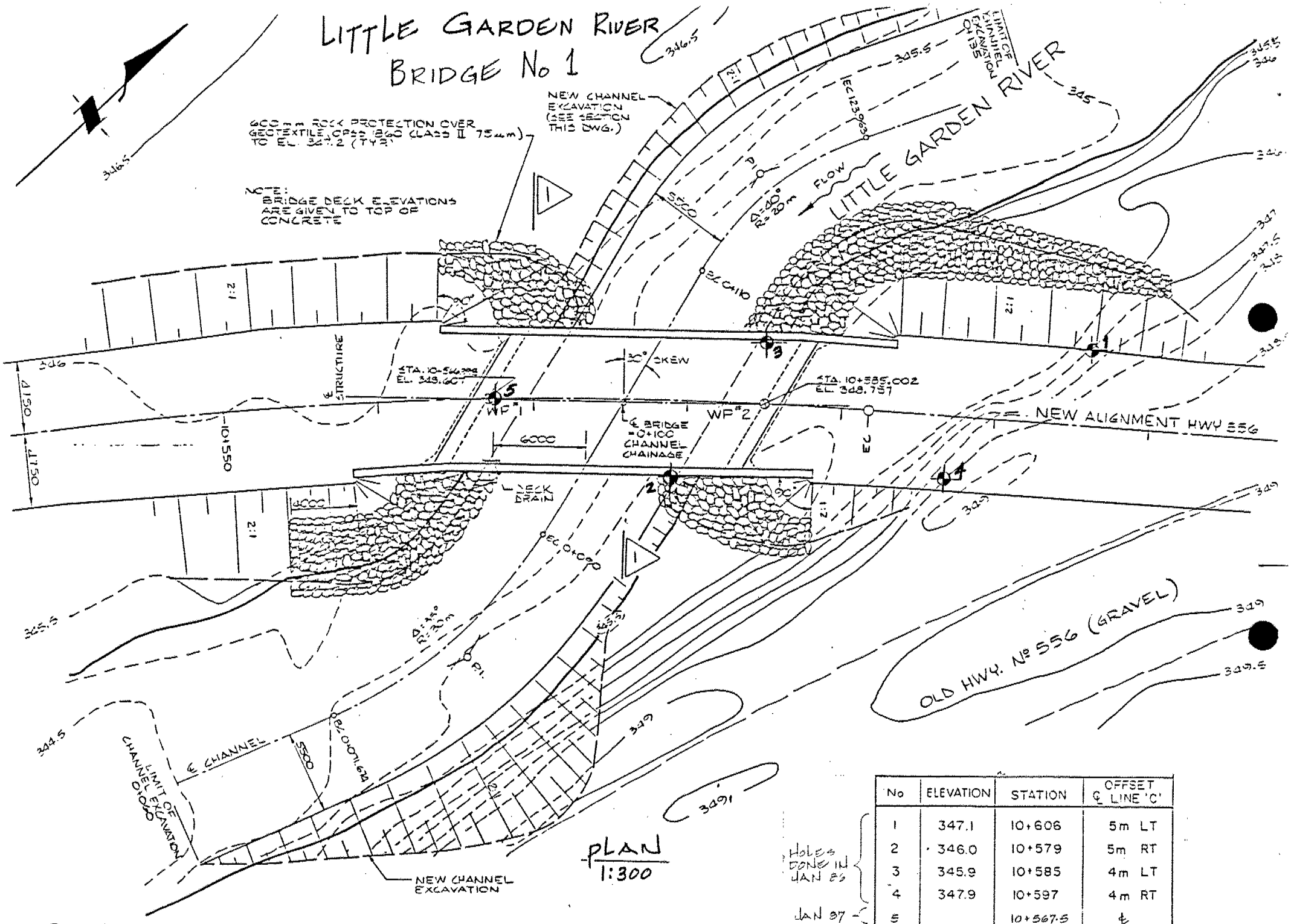
M. Devata
Chief Foundations Engineer
(East)

LP/MD/mmj

Attachs.

c.c. - J.B. MacMaster
G.D. Newell
C.E. Pritchard
K. Bassi
J.H. Peer

LITTLE GARDEN RIVER
BRIDGE No 1



PLAN
1:300

	No	ELEVATION	STATION	OFFSET ℄ LINE 'C'
HOLES DONE IN JAN 96	1	347.1	10+606	5m LT
	2	346.0	10+579	5m RT
	3	345.9	10+585	4m LT
	4	347.9	10+597	4m RT
JAN 97	5		10+567.5	℄

REMOVE EXISTING TIMBER BRIDGE DOWNSTREAM.

DRAFT FOR DISCUSSION ONLY

5

V : 277-85-01 LOCATION Sta. 10+867.5 3 C ORIGINATED BY M.J.

DIST 18 HWY 556 BOREHOLE TYPE H.S. Auger, BW Casing, Cone Pen Test COMPILED BY L.P.

DATUM GEODETIC DATE 87-01-15/20 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 x 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						
345.8	Ground Surface										
0.0	Peat		1	SS	7		345				
345.1 0.7	Fine silty sand		2	SS	20						
	Sand, some silt, gravel (sand well-graded)		3	SS	30		344				
			4	SS	125	▼	343				
	Occ. cobbles and boulders		5	SS	82	*					
			6	SS	38		342				
	Dense, Very Loose		7	SS	76		341				
340.1 5.4	Sand and gravel, some silt		8	SS	70/8cm		340				REC= 63% RQD= 47%
338.9 6.6	Occ. boulders V. Dense boulders		9	RC							REC= 75% RQD= 0%
	Bedrock		10	RC			339				REC= 90% RQD= 13%
	Granitic Fault Breccia		11	RC							
	Slightly weathered		12	RC			338				REC= 71% RQD= 0%
337.8 8.0	End of Borehole										
	*Groundwater level measured at end of temporary open borehole. May not be stabilized										

+3, +5 : Numbers refer to Sensitivity

20
15 ε (%) STRAIN AT FAILURE

memorandum

Tel: 248-3282

Ontario

To: O.E. Ramakko
Head, Structural Section
Northwestern Region

Date: 1986 11 07

ATTEN: R.J. Krisciunas
Senior Structural Engineer

From: Foundation Design Section
Room 315, Central Building
Downsview

RE: W.P. 277-85-01
Little Garden River Crossing No. 1
Hwy 556, Site 38,5-20
Dist. 18, Sault Ste Marie

Further to your memorandum of 86-10-16, we have reviewed the Preliminary General Arrangement drawing (dated September '86) for the above-noted project.

We note that subsequent to the issue of the Foundation Investigation and Design Report, the location of the structure has been changed. When we were requested to carry out a foundation investigation for this project, we were informed that the structure would be located along the new alignment of Hwy. 556 at the crossing of the existing Little Garden River. However, as shown on the preliminary drawing, the structure has been shifted approximately 15 m to the west. Consequently, we have no subsurface information available for the west abutment on the west river bank.

In view of the relocation of the structure, we feel that additional borings will be reqired at this site in order to obtain the required subsurface information.

Upon completion of the fieldwork, we will once again review the preliminary dwg., and provide you with our comments.

L. Politano
Project Foundations Engineer

for

M. Devata
Chief Foundations Engineer (East)

W.P. 277-85-01

memorandum

Ontario

To: O.E. Ramakko
Head, Structural Section
Thunder Bay

Date: 1986 09 17

From: Foundation Design Section
Room 315, Central Building

RE: Little Garden River Bridges No. 1 & No. 2
Sites 38S-20 and 386-21
Highway 556
District 18 - Sault Ste. Marie

Further to your memo of 86 09 12 and recent telephone conversations, we understand that consideration is being given to the construction of twin cell(2 - 6 x 3 m) concrete box culverts with retaining walls at the above-noted sites. The proposed elevation of the underside of the culvert at crossing No. 1 is Elev. 344. At crossing No. 2, the proposed founding elevation is Elev.350.

Your concern with this alternative is the potential dewatering problems. The following are our comments with regards to dewatering.

Little Garden River Crossing No. 1

If the excavation is to be advanced to Elev. 344, a dewatering scheme will be required since the predominant deposit consists of gravel, sand and boulders. Since the material is dense to very dense and includes boulders and cobbles, the use of well points or sheet piling is not considered feasible.

An alternative which could be utilized at this site after the creek has been diverted involves advancing the excavation down to Elev. 344 and providing perimeter ditches 0.3 to 0.4 m below the base of the excavation. Water seeping into the excavation would have to be sumped from a number of pumps. The denseness of the material may permit such a scheme to function.

It should be noted, however, that considering the nature of the soil and the water elevation, is is difficult to predict the amount of water which will seep into the excavation. Since a very large excavation is required for the construction of the twin-box culverts, it may be difficult to control the volumes of water seeping into the excavation particularly if there are localized 'less dense" zones or seams in the immediate area.

Little Garden River Crossing No. 2

It is proposed to found the twin-box culverts at Elev. 350 The material across the site is non-cohesive in nature and subsequently is very permeable.

In order to dewater the excavation, a sheet pile coffer dam could be installed around the perimeter of the excavation. The sheet piling would have to penetrate the minimum of 2-3 m below the base of the excavation in order to adequately depress the groundwater level in the area of the proposed excavation.

Pumping from sumps would also be required in order to control the expected nominal amounts of seepage into the excavation.

If you have any questions or require additional information, please do not hesitate to contact me.

L. Politano
Project Foundations Engineer
for

M. Devata
Chief Foundations Engineer
(East)

MD/LP/mmj

M E M O R A N D U M

TO: M. S. Devata
Chief Foundations Engineer
Engineering Materials Office
Foundation Design Section
Central Building
Downsview, Ontario

DATE: 1986 09 12

FROM: Structural Section
Northwestern Region
807/577-6541 Ext. 247

ATTENTION: L. Politano
Project Foundations Engineer

Re: Little Garden River Bridge No. 1 and No. 2
Sites 38S-20 and 38S-21
Hwy. 556, Sault Ste. Marie

This serves to confirm our recent telephone conversation and my request for additional information about these two sites.

Northland Engineering of Sudbury have recently begun the structural design for these bridges. Part of their assignment requires the assessment of various structure alternatives, and one type in particular shows advantages which have caused me to consider it more closely. That alternative is a twin cell (6 m. x 3 m.) concrete box culvert with retaining walls.

The major concern I have for this type of structure relates to dewatering for the foundations. The Foundation Report notes that the underlying material is dense granular which is quite porous. Mention is also made of the need for a well point system for dewatering. Considering the large area beneath a twin cell culvert to be unwatered, and the need for a stream diversion as well, this alternative may become very expensive.

Please review the Foundation Reports for these two structures and advise as to the method of dewatering required, bedding requirements, etc. for the twin cell culvert option. The proposed elevation at the underside of each culvert is as follows:

Little Garden No. 1: Elev. 344.0
Little Garden No. 2: Elev. 350.0

O. E. Ramakko

O. E. Ramakko
Head, Structural Section

OER/eu

1

Site located on right side of photo, in heavily treed area.

2

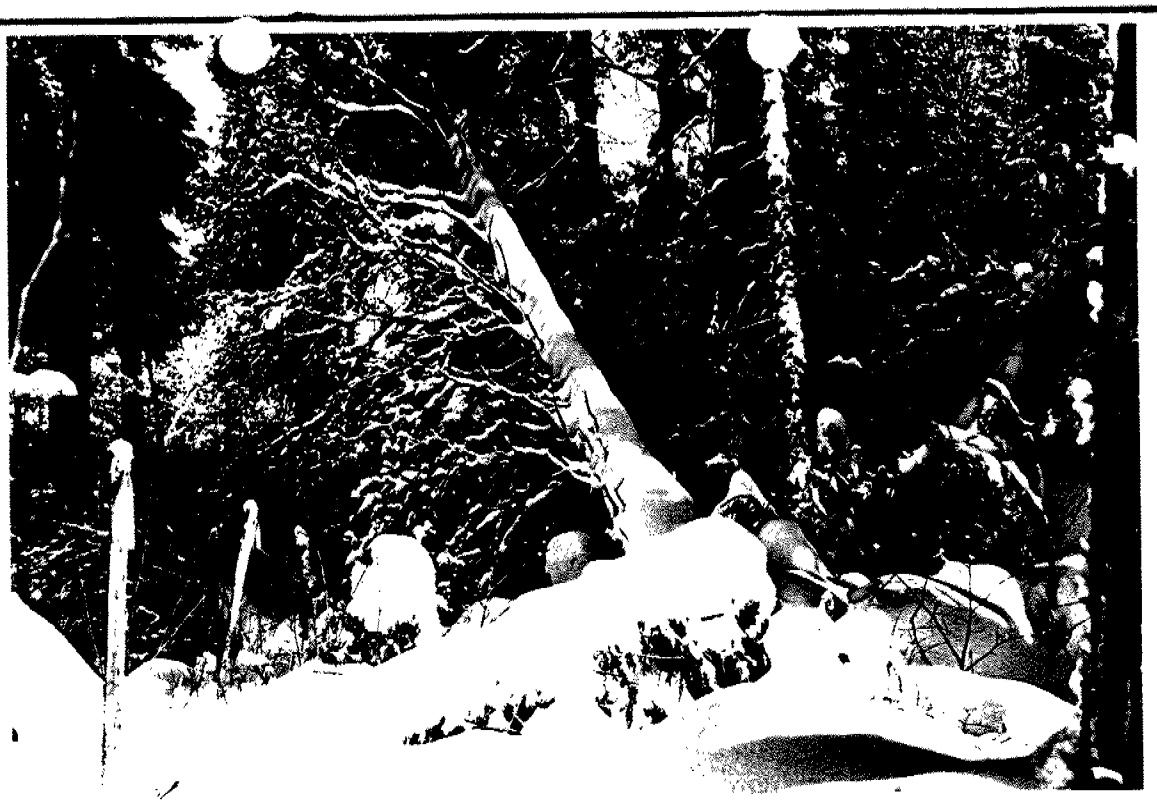
Survey line looking north-east, up to gravel Highway 556.

PHOTOGRAPHS

TERRAPROBE LIMITED

Job no. 85293	FIGURE 1
Scale	
Date JAN 86	

3



Felled trees looking north-east along survey line.

4

Survey line looking south-west across Little Garden River.

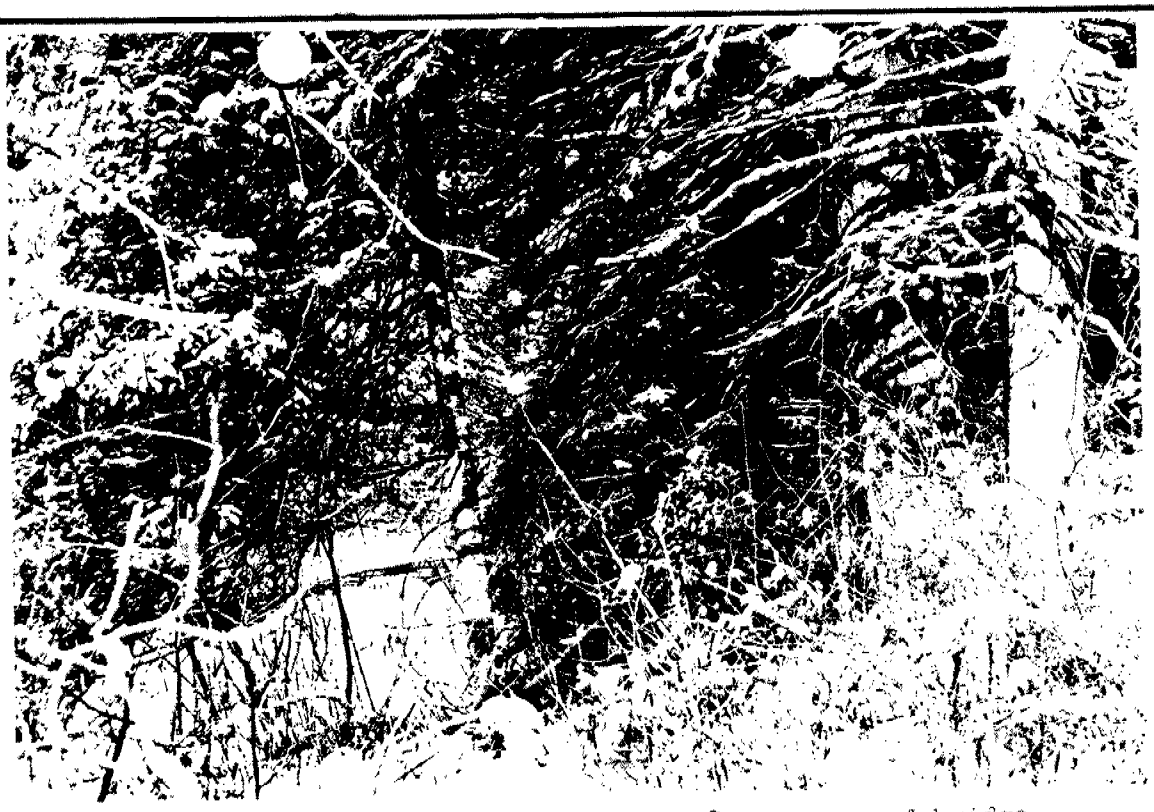
PHOTOGRAPHS

TERRAPROBE LIMITED

Job no.	85293
Scale	
Date	JAN 86

FIGURE 2

5



Heavily forested area looking north from ℄ of proposed bridge.

6

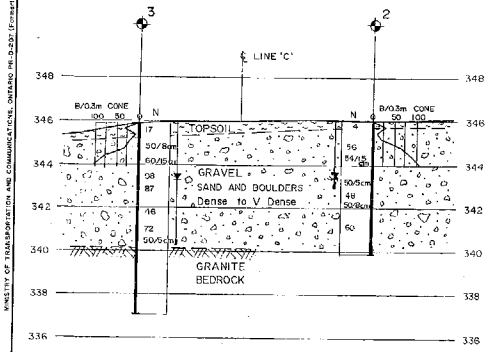
Benchmark (B.M. 349.542). N & W in the rest of 0.40 spruce.

PHOTOGRAPHS

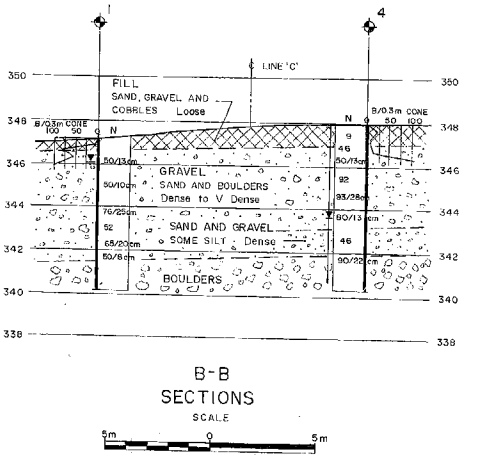
TERRAPROBE LIMITED

Job no.	85293
Scale	
Date	JAN 86

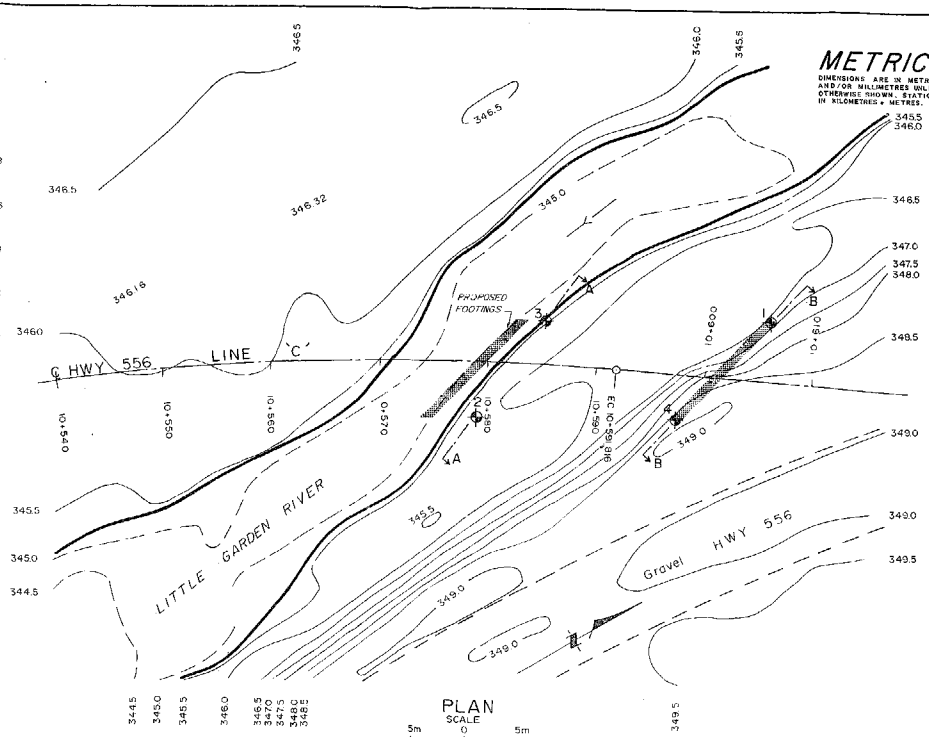
FIGURE 3



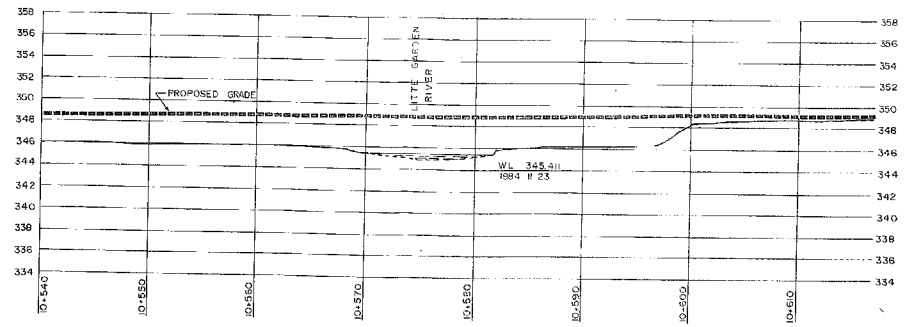
A-A



B-B
SECTIONS
SCALE
5m 0 5m



PLAN
SCALE
5m 0 5m



PROFILE OF LINE 'C'
SCALE
5m 0 5m

METRIC

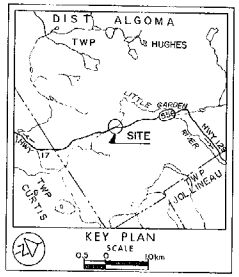
DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN. STATIONS IN KILOMETRES + METRES.

CONT No
WP No 277-85-01

LITTLE GARDEN RIVER
(CROSSING No 1)
BORE HOLE LOCATIONS & SOIL STRATA

SHEET 17

TERRAPROBE LIMITED



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 01 and 1986 02
- Piezometer

No	ELEVATION	STATION	OFFSET ℄ LINE 'C'
1	347.1	10+606	5m LT
2	346.0	10+579	5m RT
3	345.9	10+585	4m LT
4	347.9	10+597	4m 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 190.

REVISIONS		
DATE	BY	DESCRIPTION

Geocres No 41J-43

HWY No 556			DIST 18
SUBM'D PB	CHECKED	DATE 1986 02 13	SITE 386-20
DRAWN JB	CHECKED	APPROVED	DWG 277850I-A

METRIC

DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN

northland engineering limited
Consulting Engineers and Planners
KAPUSKASING — SUDBURY — TIMMINS

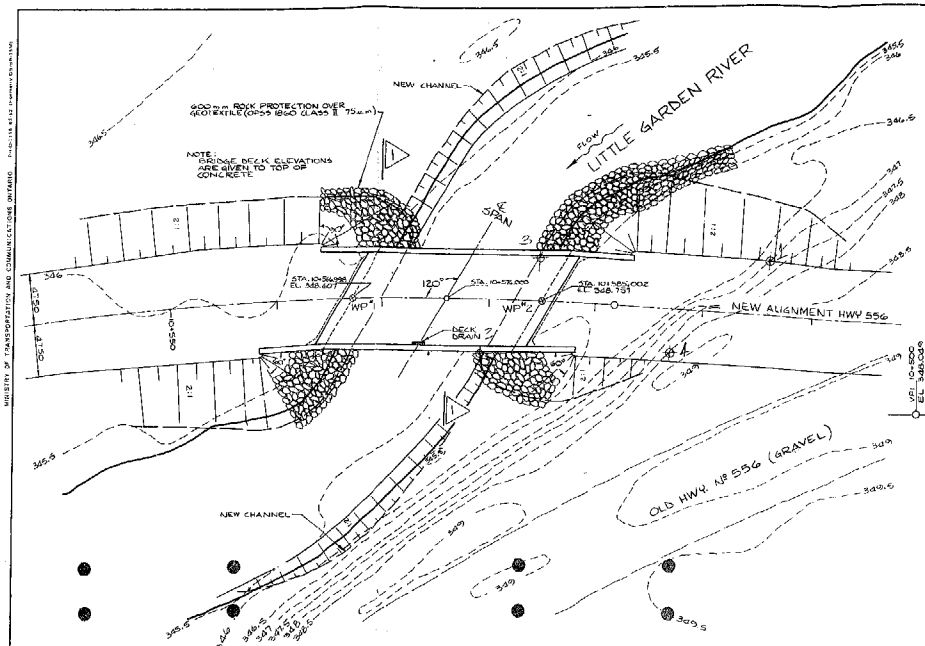
CONT No
WP No 277-85-00

LITTLE GARDEN RIVER BRIDGE No. 1
HWY. No. 556 STA. 10+576

GENERAL ARRANGEMENT

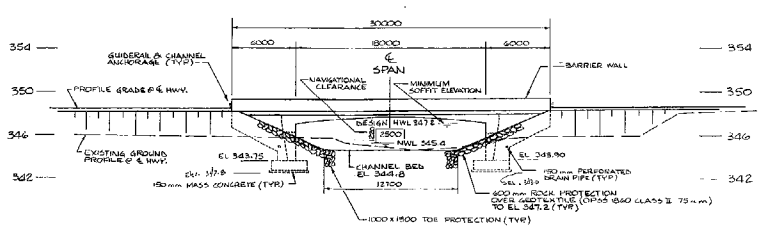
SHEET

MINISTRY OF TRANSPORTATION AND COMMUNICATIONS ONTARIO



PLAN

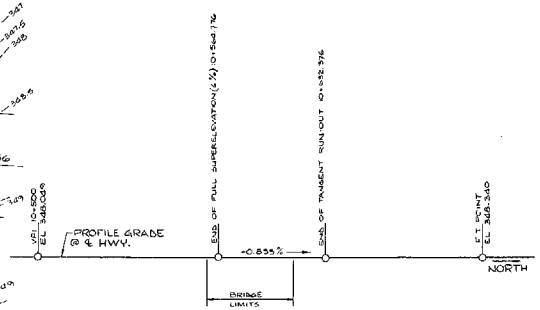
SCALE 1:200



ELEVATION

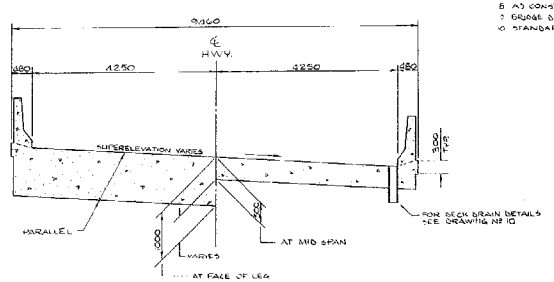
SCALE 1:200

BM 349.542
GEODETIC DATUM
N.B.W. IN ROOT OF SPRUCE 20.0 m RT.
STA. 10+650



PROFILE @ ℄ HWY. Nº 556

N.T.S.



1 SECTION

SCALE 1:50

GENERAL NOTES:

CLASS OF CONCRETE
- FOOTING AND MASS CONCRETE ------ 20 MPa
- REMAINDER ------ 30 MPa

REINFORCING STEEL
- REINFORCING STEEL TO BE GRADE 400 UNLESS OTHERWISE SPECIFIED. BARS MARKED WITH SUFFIX 'E' SHALL BE EPOXY COATED.

CLEAR COVER TO REINFORCING STEEL
- FOOTINGS ... 100 mm ± 25 mm
- FRAME LEGS AND WINGWALLS ... 70 mm ± 20 mm
- DECK SLAB ... TOP 70 mm ± 20 mm, BOTTOM 30 mm ± 10 mm
- BARRIER WALLS ... 70 mm ± 20 mm

EXCEPT AS NOTED OTHERWISE

CONSTRUCTION NOTES
- NO CONCRETE SHALL BE PLACED FOR FOOTINGS UNTIL THE DEPTH OF EXCAVATION AND CHARACTER OF THE FOUNDATION MATERIAL HAVE BEEN APPROVED BY THE ENGINEER.
- BACKFILL SHALL BE PLACED SIMULTANEOUSLY BEHIND BOTH FRAME LEGS KEEPING THE HEIGHT OF BACKFILL APPROXIMATELY THE SAME. AT NO TIME SHALL THE DIFFERENCE IN ELEVATION BE GREATER THAN 1500 mm.
- FALSEWORK SUPPORTING WINGWALLS SHALL NOT BE REMOVED UNTIL CONCRETE IN DECK HAS ATTAINED A MINIMUM STRENGTH OF 30 MPa.
- FALSEWORK SUPPORTING THE DECK SHALL NOT BE REMOVED UNTIL BACKFILL HAS BEEN PLACED BEHIND THE ABUTMENTS.

CONCRETE QUANTITIES
- CONCRETE IN BRIDGE ------
- CONCRETE IN BARRIER WALLS ------

LIST OF DRAWINGS

1. GENERAL ARRANGEMENT
2. BOREHOLE LOCATIONS AND SOIL STRATA
3. FOOTING LAYOUT AND REINFORCING
4. FRAME LAYOUT AND DETAILS
5. FRAME REINFORCING
6. WINGWALL REINFORCING AND SECTIONS
7. BARRIER WALL
8. AS CONSTRUCTED ELEVATIONS AND DIMENSIONS
9. BRIDGE DATA AND SITE NUMBER DATA
10. STANDARD DETAILS

RECEIVED
OCT 21 1986
Foundation Design Section

PRELIMINARY

OCT 9 1986

NORTHLAND ENGINEERING

ASSOCIATION OF PROFESSIONAL ENGINEERS PROVINCE OF ONTARIO
N. W. Cardwright

DRAWING NOT TO BE SCALED
100 mm ON ORIGINAL DRAWING

REVISIONS			
DATE	BY	DESCRIPTION	
DESIGN N.W.C.	CHECK	LOADING OHBDC '83-B	DATE SEPT./86
DRAWING W.B.	CHECK	SITE No 385-20	DWG 1