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STR. SITE No. 385-237

HWY. No. 557

LOCATION Hwy 557 & Cataract River

No of PAGES -

OVERSIZE DRAWINGS TO BE INCLUDED WITH THIS REPORT.

REMARKS:

FOUNDATION INVESTIGATION REPORT

CONTRACT NO. 94-233

Ontario

Ministry of
Transportation

INDEX

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

EXPLANATION OF TERMS USED IN REPORT

N VALUE: THE STANDARD PENETRATION TEST (SPT) N VALUE IS THE NUMBER OF BLOWS REQUIRED TO CAUSE A STANDARD 51mm O.D. SPLIT BARREL SAMPLER TO PENETRATE 0.3m INTO UNDISTURBED GROUND IN A BOREHOLE WHEN DRIVEN BY A HAMMER WITH A MASS OF 63.5kg, FALLING FREELY A DISTANCE OF 0.76m. FOR PENETRATIONS OF LESS THAN 0.3m N VALUES ARE INDICATED AS THE NUMBER OF BLOWS FOR THE PENETRATION ACHIEVED. AVERAGE N VALUE IS DENOTED THUS $\bar{N}$.

DYNAMIC CONE PENETRATION TEST: CONTINUOUS PENETRATION OF A CONICAL STEEL POINT (51mm O.D. 60° CONE ANGLE) DRIVEN BY 475 J IMPACT ENERGY ON 'A' SIZE DRILL RODS. THE RESISTANCE TO CONE PENETRATION IS MEASURED AS THE NUMBER OF BLOWS FOR EACH 0.3m ADVANCE OF THE CONICAL POINT INTO THE UNDISTURBED GROUND.

SOILS ARE DESCRIBED BY THEIR COMPOSITION AND CONSISTENCY OR DENSENESS.

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

c_u (kPa)	0 - 12	12 - 25	25 - 50	50 - 100	100 - 200	>200
	VERY SOFT	*SOFT*	*FIRM*	*STIFF*	*VERY STIFF*	*HARD*

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

N (BLOWS/0.3m)	0 - 5	5 - 10	10 - 30	30 - 50	>50
	VERY LOOSE	*LOOSE*	*COMPACT*	*DENSE*	*VERY DENSE*

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

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

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

R Q D (%)	0 - 25	25 - 50	50 - 75	75 - 90	90 - 100
	VERY POOR	*POOR*	*FAIR*	*GOOD*	*EXCELLENT*

JOINTING AND BEDDING:

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

ABBREVIATIONS AND SYMBOLS

FIELD SAMPLING

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

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
CATARACT RIVER (BLIND RIVER) BRIDGE
W.P. 5-87-01 SITE 38S-237
HWY 557, DISTRICT 18, SAULT STE. MARIE

INTRODUCTION

This report summarizes the results of a foundation investigation for the proposed crossing of Cataract River at Hwy. 557. The investigation was carried out at the request of Foundation Design Section of Ministry of Transportation of Ontario.

This report contains geotechnical information pertaining to structure foundations, approach embankments and related earthworks between Sta. 20 + 360 and Sta. 20 + 440.

SITE DESCRIPTION

The site is located at the present crossing of Cataract River and Hwy. 557, in District 18, Sault Ste. Marie, Ontario. The existing crossing consist of a single span (34.0 m length) Bailey bridge structure with timber deck. The exact type of foundations used is not known.

The surrounding area is covered with heavy vegetation and scattered cottages. Rock outcrops are visible on both sides of the existing highway. The river channel, at the crossing, is approximately 30 m wide and about 5.0 m deep. At the time of the investigation, October 19, 1990, the water level in the river was at Elevation 179.7 m, about 3.8 m deep. A gentle slope, of about 2 horizontal to 1 vertical, rises out of the bed at both the banks. The banks are covered by heavy bush, some trees and boulders.

PROCEDURE

The field investigation was carried out between the period of October 15 and 21, 1990. The fieldwork consist of drilling seven boreholes, two cone tests and one test pit. The boreholes, on land, were advanced using a track mounted auger machine equipped with 83 mm I.D. hollow stem augers and B size casing. The boreholes, in water, were advanced using skid mounted diamond drill rig on a raft. Three boreholes were further advanced in the rock, by using BXT size core bits. Hole 6 was excavated by a back-hoe to determine the lateral extent, at the footing location, of the bedrock surface.

Samples were recovered by means of a 50 mm O.D. split spoon sampler driven into the soil according to the specification of the Standard penetration Test (ASTM D 1586-84). In addition, relatively undisturbed samples were retrieved using 50 mm thin walled shelby tubes. Field vane tests were carried out in the stiff to soft cohesive deposits.

Laboratory testing was carried out on representative samples to identify and determine the physical properties of the overburden including:

Natural moisture content
Grain size distribution
Atterberg Limit
Unit Weight
Quick Undrained Triaxial test

The elevations of the boreholes were referenced to a local geodetic benchmark, at Elevation 181.49 m, provided by the MTO local office. (rivet in bedrock, 16.2 m Lt, Sta. 20 + 373.3).

SITE GEOLOGY AND SUBSURFACE CONDITIONS

Geologically, the site lies in the area known as Precambrian Shield. The area has been deeply buried in the earth's crust and the rocks have been highly metamorphosed, or changed, by intense heat and pressure. The characteristic bedrock belongs to Gowanda formation. Two major faults have been recorded to exist in this vicinity. The bedrock is generally overlain by geologically recent deposits of sand and gravel, clay and silt of lacustrine origin.

The subsoil conditions are variable from the north to the south bank. The soils, on the north side of the river bank, consist of very loose to compact sand and gravel fill, overlying very stiff to soft layered clayey silt to silty clay, overlying compact gravelly sand which in turn overlies Gabro Bedrock. However, on the south side, a veneer of loam layer with rock fragments, or very loose to loose gravelly sand fill, overlies the slaty Limestone Bedrock at shallow depths. Along the river bed, loose gravelly sand overlies loose to compact silt, which in turn overlies Gabro Bedrock.

The boundaries of the different strata, together with the field and laboratory test results, appear on the Record of Borehole sheets appended to this report. Also refer to the sheets for the locations and elevations of the boreholes. Stratigraphical sections of the subsurface conditions are shown on Drawing 58701-A.* Detailed description of the different strata are provided below.

*Dwg. No. 2, (Sheet 39) of the Contract Drawings.

Gravelly Sand (Fill)

The surficial gravelly sand fill material was encountered at Boreholes 6, 7 and 5. At the south bank, this fill extends to Elevation 179.6 ± 0.1 m, about 2.5 m below the existing road surface. It contains wood planks, some silt and trace of organics, and overlies the bedrock at south bank.

However, the gravelly sand fill at the north bank (Borehole 5) extends to the depth of 0.8 m, Elevation 181.5 m. It overlies the layered clayey silt deposit.

The presence of cobbles and boulders was evident. This fill appears to have been placed during the construction of the existing embankments. The 'N' values vary from 2 to 7 blows, indicating a state of compaction varying from very loose to loose. The moisture content varies from 8 to 18 percent. Typical gradation curve is shown in Figure 1.

Loam and Rock fragments

On the south side of the river, a thin veneer of loam mixed with rock fragments forms the surficial soils at Borehole 1. It is 40 cm thick and in a compact state.

Gravelly Sand (Native)

The river bed consist of gravelly sand with some silt, and its thickness at Boreholes 2, 3 and 4, varies from 0.3 to 0.9 m. Cobbles and boulders were also evident at the surface of the river bed. At the north bank, this layer is encountered at the surface, at Borehole 8, and extends to the depth of 1.3 m. This deposit is also present underneath the layered clayey silt deposit at Boreholes 5 and 8. The thickness of the underlying layer varies from 0.8 to 1.0 m. The 'N' values vary from 4 to 29 blows, indicating a state of compaction varying from loose to compact. The moisture content varies from 8 to 16 percent. Typical gradation curves are given in Figures 2 and 3.

Silt

At the river location, at Boreholes 2 and 4, the gravelly sand is underlain by a deposit of silt. The silt contains some sand and trace of clay. Based on 'N' values of 9 to 30, this non cohesive deposit is in a loose to compact state. The thickness of this layer varies from 1.6 to 2.3 m. The moisture content varies from 21 to 23 percent. Typical gradation curve is given in Figure 4.

Clayey Silt to Silt to Silty Clay

The deposit was encountered at the north bank, at Boreholes 5 and 8. This deposit is present beneath the gravelly sand. The stratum is layered and its thickness varies from 1.7 to 2.7 m. The individual layers, which vary from about 3 mm to 30 mm in thickness, are distinguished by colour, varying from red-brown to light grey to dark grey.

Undrained shear strength of the soil was determined both by the in situ field vane tests, and by the Quick Undrained Triaxial test. In the upper 1.5 m, the shear strength is in excess of 115 kpa, indicating it is in a very stiff state. This deposit becomes weaker with depth and the shear strength for the lower 1.2 m drops from 55 kpa to 20 kpa, indicating a consistency of stiff to soft.

The results from the three Atterberg Limit test (Figure 5), performed on this material are summarized as follows:

Property	Range	Average
Natural Moisture Content (%)	28 - 33	30.0
Liquid Limit (%)	36 - 39	37.5
Plastic Limit (%)	17 - 33	23.0
Plasticity Index (%)	5 - 22	14.5
Unit Weight (kN/cu.m)	18.9 -20.3	19.3

From the plasticity chart, the deposit is classified as inorganic clayey silt to silty clay of intermediate plasticity. However, the silt layers were non-plastic.

Grain size distribution envelope is given in Figure 6. Due to a layered nature of this deposit, the grain size distribution carried out on the sample is not indicative of the high clay content.

Bedrock

Bedrock was core drilled at the locations of Boreholes 1, 4 and 5. The type of bedrock varies across the site. Along the south bank, the bedrock is identified as slaty limestone, while at the river channel and at the north bank, the bedrock is identified as Gabro of ultramafic type. Both the rock types are generally strong to very strong in nature. Core recoveries varied from 95 % to 100 % and R.Q.D. ranged from 35 to 100 %. The quality of the rock is defined as good to excellent, except in the upper 1.1 m at Borehole 1, where it is moderately weathered and poor.

The bedrock dips down into the channel, and along the river banks it dips from south to north. Variations in the bedrock levels must be expected due to the presence of faults. At the south bank, the bedrock level varies from 0.4 to 2.5 m depth, i.e. Elevation 179.9 to 179.5 m. Rock outcrops were visible at surface Elevation 180.3 m. While at the north bank, the bedrock level is at 3.8 to 4.5 m depth, i.e. Elevation 178.9 to 177.8 m. Along the river channel, the bedrock level varies from Elevation 177.4 to 174.6 m.

Groundwater Conditions

Observation of the groundwater level was carried out by measuring the water levels in the open boreholes. Groundwater was at river level, i.e. Elevation 179.7 m on October 19, 1990. It should be noted that the groundwater is subject to changes with the fluctuations in the river levels.

MISCELLANEOUS

The fieldwork for this investigation was carried out under the supervision of S. Magdolen, Geologist, The equipment was owned and operated by Master Soils Investigation Limited.

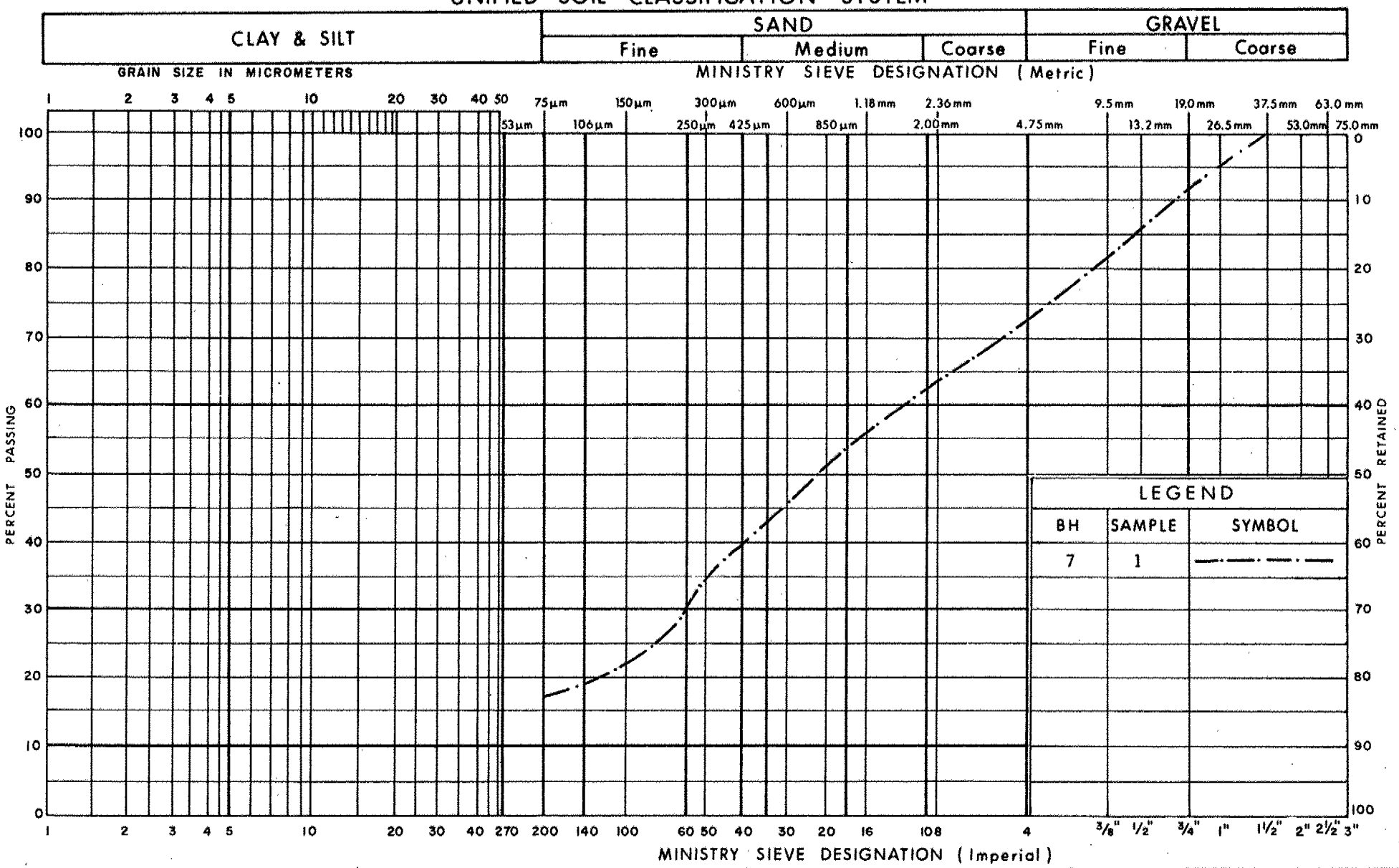
The project was carried out under the supervision of S. Bandukwala, Project Engineer. The report was written by S. Bandukwala, and reviewed by L. Rak, Principal Engineer.

Note: The preceding report is a copy of the factual information from the Foundation Report prepared by McClymont and Rak Engineers Inc. (consulting geotechnical engineers for this project), under the technical supervision of the M.T.O. Foundation Design Section.

T.C. Kim, P. Eng.
Senior Foundation Engineer

APPENDIX

UNIFIED SOIL CLASSIFICATION SYSTEM



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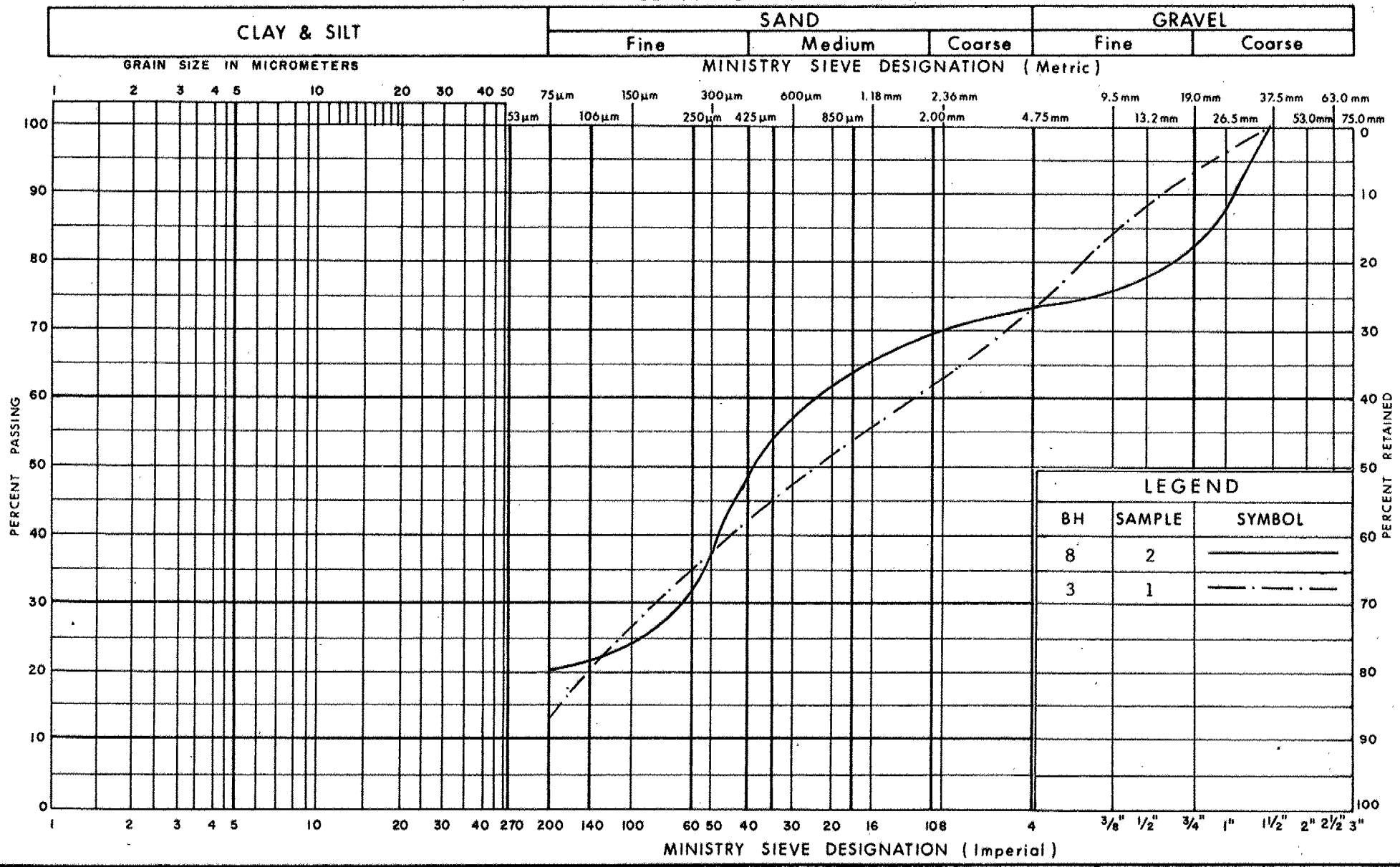
GRAIN SIZE DISTRIBUTION
GRAVELLY SAND (FILL)

FIG No 1
W P 5-87-01

10

UNIFIED SOIL CLASSIFICATION SYSTEM



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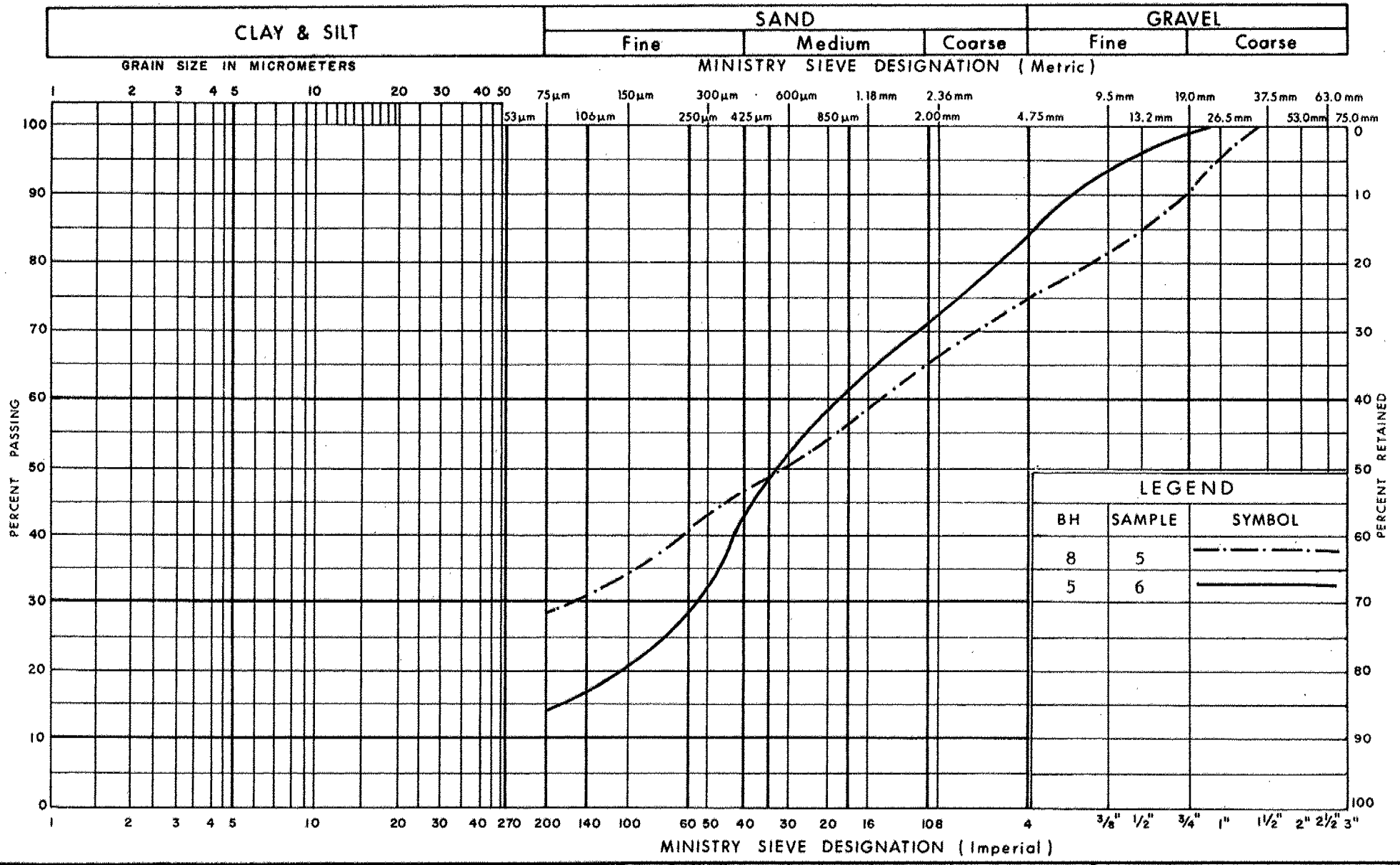
GRAIN SIZE DISTRIBUTION
GRAVELLY SAND, SOME SILT

FIG No 2
W P 5-87-01

11

UNIFIED SOIL CLASSIFICATION SYSTEM



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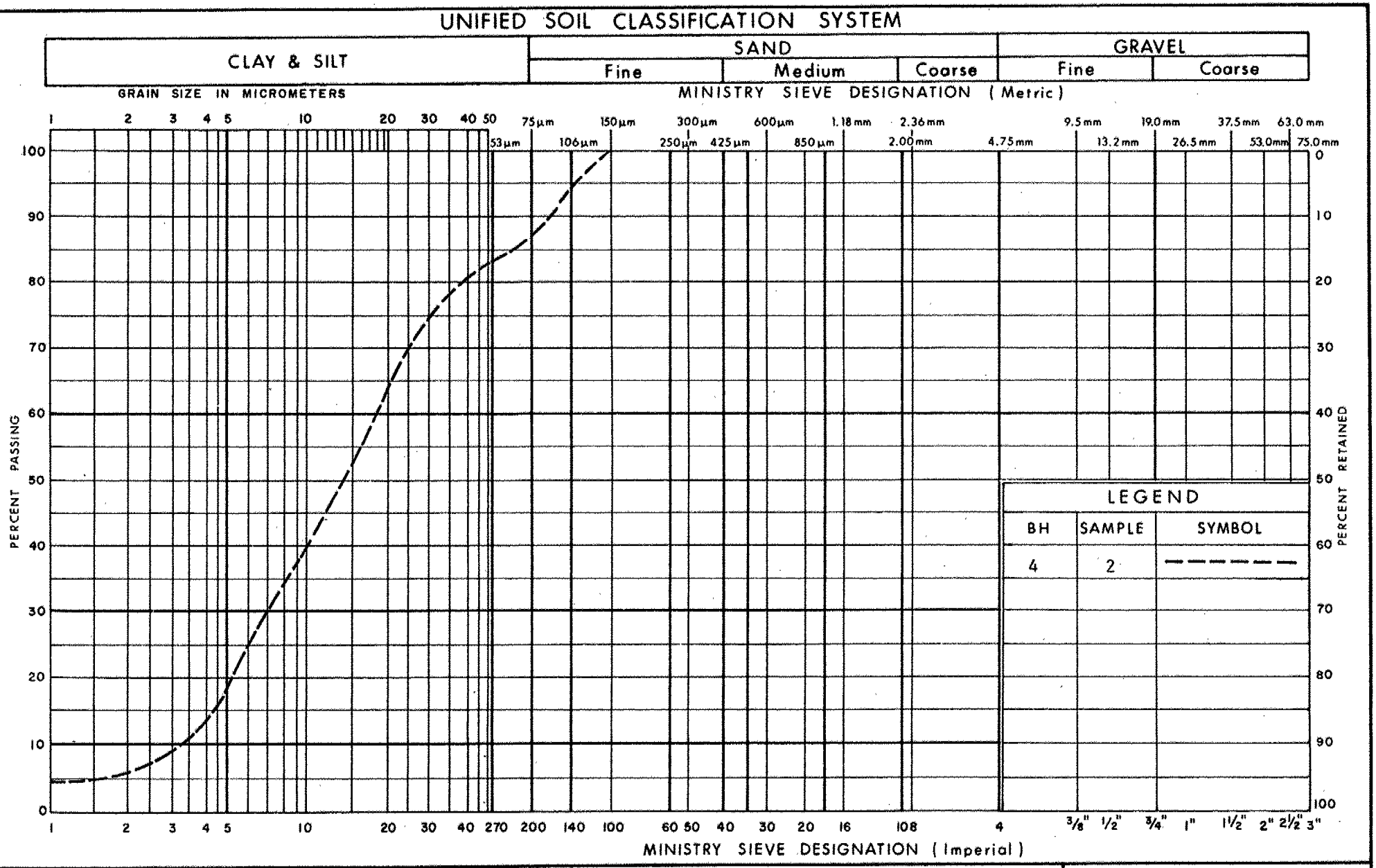
GRAIN SIZE DISTRIBUTION

GRAVELLY SAND, SOME SILT

FIG No 3

W P 5-87-01

12



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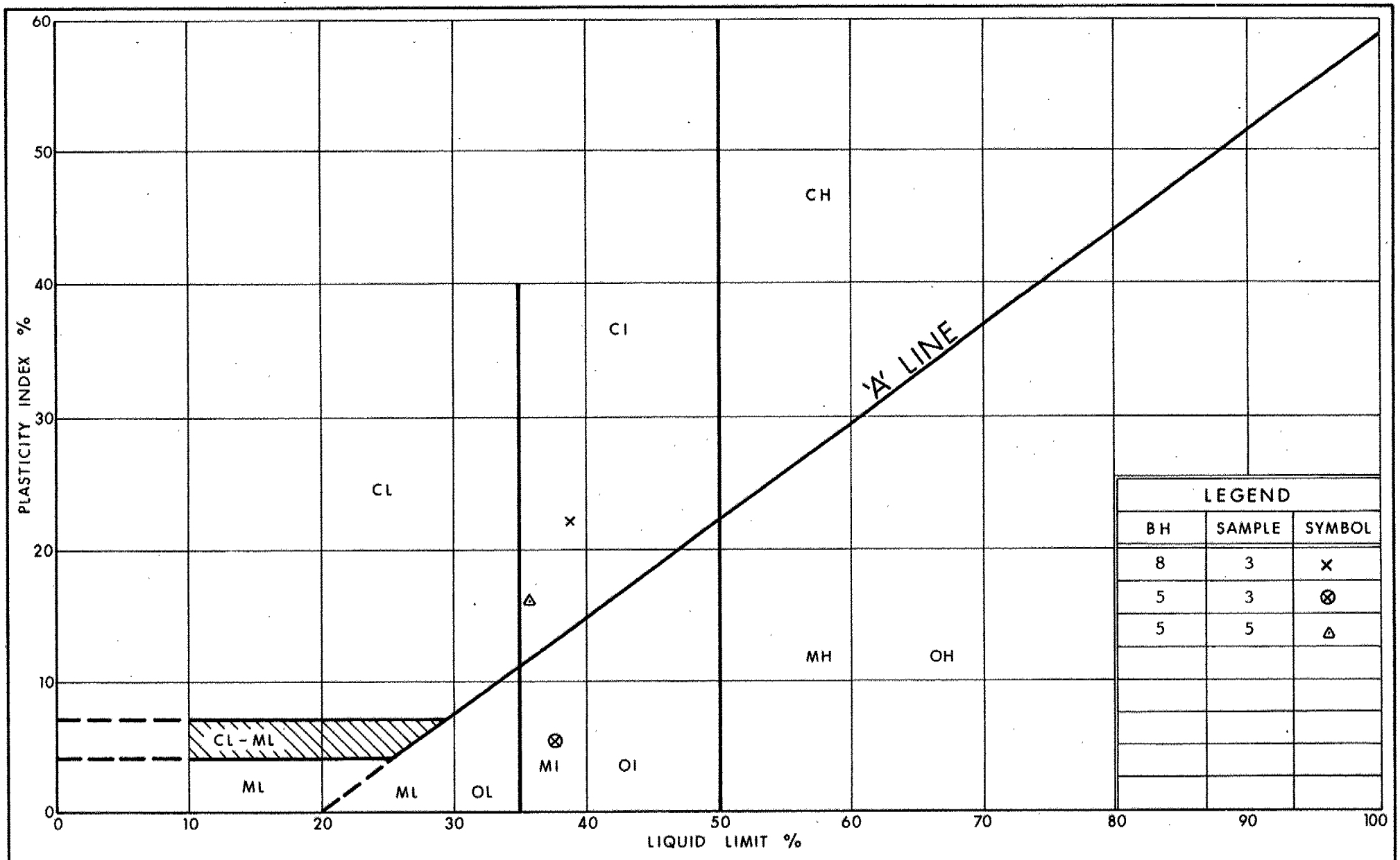
GRAIN SIZE DISTRIBUTION
SILT
SOME SAND, TRACE OF CLAY

FIG No 4
W P 5-87-01



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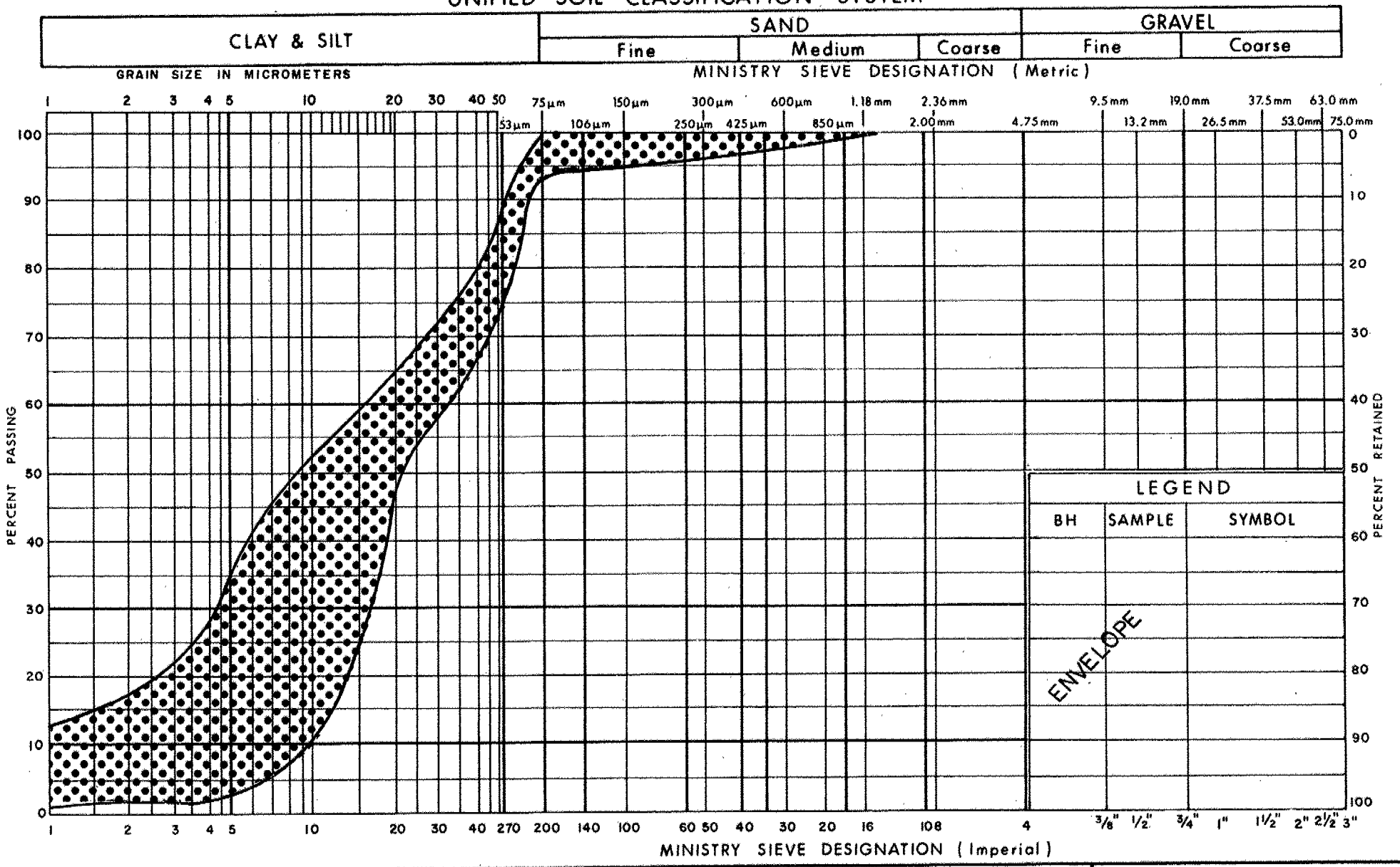
PLASTICITY CHART

LAYERED CLAYEY SILT TO SILT TO SILTY CLAY

FIG No 5

W P 5-87-01

UNIFIED SOIL CLASSIFICATION SYSTEM



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GRAIN SIZE DISTRIBUTION

LAYERED CLAYEY SILT TO SILT TO SILTY CLAY

FIG No 6

W P 5-87-01

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RECORD OF BOREHOLE No 1 — METRIC

W P 5-87-01 LOCATION Sta. 20 + 397.7 m, 14.6 m Lt of Hwy 557 ORIGINATED BY SM

DIST 18 HWY 557 BOREHOLE TYPE Wash boring and BXT rock core COMPILED BY SM

DATUM Geodetic DATE October 16 and 17, 1990 CHECKED BY SB

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 kPa (○ 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
180.3	Ground surface										
0.0 179.9	Loam and rock fragments, compact		1	SS	12		180		0		
0.4	SLATY LIMESTONE BEDROC Light grey, layered		2	RC BXT	REC 100%		179				RQD 35%
	medium bedding, strong to very strong		3	RC BXT	REC 100%		178				RQD 100%
176.8	moderately weathered to 1.1m, poor to excellent quality		4	RC BXT	REC 100%		177				RQD 88%
3.5	End of Borehole										

*Water level not observed.

OFFICE REPORT ON SOIL EXPLORATION

+3, ×5 : Numbers refer to Sensitivity

15 20 10 5 (%) STRAIN AT FAILURE

Ministry of Transportation Ontario

RECORD OF BOREHOLE No 2 METRIC

W P 5-87-01 LOCATION Sta. 20 + 426.2 m, 10.4 m Lt of ℄ of Hwy 557 ORIGINATED BY SM

DIST 18 HWY 557 BOREHOLE TYPE Wash boring COMPILED BY SM

DATUM Geodetic DATE October 20, 1990 CHECKED BY SB

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 kPa ○ 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
179.7	River water level										
0.0	WATER						179				
							178				
177.0	River Bottom						177				
2.7	Gravelly sand, loose		1	SS	4				○		
3.0	SILT some sand, trace of clay, rock fragments, loose to compact		2	SS	30		176				
175.1											
4.6	Probable bedrock End of Borehole										

OFFICE REPORT ON SOIL EXPLORATION

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

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

RECORD OF BOREHOLE No 3

METRIC

W P 5-87-01 LOCATION Sta. 20 + 439.7m, 16.2m Lt of ℄ of Hwy 557 ORIGINATED BY SM

DIST 18 HWY 557 BOREHOLE TYPE Wash boring COMPILED BY SM

DATUM Geodetic DATE October 19, 1990 CHECKED BY SB

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE	PLASTIC LIMIT W_P / NATURAL MOISTURE CONTENT W / LIQUID LIMIT W_L WATER CONTENT (%) 10 20 30	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES						
179.7	River water level										
0.0	WATER						179				
178.3	River Bottom										
1.4	GRAVELLY SAND some silt, rock fragments, compact		1	SS	21		178		o		28 55 (17)
177.4											
2.3	Probable bedrock End of Borehole										

OFFICE REPORT ON SOIL EXPLORATION

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

15 20 10 5 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 4 — METRIC

W P 5-87-01 LOCATION Sta. 20 + 421.1m, 10.2m Lt of ℄ of Hwy 557 ORIGINATED BY SM

DIST 18 HWY 557 BOREHOLE TYPE Wash boring and BXT rock core COMPILED BY SM

DATUM Geodetic DATE October 20, 1990 CHECKED BY SB

ELEV / DEPTH	SOIL PROFILE 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 kPa (○ 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
179.7	River water level										
0.0	WATER						179				
							178				
177.4	River Bottom										
2.3	GRAVELLY SAND some silt, loose		1	SS	7		177		o		
176.9											
2.8	SILT some sand, trace of clay, compact to loose		2	SS	14				o		0 12 83 5
							176				
			3	SS	9				o		
174.6							175				
5.1	GABRO BEDROCK ultramafic dark grey wide jointing, strong to very strong, good to excellent quality		4	RC EXT	100%						RQD 95%
			5	RC EXT	95%		174				RQD 87%
173.1											
6.6	End of Borehole										

+3, ×5 : Numbers refer to Sensitivity

15 20 10 5 (%) STRAIN AT FAILURE

OFFICE REPORT ON SOIL EXPLORATION

RECORD OF BOREHOLE No 5

METRIC

W P 5-87-01 LOCATION Sta. 20 + 427.3m, 4.4m Rt of ℄ of Hwy 557 ORIGINATED BY SM

DIST 18 HWY 557 BOREHOLE TYPE Hollow stem auger and BXT rock core COMPILED BY SM

DATUM Geodetic DATE October 17, 18, 1990 CHECKED BY SB

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 kPa (○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT Wp / NATURAL MOISTURE CONTENT W / LIQUID LIMIT W_L — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ Kn/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
182.3	Ground surface										
0.0	GRAVELLY SAND some silt, very loose (FILL)		1	SS	3		182				
181.5											
0.8	CLAYEY SILT TO SILT TO SILTY CLAY layered, red-brown, light grey and dark grey, very stiff to soft		2	SS	8					19.0	
			3	SS	6		181			19.0	0 0 84 16
			4	SS	5		180				0 4 90 6
178.8			5	TW	PM	▼	179			18.9	0 4 83 13
3.5	GRAVELLY SAND some silt, compact		6	SS	10						16 71 (13)
177.8							178				
4.5	GABRO BEDROCK ultramafic dark grey wide jointing, strong to very strong, good to excellent quality		7	RC BXT	100%						RQD 97%
			8	RC BXT	100%		177				RQD 78%
							176				
174.8			9	RC BXT	100%		175				RQD 91%
7.5	End of Borehole										

OFFICE REPORT ON SOIL EXPLORATION

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

15 20 10 5 (%) STRAIN AT FAILURE

Ministry of Transportation Ontario

RECORD OF TEST-PIT No 6

METRIC

W P 5-87-01 LOCATION Sta. 20 + 380.8m, 6.6m Rt of ℄ of Hwy 557 ORIGINATED BY SM

DIST 18 HWY 557 BOREHOLE TYPE Test pit by backhoe COMPILED BY SM

DATUM Geodetic DATE October 21, 1990 CHECKED BY SB

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT N (20 40 60 80 100) SHEAR STRENGTH kPa ○ 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						
181.0	Ground surface										
	GRAVELLY SAND rock fragments, some silt, wood planks (FILL)					▼	180				
179.5											
1.5	Bedrock End of Test-pit										

OFFICE REPORT ON SOIL EXPLORATION

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

15 20 10 5 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 7

METRIC

W P 5-87-01 LOCATION Sta. 20 + 383.3m, 2.9m Rt of ℄ of Hwy 557 ORIGINATED BY SM

DIST 18 HWY 557 BOREHOLE TYPE Solid stem auger COMPILED BY SM

DATUM Geodetic DATE October 19, 1990 CHECKED BY SB

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 kPa (○ 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
182.2	Ground surface										
0.0	Asphalt: 40 mm GRAVELLY SAND rock fragments, some silt, wood pieces, very loose to loose (FILL)		1	SS	7		182 181		o		27 56 (17)
			2	SS	2				o		
179.7			3	SS	50/12 cm	▼	180		o		
2.5	Probable bedrock End of Borehole										

OFFICE REPORT ON SOIL EXPLORATION

+3, ×5 : Numbers refer to Sensitivity

15 20 10 5 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 8

METRIC

W P 5-87-01 LOCATION Sta. 20 + 433.4m, 2.5m Lt of ℄ of Hwy 557 ORIGINATED BY SM

DIST 18 HWY 557 BOREHOLE TYPE Solid stem auger COMPILED BY SM

DATUM Geodetic DATE October 19, 1990 CHECKED BY SB

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 kPa ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE 20 40 60 80 100	PLASTIC LIMIT W_p / NATURAL MOISTURE CONTENT W / LIQUID LIMIT W_L WATER CONTENT (%) 10 20 30	UNIT WEIGHT γ Kn/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
182.7	Ground surface										
0.0	Granular: 280 mm		1	SS	29				○		
	GRAVELLY SAND some silt, compact						182				
181.4			2	SS	16				○		27 55 (18)
1.3	CLAYEY SILT TO SILT TO SILTY CLAY layered, very stiff to stiff		3	SS	11		181		×+		0 6 81 13
179.7			4	SS	7				○		0 5 94 1
3.0	GRAVELLY SAND some silt, compact		5	SS	11	▼	180		○		25 48 (27)
178.9							179				
3.8	Probable bedrock End of Borehole										

UNIT WEIGHT: 20.3

OFFICE REPORT ON SOIL EXPLORATION

+³, ×⁵ : Numbers refer to Sensitivity

15 20 10 5 (%) STRAIN AT FAILURE

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MC CLYMONT & RAK ENGINEERS, INC.

GEOTECHNICAL CONSULTANTS

C1194 DECEMBER 1990

FOUNDATION INVESTIGATION REPORT
CATARACT RIVER FOR
(BLIND RIVER) STRUCTURE
W.P. 5-87-01 SITE 38S-237
HWY 557, DISTRICT 18, SAULT STE. MARIE

CONT 94-233

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FOUNDATION INVESTIGATION REPORT
CATARACT RIVER (BLIND RIVER) FOR STRUCTURE
W.P. 5-87-01 SITE 38S-237
HWY 557, DISTRICT 18, SAULT STE. MARIE

INTRODUCTION

This report summarizes the results of a foundation investigation for the proposed crossing of Blind River at Highway 557. The investigation was carried out at the request of Foundation Design Section of Ministry of Transportation of Ontario.

This report contains geotechnical information pertaining to structure foundations, approach embankments and related earthworks between Sta. 20 + 360 and Sta. 20 + 440.

SITE DESCRIPTION

The site is located at the present crossing of Blind River and Highway 557, in District 18, Sault Ste. Marie, Ontario. The existing crossing consist of a single span (34.0 m length) Bailey bridge structure with timber deck. The exact type of foundations used is not known.

The surrounding area is covered with heavy vegetation and scattered cottages. Rock outcrops are visible on both sides of the existing highway. The river channel, at the crossing, is approximately 30 m wide and about 5.0 m deep. At the time of the investigation, October 19, 1990, the water level in the river was at Elevation 179.7 m, about 3.8 m deep. A gentle slope, of about 2 horizontal to 1 vertical, rises out of the bed at both the banks. The banks are covered by heavy bush, some trees and boulders.

PROCEDURE

The field investigation was carried out between the period of October 15 and 21, 1990. The fieldwork consist of drilling seven boreholes, two cone tests and one test pit. The boreholes, on land, were advanced using a track mounted auger machine equipped with 83 mm I.D. hollow stem augers and B size casing. The boreholes, in water, were advanced using skid mounted diamond drill rig on a raft. Three boreholes were further advanced in the rock, by using BXT size core bits. Hole 6 was excavated by a back-hoe to determine the lateral extent, at the footing location, of the bedrock surface.

Samples were recovered by means of a 50 mm O.D. split spoon sampler driven into the soil according to the specification of the Standard penetration Test (ASTM D 1586-84). In addition, relatively undisturbed samples were retrieved using 50 mm thin walled shelby tubes. Field vane tests were carried out in the stiff to soft cohesive deposits.

Laboratory testing was carried out on representative samples to identify and determine the physical properties of the overburden including:

Natural moisture content
Grain size distribution
Atterberg Limit
Unit Weight
Quick Undrained Triaxial test

The elevations of the boreholes were referenced to a local geodetic benchmark, at Elevation 181.49 m, provided by the MTO local office. (rivet in bedrock, 16.2 m Lt, Sta. 20 + 373.3).

SITE GEOLOGY AND SUBSURFACE CONDITIONS

Geologically, the site lies in the area known as Precambrian Shield. The area has been deeply buried in the earth's crust and the rocks have been highly metamorphosed, or changed, by intense heat and pressure. The characteristic bedrock belongs to Gowanda formation. Two major faults have been recorded to exist in this vicinity. The bedrock is generally overlain by geologically recent deposits of sand and gravel, clay and silt of lacustrine origin.

The subsoil conditions are variable from the north to the south bank. The soils, on the north side of the river bank, consist of very loose to compact sand and gravel fill, overlying very stiff to soft layered clayey silt to silty clay, overlying compact gravelly sand which in turn overlies Gabro Bedrock. However, on the south side, a veneer of loam layer with rock fragments, or very loose to loose gravelly sand fill, overlies the slaty Limestone Bedrock at shallow depths. Along the river bed, loose gravelly sand overlies loose to compact silt, which in turn overlies Gabro Bedrock.

The boundaries of the different strata, together with the field and laboratory test results, appear on the Record of Borehole sheets appended to this report. Also refer to the sheets for the locations and elevations of the boreholes. Stratigraphical sections of the subsurface conditions are shown on Drawing 58701-A. Detailed description of the different strata are provided below.

Gravelly Sand (Fill)

The surficial gravelly sand fill material was encountered at Boreholes 6, 7 and 5. At the south bank, this fill extends to Elevation 179.6 $\pm$ 0.1 m, about 2.5 m below the existing road surface. It contains wood planks, some silt and trace of organics, and overlies the bedrock at south bank.

However, the gravelly sand fill at the north bank (Borehole 5) extends to the depth of 0.8 m, Elevation 181.5 m. It overlies the layered clayey silt deposit.

The presence of cobbles and boulders was evident. This fill appears to have been placed during the construction of the existing embankments. The 'N' values vary from 2 to 7 blows, indicating a state of compaction varying from very loose to loose. The moisture content varies from 8 to 18 percent. Typical gradation curve is shown in Figure 1.

Loam and Rock fragments

On the south side of the river, a thin veneer of loam mixed with rock fragments forms the surficial soils at Borehole 1. It is 40 cm thick and in a compact state.

Gravelly Sand (Native)

The river bed consist of gravelly sand with some silt, and its thickness at Boreholes 2, 3 and 4, varies from 0.3 to 0.9 m. Cobbles and boulders were also evident at the surface of the river bed. At the north bank, this layer is encountered at the surface, at Borehole 8, and extends to the depth of 1.3 m. This deposit is also present underneath the layered clayey silt deposit at Boreholes 5 and 8. The thickness of the underlying layer varies from 0.8 to 1.0 m. The 'N' values vary from 4 to 29 blows, indicating a state of compaction varying from loose to compact. The moisture content varies from 8 to 16 percent. Typical gradation curves are given in Figures 2 and 3.

Silt

At the river location, at Boreholes 2 and 4, the gravelly sand is underlain by a deposit of silt. The silt contains some sand and trace of clay. Based on 'N' values of 9 to 30, this non cohesive deposit is in a loose to compact state. The thickness of this layer varies from 1.6 to 2.3 m. The moisture content varies from 21 to 23 percent. Typical gradation curve is given in Figure 4.

Clayey Silt to Silt to Silty Clay

The deposit was encountered at the north bank, at Boreholes 5 and 8. This deposit is present beneath the gravelly sand. The stratum is layered and its thickness varies from 1.7 to 2.7 m. The individual layers, which vary from about 3 mm to 30 mm in thickness, are distinguished by colour, varying from red-brown to light grey to dark grey.

Undrained shear strength of the soil was determined both by the in situ field vane tests, and by the Quick Undrained Triaxial test. In the upper 1.5 m, the shear strength is in excess of 115 kpa, indicating it is in a very stiff state. This deposit becomes weaker with depth and the shear strength for the lower 1.2 m drops from 55 kpa to 20 kpa, indicating a consistency of stiff to soft.

The results from the three Atterberg Limit test (Figure 5), performed on this material are summarized as follows:

Property	Range	Average
Natural Moisture Content (%)	28 - 33	30.0
Liquid Limit (%)	36 - 39	37.5
Plastic Limit (%)	17 - 33	23.0
Plasticity Index (%)	5 - 22	14.5
Unit Weight (kN/cu.m)	18.9 -20.3	19.3

From the plasticity chart, the deposit is classified as inorganic clayey silt to silty clay of intermediate plasticity. However, the silt layers were non-plastic.

Grain size distribution envelope is given in Figure 6. Due to a layered nature of this deposit, the grain size distribution carried out on the sample is not indicative of the high clay content.

Bedrock

Bedrock was core drilled at the locations of Boreholes 1, 4 and 5. The type of bedrock varies across the site. Along the south bank, the bedrock is identified as slaty limestone, while at the river channel and at the north bank, the bedrock is identified as Gabro of ultramafic type. Both the rock types are generally strong to very strong in nature. Core recoveries varied from 95 % to 100 % and R.Q.D. ranged from 35 to 100 %. The quality of the rock is defined as good to excellent, except in the upper 1.1 m at Borehole 1, where it is moderately weathered and poor.

The bedrock dips down into the channel, and along the river banks it dips from south to north. Variations in the bedrock levels must be expected due to the presence of faults. At the south bank, the bedrock level varies from 0.4 to 2.5 m depth, i.e. Elevation 179.9 to 179.5 m. Rock outcrops were visible at surface Elevation 180.3 m. While at the north bank, the bedrock level is at 3.8 to 4.5 m depth, i.e. Elevation 178.9 to 177.8 m. Along the river channel, the bedrock level varies from Elevation 177.4 to 174.6 m.

Groundwater Conditions

Observation of the groundwater level was carried out by measuring the water levels in the open boreholes. Groundwater was at river level, i.e. Elevation 179.7 m on October 19, 1990. It should be noted that the groundwater is subject to changes with the fluctuations in the river levels.

DISCUSSIONS AND RECOMMENDATIONS

It is proposed to upgrade the existing road to the current MTO standards. This requires a replacement of the existing single span Bailey bridge with a new bridge structure placed at the same location. In addition, a Bailey bridge - construction detour, will be placed to the west of the present alignment.

The replacement bridge will be a 39.0 m single span concrete or steel structure. The detour bridge will be a double span structure, with span lengths of 27.0 and 15.0 m. It is proposed to raise the existing grade by about 1.5 to 2.0 m, proposed grade Elevation 183.5 to 184.0 m.

Single Span Replacement Structure

Based on the soil conditions and the proposed grades, it is recommended that the proposed structure be supported on conventional spread foundations founded on compacted rock fill.

Since the road will be widened, the footprint of the proposed footings will extend beyond the top edge of the existing embankment. As a result, rock fill will be partly placed into the river channel. The existing embankment fill, consisting of gravelly sand, is in a very loose to loose state, and therefore not considered suitable for supporting the structure.

At the south abutment the existing embankment fill must be removed, to 0.3 m above the river level and about 2.2 m below the road surface, and replaced by compacted rock fill. This corresponds to Elevation 180.0 m, as the river level was at Elevation 179.7 m at the time of investigation. At the north abutment, at Borehole 5, very loose gravelly sand fill was encountered to Elevation 181.5 m. The sand fill must also be replaced by compacted rock fill.

In addition, a cushion of rock fill must be maintained between the underside of the north abutment footing, and the underlying cohesive soils. The footings can then be founded on this compacted rock fill cushion, of a minimum thickness of 0.9 m..

The recommended bearing capacities and the founding elevations, as per the O.H.B.D.C., for an assumed 4.0 m wide footing, are given below:

Material	Bearing Capacity at S.L.S. Type 11 (kpa)	Factored Bearing Capacity at U.L.S. (kpa)	Anticipated Founding El. (m)
Rock Fill	250	600	182.3 to 181.7

The rock fill should extend out at least 2.0 m from the underside of the proposed footings. The slope of the rock fill at 1.5 H to 1.0 V is expected to be stable. The rock fill in the upper 0.6 m depth, beneath the footings, should be limited in size to 300 mm. It is recommended that the surface of the rock fill should be covered by a mud-slab, of low slump concrete, to provide a good working base.

The settlement of the rock fill is estimated to be about 1.0 percent of the height of the fill, i.e. about 2.0 to 4.0 cm. The settlement of the underlying cohesive layered soils, at the north abutment, is difficult to predict due to the layered nature of the deposit. However, this can be estimated in the range of 2.0 to 3.5 cm. The total maximum settlement is estimated to be about 5.5 cm.

In order to minimize the amount of post construction settlement it is recommended, however, that the fill be placed at least 3 months prior to the construction of the abutments. Considerations can be given to static surcharge, 1.5 m high, for the north abutment, in order to minimize the settlements and the pre-loading time period required prior to the construction of the abutments.

Detour Structure

The centre pier and the north abutment of the temporary Bailey bridge structure will be constructed in the river channel, and therefore can be supported on timber crib or box type structures, filled with rock fill. The allowable bearing capacity at S.L.S., and factored bearing capacity at U.L.S., for the assumed 3.0 m wide footing, for the crib structure supported on the river bed, are 150 and 350 kpa respectively. The south abutment can be supported on bedrock at Elevation 179.9 m. The factored bearing capacity at U.L.S., for the limestone bedrock is 3000 kpa.

Alternatively, the abutments can be supported on rock fill. The bearing capacities of the rock fill are given in the preceding section.

OTHER CONSIDERATIONS

Approach Fills

The height of fill required to achieve the proposed profile grade of Highway 557, in the vicinity of the existing road, is in the order of 1.5 to 2.0 m. Outside the existing embankments, the fill will be maximum 5.0 m deep. Any topsoil or organic material should be removed within the plan limits of the approach embankments.

The embankments consisting of rock fill can be placed at 1.5 H : 1.0 V. Any other suitable fill can be placed at 2.0 H : 1.0 V.

Settlement of the very loose to loose granular materials, at the south abutment, will probably occur as embankment construction proceeds but this should be complete well before the pavement is constructed. At the north abutments, it is difficult to predict the total settlements due to the layered nature of cohesive soils, however, the magnitude is expected to be within the tolerable limits of construction, say 40 mm.

No stability problems are anticipated for the proposed height of permanent embankment.

Lateral Earth Pressure

Free draining granular materials such as Granular 'A' or 'B' or rock fill are recommended as appropriate backfill to abutment walls to prevent hydrostatic pressure build-up.

Lateral earth pressures should be computed in accordance with Section 6.6.1.2 of the O.H.B.D.C. The design parameters are as follows:

	Granular 'A'	Granular 'B'	Rockfill
Angle of Internal Friction (degrees)	35	30	35
Unit Weight (kN/cu.m.)	22.8	21.2	17.5
Active earth pressure co-ef (K_a)	0.27	0.33	0.27
At-rest earth pressure co-ef (K_o)	0.43	0.50	0.43

An active condition (k_a) may be assumed to apply for a yielding structure. For rigid and unyielding structure, at rest condition (K_o) is applicable.

Lateral Resistance

For footings placed directly on bedrock, the sliding resistance between the concrete footing and bedrock may be calculated using an unfactored ϕ value of 40^0, provided the rock surface is generally rough. For footings placed on rock fill, an unfactored ϕ value of 35^0, may be used.

Frost Protection

The footings require an equivalent of minimum of 1.8 m of soil cover for frost protection. The insulation value of rock fill is half of soil cover.

Dewatering

The river level was, on October 19, 1990, at Elevation 179.7 m. Any excavations below the river level will require dewatering. The excavations for the abutment footings of the replacement structure will be above the river level and therefore no major dewatering problems are anticipated.

MISCELLANEOUS

The fieldwork for this investigation was carried out under the supervision of S. Magdolen, Geologist. The equipment was owned and operated by Master Soils Investigation Limited.

The project was carried out under the supervision of S.Bandukwala, Project Engineer. The report was written by S.Bandukwala, and reviewed by L.Rak, Principal Engineer.

Submitted by

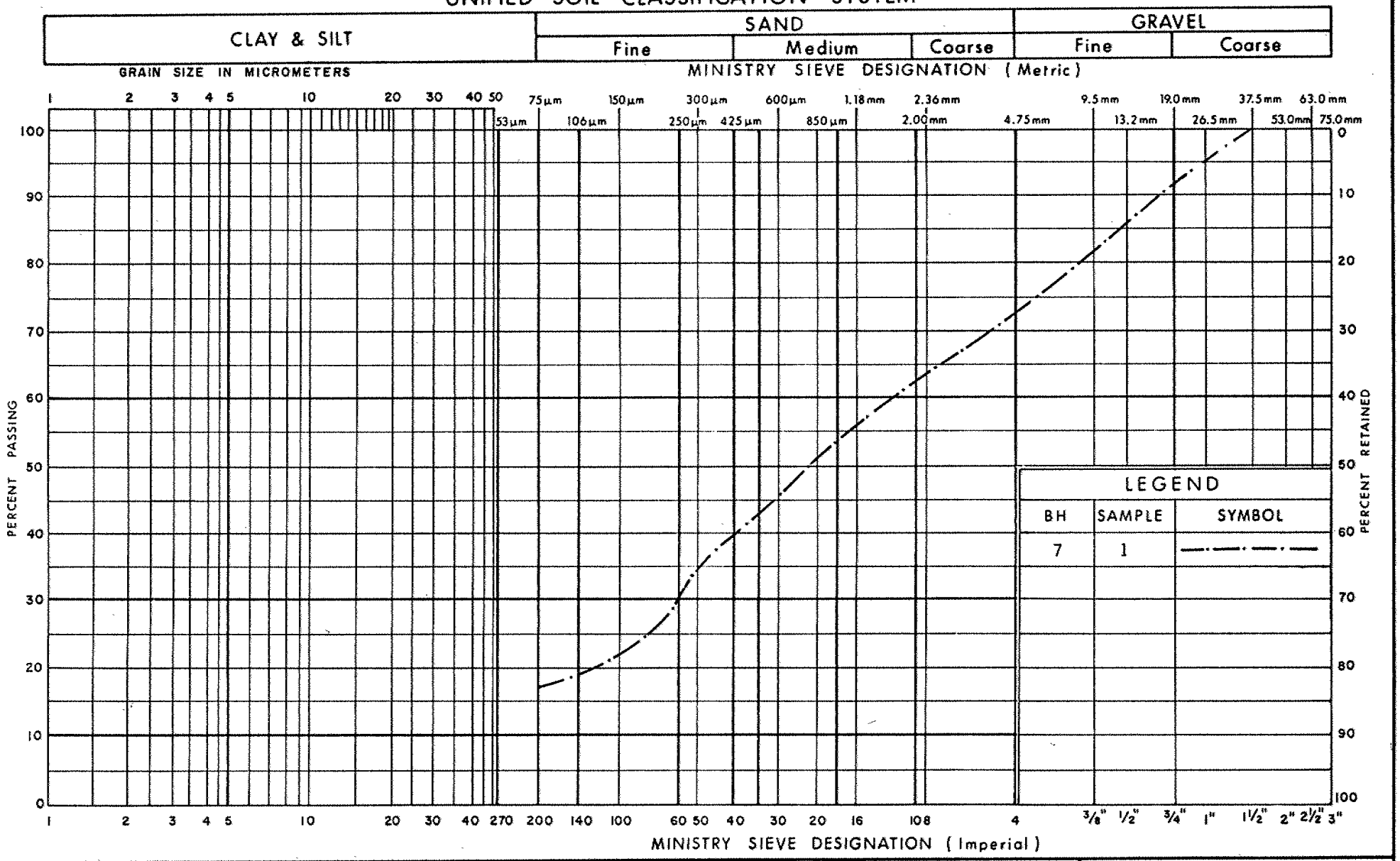
MCCLYMONT AND RAK ENGINEERS INC.

S. Bandukwala, P.Eng.

L.J. Rak, P.Eng.

78 12 M

UNIFIED SOIL CLASSIFICATION SYSTEM



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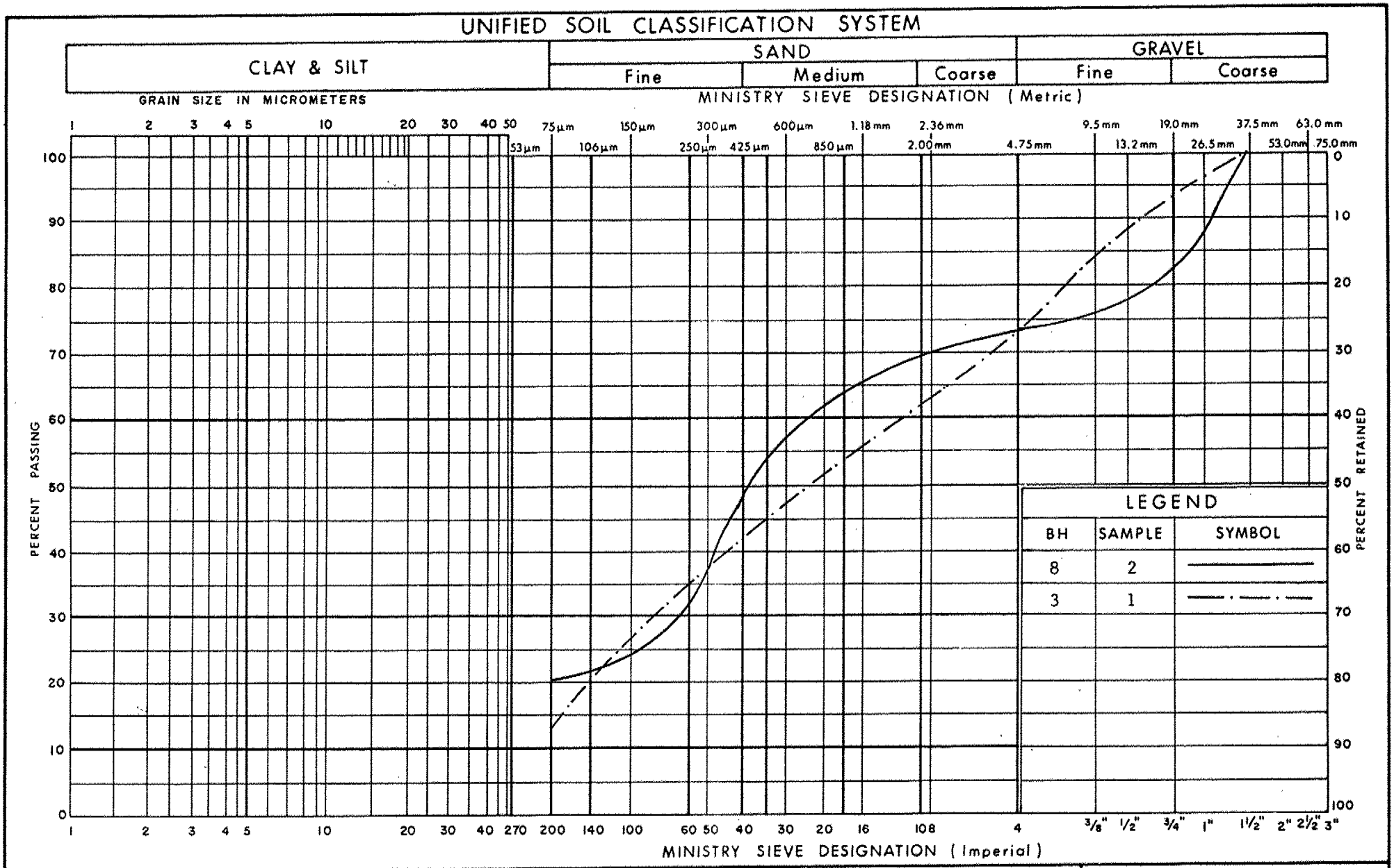
GRAIN SIZE DISTRIBUTION
GRAVELLY SAND (FILL)

FIG No 1

W P 5-87-01



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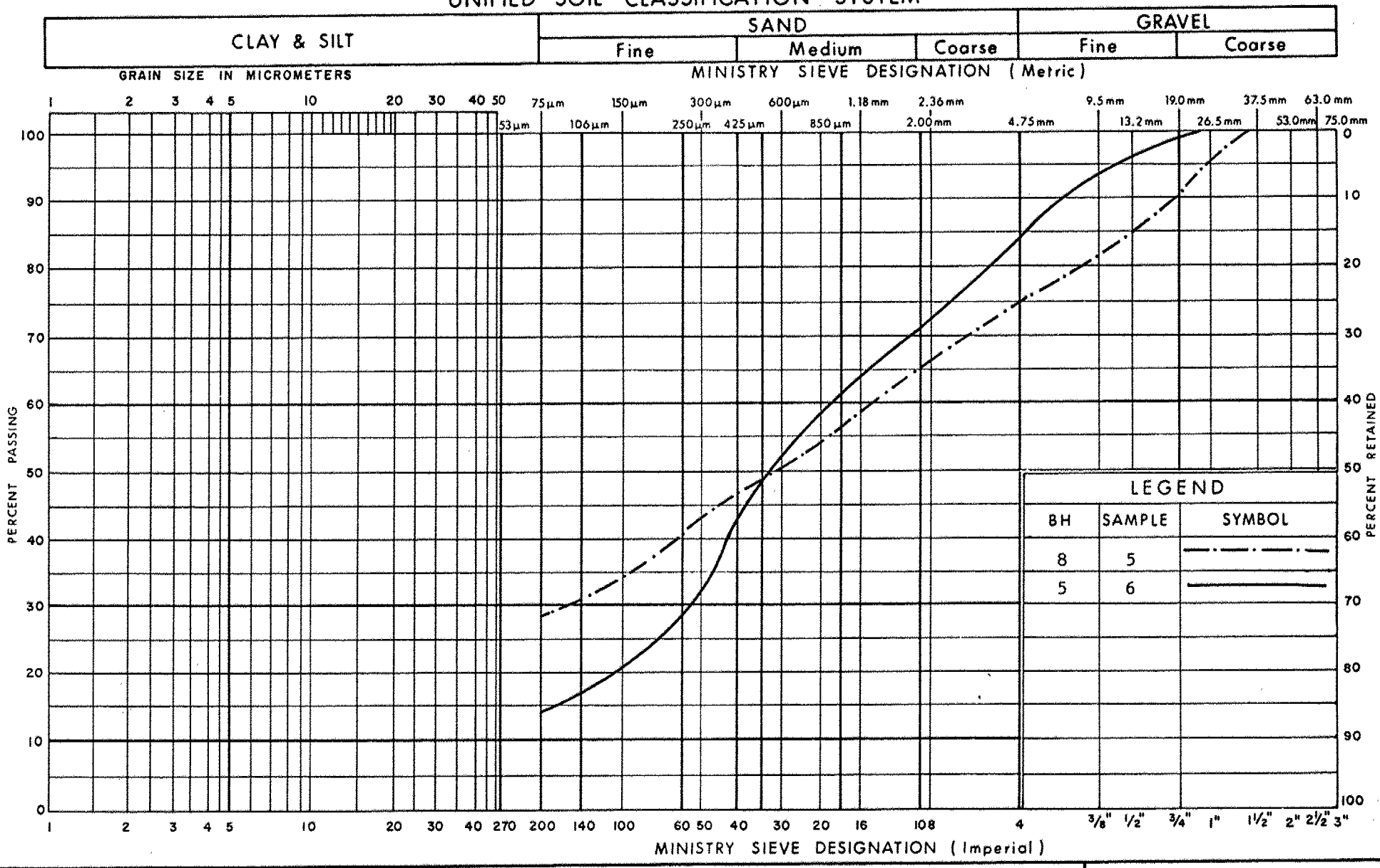
GRAIN SIZE DISTRIBUTION
GRAVELLY SAND, SOME SILT

FIG No 2

W P 5-87-01

78 12 M

UNIFIED SOIL CLASSIFICATION SYSTEM



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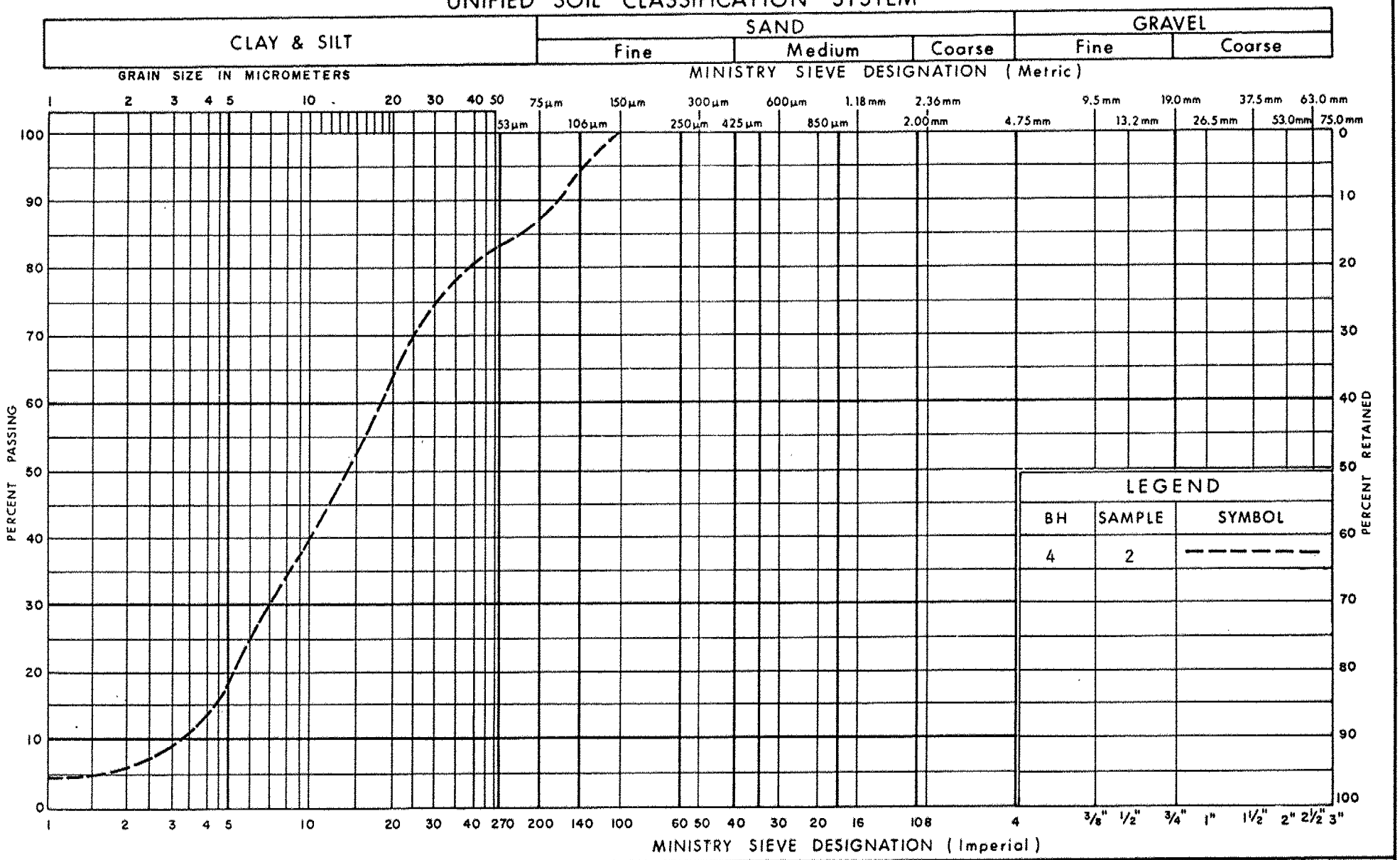
GRAIN SIZE DISTRIBUTION

GRAVELLY SAND, SOME SILT

FIG No 3

W P 5-87-01

UNIFIED SOIL CLASSIFICATION SYSTEM



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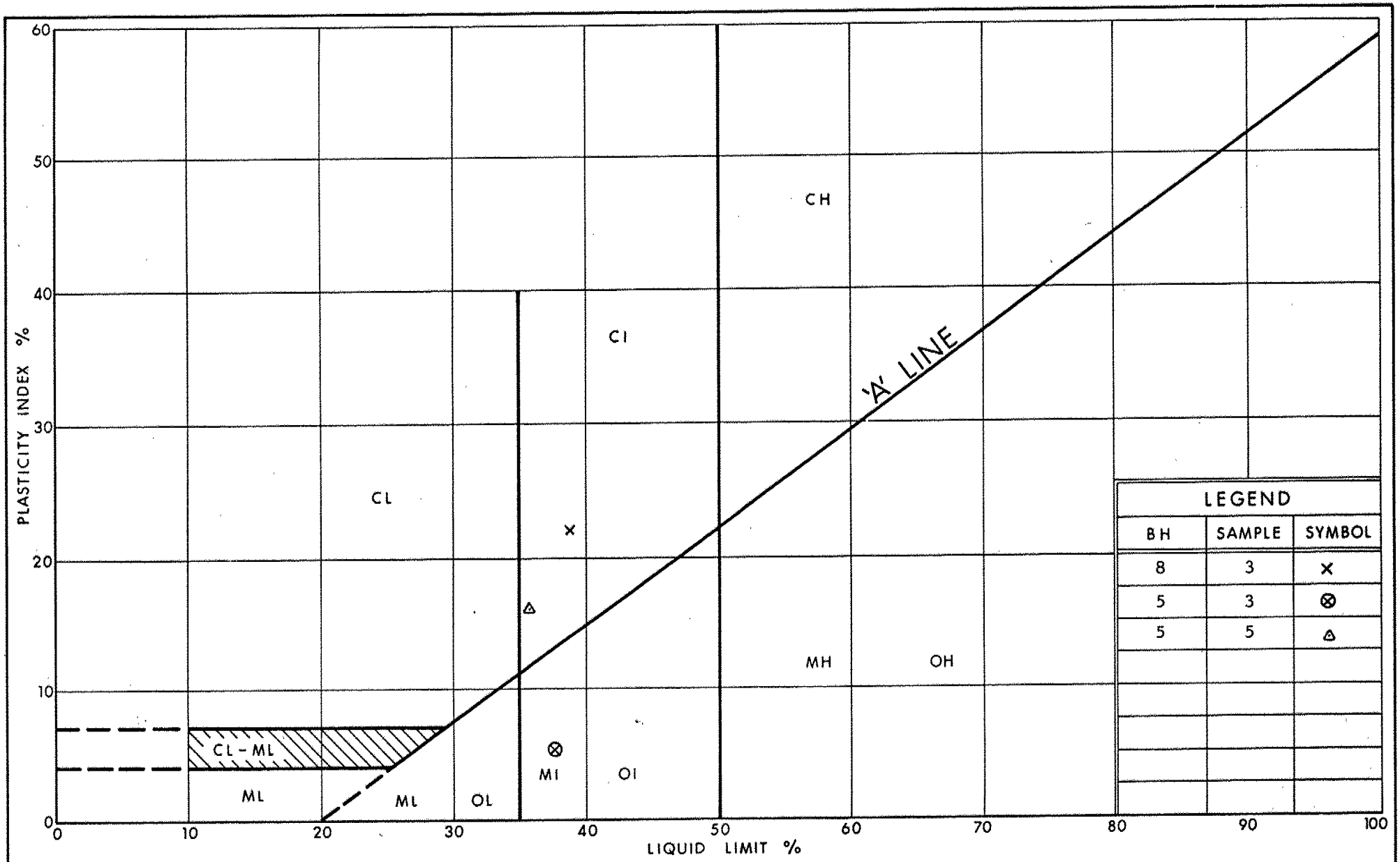
GRAIN SIZE DISTRIBUTION
SILT
SOME SAND, TRACE OF CLAY

FIG No 4

W P 5-87-01



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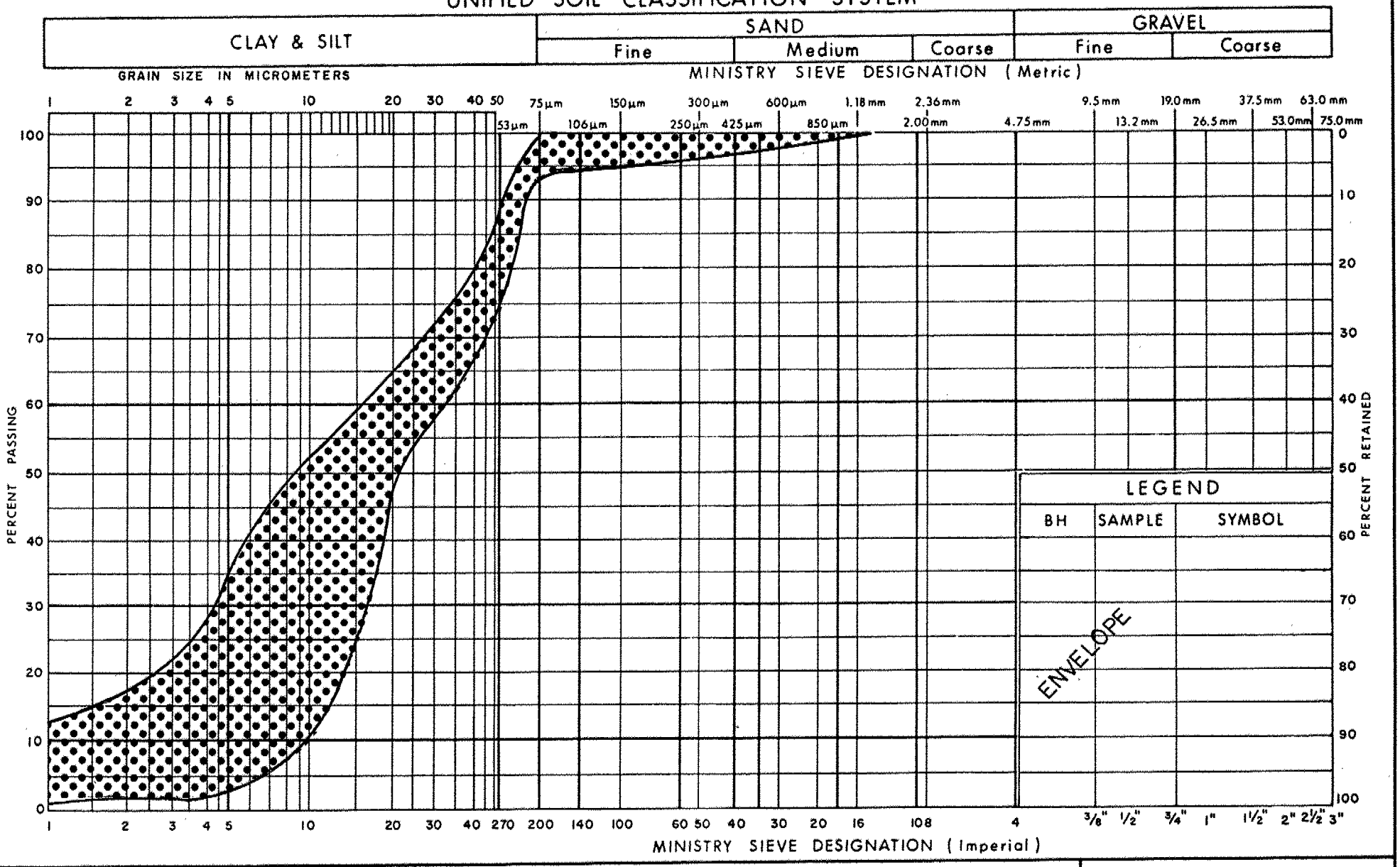
PLASTICITY CHART

LAYERED CLAYEY SILT TO SILT TO SILTY CLAY

FIG No 5

W P 5-87-01

UNIFIED SOIL CLASSIFICATION SYSTEM



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GRAIN SIZE DISTRIBUTION

LAYERED CLAYEY SILT TO SILT TO SILTY CLAY

FIG No 6

W P 5-87-01

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

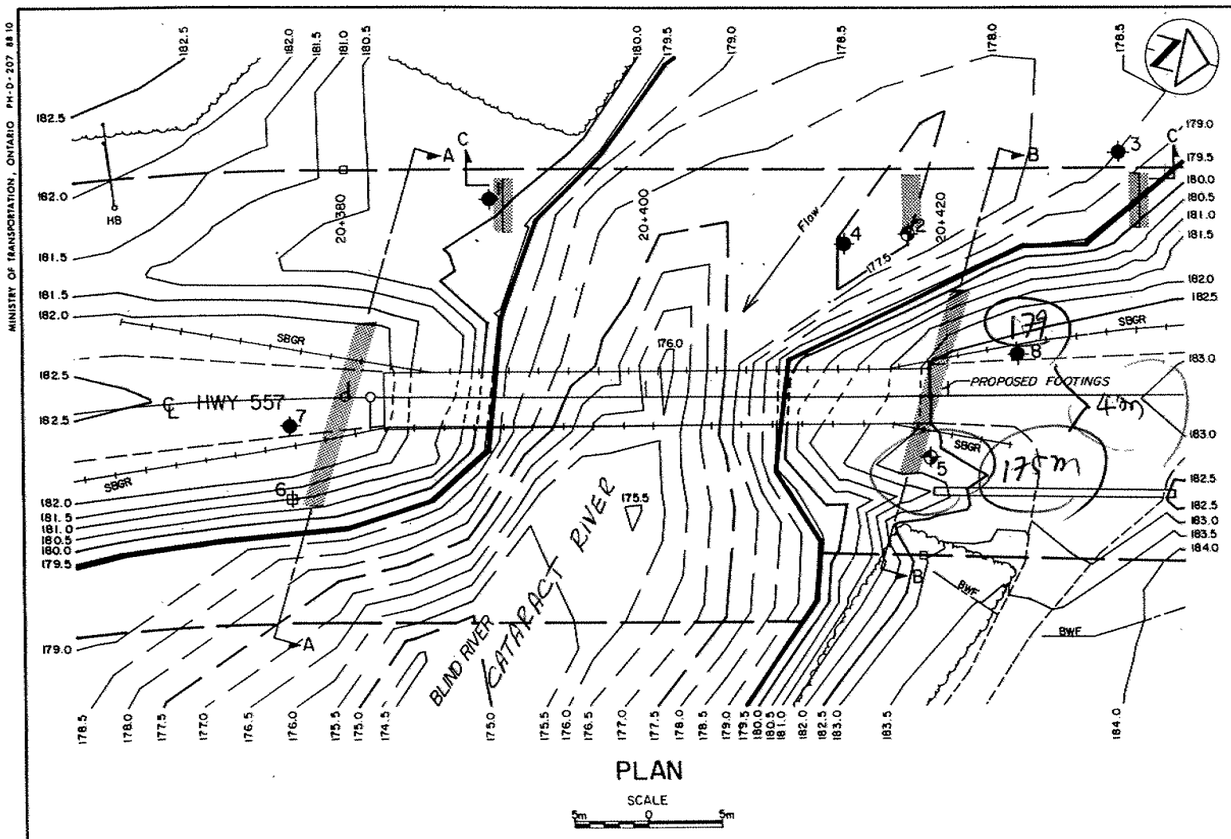
m_v	kPa^{-1}	COEFFICIENT OF VOLUME CHANGE
C_c	1	COMPRESSION INDEX
C_s	1	SWELLING INDEX
C_α	1	RATE OF SECONDARY CONSOLIDATION
c_v	m^2/s	COEFFICIENT OF CONSOLIDATION
H	m	DRAINAGE PATH
T_v	1	TIME FACTOR
U	%	DEGREE OF CONSOLIDATION
σ'_{vo}	kPa	EFFECTIVE OVERBURDEN PRESSURE
σ'_p	kPa	PRECONSOLIDATION PRESSURE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

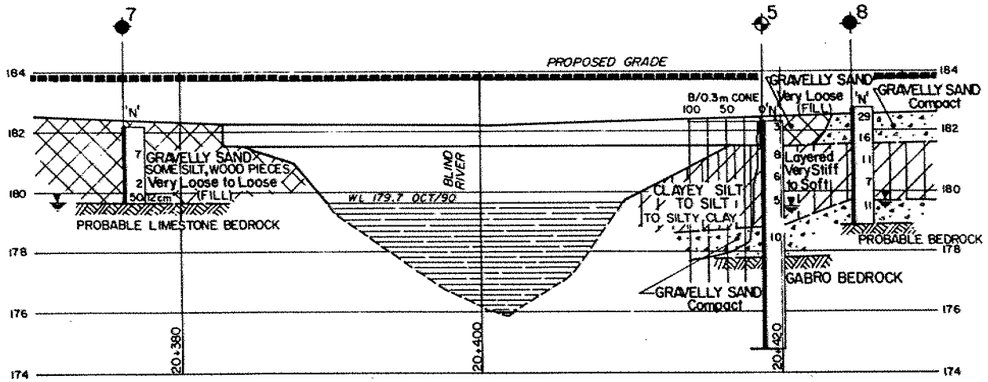
MINISTRY OF TRANSPORTATION, ONTARIO PH-0-207 88 10



PLAN

SCALE 5m 0 5m

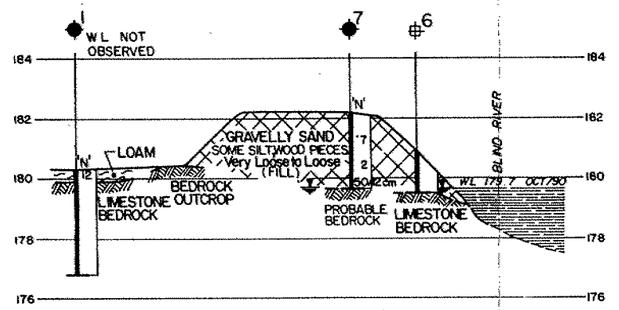
175 – 179



℄ PROFILE OF HWY 557

SCALE

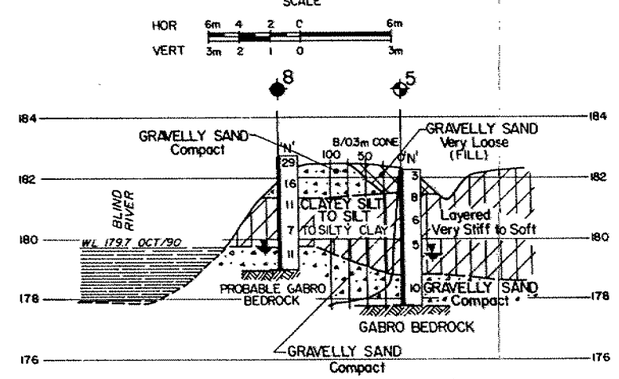
HOR 6m 4 2 0 6m
VERT 3m 2 1 0 3m



SECTION A-A

SCALE

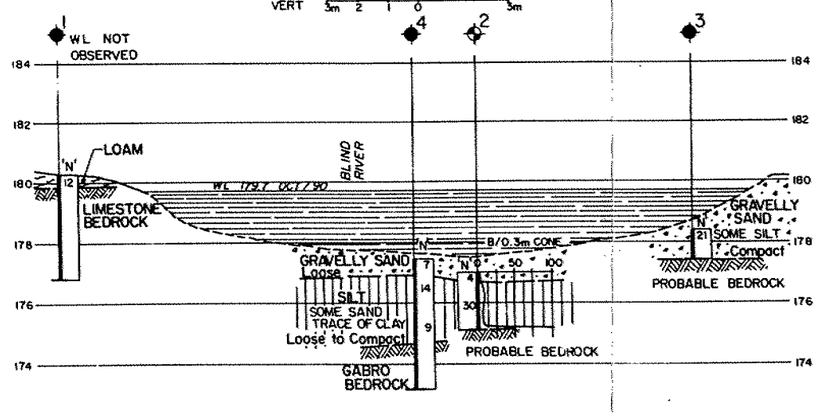
HOR 6m 4 2 0 6m
VERT 3m 2 1 0 3m



SECTION B-B

SCALE

HOR 6m 4 2 0 6m
VERT 3m 2 1 0 3m



SECTION C-C

SCALE

HOR 6m 4 2 0 6m
VERT 3m 2 1 0 3m

REF No E-360-557-1 1989/11

METRIC

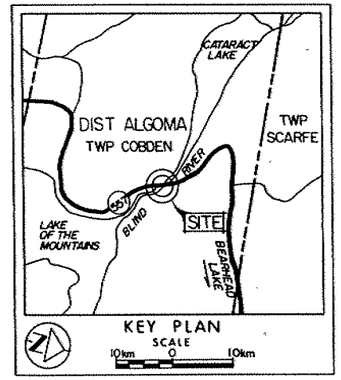
DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN. STATIONS IN KILOMETRES + METRES.

CONT No
WP No 5-87-01

BLIND RIVER & HWY 557
CATARACT RIVER
BORE HOLE LOCATIONS & SOIL STRATA

SHEET

MCCLYMONT & RAK ENGINEERS, INC



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 Oct 1990
- TEST PIT

No	ELEVATION	STATION	OFFSET
1	180.3	20+397.7	14.6 LT
2	179.7	20+426.2	10.4 LT
3	179.7	20+439.7	16.2 LT
4	179.7	20+421.1	10.2 LT
5	182.3	20+427.3	4.4 RT
6	181.0	20+380.8	6.6 RT
7	182.2	20+383.3	2.9 RT
8	182.7	20+433.4	2.5 LT

-=NOTE=-

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

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

REV.	DATE	BY	DESCRIPTION

Geocres No 41J-51

HWY No 557			DIST 18
SUBM'D SB	CHECKED	DATE Nov. 90	SITE 38S-237
DRAWN ER	CHECKED	APPROVED	DWG 5870I-A

Ministry of Transportation
Ontario

RECORD OF BOREHOLE No 1 METRIC

W P 5-87-01 LOCATION Sta. 20 + 397.7 m, 14.6 m Lt of Hwy 557 ORIGINATED BY SM
DIST 18 HWY 557 BOREHOLE TYPE Wash boring and BXT rock core COMPILED BY SM
DATUM Geodetic DATE October 16 and 17, 1990 CHECKED BY SB

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 kPa ○ 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
180.3	Ground surface										
0.0 179.9	Loam and rock fragments, compact		1	SS	12		180		o		
0.4	SLATY LIMESTONE BEDROC Light grey, layered		2	RC BXT	REC 100%		179				RQD 35%
	medium bedding, strong to very strong		3	RC BXT	REC 100%		178				RQD 100%
176.8	moderately weathered to 1.1m, poor to excellent quality		4	RC BXT	REC 100%		177				RQD 88%
3.5	End of Borehole										

*Water level not observed.

OFFICE REPORT ON SOIL EXPLORATION

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

15 20/10 5 (%) STRAIN AT FAILURE

Ministry of Transportation
Ontario

RECORD OF BOREHOLE No 2

METRIC

W P 5-87-01 LOCATION Sta. 20 + 426.2 m, 10.4 m Lt of ℄ of Hwy 557 ORIGINATED BY SM

DIST 18 HWY 557 BOREHOLE TYPE Wash boring COMPILED BY SM

DATUM Geodetic DATE October 20, 1990 CHECKED BY SB

OFFICE REPORT ON SOIL EXPLORATION

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ 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
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES						
179.7	River water level										
0.0	WATER						179				
							178				
177.0	River Bottom						177				
2.7	Gravelly sand, loose		1	SS	4				o		
3.0	SILT some sand, trace of clay, rock fragments, loose to compact		2	SS	30		176				
175.1											
4.6	Probable bedrock End of Borehole										

+3, ×5 : Numbers refer to Sensitivity

15 20 5 10 (%) STRAIN AT FAILURE

Ministry of Transportation
Ontario

RECORD OF BOREHOLE No 3

METRIC

W P 5-87-01 LOCATION Sta. 20 + 439.7m, 16.2m Lt of ℄ of Hwy 557 ORIGINATED BY SM

DIST 18 HWY 557 BOREHOLE TYPE Wash boring COMPILED BY SM

DATUM Geodetic DATE October 19, 1990 CHECKED BY SB

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 — SHEAR STRENGTH kPa: ○ UNCONFINED, + FIELD VANE, ● QUICK TRIAXIAL, × LAB VANE	PLASTIC LIMIT W_P — NATURAL MOISTURE CONTENT W — LIQUID LIMIT W_L — WATER CONTENT (%) 10 20 30	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES						GR SA SI CL
179.7	River water level										
0.0	WATER						179				
178.3	River Bottom										
1.4	GRAVELLY SAND some silt, rock fragments, compact		1	SS	21		178		○		28 55 (17)
177.4											
2.3	Probable bedrock End of Borehole										

OFFICE REPORT ON SOIL EXPLORATION

+3, ×5 : Numbers refer to Sensitivity

15 20/10 5 (%) STRAIN AT FAILURE

Ministry of Transportation
Ontario

RECORD OF BOREHOLE No 4 — METRIC

W P 5-87-01 LOCATION Sta. 20 + 421.1m, 10.2m Lt of ℄ of Hwy 557 ORIGINATED BY SM
DIST 18 HWY 557 BOREHOLE TYPE Wash boring and BXT rock core COMPILED BY SM
DATUM Geodetic DATE October 20, 1990 CHECKED BY SB

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES 'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT N (20 40 60 80 100) / SHEAR STRENGTH kPa (○ 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
179.7	River water level										
0.0	WATER						179				
							178				
177.4	River Bottom										
2.3	GRAVELLY SAND some silt, loose		1	SS	7		177		o		
176.9											
2.8	SILT some sand, trace of clay, compact to loose		2	SS	14		176		o		0 12 83 5
			3	SS	9		175		o		
174.6											
5.1	GABRO BEDROCK ultramafic dark grey wide jointing, strong to very strong, good to excellent quality		4	RC BXT	100%		174				RQD 95%
			5	RC BXT	95%						RQD 87%
173.1											
6.6	End of Borehole										

OFFICE REPORT ON SOIL EXPLORATION

+3, ×5 : Numbers refer to Sensitivity

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

Ministry of Transportation
Ontario

RECORD OF BOREHOLE No 5 METRIC

W P 5-87-01 LOCATION Sta. 20 + 427.3m, 4.4m Rt of ℄ of Hwy 557 ORIGINATED BY SM
DIST 18 HWY 557 BOREHOLE TYPE Hollow stem auger and BXT rock core COMPILED BY SM
DATUM Geodetic DATE October 17, 18, 1990 CHECKED BY SB

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 kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT Wp / NATURAL MOISTURE CONTENT W / LIQUID LIMIT WL — WATER CONTENT (%) 10 20 30	UNIT WEIGHT γ Kn/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
182.3	Ground surface										
0.0	GRAVELLY SAND some silt, very loose (FILL)		1	SS	3		182		○		
181.5											
0.8	CLAYEY SILT TO SILT TO SILTY CLAY layered, red-brown, light grey and dark grey, very stiff to soft		2	SS	8					19.0	
							181				
			3	SS	6				⊢○⊣	19.0	0 0 84 16
							180		○		0 4 90 6
			4	SS	5			+			
						▼					
178.8			5	TW	PM		179		○	18.9	0 4 83 13
3.5	GRAVELLY SAND some silt, compact										
			6	SS	10				○		16 71 (13)
177.8							178				
4.5	GABRO BEDROCK ultramafic dark grey wide jointing, strong to very strong, good to excellent quality		7	RC BXT	100%						RQD 97%
							177				
			8	RC BXT	100%						RQD 78%
							176				
			9	RC BXT	100%						RQD 91%
174.8							175				
7.5	End of Borehole										

OFFICE REPORT ON SOIL EXPLORATION

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

20
15 ◇ 5 (%) STRAIN AT FAILURE
10

Ministry of Transportation
Ontario

RECORD OF TEST-PIT No 6

METRIC

W P 5-87-01 LOCATION Sta. 20 + 380.8m, 6.6m Rt of ℄ of Hwy 557 ORIGINATED BY SM

DIST 18 HWY 557 BOREHOLE TYPE Test pit by backhoe COMPILED BY SM

DATUM Geodetic DATE October 21, 1990 CHECKED BY SB

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) SHEAR STRENGTH kPa: o UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB VANE	PLASTIC LIMIT Wp / NATURAL MOISTURE CONTENT W / LIQUID LIMIT W_L — WATER CONTENT (%)	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES						
181.0	Ground surface										
179.5	GRAVELLY SAND rock fragments, some silt, wood planks (FILL)					▼	180				
1.5	Bedrock End of Test-pit										

OFFICE REPORT ON SOIL EXPLORATION

+3, ×5 : Numbers refer to Sensitivity

15 20 10 5 (%) STRAIN AT FAILURE

Ministry of Transportation
Ontario

RECORD OF BOREHOLE No 7

METRIC

W P 5-87-01 LOCATION Sta. 20 + 383.3m, 2.9m Rt of ℄ of Hwy 557 ORIGINATED BY SM

DIST 18 HWY 557 BOREHOLE TYPE Solid stem auger COMPILED BY SM

DATUM Geodetic DATE October 19, 1990 CHECKED BY SB

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ 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 (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES						GR SA SI CL
182.2	Ground surface										
0.0	Asphalt: 40 mm						182				
	GRAVELLY SAND rock fragments, some silt, wood pieces, very loose to loose		1	SS	7				o		27 56 (17)
	(FILL)		2	SS	2		181		o		
179.7			3	SS	50/12 cm	▼	180		o		
2.5	Probable bedrock End of Borehole										

OFFICE REPORT ON SOIL EXPLORATION

+3, ×5 : Numbers refer to Sensitivity

15 20/10 5 (%) STRAIN AT FAILURE

Ministry of Transportation
Ontario

RECORD OF BOREHOLE No 8

METRIC

W P 5-87-01 LOCATION Sta. 20 + 433.4m, 2.5m Lt of ℄ of Hwy 557 ORIGINATED BY SM

DIST 18 HWY 557 BOREHOLE TYPE Solid stem auger COMPILED BY SM

DATUM Geodetic DATE October 19, 1990 CHECKED BY SB

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES 'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (o UNCONFINED, • QUICK TRIAXIAL, + FIELD VANE, × LAB VANE)	PLASTIC LIMIT Wp / NATURAL MOISTURE CONTENT W / LIQUID LIMIT WL / WATER CONTENT (%)	UNIT WEIGHT γ Kn/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
182.7	Ground surface							20 40 60 80 100	10 20 30		
0.0	Granular: 280 mm		1	SS	29				o		
	GRAVELLY SAND some silt, compact						182				
181.4			2	SS	16				o		27 55 (18)
1.3	CLAYEY SILT TO SILT TO SILTY CLAY layered, very stiff to stiff		3	SS	11		181		o	20.3	0 6 81 13
								>+			
			4	SS	7				o		0 5 94 1
179.7						▼	180				
3.0	GRAVELLY SAND some silt, compact		5	SS	11				o		25 48 (27)
178.9							179				
3.8	Probable bedrock End of Borehole										

OFFICE REPORT ON SOIL EXPLORATION

+3, ×5 : Numbers refer to Sensitivity

15 20 10 5 (%) STRAIN AT FAILURE

Ministry of Transportation Ontario

FAXGRAM

PLEASE TYPE

DATE AUG. 29/95 PAGE 1 OF 1

TO:	FROM:
R.J. KRISCIUNAS, HEAD STRUCTURAL - NORTHWESTERN ATT: C.L. BROWN, STRUCT. ENG.	PAVEMENTS AND FOUNDATIONS SECTION RM 315, CENTRAL BUILDING DOWNSVIEW, ONTARIO

SUBJECT: CATARACT R. BR.
SITE 385-233
WP 5-87-01, CONTRACT. 94-233

THIS FAXGRAM CONFIRMS OUR DISCUSSION BY PHONE FOR THE ABOVE PROJECT. YOUR DESCRIPTION OF A VOID ENCOUNTERED BENEATH THE TREMIE POUR WOULD INDICATE A PROBLEM WITH THE QUALITY OF THE TREMIE CONCRETE UTILIZED. THE VOIDS COULD ~~MA~~ ALSO BE DUE TO WATER FLOW AT THE BEDROCK SURFACE. REGARDLESS AS TO WHY THERE ARE VOIDS THIS OFFICE BELIEVES THAT THE RESPONSIBILITY LIES WITH THE CONTRACTOR TO HAVE THIS SITUATION CORRECTED. IT MAY BE NECESSARY TO CONFIRM THE QUALITY OF TREMIE UTILIZED AND TO MAKE SURE THAT IT CAN SUSTAIN THE REQUIRED LOADS. PRESSURE GROUTING COULD BE USED TO FILL THE VOID, HOWEVER PROOF AS TO THE SUCCESS OF THIS OPERATION WOULD HAVE TO BE PROVIDED BY THE CONTRACTOR. WE HAVE RESERVATIONS AS TO THE LEVEL OF SUCCESS FOR THIS OPERATION. IF THIS CANNOT BE ACCOMMODATED THE REMOVAL AND REPLACEMENT OF ALL TREMIE DOWN TO THE FOUNDING DEPTH WOULD BE REQUIRED. WE HOPE THESE COMMENTS ARE WHAT YOU REQUIRE.

MARTIN MICHALEK, JR. ENG.
FOR TAE. KIM, SR. ENG.

ADM-S-481 91-05

METRIC

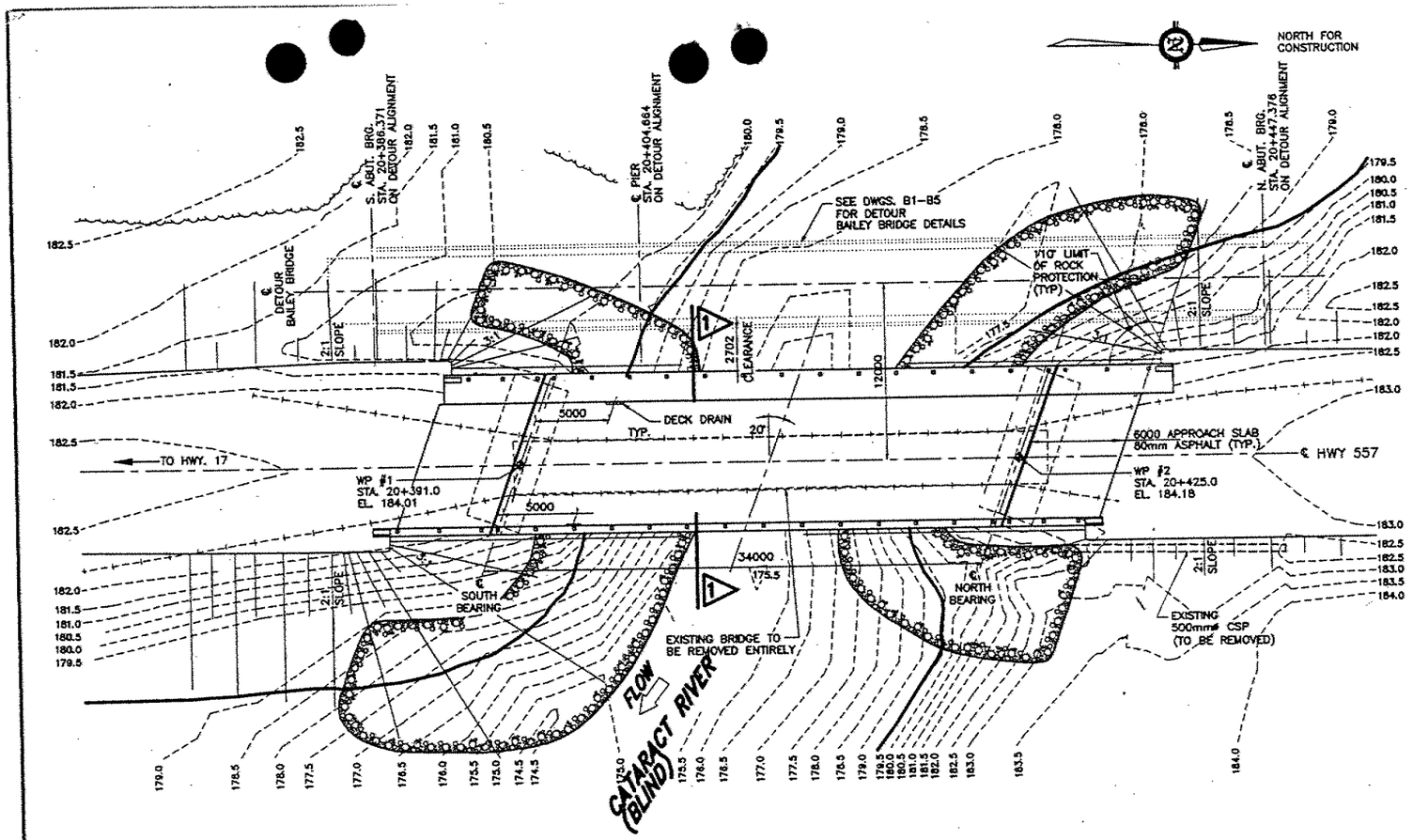
DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN

CONT. No. 94-233
WP No. 5-87-01

CATARACT RIVER BR.

GENERAL ARRANGEMENT

SHEET 38



PLAN

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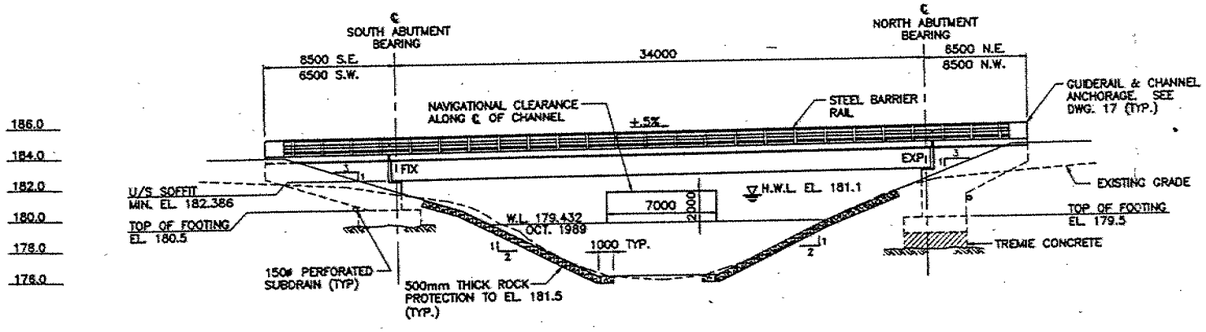

ELEVATION

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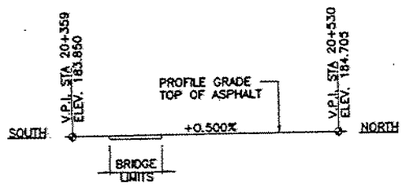
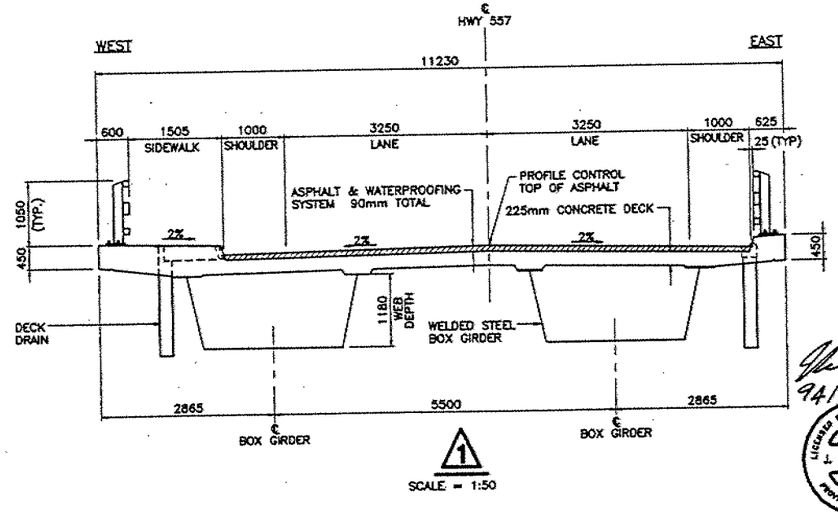


PROFILE OF HWY. 557

SCALE = N.T.S.



SCALE = 1:50

GENERAL NOTES

THE CONTRACTOR SHALL ESTABLISH THE BEARING SEAT ELEV. BY DEDUCTING THE ACTUAL BEARING THICKNESS FROM THE TOP OF BEARING ELEVATIONS. IF THE ACTUAL BEARING THICKNESSES ARE DIFFERENT FROM THOSE GIVEN WITH THE BEARING DESIGN DATA, THE CONTRACTOR SHALL ADJUST THE REINFORCING STEEL TO SUIT.

CLASS OF CONCRETE

ALL CONCRETE ——— 30 MPa

REINFORCING STEEL

GRADE 400W UNLESS OTHERWISE SPECIFIED
BAR MARKS WITH SUFFIX "C" DENOTE COATED BARS.

CLEAR COVER TO REINFORCING STEEL

FOOTINGS ——— 100±25
ABUTMENTS AND WINGWALLS ——— 70±20
DECK
TOP ——— 70±20
BOTTOM ——— 40±10
REMAINDER UNLESS OTHERWISE NOTED ——— 70±20

LIST OF DRAWINGS

LIST OF ABBREVIATIONS

W.P. – WORKING POINT
W.L. – WATER LEVEL
H.W.L. – HIGH WATER LEVEL

APPLICABLE STANDARD DRAWINGS

OPSD 3923.00 – SUPPORTS FOR REINFORCING STEEL
OPSD 3501.00 – GRANULAR BACKFILL REQUIREMENTS

94/12/14

LICENCED PROFESSIONAL ENGINEER J. R. SCHAEFER PROVINCE OF ONTARIO

LICENCED PROFESSIONAL ENGINEER S. S. W. WONG PROVINCE OF ONTARIO

BM 181.490
GEODETIC DATUM
ROCK RIVET IN ROCK
16.2 LT. 204373.3

DRAWING NOT TO BE SCALED
100mm ON ORIGINAL DRAWING

REVISIONS			
DATE	BY	DESCRIPTION	
DESIGN JRS	CHK SW	CODE OHBDC-83	LOAD C1	DATE 04/91
DRAWN JHB	CHK LP	SITE 38S-237	STRUCT	SCHEME	DWG 1

LATEST UPDATE : 1994-12-01 15:09

PWC/PROJS/DRAWINGS/5-87-01/

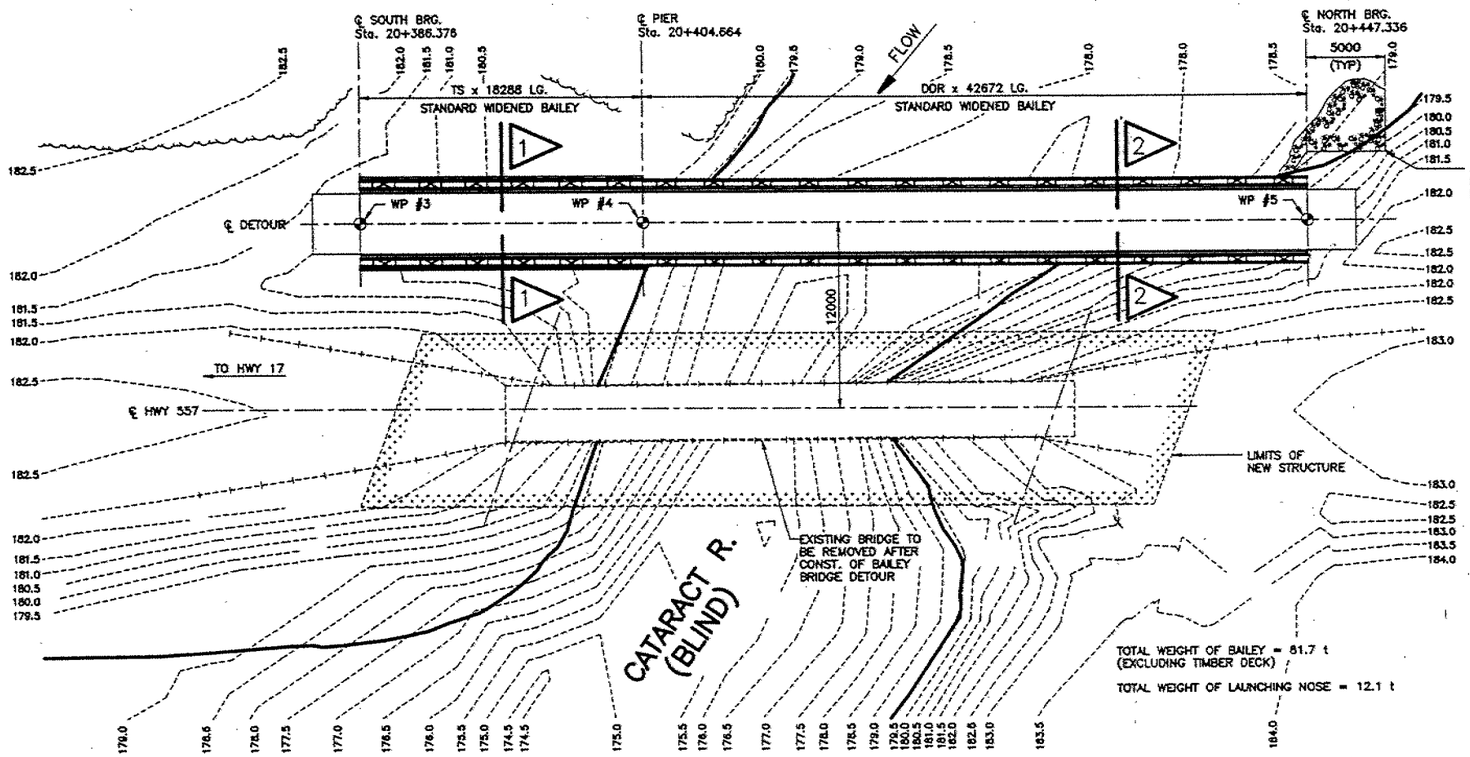
NORTH FOR CONSTRUCTION

METRIC
DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN

CONT. No. 94-233
WP No. 5-87-01

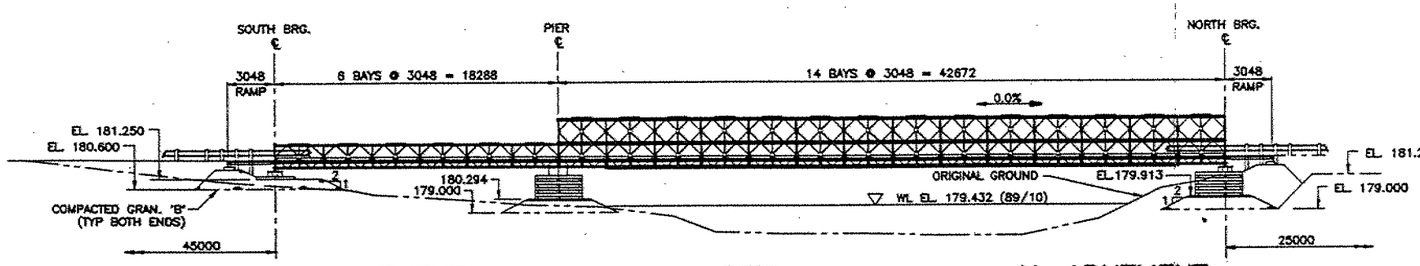
CATARACT RIVER BR
GENERAL ARRANGEMENT
BAILEY BRIDGE

SHEET 32

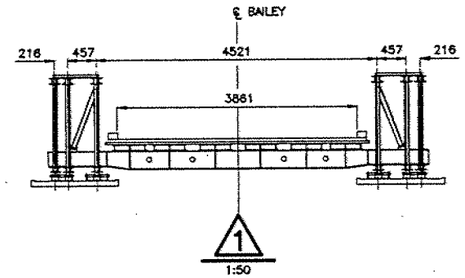


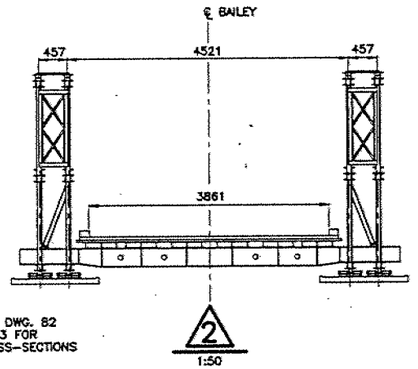
PLAN
1:200

WP	STATION	ELEVATION
3	20+386.376	182.500
4	20+404.664	182.500
5	20+447.336	182.500



ELEVATION
1:200





NOTE: REFER TO DWG. B2 & DWG. B3 FOR FULL CROSS-SECTIONS

NOTES TO CONTRACTOR

DECKING SHALL BE INSTALLED AS SHOWN ON DWG. B5.

GUIDE RAIL SHALL BE INSTALLED AS SHOWN ON DWG. B5.

CARRY OUT ALL EXCAVATION GRADING AND FILL OPERATIONS AS REQUIRED ALONG DETOUR ALIGNMENT PRIOR TO ERECTING AND LAUNCHING OF BAILEY BRIDGE.

ERECTION AND LAUNCHING

THE TOPS OF ALL ROLLERS SHALL BE LEVELLED ACROSS IN PAIRS AT RIGHT ANGLES TO THE CENTRE LINE OF THE STRUCTURE.

THE LAUNCHING NOSE SHALL CONSIST OF 18.288m OF STANDARD WIDENED SINGLE-SINGLE SKELETON CONSTRUCTION AND 6.096 OF STANDARD WIDENED DOUBLE-SINGLE SKELETON CONSTRUCTION.

THE LAUNCHING LINKS SHALL BE INSERTED 9.15m FROM THE TIP OF THE NOSE.

ALL PINS, BOLTS, AND THREADED PARTS MUST BE FREE OF DIRT AND SHALL BE LUBRICATED AT THE TIME OF INSTALLATION.

TRANSOM CLAMP TIGHTENING BARS MUST BE WIRED TO THE PANEL VERTICALS. SWAY BRACES MUST BE FULLY TIGHTENED TO GAUGE BLOCKS AND ALL LOCK NUTS SECURED.

THE WEAR DECK SHALL BE INSTALLED AFTER LAUNCHING HAS BEEN COMPLETED.

BRACING FRAME BOLTS SHALL BE INSTALLED IN THE REINFORCING CHORDS PRIOR TO THE CHORDS BEING INSTALLED ON THE PANELS.

TAPER CHORD REINFORCING SHALL BE USED FOR LAUNCHING AND DELAUNCHING.

AFTER LAUNCHING, ENTIRE BAILEY BRIDGE SHALL BE JACKED AS ONE UNIT TO FACILITATE REMOVAL OF ROLLERS. ALL JACKING SHALL BE DONE SIMULTANEOUSLY AND DIFFERENCES IN ELEVATIONS OF BAILEY BRIDGE AT ADJACENT JACK POINTS SHALL NOT EXCEED 50mm. PROVIDE SUITABLE JACKS AND BLOCKING AT PIER LOCATION.

REMOVE TOP PINS IN PANELS AFTER LAUNCHING IS COMPLETED AT PIER LOCATION ONLY. (SEE DWG. B4)

MAINTENANCE

THE CONTRACTOR SHALL BE RESPONSIBLE FOR THE MAINTENANCE OF THE STRUCTURE AND APPROACHES INCLUDING THE FOLLOWING:

- CHECK THAT ALL BRACING BOLTS, CHORD BOLTS, AND TRANSOM CLAMPS ARE, AND REMAIN, FULLY TIGHTENED
- KEEP BASEPLATES AND BEARINGS FREE OF DEBRIS. INSPECT BASEPLATES AND ABUTMENTS PERIODICALLY AND CORRECT ANY UNEVEN SETTLEMENT TO THE SATISFACTION OF THE ENGINEER. PACKING UNDER THE TRANSOMS AND RAMPS MUST BE KEPT TIGHT AT ALL TIMES.
- THE ENGINEER IS TO BE NOTIFIED IMMEDIATELY OF ANY DAMAGE TO THE BAILEY BRIDGES OR SUPPORTS.

LIST OF DRAWINGS

LIST OF ABBREVIATIONS

WP - DENOTES WORKING POINT

WL - DENOTES WATER LEVEL

S. ABUTMENT

1. EXCAVATE TO EL. 180.600 AT SOUTH ABUTMENT WITHIN LIMITS SHOWN. PROVIDE GRANULAR 'B' TYPE 1 PAD FOR TIMBER GRILLAGE AND RAMP.
2. PROVIDE A 10m WIDE LEVEL AREA AT EL. 181.250 TO FACILITATE ERECTION AND LAUNCHING OF BAILEY BRIDGE. THIS AREA TO EXTEND UNDER BAILEY AND 45m SOUTH OF SOUTH ABUTMENT.
3. PROVIDE REMAINDER OF GRANULAR 'B' TYPE 1 PAD FOR RAMP AT SOUTH ABUTMENT AS DETAILED ON DWG. B2.

NOTE: FOR LAUNCHING & DELAUNCHING LAYOUT DETAILS REFER TO DWG. B5.

PIER

1. EXCAVATE TO EL. 179.000 OR BEDROCK AT PIER WITHIN LIMITS SHOWN.
2. PROVIDE ROCK FILL AND A 100mm CONCRETE CHINKING AT EL. 180.294 FOR TIMBER CRIB AS DETAILED ON DWG. B4.

N. ABUTMENT

1. EXCAVATE TO EL. 179.000 OR BEDROCK AT NORTH ABUTMENT WITHIN LIMITS SHOWN.
2. PROVIDE ROCK FILL AND A 100mm CONCRETE CHINKING AT EL. 179.913 FOR TIMBER CRIB AS DETAILED ON DWG. B3.
3. PROVIDE A 10m WIDE LEVEL AREA AT EL. 181.250 TO FACILITATE LAUNCHING OF BAILEY BRIDGE. THIS AREA TO EXTEND 25m NORTH OF NORTH ABUTMENT.
4. PRIOR TO LAUNCHING BAILEY BRIDGE, PROVIDE 500mm THICK ROCK PROTECTION.
5. PROVIDE REMAINDER OF GRANULAR 'B' TYPE 1 PAD FOR RAMP AT NORTH ABUTMENT AS DETAILED ON DWG. B3.

D. C. DYKSTRA
PROFESSIONAL ENGINEER
PROVINCE OF ONTARIO
94/12/14

J. R. SCHAEFER
PROFESSIONAL ENGINEER
PROVINCE OF ONTARIO
94/12/14

B.M. 181.490
GEODETIC DATUM
ROCK RIVET IN ROCK
16.2 LT. 20+373.3

DRAWING NOT TO BE SCALED
100mm ON ORIGINAL DRAWING

REVISIONS		
DATE	BY	DESCRIPTION

DESIGN	JRS	CHK DCD	CODE OHBDC'83	LOAD	A	DATE	09/91
DRAWN	RJG	CHK J.N.	SITE 38S-237	STRUCT		SCHEME	DWG B1

\DWG\BRIDGE_DRAWINGS\5-87-01/B1

LATEST UPDATE : 1994-12-06 08:58

memorandum

Ontario

To: R.J. Krisciunas, P. Eng.
Head, Structural

Date: 16 12 94

Att: R.J. Schaefer, P. Eng.

From: Foundation Design Section
Rm. 315, Central Building

Re: WP 5-87-01, Hwy 557, Site 38S-237
Cataract (Blind) River Bridge

We have reviewed the contract drawings and documents for the aforementioned project which were provided by your office and have the following comments.

1. During construction of the footings on bedrock, any weathered or loose material should be removed in order to provide a sound base.

2. As the north abutment footing is being placed below the ground water level the existence of a non-cohesive gravelly sand layer will impose dewatering problems and construction difficulties. The following should be added to the Non-Standard Special Provisions:

   Groundwater Control System
   The provisions of OPSS 902.10.02 are extended to cover the following:

   The Contractor is advised that the soil at this site is susceptive to boiling and disturbance under conditions of unbalanced hydrostatic head. It is the Contractor's responsibility to lower the groundwater elevation to a minimum of 0.5 m below any excavation and to construct the footings in the dry without disturbing foundation soil.

   The Contractor shall propose the details of a groundwater Control System sealed and signed by a professional engineer licensed in Ontario and with proven expertise in dewatering design. This proposal shall be submitted for the review of the Engineer at least four (4) weeks prior to the installation of the groundwater Control System.

   The contractor shall allow for all the cost including labour, equipment and material for the design, detailing, complete installation, monitoring and operation of groundwater Control System under this item.

3. For the detour structure being placed 12 m west of the centreline of Hwy 557, any loose material should be removed before placement of any rockfill or rock filled timber cribs. As the structure foundations will be placed on the existing non-cohesive gravelly sand, settlement will occur immediately upon placement.

There are no other comments at this time. If there are any questions please contact this office.

M. Michalek, P. Eng.
Foundation Engineer
For:
T. Kim, P. Eng.
Sr. Foundation Engineer

cc. I Hussain

MEMORANDUM

TO: T. Kim
Senior Foundation Engineer
Foundation Design Section
Rm. 315 Central Building
Downsview

FROM: Structural Section
Northwestern Region
807/473-2193
807/473-2167 (fax)

DATE: January 4, 1995

ATTN: M. Michalek

RE: **Cataract (Blind) River Bridge, Site 38S-237**
WP 5-87-01, Contract 94-233

This is to confirm our telephone conversation regarding your memo (94/12/16) on the above. Since we are using tremie concrete placed on bedrock as a base for the north abutment footing, the N.S.S.P. you provided will not be applicable.

J.R. Schaefer
Structural Engineer

w:\docs\sites18\38s-237\north.ftg

memorandum

Ontario

To: R.J. Krisciunas
Head, Structural Section
Northwestern Region

Date: 1990 12 21

From: Foundation Design Section
Room 315, Central Building

Re: Foundation Investigation Report For
Blind River Structure, Hwy. 557
W.P. 5-87-01, Site 38S-237
District 18, Sault Ste. Marie

The Foundation Design Section retained McClymont & Rak Engineers, Inc., consulting geotechnical engineers, to carry out a foundation investigation for the above-noted project. The Foundation Investigation and Design Report is forwarded under cover of this memo.

After preparing the consultant agreement, this office provided technical supervision including the establishment of terms of reference and careful review of the consultant's proposals and progress at all stages of the project. Several meetings were held with the consultant during the field investigation phase to review progress data and during office engineering phase to review foundation design options. The Foundation Investigation (factual) portion of the report was reviewed only for format, and its accuracy and completeness are the responsibility of the consultant. The Foundation Design (recommendation) portion of the report has been carefully reviewed by this office based on the subsurface information provided by the consultant.

We consider that adequate recommendations are provided in the accompanying report regarding the design and construction for the proposed structure foundations.

.../2

Please contact this office if you require elaboration or clarification on the contents of the attached report.

Dr. B. Iyer, P. Eng.
Sr. Foundation Engineer

for

M. Devata, P. Eng.
Chief Foundation Engineer

MD/BI/jb

cc: R.J. Krisciunas (3)
J.R. Morgenroth
O.E. Ramakko
F.A. Adams (2)
K.G. Bassi
S.J. Dunham
E.A. Joseph
File

memorandum

Ontario

To: R.J. Krisciunas
Head, Structural Section
Northwestern Region

Date: 1991 01 28

From: Foundation Design Section
Room 315, Central Bldg.

Re: Blind River Structures
Hwy. 557, Site No. 385-237
W.P. 5-87-01
District 18, Sault Ste. Marie

This is in reply to your memo to M. Devata dated January 8, 1991.

The details of the proposed construction in terms of structure type, locations and elevations of proposed foundations etc. are not available at our office. We would like to review this information in light of the subsurface soil and bedrock data at the site. Following this review, we would offer our comments for the items raised in the reference memo.

Please forward details of the proposed construction for our review at your earliest convenience.

Dr. B. Iyer, P. Eng.
Sr. Foundation Engineer

BI/jb

MEMORANDUM

TO: M. Devata
Chief Foundation Engineer
Foundation Design Section
Central Building, 3rd Floor
Downsview

DATE: January 8, 1991

FROM: Structural Section
Northwestern Region
807/473-2000, Ext. 2252

Re: **Foundation Investigation Report**
For Blind River Structure,
Hwy. 557, W. P. 5-87-01,
Site No. 38S-237, District 18
Sault Ste. Marie

We have reviewed the above document and would like your comments on the following proposals:

1. As we are now proposing a rigid frame structure, differential settlement cannot be tolerated Therefore, we propose placing the footings on bedrock utilizing tremie concrete at the north abutment.

2. Excavation at the north abutment of the replacement structure to bedrock may cause undermining of a detour north abutment crib. We suggest using timber piles for the centre pier and north abutment of the detour structure. Timber piles would also be used for support of falsework of the replacement structure.

We would appreciate your input on the above at your earliest convenience.

J. R. Schaefer, P. Eng.
Structural Engineer

JRS/eu

To File