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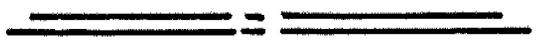
W. O. No. _____

STR. SITE No. _____

HWY. No. 637

LOCATION Wanapiteik River Crossing

No of PAGES -



OVERSIZE DRAWINGS TO BE INCLUDED WITH THIS REPORT. _____

REMARKS: _____

G.I.F-30 SEPT. 1976

FOUNDATION INVESTIGATION REPORT

CONTRACT NO 86-206



Ministry of
Transportation and
Communications

I N D E X

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Note: For the purpose of this contract this report supercedes all other foundation reports prepared by or for the Ministry in connection with the above mentioned project.

EXPLANATION OF TERMS USED IN REPORT

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

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

SOILS ARE DESCRIBED BY THEIR COMPOSITION AND CONSISTENCY OR DENSENESS.

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

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

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

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

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

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

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

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

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'_{v0}	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 = $\frac{c_u}{\tau_r}$

STRESS AND STRAIN

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

PHYSICAL PROPERTIES OF SOIL

ρ_s	kg/m ³	DENSITY OF SOLID PARTICLES	e	1, %	VOID RATIO
γ_s	kn/m ³	UNIT WEIGHT OF SOLID PARTICLES	n	1, %	POROSITY
ρ_w	kg/m ³	DENSITY OF WATER	w	1, %	WATER CONTENT
γ_w	kn/m ³	UNIT WEIGHT OF WATER	S_r	%	DEGREE OF SATURATION
ρ	kg/m ³	DENSITY OF SOIL	w_L	%	LIQUID LIMIT
γ	kn/m ³	UNIT WEIGHT OF SOIL	w_p	%	PLASTIC LIMIT
ρ_d	kg/m ³	DENSITY OF DRY SOIL	w_s	%	SHRINKAGE LIMIT
γ_d	kn/m ³	UNIT WEIGHT OF DRY SOIL	I_p	%	PLASTICITY INDEX = $w_L - w_p$
ρ_{sat}	kg/m ³	DENSITY OF SATURATED SOIL	I_L	1	LIQUIDITY INDEX = $\frac{w - w_p}{I_p}$
γ_{sat}	kn/m ³	UNIT WEIGHT OF SATURATED SOIL	I_C	1	CONSISTENCY INDEX = $\frac{w_L - w}{I_p}$
ρ'	kg/m ³	DENSITY OF SUBMERGED SOIL	e_{min}	1, %	VOID RATIO IN LOOSEST STATE
γ'	kn/m ³	UNIT WEIGHT OF SUBMERGED SOIL	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

Wanapitei River Crossing

W.P. 122-79-02, Site 46-203

Hwy. 637, Line 'D'

District 17, SudburyINTRODUCTION:

This report summarizes the factual information obtained from three foundation investigations carried out at the site mentioned above. The most recent fieldwork consisted of 13 sampled boreholes ranging in depth from 4.4 to 14.0 m and 2 dynamic cone tests, carried out between 84-03-26 and 84-04-04. The boreholes were advanced by means of hollow stem augers on land and wash boring techniques on the river.

Previous drilling at this site included 7 sampled boreholes and 11 dynamic cone penetration tests carried out from 82 03 15 to 82 03 18 and 80 09 05 to 80 09 06. The boreholes were advanced by means of hollow stem augers and washboring techniques. Bedrock was proven in 5 boreholes by obtaining up to 3.5 m of BXL rock core. The boreholes and cone tests ranged in depth from 4.7 to 17.9 m.

SITE DESCRIPTION

The site is located 10 km west of Hwy. 69 at the crossing of Hwy. 637 over the Wanapitei River, in the Geographic Township of Waldie, District of Sudbury. The proposed crossing is located on a slow flowing relatively wide 60 m section of the river flanked by a flat swampy floodplain to the west. The proposed structure site is approximately 300 m upstream of the existing crossing. The present crossing consists of two Bailey bridges founded on bedrock outcrops. The rock outcrops at the existing structures control the upstream water level.

The regional topography is typical Canadian Shield terrain consisting of knobby hills and rock ridges interspersed with hollows and swamps. Several rock outcroppings and scraps are evident in the area and tend to control the course of the river.

SUBSURFACE CONDITIONS

General

The subsurface conditions across the site are generally uniform. A 1.2 to 1.8 m surficial layer of soft to firm inorganic silt of slight plasticity to silty clay was generally encountered within the flood plain of the river. The dominant deposit across the site is a soft to stiff organic silt to organic silty clay. This organic stratum ranges in thickness from 3 to 12.2 m. Underlying the organic deposit is either granite bedrock or a 0.3 to 2.5 m layer of compact to very dense silty sand.

Two borings were advanced through the east and west approach embankments and 3.7 to 5.5 m of silty clay fill material was encountered. The eastern approach fill is underlain by subsoils as described above. The western approach fills are underlain by subsoils which vary from those encountered across the rest of the site. The silty clay fill at the west approach is underlain by 3 m of sand fill. Underlying the sand fill is a 3.7 m layer of organic silty clay, and a 1.8 m deposit of silty clay with sand some gravel. Overlying bedrock is a 1.7 m stratum of sand with silt some gravel.

The boundaries between the various soil types, insitu and laboratory test results are shown on the attached Record of Borehole Sheets. The locations and elevations of the boreholes and estimated stratigraphical profile and sections based on the borehole data are shown on Drawing No. 2 & 2A of the Contract structure drawings.

The various subsoil types encountered are described in the following paragraphs.

Fill - Silty Clay some Sand trace Gravel

A cohesive fill material was encountered in the east and west approach embankments. The thickness of the fill varies from 3.7 to 5.5 m at the borehole locations (BH 800 & 809). The approach embankments were constructed under Ministry Contract No. 83-213.

The fill material is generally comprised of silty clay with occasional pockets of sand. Atterberg limit testing on samples from the fill indicate the silty clay to vary from a low to intermediate plasticity. The results of the Atterberg tests are plotted on Fig. 1.

A grain size distribution test carried out on a sample from the deposit is shown graphically on Fig. 2.

Standard Penetration Test 'N' values ranging from 6 to 18 indicate the fill has been subjected to a moderate degree of compaction.

Fill - Sand trace of Gravel and Silt

This granular fill material was encountered immediately below the cohesive fill in the most westerly investigated area of the site (BH 800). The stratum is 3.0 m thick and appears to be backfill for the muskeg excavation carried out under the west approach fill.

This fill material is predominantly sand containing traces of gravel and silt. Occasional pockets of silt and silty clay were encountered within the deposit. One grain size distribution test was carried out on a sample and the results are plotted on Fig. 2.

Based on 'N' values ranging from 2 to 3, it appears that the fill was not subjected to any compaction.

Inorganic Silt to Silty Clay

The surficial deposit of inorganic silt to silty clay was generally encountered across the site except within the river channel and a few locations on the river banks. The deposit varies from a silt of slight plasticity to a silty clay of low plasticity, and appears to be an alluvial deposit. Traces of sand and root structures were generally found within the stratum.

An atterberg limit test carried out on a sample from this deposit indicates the material to be a silt of slight plasticity (ML zone). The results of this test are plotted on Fig. 1.

Results of grain size distribution tests completed on samples from this stratum are plotted on Fig. 3.

Generally the deposit is assessed to be of a cohesive nature with consistency ranging from soft to firm based on Standard Penetration Test 'N' values ranging from 2 to 6.

Organic Silt to Organic Silty Clay

This cohesive stratum is the dominant deposit across the site and was encountered at the surface or immediately below the surficial deposits of inorganic silt to silty clay or fill material. The thickness of the stratum varies from 3.0 to 12.2 m. The deposit is comprised of organic silt with traces of sand in the upper portion and changing to an organic silty clay with depth. Lenses or pockets of black organics were encountered throughout the deposit.

The results of Atterberg Limit Tests carried out on samples from the organic silt and organic silty clay are shown on the Plasticity Chart, Fig. 4 and are summarized below.

Organic Silt of Low Plasticity trace of Sand

			<u>Range</u>	<u>Average</u>
Natural Moisture Content	(w)	%	24-48	40%
Liquid Limit	(w _L)	%	25-35	31%
Plastic Limit	(w _p)	%	21-32	25%
Plasticity Index	(I _p)	%	2-10	6%

Organic Silty Clay

			<u>Range</u>	<u>Average</u>
Natural Moisture Content	(w)	%	35-53	45%
Liquid Limit	(w _L)	%	35-52	42%
Plastic Limit	(w _p)	%	24-38	27%
Plasticity Index	(I _p)	%	6-29	15%

The Atterberg Limits indicate that the deposit is organic and generally varies from a low to medium plasticity. In addition, testing to determine the percentage of organic matter by weight was carried out on 12 samples. This testing yielded organic contents ranging from 1.9 to 7.3% with an average of 3.8%, indicating the deposit is highly organic in nature.

The consolidation characteristics of this deposit were determined by means of five one-dimensional consolidation tests. The results are plotted on Fig. 5 and 6 for 3 tests with a summary for all tests listed below.

	<u>Range</u>	<u>Average</u>
Preconsolidation Pressure (Pc) kPa	34 - 78	59
Compression Index (Cc)	0.18 - 0.33	0.28
Initial Void Ratio (e ₀)	1.03 - 1.311	1.163

Grain size distribution testing carried out on samples from this deposit are plotted on Fig. 7.

Undrained shear strengths as measured by in-situ vane testing were found to range from 15 to 97 kPa in extreme cases, but generally ranged from 25 to 55 kPa with an average strength of 35 kPa. Undrained shear strengths determined by triaxial tests are somewhat lower averaging 24 kPa and generally ranging from 12 to 33 kPa with an extreme case of 42 kPa. Based on the undrained shear strength testing the deposit is assessed to range from a soft to stiff consistency, generally being firm.

Sand with Silt some Gravel

A 0.3 to 2.5 m deposit of sand with silt some gravel was encountered in various locations overlying bedrock. The stratum does not appear to be continuous across the site with no generally observed patterns. Occasional cobbles or boulders were encountered within this deposit on the east side (BH #13, 10, and 810).

Grain size distribution tests carried out on samples from this stratum are plotted on Fig. 8 and indicate the deposit to be composed of a coarse grained granular material.

Based on Standard Penetration Test 'N' values ranging from 5 to 39 the deposit has a denseness ranging from loose to dense but is generally compact.

Silty Clay with Sand some Gravel

This stratum was only encountered at the most westerly investigated portion of the site (BH 800), and was found between the organic silty clay and the sand with silt. The deposit is 1.8 m thick.

An atterberg test carried out on a sample indicates the deposit to be silty clay of medium plasticity. The results are plotted on Fig. 1.

Interpretation of an 'N' value of 22 blows indicates the consistency of the deposit is very stiff.

Bedrock

The bedrock varies in elevation considerably over the site and is steeply sloping in the vicinity of the river banks. The bedrock elevation ranges from 177.5 to 189.1 with the lowest elevations being encountered within the river and the highest elevations on the west bank.

Bedrock slopes in the area of the river banks calculated from available data indicate dips ranging from 50° at the west river bank to 30° at the east river bank. The bedrock dips outside the limits of the river banks appear to be much more modest, approximately 15 to 20°.

The sloping nature of the bedrock was evidenced during drilling by the bending of drill rods and a tendency for augers to corkscrew upon contact with bedrock.

The bedrock is a fine to medium grained rock of possible meta-sedimentary origin. Intrusive felsic stringers and dykes are also present within the rock, notably at BH 2 where they constituted the entire 1.5 m core run.

The rock is generally of sound quality with minor fracturing and jointing. Some weathering is also evident particularly within the intrusive felsic rock of borehole 2. The rock quality designation (RQD) ranges from approximately 50 to 90 percent.

Groundwater

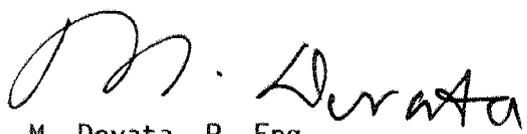
The groundwater levels recorded were generally slightly above or below the river level at elevation 193.2. The groundwater level is probably controlled by the river level.

MISCELLANIOUS

The "Foundation Investigation and Design Report" for this project was prepared by H. Sturm, P.Eng., of the MTC Foundation Design Section. This report contains only the factual information from that report.



L. Politano, P. Eng.
Project Foundations Engineer



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

APPENDIX

RECORD OF BOREHOLE No 1

METRIC

WP 122-79-02 LOCATION Sta. 12 + 190, E Hwy. 637 Line "D" ORIGINATED BY B.D.
 DIST 17 HWY 637 BOREHOLE TYPE Hollow Stem Auger, BX Rock Core COMPILED BY B.D.
 DATUM Geodetic DATE 1982 03 15 CHECKED BY C.N.

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			'N' VALUES	20	40	60	80						100
194.0	Top of snowpack															GR SA 51 CL	
0.0	250mm snow, Organic silt Firm Mottled Brown to dark gray with clayey zones	[Stratigraphic Column]	1	SS	2										17.8 Po=34.1kPa e _o =1.18 c _c =0.33	Om=2.6Z Om=7.3Z	
			2	TW	PH												
			3	SS	2												
			4	TW	PH												
			5	SS	2												
			6	TW	PH												
			7	SS	1												
			8	TW	PH												
			9	SS													
186.8	7.2 Granitized Meta- sediment, Fine to Med. Grains Felsic Stringers Sound	[Stratigraphic Column]	10	RC Bx	100% Rec											RQD=67Z	
			11	RC Bx	100% Rec												RQD=97Z
183.3																	
10.7	End of Borehole																

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

OFFICE REPORT ON SOIL EXPLORATION

RECORD OF BOREHOLE No 2

METRIC

W P 122-79-02 LOCATION Sta. 12 + 197.5 o/s 5.0 Lt & Hwy. 637 Line "D" ORIGINATED BY B.D.
 DIST 17 HWY 637 BOREHOLE TYPE Cone Test + Bx Rock Core COMPILED BY B.D.
 DATUM Geodetic DATE 1982 03 16 CHECKED BY C.H.

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			'N' VALUES	20	40	60						80
193.8	Ground Level															
0.0	Probable Organic silt															
188.2																
186.6																
5.8	Intrusive felsic dyke, Fractured and weathered		1	RC Bx	100% Rec										RQD=82%	
186.6																
7.2	End of Borehole															

OFFICE REPORT ON SOIL EXPLORATION

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

RECORD OF BOREHOLE No 3

METRIC

W P 122-79-02 LOCATION Sta. 12 + 193.5 o/s 5.0 Rt & Hwy.637 Line "D" ORIGINATED BY S.D.
 DIST 17 HWY 637 BOREHOLE TYPE Cone Test & Auger COMPILED BY S.D.
 DATUM Geodetic DATE 1982 03 16 CHECKED BY C.M.

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			'N' VALUES	20					
193.9	Top of Snowpack												
0.0	250mm snow												
	Probable Organic silt												
185.0													
8.9	Auger refusal Probable Bedrock												
183.2													
10.7	Cone refusal Lower 3 meter rod severly bent												

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

OFFICE REPORT ON SOIL EXPLORATION

RECORD OF BOREHOLE No 4

METRIC

W P 122-79-02 LOCATION Sta. 12 + 202.5 P Hwy. 637 Line "D" ORIGINATED BY B.D.
 DIST 17 HWY 637 BOREHOLE TYPE Hollow Stem Auger - Continuous Vanes COMPILED BY B.D.
 DATUM Geodetic DATE 1982 03 17 CHECKED BY C.M.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
193.7	Top of Snowpack																
0.0	250 mm Snow																
	Probable Organic Silt																
183.6	Refusal to Augering Probable Bedrock End of Borehole																

OFFICE REPORT ON SOIL EXPLORATION

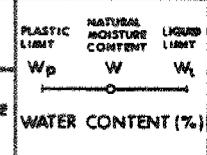
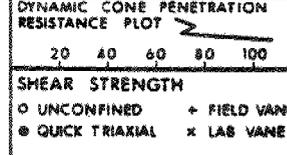
+3, x5: Numbers refer to Sensitivity 20
 15 - 5 (%) STRAIN AT FAILURE
 10

RECORD OF BOREHOLE No 6

METRIC

W P 122-79-02 LOCATION Sta. 12 + 220.6 o/s 2.5 Lt & Hwy. 637 Line "D" ORIGINATED BY B.D.
 DIST 17 HWY 637 BOREHOLE TYPE Cone Test COMPILED BY B.D.
 DATUM Geodetic DATE 1982 03 17 CHECKED BY C.M.

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100	PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE								
193.0	Ice Surface											
0.0												
	Water											
185.3	River Bottom											
7.7												
	Probable Organic silt											
179.5												
13.0	Probable Silty sand and gravel											
178.5												
14.5	Refusal Probable Bedrock											



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

OFFICE REPORT ON SOIL EXPLORATION

RECORD OF BOREHOLE No 7

METRIC

W P 122-79-02 LOCATION Sta. 12 + 214.6 o/s 2.5 Rt & Hwy. 637 Line "D" ORIGINATED BY B.D.
 DIST 17 HWY 637 BOREHOLE TYPE Cone Test COMPILED BY B.D.
 DATUM Geodetic DATE 1982 03 16 CHECKED BY C.M.

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			'N' VALUES	20	40					
192.0	Ice Surface													
0.0														
	Water					192								
						190								
188.0	River Bottom					188								
5.0						186								
	Probable Organic silt					184								
						182								
						180								
179.3														
178.7	Probable sand and gravel													
14.3	Refusal Probable Bedrock													

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

OFFICE REPORT ON SOIL EXPLORATION

RECORD OF BOREHOLE No 8

METRIC

W P 122-79-02 LOCATION Sta. 12 + 218 o/s 4.0 Rt & Hwy. 637 Line "D" ORIGINATED BY B.D.
 DIST 17 HWY 637 BOREHOLE TYPE Wash Bore, Bx Rock Core COMPILED BY B.D.
 DATUM Geodetic DATE 1982-03 15 & 16 CHECKED BY C.M.

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			'N' VALUES	SHEAR STRENGTH							
							20	40	60	80	100				
193.0	Ice Surface														
0.0															
	Water														
185.8	River Bottom														
7.2	Organic Silt, occ. fine sand seams Traces of Wood and Peat, soft, Brown to Grey		1	SS	0										
			2	SS	0										
			3	SS	0										
			4	SS	1										
			5	SS	5										
14.5	Silty sand & Gravel														
177.5	Compact Brown		6	SS	22										30 60 (10)
15.5	Granitized Meta- sediment, felsic Stringers & Dykes Minor Fracturing Sound		7	RC Bx	100% Rec										RQD = 70%
175.1			8	RC Bx	100% Rec										RQD = 50%
17.9	End of Borehole														

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

OFFICE REPORT ON SOIL EXPLORATION

RECORD OF BOREHOLE No 9

METRIC

W P 122-79-02 LOCATION Sta. 12 + 256.6 o/s 3.0 Lt @ Hwy. 637 Line "D" ORIGINATED BY B.D.
 DIST 17 HWY 637 BOREHOLE TYPE Wash Bore, Cone Test and Bx Rock Core COMPILED BY B.D.
 DATUM Geodetic DATE 1982 03 17 & 18 CHECKED BY C.H.

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT MATTER MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	NUMBER	TYPE	'N' VALUES			20	40	60	80	100	W _p	W	W _L		
193.0	Ice Surface															
0.0	Water															
186.2	River Bottom															
6.8	Organic silt Soft Brown to Grey															
		1	SS	0												
		2	SS	0												
		3	SS	0												
179.0		4	SS	13												
14.0	Silty Sand & Grava Compact, Brown															
177.9																
15.1	Granitized Meta- sediment, Fine to Medium grained	5	RC	Rec 100%												
	Felsic Stringers	6	RC	100%												
175.4	Hard, Fractured		Bx	Rec												
17.6	End of Borehole Lower 3M Rod bent during driving of cone															

OFFICE REPORT ON SOIL EXPLORATION

+3, +5: Numbers refer to
Sensitivity

20
15 → 5 (%) STRAIN AT FAILURE
10

RECORD OF BOREHOLE No 10

METRIC

W P 122-79-02 LOCATION Sta. 12 + 260.6 o/s 2.5 L.R. Hwy. 637 Type "D" ORIGINATED BY B.D.
 DIST 17 HWY 637 BOREHOLE TYPE Cone Test COMPILED BY B.D.
 DATUM Geodetic DATE 1982 03 17 CHECKED BY C.M.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100	SHEAR STRENGTH ○ UNCONFINED + FIELD VANE ⊗ QUICK TRIAXIAL x LAB VANE	PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES									
193.0	Ice Surface													
0.0	Water						192							
							190							
188.3	River Bottom						188							
4.8	Probable Organic silt						186							
							184							
							182							
181.0							180							
12.0	Probable Silty Sand and Gravel													
178.5	Refusal Probable Bedrock													
14.5														

OFFICE REPORT ON SOIL EXPLORATION

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

RECORD OF BOREHOLE No 11

METRIC

WP 122-79-02 LOCATION Sta. 12 + 254.6 o/s 2.5 Rt. & Hwy. 637 Line "D" ORIGINATED BY B.D.
 DIST 17 HWY 637 BOREHOLE TYPE Cone Test COMPILED BY B.D.
 DATUM Geodetic DATE 1982 03 17 CHECKED BY C.N.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100	PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES									SHEAR STRENGTH ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE
193.0	Ice Surface													
0.0	Water						192							
								190						
									188					
186.3	River Bottom													
6.7	Probable Organic silt						186	Rods sank under own weight						
								184						
								182						
								180						
13.3	Probable Silty													
178.9	Sand and Gravel													
14.1	Refusal Probable Bedrock													

OFFICE REPORT ON SOIL EXPLORATION

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

RECORD OF BOREHOLE No 12

METRIC

W P 122-79-02 LOCATION Sta. 12 + 258 o/s 4.0 Rt & Hwy. 637 Line "D" ORIGINATED BY B.D.
 DIST 17 HWY 637 BOREHOLE TYPE Cone Test COMPILED BY B.D.
 DATUM Gondaric DATE 1982 03 17 CHECKED BY C.M.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
193.0	Ice Surface																
0.0							192										
	Water						190										
188.7	River Bottom																
4.8							188										
	Probable Organic Silt						186										
							184										
182.8																	
10.2	Probable Silty Sand and Gravel						182										
181.4																	
11.6	Refusal Probable Bedrock										50/0mm						

OFFICE REPORT ON SOIL EXPLORATION

+3, x5 Numbers refer to Sensitivity
 20
 15-25 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 13

METRIC

W P 122-79-02 LOCATION Sta. 12 + 272.5 @ Hwy. 637 Line "D" ORIGINATED BY B.D.
 DIST 17 HWY 637 BOREHOLE TYPE Hollow Stem Auger COMPILED BY B.D.
 DATUM Geodetic DATE 1982 03 17 CHECKED BY C.M.

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			'N' VALUES	20	40	60	80					
194.3	Top of Snowpack															
0.0	250mm snow Organic Silt Soft Mottled Brown to Dark Grey Occ. plant remains		1	SS	2											0 15 (85)
			2	TW	PH										18.9	0 _m =2.52
			3	SS	2											0 _m =5.62
			4	TW	PH											0 _m =3.52
			5	SS	1											P ₀ =53.6kPa
			6	TW	PH											e ₀ =1.03
			7	SS	1											c _c =0.18
			8	TW	PH											
			9	SS	0											0 1 (99)
			10	TW	PH											
186.0																
8.3																
84.7	Silty Sand & Gravel Occ. Cobble, Compact Brown		11	SS	18											
9.6	Refusal to Augering Spoon bent at bottom sample. Probable Bedrock															

OFFICE REPORT ON SOIL EXPLORATION

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

RECORD OF BOREHOLE No 15

METRIC

W P 122-79-02 LOCATION Sta. 12 + 277.6 o/s 5.0 Rt & Hwy. 637 Line "D" ORIGINATED BY B.D.
 DIST 17 HWY 637 BOREHOLE TYPE Cone Test COMPILED BY B.D.
 DATUM Geodetic DATE 1982 03 17 CHECKED BY C.M.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			SHEAR STRENGTH									
194.2	Top of Snowpack																
0.0	250mm snow																
	Probable Organic silt						192										
							190										
188.0							188										
6.2	Probable silty sand and gravel																
186.7																	
7.5	Refusal Probable Bedrock																

OFFICE REPORT ON SOIL EXPLORATION

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

RECORD OF BOREHOLE No 103 (Formerly BH # 3) METRIC

W P 122-79-02 LOCATION Sta. 12 + 198.4, @ Hwy. 637 Line "D" ORIGINATED BY R.B.
 DIST 17 HWY 637 BOREHOLE TYPE Hollow Stem Auger, BXL Rock Core & Cone Test COMPILED BY R.B.
 DATUM Geodetic DATE 1980 09 05 CHECKED BY C.M.

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE			'N' VALUES	20						40
193.3	Ground Surface													
0.0	Organic Silty Clay		1	SS	5								0 5 89 6 e ₀ = 1.186 P _c = 65kPa C _c = 0.323 RQD = 60%	
	Stiff to Firm		2	SS	2									
			3	TW	PH									
			4	SS	2									
			5	TW	PH									
187.3			6	SS	2									
6.3			7	BXL RC	Rec 90%									
185.6	Granite Bedrock													
7.0	End of Borehole													

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

RECORD OF BOREHOLE No 104 (Formerly BH # 4) METRIC
WP 18-79-00

W P 122-79-02 LOCATION Sta. 12 + 282.8. o/s 1.8m Rt. of Hwy. 637 Line "D" ORIGINATED BY R.B.
 DIST 17 HWY 637 BOREHOLE TYPE Hollow Stem Auger, BXL Rock Core & Cone Test COMPILED BY R.B.
 DATUM Geodetic DATE 1980 09 06 CHECKED BY C.M.

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC NATURAL LIQUID LIMIT MOISTURE CONTENT LIMIT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	NUMBER	TYPE	W' VALUES			20	40	60	80	100	W _p	W	W _L		
123.7	Ground Level															
0.0	Organic Silty Clay Stiff to Firm	1	SS	6	↓						WATER CONTENT (%) 20 40 60 17.0			0 9 80 11 0 9 85 6 e ₀ = 1.106 P _c = 65 kPa C _c = 0.273 O _m = 2.77		
		2	SS	3												
		3	TW	PH												
		4	SS	2												
187.7		5	TW	PH												
6.0	Boulder	6	RC	Rec 80Z												
187.0		7	SS	5												
6.7	Silty Fine Sand Loose	8	SS	4/8												
185.8		9	BXL RC	Rec 80Z												
7.9	Granite Bedrock				1cm	Hammer Bouncing										
184.2														RQD = 95Z		
9.5	End of Borehole															

*3, *5: Numbers refer to
Sensitivity

20
15
10

5 (% STRAIN AT FAILURE)

RECORD OF BOREHOLE No 800

METRIC

W P 122-79-02 LOCATION Sta. 12 + 166.0; 4 Hwy. 637 Line D ORIGINATED BY DT & ES
 DIST 17 HWY 637 BOREHOLE TYPE Hollow Stem Auger COMPILED BY DT
 DATUM Geodetic DATE 84 03 26 - 27 CHECKED BY CP

ELEV DEPTH	SOIL PROFILE DESCRIPTION	STRAT PLOT	SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT Y	REMARKS & GRAIN SIZE DISTRIBUTION (%)
			NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
195.5	Ground Surface																
0.0	Silty Clay (Fill) some sand trace gravel Occasional Pockets of Sand Firm to Stiff		1	SS	9	+	194										
191.8			2	SS	8		192										5 35 39 21
3.7			3	SS	15												0 90 10 0
188.8	Sand (Fill) trace gravel and silt Occasional Pockets of Silty Clay Very Loose		4	SS	6												
6.7			5	SS	2												
185.1			6	SS	2												
10.4	Organic Silty Clay Soft		7	SS	3												
183.3			8	SS	3												
12.2	Silty Clay with Sand some gravel Very Stiff		9	SS	3												
181.6			10	SS	22												
13.9	Sand with silt Loose some gravel Very Dense		11	SS	6												
181.6			12	SS	45/150												16 40 39 5
13.9	End of Borehole Refusal to Auger Probable Bedrock																

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

OFFICE REPORT ON SOIL EXPLORATION

RECORD OF BOREHOLE No 801

METRIC

W P 122-79-02 LOCATION Sta. 12 + 174.0; O/S 150 m RT & Hwy. 637 Line D ORIGINATED BY DT
 DIST 17 HWY 637 BOREHOLE TYPE Solid Stem Auger COMPILED BY DT
 DATUM Geodetic DATE 84 03 29 CHECKED BY [Signature]

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			'N' VALUES	20	40	60	80						100	WATER CONTENT (%)
193.5	Ground Surface																	
0.0	Inorganic Silt some sand trace clay Firm		1	SS	5											0 13 81 6		
192.1	Organic Silt trace sand to Organic Silty Clay Firm		2	SS	2													
1.4				3	TW	PH											17	
183.0				4	SS	39												18 60 22 0
10.5			Sand, some gravel some silt Dense															
181.8	End of Borehole Refusal to Auger Probable Bedrock																	

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

OFFICE REPORT ON SOIL EXPLORATION

RECORD OF BOREHOLE No 802

METRIC

W P 122-79-02 LOCATION Sta. 12 + 184.0; O/S 16.0 m RT & Hwy. 637 Line D ORIGINATED BY DT & HS
 DIST 17 HWY 637 BOREHOLE TYPE Solid Stem Auger COMPILED BY DT
 DATUM Geodetic DATE 84 03 28 CHECKED BY CP

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT Y kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	NUMBER	TYPE	'N' VALUES			20	40	60	80	100	W _p	W	W _L		
193.2	Ground Surface															
0.0	Inorganic Silt some sand trace clay & roots Soft	1	SS	2											0 15 77 8	
191.7																
1.5	Organic Silt trace sand to Organic Silty Clay Occasional Pockets of Black Organics Firm	2	SS	2										18.1		
		3	FW	PH												
		4	SS	3												
181.6																
11.6	End of Borehole Refusal to Auger Probable Bedrock															

OFFICE REPORT ON SOIL EXPLORATION

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

RECORD OF BOREHOLE No 803

METRIC

W P 122-79-02 LOCATION Sta. 12 + 180.0; O/S 30.0 m RT of Hwy. 637 Line D ORIGINATED BY DT & HS
 DIST 17 HWY 637 BOREHOLE TYPE Solid Stem Auger COMPILED BY DT
 DATUM Geodetic DATE 1984 03 28 CHECKED BY *[Signature]*

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
193.3	Ground Surface															
0.0	Inorganic Silt some sand trace clay & roots Soft	1	SS	2												0 15 76 9
191.8																O.M.* = 3.9%
1.5	Organic Silt trace sand to Organic Silty Clay Occasional lenses of Black Organics	2	SS	2			24									
		3	TW	PH										15.9		
181.9																
11.4	End of Borehole Refusal to Auger Probable Bedrock * O.M. = percentage of organic matter by weight															

OFFICE REPORT ON SOIL EXPLORATION

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

RECORD OF BOREHOLE No 804

METRIC

W P 122-79-02 LOCATION Sta. 12 + 170.0; O/S 26.0 m RT E Hwy. 637 Line D ORIGINATED BY DT
 DIST 17 HWY 637 BOREHOLE TYPE Solid Stem Auger COMPILED BY DT
 DATUM Geodetic DATE 84 03 29 CHECKED BY [Signature]

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC NATURAL LIQUID LIMIT MOISTURE CONTENT LIMIT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			VALUES	20	40	60	80	100	W _p	W		
193.6	Ground Surface															
0.0	Inorganic Silt some sand trace clay Soft		1	SS	3											
192.1			2	SS	2											
1.5	Organic Silt trace of sand to Organic Silty Clay		3	UV	PH										16.3	
	Firm															
180.5																
13.1	Sand some gravel															
179.6	some silt Compact		4	SS	29										19	55 23 3
14.0	End of Borehole Refusal to Auger Probable Bedrock															

OFFICE REPORT ON SOIL EXPLORATION

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

RECORD OF BOREHOLE No 806

METRIC

W P 122-79-02 LOCATION Sta. 12 + 175.0; O/S 10.0 m LT Hwy. 637 Line D ORIGINATED BY DT
 DIST 17 HWY 637 BOREHOLE TYPE Solid Stem Auger COMPILED BY DT
 DATUM Geodetic DATE 84 03 30 CHECKED BY [Signature]

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
193.9	Ground Surface															
0.0	Inorganic Silty Clay some sand trace gravel pieces of wood Firm	1	SS	6	*											
192.5		2	SS	3												
1.4	Organic Silt trace sand to Organic Silty Clay Firm	3	TW	PH										17.0		
185.4		4	SS	100A	50 mm											
8.5	Sand, some gravel some silt Dense	5	SS	31												
184.3																
9.6	End of Borehole Refusal to Auger Probable Bedrock * Note: Groundwater Level not established															

OFFICE REPORT ON SOIL EXPLORATION

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

RECORD OF BOREHOLE No 807

METRIC

W P 122-79-02 LOCATION Sta. 12 + 184.0; O/S 10.0 m LT @ Hwy. 637 Line D ORIGINATED BY DT
 DIST 17 HWY 637 BOREHOLE TYPE Solid Stem Auger COMPILED BY DT
 DATUM Geodetic DATE 84 04 02 CHECKED BY [Signature]

ELEV DEPTH	SOIL PROFILE DESCRIPTION	STRAT PLOT	SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
			NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
193.7	Ground Surface																
0.0	Inorganic Silty Clay some sand, trace fibrous organics Firm		1	SS	5												
192.5																	
1.2	Organic Silt trace sand to Organic Silty Clay Pockets of Organics Stiff to Firm		2	SS	3		192										O.M. ** = 6.0%
							190										17.4
187.5			3	TW	PH												
							188										
187.5			4	SS	100% 100mm												
6.2	End of Borehole Refusal to Auger Probable Bedrock																
	* Note Groundwater Level not established																
	** O.M. = Percentage of organic matter by weight																

OFFICE REPORT ON SOIL EXPLORATION

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

RECORD OF BOREHOLE No 808

METRIC

W P 122-79-02 LOCATION Sta. 12 + 200.0; O/S 10.0 m LT & Hwy. 637 Line D ORIGINATED BY DT
 DIST 17 HWY 637 BOREHOLE TYPE Solid Stem Auger COMPILED BY DT
 DATUM Geodetic DATE 84 04 02 CHECKED BY 

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			'N' VALUES	20	40	60	80					
193.5	Ground Surface															
0.0	Inorganic Silt, some sand, trace of roots		1	SS	2											
192.1	Soft															
1.4	Organic Silt trace sand to Organic Silty Clay		2	SS	2											0 5 90 5
	Stiff															
189.1	some gravel		3	SS	76/180											
4.4	End of Borehole Refusal to Auger Probable Bedrock															
	* Note: Groundwater Level not established															

OFFICE REPORT ON SOIL EXPLORATION

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

RECORD OF BOREHOLE No 809

METRIC

W P 122-79-02 LOCATION Sta. 12 + 297.6; 4 Hwy. 637 Line D ORIGINATED BY DT
 DIST 17 HWY 637 BOREHOLE TYPE Solid Stem Auger COMPILED BY DT
 DATUM Geodetic DATE 84 04 04 CHECKED BY [Signature]

ELEV DEPTH	SOIL PROFILE DESCRIPTION	STRAT PLOT	SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
			NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
199.0	Ground Surface																
0.0	Silty Clay (Fill) some sand trace gravel trace of fibrous organics Stiff to Very Stiff	[Hatched]	1	SS	18		198										
			2	SS	10		196										
			3	SS	15		194										
193.5	Organic Silt trace of wood and fibrous organics to Organic Silty Clay Soft to Stiff	[Hatched]	4	SS	17		192										
5.5			5	SS	3		190										
							188										
186.8	Probable Sand some gravel						186										
12.2																	
185.4	End of Borehole Refusal to Auger Probable Bedrock																
13.6																	

OFFICE REPORT ON SOIL EXPLORATION

+3, x5: Numbers refer to
Sensitivity

20
15 5 (%) STRAIN AT FAILURE
10

RECORD OF BOREHOLE No 810

METRIC

W P 122-79-02 LOCATION Sta. 12 + 270.5; O/S 6.1 m RT of Hwy. 637 Line D ORIGINATED BY DT
 DIST 17 HWY 637 BOREHOLE TYPE Solid Stem Auger COMPILED BY DT
 DATUM Geodetic DATE 84 04 04 CHECKED BY *[Signature]*

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
194.1	Ground Surface															
0.0	Inorganic Silt trace sand & roots Soft	1	SS	2												
192.7																
1.4	Organic Silt trace sand occasional pockets of Black organics to Organic Silty Clay Soft to Stiff	2	TW	PH										16.5	P _c = 78 kPa e ₀ = 1.311 C _c = 0.300	
		3	SS	2												
		4	SS	2												
183.6	Sand some gravel Occasional cobbles Very Dense															
10.5																
182.5	End of Borehole Refusal to Auger Probable Bedrock															
11.6																

OFFICE REPORT ON SOIL EXPLORATION

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

RECORD OF BOREHOLE No 812

METRIC

W P 122-79-02 LOCATION Sta. 12 + 208.6; O/S 4.5 m RT of Hwy. 637 Line D ORIGINATED BY DT
 DIST 17 HWY 637 BOREHOLE TYPE Dynamic Cone Test COMPILED BY DT
 DATUM Geodatic DATE 84 04 02 CHECKED BY [Signature]

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100	PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT Y	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE								
193.2	Water Surface											
0.0	Water											
191.1	River Bottom											
2.1	Probable Organic Silt to Organic Silty Clay											
181.2	End of Cone Test											
12.0	Probable Bedrock											

OFFICE REPORT ON SOIL EXPLORATION

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

RECORD OF BOREHOLE No 813

METRIC

W P 122-79-02 LOCATION Sta. 12 + 205.2; O/S 4.6 m LT & Hwy. 637 Line D ORIGINATED BY DT
 DIST 17 HWY 637 BOREHOLE TYPE Wash Bore COMPILED BY DT
 DATUM Geodetic DATE 84 04 03 CHECKED BY *[Signature]*

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	NUMBER	TYPE	'N' VALUES			20 40 60 80 100	SHEAR STRENGTH kPa					
						○ UNCONFINED	+ FIELD VANE						
						● QUICK TRIAXIAL	x LAB VANE						
						10 20 30 40 50							
193.2	Water Surface												
0.0	Water												
191.4	River Bottom					192							
1.8	Organic Silt trace sand to Organic Silty Clay with fine roots and pockets of black organics.	1	SS	1		190						16.	
		2	TW	PM		188							
						186							
						184							
						182							
181.0	End of Borehole												
12.2	Probable Bedrock												

OFFICE REPORT ON SOIL EXPLORATION

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

RECORD OF BOREHOLE No 814

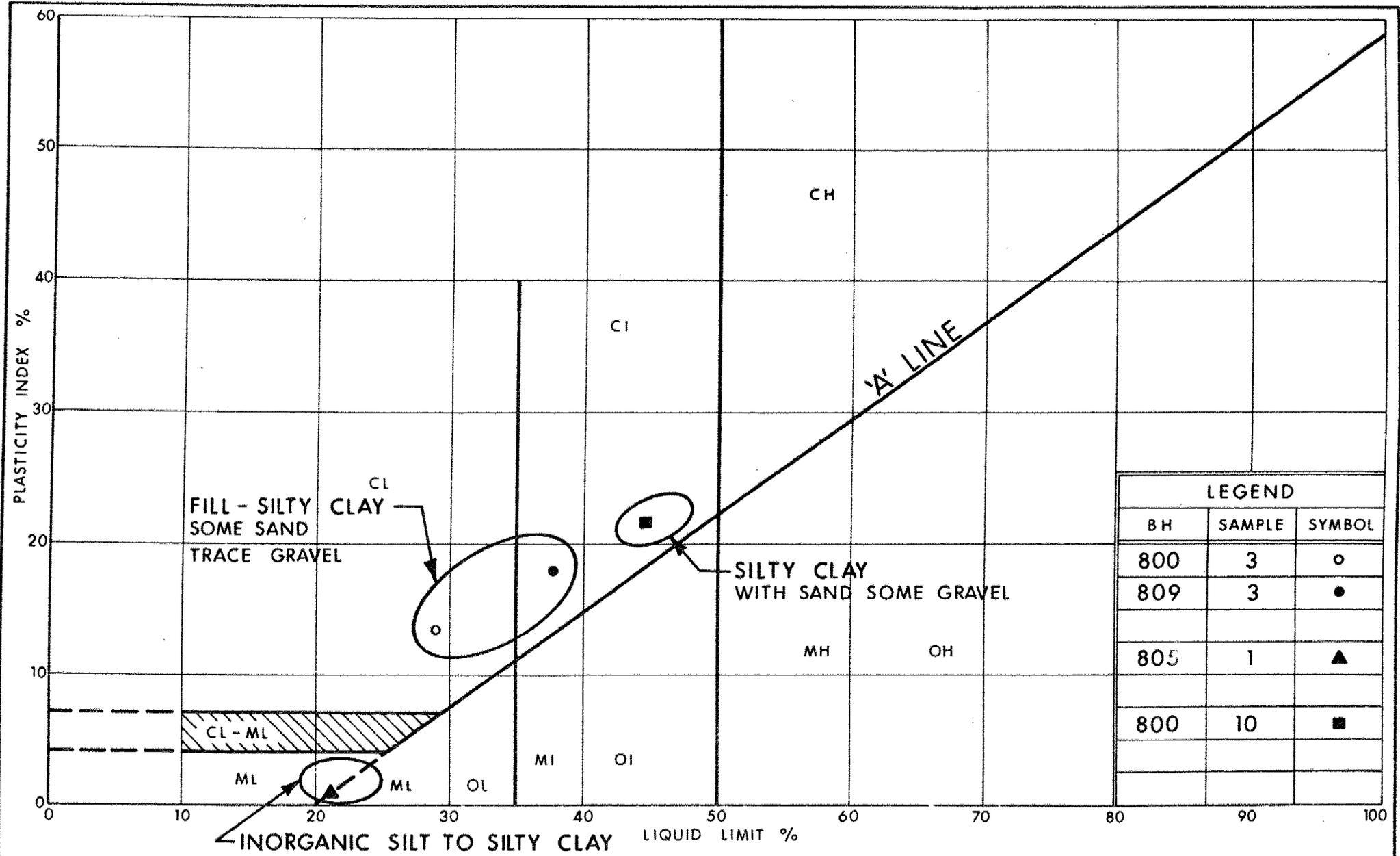
METRIC

W P 122-79-02 LOCATION Sta. 12 + 267.8; O/S 10.6 m Lt @ Hwy. 637 Line D ORIGINATED BY DT
 DIST 17 HWY 637 BOREHOLE TYPE Dynamic Cone Test COMPILED BY DT
 DATUM Geodetic DATE 84 04 03 CHECKED BY [Signature]

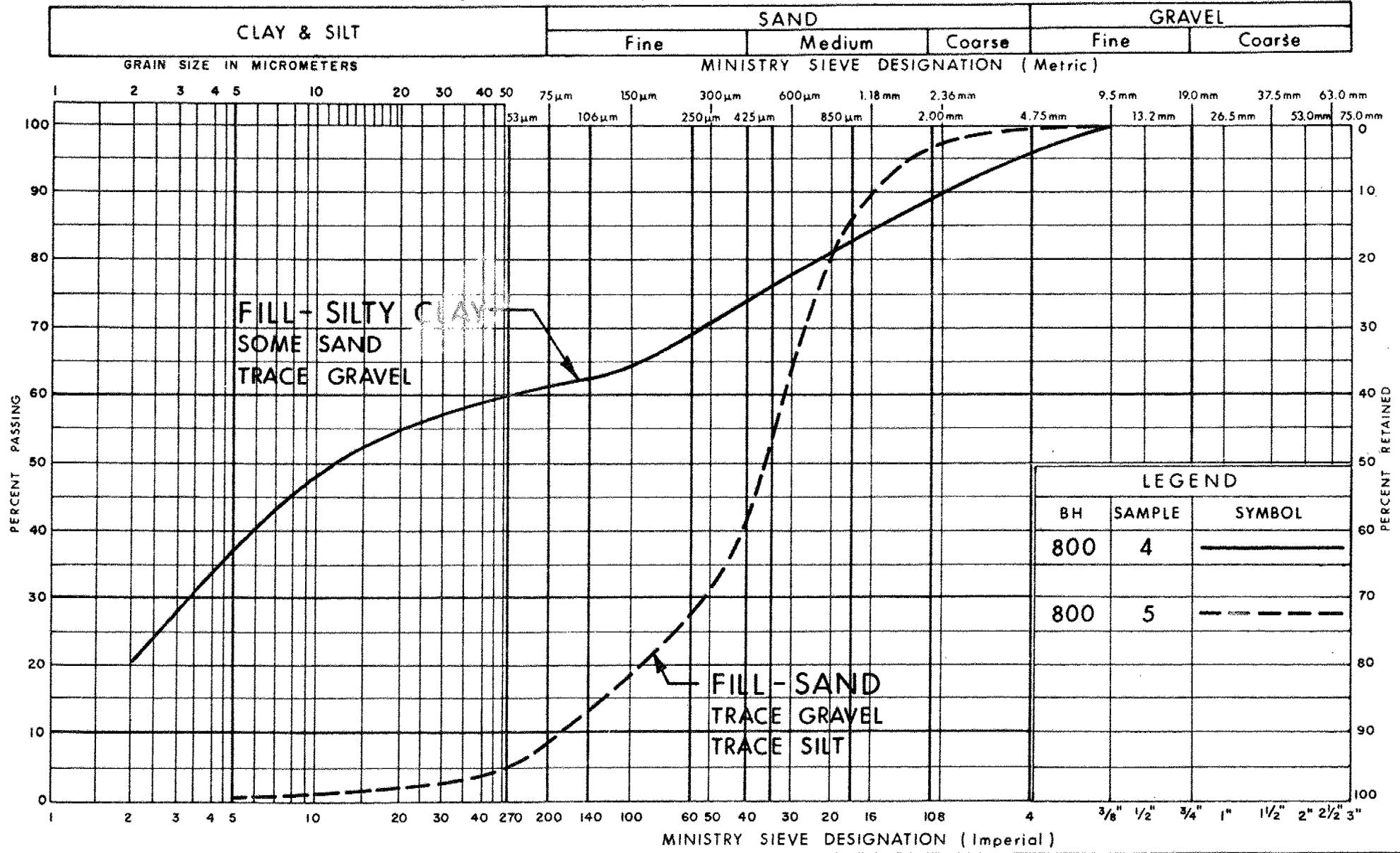
SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100	PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL	
ELEV DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE									'N' VALUES
193.2	Water Surface												
0.0	Water												
190.2	River Bottom												
3.0	Probable Organic Silt to Organic Silty Clay												
188													
186													
184													
182													
179.6	End of Cone Test Probable Bedrock												
13.6													

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

OFFICE REPORT ON SOIL EXPLORATION

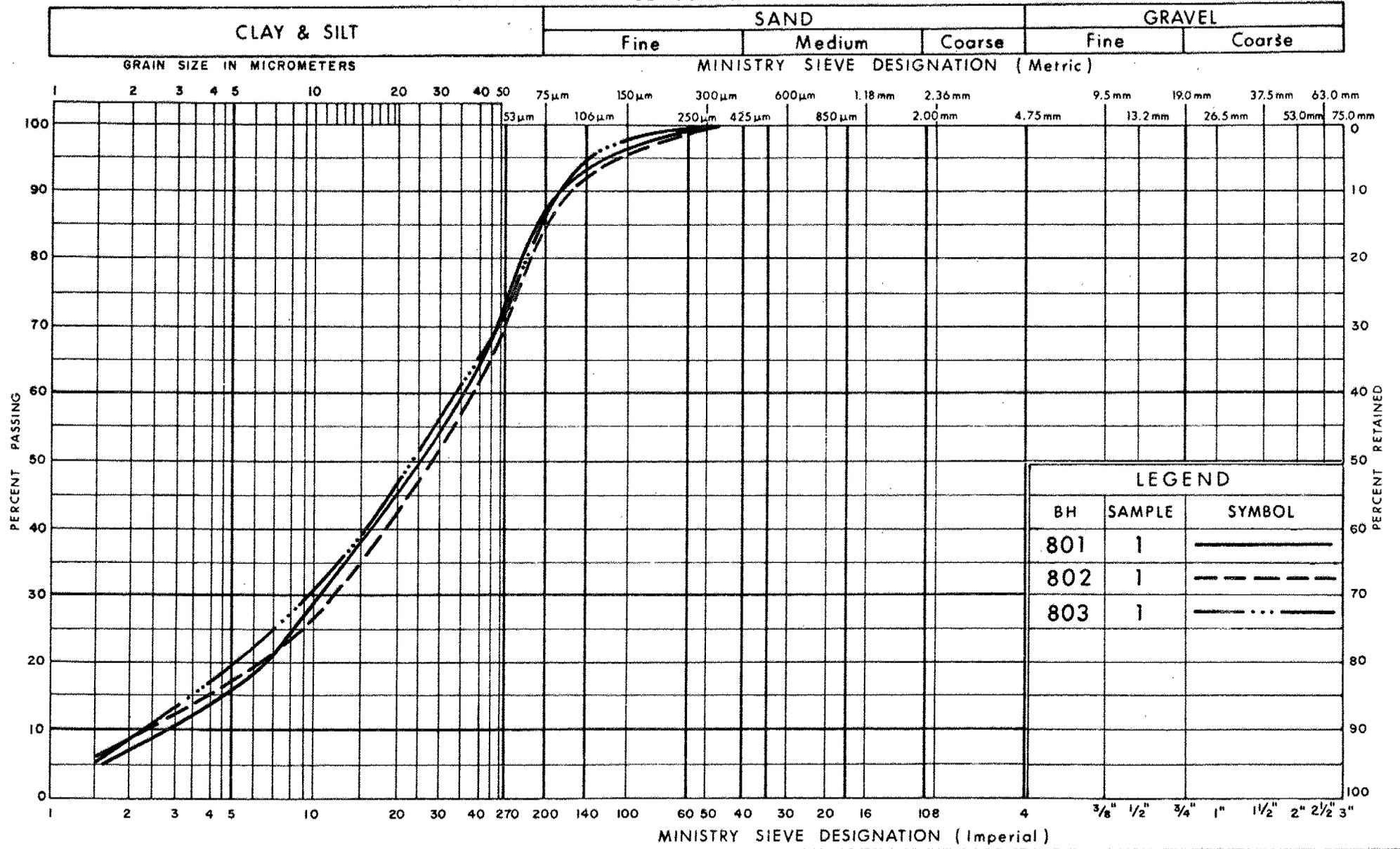


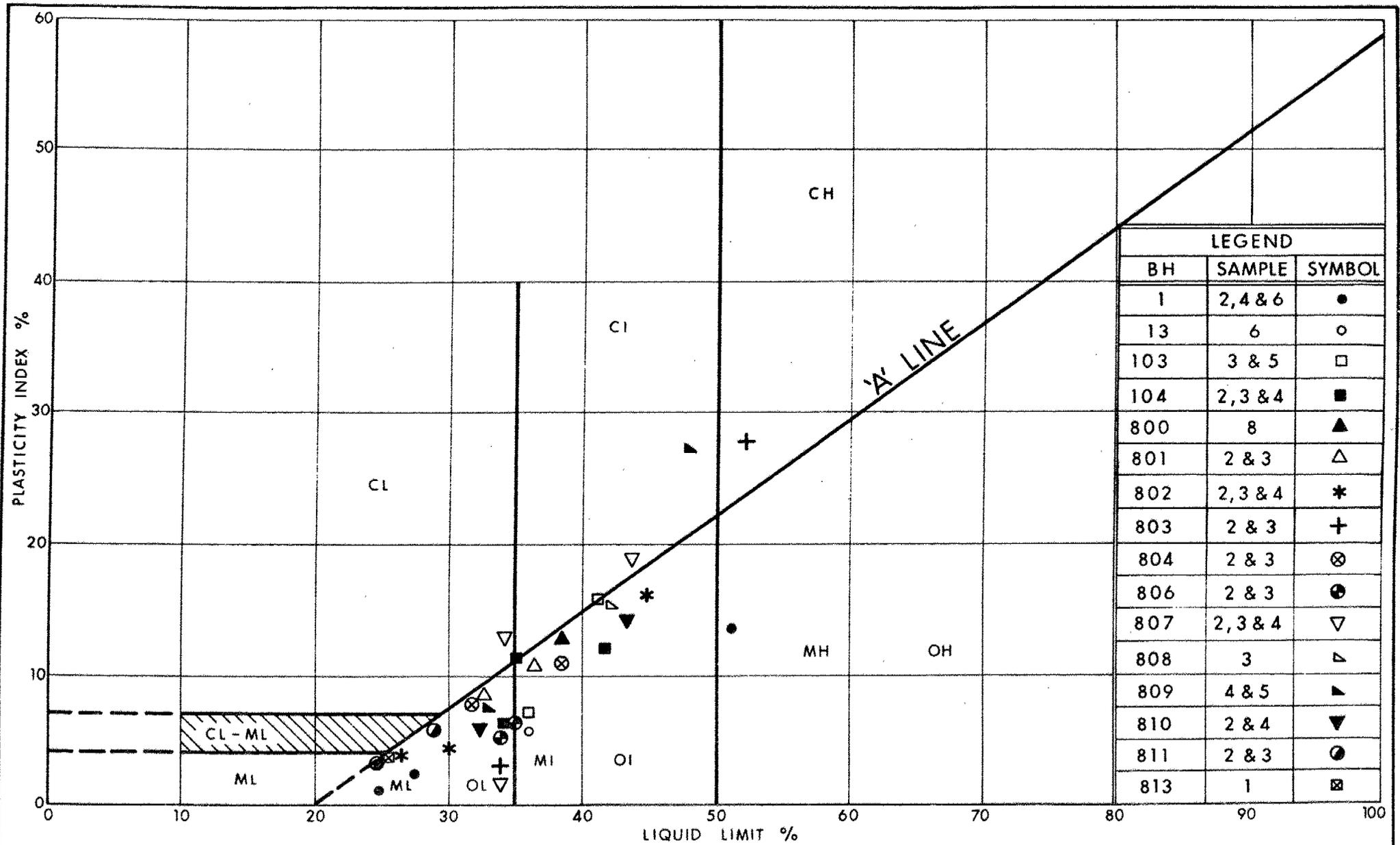
UNIFIED SOIL CLASSIFICATION SYSTEM



LEGEND		
BH	SAMPLE	SYMBOL
800	4	—————
800	5	- - - - -

UNIFIED SOIL CLASSIFICATION SYSTEM





VOID RATIO - PRESSURE CURVES

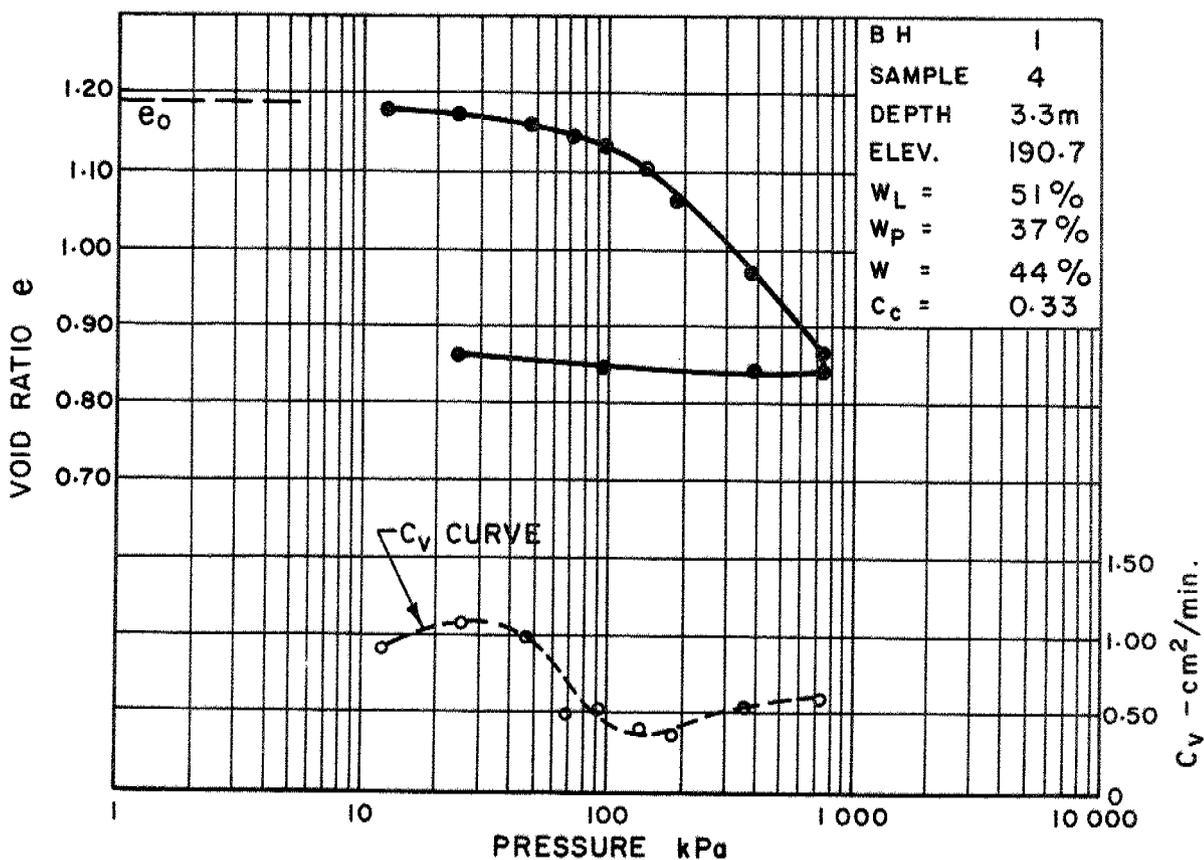
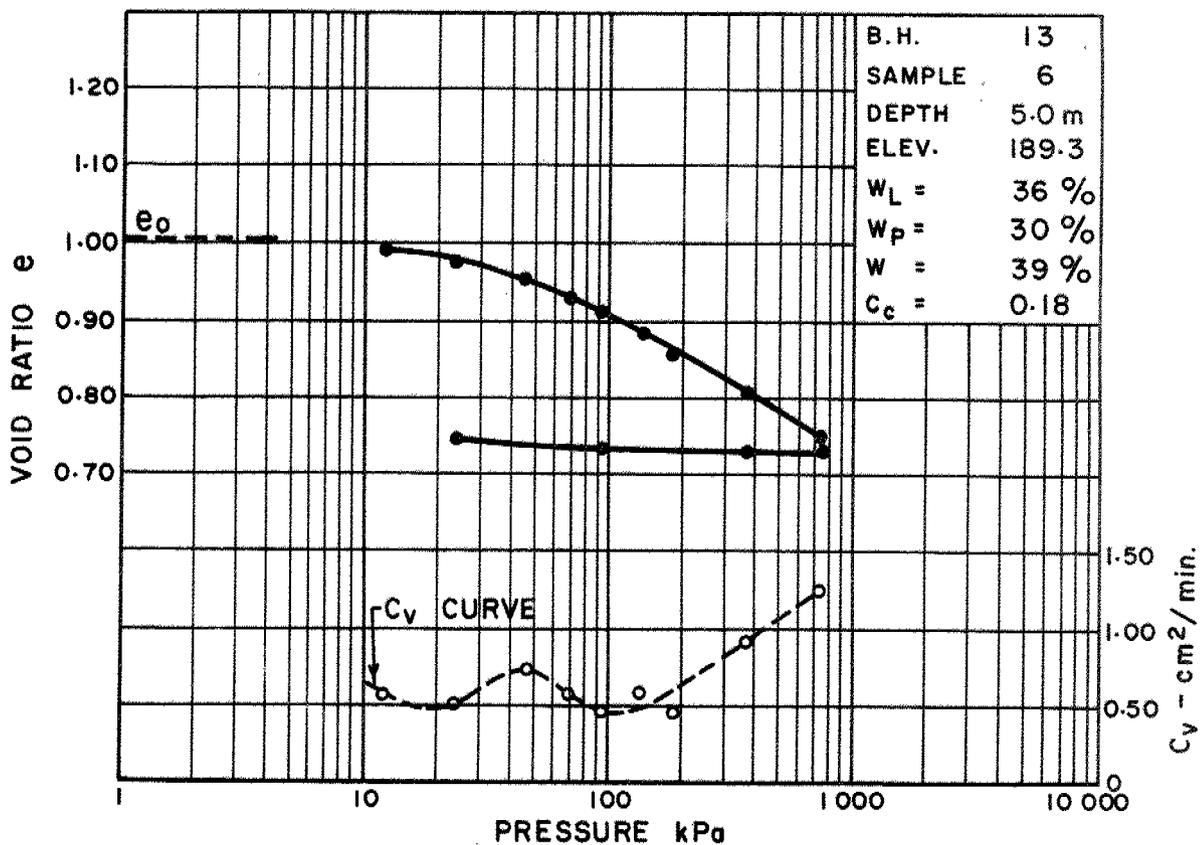
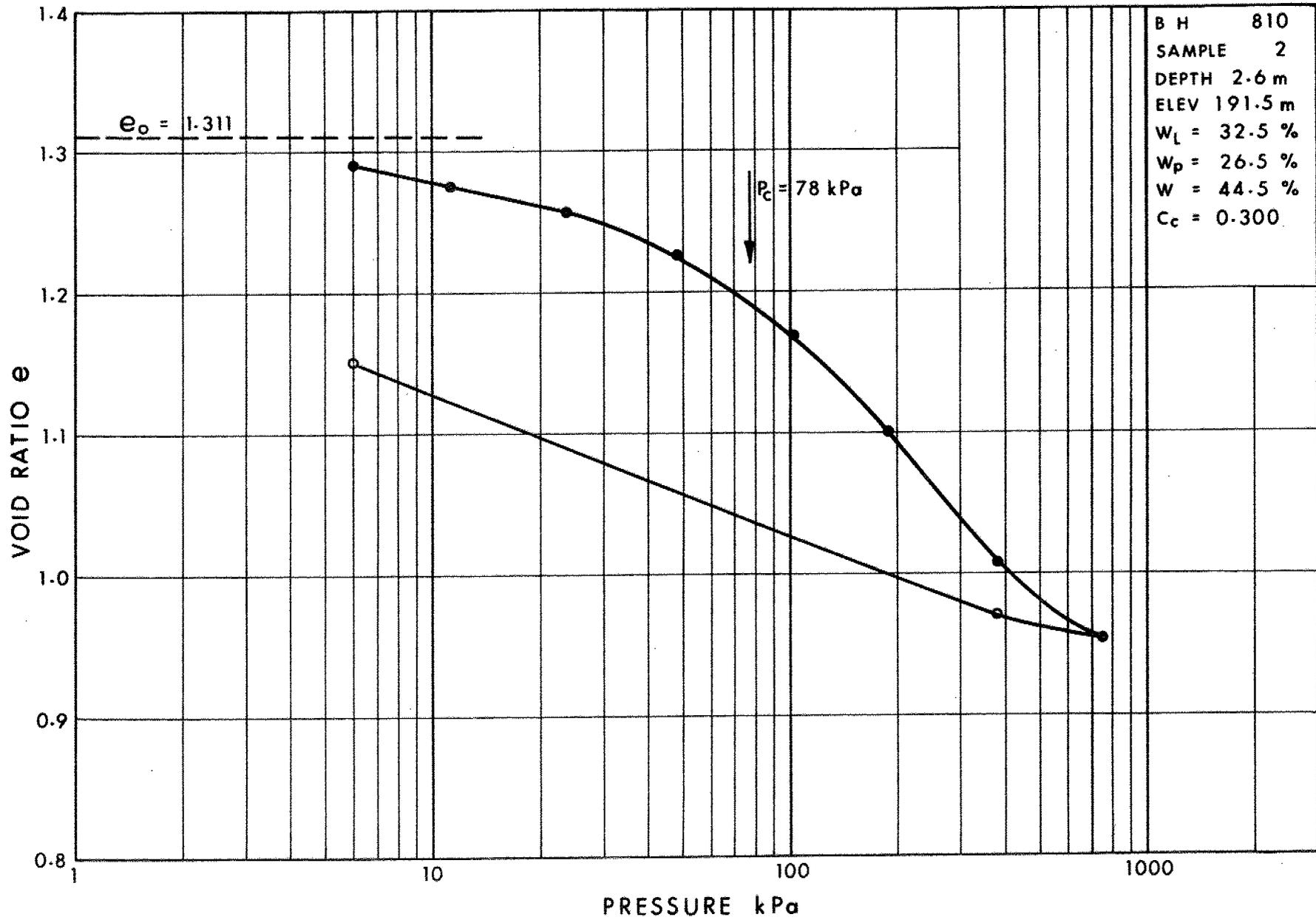


Fig. No. 5

VOID RATIO - PRESSURE CURVE



B H	810
SAMPLE	2
DEPTH	2.6 m
ELEV	191.5 m
W _L	32.5 %
W _p	26.5 %
W	44.5 %
C _c	0.300

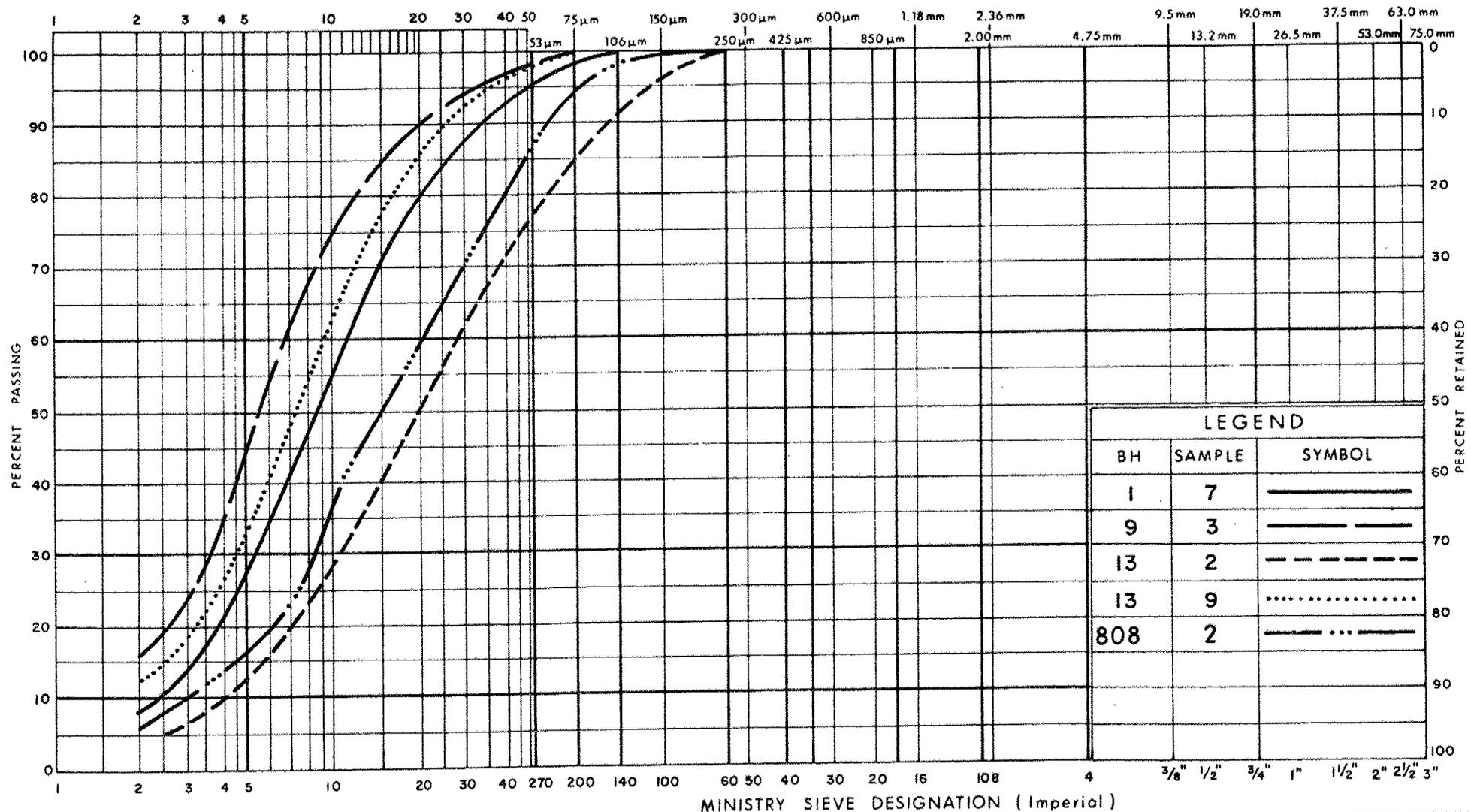
FIG 6

UNIFIED SOIL CLASSIFICATION SYSTEM

CLAY & SILT	SAND			GRAVEL	
	Fine	Medium	Coarse	Fine	Coarse

GRAIN SIZE IN MICROMETERS

MINISTRY SIEVE DESIGNATION (Metric)



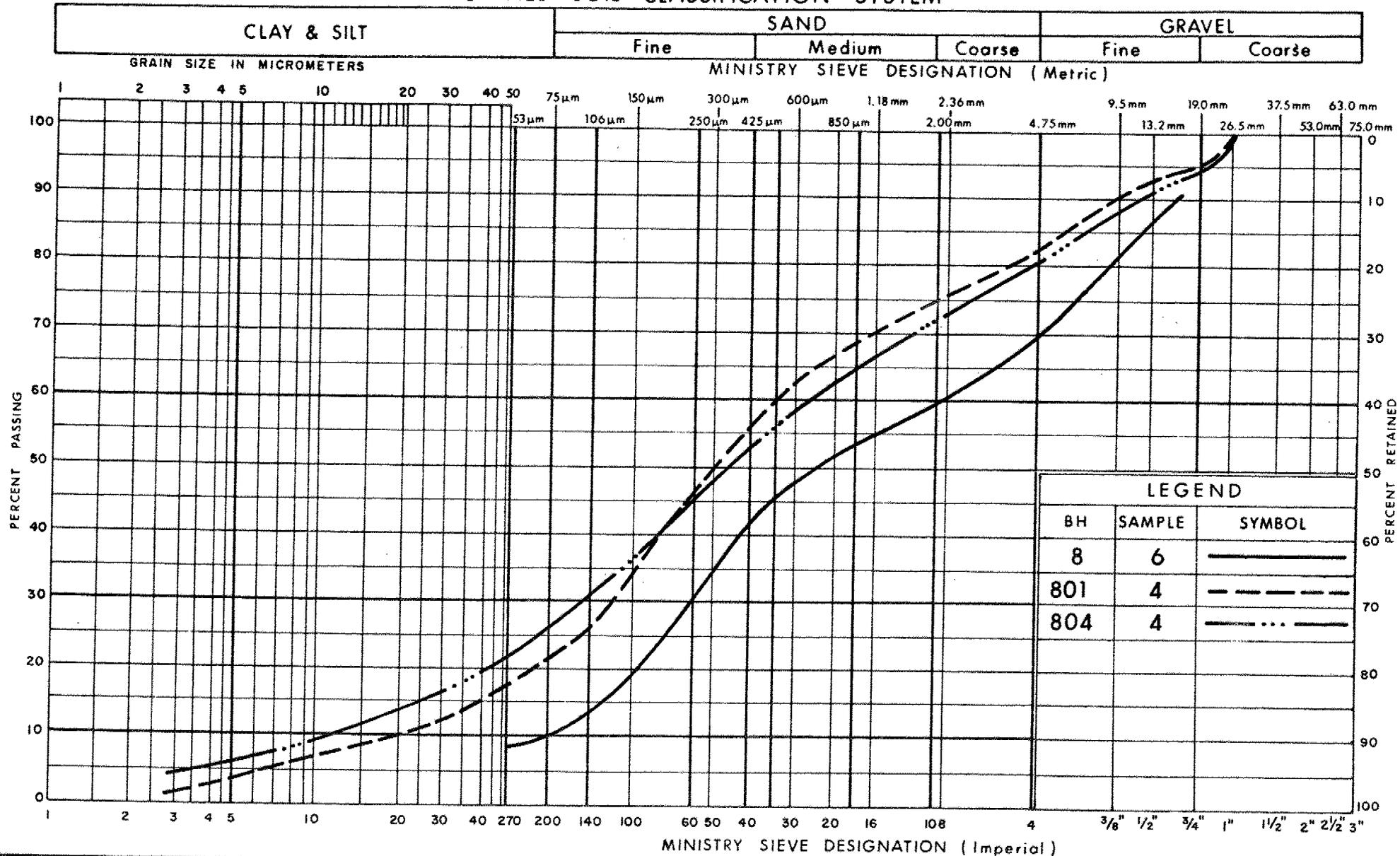
LEGEND		
BH	SAMPLE	SYMBOL
1	7	—————
9	3	- - - - -
13	2	- · - · -
13	9
808	2	- - - - -



GRAIN SIZE DISTRIBUTION ORGANIC SILT TO ORGANIC SILTY CLAY

FIG No 7
WP 122-79-02

UNIFIED SOIL CLASSIFICATION SYSTEM



Ministry of
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GRAIN SIZE DISTRIBUTION SAND, WITH SILT SOME GRAVEL

FIG No 8

W P 122-79-02

ENGINEERING MATERIALS OFFICE
PAVEMENT & FOUNDATION DESIGN SECTION

WP 18-79-00

DIST 17

HWY 637

STR SITE

Wanapitei River Crossing

DISTRIBUTION

S. McCombie (2)
B. MacKinnon
G. Ricker
J.M. Bernhardt (2)
E. Van Beilen
B.J. Giroux

R. Hore

L. Argo)
J. Anderson) Cover only
T.J. Kovich)

Files

FOUNDATION INVESTIGATION REPORT

For

Wanapitei River Crossing
W.P. 18-79-00, Highway 637
District 17, Sudbury

INTRODUCTION

This report contains the results of a preliminary foundation investigation of 2 alternative crossings of the Wanapitei River by Highway 637. The more southerly line referred to as Line 'R' crosses just north of the existing bailey bridge. Line 'B' crosses the Wanapitei River some 300 metres further upstream. Field work consisted of 4 sampled boreholes advanced with a track mounted auger machine during the period September 4th to 6th, 1980.

SITE DESCRIPTION

The site is located approximately 10 km west of Highway 69 where Highway 637 crosses the Wanapitei River. The surrounding area consists of rock ridges outcropping through the shallow till overburden.

In the area of the crossings the Wanapitei River is slow flowing, with a width of approximately 60 metres. The water level is controlled by a rock ridge located downstream of the present crossing. The flood plain east of the river is narrow and intermittent while to the west it forms a continuous strip of low swampy ground.

SUBSOIL AND RECOMMENDATIONS

Line 'B' West Approach

The proposed embankment grade at this location is 196.8 requiring a fill height of about 3 metres.

SUBSURFACE CONDITIONS

Subsoil consists of about 6 metres of stiff to firm organic silty clay which overlies granite bedrock. The organic silty clay has

an undrained shear strength, as measured by field vane, ranging from 25 to in excess of 50 kPa. A plot of plastic index versus liquid limit (Figure 1) indicates the material to be an organic soil of low to intermediate plasticity. Moisture content varies from 30 to 45 percent. Boundaries between soil strata as well as a summary of all field and laboratory tests performed are shown on Record of Borehole Sheet No. 4 in the Appendix.

Groundwater was encountered approximately 1 metre below the ground surface and corresponds to the river level.

RECOMMENDATIONS

Foundations

It is recommended that the abutment be supported on H-piles driven to bedrock at elevation 187. Loads equal to the structural capacity of the section chosen may be employed.

Approach Fill

The approach fill may be constructed with 2 horizontal to 1 vertical side slopes. The forward slope should be constructed at 2 horizontal to 1 vertical with a 2 metre wide berm at existing ground level as shown in Figure 2. Rip rap should extend into the river for a minimum of 12 metres to protect the forward slope from steepening due to scour. It is estimated that settlement of the subsoil under the embankment will not exceed 240 mm.

Line 'B' East Approach

The proposed embankment grade at this location is about 197.5 requiring a fill height of 3.5 to 4 metres.

SUBSURFACE CONDITIONS

Subsoil consists of 6 metres of stiff to firm organic silty clay overlying 2 metres of loose silty sand which in turn overlies granite bedrock. The undrained shear strength of the organic silty clay, as measured by field vane tests, ranges from 25 to 50 kPa. A plot of plastic index versus liquid limit (Figure 1) shows the layer to be organic and of low to intermediate plasticity. Moisture content

ranges from 22 to 40 percent. Boundaries between soil strata as well as a summary of all field and laboratory tests performed are on Record of Borehole Sheet No. 4 in the Appendix.

Groundwater was encountered at a depth of approximately 1 metre which corresponds with the prevailing river water level.

RECOMMENDATIONS

Foundations

The abutment should be supported on steel H-piles driven to bedrock at elevation 186. Loads equal to the structural capacity of the pile section chosen may be employed.

Approach Fill

The approach embankment may be constructed with 2 horizontal to 1 vertical side slopes. The forward slope should be constructed at 2 horizontal to 1 vertical with a 9 metre wide berm at the existing ground level as shown in Figure 3. A rip rap blanket should extend into the river for a minimum of 12 metres to prevent steepening of the forward slope by scour. Settlement of the subsoil underlying the embankment will not exceed 250 mm.

Line 'R' West Approach

The proposed grade in this area is about 197.1 requiring a fill height of about 2 metres.

SUBSURFACE CONDITIONS

Granite bedrock outcrops to form the western shore of the river in this area.

RECOMMENDATIONS

The west abutment would be founded on the bedrock with a design loading of up to 5 MPa. Requirements for benching or dowling of the rock would be assessed when the exact location of the abutment was determined. No stability problems exist in this area.

Line 'R' East Approach

The proposed profile grade at this abutment is about 198.7 requiring an approach fill of approximately 5.5 metres.

SUBSURFACE CONDITIONS

Subsoil consists of 7 to 8 metres of organic silty clay overlying 1 to 5 metres of loose to compact fine silty sand which in turn overlies granite bedrock. The organic silty clay has a stiff to firm consistency with an undrained shear strength, as measured by field vane, of from 25 to 50 kPa. A plot of liquid limit versus plastic index (Figure 1) shows this layer to be organic and of low to intermediate plasticity. Moisture content varies from 42 to 47 percent. Boundaries between soil types as well as a summary of all field and laboratory tests performed are shown on Record of Borehole Sheets 1 and 2 located in the Appendix.

Groundwater was encountered at a depth of approximately 1 metre which corresponded to the prevailing river level.

RECOMMENDATIONS

Foundations

The east abutment should be supported on steel H-piles driven to bedrock with design loads equal to the structural capacity of the section chosen. The rock surface varies from elevation 185.6 at ϕ to 180.7 some 11 metres to the north.

Approach Fill

The east approach fill may be constructed with 2 horizontal to 1 vertical side slopes. The forward slope should be 2 horizontal to 1 vertical with an 18 metre wide berm at approximately the existing ground level as shown in Figure 4. The relationship between fill height and berm length is shown in Figure 5 for this abutment (e.g. a grade reduction of 2 metres would reduce the required berm length to 9 metres.) Rip rap should extend for a minimum of 12 metres into the river to prevent scour steepening the forward slope. Settlement of the subsoil underlying the embankment will not exceed 250 mm.

Line 'R' East Channel

Granite bedrock is exposed in the area of this crossing. Any structure in this area would be founded on bedrock.

SUMMARY

Line 'B'

Subsoil on both approaches consists of approximately 6 metres of organic silty clay overlying bedrock. The structure abutments would be supported on steel H-piles driven to bedrock. To insure embankment stability in the forward direction a 2 metre wide berm on the west bank and a 9 metre wide berm on the east bank would be required.

Line 'R'

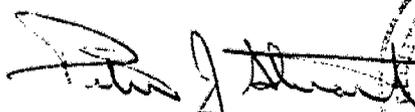
The west abutment will be located in an area of a bedrock outcrop. In the area of the east approach subsoil consists of 7 to 8 metres of organic silty clay overlying up to 5 metres of silty sand which in turn overlies bedrock.

The west abutment will be founded on spread footings on bedrock while the east abutment will be supported on steel H-piles to bedrock. No stability problems exist in the area of the west abutment but an 18 metre wide berm in the forward direction will be required to insure the east approach stability. Alternatively, a reduction of the grade in this area by 2 metres will allow the berm length to be reduced to 9 metres.

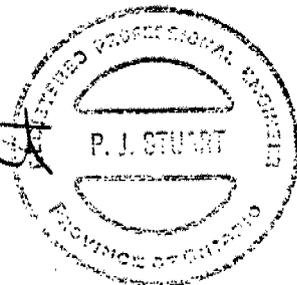
GENERAL

The stability of the approaches in the forward direction is dependent on the height of fill; the soil strength; as well as the depth of the river and the steepness of the underwater slopes. These slopes are generally steeper and therefore less favourable along the eastern shore.

The recommendations provided in this report are preliminary in nature and are intended for planning and estimating purposes only. Some modification of these recommendations could result from a more extensive final investigation.



P.J. Stuart, P. Eng.
Foundations Engineer



M. Devata, P. Eng.
Senior Foundations Engineer

APPENDIX

RECORD OF BOREHOLE No 1

W P 18-79-00 LOCATION Sta. 52+751.2 @ Line 'R' ORIGINATED BY R.B.
 DIST 17 HWY 637 BOREHOLE TYPE Auger, B Casing, BXL Core, Cone Test COMPILED BY R.B.
 DATUM Geodetic DATE 80/09/04 CHECKED BY P.J.S.

SOIL PROFILE			SAMPLES		GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			'N' VALUES	20	40						60
193.9	Ground Level														
0.0	Organic Silty Clay Stiff to Firm		1	SS	2										
			2	SS	2										
			3	SS	1/37										
			4	SS	1/46										
			5	SS	2										
			6	SS	1/37										
			7	SS	2										
186.7	Silty Fine Sand														
185.6	Compact														
8.3	Granite Bedrock		8	SS	19										
			9	BXL RC	REC 80%										
184.1	End of Borehole													RQD = 75%	

+3, x5: Numbers refer to Sensitivity



20
15 (°) STRAIN AT FAILURE
10

RECORD OF BOREHOLE No 3

W P 18-79-00 LOCATION Sta. 52+795.5 @ Line 'B' ORIGINATED BY R.B.
 DIST 17 HWY 637 BOREHOLE TYPE Hollow Stem Auger, BXL Core, Vane & Cone Test COMPILED BY R.B.
 DATUM Geodetic DATE 80/09/05 CHECKED BY _____

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ t/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			'N' VALUES	SHEAR STRENGTH kPa						
193.5	Ground Surface						20 40 60 80 100							
0.0	Organic Silty Clay Stiff to Firm		1	SS	5									
			2	SS	2									
			3	TW	PH								1.76	0 5 89 6 L _o = 1.186 F _c = 65 kPa C _c = 0.323
			4	SS	2									
			5	TW	PH								1.74	
187.3	Granite Bedrock		6	SS	45/	15 cm								
6.3			7	BXL RC	REC 90%								RQD = 60%	
185.6	End of Borehole													
7.9														

+3, x⁵: Numbers refer to Sensitivity

20
15
10

5 (% STRAIN AT FAILURE)

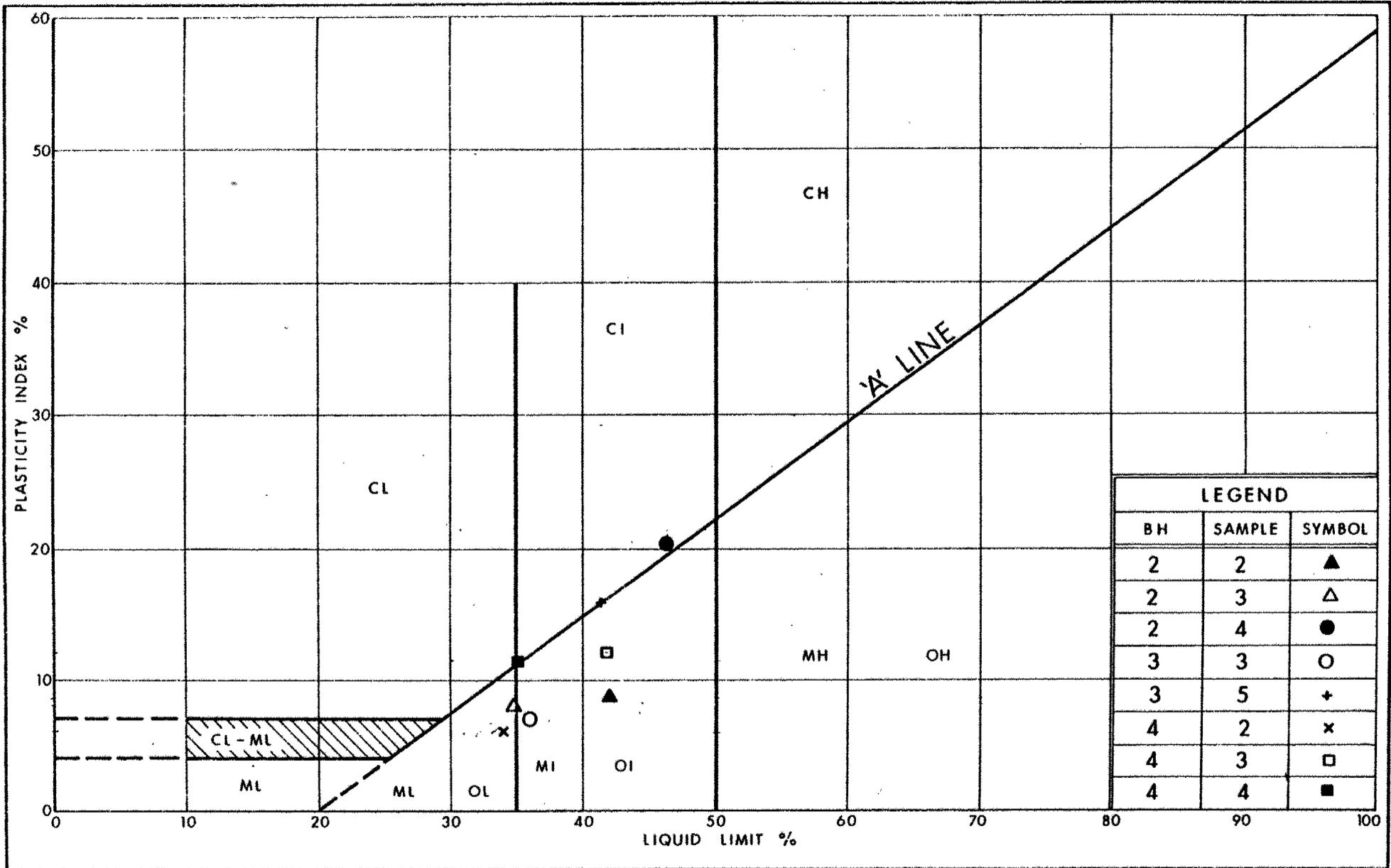
RECORD OF BOREHOLE No 4

W P 18-79-00 LOCATION Sta. 52+894.0 1.8 m Lt. Line 'B' ORIGINATED BY R.B.
 DIST 17 HWY 637 BOREHOLE TYPE Hollow Stem Auger, BXL Core, Vane & Cone Tests COMPILED BY R.B.
 DATUM Geodetic DATE 80/09/06 CHECKED BY P.J.S.

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			'N' VALUES	20	40	60	80						100	WATER CONTENT (%)	
193.7	Ground Level																		
0.0	Organic Silty Clay Stiff to Firm		1	SS	6														
			2	SS	3														
			3	TW	PH														
			4	SS	2														
			5	TW	PH														
187.7	Boulder		7	RC	REC 90%														
187.0	Silty Fine Sand Loose		8	SS	5														
185.8	Granite Bedrock		9	SS	41/13														
7.9			10	BXL RC	REC 80%														
184.2	End of Borehole																	RQD = 95%	
9.5																			

+3, x5: Numbers refer to Sensitivity

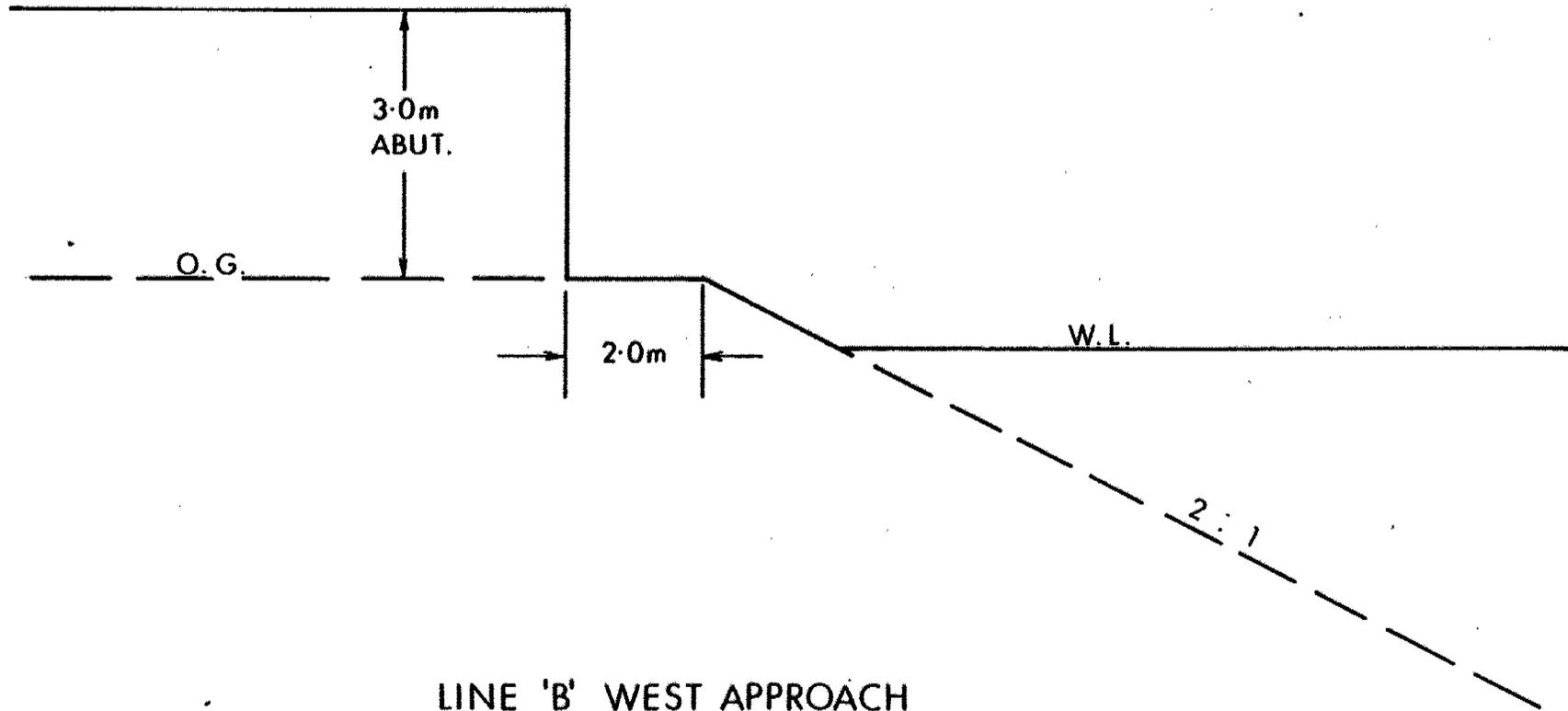
20
15 → 5 (%) STRAIN AT FAILURE
10



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PLASTICITY CHART
ORGANIC
SILTY CLAY

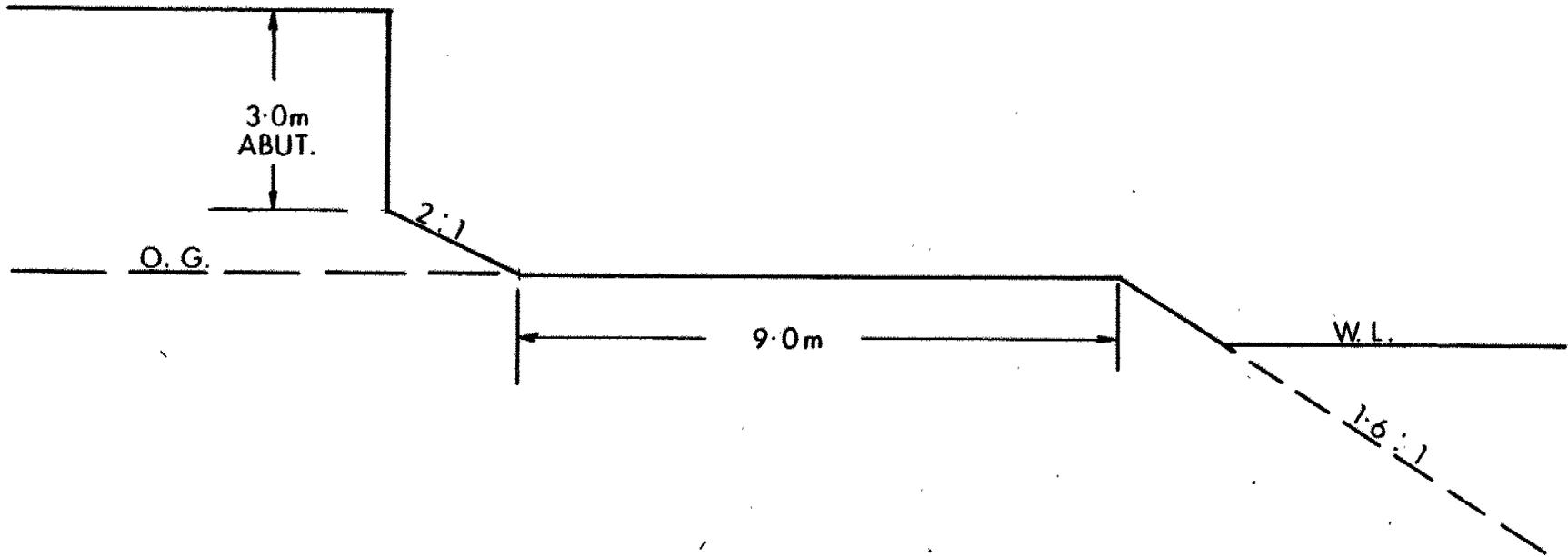
FIG No 1
W P 18-79-00



LINE 'B' WEST APPROACH

FIG. 2

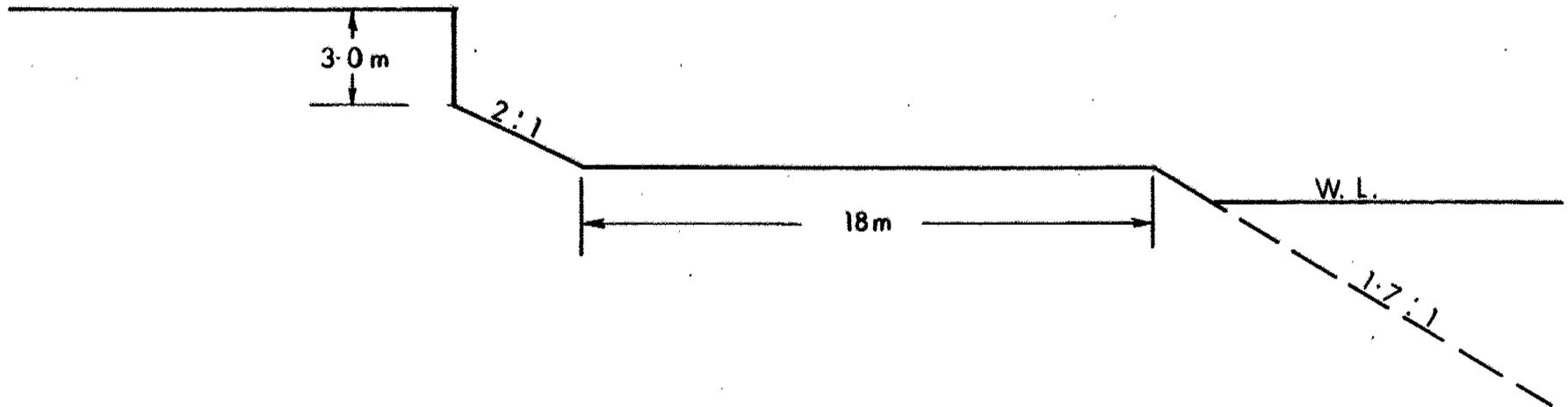
W. P. 18-79-00



LINE B EAST APPROACH

FIG. 3

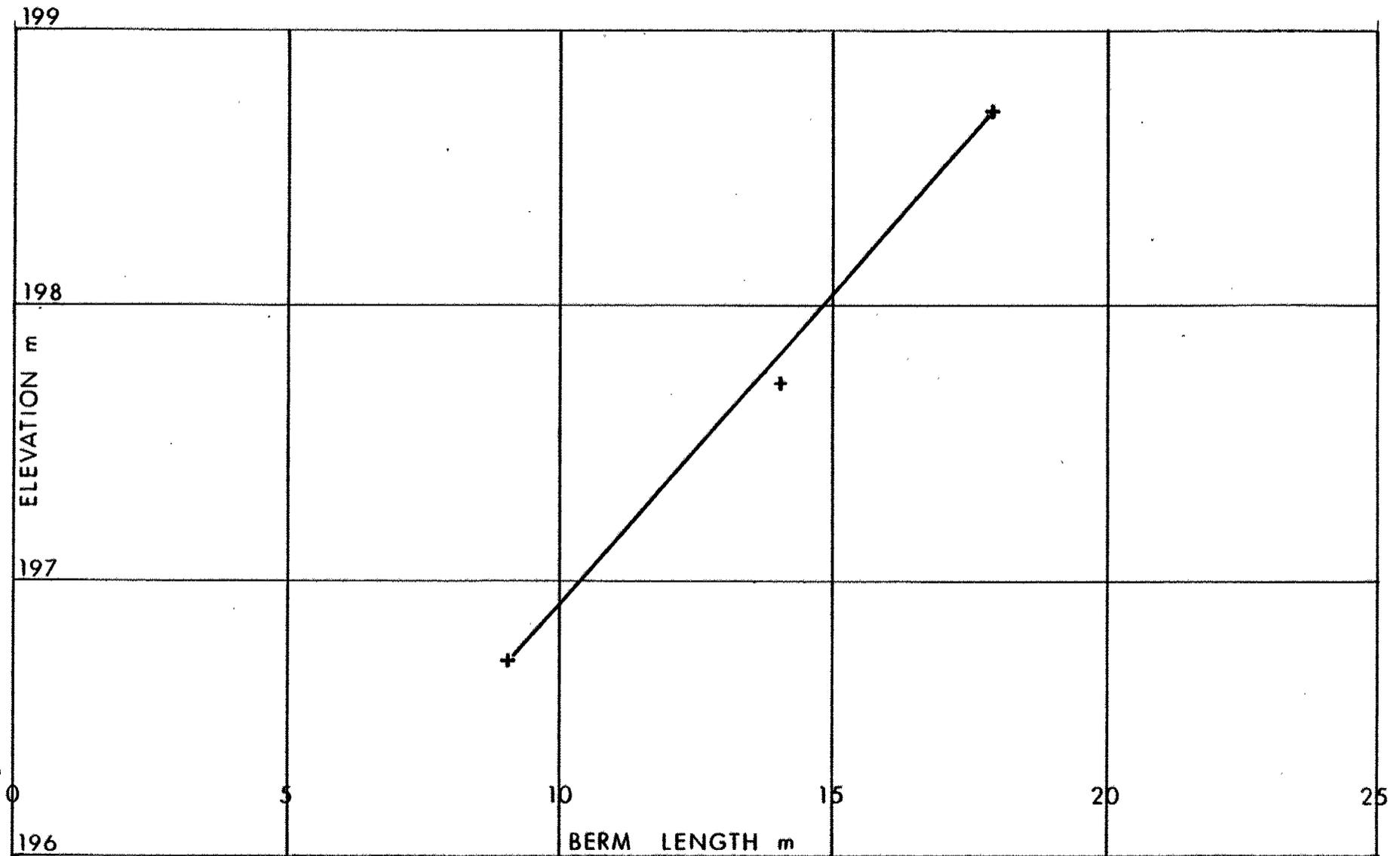
W.P. 18-79-00



LINE 'R' EAST APPROACH

FIG. 4

W. P. 18-79-00



GRADE vs BERM LENGTH EAST APPROACH LINE 'R'

FIG. 5

W.P. 18-79-00

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:

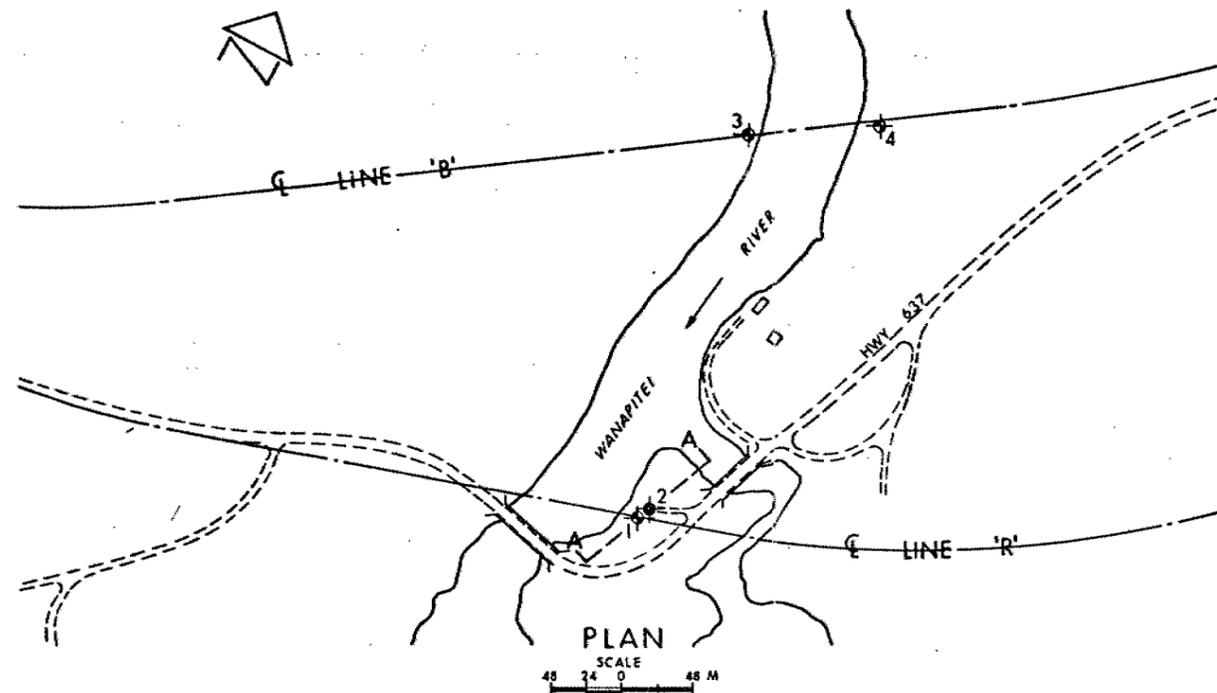
RQD (%)	0 - 25	25 - 50	50 - 75	75 - 90	90 - 100
	VERY POOR	POOR	FAIR	GOOD	EXCELLENT

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

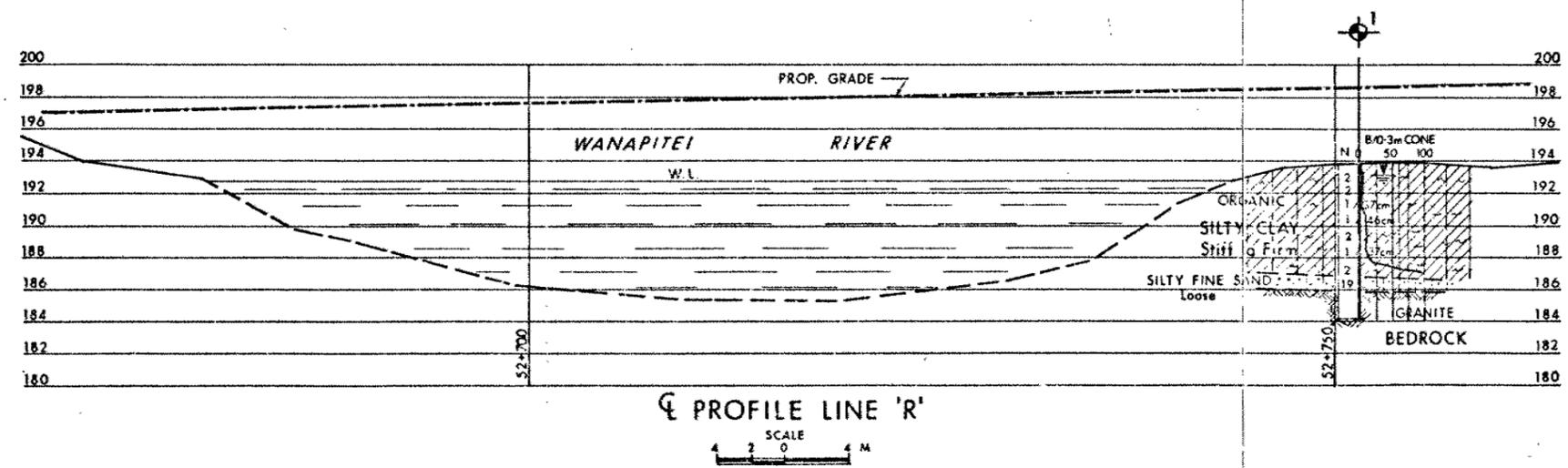
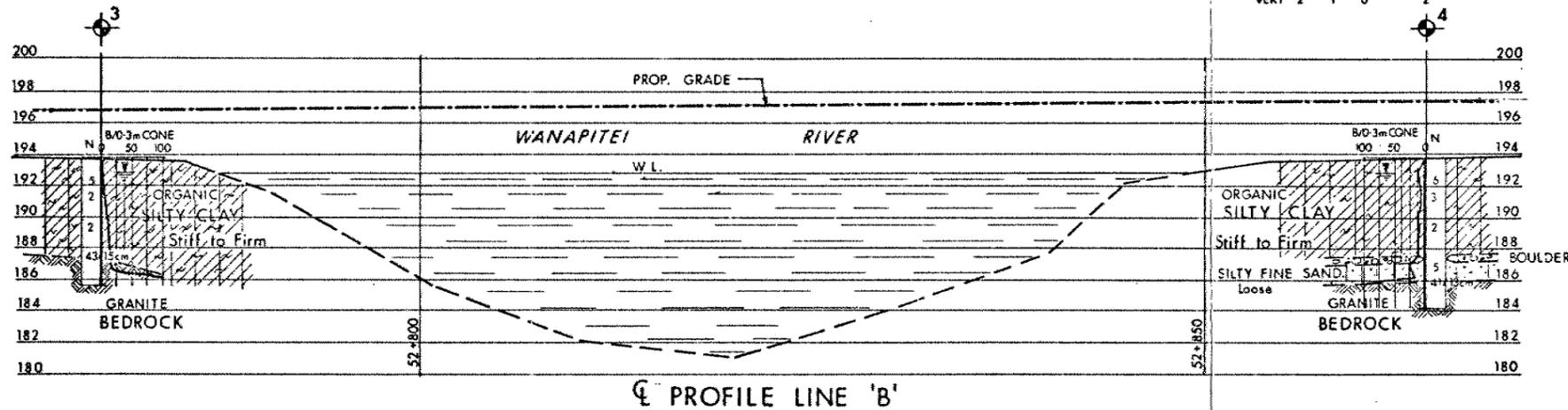
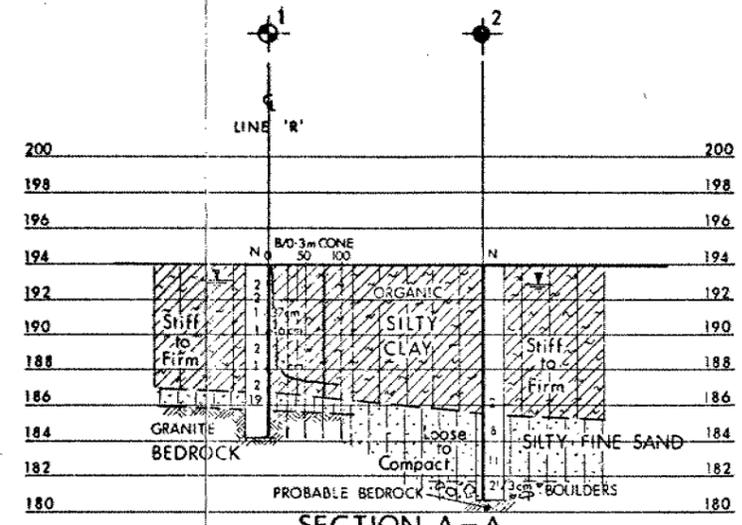
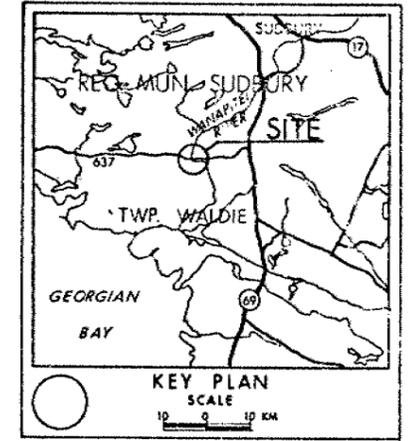
ABBREVIATIONS AND SYMBOLS

FIELD SAMPLING		MECHANICAL PROPERTIES OF SOIL	
S S	SPLIT SPOON	m_v	kPa^{-1} COEFFICIENT OF VOLUME CHANGE
W S	WASH SAMPLE	C_c	1 COMPRESSION INDEX
S T	SLOTTED TUBE SAMPLE	C_s	1 SWELLING INDEX
B S	BLOCK SAMPLE	C_α	1 RATE OF SECONDARY CONSOLIDATION
C S	CHUNK SAMPLE	c_v	m^2/s COEFFICIENT OF CONSOLIDATION
T W	THINWALL OPEN	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 = $\frac{c_u}{\tau_r}$
STRESS AND STRAIN		PHYSICAL PROPERTIES OF SOIL	
u_w	kPa PORE WATER PRESSURE	ρ_s	kg/m^3 DENSITY OF SOLID PARTICLES
r_u	1 PORE PRESSURE RATIO	γ_s	kN/m^3 UNIT WEIGHT OF SOLID PARTICLES
σ	kPa TOTAL NORMAL STRESS	ρ_w	kg/m^3 DENSITY OF WATER
σ'	kPa EFFECTIVE NORMAL STRESS	γ_w	kN/m^3 UNIT WEIGHT OF WATER
τ	kPa SHEAR STRESS	ρ	kg/m^3 DENSITY OF SOIL
$\sigma_1, \sigma_2, \sigma_3$	kPa PRINCIPAL STRESSES	γ	kN/m^3 UNIT WEIGHT OF SOIL
ϵ	% LINEAR STRAIN	ρ_d	kg/m^3 DENSITY OF DRY SOIL
$\epsilon_1, \epsilon_2, \epsilon_3$	% PRINCIPAL STRAINS	γ_d	kN/m^3 UNIT WEIGHT OF DRY SOIL
E	kPa MODULUS OF LINEAR DEFORMATION	ρ_{sat}	kg/m^3 DENSITY OF SATURATED SOIL
G	kPa MODULUS OF SHEAR DEFORMATION	γ_{sat}	kN/m^3 UNIT WEIGHT OF SATURATED SOIL
μ	1 COEFFICIENT OF FRICTION	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_{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^2 SEEPAGE FORCE



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

CONT No
WP No 18-79-00
WANAPITEI RIVER CROSSING
BORE HOLE LOCATIONS & SOIL STRATA
SHEET



LEGEND

- Bore Hole
- ⊕ Dynamic Cone Penetration Test (Cone)
- ⊙ Bore Hole & Cone
- N Blows/0.3m (Std Pen Test, 475 J/blow)
- CONE Blows/0.3m (60° Cone, 475 J/blow)
- W.L. at time of investigation 80 09 05

No	ELEVATION	STATION	OFFSET
1	193.9	52+751.2	LINE 'R'
2	193.8	52+753.4	9.0 LT. LINE 'R'
3	193.5	52+795.5	LINE 'B'
4	193.7	52+894.0	1.8 LT. LINE 'B'

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

REVISIONS	DATE	BY	DESCRIPTION

Geocres No 411-115

HWY No	637	DIST	17
SUBM'DP S	CHECKED	DATE	80 12 18
DRAWNOL J	CHECKED	APPROVED	SITE

DWG 187900-A

