

FOUNDATION INVESTIGATION REPORT

CONTRACT NO 91-29



Ministry of
Transportation

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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

2

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

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

SOILS ARE DESCRIBED BY THEIR COMPOSITION AND CONSISTENCY OR DENSENESS.

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

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

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

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

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

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

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

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

JOINTING AND BEDDING:

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

ABBREVIATIONS AND SYMBOLS

FIELD SAMPLING

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

STRESS AND STRAIN

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

MECHANICAL PROPERTIES OF SOIL

m_v	kPa ⁻¹	COEFFICIENT OF VOLUME CHANGE
C_c	1	COMPRESSION INDEX
C_s	1	SWELLING INDEX
C_α	1	RATE OF SECONDARY CONSOLIDATION
c_v	m ² /s	COEFFICIENT OF CONSOLIDATION
H	m	DRAINAGE PATH
T_v	1	TIME FACTOR
U	%	DEGREE OF CONSOLIDATION
σ'_{vo}	kPa	EFFECTIVE OVERBURDEN PRESSURE
σ'_p	kPa	PRECONSOLIDATION PRESSURE
τ_f	kPa	SHEAR STRENGTH
c'	kPa	EFFECTIVE COHESION INTERCEPT
ϕ'	-°	EFFECTIVE ANGLE OF INTERNAL FRICTION
c_u	kPa	APPARENT COHESION INTERCEPT
ϕ_u	-°	APPARENT ANGLE OF INTERNAL FRICTION
τ_R	kPa	RESIDUAL SHEAR STRENGTH
τ_r	kPa	REMOULDED SHEAR STRENGTH
S_f	1	SENSITIVITY = $\frac{c_u}{\tau_r}$

PHYSICAL PROPERTIES OF SOIL

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

FOUNDATION INVESTIGATION REPORT

For

Dorchester Swamp - Hwy. 401

Sta. 14+300 To Sta. 14+850

W.P. 477-89-01

District 2, London

INTRODUCTION

This report contains the results of a soil investigation carried out at the above mentioned site to provide information for the pre-loading of the Dorchester Swampy area adjacent to Hwy. 401.

The field work for this project was carried out between 90 07 26 and 90 07 31, and comprised of eight sampled boreholes and Dynamic Cone Penetration Test adjacent to these boreholes.

Boreholes were advanced to a maximum depth of 12.6 m (El. 250.2 m) below the existing ground level using a continuous flight hollow stem auger. However, Dynamic Cone Penetration test was taken to a maximum depth of 14.9 m (El. 247.0 m) below ground level.

SITE DESCRIPTION

The site under investigation is located about 500 m east of Hwy. 401 and Dorchester Road in the Township of Dorchester.

The topography of the site is flat to gently undulating. This section of the highway crosses a swamp which is bordered by farm land. Physiographically the area is located in the region known as the "Caradoc Sand Plains".

SUBSURFACE CONDITIONS

The underlying subsoil at this site, with the exception of the existing embankment fill consists of peat underlain by marl which overlies sand. For classification purposes, the soils encountered at this site can be divided into four different zones.

- a) Embankment Fill
- b) Peat
- c) High Plastic Silt to Clayey Silt (Marl)
- d) Sand, trace Silt, trace Gravel

The soils encountered during the course of the investigation, together with the field and laboratory test results are shown on the Record of Borehole Sheets contained in the Appendix of this report. Three stratigraphical Sections are shown on Drawing No. 4778901-A. This drawing also shows the locations and elevations of the borings. In addition, information provided by the Geotechnical Section of the Southwestern Region is also included in this report. A summary plot of the soil properties are shown on Figure 9. Description of the strata encountered are given below.

Embankment Fill

This fill which was placed to raise the grade level consists layers of clayey silt and sand with varying proportions of silt and gravel sized particles. The thickness of the fill was observed to be about 10.5 m and extends to El. 252.6 m. The Standard Penetration Test results were observed to vary between 3 blows/30 cm and 19 blows/30 cm with an average value of 10 blows/30 cm.

The embankment fill is underlain by 1.1 m to 1.5 m of firm high plastic silt to clayey silt (marl) with occasional organic layers.

Peat

The borings in the swampy area indicate 1.4 m to 3.4 m of very soft to soft peat. This organic layer extends to about El. 261 to 257.9 m. The organic content of this peat layer varies over a wide range (18.5% to 85%). The natural moisture content was observed to vary from 68% to 441%. However, the low moisture content was indicated by the samples obtained above ground water level from boreholes located north of Hwy. 401. Vane Shear tests carried out in this organic layer indicate shear strength in the range of 10 kPa to 14 kPa.

High Plastic Silt to Clayey Silt (Marl)

This deposit was encountered immediately below the peat layer. The thickness of this deposit varies from 3.8 m to 7.2 m and extends to El. 256.0 m to 251.3 m. The results of the Atterberg Limit test are shown on Figure 1 & Figure 2. The natural moisture content was observed to vary from 68% to 245% in the area where high plastic silt and occasional organic layers were encountered. However, samples obtained from clayey silt stratum indicated moisture content in the range of 29.5% to 69%. The bulk unit weight was observed to vary widely (11.2 kN/m^3 to 19.3 kN/m^3) depending on the type of material. The in situ Vane Shear test carried out in this marl indicate shear strength varying from 6 kPa to 29 kPa. As indicated before higher unit weight and shear strength values were observed in the area where clayey silt was encountered.

Sand, trace Silt, trace Gravel

This sandy deposit was encountered in all the boreholes immediately below the marl layer. The Grain Size Distribution test was carried out on one representative sample and the results are shown on Figure 3. The Standard Penetration Test values vary from 1 blow/30 cm to 8 blows/30 cm indicating very loose to loose state of compaction. Considering the nature of the investigation and the hydrostatic condition observed, boreholes were terminated in this deposit, and the full extent of this deposit was not proven.

Groundwater Conditions

The groundwater was encountered in all the boreholes, and was observed at or near the ground level in the boreholes located south of Hwy. 401, whereas, in boreholes located north of Hwy. 401, it was observed about 1.6 m to 2.0 m below the existing ground level. The groundwater level at each borehole location is as follows:

<u>Borehole No.</u>	<u>Elevation (m)</u>
1	262.3
2	261.7
3	261.0
6	259.5
7	259.5
8	259.2

Sub-artesian condition was observed in boreholes located on Hwy. 401 shoulders. The groundwater in these two boreholes was first encountered around El. 251.5 m and at the end of drilling ($\frac{1}{2}$ hr. to 1 hr.) it rose up to about El. 259.8 to 259.3 m.

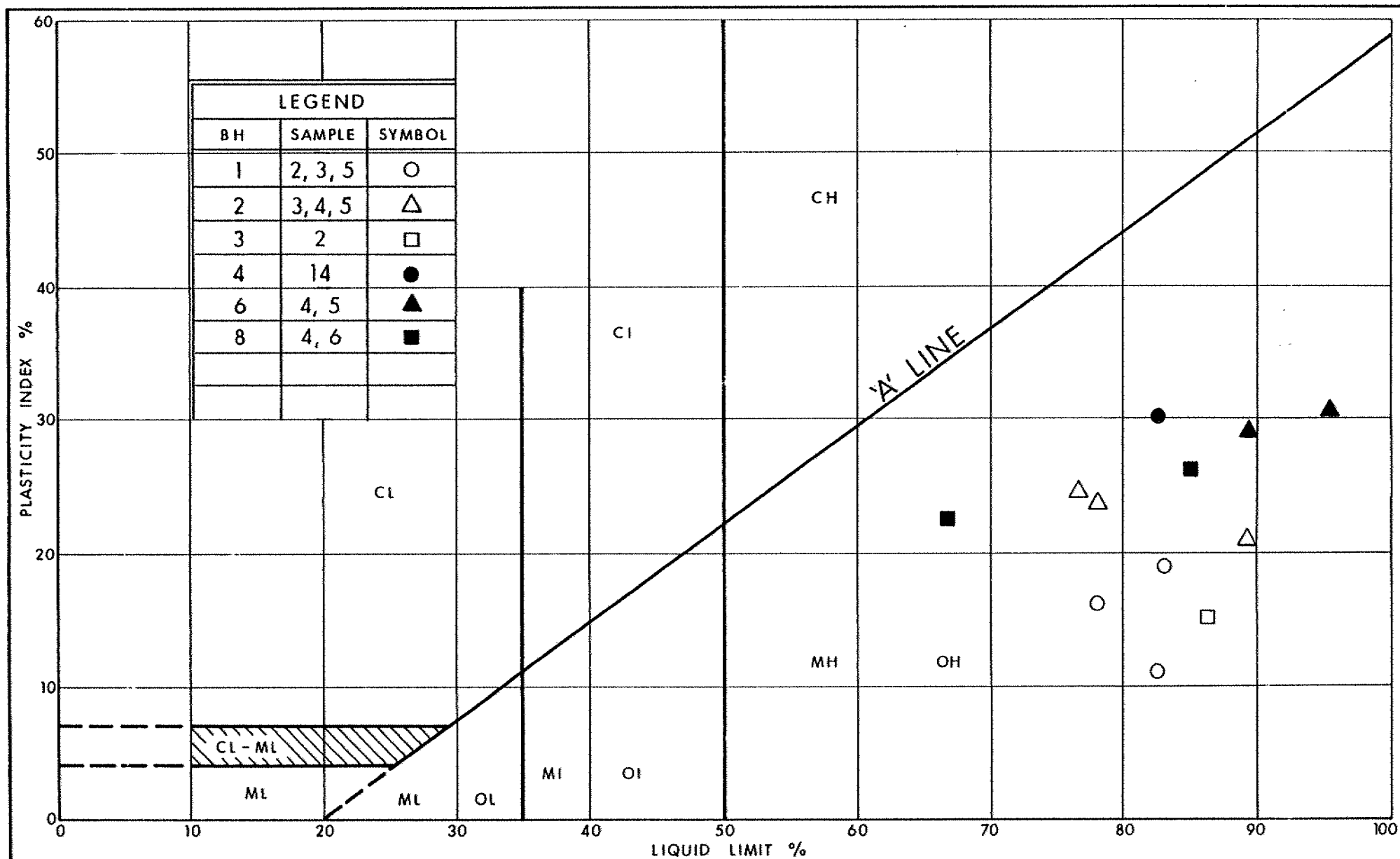
MISCELLANEOUS

The field work for this investigation was carried out under the supervision of Mr. M. Vasavithasan, Foundation Engineer, and Mr. J. LeMessurier, Student Engineer. The equipment used was owned and operated by Master Soil Investigation Ltd. This report was prepared by Mr. M. Vasavithasan, reviewed by Mr. P. Payer, Senior Foundation Engineer, and approved by Mr. M.S. Devata, Chief Foundation Engineer.



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 Foundation Engineer

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 Chief Foundation Engineer



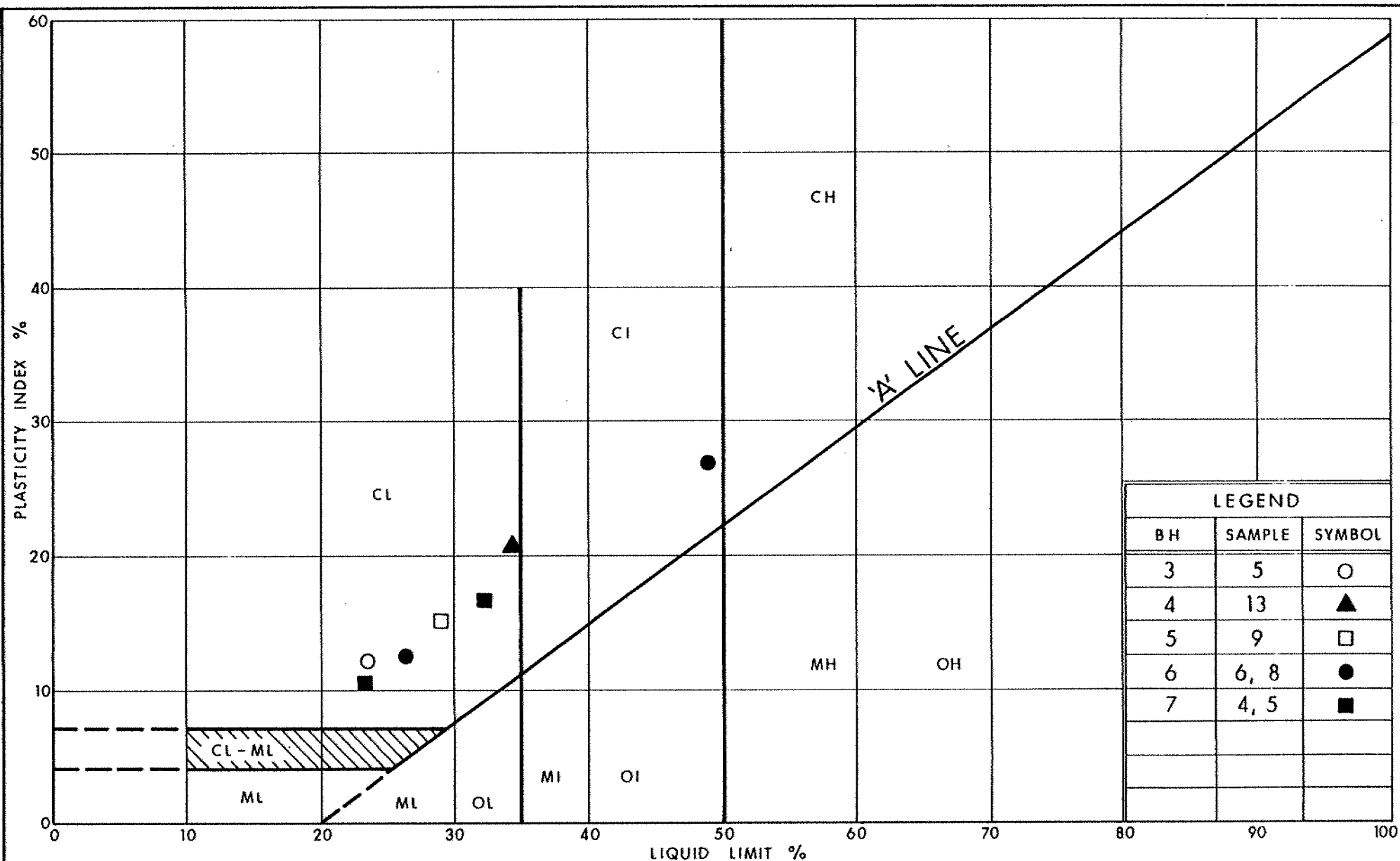
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PLASTICITY CHART HIGH PLASTIC SILTS (MARL)

FIG No 1

W P 477-89-01



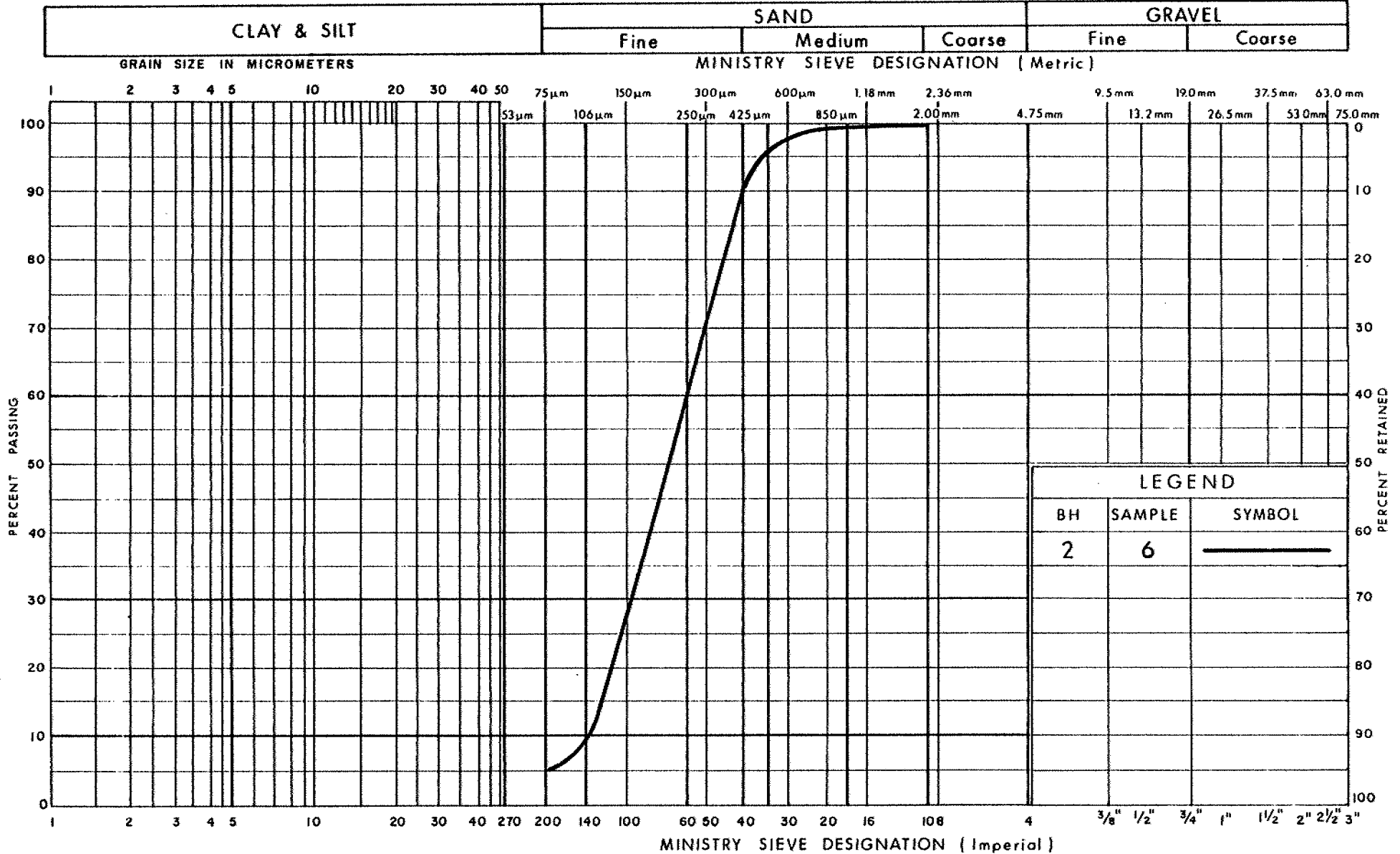
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PLASTICITY CHART CLAYEY SILT

FIG No 2

W P 477-89-01

UNIFIED SOIL CLASSIFICATION SYSTEM



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GRAIN SIZE DISTRIBUTION
SAND, TRACE OF SILT

FIG No 3

W P 477 - 89 - 01

RECORD OF BOREHOLE No 1

1 OF 1

METRIC 10

W.P. 477 - 89 - 01 LOCATION CO - ORDS. N 4 758 529.5; E 422 845.5 ORIGINATED BY M V&J L
 DIST 2 HWY 401 BOREHOLE TYPE CONE TEST & CONTINUOUS FLIGHT AUGER (H.S) COMPILED BY M V
 DATUM GEODETIC DATE 90 07 25 CHECKED BY P P

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	'N' VALUES			20 40 60 80 100	20 40 60 80 100	w _p	w	w _L		
262.4	Ground Surface													
0.0	Peat, Very Soft to Soft		1	SS	1	/46cm	262							ORG. = 25.5%
261.0							261							
1.4			2	TW	PM		260						11.2	
	Occasional Layers of Peat		3	SS	1	/46cm	259							
			4	SS	1	/46cm	258							
							257							
	High Plastic Silt With Decayed Shell Fragments, Very Soft to Soft (Marl)		5	TW	PM		256						13.3	
			6	SS	1	/46cm	255							
254.4							254							
8.0	Sand, Trace of Silt, Trace of Gravel, Very Loose to Loose		7	SS	1		253							
252.2														
10.2	End of Borehole Note: STA. 14 + 400: O/S 32.9m RT. CL. HWY. 401													

RECORD OF BOREHOLE No 2

1 OF 1

METRIC 11

W.P. 477 - 89 - 01 LOCATION CO - ORDS. N 4 758 555.5; E 422 942.2 ORIGINATED BY M V&J L
DIST 2 HWY 401 BOREHOLE TYPE CONE TEST & CONTINUOUS FLIGHT AUGER (H.S) COMPILED BY M V
DATUM GEODETIC DATE 90 07 27 CHECKED BY P P

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100	W _P	W	W _L			
								SHEAR STRENGTH kPo ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE		WATER CONTENT (%) 50 100 150				
261.9	Ground Surface													
0.0	Peat, Very Soft		1	SS	1		261					w=230		ORG. = 23%
260.3							260							
1.6	Layers of High Plastic Silt With Decayed Shell Fragments (Mori), and Peat, Very Soft		2	SS	1	/46cm	259							
			3	TW	PM		258						13.3	
			4	SS	1	/46cm	257							
256.0			5	TW	PM		256						12.4	ORG. = 28%
5.9	Sand, Trace of Silt, Trace of Gravel, Very Loose		6	SS	2									0 95 (5)
255.3														
6.6	End of Borehole													
	Probable Sand, Trace of Silt, Trace of Gravel, Very Loose to Loose													
	Note: STA. 14 + 500: O/S 30.2m RT. CL HWY. 401													
247.0														
14.9	End of Cone Test													

RECORD OF BOREHOLE No 3

1 OF 1

METRIC

12

W.P. 477 - 89 - 01 LOCATION CO - ORDS. N 4 758 577.5; E 423 040.0 ORIGINATED BY M V&J L
 DIST 2 HWY 401 BOREHOLE TYPE CONE TEST & CONTINUOUS FLIGHT AUGER (H.S) COMPILED BY M V
 DATUM GEODETTIC DATE 90 07 27 CHECKED BY P P

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				UNIT WEIGHT 7 kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100	20 40 60 80 100	20 40 60 80 100	20 40 60 80 100		
261.2	Ground Surface												
0.0	Peat, Very Soft		1	SS	1	/46cm	261						
259.8							260						
1.4							259						
	Layers of High Plastic Silt With Decayed Shell Fragments (Marl), and Peat, Very Soft		2	TW	PM		258					12.3	ORG. = 57%
			3	SS	1	/46cm	257						
			4	SS	1		256						
255.1	Clayey Silt With Occasional Decayed Shell Fragments		5	TW	PM		255					19.3	
6.1	Sand, Trace of Silt, Trace of Gravel, Loose		6	SS	8		254						
253.6													
7.8	End of Borehole												
	Probable Sand, Trace of Silt, Trace of Gravel, Loose to Compact												
250.5													
10.7	End of Cone Test												
	Note: STA. 14 + 600; O/S 29.9m RT. CL. HWY. 401												

RECORD OF BOREHOLE No 4 1 OF 1 METRIC 13

W.P. 477 - 89 - 01 LOCATION CO - ORDS. N 4 758 547.0; E 422 841.5 ORIGINATED BY M V&J L
 DIST 2 HWY 401 BOREHOLE TYPE CONE TEST & CONTINUOUS FLIGHT AUGER (H.S) COMPILED BY M V
 DATUM GEODETIC DATE 90 07 27 CHECKED BY P P

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	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100	20 40 60 80 100					
263.3	Hwy. 401 Shoulder													
0.0	Sand And Gravel, Some Silt, Loose (Fill)		1	SS	6		263							
262.2			2	SS	6		262							
1.1			3	SS	19		261							
			4	SS	12		260							
			5	SS	12		259							
			6	SS	10		258							
	Clayey Silt, Some Sand, Some Gravel, Firm to Stiff (Fill)		7	SS	9		257							
			8	SS	8		256							
			9	SS	9		255							
			10	SS	11		254							
			11	SS	10		253							
			12	SS	13		252							
252.8			13	SS	8		251							
10.5 252.4	Peat, Soft		14	SS	7									
10.9	High Plastic Silt With Occasional Decayed Shell Fragments, Firm (Mori)													
251.3														
12.0	Sand, Trace of Silt, Trace of Gravel, Loose		15	SS	7									
250.7														
12.6	End of Borehole Note: STA. 14 + 400; O/S 15.1m RT. CL. HWY. 401													

RECORD OF BOREHOLE No 5

1 OF 1

METRIC 14

W.P. 477 - 89 - 01 LOCATION CO - ORDS. N 4 758 575.5; E 422 834.5 ORIGINATED BY M V&J L
DIST 2 HWY 401 BOREHOLE TYPE CONE TEST & CONTINUOUS FLIGHT AUGER (H.S) COMPILED BY M V
DATUM GEODETIC DATE 90 07 31 CHECKED BY P P

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	20 40 60 80 100					
263.1	Hwy. 401 Shoulder													
0.0	Sand And Gravel, Some Silt, Loose (Fill)													
261.3			1	SS	3									
1.8			2	SS	11									
	Cloyey Silt, Some Sand, Some Gravel, Firm to Stiff (Fill)		3	SS	14									
			4	SS	7									
256.3			5	SS	9									
6.8			6	SS	14									
	Silt With Sand, Trace of Gravel, Trace of Clay, Loose to Compact (Fill)		7	SS	10									
			8	SS	6									
252.6			9	SS	7									
10.5	Cloyey Silt With Occasional Shell Fragments Firm		10	SS	5									
251.5			11	SS	3									
11.6	Sand, Trace of Silt, Trace of Clay, Very Loose to Loose													
250.5														
12.6	End of Borehole Note: STA. 14 + 400; O/S 14.5m L.T. CL. HWY. 401													

RECORD OF BOREHOLE No 6

1 OF 1

METRIC 15

W.P. 477 - 89 - 01 LOCATION CO - ORDS. N 4 758 589.0; E 422 831.5 ORIGINATED BY M V&J L
DIST 2 HWY 401 BOREHOLE TYPE CONE TEST & CONTINUOUS FLIGHT AUGER (H.S) COMPILED BY M V
DATUM GEODETIC DATE 90 07 31 CHECKED BY P P

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	20 40 60 80 100					
261.3	Ground Surface													
0.0							261							
	Peat With Occasional Partially Decomposed Timber, Very Soft		1	SS	1	/46cm	260						w=211	ORG. = 52%
			2	SS	3		259						w=441	ORG. = 79%
258.4			3	SS	1		258							
2.9			4	TW	PM		257						13.1	
	High Plastic Silt With Decayed Shell Fragments, Occasional Layers of Peat, Very Soft to Soft		5	SS	1	/46cm	256						w=245	
			6	TW	PM		255						16.4	
	Silty Clay to Clayey Silt With Decayed Shell Fragments (Marl)		7	SS	1	/46cm	254							
			8	SS	1	/46cm	253							
251.3							252							
10.1	Sand, Trace of Silt, Trace of Gravel, Very Loose to Loose		9	SS	2		251							
250.2														
11.1	End of Borehole Probable Sand, Trace of Silt, Trace of Gravel, Loose													
249.1														
12.2	End of Cone Test Note: STA. 14 + 400: O/S 27.9m LT. CL. HWY. 401													

RECORD OF BOREHOLE No 7

1 OF 1

METRIC 16

W.P. 477 - 89 - 01 LOCATION CO - ORDS. N 4 758 612.5; E 422 929.0 ORIGINATED BY M V&J L
DIST 2 HWY 401 BOREHOLE TYPE CONE TEST & CONTINUOUS FLIGHT AUGER (H.S) COMPILED BY M V
DATUM GEODETIC DATE 90 07 31 CHECKED BY P P

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT 7 KN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100	20 40 60 80 100	20 40 60 80 100	20 40 60 80 100	20 40 60 80 100		
261.2	Ground Surface													
0.0														
	Peat, Very Soft		1	SS	1									ORG. = 23.5%
			2	SS	1									ORG. = 41%
258.0														
3.2			3	SS	1	/46cm								
	Clayey Silt With Decayed Shell Fragments (Mori). Occasional Layers of Peat, Very Soft to Soft		4	TW	PM								18.3	
			5	SS	1	/46cm								
254.2														
253.9	Sand, Trace of Silt & Gravel		6	SS	2									
7.3	End of Borehole Probable Sand, Trace of Silt, Trace of Gravel, Very Loose to Loose													
252.1														
9.1	End of Cone Test Note: STA. 14 + 500; O/S 28.6m LT. CL. HWY. 401													

RECORD OF BOREHOLE No 8

1 OF 1

METRIC 17

W.P. 477 - 89 - 01 LOCATION CO - ORDS. N 4 758 631.5; E 423 027.0 ORIGINATED BY M V&J L
DIST 2 HWY 401 BOREHOLE TYPE CONE TEST & CONTINUOUS FLIGHT AUGER (H.S) COMPILED BY M V
DATUM GEODETTIC DATE 90 07 31 CHECKED BY P P

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT 7 kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100	20 40 60 80 100	20 40 60 80 100	20 40 60 80 100	20 40 60 80 100		
261.3	Ground Surface													
0.0	Peat, Very Soft		1	SS	1		261							ORG. = 18.5%
			2	TW	PM		260							
			3	SS	1		259							
257.9	High Plastic Silt With Decayed Shell Fragments Very Soft to Soft (Marl)		4	TW	PM	/46cm	258						10.4	ORG. = 85%
			5	SS	1		257							
			6	SS	1		256							
			7	SS	4		255							
253.9	Sand, Trace of Silt, Trace of Gravel, Loose						254							ORG. = 28.5%
7.4														
253.2	End of Borehole Probable Sand, Trace of Silt, Trace of Gravel, Loose													
8.1	End of Cone Test													
252.2	Note: STA. 14 + 600; O/S 25.0m LT. CL. HWY. 401													

RECORD OF BOREHOLE No P1 1 OF 1 METRIC 18

W.P. 477 - 89 - 01 LOCATION CO - ORDS. N 4 758 519.0; E 422 797.5 ORIGINATED BY
DIST 2 HWY 401 BOREHOLE TYPE HAND AUGER COMPILED BY M V
DATUM GEODETIC DATE 89 06 TO 90 04 CHECKED BY P P

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	STRAT PLOT	NUMBER	TYPE	'N' VALUES			SHEAR STRENGTH kPa									
262.0	Ground Surface						20	40	60	80	100						
0.0	Peat					*											
261.0																	
1.0	High Plastic Silt With Decayed Shell Fragments (Marl) and Occasional Layers of Peat																
259.0																	
3.0 258.6	Silty Clay																
3.4	End of Borehole * Note: Water Level Not Established																

RECORD OF BOREHOLE No P2 1 OF 1 METRIC 19

W.P. 477 - 89 - 01 LOCATION CO - ORDS. N 4 758 599.0; E 423 137.0 ORIGINATED BY
 DIST 2 HWY 401 BOREHOLE TYPE HAND AUGER COMPILED BY M V
 DATUM GEODETIC DATE 89 06 TO 90 04 CHECKED BY P P

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					
260.9	Ground Surface																
0.0	Peat					*											
259.8							260										
1.1							259										
	High Plastic Silt With Decayed Shell Fragments (Marl) and Occasional Layers of Peat						258										
							257										
255.8							256										
5.1	Sand, Trace of Silt, Trace of Gravel						255										
254.9																	
6.0	End of Borehole • Note: Water Level Not Established																

RECORD OF BOREHOLE No P3

1 OF 1

METRIC 20

W.P. 477 - 89 - 01 LOCATION CO - ORDS. N 4 758 622.0; E 423 234.5 ORIGINATED BY
DIST 2 HWY 401 BOREHOLE TYPE HAND AUGER COMPILED BY M.V.
DATUM GEODETIC DATE 89 06 TO 90 04 CHECKED BY P.P.

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 7 kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
260.9	Ground Surface																
0.0	Peat					*											
259.9							260										
1.0	High Plastic Silt With Decayed Shell Fragments (Marl) and Occasional Layers of Peat																
258.9							259										
2.0	Sand, Trace of Silt, Trace of Gravel																
258.4																	
2.5	End of Borehole																
	* Note: Water Level Not Established																

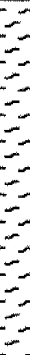


RECORD OF BOREHOLE No P4 1 OF 1 METRIC 21

W.P. 477 - 89 - 01 LOCATION CO - ORDS. N 4 758 575.0; E 422 761.0 ORIGINATED BY
DIST 2 HWY 401 BOREHOLE TYPE HAND AUGER COMPILED BY M.V.
DATUM GEODETIC DATE 89 06 TO 90 04 CHECKED BY P.P.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT 7 kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100	W _p	W	W _L		
262.0	Ground Surface																
0.0	Peat					*											
260.8																	
1.2																	
	Silty Clay to Clayey Silt With Decayed Shell Fragments (Marl)																
257.5																	
4.5	End of Borehole																
	* Note: Water Level Not Established																

RECORD OF BOREHOLE No P5 1 OF 1 METRIC 22

W.P. 477 - 89 - 01 LOCATION CO - ORDS. N 4 758 580.0; E 422 782.5 ORIGINATED BY
DIST 2 HWY 401 BOREHOLE TYPE HAND AUGER COMPILED BY M.V.
DATUM GEODETIC DATE 89 06 TO 90 04 CHECKED BY P.P.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100									
								SHEAR STRENGTH kPa									
								WATER CONTENT (%)									
262.0																	
0.0	Peat					*	261										
							260										
							259										
258.4																	
3.6	High Plastic Silt (Marl)						258										
							257										
256.3																	
5.7	Silty Clay to Clayey Silt With Decayed Shell Fragments (Marl)						256										
255.6																	
6.4	End of Borehole																
	* Note: Water Level Not Established																

RECORD OF BOREHOLE No P6

1 OF 1

METRIC 23

W.P. 477 - 89 - 01 LOCATION CO - ORDS. N 4 758 661.0; E 423 122.5 ORIGINATED BY
DIST 2 HWY 401 BOREHOLE TYPE HAND AUGER COMPILED BY M V
DATUM GEODETIC DATE 89 06 TO 90 04 CHECKED BY P P

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT 7 KN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100	20 40 60 80 100	20 40 60 80 100	50 100 150	50 100 150	50 100 150				
261.0	Ground Surface					*											
0.0																	
	Peat																
257.9																	
3.1	High Plastic Silt With Decayed Shell Fragments (Marl)																
257.0																	
4.0	Sand, Trace of Silt, Trace of Gravel																
255.4																	
5.6	End of Borehole																
	* Note: Water Level Not Established																

ENGINEERING MATERIALS OFFICE
FOUNDATION DESIGN SECTION

WP 477-89-01 DIST 2
HWY 401 STR SITE

Dorchester Swamp - Hwy. 401
Sta. 14+300 to Sta. 14+850

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FOUNDATION INVESTIGATION REPORT

For

Dorchester Swamp - Hwy. 401

Sta. 14+300 To Sta. 14+850

W.P. 477-89-01

District 2, London

INTRODUCTION

This report contains the results of a soil investigation carried out at the above mentioned site to provide information for the pre-loading of the Dorchester Swampy area adjacent to Hwy. 401.

The field work for this project was carried out between 90 07 26 and 90 07 31, and comprised of eight sampled boreholes and Dynamic Cone Penetration Test adjacent to these boreholes.

Boreholes were advanced to a maximum depth of 12.6 m (El. 250.2 m) below the existing ground level using a continuous flight hollow stem auger. However, Dynamic Cone Penetration test was taken to a maximum depth of 14.9 m (El. 247.0 m) below ground level.

SITE DESCRIPTION

The site under investigation is located about 500 m east of Hwy. 401 and Dorchester Road in the Township of Dorchester.

The topography of the site is flat to gently undulating. This section of the highway crosses a swamp which is bordered by farm land. Physiographically the area is located in the region known as the "Caradoc Sand Plains".

SUBSURFACE CONDITIONS

The underlying subsoil at this site, with the exception of the existing embankment fill consists of peat underlain by marl which overlies sand. For classification purposes, the soils encountered at this site can be divided into four different zones.

- a) Embankment Fill
- b) Peat
- c) High Plastic Silt to Clayey Silt (Marl)
- d) Sand, trace Silt, trace Gravel

The soils encountered during the course of the investigation, together with the field and laboratory test results are shown on the Record of Borehole Sheets contained in the Appendix of this report. Three stratigraphical Sections are shown on Drawing No. 4778901-A. This drawing also shows the locations and elevations of the borings. In addition, information provided by the Geotechnical Section of the Southwestern Region is also included in this report. A summary plot of the soil properties are shown on Figure 9. Description of the strata encountered are given below.

Embankment Fill

This fill which was placed to raise the grade level consists layers of clayey silt and sand with varying proportions of silt and gravel sized particles. The thickness of the fill was observed to be about 10.5 m and extends to El. 252.6 m. The Standard Penetration Test results were observed to vary between 3 blows/30 cm and 19 blows/30 cm with an average value of 10 blows/30 cm.

The embankment fill is underlain by 1.1 m to 1.5 m of firm high plastic silt to clayey silt (marl) with occasional organic layers.

Peat

The borings in the swampy area indicate 1.4 m to 3.4 m of very soft to soft peat. This organic layer extends to about El. 261 to 257.9 m. The organic content of this peat layer varies over a wide range (18.5% to 85%). The natural moisture content was observed to vary from 68% to 441%. However, the low moisture content was indicated by the samples obtained above ground water level from boreholes located north of Hwy. 401. Vane Shear tests carried out in this organic layer indicate shear strength in the range of 10 kPa to 14 kPa.

High Plastic Silt to Clayey Silt (Marl)

This deposit was encountered immediately below the peat layer. The thickness of this deposit varies from 3.8 m to 7.2 m and extends to El. 256.0 m to 251.3 m. The results of the Atterberg Limit test are shown on Figure 1 & Figure 2. The natural moisture content was observed to vary from 68% to 245% in the area where high plastic silt and occasional organic layers were encountered. However, samples obtained from clayey silt stratum indicated moisture content in the range of 29.5% to 69%. The bulk unit weight was observed to vary widely (11.2 kN/m^3 to 19.3 kN/m^3) depending on the type of material. The in situ Vane Shear test carried out in this marl indicate shear strength varying from 6 kPa to 29 kPa. As indicated before higher unit weight and shear strength values were observed in the area where clayey silt was encountered.

Sand, trace Silt, trace Gravel

This sandy deposit was encountered in all the boreholes immediately below the marl layer. The Grain Size Distribution test was carried out on one representative sample and the results are shown on Figure 3. The Standard Penetration Test values vary from 1 blow/30 cm to 8 blows/30 cm indicating very loose to loose state of compaction. Considering the nature of the investigation and the hydrostatic condition observed, boreholes were terminated in this deposit, and the full extent of this deposit was not proven.

Groundwater Conditions

The groundwater was encountered in all the boreholes, and was observed at or near the ground level in the boreholes located south of Hwy. 401, whereas, in boreholes located north of Hwy. 401, it was observed about 1.6 m to 2.0 m below the existing ground level. The groundwater level at each borehole location is as follows:

<u>Borehole No.</u>	<u>Elevation (m)</u>
1	262.3
2	261.7
3	261.0
6	259.5
7	259.5
8	259.2

Sub-artesian condition was observed in boreholes located on Hwy. 401 shoulders. The groundwater in these two boreholes was first encountered around El. 251.5 m and at the end of drilling ($\frac{1}{2}$ hr. to 1 hr.) it rose up to about El. 259.8 to 259.3 m.

DISCUSSION AND RECOMMENDATIONS

General

It is proposed to widen the existing Highway 401 to accommodate two future lanes on either side without altering the median. The existing Highway 401 in this area crosses a swamp which is about 550 m in length. There is no specific record available with regards to subexcavation of the swampy material underneath the existing highway. According to available information, there was some settlement problem over the years and required constant maintenance. At present, the Highway 401 shows no major distress or settlement in this area.

It is understood that the fill for the widen portion could be left in place for as long a period as three years before the commencement of pavement operation. Measures to ensure the stability, subexcavation requirements and also the associated settlement of the pre-loading in this swampy area which is located about 500 m east of Dorchester road (Sta. 14+300 to Sta. 14+850) will be discussed.

The results of the stability analyses carried out for various stages of fill placement such as fill on existing ground level, during excavation and at the end of backfill are shown on Figure 5 to Figure 8.

Pre-Loading of Swamp

The organics and marl encountered at this site is expected to settle due to the embankment loading by large order of magnitude and the settlements will take place for a long period of time. If the fill is placed on the existing ground level without any subexcavation of weak material, the total settlement will be excessive and expected to continue for a long period of time. Since the amount of proposed embankment loading is limited and consequently continuous maintenance will be required for a major highway of this nature.

In order to reduce the post construction settlement, it is recommended to subexcavate part of the compressible deposit and backfill with granular material up to about 0.3 m above the groundwater level and the remainder with the acceptable earth material. This method of construction will induce additional vertical stress in the underlying soil and further accelerate the settlement. In order to achieve this, the placement of fill should be carried out as follows:

- 1) The subexcavation of the organic layer and marl is required to a depth of about El. 257.5 m.

The excavation should be carried out in 2.0 m strips as shown on Figure 4 to avoid any failure of the existing embankment.

The use of light equipment and also keeping the equipment at a safe distance beyond the edge of the existing shoulder is essential. This aspect should be given in the contract to warn the contractor.

- 2) Backfilling of the subexcavated portion should be carried out prior to the commencement of the subexcavation of a new strip.
- 3) Granular backfill shall be used at or below groundwater level and above the water level any acceptable earth material may be used.

The embankment should be constructed to the finished grade of the highway. As the settlements progresses with time the roadway could be brought to the required level with additional lifts.

Any minor localized failures occurred during the construction due to displacement of high plastic silts (marl) can be removed prior to the placement of the backfill.

It is estimated that the settlement will be in the order of 0.6 m to 1.4 m depending on the thickness of the compressible layer. However, the majority of the settlements are expected to take place within first 1½ to 2½ years.

In order to study the performance of the roadway and the magnitude of settlement, some monitoring will be required. A simple method will be taking periodic cross-section at various time intervals in order to determine the amount of settlement. However in some localized areas, the observed magnitude and rate of settlement are of concern, these areas may have to be treated separately. One method of achieving the end result is to remove the previously placed fill material and replaced with light weight aggregate before commencing the pavement operation. The Foundation Design Section would assist the Region in developing monitoring methods and consultation during the construction.

MISCELLANEOUS

The field work for this investigation was carried out under the supervision of Mr. M. Vasavithasan, Foundation Engineer, and Mr. J. LeMessurier, Student Engineer. The equipment used was owned and operated by Master Soil Investigation Ltd. This report was prepared by Mr. M. Vasavithasan, reviewed by Mr. P. Payer, Senior Foundation Engineer, and approved by Mr. M.S. Devata, Chief Foundation Engineer.



M. Vasavithasan

M. Vasavithasan, P.Eng.
Foundation Engineer

M.S. Devata

M.S. Devata, P.Eng.
Chief Foundation Engineer

APPENDIX

RECORD OF BOREHOLE No 1

1 OF 1

METRIC

W.P. 477 - 89 - 01 LOCATION CO - ORDS. N 4 758 529.5; E 422 845.5 ORIGINATED BY M V&J L
DIST 2 HWY 401 BOREHOLE TYPE CONE TEST & CONTINUOUS FLIGHT AUGER (H.S) COMPILED BY M V
DATUM GEODETTIC DATE 90 07 26 CHECKED BY P P

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	20 40 60 80 100					
262.4	Ground Surface													
0.0	Peat, Very Soft to Soft		1	SS	1	/46cm	262							ORG. = 25.5%
261.0							261							
1.4			2	TW	PM	/46cm	260						11.2	
	Occasional Layers of Peat		3	SS	1	/46cm	259							
							258							
			4	SS	1	/46cm	257							
							256						13.3	
	High Plastic Silt With Decayed Shell Fragments, Very Soft to Soft (Marl)		5	TW	PM	/46cm	255							
			6	SS	1	/46cm	254							
254.4							253							
8.0	Sand, Trace of Silt, Trace of Gravel, Very Loose to Loose		7	SS	1									
252.2														
10.2	End of Borehole Note: STA. 14 + 400; O/S 32.9m RT. CL. HWY. 401													

RECORD OF BOREHOLE No 2

1 OF 1

METRIC

W.P. 477 - 89 - 01 LOCATION CO - ORDS. N 4 758 555.5; E 422 942.2 ORIGINATED BY M V&J L
DIST 2 HWY 401 BOREHOLE TYPE CONE TEST & CONTINUOUS FLIGHT AUGER (H.S) COMPILED BY M V
DATUM GEODETIC DATE 90 07 27 CHECKED BY P P

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	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
261.9	Ground Surface																
0.0	Peat, Very Soft		1	SS	1		261									w=230	ORG. = 23%
260.3							260										
1.6	Layers of High Plastic Silt With Decayed Shell Fragments (Mori), and Peat, Very Soft		2	SS	1	/46cm	259									13.3	
			3	TW	PM		258										
			4	SS	1	/46cm	257										
256.0			5	TW	PM		256									12.4	ORG. = 28%
5.9	Sand, Trace of Silt, Trace of Gravel, Very Loose		6	SS	2												0 95 (5)
255.3																	
6.6	End of Borehole																
	Probable Sand, Trace of Silt, Trace of Gravel, Very Loose to Loose																
	Note: STA. 14 + 500; O/S 30.2m RT. CL. HWY. 401																
247.0																	
14.9	End of Cone Test																

RECORD OF BOREHOLE No 3

1 OF 1

METRIC

W.P. 477 - 89 - 01 LOCATION CO - ORDS. N 4 758 577.5; E 423 040.0 ORIGINATED BY M V&J L
 DIST 2 HWY 401 BOREHOLE TYPE CONE TEST & CONTINUOUS FLIGHT AUGER (H.S) COMPILED BY M V
 DATUM GEODETTIC DATE 90 07 27 CHECKED BY P P

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 7 kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
261.2	Ground Surface																
0.0	Peat, Very Soft		1	SS	1	/46cm	261										
259.8							260										
1.4							259										
	Layers of High Plastic Silt With Decayed Shell Fragments (Marl), and Peat, Very Soft		2	TW	PM		258									12.3	ORG. = 57%
			3	SS	1	/46cm	257										
			4	SS	1		256										
255.1	Clayey Silt With Occasional Decayed Shell Fragments		5	TW	PM		255									19.3	
6.1	Sand, Trace of Silt, Trace of Gravel, Loose		6	SS	8		254										
253.6																	
7.6	End of Borehole																
	Probable Sand, Trace of Silt, Trace of Gravel, Loose to Compact																
250.5																	
10.7	End of Cone Test																
	Note: STA. 14 + 600; O/S 29.9m RT. CL. HWY. 401																

RECORD OF BOREHOLE No 4

1 OF 1

METRIC

W.P. 477 - 89 - 01 LOCATION CO - ORDS. N 4 758 547.0; E 422 841.5 ORIGINATED BY M V&J L
DIST 2 HWY 401 BOREHOLE TYPE CONE TEST & CONTINUOUS FLIGHT AUGER (H.S) COMPILED BY M V
DATUM GEODETIC DATE 90 07 27 CHECKED BY P P

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	20 40 60 80 100					
263.3	Hwy. 401 Shoulder													
0.0	Sand And Gravel, Some Silt, Loose (Fill)													
262.2			1	SS	6									
1.1			2	SS	6									
			3	SS	19									
			4	SS	12									
			5	SS	12									
			6	SS	10									
	Clayey Silt, Some Sand, Some Gravel, Firm to Stiff (Fill)		7	SS	9									
			8	SS	8									
			9	SS	9									
			10	SS	11									
			11	SS	10									
			12	SS	13									
			13	SS	8									
252.8														
10.5 252.4	Peat, Soft		14	SS	7									
10.9	High Plastic Silt With Occasional Decayed Shell Fragments, Firm (Marl)													
251.3														
12.0	Sand, Trace of Silt, Trace of Gravel, Loose		15	SS	7									
250.7														
12.6	End of Borehole Note: STA. 14 + 400; O/S 15.1m RT. CL. HWY. 401													

RECORD OF BOREHOLE No 5

1 OF 1

METRIC

W.P. 477 - 89 - 01 LOCATION CO - ORDS. N 4 758 575.5; E 422 834.5 ORIGINATED BY M. V&J. L.
DIST 2 HWY 401 BOREHOLE TYPE CONE TEST & CONTINUOUS FLIGHT AUGER (H.S.) COMPILED BY M. V.
DATUM GEODETIC DATE 90 07 31 CHECKED BY P. P.

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 7 kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100	20 40 60 80 100	20 40 60 80 100	20 40 60 80 100					
263.1	Hwy. 401 Shoulder															
0.0	Sand And Gravel, Some Silt, Loose (Fill)															
261.3			1	SS	3											
1.8																
	Clayey Silt, Some Sand, Some Gravel, Firm to Stiff (Fill)		2	SS	11											
			3	SS	14											
			4	SS	7											
256.3																
6.8																
	Silt With Sand, Trace of Gravel, Trace of Clay, Loose to Compact (Fill)		5	SS	9											
			6	SS	14											
			7	SS	10											
			8	SS	6											
252.6																
10.5	Clayey Silt With Occasional Shell Fragments		9	SS	7											
	Firm															
251.5																
11.6	Sand, Trace of Silt, Trace of Clay,		10	SS	5											
	Very Loose to Loose															
250.5			11	SS	3											
12.6	End of Borehole															
	Note: STA. 14 + 400; O/S 14.5m LT. CL. HWY. 401															

RECORD OF BOREHOLE No 6

1 OF 1

METRIC

W.P. 477 - 89 - 01 LOCATION CO - ORDS. N 4 758 589.0; E 422 831.5 ORIGINATED BY M V&J L
DIST 2 HWY 401 BOREHOLE TYPE CONE TEST & CONTINUOUS FLIGHT AUGER (H.S) COMPILED BY M V
DATUM GEODETIC DATE 90 07 31 CHECKED BY P P

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT 7 KN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100	20 40 60 80 100	20 40 60 80 100	20 40 60 80 100	20 40 60 80 100		
261.3	Ground Surface													
0.0														
	Peat With Occasional Partially Decomposed Timber, Very Soft		1	SS	1	/46cm	261							ORG. = 52%
			2	SS	3		260							
			3	SS	1		259							ORG. = 79%
258.4														
2.9	High Plastic Silt With Decayed Shell Fragments, Occasional Layers of Peat, Very Soft to Soft		4	TW	PM		258						13.1	
							257							
			5	SS	1	/46cm	256							
			6	TW	PM		255						16.4	
	Silty Clay to Clayey Silt With Decayed Shell Fragments (Marl)						254							
			7	SS	1	/46cm	253							
			8	SS	1	/46cm	252							
251.3							251							
10.1	Sand, Trace of Silt, Trace of Gravel, Very Loose to Loose		9	SS	2									
250.2														
11.1	End of Borehole Probable Sand, Trace of Silt, Trace of Gravel, Loose													
249.1														
12.2	End of Cone Test Note: STA. 14 + 400; O/S 27.9m LT. CL. HWY. 401													

RECORD OF BOREHOLE No 7

1 OF 1

METRIC

W.P. 477 - 89 - 01 LOCATION CO - ORDS. N 4 758 612.5; E 422 929.0 ORIGINATED BY M V&J L
DIST 2 HWY 401 BOREHOLE TYPE CONE TEST & CONTINUOUS FLIGHT AUGER (H.S.) COMPILED BY M V
DATUM GEODETIC DATE 90 07 31 CHECKED BY P P

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					
261.2	Ground Surface																
0.0	Peat, Very Soft		1	SS	1		261										ORG. = 23.5%
			2	SS	1		260										ORG. = 41%
258.0							259										
3.2	Clayey Silt With Decayed Shell Fragments (Marl), Occasional Layers of Peat, Very Soft to Soft		3	SS	1	/46cm	258										
			4	TW	PM		257										
			5	SS	1	/46cm	256										
254.2							255										
253.9	Sand, Trace of Silt & Gravel		6	SS	2		254										
7.3	End of Borehole Probable Sand, Trace of Silt, Trace of Gravel, Very Loose to Loose																
252.1																	
9.1	End of Cone Test																
	Note: STA. 14 + 500; O/S 28.6m LT. CL. HWY. 401																

RECORD OF BOREHOLE No 8

1 OF 1

METRIC

W.P. 477 - 89 - 01 LOCATION CO - ORDS. N 4 758 631.5; E 423 027.0 ORIGINATED BY M. V&J L
DIST 2 HWY 401 BOREHOLE TYPE CONE TEST & CONTINUOUS FLIGHT AUGER (H.S) COMPILED BY M. V
DATUM GEODETIC DATE 90 07 31 CHECKED BY P. P

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					
261.3	Ground Surface																
0.0	Peat, Very Soft		1	SS	1		261										ORG. = 18.5%
							260										
			2	TW	PM		259									10.4	ORG. = 85%
257.9	High Plastic Silt With Decayed Shell Fragments Very Soft to Soft (Marl)		3	SS	1	/46cm	258										ORG. = 28.5%
3.4			4	TW	PM		257									13.0	
			5	SS	1	/46cm	256										
			6	SS	1	/46cm	255										
							254										
253.9	Sand, Trace of Silt, Trace of Gravel, Loose		7	SS	4												
7.4																	
253.2	End of Borehole																
8.1	Probable Sand, Trace of Silt, Trace of Gravel, Loose																
252.2	End of Cone Test																
9.1	Note: STA. 14 + 600; O/S 25.0m LT. CL. HWY. 401																

RECORD OF BOREHOLE No P1 1 OF 1 METRIC

W.P. 477 - 89 - 01 LOCATION CO - ORDS. N 4 758 519.0; E 422 797.5 ORIGINATED BY
 DIST 2 HWY 401 BOREHOLE TYPE HAND AUGER COMPILED BY M.V.
 DATUM GEODETIC DATE 89 06 TO 90 04 CHECKED BY P.P.

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					
262.0	Ground Surface																
0.0	Peat					*											
261.0							261										
1.0	High Plastic Silt With Decayed Shell Fragments (Marl) and Occasional Layers of Peat						260										
259.0							259										
3.0 258.6	Silty Clay																
3.4	End of Borehole * Note: Water Level Not Established																

RECORD OF BOREHOLE No P2 1 OF 1 METRIC

W.P. 477 - 89 - 01 LOCATION CO - ORDS. N 4 758 599.0; E 423 137.0 ORIGINATED BY
 DIST. 2 HWY. 401 BOREHOLE TYPE HAND AUGER COMPILED BY M.V.
 DATUM GEODETIC DATE 89 06 TO 90 04 CHECKED BY P.P.

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 7 kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
260.9	Ground Surface																
0.0	Peat					*											
259.8							260										
1.1							259										
	High Plastic Silt With Decayed Shell Fragments (Marl) and Occasional Layers of Peat						258										
							257										
255.8							256										
5.1	Sand, Trace of Silt, Trace of Gravel						255										
254.9																	
6.0	End of Borehole * Note: Water Level Not Established																

RECORD OF BOREHOLE No P3 1 OF 1 METRIC

W.P. 477 - 89 - 01 LOCATION CO - ORDS. N 4 758 622.0; E 423 234.5 ORIGINATED BY
 DIST 2 HWY 401 BOREHOLE TYPE HAND AUGER COMPILED BY M V
 DATUM GEODETIC DATE 89 06 TO 90 04 CHECKED BY P P

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					
260.9	Ground Surface																
0.0	Peat					*											
259.9							260										
1.0	High Plastic Silt With Decayed Shell Fragments (Marl) and Occasional Layers of Peat																
258.9							259										
2.0	Sand, Trace of Silt, Trace of Gravel																
258.4																	
2.5	End of Borehole																
	* Note: Water Level Not Established																

RECORD OF BOREHOLE No P4 1 OF 1 METRIC

W.P. 477 - 89 - 01 LOCATION CO - ORDS. N 4 758 575.0; E 422 761.0 ORIGINATED BY
 DIST 2 HWY 401 BOREHOLE TYPE HAND AUGER COMPILED BY M V
 DATUM GEODETIC DATE 89 06 TO 90 04 CHECKED BY P P

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					
262.0	Ground Surface																
0.0	Peat					*											
260.8							261										
1.2							260										
	Silty Clay to Clayey Silt With Decayed Shell Fragments (Marl)						259										
							258										
257.5																	
4.5	End of Borehole																
	Note: Water Level Not Established																

RECORD OF BOREHOLE No P5 1 OF 1 METRIC

W.P. 477 - 89 - 01 LOCATION CO - ORDS. N 4 758 580.0; E 422 782.5 ORIGINATED BY
 DIST 2 HWY 401 BOREHOLE TYPE HAND AUGER COMPILED BY M V
 DATUM GEODETIC DATE 89 06 TO 90 04 CHECKED BY P P

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100	w _p	w	w _L		
262.0						*											
0.0	Peat																
258.4																	
3.6	High Plastic Silt (Marl)																
256.3																	
5.7	Silty Clay to Clayey Silt With Decayed Shell Fragments (Marl)																
255.6																	
6.4	End of Borehole																
	* Note: Water Level Not Established																

RECORD OF BOREHOLE No P6

1 OF 1

METRIC

W.P. 477 - 89 - 01 LOCATION CO - ORDS. N 4 758 661.0; E 423 122.5 ORIGINATED BY

DIST 2 HWY 401 BOREHOLE TYPE HAND AUGER COMPILED BY M V

DATUM GEODETIC DATE 89 06 TO 90 04 CHECKED BY P P

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					
261.0	Ground Surface																
0.0	Peat					*											
257.9							260										
3.1							259										
257.0	High Plastic Silt With Decayed Shell Fragments (Marl)						258										
4.0							257										
255.4	Sand, Trace of Silt, Trace of Gravel						256										
5.6	End of Borehole																
	* Note: Water Level Not Established																

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

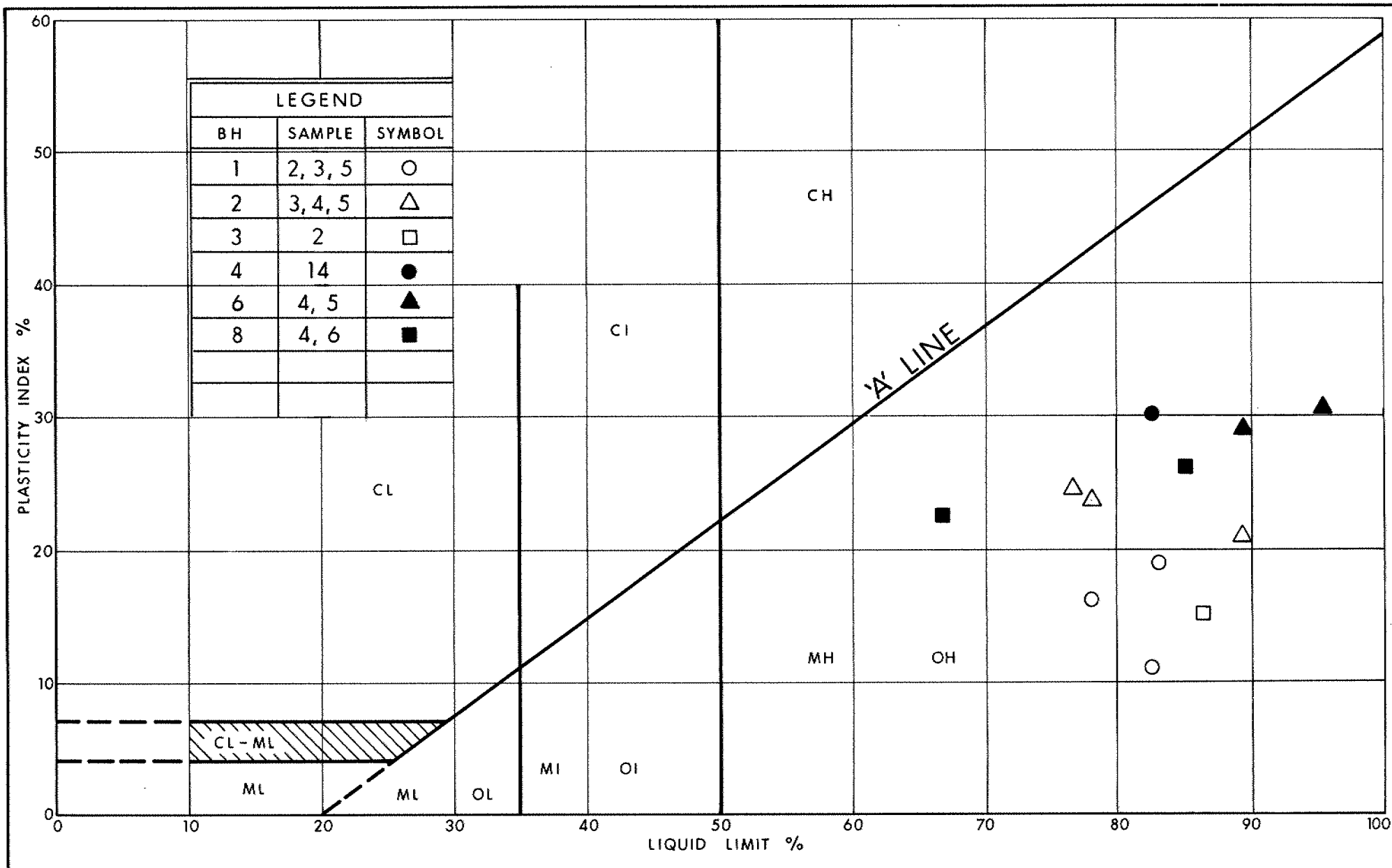
u_w	kPa	PORE WATER PRESSURE
r_u	1	PORE PRESSURE RATIO
σ	kPa	TOTAL NORMAL STRESS
σ'	kPa	EFFECTIVE NORMAL STRESS
τ	kPa	SHEAR STRESS
$\sigma_1, \sigma_2, \sigma_3$	kPa	PRINCIPAL STRESSES
ϵ	%	LINEAR STRAIN
$\epsilon_1, \epsilon_2, \epsilon_3$	%	PRINCIPAL STRAINS
E	kPa	MODULUS OF LINEAR DEFORMATION
G	kPa	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	e	1, %	VOID RATIO	e_{min}	1, %	VOID RATIO IN DENSEST STATE
γ_s	kN/m ³	UNIT WEIGHT OF SOLID PARTICLES	n	1, %	POROSITY	I_D	1	DENSITY INDEX = $\frac{e_{max} - e}{e_{max} - e_{min}}$
ρ_w	kg/m ³	DENSITY OF WATER	w	1, %	WATER CONTENT	D	mm	GRAIN DIAMETER
γ_w	kN/m ³	UNIT WEIGHT OF WATER	S_r	%	DEGREE OF SATURATION	D_n	mm	n PERCENT - DIAMETER
ρ	kg/m ³	DENSITY OF SOIL	w_L	%	LIQUID LIMIT	C_u	1	UNIFORMITY COEFFICIENT
γ	kN/m ³	UNIT WEIGHT OF SOIL	w_p	%	PLASTIC LIMIT	h	m	HYDRAULIC HEAD OR POTENTIAL
ρ_d	kg/m ³	DENSITY OF DRY SOIL	w_s	%	SHRINKAGE LIMIT	q	m ³ /s	RATE OF DISCHARGE
γ_d	kN/m ³	UNIT WEIGHT OF DRY SOIL	I_p	%	PLASTICITY INDEX = $\frac{w_L - w_p}{w - w_p}$	v	m/s	DISCHARGE VELOCITY
ρ_{sat}	kg/m ³	DENSITY OF SATURATED SOIL	I_L	1	LIQUIDITY INDEX = $\frac{w - w_p}{I_p}$	i	1	HYDRAULIC GRADIENT
γ_{sat}	kN/m ³	UNIT WEIGHT OF SATURATED SOIL	I_C	1	CONSISTENCY INDEX = $\frac{w_L - w}{I_p}$	k	m/s	HYDRAULIC CONDUCTIVITY
ρ'	kg/m ³	DENSITY OF SUBMERGED SOIL	e_{max}	1, %	VOID RATIO IN LOOSEST STATE	j	kN/m ³	SEEPAGE FORCE
γ'	kN/m ³	UNIT WEIGHT OF SUBMERGED SOIL						

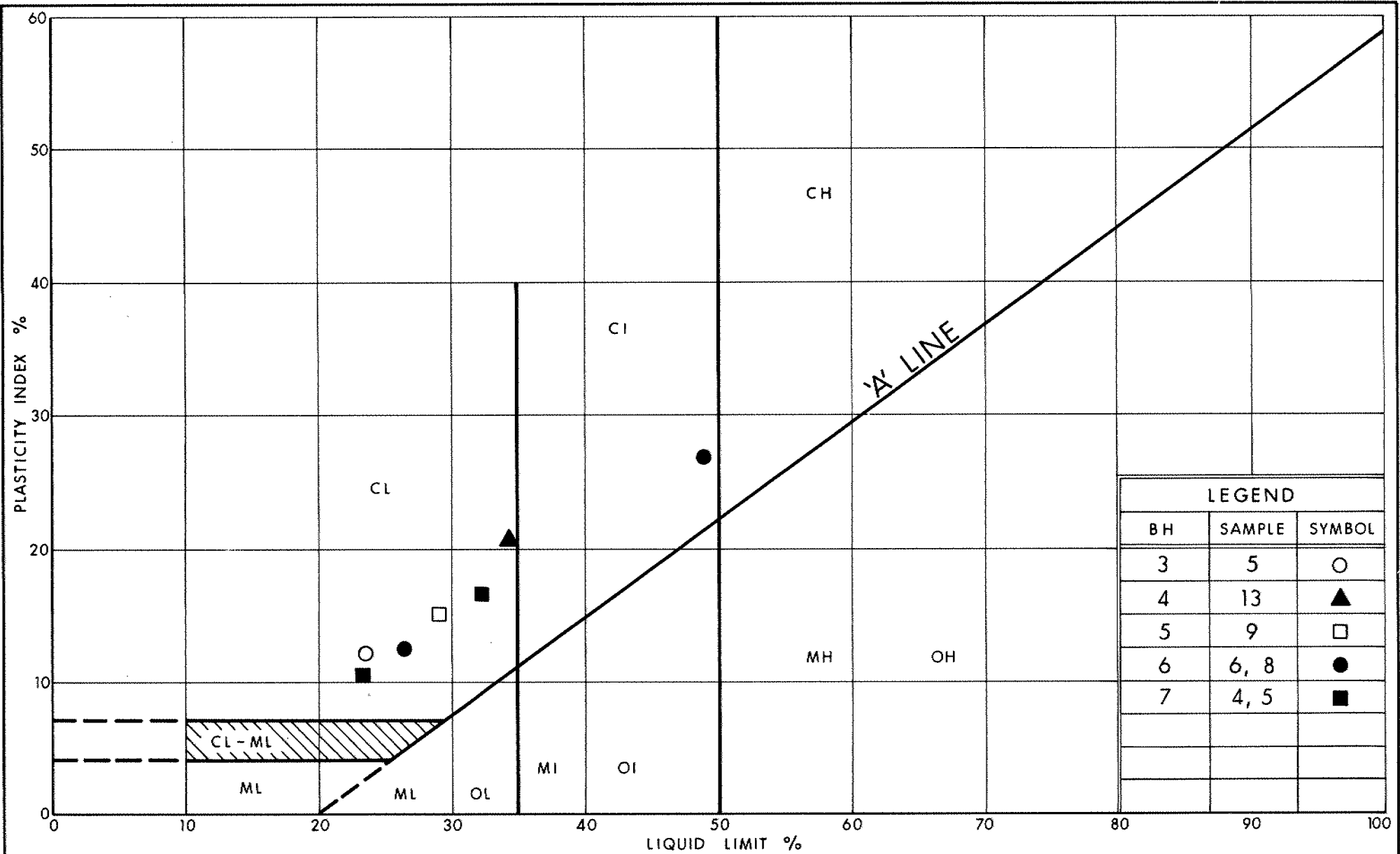


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Ontario

PLASTICITY CHART HIGH PLASTIC SILTS (MARL)

FIG No 1

W P 477-89-01



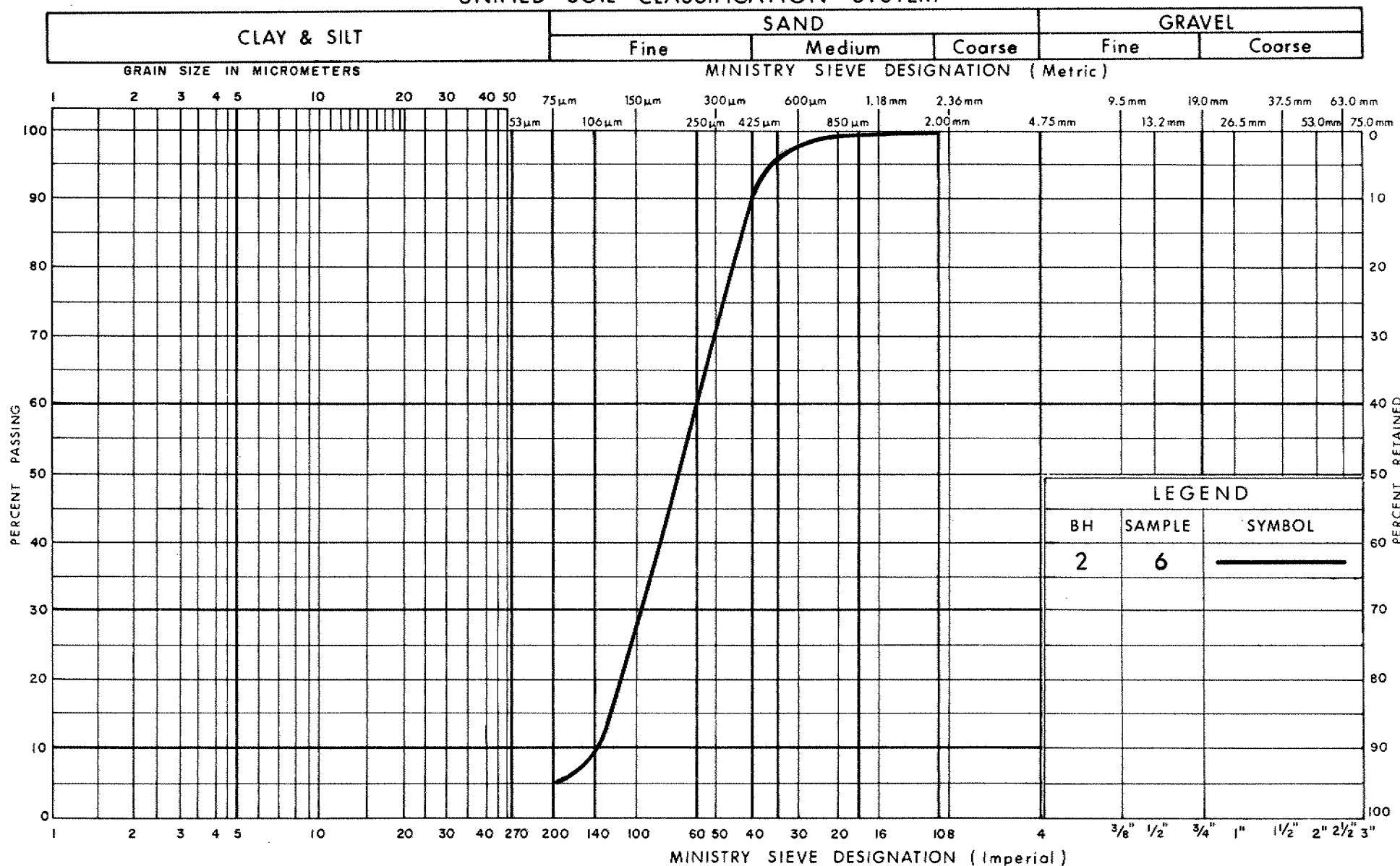
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Transportation

PLASTICITY CHART CLAYEY SILT

FIG No 2

W P 477-89-01

UNIFIED SOIL CLASSIFICATION SYSTEM



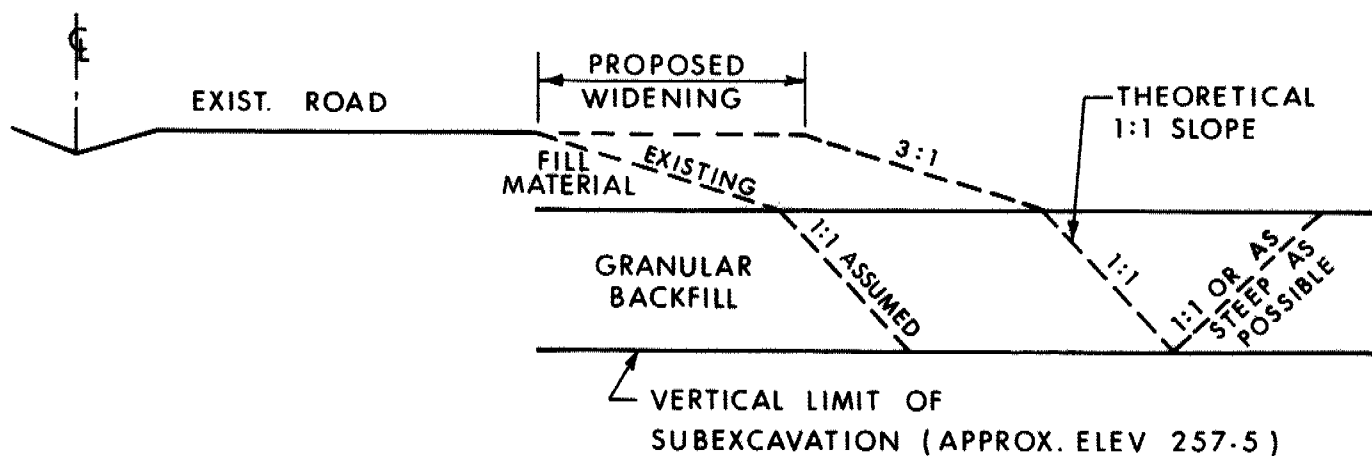
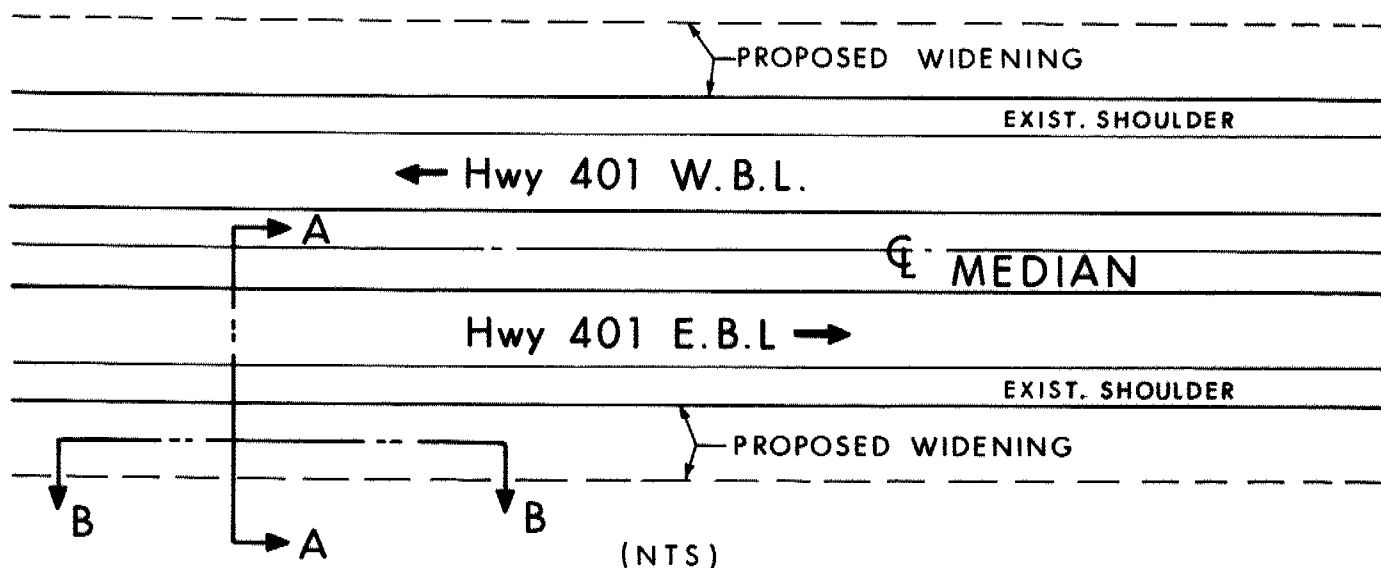
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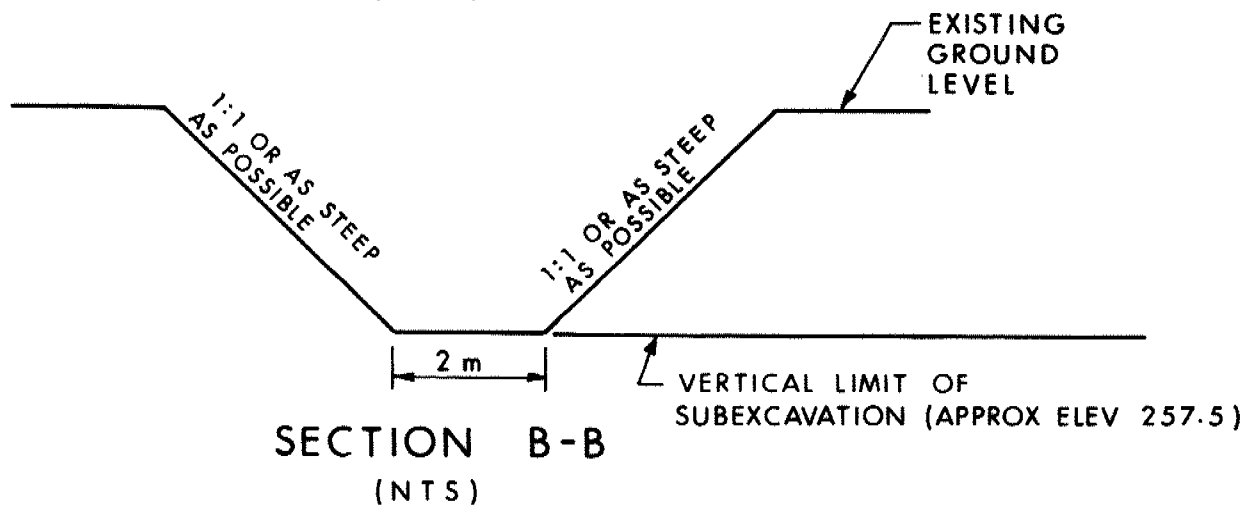
GRAIN SIZE DISTRIBUTION
SAND, TRACE OF SILT

FIG No 3

W P 477-89-01

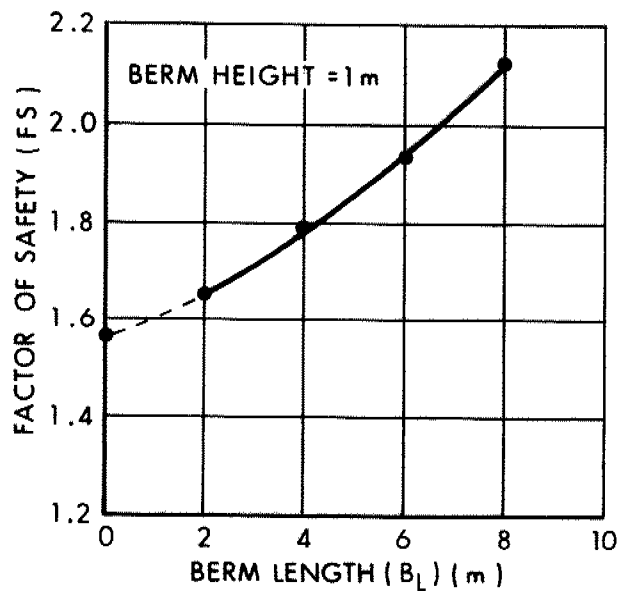
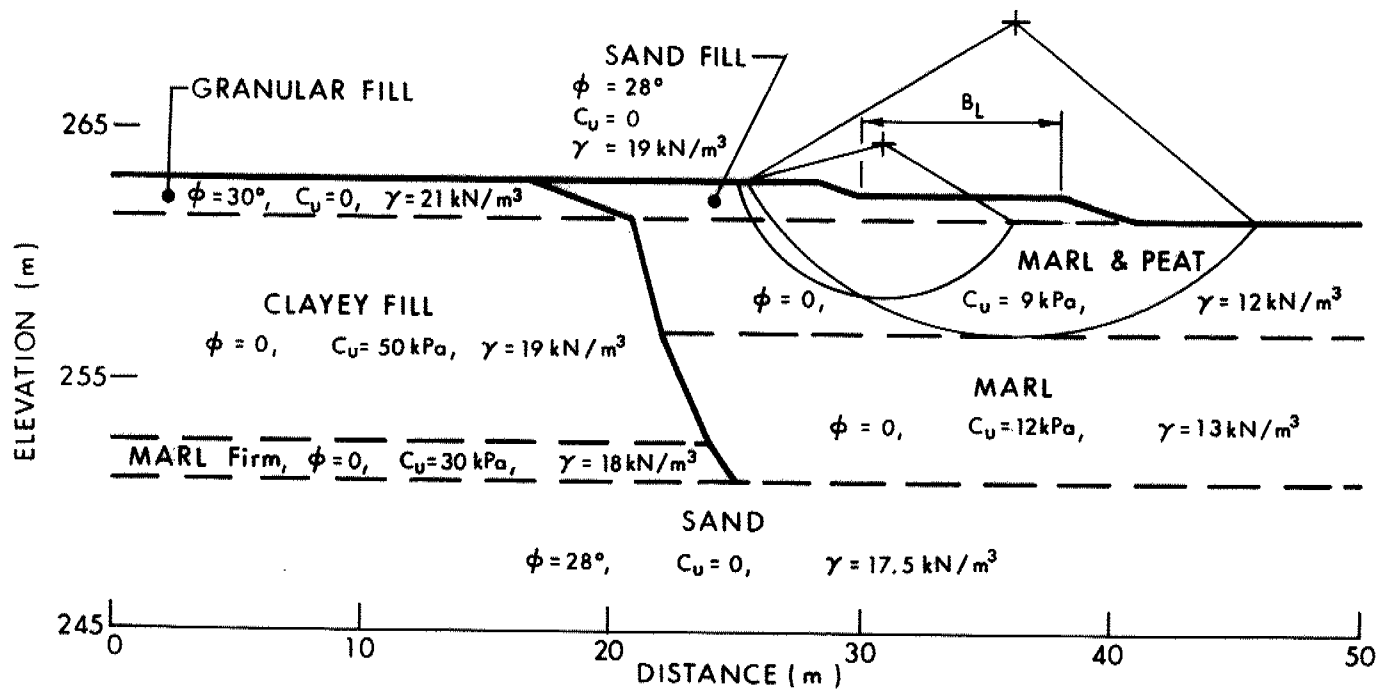


SECTION A-A
(NTS)



WP 477-89-01
Dist 2, Hwy 401

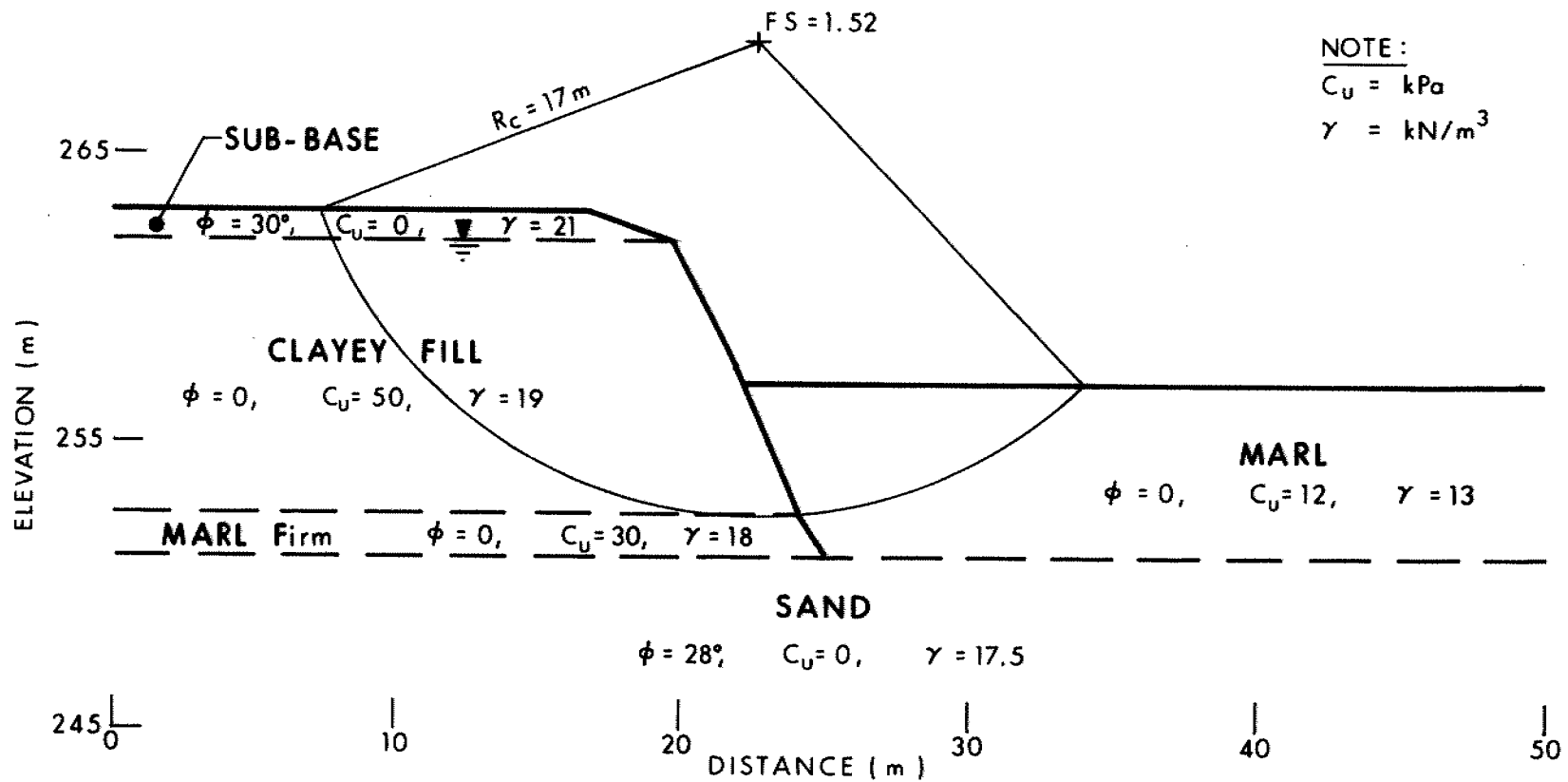
Fig. 4



STABILITY ANALYSIS FOR BERM

Fig 5

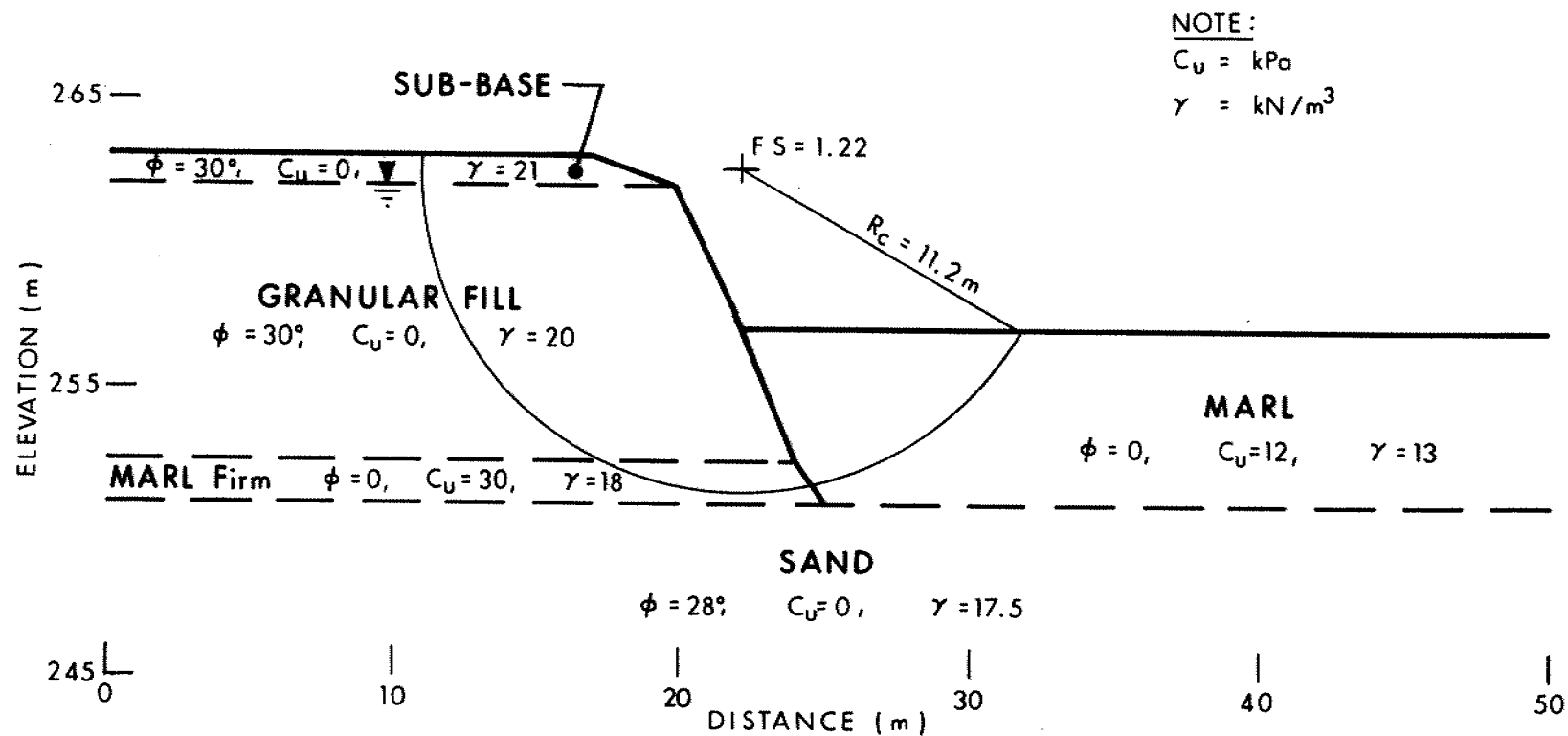
WP 477-89-01
Dist 2, Hwy 401



STABILITY ANALYSIS FOR SUB-EXCAVATION

Fig 6

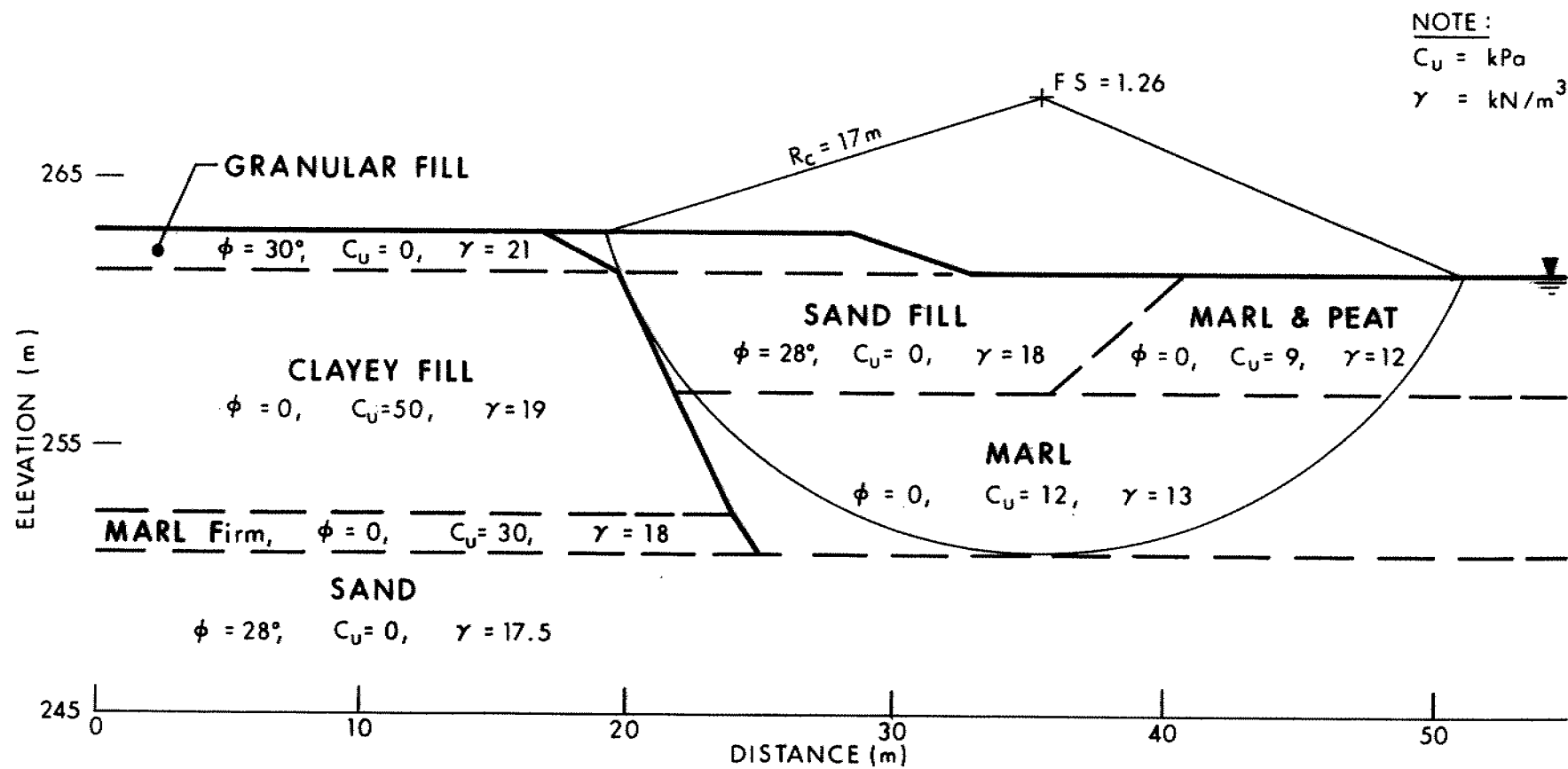
WP 477-89-01
 Dist 2, Hwy 401



STABILITY ANALYSIS FOR SUB-EXCAVATION

Fig 7

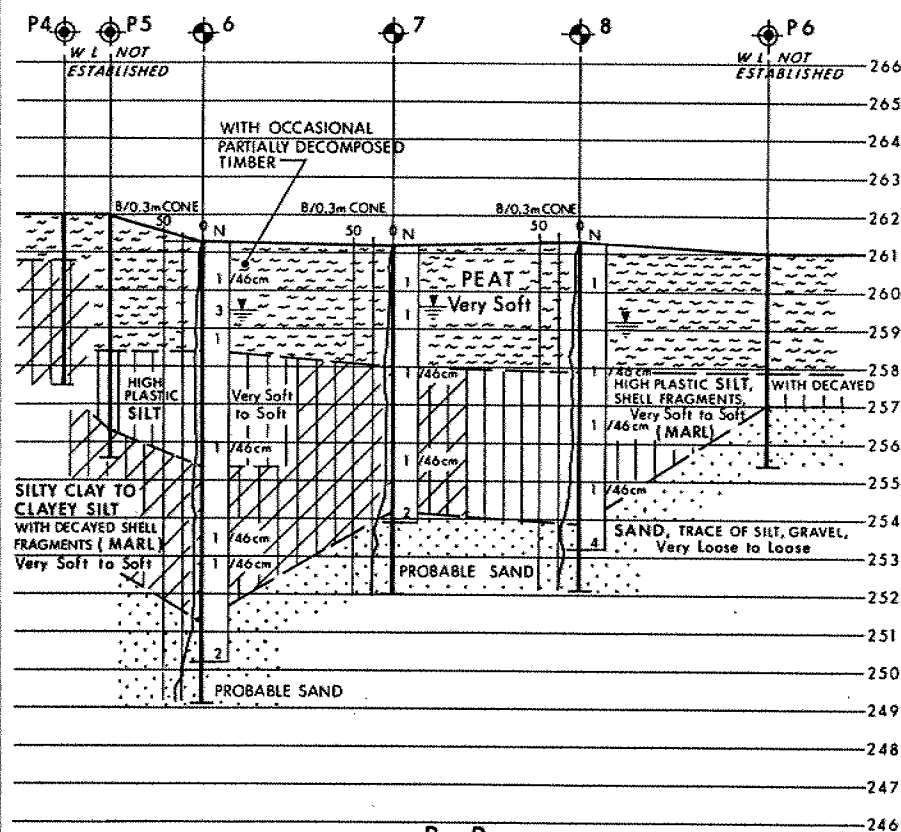
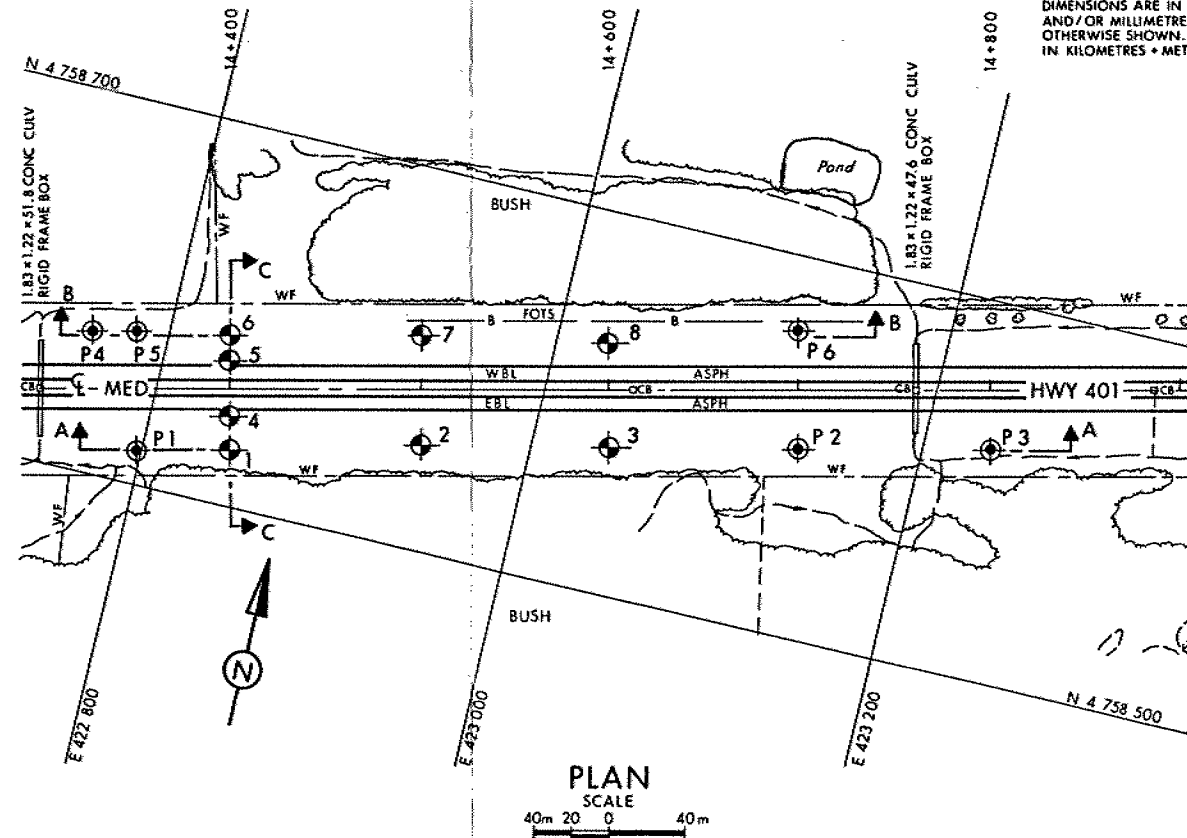
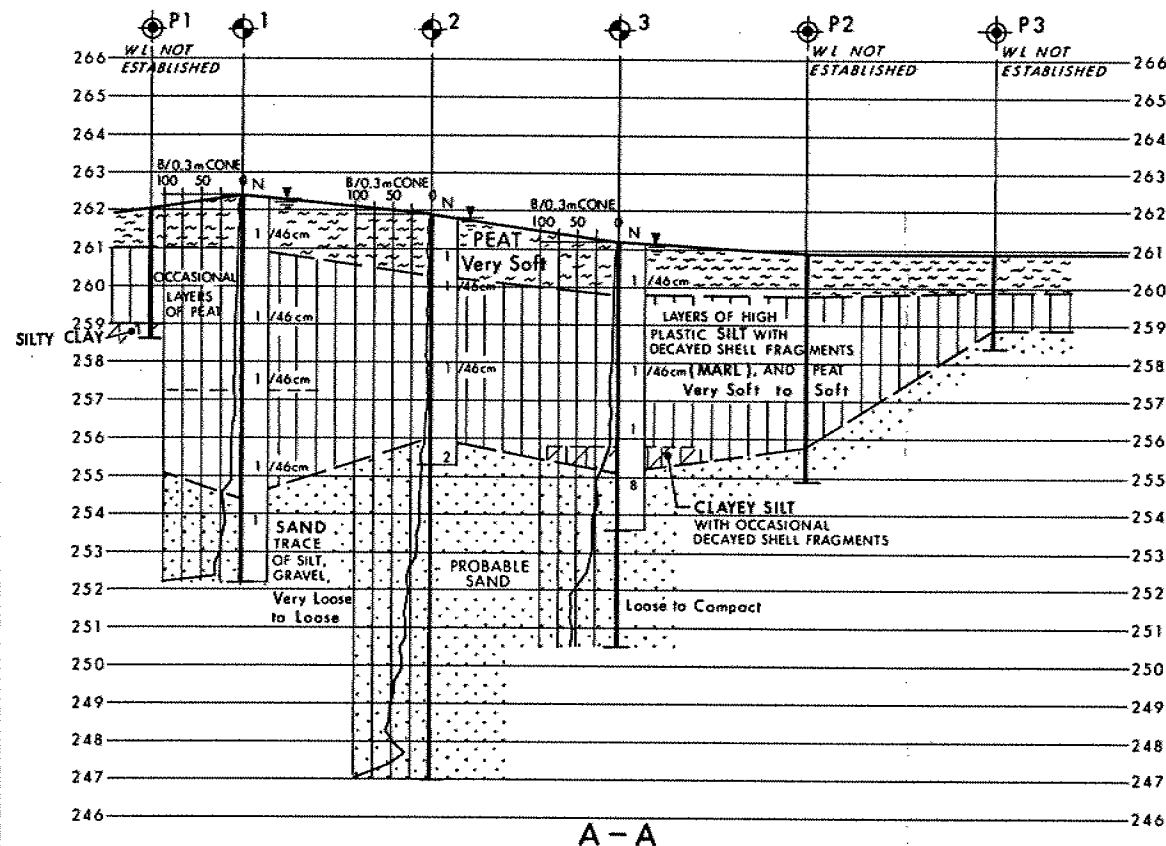
WP 477-89-01
 Dist 2, Hwy 401



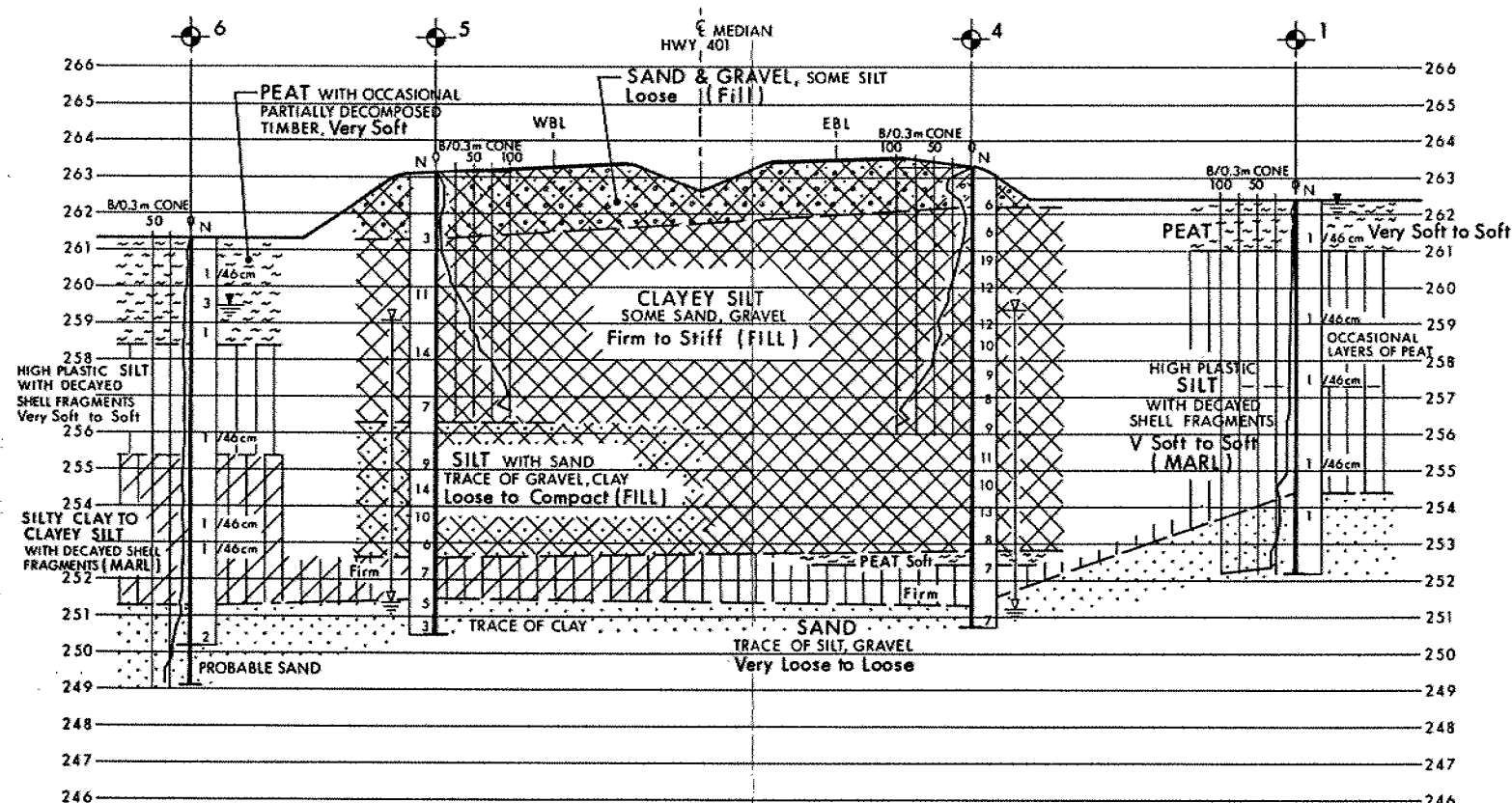
STABILITY ANALYSIS FOR BACKFILL

Fig 8

WP 477-89-01
Dist 2, Hwy 401



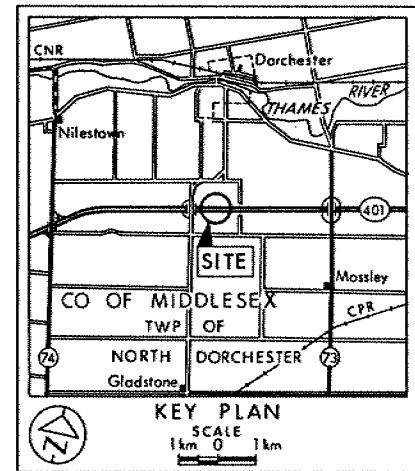
B-B
SECTIONS
SCALE
40m 20 0 40m HOR
2m 1 0 2m VERT



C-C
SECTION
SCALE
4m 2 0 4m HOR
2m 1 0 2m VERT

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

CONT No
WP No 477-89-01
DORCHESTER SWAMP
STA 14+300 TO STA 14+850
BORE HOLE LOCATIONS & SOIL STRATA



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 1990 07
- Head ARTESIAN WATER
- Encountered
- Probe Hole

No	ELEVATION	CO-ORDINATES NORTH	EAST
1	262.4	4 758 529.5	422 845.5
2	261.9	4 758 555.5	422 942.2
3	261.2	4 758 577.5	423 040.0
4	263.3	4 758 547.0	422 841.5
5	263.1	4 758 575.5	422 834.5
6	261.3	4 758 589.0	422 831.5
7	261.2	4 758 612.5	422 929.0
8	261.3	4 758 631.5	423 027.0
P1	262.0	4 758 519.0	422 797.5
P2	260.9	4 758 599.0	423 137.0
P3	260.9	4 758 622.0	423 234.5
P4	262.0	4 758 575.0	422 761.0
P5	262.0	4 758 580.0	422 782.5
P6	261.0	4 758 661.0	423 122.5

=NOTE=

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

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

REV	DATE	BY	DESCRIPTION
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Geocres No 40114-118

HWY No 401	SUBMD MV CHECKED	DATE 1990 12 04	DIST 2
DRAWN RS CHECKED	APPROVED		SITE

