

ENGINEERING MATERIALS OFFICE
FOUNDATION DESIGN SECTION

WP 476-89-05

DIST 2

HWY 401

STR SITE 19-369

Wellington Road Underpass

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FOUNDATION INVESTIGATION REPORT

For

Wellington Road Underpass

W.P. 476-89-05, Site 19-369

Highway 401, District 2, London

INTRODUCTION

This report contains the results of a foundation investigation carried out at the above mentioned site. The field work was carried out between 1993 01 25 and 1993 02 11, and comprised of three sampled boreholes and Dynamic Cone Penetration Test adjacent to these holes. In addition, Dynamic Cone Penetration Test was carried out at five locations. However, the borings for the existing bridge were advanced in October, 1954.

Boreholes were advanced to a maximum depth of 43.1 m (El. 219.1) below the existing ground level using 82 mm I.D. continuous flight hollow stem auger.

SITE DESCRIPTION

The site under investigation is located at the crossing of Highway 401 and Wellington Road in the City of London, County of Middlesex.

The topography of the surrounding area, with the exception of the existing crossing of Hwy. 401 & Wellington Road (embankment fill) is generally flat to gently undulating. Physiographically, the area is located in the region known as the "Mount Elgin Ridges".

SUBSURFACE CONDITIONS

The subsoil stratigraphy at this site consists of very stiff to hard clayey silt interbedded with compact to very dense silty sand to sandy silt layers varying in thickness from a minimum of 1.3 m to a maximum of 7.2 m. The clayey silt

deposit extends to the full depth probed. The fill consisting of clayey silt was encountered in the area where the existing Wellington Road is located. For classification purposes, the soils encountered at this site can be divided into three different zones.

- a) Clayey Silt, Occasional Sand & Silt Layers
- b) Silty Sand to Sandy Silt
- c) Clayey Silt, Trace of Gravel (fill)

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. A stratigraphical section is shown on Drawing No. 4768905-A. This drawing also shows the locations and elevations of the borings. Description of the strata encountered are given below.

The Record of Borehole Sheet as well as the information obtained from the site investigation carried out for the existing bridge is also included in the Appendix of this report.

Clayey Silt, Occasional Sand and Silt Layers

The clayey silt deposit which was encountered immediately below ground level extends to the depth probed (ie El. 219.1). The full extent of this deposit was not proven. This clayey silt deposit is interbedded with silty sand to sandy silt layers varying in thickness from a minimum of 1.3 m to a maximum of 7.2 m. In addition, occasional sand and silt layers varying in thickness from a few millimetres to a maximum of 700 mm were encountered. The results of the Atterberg Limit Tests carried out on representative soil samples are shown on Figure 1. The natural moisture content of this deposit varies from 14.3% to 25.0% with an average value of 18.3%. The Standard Penetration Test values, with the exception of few locations in Boreholes 102 and 104 (8 blows/0.3 m to 14 blows/0.3 m), were observed to vary from 15 blows/0.3 m to 54 blows/0.3 m indicating very stiff to hard consistency.

Silty Sand to Sandy Silt

This silty sand to sandy silt layer is sandwiched in the clayey silt deposit and was encountered between elevations 254.4 and 241.1. The thickness of this layer varies from a minimum of 1.3 m to a maximum of 7.2 m. The results of the Gradation Test carried out on representative soil samples are shown on Figure 2 in an envelope form. These test results indicate that this deposit is predominantly composed of sand (11% to 88%) and silt (12% - 89%). The Standard Penetration Test values in this layer varies over a wide range (10 blows/0.3 m to over 100 blows/0.3 m) indicating compact to very dense state of denseness.

Clayey Silt, Trace of Gravel (Fill)

This fill which was placed to raise the finished grade of the existing Wellington Road consist of clayey silt and trace of gravel, and was encountered in Borehole 8 which was located near the toe of the embankment. The consistency of this fill may be classified as stiff.

Groundwater Conditions

The groundwater level measurements were taken in open boreholes during investigation and was observed between El. 253.6 and El. 249.3. The groundwater level at each borehole location is as follows:

<u>Borehole No:</u>	<u>Elevation</u>
1	249.3
5	253.6
8	251.4
102	not observed
104	not observed

DISCUSSION AND RECOMMENDATIONS

General

It is proposed to widen Highway 401 to a divided eight lane facility without altering the median. As a part of the widening, the existing bridge will be replaced with four span (approximately 20.5 m end spans and 22.5 m centre spans) structure. The new underpass will be located approximately 30 m east of the present intersection and the profile grade of Wellington Road will be set at about El. 269.0±.

The existing bridge is a single span reinforced concrete rigid frame structure. The clear span between the face of the abutments is about 33.0 m. The approach embankment as well as the structure appear in good condition. However, the reinforcement of the deck has been exposed and corroded at several locations and also minor cracks have been noticed on the abutment walls.

Based on the information available in this office, the abutments of the existing bridge are supported on approximately 4.4 m wide footings placed at about elevation 258.5.

Structure Foundation

Pier:

Considering the subsoil conditions at this site, it is recommended that the piers be supported on spread footings placed at about El. 258.5. The design of the pier foundations placed at a level not higher than El. 258.5 may be carried out assuming the following bearing capacities.

Factored Bearing Capacity at U.L.S. =	450 kPa
Bearing Capacity at S.L.S. Type II =	300 kPa

Abutments:

The foundation for the abutments may be founded on engineered fill placed on competent ground. The existing approach fill as well as any spongy or soft areas observed within the base width of the proposed embankment should be removed before placing the engineered fill. The engineered fill should be placed as per Figure 3 attached to this report. The following bearing capacity values are recommended for the design of the abutment foundations placed on engineered fill.

Factored Bearing Capacity at U.L.S. =	800 kPa
Bearing Capacity at S.L.S. Type II =	350 kPa

Earth pressure should be computed as per Section 6.1.2.2 of the O.H.B.D.C. and an unyielding condition may be assumed for the computations. The Granular "A" or "B" backfill should be in accordance with the Special Provision No. 109F03. The following parameters are recommended for the granular backfill.

	<u>Granular "A"</u>	<u>Granular "B"</u>
Angle of Internal Friction	$\phi = 35^\circ$	$\phi = 30^\circ$
Unit Weight (kN/m^3)	$\gamma = 22.8$	$\gamma = 21.2$

If the abutment footings are placed on Granular A core, an unfactored coefficient of friction value of $\tan 30^\circ$ may be assumed for the estimate of the sliding resistance. However, if the footings are placed on natural ground, the sliding resistance may be estimated based on effective angle of internal friction value of $\tan 26^\circ$ neglecting the effective shear strength of the founding soil.

The footings should have a minimum of 1.2 m earth cover for the frost protection.

Approach Embankment

The maximum approach fill height is expected to be about 7.0 m. No major stability problems are anticipated for the approach embankments constructed with 2 horizontal to 1 vertical side slopes. The fill should consist of well

compacted acceptable material. The topsoil as well as any spongy or soft areas observed within the base width of the embankment should be removed before placing the fill.

Other Considerations

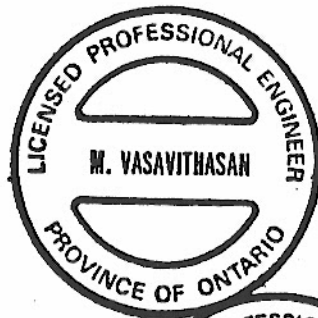
The base of the excavation for the footings which are placed on natural ground should be covered with 150 mm thick lean concrete pad upon exposure to avoid any deterioration of the founding soil.

No major dewatering problems are anticipated, however, if any minor seepage or surface run-off into the excavation may be readily handled by pumping from the sump.

During construction, if the Wellington Road is opened for traffic, a roadway protection will be required on the east side of Wellington Road.

MISCELLANEOUS

The field work for this investigation was carried out under the supervision of M. Vasavithasan. The equipments used were owned and operated by London Soil Test Ltd. of London, Ontario and Dominion Soil Investigation Inc. of London, Ontario. This report was prepared by M. Vasavithasan, Foundation Engineer, reviewed by P. Payer, Senior Foundation Engineer and approved by M. Devata, Chief Foundation Engineer.



M. Vasavithasan
M. Vasavithasan, P. Eng.
Foundation Engineer



D. Dundas
for M. Devata, P. Eng.
Chief Foundation Engineer

APPENDIX

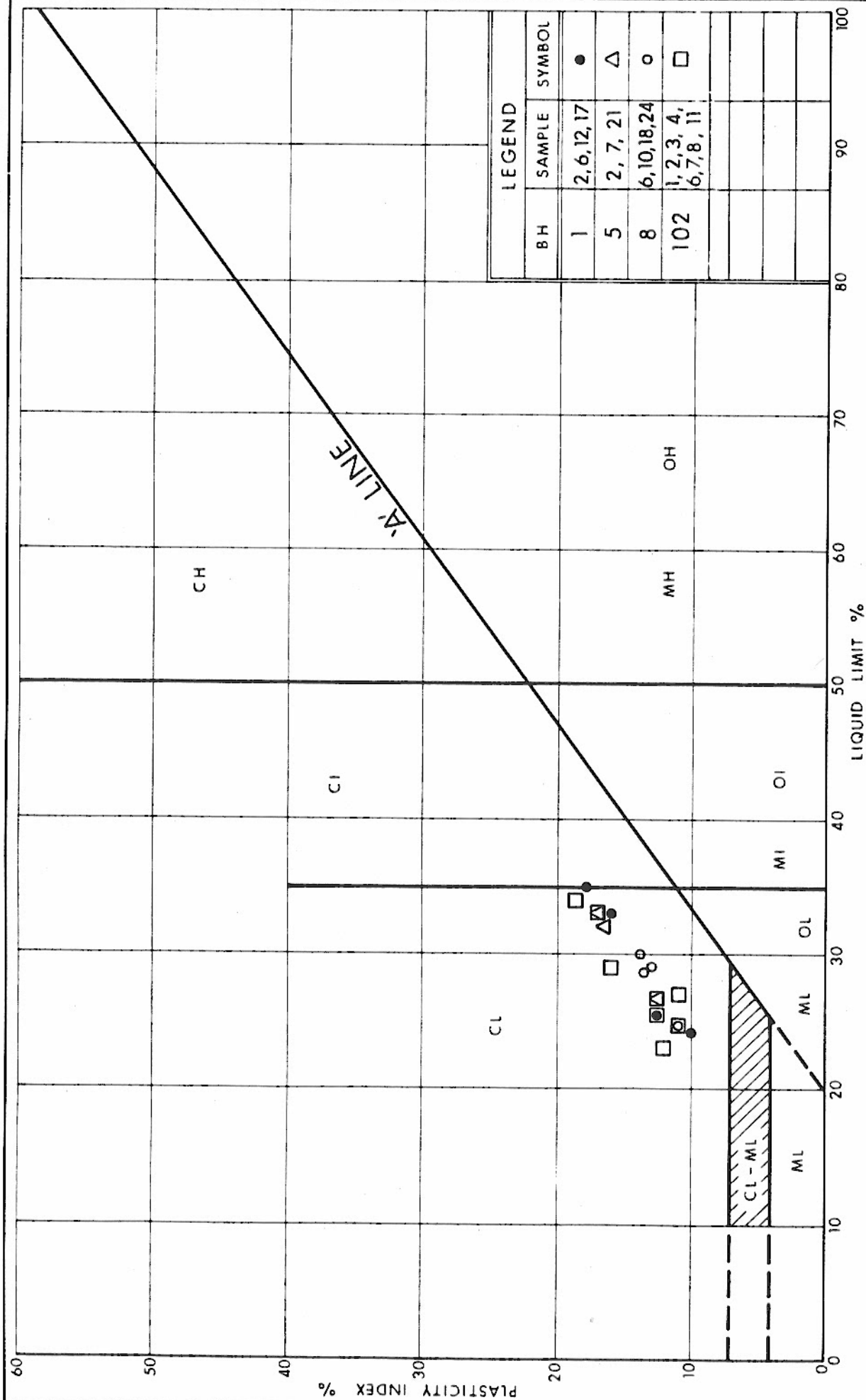


FIG No 1

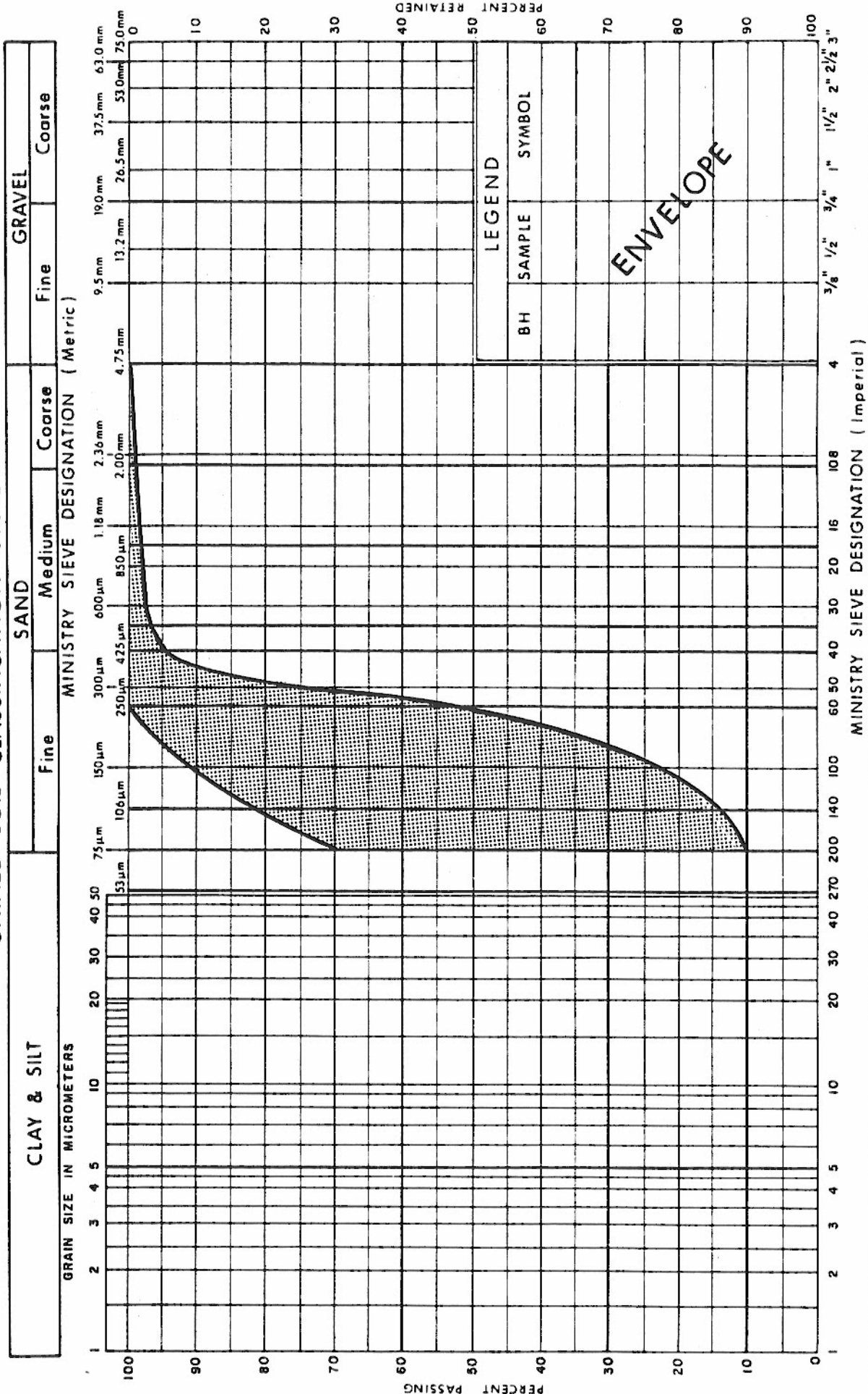
W P 476-89-05

PLASTICITY CHART

CLAYEY SILT

Ministry of
Transportation





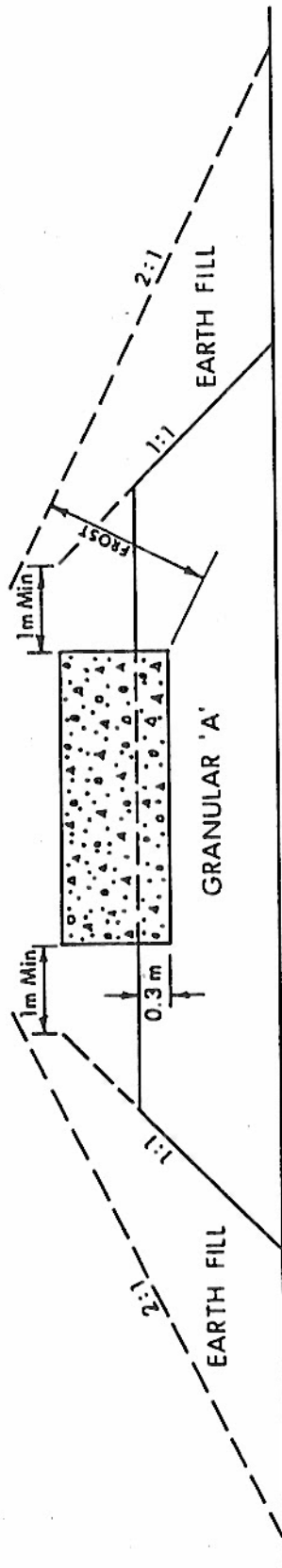
Ministry of Transportation



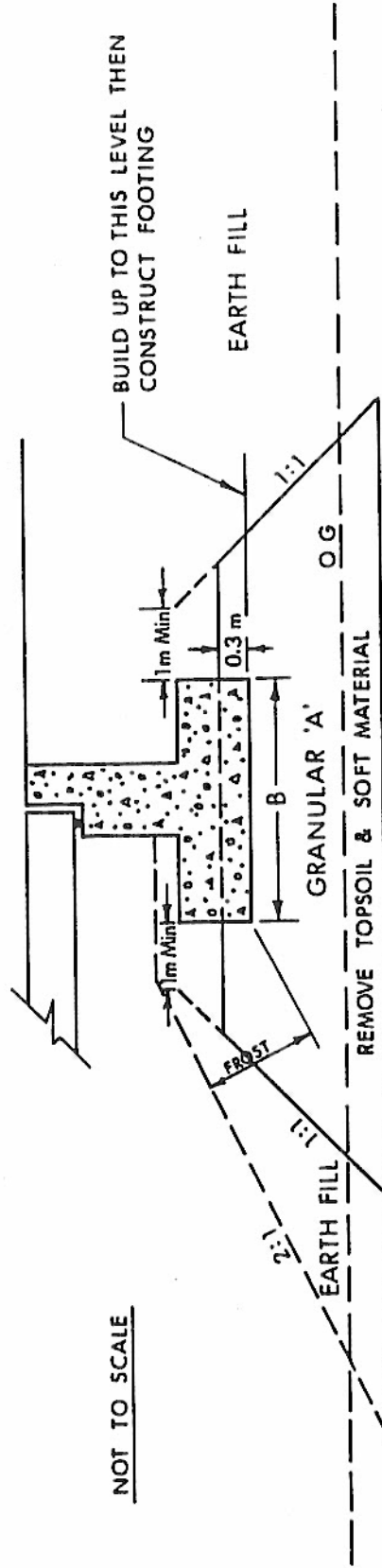
GRAIN SIZE DISTRIBUTION SILTY SAND TO SANDY SILT

FIG No 2

WP 476-89-05



X SECTION



NOT TO SCALE

LONGITUDINAL SECTION

- NOTES:
- 1 - REMOVE TOPSOIL &/OR SOFT SUBSOIL UNDER AREA OF COMPACTED GRANULAR 'A' & EARTH FILL.
 - 2 - PLACE GRANULAR 'A' & EARTH FILL TO BOTTOM OF FOOTING LEVEL, COMPACTED ACCORDING TO CURRENT M T O STANDARDS.
 - 3 - CONSTRUCT CONCRETE FOOTING.
 - 4 - PLACE REMAINDER OF GRANULAR 'A' & EARTH FILL AS REQUIRED.

EXPLANATION OF TERMS USED IN REPORT

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

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

SOILS ARE DESCRIBED BY THEIR COMPOSITION AND CONSISTENCY OR DENSENESS.

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

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

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

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

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

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

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

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

JOINTING AND BEDDING:

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

ABBREVIATIONS AND SYMBOLS

FIELD SAMPLING

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

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 = $w_L - w_p$	v	m/s	DISCHARGE VELOCITY
ρ_{sat}	kg/m ³	DENSITY OF SATURATED SOIL	I_L	1	LIQUIDITY INDEX = $\frac{w - w_p}{I_p}$	i	1	HYDRAULIC GRADIENT
γ_{sat}	kN/m ³	UNIT WEIGHT OF SATURATED SOIL	I_C	1	CONSISTENCY INDEX = $\frac{w_L - w}{I_p}$	k	m/s	HYDRAULIC CONDUCTIVITY
ρ'	kg/m ³	DENSITY OF SUBMERGED SOIL	e_{max}	1, %	VOID RATIO IN LOOSEST STATE	j	kN/m ³	SEEPAGE FORCE
γ'	kN/m ³	UNIT WEIGHT OF SUBMERGED SOIL						

RECORD OF BOREHOLE No 1

1 OF 1

METRIC

W.P. 476 - 89 - 05 LOCATION Co-ords: N 4 754 197.7; E 409 942.7 ORIGINATED BY M V
DIST. 2 HWY 401 BOREHOLE TYPE CONTINUOUS FLIGHT HOLLOW STEM AUGER & CONE TEST COMPILED BY M V
DATUM GEODETIC DATE 93 01 25 TO 93 02 02 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					
261.0	Ground Surface													
0.0	Trace of Sand and Trace of Gravel		1	SS	6		260							
	Occasional Sand Layers		2	SS	15									
			3	SS	46									
			4	SS	34									
			5	SS	29									
			6	SS	27									
			7	SS	26									
	CLAYEY SILT, Hard to Very Stiff		8	SS	20									
			9	SS	36									
			10	SS	21									
			11	SS	23									
	Occasional Silt Layers		12	SS	11									
247.1			13	SS	96									
13.9	SILTY SAND to SANDY SILT, Very Dense		14	SS	112									
243.2			15	SS	15									
17.8	Occasional Silt Layers		16	SS	37									
			17	SS	29									
	CLAYEY SILT, Very Stiff to Hard		18	SS	27									
231.6			19	SS	41									
29.4	End of Borehole													

RECORD OF BOREHOLE No 2

1 OF 1

METRIC

W.P. 476 - 89 - 05 LOCATION Co-ords: N 4 754 185.7; E 409 933.0 ORIGINATED BY M V
DIST 2 HWY 401 BOREHOLE TYPE CONE TEST COMPILED BY M V
DATUM GEODETIC DATE 93 02 11 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					
261.7	Toe of Embankment												
0.0	Probable CLAYEY SILT					260							
259.0													
2.7	End of Cone Test												

RECORD OF BOREHOLE No 3

1 OF 1

METRIC

W.P. 476 - 89 - 05 LOCATION Co-ords: N 4 754 214.0, E 409 931.0 ORIGINATED BY M V
DIST 2 HWY 401 BOREHOLE TYPE CONE TEST COMPILED BY M V
DATUM GEODETIC DATE 93 02 11 CHECKED BY P P

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE 20 40 60 80 100	PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	WATER CONTENT (%) 10 20 30	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE									
260.7	Ground Surface												
0.0	Probable CLAYEY SILT					260							
258.3													
2.4	End of Cone Test										120/28cm		

RECORD OF BOREHOLE No 4

1 OF 1

METRIC

W.P. 476 - 89 - 05 LOCATION Co-ords: N 4 754 199.8; E 409 913.5 ORIGINATED BY M V
DIST 2 HWY 401 BOREHOLE TYPE CONE TEST COMPILED BY M V
DATUM GEODETIC DATE 93 02 11 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					
261.8	Hwy. 401 EBL Shoulder												
0.0	Asphalt												
0.5	Gravelly Sand (Fill)												
	Probable												
	CLAYEY SILT												
259.4													
2.4	End of Cone Test												

RECORD OF BOREHOLE No 5

1 OF 2 METRIC

W.P. 476 - 89 - 05 LOCATION Co-ords: N 4 754 252.4; E 409 903.0 ORIGINATED BY M V
DIST 2 HWY 401 BOREHOLE TYPE CONTINUOUS FLIGHT HOLLOW STEM AUGER & CONE TEST COMPILED BY M V
DATUM GEODETIC DATE 93 02 08 & 09 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					
260.5	Ground Surface													
0.0	Trace of Sand, Trace of Gravel, Occasional Sand Layers		1	SS	31		260							
			2	SS	35		258							
			3	SS	30									
			4	SS	24									
	CLAYEY SILT, Hard to Very Stiff		5	SS	19		256							
			6	SS	17									
254.4			7	SS	20									
6.1			8	SS	30		254							
	Clayey Silt		9	SS	33									
			10	SS	18		252							
			11	SS	58									0 88 (12)
	Clayey Silt		12	SS	24		250							
			13	SS	10		248							0 1 (99)
	SILTY SAND to SANDY SILT, Occasional Clayey Silt Layers, Compact to Very Dense		14	SS	138		246							0 32 (68)
			15	SS	17									
			16	SS	29		244							0 11 89
242.0			17	SS	31		242							
18.5							240							
			18	SS	38		238							
	CLAYEY SILT, Hard to Very Stiff		19	SS	51		236							
							234							
			20	SS	28		232							
230.0														
30.5														

Continued

+3, x5, Numbers refer to
Sensitivity

20
15-0.5 (%) STRAIN AT FAILURE
10

Continued

RECORD OF BOREHOLE No 5

2 OF 2

METRIC

W.P. 476 - 89 - 05 LOCATION Co-ords: N 4 754 252.4; E 409 903.0 ORIGINATED BY M V
DIST 2 HWY 401 BOREHOLE TYPE CONTINUOUS FLIGHT HOLLOW STEM AUGER & CONE TEST COMPILED BY M V
DATUM GEODETIC DATE 93 02 08 & 09 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								
						20	40	60	80	100						
230.0	Continued CLAYEY SILT, Very Stiff		21	SS	17											
30.5																
226.5			22	SS	25											
34.0	End of Borehole															

RECORD OF BOREHOLE No 6

1 OF 1

METRIC

W.P. 476 - 89 - 05 LOCATION Co-ords: N 4 754 230.9; E 409 888.7 ORIGINATED BY M V
DIST 2 HWY 401 BOREHOLE TYPE CONE TEST COMPILED BY M V
DATUM GEODETIC DATE 93 02 08 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					
262.0	Ground Surface												
0.0	Trace of Organics												
	Probable CLAYEY SILT					260							
258.1													
3.9	End of Cone Test							120/25cm					

RECORD OF BOREHOLE No 7

1 OF 1

METRIC

W.P. 476 -- 89 -- 05 LOCATION Co-ords: N 4 754 268.4; E 409 890.7 ORIGINATED BY M V
 DIST 2 HWY 401 BOREHOLE TYPE CONE TEST COMPILED BY M V
 DATUM GEODETIC DATE 93 02 03 CHECKED BY P P

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL * LAB VANE 20 40 60 80 100	PLASTIC LIMIT W _P	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	WATER CONTENT (%) 10 20 30	UNIT WEIGHT 7 kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE									
260.8	Ground Surface												
0.0	Probable CLAYEY SILT												
256.2													
4.6	End of Cone Test												

RECORD OF BOREHOLE No 8

1 OF 2 METRIC

W.P. 476 -- 89 -- 05 LOCATION Co-ords: N 4 754 251.7; E 409 876.6 ORIGINATED BY M V
 DIST 2 HWY 401 BOREHOLE TYPE CONTINUOUS FLIGHT HOLLOW STEM AUGER & CONE TEST COMPILED BY M V
 DATUM GEODETIC DATE 93 02 03 TO 93 02 05 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	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100	20 40 60 80 100	20 40 60 80 100					
262.2	Toe of Embankment														
0.0	CLAYEY SILT, Trace of Gravel, Stiff		1	SS	10		262								
260.3	(Fill) --- Organics		2	SS	16		260								
1.8			3	SS	22										
			4	SS	34										
			5	SS	25										
			6	SS	20										
			7	SS	37										
	--- Sand		8	SS	24										
	CLAYEY SILT, Occasional Silt and Sand Layers, Very Stiff to Hard		9	SS	25										
			10	SS	24										
			11	SS	27										
			12	SS	52										
			13	SS	30										
	Occasional Silt Layers		14	SS	21										
247.7			15	SS	61										
14.5	SILTY SAND to SANDY SILT, Very Dense		16	SS	143	/15cm									0 36 (64)
			17	SS	59										
242.0			18	SS	30										0 88 (12)
20.2			19	SS	26										
	CLAYEY SILT, Very Stiff to Hard		20	SS	54										
231.7															
30.5															

Continued

+3, x5, Numbers refer to
Sensitivity

20
15-5 (%) STRAIN AT FAILURE
10

Continued

METRIC

[illegible]

+3, x5: Numbers refer to Sensitivity

RECORD OF BOREHOLE No 102

1 OF 1

METRIC

W.P. 476 - 89 - 05 LOCATION Co-ords: N 4 754 215.1; E 409 881.1 ORIGINATED BY R. MacC&A
DIST 2 HWY 401 BOREHOLE TYPE WASHBORING COMPILED BY M V
DATUM GEODETTIC DATE 54 10 28 TO 54 10 30 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					
260.8	Ground Surface																
0.0						*											
	Some Gravel		1	SS	38		260										
			2	SS	26		258										
	CLAYEY SILT, Hard to Very Stiff		3	SS	26		256										
254.6			4	SS	40		254										
6.3	SAND, Dense		5	SS	26		252										
253.3			6	SS	13		250										
7.6	CLAYEY SILT, Very Stiff to Stiff		7	SS	9		248										
			8	SS	8		246										
			9	SS	12		244										
246.2			10	SS	58		242										
14.7	SANDY SILT, Very Dense						240										
241.4																	
19.5	CLAYEY SILT, Very Stiff to Hard																
239.6			11	SS	--												
21.3	End of Borehole Note: Formerly BH# 2 of 54 - F - 224C R MacC&A: Racey MacCollum and Associates * Water Level Not Observed																

RECORD OF BOREHOLE No 104

1 OF 1

METRIC

W.P. 476 - 89 - 05 LOCATION Co-ords: N 4 754 190.1; E 409 901.6 ORIGINATED BY R McC&A
DIST 2 HWY 401 BOREHOLE TYPE WASHBORING COMPILED BY M V
DATUM GEODETTIC DATE 54 11 01 TO 54 11 03 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						*											
	Occasional Sand Layers		1	SS	25		260										
							258										
							256										
	Occasional Silt Layers						254										
			2	SS	14		252										
	CLAYEY SILT, Very Stiff to Stiff						250										
			3	SS	12		248										
246.1							246										
14.8			4	SS	90		244										
	SANDY SILT, Very Dense						242										
241.1																	
240.6	CLAYEY SILT, Very Stiff																
20.3	End of Borehole Note: Formerly BH# 4 of 54 - F - 224C R McC&A: Roney MacCallum and Associates * Water Level Not Observed																

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

CONT No
WP No 476-89-05

WELLINGTON RD REV, U'PASS

BORE HOLE LOCATIONS & SOIL STRATA



SHEET

