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GEOCRE'S No. 30 M 12-180

DIST. 6 REGION

W.P. No. 21-79-06

CONT. No. 88-67

W. O. No.

STR. SITE No. 24-145-475

HWY. No. 410

LOCATION Vodden St. Extension

No. of PAGES -

OVERSIZE DRAWINGS TO BE INCLUDED WITH THIS REPORT.

REMARKS:

G.I.-30 SEPT. 1976

FOUNDATION INVESTIGATION REPORT

CONTRACT NO 88-67



Ministry of
Transportation and
Communications

I N D E X

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

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

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	ku/m ³	SEEPAGE FORCE
γ'	kN/m ³	UNIT WEIGHT OF SUBMERGED SOIL						

FOUNDATION INVESTIGATION REPORT
For
Vodden St. Extension Underpass
W.P. 21-79-06; Site 24-145-475
Hwy. #410, District 6, Toronto

INTRODUCTION:

This report summarizes the factual information from a foundation investigation carried out between 83-07-15 and 83-07-19 at the above mentioned structure site. The fieldwork consisted of 6 sampled boreholes advanced by means of hollow and solid stem augers. The boreholes ranged in depth from 7.7 to 14.3 m below ground surface.

SITE DESCRIPTION

The site is located at the existing intersection of Heart Lake Road and Vodden Street, in the City of Brampton, Municipality of Peel.

Land use in the area is predominantly residential subdivisions west of Heart Lake Road and agricultural to the east. A large abandoned gravel pit is located approximately 250 m east of Heart Lake Road. Topography across the site is generally flat with the ground surface sloping gently to the south.

The site is located in the physiographic region known as the "Peel Plain". This region is characterized by a level to undulating "till on boulder clay" plain underlain by shale or limestone bedrock. Locally there is a partly buried esker which runs to the east of the site and extends northwest. The esker serves as a source of aggregate material and as an aquifer for wells.

SUBSURFACE CONDITIONS

General

The predominant deposit across the site consists of a loose to very dense silt with sand, trace of clay, trace of gravel. This deposit was investigated to a maximum depth of 14.0 m with occasional 0.3 to 0.6 m sand seams being encountered.

The surficial deposit in the central and eastern sections of the site is a very stiff to hard silty clay with a maximum thickness of 3 m.

A 2.4 to 7.1 m stratum of sand with silt, trace of clay, trace of gravel is found sandwiched within and between the other two major deposits in the north central and eastern portions of the investigated area.

The boundaries between the various soil types, in situ and laboratory test results are shown on the attached Record of Borehole Sheets. The elevations and locations of the boreholes are shown on Drawing No. 217906-A,** along with three estimated stratigraphical sections based on borehole data.

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

Silt with Sand, trace of Clay, trace of Gravel

The deposit of silt with sand, trace of clay, trace of gravel is found across the entire investigated site and was explored to a maximum depth of 14.3 m. Occasional sand seams of 0.3 to 0.6 m were encountered in the upper half of the deposit with occasional cobbles and/or boulders generally encountered in the lower half, below elevation 225. One exception is in the southeast corner of the site where cobbles or boulders were encountered between elevations 229 and 225.

The results of grain size distribution tests conducted on samples from this stratum indicate there is some variance in the sand and gravel contents and a very uniform clay content. The results of these tests are plotted in the form of an envelope on Figure 1.

Atterberg limit testing completed on samples from this deposit indicate the silt to be generally non-plastic with a few zones of slightly plastic material (ML zone); results are plotted on Figure 4.

Interpretation of N values ranging from 7 blows per 0.3 m to 100 blows per 8 cm indicate the denseness of this generally non-plastic silt to vary from loose in the surficial zones to very dense in the rest of the deposit.

Silty Clay, with Sand, some Gravel

The surficial deposit of silty clay, with sand and some gravel is found in the central and eastern sections of the site and varies in thickness from 1.4 to 3 m.

** NOTE: Refer to Drawing No. 2 of the Contract Drawings.

Two grain size distribution tests completed on samples from this stratum indicate a relatively uniform grain size distribution. The results of these tests are plotted on Figure 2.

Atterberg limit testing was completed on samples from this deposit and results are plotted on Figure 4. The atterberg limits indicate this stratum to be a silty clay of low plasticity (CL zone).

The consistency of the deposit is assessed as being very stiff to hard based on N values ranges from 15 blows per 0.3 m to 87 blows per 23 cm.

Sand with Silt, trace Clay, Trace Gravel

The sand with silt, trace of clay and trace of gravel deposit is found underlying the silt in the north central section of the site and sandwiched within or between the silty clay and silt layers in the eastern sector. The stratum varies in thickness from 2.4 to 7.1 m.

The results of grain size distribution tests conducted on samples from this stratum are plotted in the form of an envelope on Figure 3. The plot indicates some variance in the size of the sand particles from fine to medium.

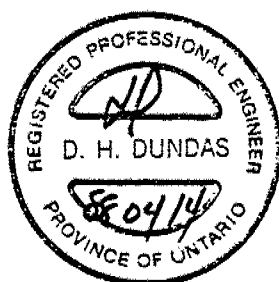
Based on N values ranging from 3 blows per 0.3 m to 70 blows per 8 cm the deposit is assessed as being very loose to very dense, with the majority of the deposit being very dense.

Groundwater Conditions

Overnight stabilized water level readings taken in five open boreholes indicated an approximate groundwater elevation of 230. Water levels taken in 3 boreholes on the same day varied from 1 to 10 m lower than the overnight readings, with the large variance being a result of whether water bearing sand seams were encountered.

MISCELLANEOUS

The fieldwork for this investigation was carried out under the supervision of Mr. H. J. Sturm, Project Foundations Engineer, using equipment owned and operated by Master Soil Investigation, Toronto. The report was written by Mr. Sturm and reviewed by Mr. M. Devata, Senior Foundations Engineer.



D. H. Dundas

D. H. Dundas, P. Eng

Senior Foundations Engineer

M. Devata

M. Devata, P. Eng.

Chief Foundations Engineer

(East)

APPENDIX

RECORD OF BOREHOLE No 1										METRIC				
W P 21-79-06		LOCATION Co-ords N 4 841 233.5; E 284 839.2				ORIGINATED BY HS								
DIST 6 HWY 410		BOREHOLE TYPE Hollow Stem Augers				COMPILED BY HS								
DATUM Geodetic		DATE 1983 07 15				CHECKED BY								
ELEV DEPTH	SOIL PROFILE DESCRIPTION	STRAT PLOT	SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC NATURAL LIQUID LIMIT MOISTURE CONTENT LIMIT			UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
			NUMBER	TYPE	'N' VALUES			20 40 60 80 100	W _p W W _L	WATER CONTENT (%)				
232.0	Ground Surface													
0.0	Silty Clay with Sand Some Gravel	Very Stiff	1	SS	15									0 80 15 5
230.6			2	SS	6									
1.4		Very Loose	3	SS	3									
			4	SS	88	15 cm								10 47 36 7
			5	SS	100	15 cm								
	Sand with Silt Trace Clay Trace Gravel		6	SS	108	28 cm								13 46 36 5
			7	SS	79	8 cm								
		Very Dense	8	SS	75	10 cm								
223.5	Occ. cobbles or boulders		9	SS	100	23 cm								
8.5			10	SS	90	15 cm								2 22 71 5
	Silt with Sand Trace Clay Trace Gravel Occasional Cobbles or Boulders Very Dense		11	SS	90	15 cm								
218.0			12	SS	105	23 cm								1 28 68 3
14.0	End of Borehole													
	* Overnight water level not established													
	** Water level taken after completion of borehole													

OFFICE REPORT ON SOIL EXPLORATION

OFFICE REPORT ON SOIL EXPLORATION

RECORD OF BOREHOLE No 2										METRIC		
W P 21-79-06		LOCATION Co-ords N 4 841 201.7; E 284 816.3		ORIGINATED BY HS								
DIST 6 HWY 410		BOREHOLE TYPE Solid Stem Augers		COMPILED BY HS								
DATUM Geodetic		DATE 1983 07 18		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 Y	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER			TYPE	'N' VALUES					
231.5	Ground Surface											GR SA SI CL
0.0	Silty Clay With Sand Some Gravel Very Stiff to Hard		1	SS	20							
			2	SS	35							
228.7			3	SS	41							18 29 33 20
2.8			4	SS	54							
	Silt With Sand Trace Clay Trace Gravel		5	SS	81							6 55 34 5
			6	SS	104	23						21 34 40 5
			7	SS	90	13						
224.2	Very Dense		8	SS	85	18						11 43 40 6
7.3	Occasional Cobbles or Boulders		9	SS	90	23						9 49 35 7
	Sand With Silt Trace Clay Trace Gravel Very Dense		10	SS	90	10						
			11	SS	100	14						
217.2			12	SS	100	23						6 66 24 4
14.3	End of Borehole											

RECORD OF BOREHOLE No 3

METRIC

W P 21-79-06 LOCATION Co-ords N 4 841 186.2; E 284 785.2 ORIGINATED BY HS
 DIST 6 HWY 410 BOREHOLE TYPE Hollow Stem Augers COMPILED BY HS
 DATUM Geodetic DATE 1983 07 18 CHECKED BY SP

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 Y	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES		20	40	60	80	100					
221.7	Ground Surface															
0.0																
	Loose to Compact		1	SS	7											
			2	SS	22											
			3	SS	45											
	Silt With Sand		4	SS	44											4 44 48 4
	Trace Clay		5	SS	80	8 cm										
	Trace Gravel		6	SS	81	15 cm										2 36 57 5
	Very Dense		7	SS	90	10 cm										
	Occasional Cobbles or Boulders		8	SS	100	8 cm										
			9	SS	100	13 cm										
			10	SS	100	20 cm										10 36 48 6
			11	SS	114	23 cm										
217.8			12	SS	100	13 cm										7 40 47 6
13.9	End of Borehole															
	** Water level taken after completion of borehole															

OFFICE REPORT ON SOIL EXPLORATION

RECORD OF BOREHOLE No 4										METRIC			
W P 21-79-06		LOCATION Co-ords N 4 841 176.6; E 284 795.5		ORIGINATED BY HS									
DIST 6 HWY 410		BOREHOLE TYPE Solid Stem Augers		COMPILED BY HS									
DATUM Geodetic		DATE 1983 07 19		CHECKED BY <i>EP</i>									
SOIL PROFILE			SAMPLES		GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT <i>V</i>		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 PILOT	NUMBER	TYPE			VALUES	20					
231.7	Ground Surface												
0.0	Loose to Compact		1	SS	7								
	Sand		2	SS	24								
			3	SS	62								
	Silt With Sand Trace Clay Trace Gravel Very Dense		4	SS	90	23 cm							0 21 74 5
			5	SS	100	14 cm							2 37 56 5
			6	SS	100	8 cm							
224.0			7	SS	100	8 cm							
7.7	End of Borehole												

OFFICE REPORT ON SOIL EXPLORATION

RECORD OF BOREHOLE No 5

METRIC

W P 21-79-06 LOCATION Co-ords N 4 841 192.5; E 284 824.5 ORIGINATED BY HS
 DIST 6 HWY 410 BOREHOLE TYPE Solid Stem Augers COMPILED BY HS
 DATUM Geodetic DATE 1983 07 19 CHECKED BY CP

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			20	40	60	80	100				
231.4	Ground Surface														
0.0	Silty Clay With Sand Some Gravel		1	SS	43										
			2	SS	47										
228.4	Hard		3	SS	52										
3.0	Silt With Sand Trace Clay Trace Gravel		4	SS	58										
			5	SS	100/23	cm									
			6	SS	100/23	cm									
223.7	Very Dense		7	SS	100/8	cm									
7.7	End of Borehole														

OFFICE REPORT ON SOIL EXPLORATION

RECORD OF BOREHOLE No 6

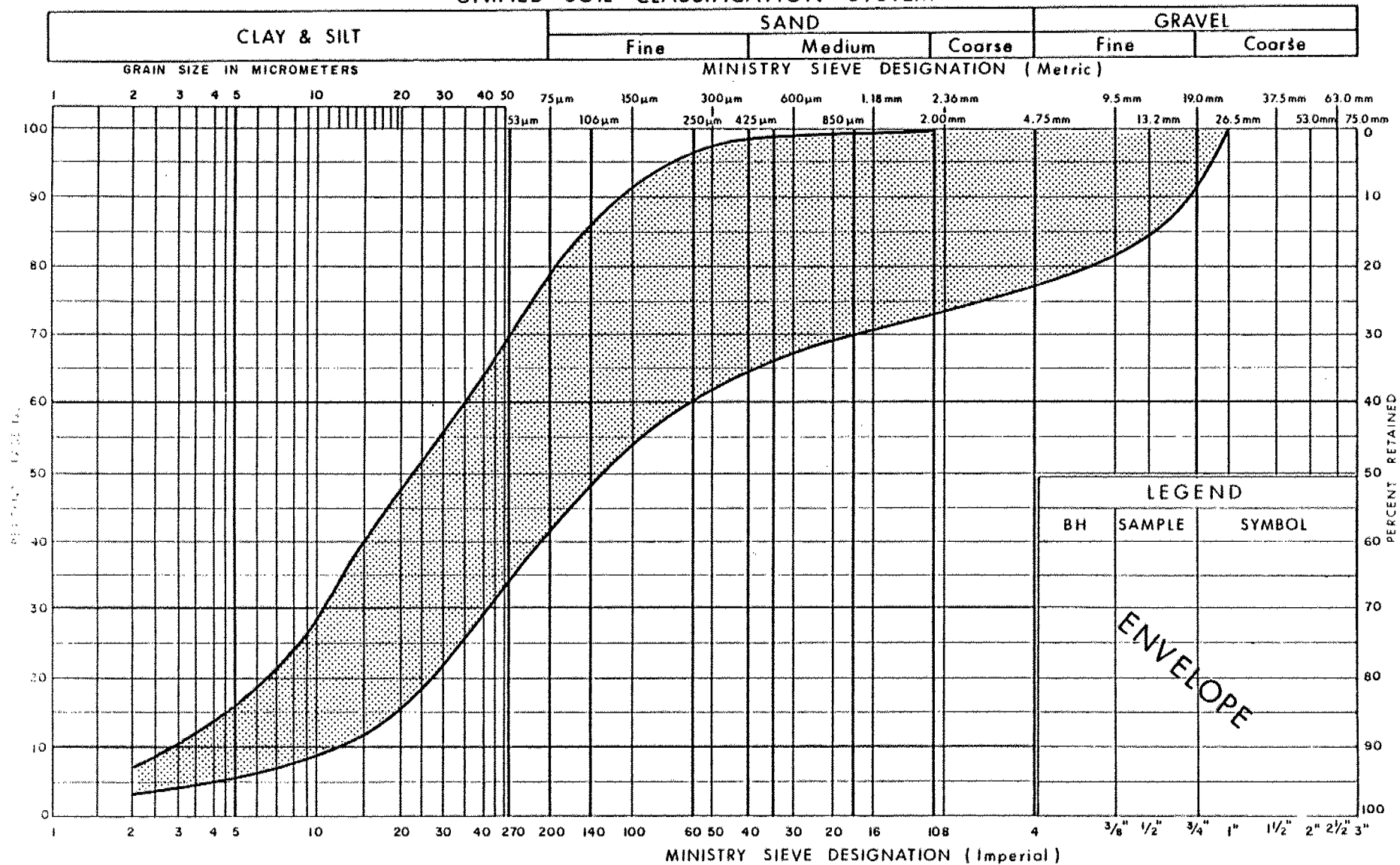
METRIC

W P 21-79-06 LOCATION Co-ords N 4 841 216.0; E 284 858.7 ORIGINATED BY HS
 DIST 6 HWY 410 BOREHOLE TYPE Solid Stem Augers COMPILED BY HS
 DATUM Geodetic DATE 1983 07 19 CHECKED BY HS

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			20	40	60	80	100					
231.9	Ground Surface															
0.0	Silty Clay With Sand Some Gravel		1	SS	42											18 29 36 17
229.8	Hard		2	SS	52											
2.1	Silt With Sand Occ. Trace Clay Cobbles Trace Gravel or Boulders Very Dense		3	SS	87	23										
			4	SS	89	23										
			5	SS	100	8 cm										
226.1			6	SS	100	13 cm										9 64 24 3
5.8	Sand With Silt Trace Clay Trace Gravel Very Dense		7	SS	100	8 cm										11 46 32 11
223.7			8	SS	100	13 cm										
8.2	Silt Very Dense															
222.6																
9.3	End of Borehole															

OFFICE REPORT ON SOIL EXPLORATION

UNIFIED SOIL CLASSIFICATION SYSTEM



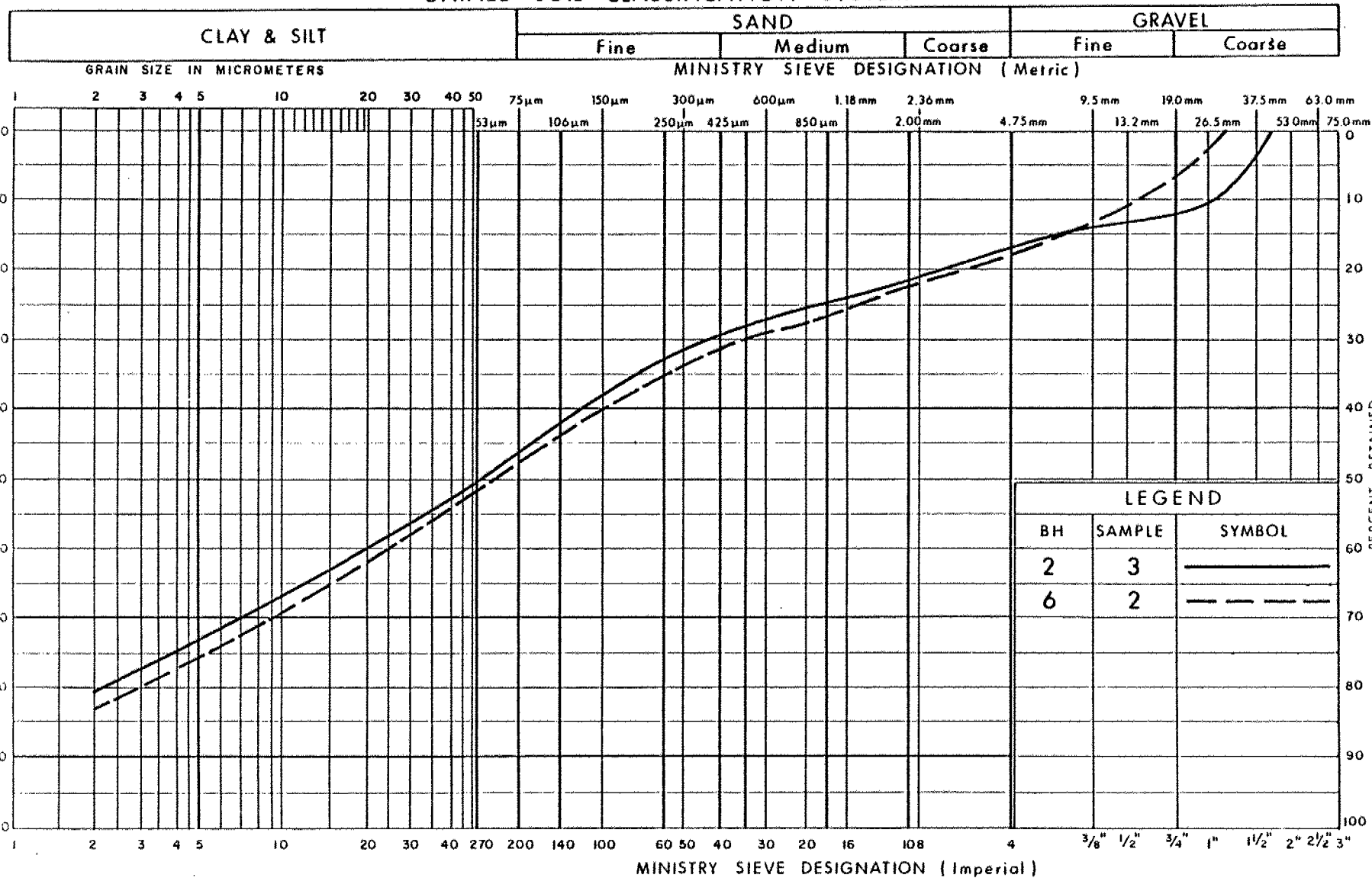
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GRAIN SIZE DISTRIBUTION
SILT WITH SAND, TRACE OF CLAY & GRAVEL

FIG No 1

W P 21-79-06

UNIFIED SOIL CLASSIFICATION SYSTEM



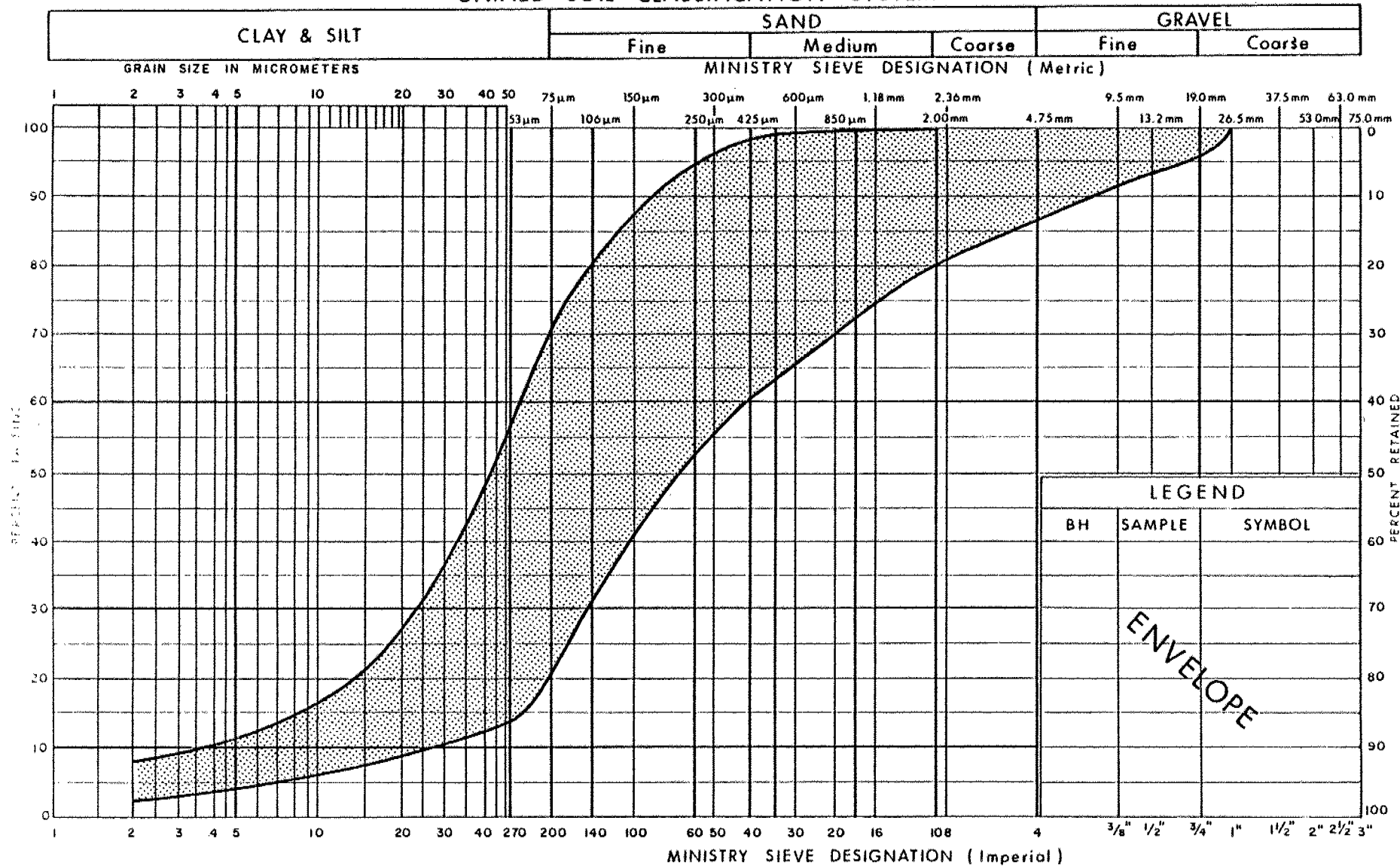
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GRAIN SIZE DISTRIBUTION
SILTY CLAY WITH SAND, SOME GRAVEL

FIG No 2

W P 21-79-06

UNIFIED SOIL CLASSIFICATION SYSTEM

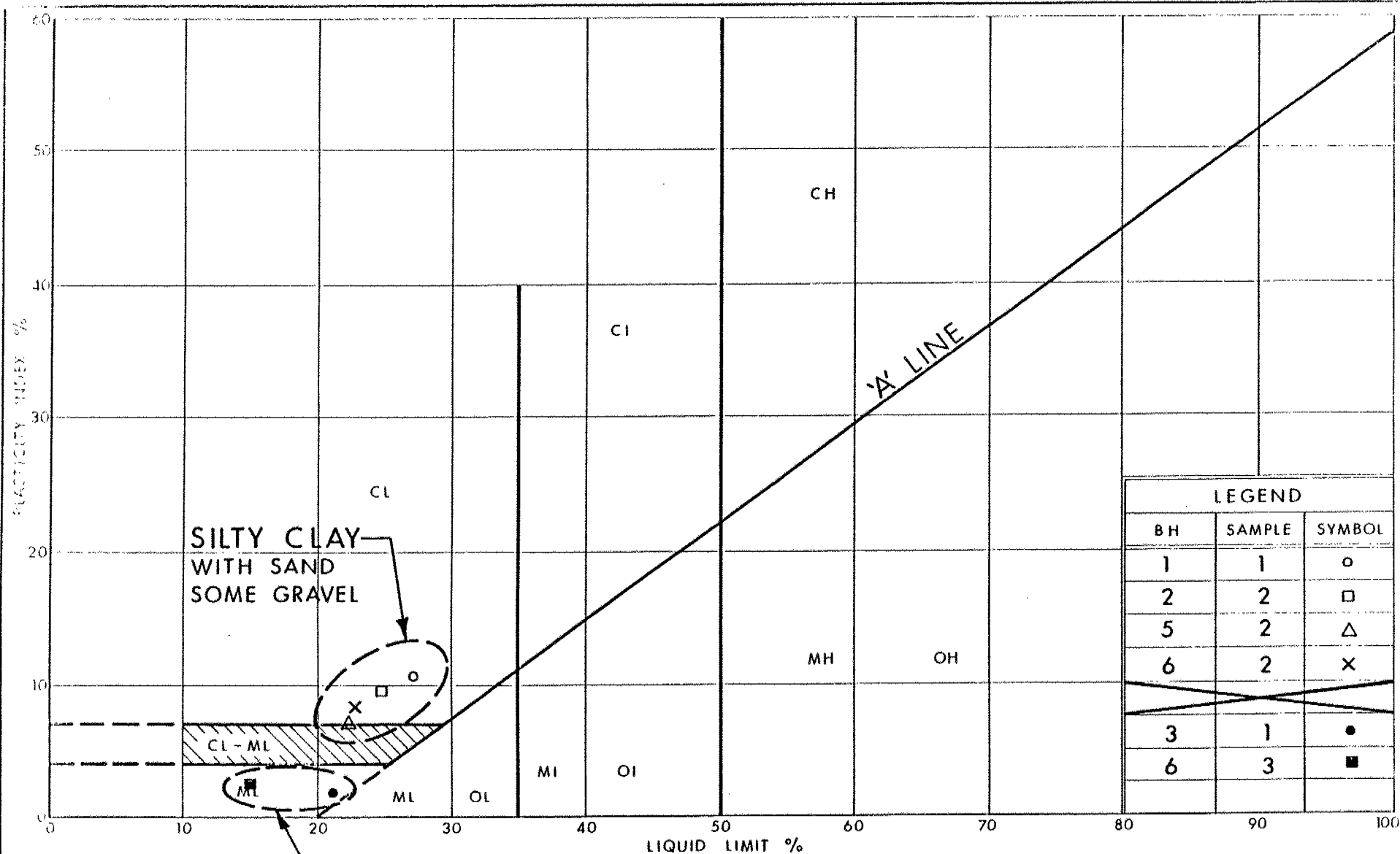


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GRAIN SIZE DISTRIBUTION
SAND WITH SILT, TRACE OF CLAY & GRAVEL

FIG No 3

W P 21-79-06



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PLASTICITY CHART

SILT WITH SAND
TRACE OF CLAY & GRAVEL

FIG No 4

W P 21-79-06

For

Brampton Esker Outlet Extension

Hwy. 410 and Williams Parkway

W.P. 21-79-13

District 6, Toronto

INTRODUCTION

This report summarizes the information obtained from a foundation investigation carried out at the above-noted site between 86 09 23 and 86 09 24 and between 86 12 17 and 86 12 22. The fieldwork consisted of 6 sampled boreholes (BH 1, 2 and 12 to 15) advanced by means of hollow stem augers. A dynamic cone penetration test accompanied two of the boreholes. The six boreholes were advanced to depths ranging between 7.8 and 15.5 m below the ground surface.

In Sept. 1986, a subsurface investigation was carried out immediately adjacent to this site for a proposed Esker Outlet alignment which has since been revised to the alignment described in this report. The investigation consisted of 5 boreholes identified as BH 1 to BH 5. BH 1 and BH 2 have been incorporated in this report.

SITE DESCRIPTION AND GEOLOGY

The site is located in the vicinity of the intersection of Hwy. 410 (Heart Lake Road) and Williams Parkway, in the City of Brampton, Municipality of Peel.

Land in the general area is predominantly used for residential subdivisions. However, an extensive gravel pit immediately to the north of the site is still operational. A large park with a pond is situated in the north-west quadrant of the intersection of Heart Lake Road and Williams Parkway. Topography across the immediate site is gently rolling with a large knob in the north-west quadrant of the intersection. The general topography across the site slopes gently towards the southeast.

The site is located in the physiographic region known as the "Peel Plain". This region is generally characterized by a level to undulating "till or boulder clay plain" underlain by shale or limestone bedrock. Locally, there is a partly buried esker which runs to the east of the site. The esker serves as a source of aggregate material and as an aquifer for local wells.

SUBSURFACE CONDITIONS

The predominant deposits across the site are non-cohesive in nature and consist primarily of fine to medium sands, and of a heterogeneous mixture of sand and gravel (glacial till). Silty clay fill is also encountered.

The boundaries between the various soil types, in-situ and laboratory test results, as well as groundwater levels are shown on the Record of Borehole sheets in the Appendix. The location of each borehole is shown in plan on Dwg. No. 217913-A together with a longitudinal stratigraphical section along the Esker Outlet Extension centreline.

For information only, the Record of Borehole Sheets for BH 3, 4 and 5, previously mentioned, have been included in the Appendix. The location of these boreholes are also shown in plan on Dwg. No. 217913-A.

The various soils encountered at this site are described as follows:

Topsoil

The area through which the Esker Outlet Extension will be constructed is generally covered by a veneer of topsoil with the obvious exception of where the ground is covered by pavement or shoulder material. The thickness of the topsoil varies between 120 and 250 mm and consists primarily of silt with organics or silty clay with organics.

In BH 3, the original topsoil was encountered under approximately 5.2 m of fill material. At this location, the lower topsoil stratum was found to have a thickness of about 300 mm.

Silty Clay (Fill)

Silty clay fill was encountered in BH 1, 2, 12, 13 extending from under the topsoil to depths ranging between 1.5 and 7.9 m below the ground surface.

The results of Atterberg Limits testing carried out on 7 samples of this cohesive material are shown on Figure 1 in the Appendix and can be summarized as follows:

		<u>Range (%)</u>
Moisture Content	(Wo)	10 - 24
Liquid Limit	(WL)	21.5 - 34.5
Plastic Limit	(WP)	15 - 22
Plasticity Index	(Ip)	4.5 - 15

The results indicate that this cohesive material consists of a silty clay of low plasticity (CL group).

No field or laboratory shear tests were carried out on samples of this material. However, based on the interpretation of standard Penetration Test 'N' values obtained within the material, it could be assumed that the fill has been well compacted.

The results of grain size distribution tests carried out on 7 samples of this material are shown in envelope form on Figure 2 in the Appendix, and are summarized as follows:

	<u>Range (%)</u>	<u>Average (%)</u>
Gravel	3 - 13	6
Sand	17 - 58	37
Silt	29 - 62	42
Clay	5 - 30	15

It should be noted that within the fill material it may be possible to encounter occasional cobbles and boulders. Similarly, it is possible to encounter large buried tree stumps. Occasional large tree stumps were encountered in the immediate vicinity of this site in a recent excavation carried out for the construction of the Hwy. 410 ramps immediately north of Williams Parkway. In addition, tree stumps were encountered in this investigation in BH 13, as shown on the Record of Borehole Sheet #3.

Seams of fine to medium sand were randomly found within the fill material. The seams vary in thickness, but are generally less than 1 m.

Sand with gravel, trace silt (Fill)

Well graded sand with gravel fill was found in BH 14 and 15 extending from the ground surface down to a depth of 3.0 and 3.7 m respectively.

A grain size distribution test was carried out on a sample of this material and the results indicate 26% gravel, 62% sand, 10% silt and 2% clay. The results are plotted on Figure 3. However, based on visual examination of the recovered samples, it appears that the gravel content varies up to 40%±.

Occasional thin seams of silt or fine sand may be randomly encountered within this non-cohesive fill, as well as occasional cobbles.

Based on the interpretation of Standard Penetration Test 'N' values, this fill is considered to be well compacted.

Fine to Medium Sand

A deposit of fine to medium sand was encountered below the silty clay fill in BH 1, 2 and 12. In BH 1, this non-cohesive deposit was found to extend from 1.5 to 2.9 m below the ground surface. In BH 2, the deposit was found to be the thickest, and encountered between depths of 2.4 and 10.5 m, while in BH 12, this sand stratum was found between depths of 7.9 and 9.4 m below the ground surface.

Based on the interpretation of Standard Penetration Test 'N' values ranging generally between 17 and 25 blows/0.3 m, the deposit is considered to be in a compact state. However, loose and dense zones may also be encountered.

Grain size distribution tests were carried out on 4 samples of this non-cohesive material and the results are shown in Figure 4 in the Appendix. The results can also be summarized as follows:

	<u>Range (%)</u>
Gravel	0 - 3
Sand	87 - 91
Silt and Clay	4 - 13

Based on the results, this material can be described as a fine to medium sand, trace gravel, silt, clay.

In BH 2, it was determined that below Elev. 229±, the sand particles become coarser with depth.

The natural moisture content of this deposit was found to vary between 2.5% and 4.5% in the 4 samples tested.

It should be noted that when this cohesionless deposit is excavated or directly tunnelled into, below the prevailing groundwater level, seepage, caving or 'boiling' could result.

Silty Clay

A seam of silty clay was encountered in BH 2 at a depth of 10.5 m below the ground surface. The thickness was determined to be approximately 1.5 m.

Based on visual identification, it appears that the deposit consists of a silty clay of low plasticity (CL group), with sand, trace gravel.

Based on a Standard Penetration Test 'N' value of 10 blows/0.3 m, this cohesive deposit is considered to have a stiff consistency.

Heterogeneous Mixture of Sand and Gravel, trace silt, clay (Glacial Till)

The predominant material across this site consists of a glacial mixture of sand and gravel and was encountered in all boreholes at depths ranging between 2.4 and 7.9 m below the ground surface. The surface of this generally non-cohesive till was found to undulate as it was encountered between Elev. 225.6 and 234.3.

Based on the interpretation of Standard Penetration Test 'N' values generally over 50 blows/0.3 m, this deposit is considered to be in a dense to very dense state.

Figure 5 in the Appendix illustrates in envelope form the results of grain size distribution tests carried out on 15 samples of this material. The results can be summarized as follows:

	<u>Range (%)</u>	<u>Average (%)</u>
Gravel	29 - 65 (but generally >40)	47
Sand	30 - 55	42
Silt	3 - 13	9
Clay	1 - 4	2

As evidenced by the results, only traces of silt and clay are included. In addition, occasional to frequent cobbles, and possibly boulders may be encountered randomly throughout this deposit.

The natural moisture content as measured in 15 samples of this material was found to range between 3% and 8.5%, with an average moisture content of 6%.

Generally this glacial deposit is cohesionless in nature. However, occasional isolated slightly plastic zones may be randomly encountered. Seams of varying thickness of sand or silt may also be found within the deposit.

It should be noted that if this material is directly tunnelled or excavated into, below the prevailing groundwater level, seepage and caving can be anticipated unless appropriate control measures are adopted.

Sand with Silt

A 1.2 m thick seam of well graded sand with silt was encountered in BH 13 at a depth of 5.2 m below the ground surface.

A grain size distribution test was carried out on a sample of this non-cohesive material, and the results are indicated on Figure 3 in the Appendix. The results can be summarized as follows: 9% gravel, 58% sand, 23% silt and 10% clay. As evidenced, the deposit also contains traces of gravel and clay.

Sand with Gravel

A 3.6 m thick deposit of sand with gravel was encountered in BH 15 at a depth of 3.7 m below the ground surface.

A grain size distribution test was carried out on a sample of this non-cohesive material, and the results are shown on Figure 3 in the Appendix. The results indicate that the tested sample consisted of 30% gravel, 58% sand, 10% silt, and 2% clay.

Based on the interpretation of Standard Penetration Test 'N' values of 29 and 41 blows/0.3 m, this deposit is considered to be in a dense state.

GROUNDWATER CONDITIONS

Standpipes were installed in each borehole with the exception of BH 14 so that stabilized groundwater levels could be determined after the boreholes were back-filled. The standpipes were installed such that they would effectively function as piezometers.

The standpipes consisted of 13 mm O.D. CPVC pipe and were saw-slotted at the tip for sections varying between 200 and 450 mm. The slotted sections were enveloped in free-draining 'P-Gravel' and the boreholes were sealed with bentonite pellets above and below the slotted standpipe section. The impermeable seals were a minimum of 350 mm thick. This type of installation ensured that the standpipes would function as piezometers.

The Record of Borehole Sheets in the Appendix illustrate the standpipe installation details.

Table 1 below summarizes the groundwater conditions across the site as determined by the field measurements within the standpipes or open boreholes.

The groundwater levels shown on the Record of Borehole Sheets most probably represent the seasonal stabilized conditions on the date indicated. It should, however, be noted that the levels may fluctuate somewhat in accordance with the time of year.

No artesian conditions were encountered with the area investigated.

As previously noted, a small pond is situated in the north-west quadrant of the intersection of Heart Lake Road and Williams Parkway. The pond is located about 350 m west of Heart Lake Road. On 86 12 23, the level of the water/ice in the pond was at Elev. 229.6±.

TABLE 1
GROUNDWATER LEVELS

Borehole (BH)	1	2	12	13	14	15
Ground Elev. @ Borehole	231.1	237.5	240.8	237.4	237.3	238.2
Date Standpipe Installed	86 09 23	86 09 24	86 12 17	86 12 18	86 12 22	86 12 19
Standpipe Tip Elev.	225.2	227.7	225.5	224.9	N/A*	224.2
Groundwater Level in open Borehole **	226.8	227.0	226.1	225.7	226.1	
Standpipe Groundwater Levels						
86 09 25	227.4	-	-	-	-	-
86 09 26	227.6	STDPIPE. DRY	-	-	-	-
86 10 08	227.7	***	-	-	-	-
86 12 05	227.5	"	-	-	-	-
86 12 22	227.4	"	227.6	227.3	-	226.8
87 01 09	227.6	"	227.6	227.3	-	226.8

NOTES:

* No standpipes installed

** Levels were measured in open boreholes at completion of borehole sampling. Levels may not therefore be stabilized.

*** Groundwater level in BH 2 below Elev. 227.7 as of 87 01 09.

MISCELLANEOUS

The fieldwork for this investigation was carried out during the period from 86 09 23 to 86 09 24 and 86 12 17 to 86 12 22 under the supervision of L. Politano (Project Foundations Engineer), R. Kohlberger (Trainee Engineer) and V. Bonnici (Student Engineer). The equipment used was owned and operated by Master Soil Investigations Ltd. of Toronto.

This report was written by L. Politano and reviewed by M. Devata, Chief Foundations Engineer (East).



D. H. Dundas

D. H. Dundas, P. Eng.

Sr. Foundations Engineer

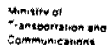
M. Devata

M. Devata, P. Eng.

Chief Foundations Engineer

(East)

APPENDIX



METRIC

W P 21-79-13 LOCATION Co-ords. N 4 841 575.5; E 284 276.0
Sta. 1 + 000 1m Rt. of Outlet C ORIGINATED BY VB
 DIST 6 HWY 410 BOREHOLE TYPE Hollow Stem Auger, Cone Test COMPILED BY LP
 DATUM Geodetic DATE 86 09 23 CHECKED BY _____

[illegible]

RECORD OF BOREHOLE No 2

METRIC

W P 21-79-13 LOCATION Co-ords. N 4 841 576.5; E 284 302.0
DIST 6 HWY 410 BOREHOLE TYPE Hollow Stem Auger, Cone Test ORIGINATED BY VB
DATUM Geodetic DATE 86 09 24 COMPILED BY LP
CHECKED BY

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	SIRAT PLOT	NUMBER	TYPE	'N' VALUES								
237.5	Ground Surface		1	SS	7								
0.0	Silty Clay with sand trace gravel (CL) Occasional cobbles (Fill)		2	SS	15								7 30 43 20
235.1			3	SS	36								13 37 37 13
2.4	Fine to Medium Sand trace silt, clay		4	SS	49								0 87 8 5
	fine sand and silt		5	SS	18								3 40 54 3
			6	SS	19								
			7	SS	25								
			8	SS	20								
	Sand becoming coarser with depth		9	SS	17								0 91 8 1
	Compact		10	SS	19								
227.0			11	SS	10								
10.5	Silty Clay with sand trace gravel (CL) Stiff		12	SS	42								66 30 3 1
225.6	Heterogeneous mixture sand and gravel, trace silt, clay (Glacial Till) numerous cobbles and boulders		13	SS	100/	15 cm							
11.9			14	SS	100/	15 cm							
223.3	End of Borehole		15	SS	100/	15 cm							
14.2	* Spoon bouncing probable cobble												
	** Standpipe dry water level measured in open borehole on 86 09 24. Water level indicated here may not represent stabilized condi- tion.												

STANDPIPE INSTALLED
BOTTOM 450mm SLOTTED

RECORD OF BOREHOLE No 3

METRIC

W P 21-79-13 LOCATION Co-ords. N 4 841 569.0; E 284 338.5 ORIGINATED BY VB
 DIST 6 HWY 410 BOREHOLE TYPE Hollow Stem Auger, Cone Test COMPILED BY LP
 DATUM Geodetic DATE 86 09 25/26 CHECKED BY

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 Wp NATURAL MOISTURE CONTENT W LIQUID LIMIT Wl WATER CONTENT (%) 10 20 30	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE						
240.3	Ground Surface									
0.0	Topsoil		11	SS	9	240				5 22 52 21
	Silty Clay some sand trace gravel (Fill) gravel content increases with depth		2	SS	14					7 18 46 29
237.9			31	SS	11					
2.4	Fine to Medium Sand with silt, trace clay, gravel (Fill) Occasional boulders decayed wood		41	SS	25	238				5 67 21 7
			51	SS	14					1 62 27 10
234.5	Topsoil (organics)		61	SS	2	236				3 41 41 15
			71	SS	23					
5.8	Silty clay with sand trace gravel (CL)		81	SS	3	234				7 37 38 18
	Firm to Very Stiff		91	SS	4					
230.8			101	SS	16	232				
			111	SS	26					
9.5	Heterogeneous mixture sand and gravel, some silt, clay (Glacial Till) Occasional to numerous cobbles and boulders Dense to Very Dense		121	SS	76	230				21 47 22 10
			131	SS	30					
			141	SS	129	228				
			151	SS	33					
	Fine to Medium Sand Compact		161	SS	19	226				
223.8			171	SS	38	224				
16.5	End of Borehole * cone bouncing probable cobble ** On 86 11 05									

STANDPIPE INSTALLED
BOTTOM 400mm SLOTTED

RECORD OF BOREHOLE No 4

METRIC

W P 21-79-13 LOCATION Co-ords. N 4 841 579.5: E 284 411.5 ORIGINATED BY VB
DIST 6 HWY 410 BOREHOLE TYPE Hollow Stem Auger COMPILED BY LP
DATUM Geodetic DATE 86 09 29 CHECKED BY _____

[illegible]

OFFICE REPORT ON SOIL EXPLORATION

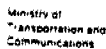
RECORD OF BOREHOLE No 5

METRIC

W P 21-79-13 LOCATION Co-ords. N 4 841 564.5; 284 380.5 ORIGINATED BY VB
 DIST 6 HWY 410 BOREHOLE TYPE Hollow Stem Auger COMPILED BY LP
 DATUM Geodetic DATE 86 09 29/30 CHECKED BY

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 (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE								
236.6	Ground Surface											
0.0	Silty Clay with sand trace of gravel (CL)		1	SS	3							1 28 49 22
235.2	Firm		2	SS	88							
1.4	Silt		3	SS	26							0 73 22 5
			4	SS	31							
			5	SS	42							
	Fine Sand and Silt Dense		6	SS	33							0 40 55 5
			7	SS	60							
	Fine to Medium Sand trace silt clay, gravel		8	SS	58							
			9	SS	42							
			10	SS	28							1 83 8 4
	Dense		11	SS	29							1 90 7 2
			12	SS	39							
			13	SS	29							0 91 6 3
226.2			14	SS	25							
10.4	Heterogenous mixture of sand and gravel trace silt, clay (Glacial Till) Occ. to numerous cobbles and boulders Dense		15	SS	51							28 62 8 2
224.0			16	SS	39	SEAL						
12.6	End of Borehole * Cobble encountered spoon jammed **On 86 10 08											

STANDPIPE INSTALLED
BOTTOM 300mm SLOTTED



$\frac{d}{dt} \left(\frac{1}{r^2} \right) = -\frac{2}{r^3} \frac{dr}{dt}$

RECORD OF BOREHOLE No 13

METRIC

W P 21-79-13 LOCATION Co-ord N 4 841 583.0; E 284 353.5
DIST 6 HWY 410 BOREHOLE TYPE Hollow Stem Auger ORIGINATED BY RK
DATUM Geodetic DATE 86 12 18 COMPILED BY LP
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 (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES		20	40	60	80	100					
237.4	Ground Surface															
0.0	Topsoil		1	SS	7										Org. Content 4%	4 58 29 9
	Silty Clay and Sand (Fill)		2	SS	17											
	Fine to Medium Sand (Fill)		3	SS	28											
	Decayed Wood		4	SS	25	8cm*										
	Decayed Wood		5	SS	16											
232.2	Silty Clay with Org. rem.		6	SS	15											9 58 23 10
231.0	Sand with silt, clay trace gravel, clay		7	SS	48											
6.4	Heterogeneous mixture of sand and gravel trace silt, clay (Glacial Till)		8	SS	47											
			9	SS	60											40 46 12 2
			10	SS	59											
			11	SS	59											
			12	SS	64											40 46 11 3
	Occasional cobbles and boulders		13	SS	66											
			14	SS	73											
	Very Dense		15	SS	89											
226.8			16	SS	136											48 42 9 1
12.6	End of Borehole															
	* Spoon bouncing ** Groundwater level measured on 87 01 09															

STANDPIPE INSTALLED
BOTTOM 450mm SLOTTED

RECORD OF BOREHOLE No 14

METRIC

W P 21-79-13 LOCATION Co-ords. N 4 841 586.5, E 284 371.5
 DIST 6 HWY 410 BOREHOLE TYPE Hollow Stem Auger ORIGINATED BY RK
 DATUM Geodetic DATE 86 12 22 COMPILED BY LP
 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 (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES		20	40	60	80	100					
237.3	Ground Surface															
0.0	Topsoil															
	Sand, with to and gravel, trace silt, clay (Fill)		1	SS	38											
			2	SS	59											
234.3			3	SS	42											
3.0			4	SS	81											
	Heterogeneous mixture of sand and gravel, some silt, trace clay (Glacial Till)		5	SS	32											
			6	SS	66											
	Occasional cobbles and boulders		7	SS	78											
			8	SS	51											
			9	SS	58											
	Very Dense		10	SS	71											
			11	SS	80											
			12	SS	56											
			13	SS	78											
224.7			14	SS	58											
12.6	End of Borehole															
	* Groundwater Level not established															

RECORD OF BOREHOLE No 15

METRIC

W P 21-79-13 LOCATION Co-ords. N 4 841 589.0; E 284 386.5
DIST 6 HWY 410 BOREHOLE TYPE Hollow Stem Auger
DATUM Geodetic DATE 86 12 19

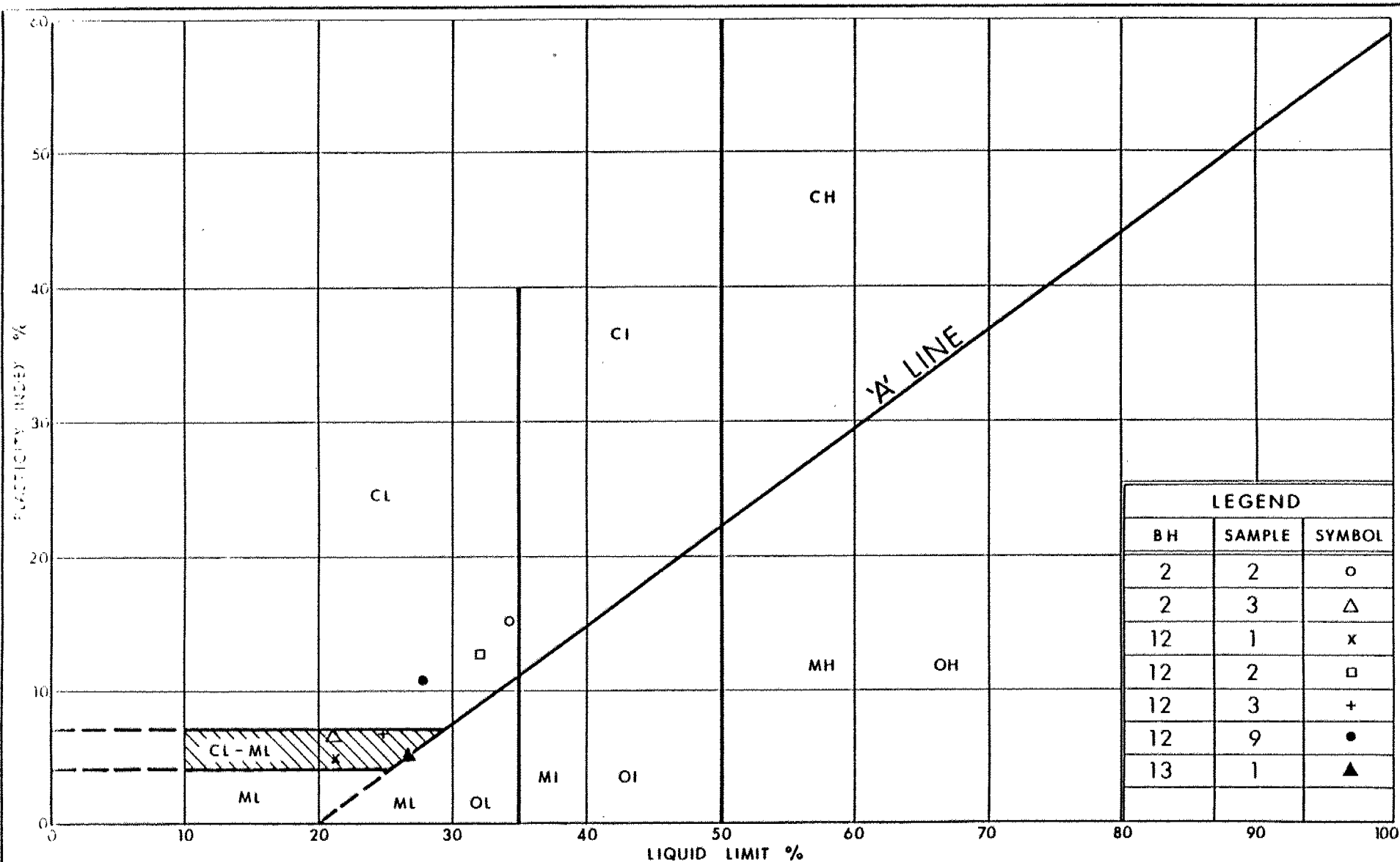
ORIGINATED BY RK

COMPILED BY LP

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 (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			20	40	60	80	100					
238.2 0.0	Silt, trace sand, clay		1	SS	36											0 7 88 5
	Sand with gravel, trace silt, clay (Probable Fill)		2	SS	66											
			3	SS	61											
234.5 3.7	Sand with gravel, trace silt, clay		4	SS	50/80											30 58 10 2
	Dense		5	SS	41											
			6	SS	29											
230.9 7.3	Heterogeneous mixture of sand and gravel, trace silt, clay		7	SS	48											53 36 9 2
	Occasional cobbles and boulders		8	SS	77											
			9	SS	54											
	Sand, some gravel		10	SS	66											17 70 10 3
			11	SS	81											
			12	SS	89											
	Very Dense		13	SS	80											
224.1 14.1	End of Borehole		14	SS	50/100											50 41 7 2
	* Spoon bouncing															
	** Groundwater level measured on 87 01 09															

STANDPIPE INSTALLED
BOTTOM 450mm SLOTTED



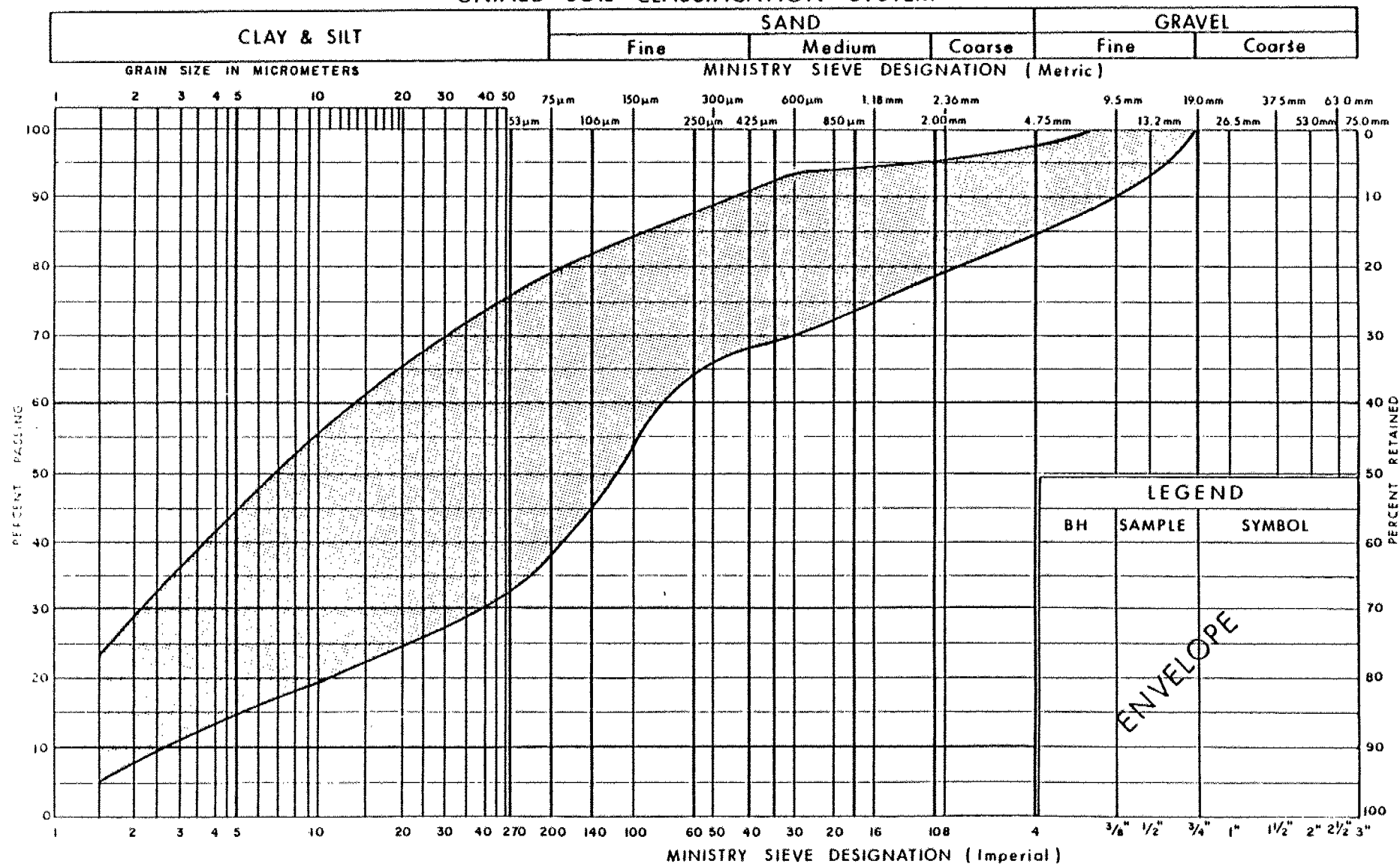
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PLASTICITY CHART SILTY CLAY, SOME/AND SAND, TRACE GRAVEL (FILL)

FIG No 1

W P 21-79-13

UNIFIED SOIL CLASSIFICATION SYSTEM



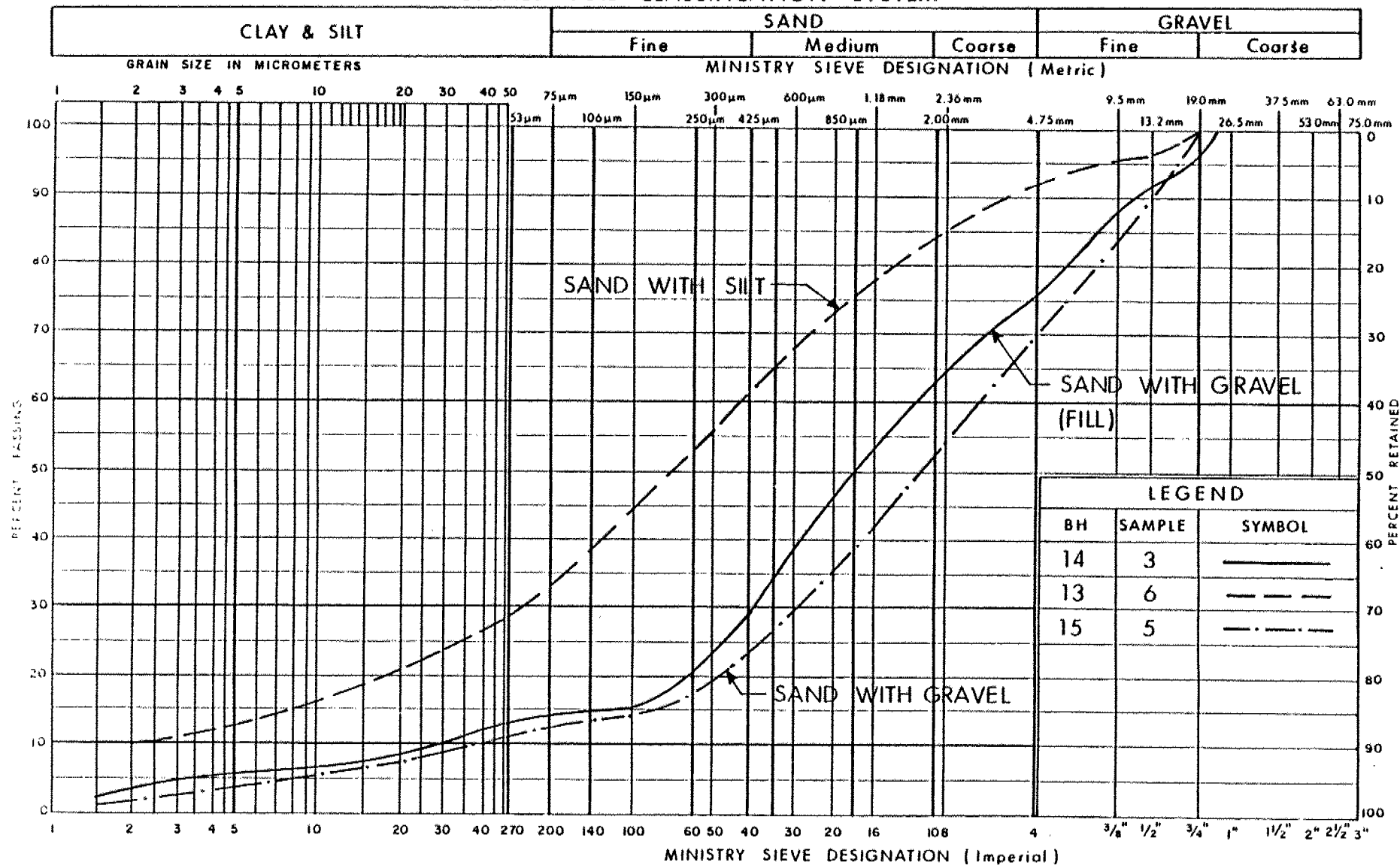
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GRAIN SIZE DISTRIBUTION
SILTY CLAY, SOME / AND SAND, TRACE GRAVEL
(FILL)

FIG No 2

W P 21-79-13

UNIFIED SOIL CLASSIFICATION SYSTEM



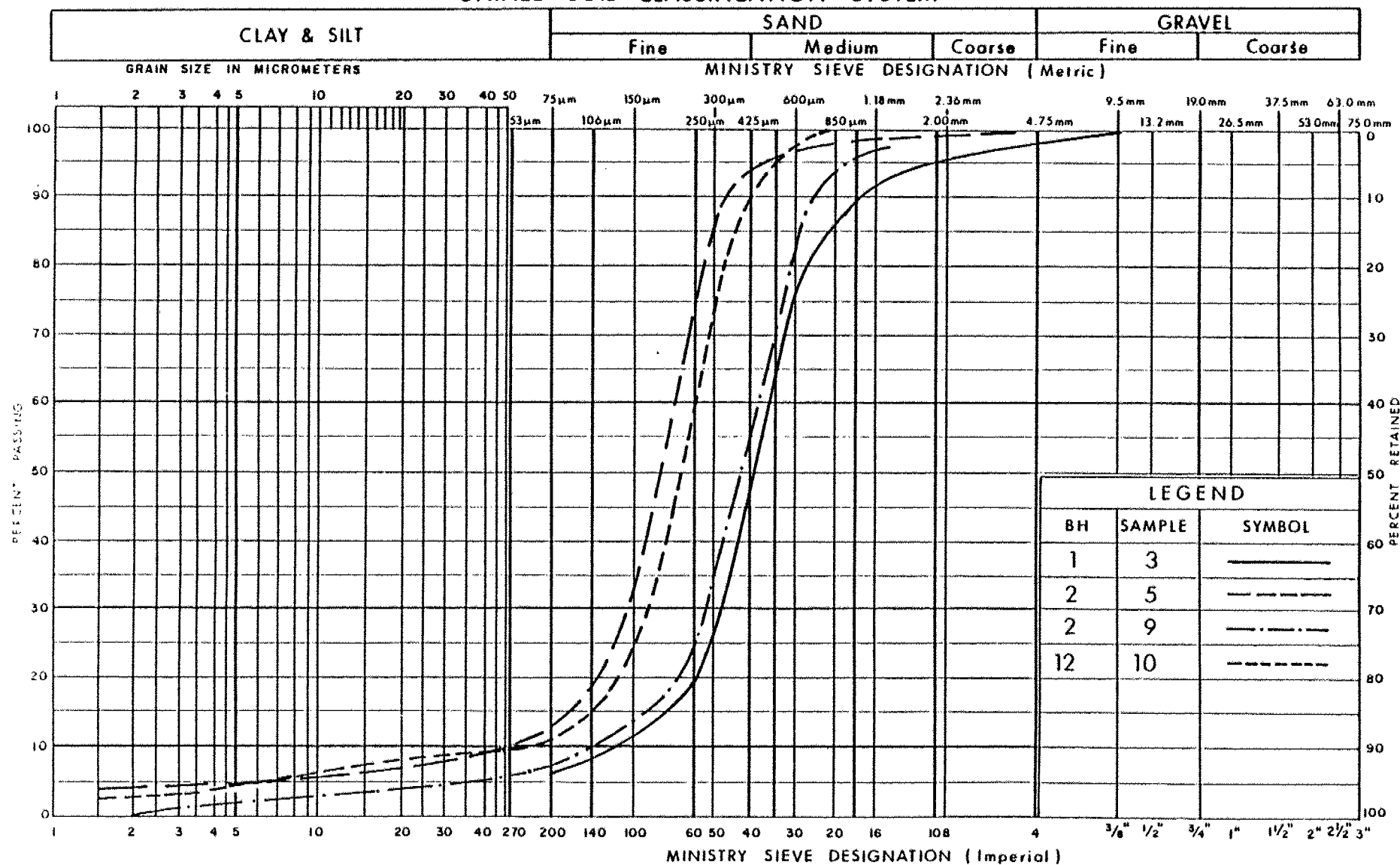
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GRAIN SIZE DISTRIBUTION

FIG No 3

W P 21-79-13

UNIFIED SOIL CLASSIFICATION SYSTEM



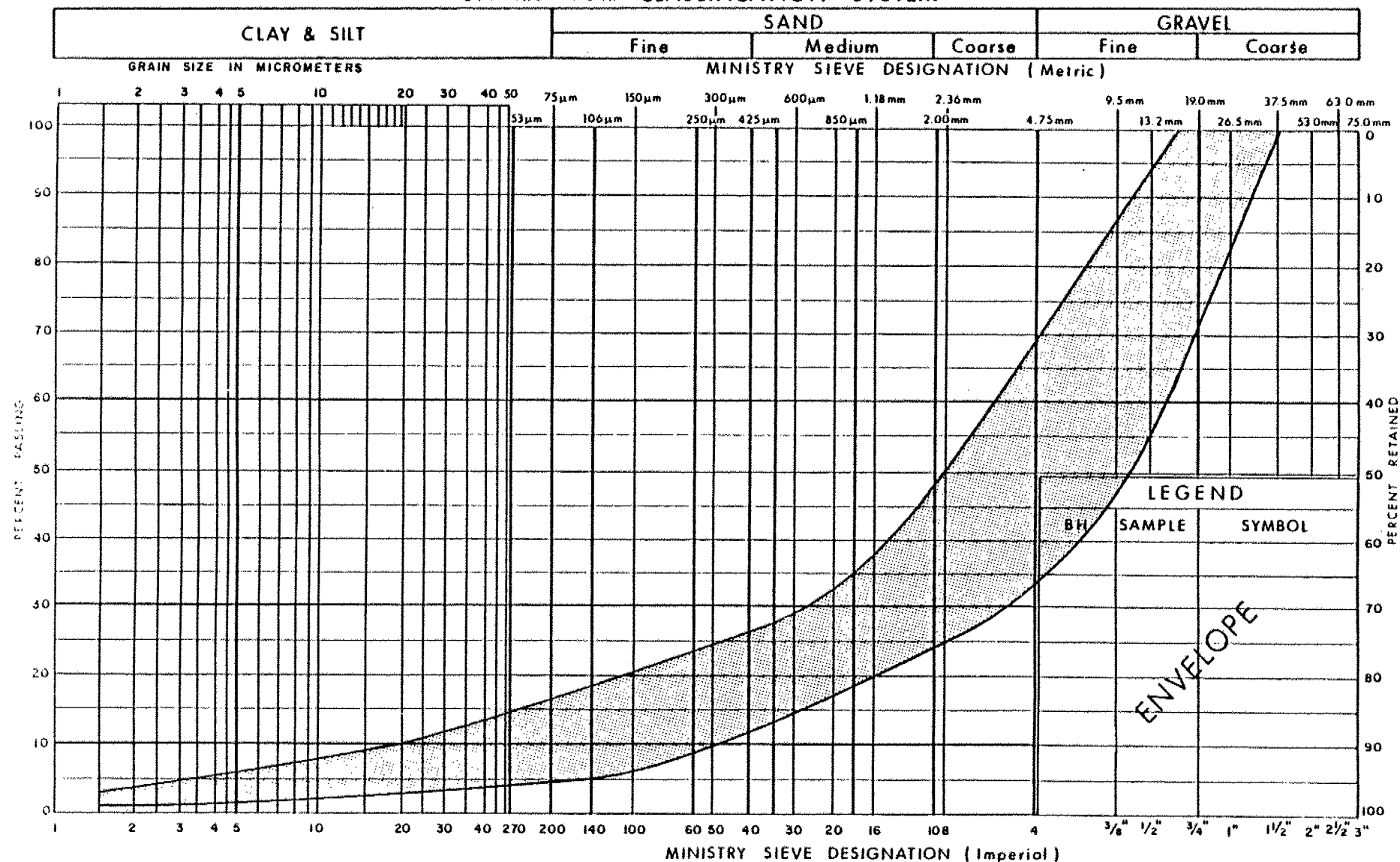
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GRAIN SIZE DISTRIBUTION
FINE TO MED SAND TRACE GRAVEL, SILT, CLAY

FIG No 4

W P 21-79-13

UNIFIED SOIL CLASSIFICATION SYSTEM



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Communications

GRAIN SIZE DISTRIBUTION
 HET MIXTURE OF SAND & GRAVEL, TRACE SILT, CLAY
 OCC TO NUMEROUS COBBLES & BOULDERS (GLACIAL TILL)

FIG No 5

W P 21-79-13



Ministry of
Transportation and
Communications

foundation investigation and design report

ENGINEERING MATERIALS OFFICE
PAVEMENT & FOUNDATION DESIGN SECTION

WP 21-79-06

DIST 6

HWY 410

STR SITE 24-145-475

Vodden St. Extension Underpass

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FOUNDATION INVESTIGATION REPORT

For

Vodden St. Extension Underpass

W.P. 21-79-06; Site 24-145-475

Hwy. #410, District 6, Toronto

INTRODUCTION:

This report summarizes the factual information from a foundation investigation carried out between 83-07-15 and 83-07-19 at the above mentioned structure site. The fieldwork consisted of 6 sampled boreholes advanced by means of hollow and solid stem augers. The boreholes ranged in depth from 7.7 to 14.3 m below ground surface.

SITE DESCRIPTION

The site is located at the existing intersection of Heart Lake Road and Vodden Street, in the City of Brampton, Municipality of Peel.

Land use in the area is predominantly residential subdivisions west of Heart Lake Road and agricultural to the east. A large abandoned gravel pit is located approximately 250 m east of Heart Lake Road. Topography across the site is generally flat with the ground surface sloping gently to the south.

The site is located in the physiographic region known as the "Peel Plain". This region is characterized by a level to undulating "till on boulder clay" plain underlain by shale or limestone bedrock. Locally there is a partly buried esker which runs to the east of the site and extends northwest. The esker serves as a source of aggregate material and as an aquifer for wells.

SUBSURFACE CONDITIONS

General

The predominant deposit across the site consists of a loose to very dense silt with sand, trace of clay, trace of gravel. This deposit was investigated to a maximum depth of 14.0 m with occasional 0.3 to 0.6 m sand seams being encountered.

The surficial deposit in the central and eastern sections of the site is a very stiff to hard silty clay with a maximum thickness of 3 m.

INDICATE

SILTS & SANDS

ARE SUSCEPTIBLE

TO BOILING IN.

CONT. PKG.

Hd.

A 2.4 to 7.1 m stratum of sand with silt, trace of clay, trace of gravel is found sandwiched within and between the other two major deposits in the north central and eastern portions of the investigated area.

The boundaries between the various soil types, in situ and laboratory test results are shown on the attached Record of Borehole Sheets. The elevations and locations of the boreholes are shown on Drawing No. 217906-A, along with three estimated stratigraphical sections based on borehole data.

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

Silt with Sand, trace of Clay, trace of Gravel

The deposit of silt with sand, trace of clay, trace of gravel is found across the entire investigated site and was explored to a maximum depth of 14.3 m. Occasional sand seams of 0.3 to 0.6 m were encountered in the upper half of the deposit with occasional cobbles and/or boulders generally encountered in the lower half, below elevation 225. One exception is in the southeast corner of the site where cobbles or boulders were encountered between elevations 229 and 225.

The results of grain size distribution tests conducted on samples from this stratum indicate there is some variance in the sand and gravel contents and a very uniform clay content. The results of these tests are plotted in the form of an envelope on Figure 1.

Atterberg limit testing completed on samples from this deposit indicate the silt to be generally non-plastic with a few zones of slightly plastic material (ML zone); results are plotted on Figure 4.

Interpretation of N values ranging from 7 blows per 0.3 m to 100 blows per 8 cm indicate the denseness of this generally non-plastic silt to vary from loose in the surficial zones to very dense in the rest of the deposit.

Silty Clay, with Sand, some Gravel

The surficial deposit of silty clay, with sand and some gravel is found in the central and eastern sections of the site and varies in thickness from 1.4 to 3 m.

Two grain size distribution tests completed on samples from this stratum indicate a relatively uniform grain size distribution. The results of these tests are plotted on Figure 2.

Atterberg limit testing was completed on samples from this deposit and results are plotted on Figure 4. The atterberg limits indicate this stratum to be a silty clay of low plasticity (CL zone).

The consistency of the deposit is assessed as being very stiff to hard based on N values ranges from 15 blows per 0.3 m to 87 blows per 23 cm.

Sand with Silt, trace Clay, Trace Gravel

The sand with silt, trace of clay and trace of gravel deposit is found underlying the silt in the north central section of the site and sandwiched within or between the silty clay and silt layers in the eastern sector. The stratum varies in thickness from 2.4 to 7.1 m.

The results of grain size distribution tests conducted on samples from this stratum are plotted in the form of an envelope on Figure 3. The plot indicates some variance in the size of the sand particles from fine to medium.

Based on N values ranging from 3 blows per 0.3 m to 70 blows per 8 cm the deposit is assessed as being very loose to very dense, with the majority of the deposit being very dense.

Groundwater Conditions

Overnight stabilized water level readings taken in five open boreholes indicated an approximate groundwater elevation of 230. Water levels taken in 3 boreholes on the same day varied from 1 to 10 m lower than the overnight readings, with the large variance being a result of whether water bearing sand seams were encountered.

DISCUSSION AND RECOMMENDATIONS

General

In order to carry the proposed easterly extension of Vodden Street over the planned Highway 410, a two span (36 m, 37 m) underpass structure is contemplated. Vodden Street presently runs west from Heart Lake Road and present proposals call for its extension to the east with the existing alignment being maintained west of Heart Lake Road and curving slightly to the south on the eastern extension. The proposed profile grades will require earth cuts in the order of 6 m deep for Highway 410 and raising the grade by up to 2 m on the Vodden Street extension.

The subsoil was investigated to a maximum depth of 14.3 m and a loose to very dense silt with sand was found to be the predominant stratum extending across the site. This deposit is divided occasionally by thin sand seams in the upper portion, with cobbles and/or boulders encountered in the lower levels.

In the central and eastern section of the investigated area the silt is overlain by a surficial layer of silty clay, except in the northeast corner where a 7.1 m deposit of sand with silt is sandwiched between the silty clay and silt layers. This sand stratum also extends to the south and east dividing the underlying silt deposit.

The following recommendations pertain to the design and construction of the structure foundations and related earthworks.

Structure Foundations

In view of the encountered subsurface conditions it is recommended that the structure be supported on spread footings. The following table summarizes the bearing capacities applicable to the indicated founding elevations.

	<u>Footing Elevation</u>	<u>Factored Bearing Capacity at U.L.S. (kPa)</u>	<u>Bearing Capacity at S.L.S. Type II (kPa)</u>
West Abutment	229.0	600	400
	228.0	1,000	650
Pier	229.0	600	400
	227.0	1,000	650
East Abutment	229.0	600	400
	228.5	1,000	650

Dewatering

Dewatering of the footing excavations will be required in order to prevent "boiling" of the base of the excavation. This can be accomplished by using depressed perimeter ditches around footing excavations and pumping from sumps.

Excavation of the Highway 410 cut should be completed prior to footing construction in order to help alleviate "boiling" of the silt stratum underlying the footings.

The abutments should be backfilled with a free draining granular material and earth pressures against the abutment wall can be computed as per Subsection 6.6.1.2.2 of the O.H.B.C.D. Manual.

The underside of all footing elements should be provided with a minimum of 1.3 m of earth cover for frost protection purposes.

No stability problems are anticipated for fill heights of 2 m and cuts of 6 m constructed with 2:1 slopes. Placement of a granular blanket on the cut slopes is recommended to prevent sloughing of the slope due to water seepage from sand seams.

MISCELLANEOUS

The fieldwork for this investigation was carried out under the supervision of Mr. H. J. Sturm, Project Foundations Engineer, using equipment owned and operated by Master Soil Investigation, Toronto. The report was written by Mr. H. J. Sturm and reviewed by Mr. M. Devata, Senior Foundations Engineer.



H. J. Sturm, P. Eng.
Project Foundations Engineer



For

M. Devata, P. Eng.
Senior Foundations Engineer

APPENDIX

RECORD OF BOREHOLE No 1

METRIC

W P 21-79-06 LOCATION Co-ords N 4 841 233.5; E 284 839.2 ORIGINATED BY HS
 DIST 6 HWY 410 BOREHOLE TYPE Hollow Stem Augers COMPILED BY HS
 DATUM Geodetic DATE 1983 07 15 CHECKED BY CP

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			SHEAR STRENGTH								
232.0	Ground Surface							20 40 60 80 100	○ UNCONFINED	+ FIELD VANE	● QUICK TRIAXIAL	x LAB VANE				GR SA SI CL
0.0	Silty Clay with Sand Some Gravel	Very Stiff	1	SS	15	*										
230.6			2	SS	6											0 80 15 5
1.4		Very Loose	3	SS	3											
			4	SS	88	15 cm										10 47 36 7
			5	SS	100	15 cm										
	Sand with Silt Trace Clay Trace Gravel		6	SS	108	28 cm										13 46 36 5
		Very Dense	7	SS	79	8 cm										
	Occ. cobbles or boulders		8	SS	75	10 cm										
223.5			9	SS	100	23 cm										
8.5	Silt with Sand Trace Clay Trace Gravel Occasional Cobbles or Boulders Very Dense		10	SS	90	15 cm										2 22 71 5
			11	SS	90	15 cm										
218.0			12	SS	105	23 cm										1 28 68 3
14.0	End of Borehole															
	* Overnight water level not established															
	** Water level taken after completion of borehole															

OFFICE REPORT ON SOIL EXPLORATION

RECORD OF BOREHOLE No 2

METRIC

W P 21-79-06 LOCATION Co-ords N 4 841 201.7; E 284 816.3 ORIGINATED BY HS
 DIST 6 HWY 410 BOREHOLE TYPE Solid Stem Augers COMPILED BY HS
 DATUM Geodetic DATE 1983 07 18 CHECKED BY SP

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					
231.5	Ground Surface																
0.0	Silty Clay With Sand Some Gravel Very Stiff to Hard		1	SS	20		230										
			2	SS	35												
228.7			3	SS	41												
2.8			4	SS	54												
	Silt With Sand Trace Clay Trace Gravel		5	SS	81												
			6	SS	104	23 cm											
			7	SS	90	13 cm											
224.2	Very Dense																
7.3			8	SS	85	18 cm											
	Occasional Cobbles or Boulders		9	SS	90	23 cm											
	Sand With Silt Trace Clay Trace Gravel Very Dense		10	SS	90	10 cm											
			11	SS	100	14 cm											
217.2																	
14.3	End of Borehole		12	SS	100	23 cm											

OFFICE REPORT ON SOIL EXPLORATION

RECORD OF BOREHOLE No 3

METRIC

W P 21-79-06 LOCATION Co-ords N 4 841 186.2; E 284 785.2
 DIST 6 HWY 410 BOREHOLE TYPE Hollow Stem Augers
 DATUM Geodetic DATE 1983 07 18

ORIGINATED BY HS
 COMPILED BY HS
 CHECKED BY CP

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					
231.7	Ground Surface															GR SA SI CL
0.0																
	Loose to Compact		1	SS	7											
			2	SS	22											
			3	SS	45											4 44 48 4
	Silt With Sand		4	SS	44											
	Trace Clay		5	SS	80	8 cm										
	Trace Gravel		6	SS	81	15 cm										2 36 57 5
	Very Dense															
			7	SS	90	10 cm										
	Occasional Cobbles or Boulders		8	SS	100	8 cm										
			9	SS	100	13 cm										
			10	SS	100	20 cm										10 36 48 6
			11	SS	114	23 cm										
217.8			12	SS	100	13 cm										7 40 47 6
13.9	End of Borehole															
	** Water level taken after completion of borehole															

OFFICE REPORT ON SOIL EXPLORATION

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



RECORD OF BOREHOLE No 4

METRIC

W P 21-79-06 LOCATION Co-ords N 4 841 176.6; E 284 795.5 ORIGINATED BY HS
DIST 6 HWY 410 BOREHOLE TYPE Solid Stem Augers COMPILED BY HS
DATUM Geodetic DATE 1983 07 19 CHECKED BY *SP*

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					
231.7	Ground Surface																
0.0	Loose to Compact		1	SS	7												
	Sand		2	SS	24												
			3	SS	62												0 21 74 5
	Silt With Sand Trace Clay Trace Gravel Very Dense		4	SS	90	23 cm											
			5	SS	100	14 cm											2 37 56 5
			6	SS	100	8 cm											
224.0			7	SS	100	8 cm											
7.7	End of Borehole																

+3, x5: Numbers refer to
Sensitivity

20
15 $\frac{1}{5}$ (%) STRAIN AT FAILURE
10

RECORD OF BOREHOLE No 5

METRIC

W P 21-79-06 LOCATION Co-ords N 4 841 192.5; E 284 824.5 ORIGINATED BY HS
 DIST 6 HWY 410 BOREHOLE TYPE Solid Stem Augers COMPILED BY HS
 DATUM Geodetic DATE 1983 07 19 CHECKED BY CP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			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				
								SHEAR STRENGTH				
231.4	Ground Surface											
0.0	Silty Clay With Sand Some Gravel		1	SS	43		230					
			2	SS	47							
228.4	Hard		3	SS	52							
3.0	Silt With Sand Trace Clay Trace Gravel		4	SS	58		228					
			5	SS	100	23 cm	226					
	Very Dense		6	SS	100	23 cm						
223.7	End of Borehole		7	SS	100	8 cm	224					
7.7												

OFFICE REPORT ON SOIL EXPLORATION

RECORD OF BOREHOLE No 6

METRIC

W P 21-79-06 LOCATION Co-ords N 4 841 216.0; E 284 858.7 ORIGINATED BY HS
 DIST 6 HWY 410 BOREHOLE TYPE Solid Stem Augers COMPILED BY HS
 DATUM Geodetic DATE 1983 07 19 CHECKED BY CP

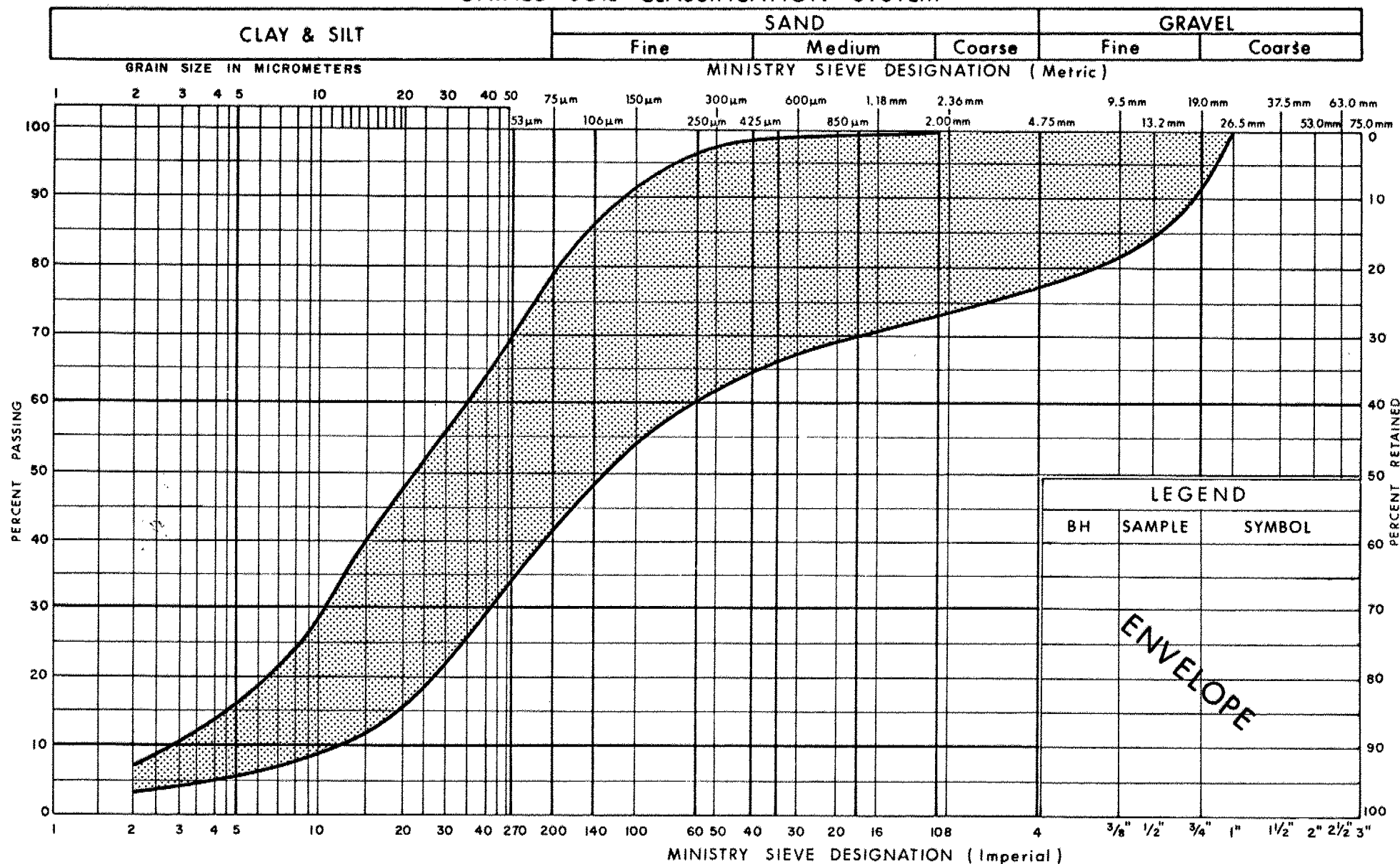
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
231.9	Ground Surface																
0.0	Silty Clay With Sand Some Gravel		1	SS	42												18 29 36 17
229.8	Hard		2	SS	52												
2.1	Silt With Sand Trace Clay Trace Gravel or Boulders Very Dense		3	SS	87	23 cm											
			4	SS	89	23 cm											
226.1			5	SS	100	8 cm											
5.8	Sand With Silt Trace Clay Trace Gravel Very Dense		6	SS	100	13 cm											9 64 24 3
223.7			7	SS	100	8 cm											11 46 32 11
8.2	Silt Very Dense		8	SS	100	13 cm											
222.6																	
9.3	End of Borehole																

+3, x⁵: Numbers refer to
Sensitivity

20
15 5 (%) STRAIN AT FAILURE
10

OFFICE REPORT ON SOIL EXPLORATION

UNIFIED SOIL CLASSIFICATION SYSTEM



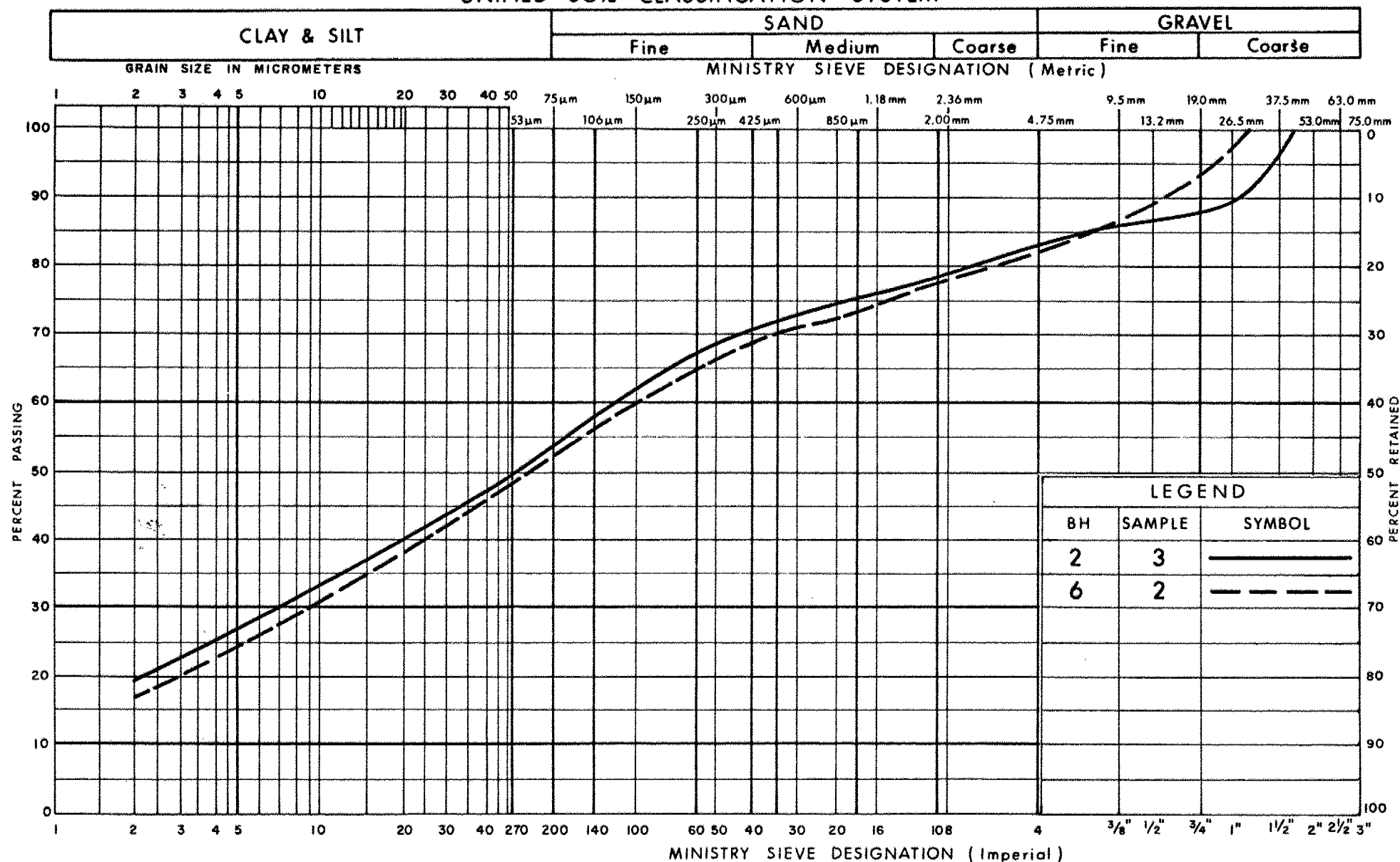
Ministry of
Transportation and
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GRAIN SIZE DISTRIBUTION
SILT WITH SAND, TRACE OF CLAY & GRAVEL

FIG No 1

W P 21-79-06

UNIFIED SOIL CLASSIFICATION SYSTEM



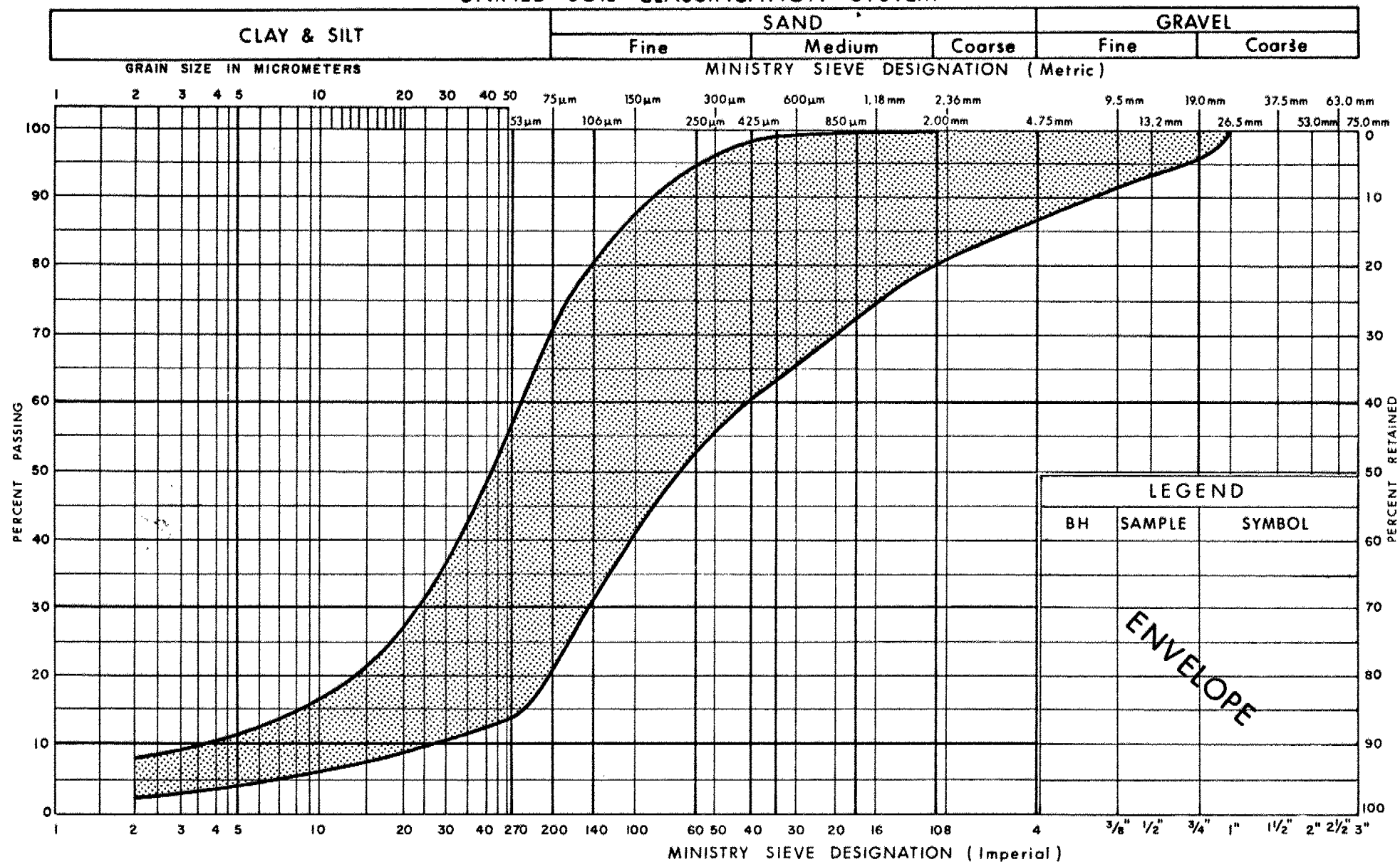
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Communications

GRAIN SIZE DISTRIBUTION
SILTY CLAY WITH SILT, SOME GRAVEL

FIG No 2

W P 21-79-06

UNIFIED SOIL CLASSIFICATION SYSTEM



Ontario

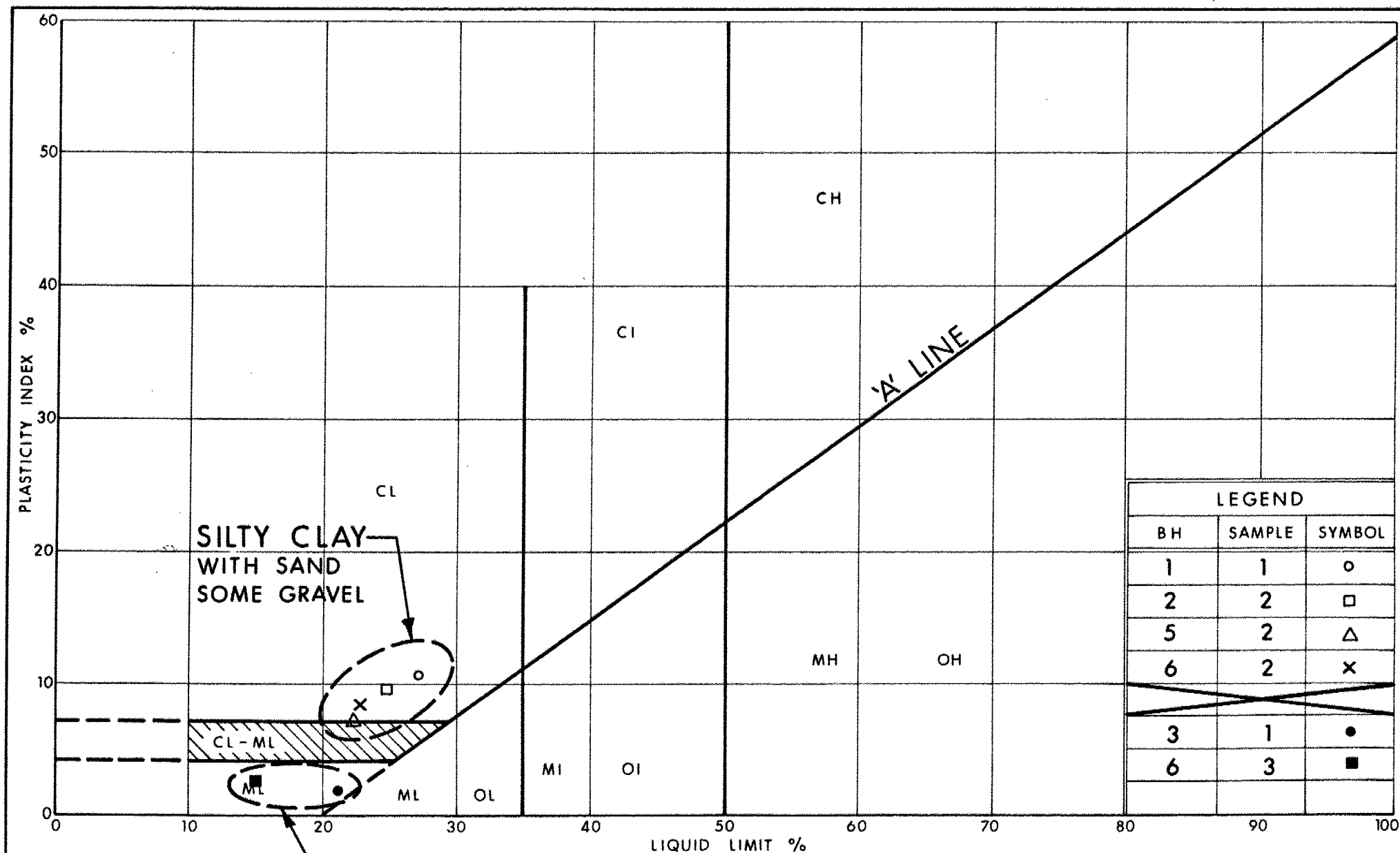
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GRAIN SIZE DISTRIBUTION

SAND WITH SILT, TRACE OF CLAY & GRAVEL

FIG No 3

W P 21-79-06



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PLASTICITY CHART

SILT WITH SAND
TRACE OF CLAY & GRAVEL

FIG No 4

W P 21-79-06

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_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 = $w_L - w_p$	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^2	SEEPAGE FORCE
γ'	kN/m^3	UNIT WEIGHT OF SUBMERGED SOIL						

METRIC
DIMENSIONS ARE IN MILLIMETRES
AND/OR MILLIMETRES TO THE NEAREST
OTHERWISE SHOWN IN METRES
IN KILOMETRES + MILLIMETRES

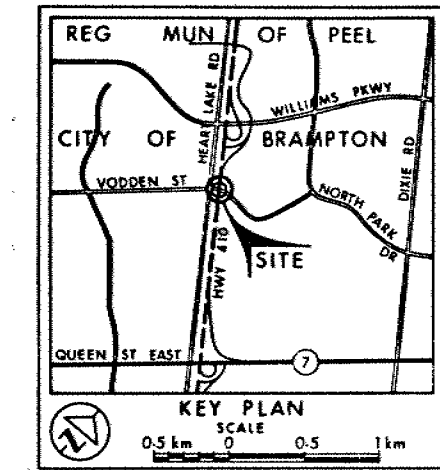
CONT No
WP No 21-79-06

VODDEN ST UNDERPASS

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 1983 07
- W.L. taken after completion of Borehole

No	ELEVATION	CO-ORDINATES NORTH	EAST
1	232.0	4841233.5	284839.2
2	231.5	4841201.7	284816.3
3	231.7	4841186.2	284785.2
4	231.7	4841176.6	284795.5
5	231.4	4841192.5	284824.5
6	231.9	4841216.0	284858.7

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.

DATE	BY	DESCRIPTION
1983 08 24	DATE	DATE
1983 08 24	DATE	DATE

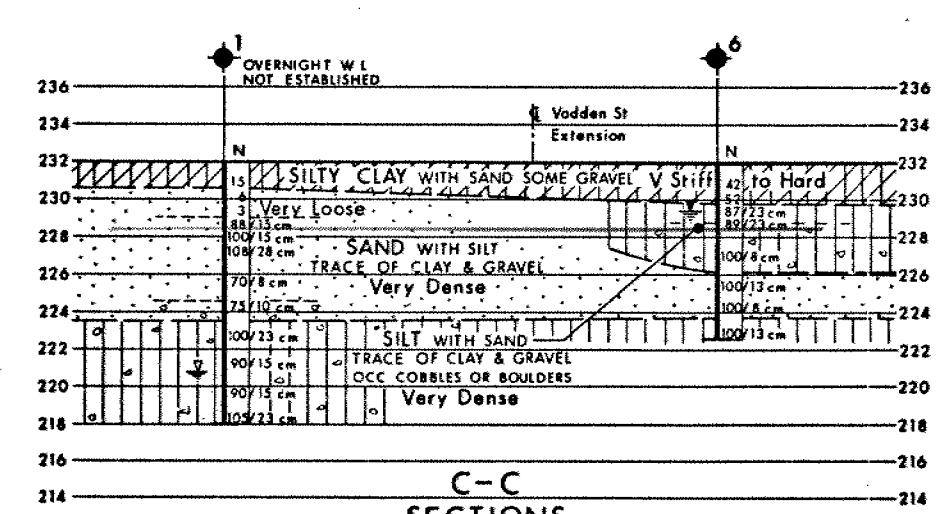
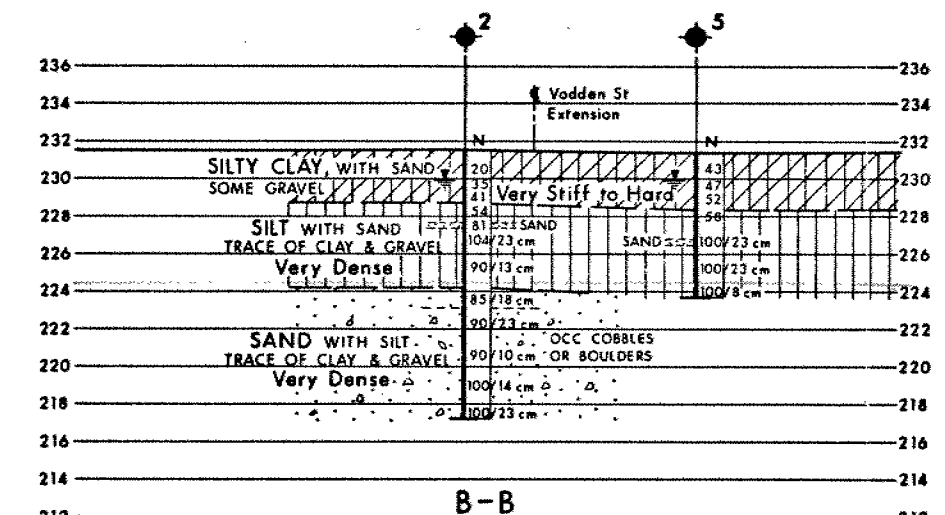
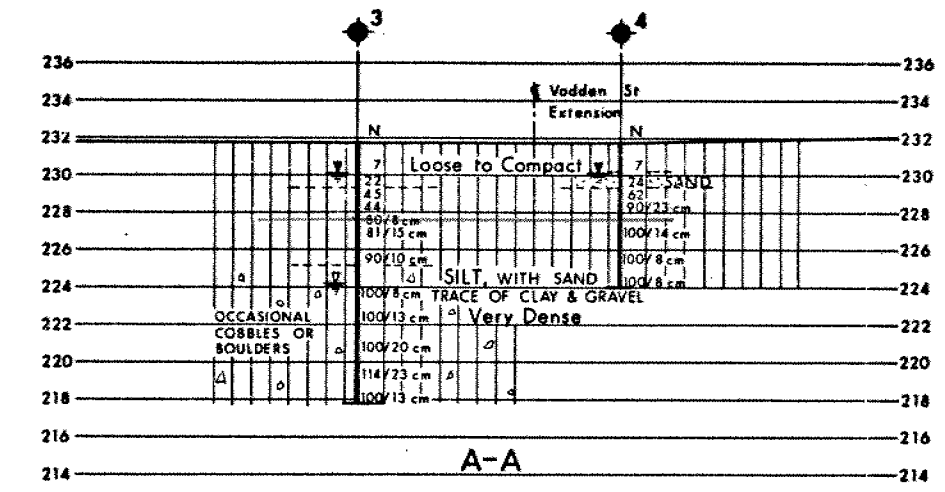
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HWY No 410 DIST 6

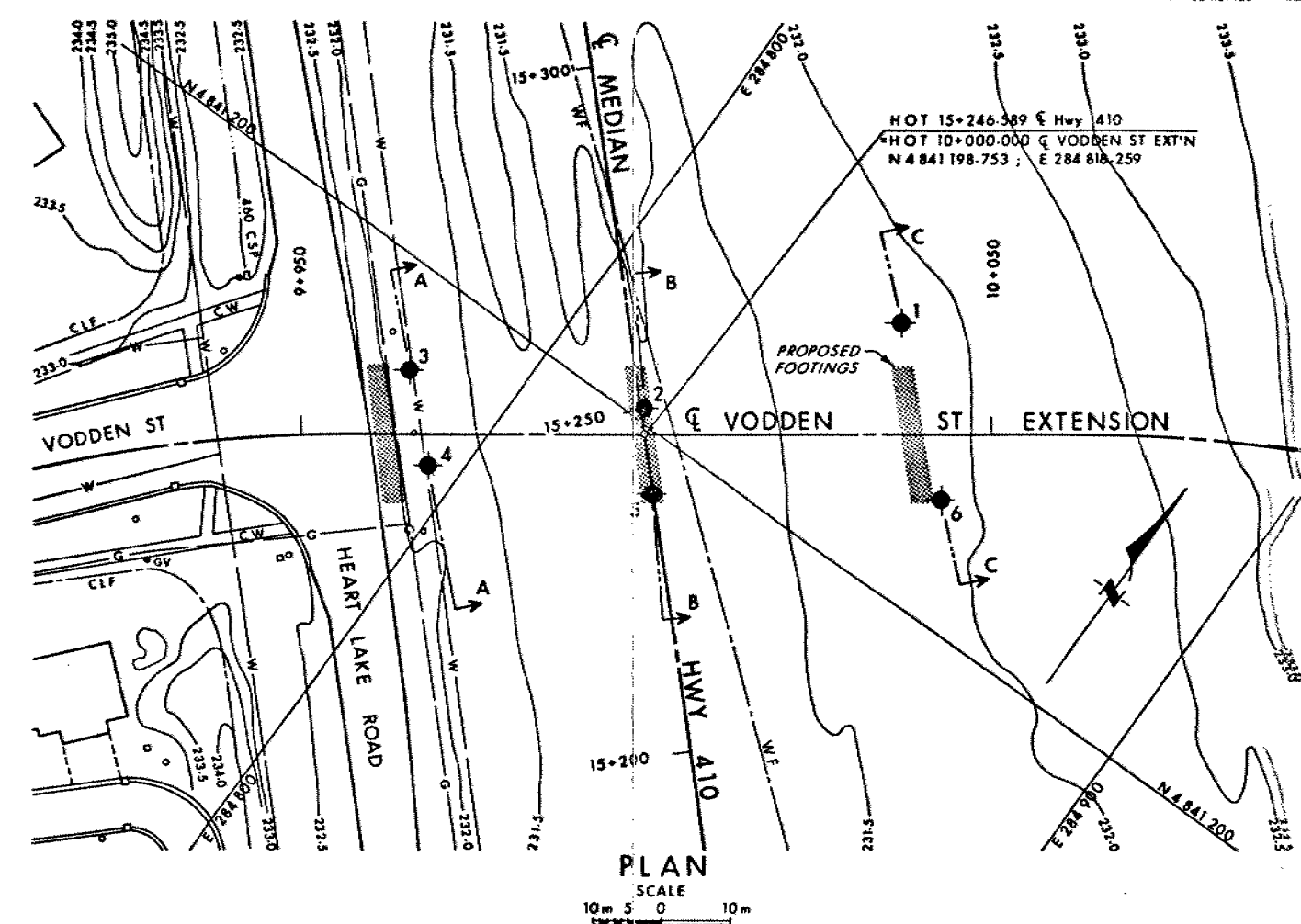
SUBMITTAL CHECKED DATE 1983 08 24 SITE 24-145-475

DRAWN BY CHECKED DATE 1983 08 24 DWG 217906-A

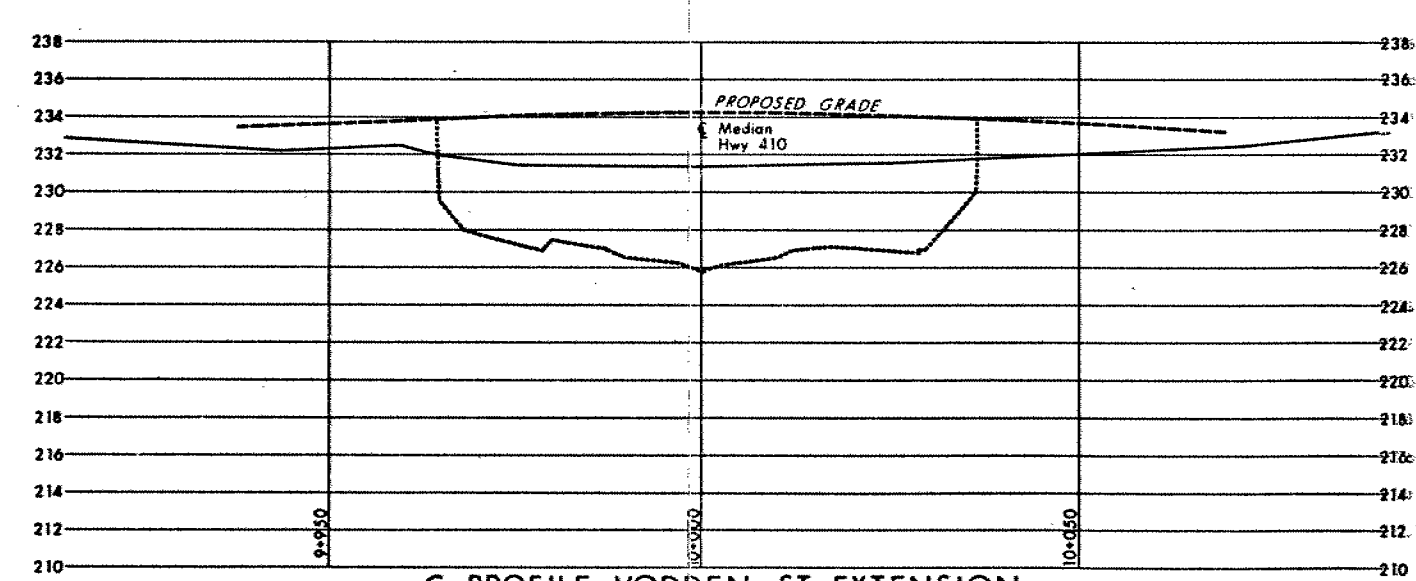
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SECTIONS
SCALE
4m 2 0 4m



PLAN
SCALE
10m 5 0 10m



C PROFILE VODDEN ST EXTENSION
SCALE
HOR 10m 5 0 10m
VERT 4m 2 0 4m

METRIC

DIMENSIONS ARE IN METRES
AND/OR MILLIMETRES
UNLESS OTHERWISE SHOWN

DIST. NO 6

CONT No

WP No 21-79-06

HWY. 410-VODDEN ST. U'PASS

GENERAL ARRANGEMENT



SHEET

GENERAL NOTES

CLASS OF CONCRETE

DECK & PIER COLLUMNS	35 MPa
PIER, ABUTMENTS & WINGWALLS	30 MPa
ABUTMENTS & WINGWALLS	30 MPa
REMAINDER	20 MPa

CLEAR COVER TO REINF. STEEL

FOOTINGS	100 ± 25
PIER, ABUTMENTS & WINGWALLS	100 ± 25
FRONT FACES	80 ± 20
DECK TOP	70 ± 20
BOTT.	50 ± 10
REMAINDER	70 ± 20

UNLESS OTHERWISE NOTED

REINFORCING STEEL

REINFORCING STEEL SHALL BE GRADE 400
REINFORCING BARS WITH DESIGNATION
'C' AT END OF BAR MARKS SHALL BE EPOXY
COATED BARS.

CONSTRUCTION NOTES

THE CONTRACTOR SHALL FINISH THE
BEARING SEATS DEAD LEVEL TO THE
SPECIFIED ELEVATIONS WITH A
TOLERANCE OF ± 3mm.

NO CONCRETE SHALL BE PLACED ABOVE THE
ABUTMENT BEARING SEAT ELEVATION UNTIL THE
CONCRETE IN THE DECK HAS BEEN STRESSED
AND GROUTED.

LIST OF DRAWINGS

1. GENERAL ARRANGEMENT
2. BOREHOLE LOCATION & SOILS STRATA
3. FOOTINGS
4. WEST ABUTMENT
5. EAST ABUTMENT
6. PIER DETAILS
7. DECK DETAILS
8. LONGITUDINAL TENDON DETAILS
9. TRANSVERSE TENDON DETAILS
10. DECK REINFORCING I
11. DECK REINFORCING II
12. BARRIER WALL ON SIDEWALK
13. RAILING FOR BARRIER WALL
14. JOINT ANCHORAGE AND ARMOURING
15. 6000 mm APPROACH SLAB
16. DETAILS OF CONCRETE SLOPE PAVING
17. BRIDGE DATE & SITE NUMBER DATA
18. AS CONSTRUCTED ELEV. & DIMENSIONS
19. QUANTITIES - STRUCTURE
20. QUANTITIES - STRUCTURE
21. STANDARD DETAILS



REVISION	DATE	BY	CHECK	DESCRIPTION
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				

DRAWING NOT TO BE SCALED
100 mm ON ORIGINAL DRAWING

CURVE 51 DATA

Δ 13° 46' 21.82"
R 400.00
T 105.943
E 211.837
M 1.403

NORTH
FOR CONSTR

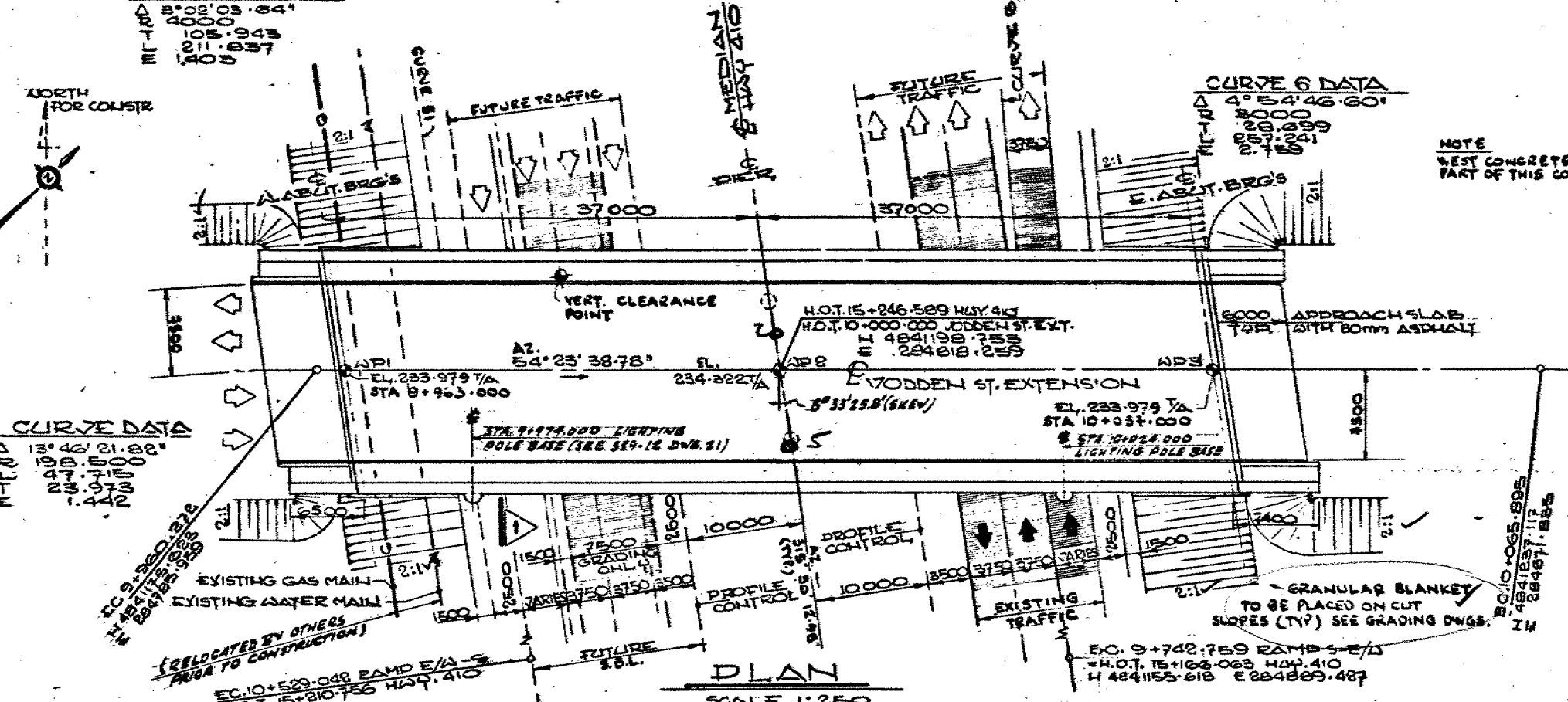
CURVE DATA

Δ 13° 46' 21.82"
R 400.00
T 105.943
E 211.837
M 1.403

CURVE 6 DATA

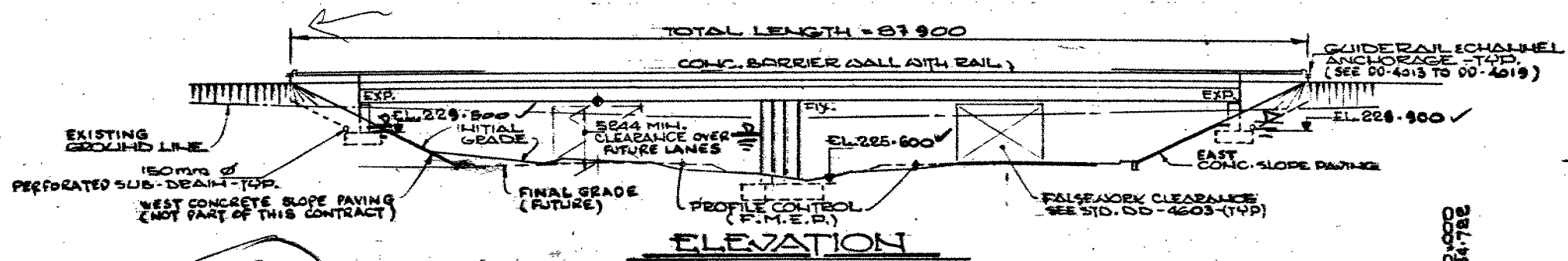
Δ 1° 54' 46.60"
R 2000.00
T 35.899
E 258.241
M 2.458

NOTE
WEST CONCRETE SLOPE PAVING NOT
PART OF THIS CONTRACT.



PLAN

SCALE 1:250

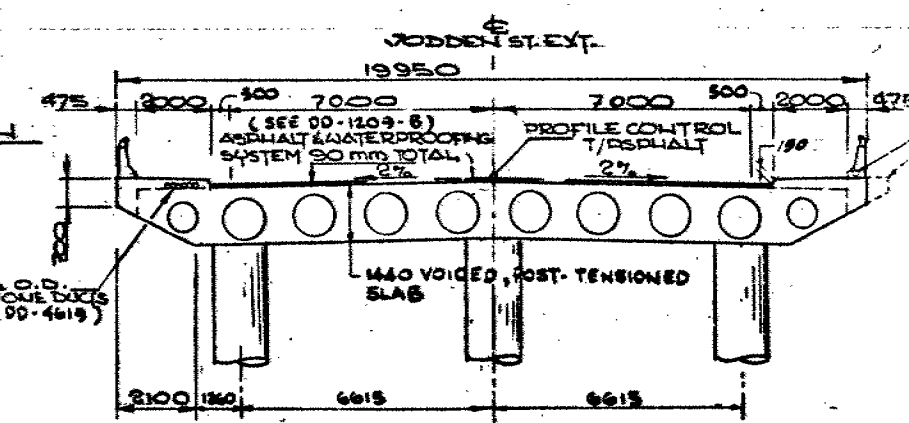


ELEVATION

SCALE 1:250

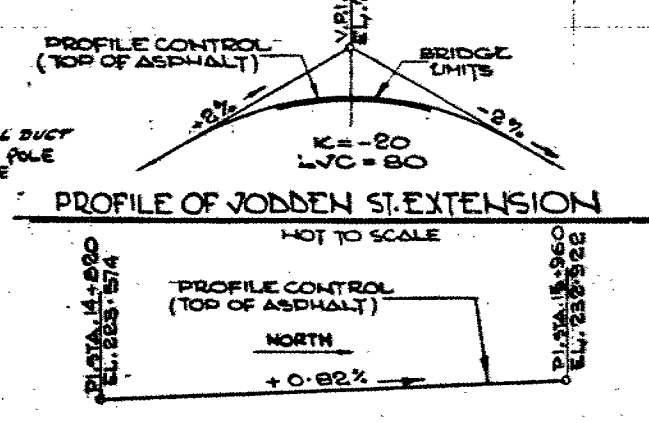
Excavation of Highway 410
cut prior to fig. etc. → Reduce
dewatering problems.

B.M. 231.456
N.E.A. IN N.W. ROOT
OF IRONWOOD
56-01.15+110.8



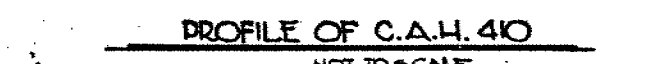
TYP. DECK SECTION

SCALE 1:100



PROFILE OF JODDEN ST. EXTENSION

NOT TO SCALE



PROFILE OF C.A.H. 410

NOT TO SCALE

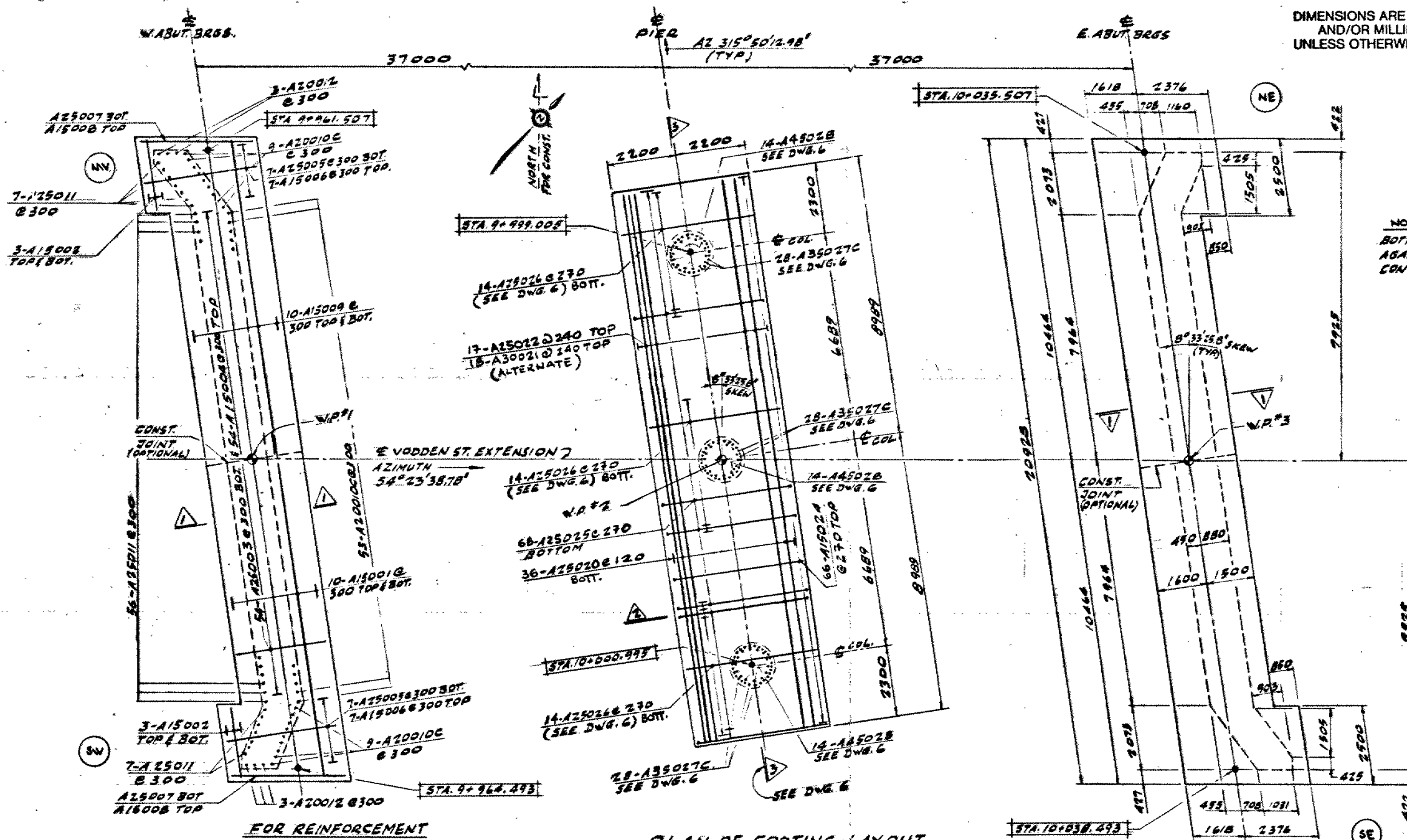
METRIC

DIMENSIONS ARE IN METRES
AND/OR MILLIMETRES
UNLESS OTHERWISE SHOWN

CONT No	WP	No 21-73-06
HWY. 410 VODDEN ST. U-PASS		
FOOTINGS		



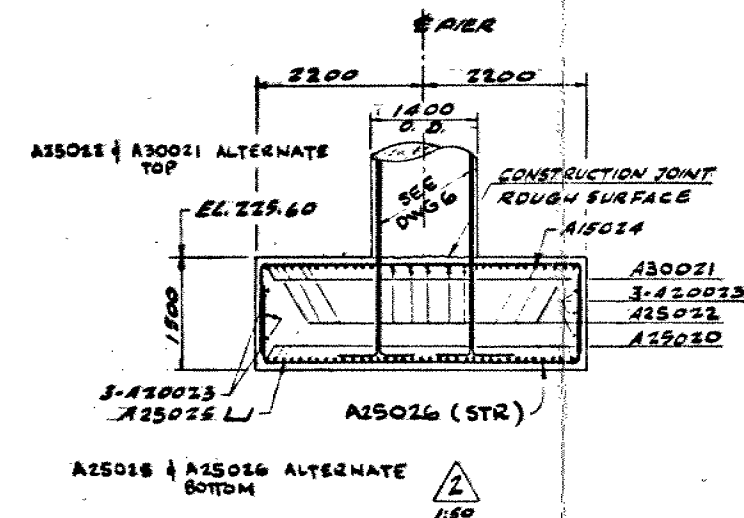
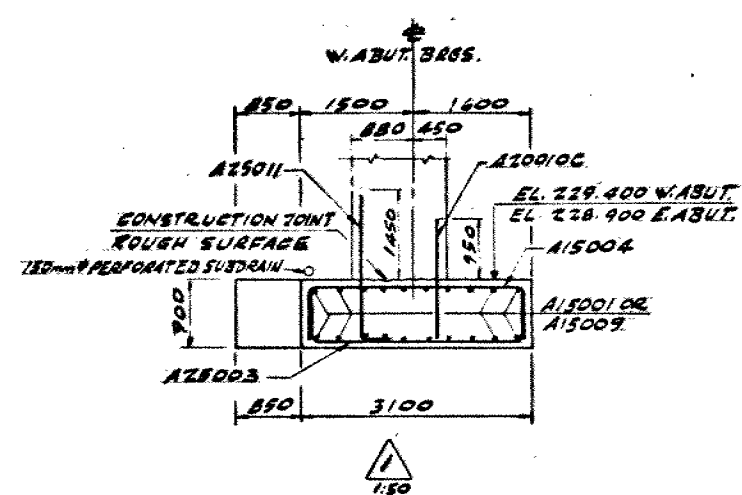
SHEET



NOTE:
BOTTOM OF STRUCTURE FOOTINGS TO BE PROTECTED
AGAINST BOILING OF FOUNDATION MATERIAL DURING
CONSTRUCTION.

PLAN OF FOOTING LAYOUT

NOTE:
REINFORCING STEEL IN EAST
ABUTMENT SIMILAR.



NOTE:
DIMENSIONS FOR WEST ABUTMENT ARE
SIMILAR. N.W. = S.E. & S.W. = N.E.

LOCATION	STATION	NORTH	EAST
N.W.	9+491.507	484184.408	284781.185
W.P.1	9+763.000	484177.208	284788.177
S.W.	9+964.493	484170.008	284795.170
NORTH	9+999.005	484120.548	284813.600
W.P.2	10+000.000	484118.750	284818.260
SOUTH	10+000.999	484113.952	284822.920
N.E.	10+035.507	484227.492	284841.350
W.P.3	10+037.000	484220.292	284848.343
S.E.	10+038.493	484213.092	284855.335

NOTE:
THIS DRAWING TO BE READ IN
CONJUNCTION WITH DWG. 4, 5 & 6.



DRAWING NOT TO BE SCALED
100 mm ON ORIGINAL DRAWING

REVISIONS	DATE	BY	DESCRIPTION	DATE	BY
DESIGN		CHECK	LOADING	DATE	BY
DRAWING		CHECK	S.M.	SITE No	DWG