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DIST. 2 REGION

W.P. No. 2620-90-00(A)

CONT. No. 94-401

W. O. No.

STR. SITE No. N/A

HWY. No. 401

LOCATION W-4 Service Centre
Retrofit

No. of PAGES -

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OVERSIZE DRAWINGS TO BE INCLUDED WITH THIS REPORT.

REMARKS:



Ministry
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See WP 2602 90-01 115 sites

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FOUNDATION INVESTIGATION REPORT

CONTRACT NO. 94-401



Ministry of
Transportation

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

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 1" 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

SS	SPLIT SPOON	TP	THINWALL PISTON
WS	WASH SAMPLE	OS	OSTERBERG SAMPLE
ST	SLOTTED TUBE SAMPLE	RC	ROCK CORE
BS	BLOCK SAMPLE	PH	TW ADVANCED HYDRAULICALLY
CS	CHUNK SAMPLE	PM	TW ADVANCED MANUALLY
TW	THINWALL OPEN	FS	FOIL SAMPLE

STRESS AND STRAIN

u_w	kPa	PORE WATER PRESSURE
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^3	SEEPAGE FORCE
γ'	kN/m^3	UNIT WEIGHT OF SUBMERGED SOIL						

FOUNDATION INVESTIGATION REPORT

For

High Mast Lighting Foundations

Highway 401, Service Centre, East Bound Lanes, W-4

W.P. 2620-90-00 (A)

District 2, London

INTRODUCTION

This report summarizes the factual information obtained from a foundation investigation performed at the above-mentioned site between 93-10-06 and 93-10-07. The field work consisted of advancing one borehole at each High Mast Lighting (HML) location in order to establish soil parameters for the design of the 3 HML foundations. For borehole locations refer to Drawing A. All three boreholes were drilled to a depth of 9.6 metres.

SITE DESCRIPTION

The site is located south-east of the Service Centre on Highway 401, eastbound lanes, approximately 5 km west of Woodstock. The topography in the vicinity of the Service Centre is undulating. The surrounding area is farm land. Physiographically the area is located in the region known as the "Oxford Till Plain".

SUBSURFACE CONDITIONS

The investigation consisted of advancing one borehole at each of the three HML locations to depths of about 9.6 m.

The subsoil at the borehole locations consists predominantly of a heterogeneous mixture of clayey silt, sand and gravel (glacial till). Sandy silt fill is present in boreholes P1 and P3 to depths of 1.3 metres. Sandy silt is present in boreholes P1, P2 and P3 to depths of 2.9, 1.4 and 2.9 respectively. The sandy silt overlies the glacial till described above.

A more detailed description of the subsurface conditions encountered is given below.

Organic Silt Fill/ Sandy Silt Fill

A 1.3 m thick layer of organic silt fill with a trace of gravel and sand was found in Borehole P3. A 1.3 m thick layer of sandy silt fill with a trace of gravel, clay and organics was found in Borehole P1. No index tests were carried out on this material.

Sandy Silt

Below the organic silt fill/sandy silt fill or from the ground surface, a layer of sandy silt ranging from 1.4 to 1.6 metres was encountered in all 3 boreholes.

Clayey Silt, Sand and Gravel (Glacial Till)

Below the sandy silt layer, a thick deposit of a heterogeneous mixture of clayey silt, sand and gravel (glacial till) was encountered in all boreholes. The upper 1.9 and 1.7 metres of this material in Boreholes P1 and P2 respectively is brown in colour as a result of oxidation and desiccation. Below this the material is grey. In Borehole P3, the material is grey from immediately below the sandy silt layer.

The results from the Atterberg Limit Test performed on this material are plotted on Figure 1 and summarized as follows.

Index Properties	Range %
Moisture Content (w)	7.5 - 16
Liquid Limit (w_L)	16 - 38
Plastic Limit (w_p)	12 - 17
Plasticity Index (I_p)	4 - 21

From the visual examination of samples, this material was classified as a heterogeneous mixture of clayey silt, sand and gravel. From the plasticity chart (Figure 1), the clayey silt part of the mixture can be classified as a clayey silt with trace of sand and gravel with low plasticity (CL).

Grain size distribution tests were carried out on these materials and are shown in an envelope form in Figure 2.

GROUNDWATER CONDITIONS

Groundwater conditions were observed through the measurement of water levels in the open boreholes.

Boreholes P1 and P2 were dry on completion. In borehole P3, ponded water was encountered between elevations 330.2 and 329.4. It appears that water draining from the existing parking area adjacent to the Service Centre had permeated into the surface soils at this location and was ponded on top of the relatively impermeable glacial till at the time of drilling.

Occasional thin sand layers were encountered in the glacial till in the boreholes.


MISCELLANEOUS

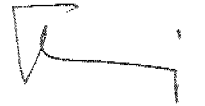
The field work for this project was carried out under the supervision of E. R. Magni, Soils Supervisor, Geotechnical Section, Southwestern Region and T. C. Kim, Sr. Foundation Engineer. The drilling equipment was owned and operated by London Soil Test, London.

This report was written by E. R. Magni, Soils Supervisor, and reviewed by T. C. Kim, Sr. Foundation Engineer.

Association of Professional Engineers of Ontario

Limited Licensee

Name: E.R. MAGNI	
Number: 28566305	
Employer: Ministry of Transportation London, Ontario	
Category: GEOLOGICAL: Highway Materials Evaluation	
This Licence is subject to the above limitations as detailed on the certificate.	



E. R. Magni
Soils Supervisor
Geotechnical Section
Southwestern Region




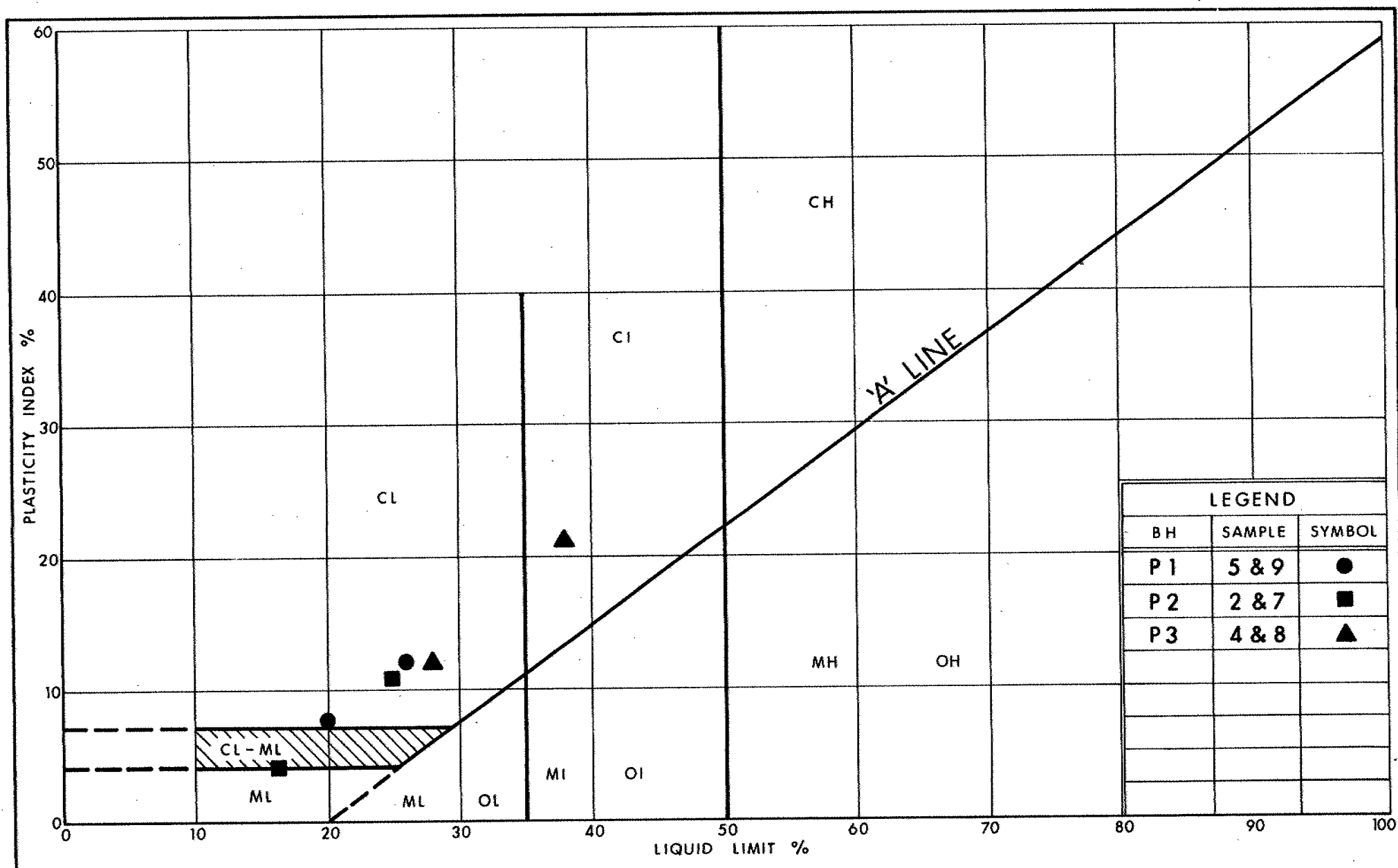

Tae C. Kim, P.Eng.
Sr. Foundation Engineer
Foundation Design Section

TABLE 1 - LOCATION AND SOIL PARAMETERS

<u>Borehole No:</u>	<u>Elevation (m)</u> From To		<u>Type of Soil</u>	<u>Denseness or Consistency</u>	<u>Ø (deg)</u>	<u>qu (kPa)</u>	<u>γ kN/m³</u>
P1	334.9	333.6	Cohesionless	Compact	30	-	19.6
	333.6	332.0	Cohesionless	Compact	32	-	19.9
	332.0	325.3	Cohesive	Hard	-	500	21.2
P2	332.1	330.7	Cohesionless	Loose	29	-	19.0
	330.7	322.6	Cohesive	Hard	-	500	21.2
P3	332.3	331.0	Cohesive	Firm	-	100	19.0
	331.0	329.4	Cohesionless	Loose to Compact	29	-	19.0
	329.4	322.9	Cohesive	Hard	-	500	21.2

APPENDIX



Ministry of
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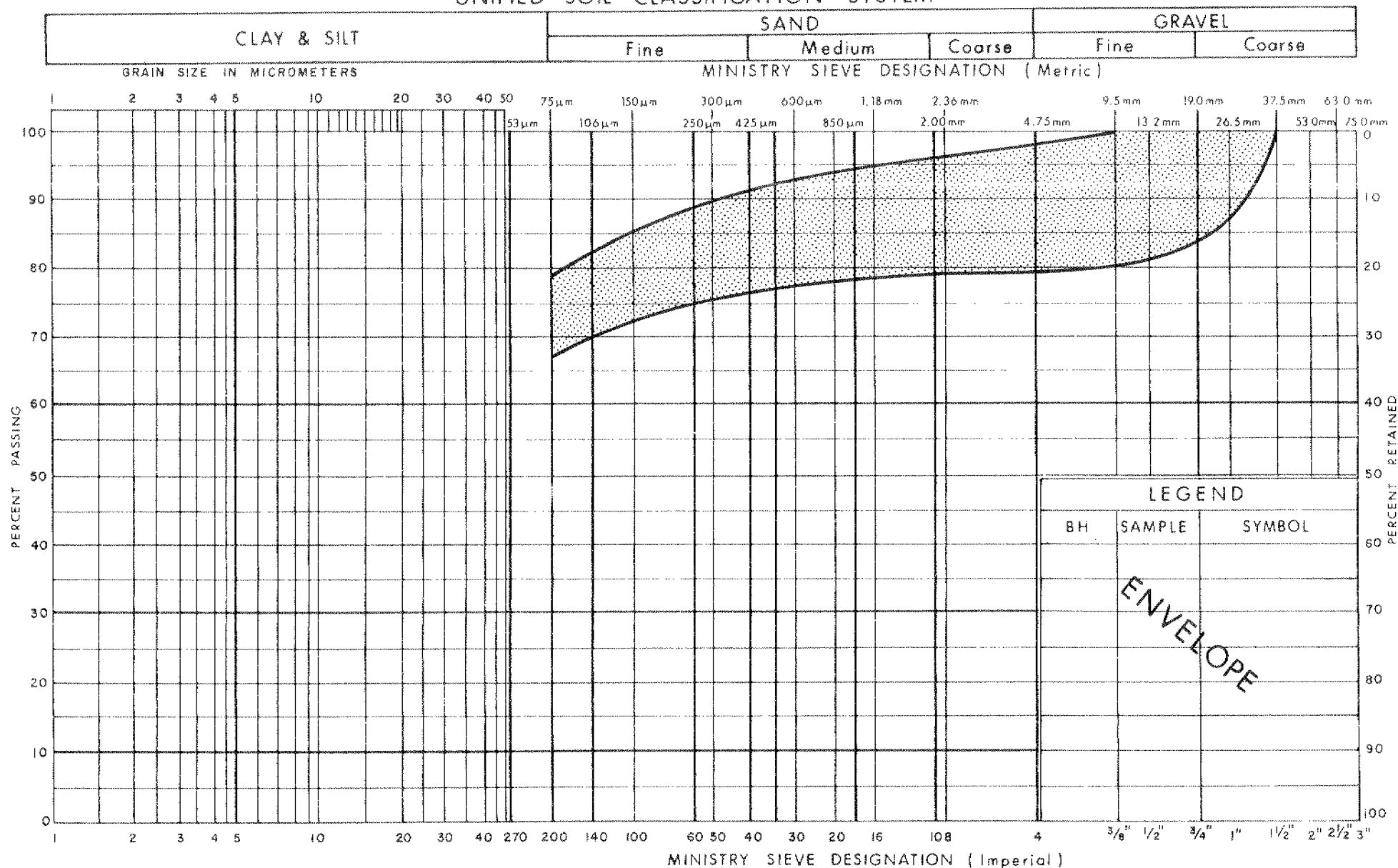
Ontario

PLASTICITY CHART
HET MIXTURE OF
CLAYEY SILT, SAND & GRAVEL (Glacial Till)

FIG No 1

W P 2620-90-00(A)

UNIFIED SOIL CLASSIFICATION SYSTEM



Ontario

Ministry of
Transportation

GRAIN SIZE DISTRIBUTION

HET MIXTURE OF

CLAYEY SILT, SAND & GRAVEL (Glacial Till)

FIG No 2

W P 2620-90-00(A)

RECORD OF BOREHOLE No P1

1 OF 1

METRIC

W.P. 2620 - 90 - 00 (A) LOCATION CO-ORDS: N 4 770.144; E 199.104 ORIGINATED BY E M&T K
DIST 2 HWY 401 BOREHOLE TYPE CONTINUOUS FLIGHT HOLLOW STEM AUGER & CONE TEST COMPILED BY M V
DATUM GEODETIC DATE 93 10 06 CHECKED BY T K

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100	20 40 60 80 100	W _p W W _L	WATER CONTENT (%) 10 20 30			
334.9	Ground Surface					DRY *								
0.0	SANDY SILT, Trace of Gravel, Trace of Clay, Trace of Organics, Compact (Fill)		1	SS	13		334							
333.6														
1.3	SANDY SILT, Trace of Gravel, Compact		2	SS	17		333							7 39 (54)
			3	SS	19									
332.0			4	SS	50		332							
2.9			5	SS	97		331							4 29 (67)
			6	SS	81		330							
			7	SS	95		329							
			8	SS	181	328								
			9	SS	93	327								
325.3						326							20 12 (68)	
9.6	End of Borehole *Note: Borehole Dry on Completion													

RECORD OF BOREHOLE No P2

1 OF 1

METRIC

W.P. 2620 - 90 - 00 (A) LOCATION CO-ORDS: N 4 770 148; E 199 219 ORIGINATED BY E MacT K
DIST 2 HWY 401 BOREHOLE TYPE CONTINUOUS FLIGHT HOLLOW STEM AUGER COMPILED BY M V
DATUM GEODETTIC DATE 93 10 06 CHECKED BY T K

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
								SHEAR STRENGTH kPa					WATER CONTENT (%)				
								○ UNCONFINED	+ FIELD VANE	● QUICK TRIAXIAL	× LAB VANE		10	20	30		
332.1	Ground Surface																
0.0	Topsoil																
	SANDY SILT, Trace of Gravel, Loose		1	SS	8		331										
330.7			2	SS	29		330										2 20 (78)
1.4			3	SS	55		329										
			4	SS	55		328										
			5	SS	52		327										
			6	SS	118		326										4 27 (69)
			7	SS	131	/23cm	325										
			8	SS	104	/15cm	324										
			9	SS	119	/23cm	323										
322.6																	
9.5	End of Borehole																
	*Note: Borehole Dry on Completion																

RECORD OF BOREHOLE No P3

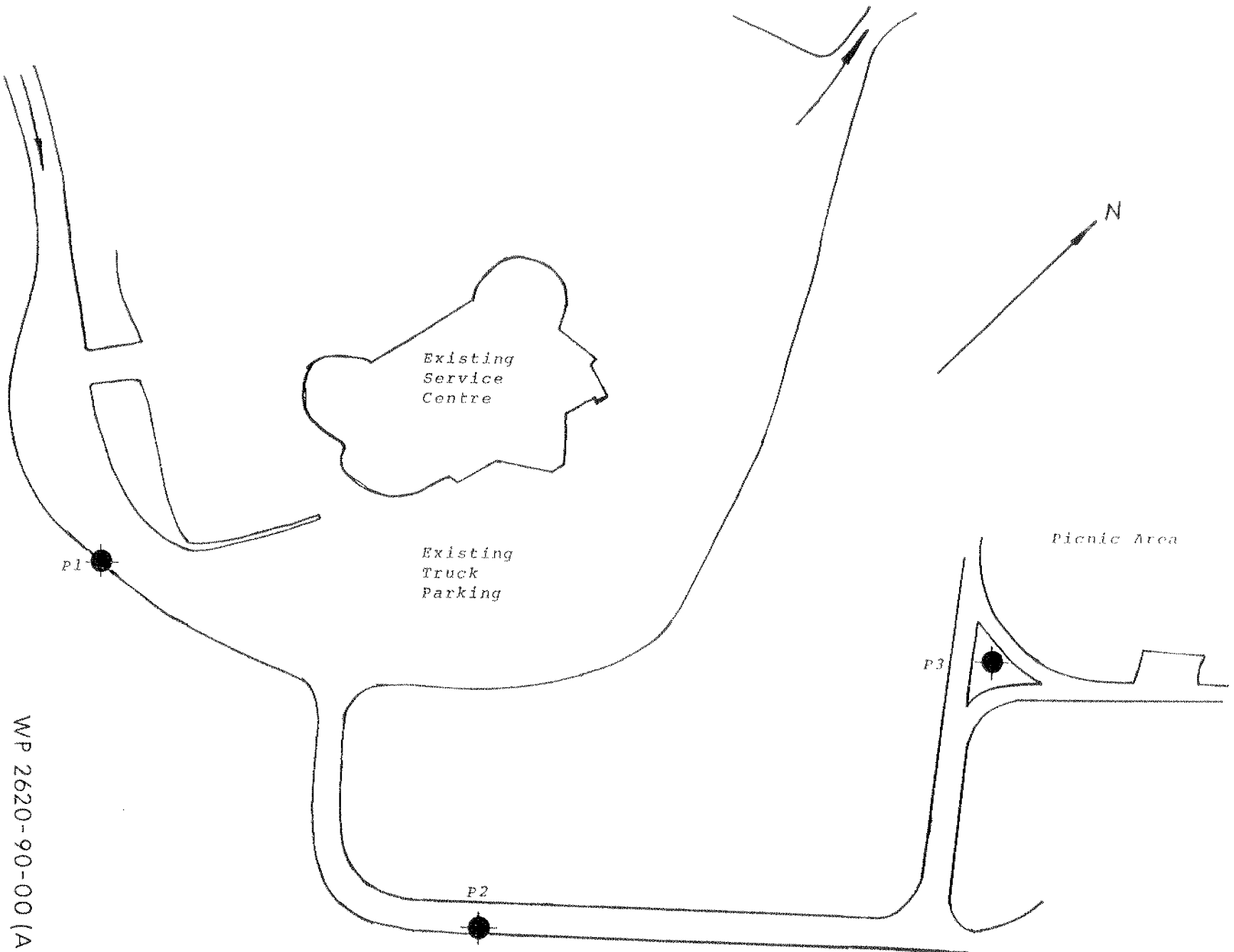
1 OF 1

METRIC

W.P. 2620 - 90 - 00 (A) LOCATION CO-ORDS: N 4 770 267; E 199 254 ORIGINATED BY E M
DIST 2 HWY 401 BOREHOLE TYPE SOLID STEM AUGER COMPILED BY M V
DATUM GEODETIC DATE 93 10 07 CHECKED BY T K

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
332.3	Ground Surface																
0.0	ORGANIC SILT, Trace of Gravel, Trace of Sand, Firm (Fill)		1	SS	8	DRY *	332										
331.0							331										
1.3	SANDY SILT, Trace of Clay, Loose to Compact		2	SS	5		330										
329.4			3	SS	20		329										5 38 (57)
2.9			4	SS	39		328										
			5	SS	48		327										
			6	SS	151		326										
			7	SS	100	/8cm	325										
			8	SS	100	/8cm	324										
322.9			9	SS	100	/8cm	323										
9.4	End of Borehole																
	*Note: Borehole Dry on Completion Perched Water Was Encountered Between El. 330.2 & El. 329.4																

WP 2620-90-00 (A)
Dist. 2 , Hwy. 401
Geocres No. 40P2-53
Dwg. A



FOUNDATION INVESTIGATION REPORT
For
W4 - Service Centre Detention Pond
W.P. 2620-90-00(B)
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 on 1993 10 07, and comprised of one sampled borehole.

Borehole was advanced to a maximum depth of 9.6 m (El. 321.6) below the existing ground level using 82 mm continuous flight solid stem auger. The borehole location is shown on Drawing A.

SITE DESCRIPTION

The site under investigation is located in the picnic area south of Hwy. 401 which is approximately 3.0 km east of Hwy 401 and Folden Road, in the Township of Southwest Oxford.

The site is located in an area where the surface is drumlinized. The topography of the site is generally undulating. The area in the vicinity of the site is rural in nature and primary use of the land is for agricultural purposes. Physiographically, the area is located in the region known as the "Oxford Till Plain".

SUBSURFACE CONDITIONS

The underlying subsoil at this location consists of 6.8 m loose to compact sandy silt underlain by very dense silt. For classification purposes, the soils encountered at this location can be divided into two different zones:

a) Sandy Silt, Trace Gravel, Trace Clay

b) Silt, Trace Sand, Trace Clay

The soils encountered during the course of the investigation, together with the field and laboratory test results are shown on the Record of Borehole Sheet contained in the Appendix of this report. Description of the strata encountered are given below:

Sandy Silt, Trace Gravel, Trace Clay

This deposit was encountered immediately below the topsoil. The thickness of this deposit was observed to be about 6.3 m and extends to elevation 324.4. The results of the Gradation Test carried out on representative soil samples are shown on Figure 1 in an envelope form. These test results indicate that this deposit is predominantly composed of sand (32% to 41%) and silt (46% to 56%). The upper 0.5 m of this deposit was observed to contain organics. Based on Standard Penetration Test results, this deposit may be classified as loose to compact state of denseness down to elevation 326 and below this depth, it may be classified as compact to very dense state of denseness.

Silt, Trace Sand, Trace Clay

The upper boundary of this deposit was encountered at about elevation 324.4. The Gradation Test carried out on one sample is shown on Figure 2. The Standard Penetration Test results in this deposit (over 100 blows/0.3 m) indicate very dense state of denseness. The full extent of this deposit was not proven below El: 321.6.

Groundwater Conditions

The borehole was observed to be dry on completion. However, the water well data obtained from the Ministry of Environment Ontario indicate that the static

groundwater level in the vicinity of the proposed site varies from elevation 309.7 to 300.2 and the flow in the aquifer is in southerly direction. The static groundwater level at some of the wells in the vicinity of the proposed site is as follows:

MOE Well No	Location (UTM)*	Static Water Elevation	Remarks
2333	N 4 768 130 E 516 650	291.0	Supply to Picnic Area
2334	N 4 768 225 E 516 560	309.7	Supply to Service Centre
2335	N 4 767 710 E 516 980	300.2	
2336	N 4 768 180 E 516 500	307.9	
2337	N 4 767 870 E 516 380	Dry	Bottom of Well El. 304.1
2338	N 4 767 240 E 515 750	Dry	Bottom of Well El. 239.1 Bedrock
3891	N 4 768 445 E 515 881	300.3	

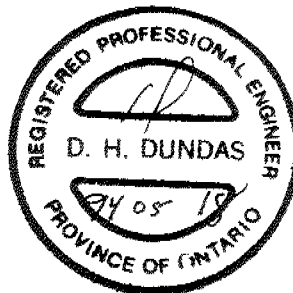
* Note: UTM: Universal Transverse Mercator Co-ordinates in Metres.

MISCELLANEOUS

The fieldwork for this investigation was carried out under the supervision of M. Vasavithasan. The equipment used was owned and operated by London Soil Test. This report was prepared by M. Vasavithasan, Foundation Engineer, reviewed by Tae C. Kim, Senior Foundation Engineer and approved by D. Dundas, Chief Foundation Engineer (Acting).



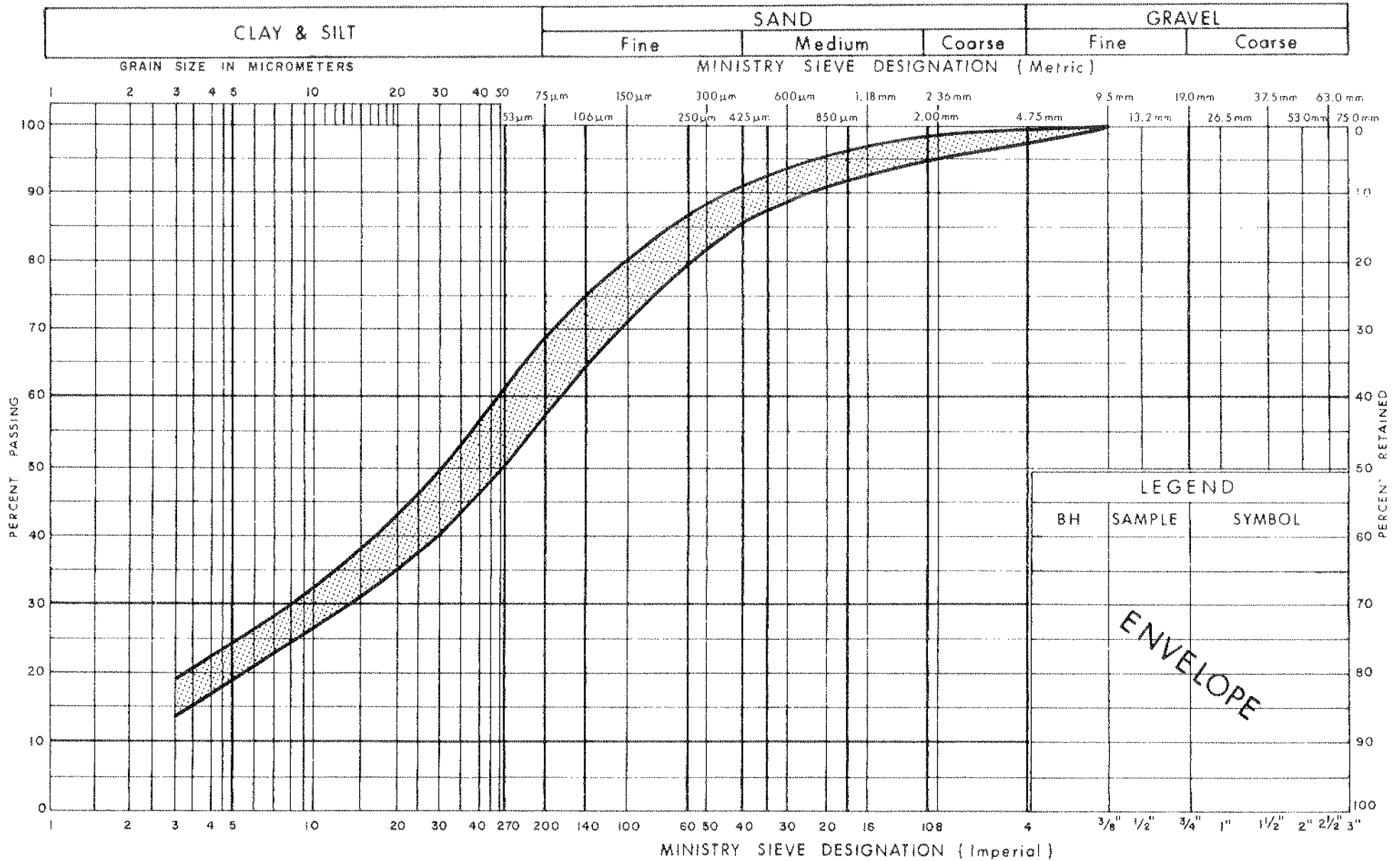
Tae C. Kim
Tae C. Kim, P. Eng.
Sr. Foundation Engineer



D. Dundas
D. Dundas, P. Eng.
Chief Foundation Engineer
Acting

APPENDIX

UNIFIED SOIL CLASSIFICATION SYSTEM



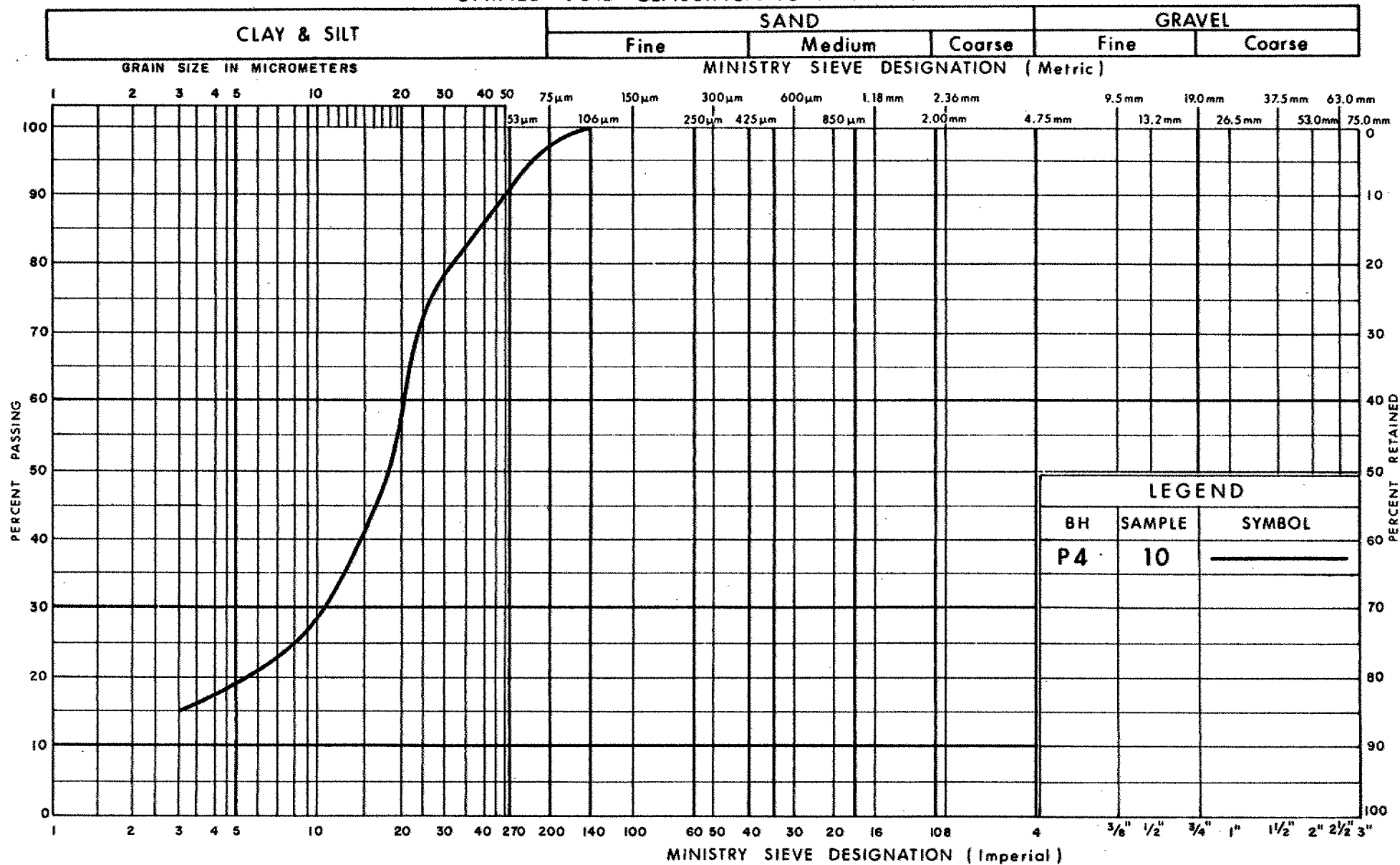
Ministry of
Transportation

GRAIN SIZE DISTRIBUTION
SANDY SILT, TRACE GRAVEL, TRACE CLAY

FIG No 1

W P 2620-90-00(B)

UNIFIED SOIL CLASSIFICATION SYSTEM



Ministry of
Transportation

Ontario

GRAIN SIZE DISTRIBUTION
SILT, TRACE SAND, TRACE CLAY

FIG No 2

W P 2620-90-00(B)

RECORD OF BOREHOLE No P4

1 OF 1

METRIC

W.P. 2620 - 90 - 00(B) LOCATION CO-ORDS: N 4 770 290; E 199 321 ORIGINATED BY M.V.
DIST 2 HWY 401 BOREHOLE TYPE SOLID STEM AUGER COMPILED BY M.V.
DATUM GEODETIC DATE 93 10 07 CHECKED BY T.K.

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	WATER CONTENT (%) W	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100						
331.2	Ground Surface																	
0.0	Topsail					DRY *												
			1	SS	21		330											2 38 43 11
			2	SS	7		329											
			3	SS	7		328											3 41 45 10
	SANDY SILT, Trace Gravel, Trace Clay, Loose to Compact		4	SS	7		327											
			5	SS	4		326											
			6	SS	16		325											1 32 56 11
			7	SS	27		324											
	Compact to Very Dense		8	SS	65		323											2 40 54 4
324.4							322											
6.8	SILT, Trace Sand, Trace Clay, Very Dense		9	SS	77	/15cm												
			10	SS	103													0 2 67 11
321.8																		
9.6	End of Borehole *Note: Borehole Dry on Completion																	

PLAN
SCALE
20m 10 0 20m

Dwg. A

FILE



Ministry
of
Transportation

FOUNDATION DESIGN SECTION

**foundation
investigation and
design report**

ENGINEERING MATERIALS OFFICE

FOUNDATION DESIGN SECTION

W.P. 2620-90-00(A)
Highway 401

District 2
Service Centre, E.B.L.
West of Woodstock

High Mast Lighting Foundations

CONT 94-401

DISTRIBUTION

A. Ho (2)
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FOUNDATION INVESTIGATION REPORT

For

High Mast Lighting Foundations

Highway 401, Service Centre, East Bound Lanes, CW-4

W.P. 2620-90-00 (A)

District 2, London

INTRODUCTION

This report summarizes the factual information obtained from a foundation investigation performed at the above-mentioned site between 93-10-06 and 93-10-07. The field work consisted of advancing one borehole at each High Mast Lighting (HML) location in order to establish soil parameters for the design of the 3 HML foundations. For borehole locations refer to Drawing A. All three boreholes were drilled to a depth of 9.6 metres.

SITE DESCRIPTION

The site is located south-east of the Service Centre on Highway 401, eastbound lanes, approximately 5 km west of Woodstock. The topography in the vicinity of the Service Centre is undulating. The surrounding area is farm land. Physiographically the area is located in the region known as the "Oxford Till Plain".

SUBSURFACE CONDITIONS

The investigation consisted of advancing one borehole at each of the three HML locations to depths of about 9.6 m.

The subsoil at the borehole locations consists predominantly of a heterogeneous mixture of clayey silt, sand and gravel (glacial till). Sandy silt fill is present in boreholes P1 and P3 to depths of 1.3 metres. Sandy silt is present in boreholes P1, P2 and P3 to depths of 2.9, 1.4 and 2.9 respectively. The sandy silt overlies the glacial till described above.

A more detailed description of the subsurface conditions encountered is given below.

Organic Silt Fill/ Sandy Silt Fill

A 1.3 m thick layer of organic silt fill with a trace of gravel and sand was found in Borehole P3. A 1.3 m thick layer of sandy silt fill with a trace of gravel, clay and organics was found in Borehole P1. No index tests were carried out on this material.

Sandy Silt

Below the organic silt fill/sandy silt fill or from the ground surface, a layer of sandy silt ranging from 1.4 to 1.6 metres was encountered in all 3 boreholes.

Clayey Silt, Sand and Gravel (Glacial Till)

Below the sandy silt layer, a thick deposit of a heterogeneous mixture of clayey silt, sand and gravel (glacial till) was encountered in all boreholes. The upper 1.9 and 1.7 metres of this material in Boreholes P1 and P2 respectively is brown in colour as a result of oxidation and desiccation. Below this the material is grey. In Borehole P3, the material is grey from immediately below the sandy silt layer.

The results from the Atterberg Limit Test performed on this material are plotted on Figure 1 and summarized as follows.

Index Properties	Range %
Moisture Content (w)	7.5 - 16
Liquid Limit (w_L)	16 - 38
Plastic Limit (w_p)	12 - 17
Plasticity Index (I_p)	4 - 21

From the visual examination of samples, this material was classified as a heterogeneous mixture of clayey silt, sand and gravel. From the plasticity chart (Figure 1), the clayey silt part of the mixture can be classified as a clayey silt with trace of sand and gravel with low plasticity (CL).

Grain size distribution tests were carried out on these materials and are shown in an envelope form in Figure 2.

GROUNDWATER CONDITIONS

Groundwater conditions were observed through the measurement of water levels in the open boreholes.

Boreholes P1 and P2 were dry on completion. In borehole P3, ponded water was encountered between elevations 330.2 and 329.4. It appears that water draining from the existing parking area adjacent to the Service Centre had permeated into the surface soils at this location and was ponded on top of the relatively impermeable glacial till at the time of drilling.

Occasional thin sand layers were encountered in the glacial till in the boreholes.

DISCUSSION AND RECOMMENDATIONS

A foundation investigation was carried out between 93-10-06 and 93-10-07 at the above noted site in order to establish soil parameters for the design of 3 HML foundations. The investigation consisted of advancing one borehole at each of the HML locations to a depth of 9.6 m below the ground level.

The proposed locations of each of the HML are shown of Drawing A.

Design Considerations

The High Mast Lighting foundations will be supported on a single concrete caisson and the design should be in accordance with the method described by Broms as per the following papers.

BROMS, B.B.: Lateral Resistance of Piles in Cohesive Soils, Journal of the Soil Mechanics and Foundation Division, ASCE, Vol. 90, No. SM2, Paper No. 3825, March 1964.

BROMS, B.B.: Lateral Resistance of Piles in Cohesive Soils, Journal of the Soil Mechanics and Foundation Division, ASCE, Vol 90, No. SM3, Paper No. 3909, May 1964.

BROMS, B.B.: Design of Laterally Loaded Piles, Journal of the Soil Mechanics and Foundation Division, ASCE, Vol. 91, Paper No. SM3, May 1965.

The soil parameters provided in Table 1 are recommended for the design of the HML foundations. The following notation has been adopted:

- ϕ = apparent angle of friction for cohesionless soils in degrees
 q_u = unconfined compressive strength in kPa ($q_u = 2 \times C_u$) for cohesive soils
 γ = bulk unit weight in kN/m^3

The material within the zone of frost penetration depth should not be included in calculations of lateral resistance. At this site, the depth of frost penetration is 1.2 m.

Construction Considerations

Some of the caissons in part will be located within layers of non-cohesive subsoil, and a perched groundwater level is at a higher level in at least one borehole. In view of this, the following Special Provisions should be included in the contract documents:

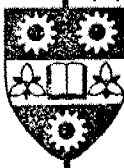
"The Contractor shall install concrete footings in earth for high mast poles. At the various pole locations, soil deposits consist of mixtures of silts, sand and trace of gravels. Groundwater is likely to be encountered above the base level.

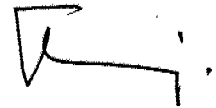
The soil is susceptible to conditions of unbalanced hydrostatic head and seepage forces and is likely to 'boil' and become unstable under such conditions. The Contractor shall maintain the stability of the soil in the sides and bases of the holes for the concrete footings at all times from commencement of their construction to the placing of concrete."

MISCELLANEOUS

The field work for this project was carried out under the supervision of E. R. Magni, Soils Supervisor, Geotechnical Section, Southwestern Region and T. C. Kim, Sr. Foundation Engineer. The drilling equipment was owned and operated by London Soil Test, London.

This report was written by E. R. Magni, Soils Supervisor, and reviewed by T. C. Kim, Sr. Foundation Engineer.

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E. R. Magni
Soils Supervisor
Geotechnical Section
Southwestern Region


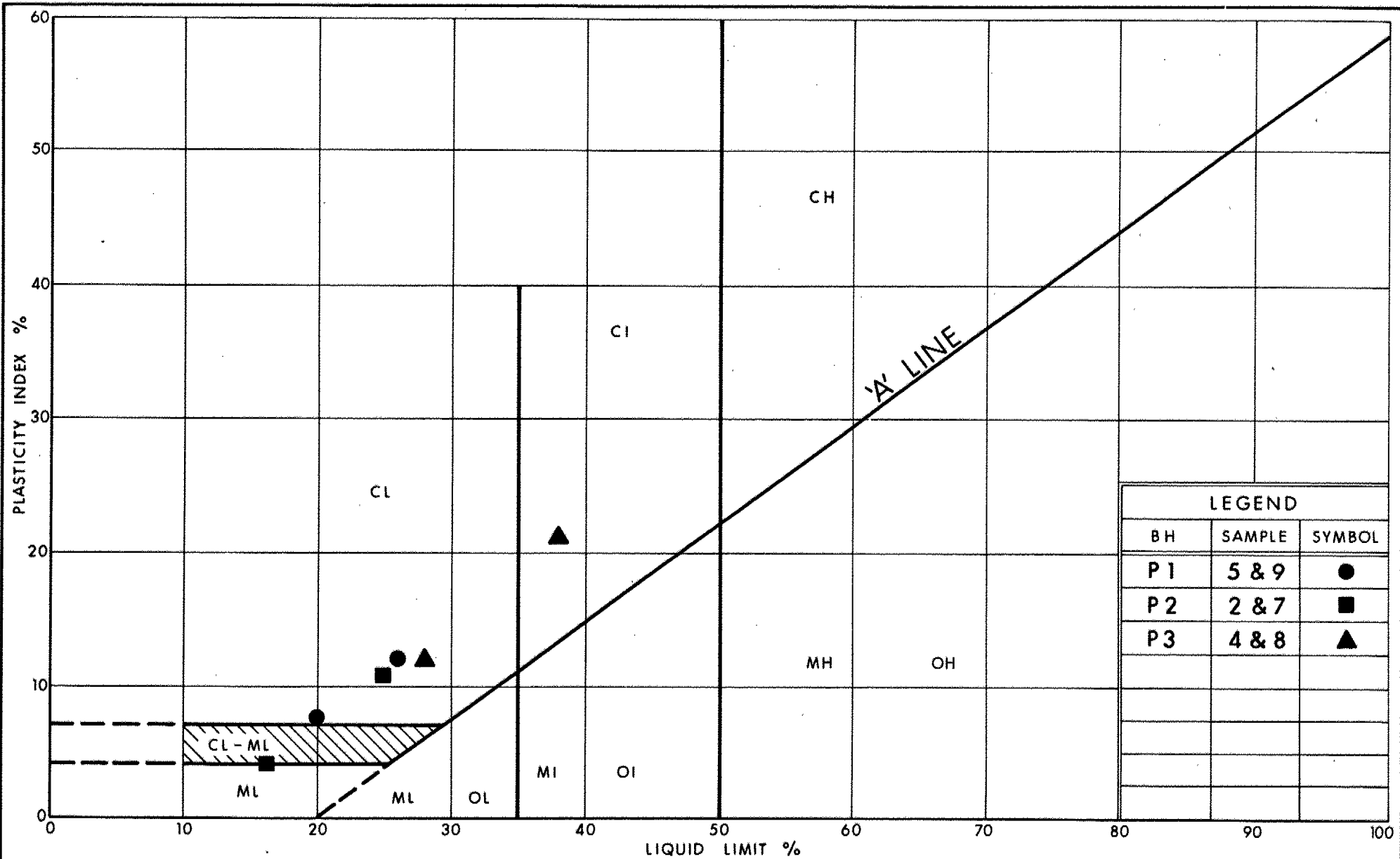

 Tae C. Kim, P.Eng.
 Sr. Foundation Engineer
 Foundation Design Section

TABLE 1 - LOCATION AND SOIL PARAMETERS

<u>Borehole No:</u>	Elevation (m) From To		Type of Soil	Denseness or Consistency	Ø (deg)	qu (kPa)	γ kN/ m ³
P1	334.9	333.6	Cohesionless	Compact	30	-	19.6
	333.6	332.0	Cohesionless	Compact	32	-	19.9
	332.0	325.3	Cohesive	Hard	-	500	21.2
P2	332.1	330.7	Cohesionless	Loose	29	-	19.0
	330.7	322.6	Cohesive	Hard	-	500	21.2
P3	332.3	331.0	Cohesive	Firm	-	100	19.0
	331.0	329.4	Cohesionless	Loose to Compact	29	-	19.0
	329.4	322.9	Cohesive	Hard	-	500	21.2

APPENDIX



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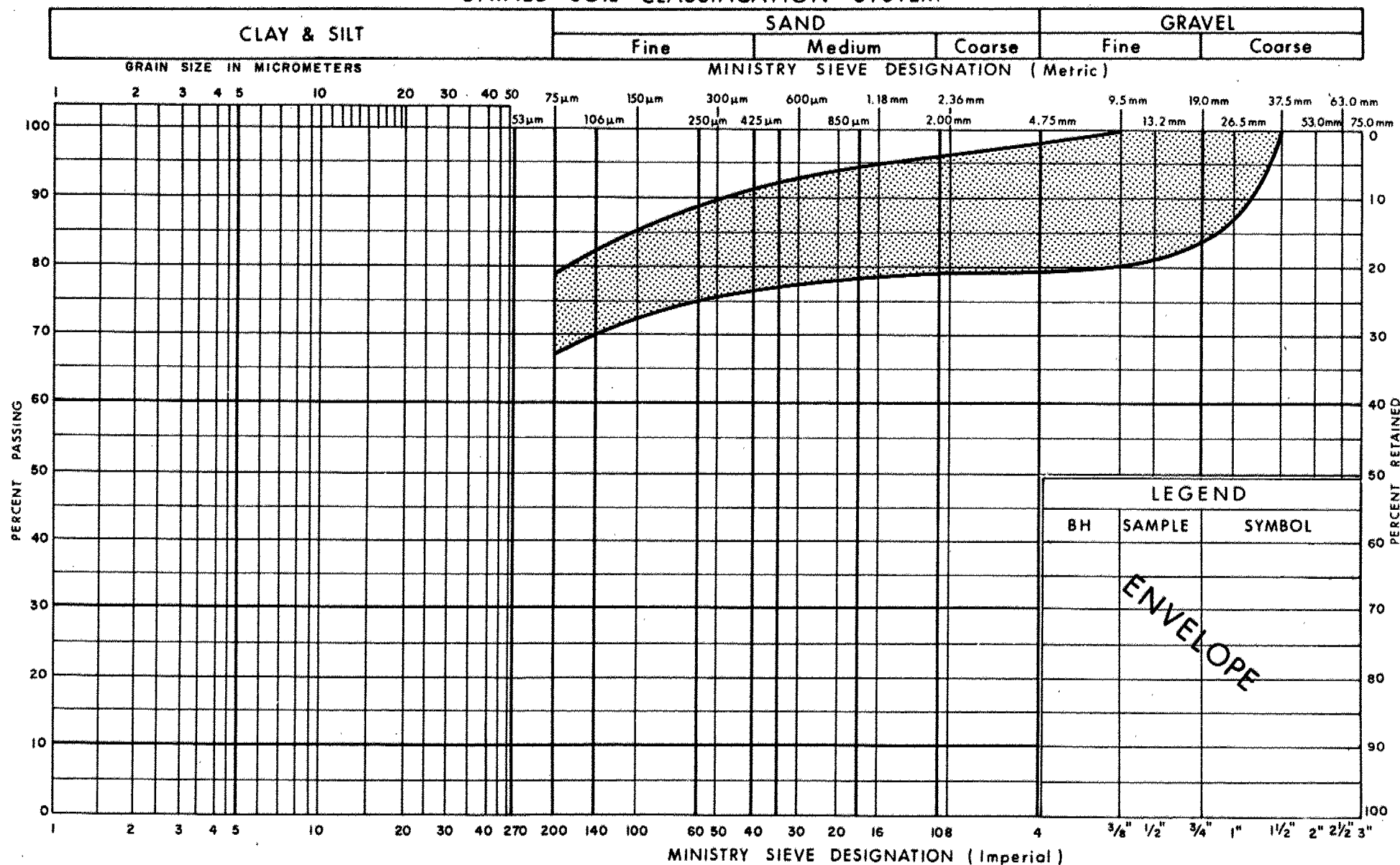
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PLASTICITY CHART
HET MIXTURE OF
CLAYEY SILT, SAND & GRAVEL (Glacial Till)

FIG No 1

W P 2620-90-00(A)

UNIFIED SOIL CLASSIFICATION SYSTEM



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GRAIN SIZE DISTRIBUTION HET MIXTURE OF CLAYEY SILT, SAND & GRAVEL (Glacial Till)

FIG No 2

W P 2620-90-00(A)

RECORD OF BOREHOLE No P1

1 OF 1

METRIC

W.P. 2620 - 90 - 00 (A) LOCATION CO-ORDS: N 4 770 144; E 199 104 ORIGINATED BY E M&T K
DIST 2 HWY 401 BOREHOLE TYPE CONTINUOUS FLIGHT HOLLOW STEM AUGER & CONE TEST COMPILED BY M V
DATUM GEODETIC DATE 93 10 06 CHECKED BY T K

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				UNIT WEIGHT 7 KN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20 40 60 80 100	20 40 60 80 100	20 40 60 80 100	20 40 60 80 100		
334.9	Ground Surface												
0.0	SANDY SILT, Trace of Gravel, Trace of Clay, Trace of Organics, Compact (Fill)		1	SS	13	DRY *	334						
333.6			2	SS	17		333						7 39 (54)
1.3	SANDY SILT, Trace of Gravel, Compact		3	SS	19		332						
332.0			4	SS	50		331						4 29 (67)
2.0			5	SS	97		330						
			6	SS	81		329						
			7	SS	95		328						
			8	SS	181	/23cm	327						
			9	SS	93		326						20 12 (68)
325.3													
9.6	End of Borehole *Note: Borehole Dry on Completion												

RECORD OF BOREHOLE No P2

1 OF 1

METRIC

W.P. 2820 - 90 - 00 (A) LOCATION CO-ORDS: N 4 770 148; E 199 219 ORIGINATED BY E M&T K
DIST 2 HWY 401 BOREHOLE TYPE CONTINUOUS FLIGHT HOLLOW STEM AUGER COMPILED BY M V
DATUM GEODETIC DATE 93 10 06 CHECKED BY T K

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT 7 kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			'N' VALUES	20	40	60	80	100	W _p	W		
332.1	Ground Surface															
0.0	Topsoil - SANDY SILT, Trace of Gravel, Loose		1	SS	8											
330.7			2	SS	29											
1.4			3	SS	55											
			4	SS	55											
			5	SS	52											
			6	SS	118											
			7	SS	131	/23cm										
			8	SS	104	/15cm										
			9	SS	119	/23cm										
322.6																
9.5	End of Borehole Note: Borehole Dry on Completion															

RECORD OF BOREHOLE No P3

1 OF 1

METRIC

W.P. 2620 - 90 - 00 (A) LOCATION CO-ORDS: N 4 770 267; E 199 254 ORIGINATED BY E.M.
 DIST 2 HWY 401 BOREHOLE TYPE SOLID STEM AUGER COMPILED BY M.V.
 DATUM GEODETIC DATE 93 10 07 CHECKED BY T.K.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
332.3	Ground Surface																
0.0	ORGANIC SILT, Trace of Gravel, Trace of Sand, Firm (Fill)		1	SS	8	DRY *	332										
331.0							331										
1.3	SANDY SILT, Trace of Clay, Loose to Compact		2	SS	5												
			3	SS	20		330										
329.4		brown															5 38 (57)
2.9		grey	4	SS	39		329										7 15 (78)
			5	SS	48		328										
			6	SS	151		327										
	Heterogeneous Mixture of CLAYEY SILT, SAND and GRAVEL, Hard (Glacial Till)		7	SS	100	/8cm	326										
			8	SS	100	/8cm	325										0 1 (99)
322.9			9	SS	100	/8cm	324										
9.4	End of Borehole						323										
	*Note: Borehole Dry on Completion Perched Water Was Encountered Between El. 330.2 & El. 329.4																

Existing
Service
Centre

Existing
Truck
Parking

Picnic Area

P1

P3

P2

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

SS SPLIT SPOON	TP THINWALL PISTON
WS WASH SAMPLE	OS OSTERBERG SAMPLE
ST SLOTTED TUBE SAMPLE	RC ROCK CORE
BS BLOCK SAMPLE	PH TW ADVANCED HYDRAULICALLY
CS CHUNK SAMPLE	PM TW ADVANCED MANUALLY
TW THINWALL OPEN	FS 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 = $\frac{c_u}{\tau_r}$

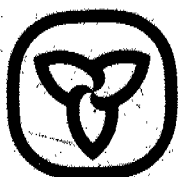
PHYSICAL PROPERTIES OF SOIL

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

G.I.-30 SEPT. 1976

GEOCRES No. 4012-53DIST. 2 REGION W.P. No. 2620-90-00(B)CONT. No. 94-401W. O. No. STR. SITE No. W-4HWY. No. 401LOCATION Service Centre at
JugersollNo of PAGES -

OVERSIZE DRAWINGS TO BE INCLUDED WITH THIS REPORT. REMARKS:



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REMARKS p&D Mark Ayton 519-649-3120

Giffels Bmy 675-5950

Jim Bartlett 235-3776

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FOUNDATION DESIGN SECTION

**foundation
investigation and
design report**

ENGINEERING MATERIALS OFFICE
FOUNDATION DESIGN SECTION

WP 2620-90-00(B) DIST 2

HWY 401 STR SITE -

W4 - Service Centre Detention Pond

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FOUNDATION INVESTIGATION REPORT
For
W4 - Service Centre Detention Pond
W.P. 2620-90-00(B)
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 on 1993 10 07, and comprised of one sampled borehole.

Borehole was advanced to a maximum depth of 9.6 m (E). 321.6) below the existing ground level using 82 mm continuous flight solid stem auger. The borehole location is shown on Drawing A.

SITE DESCRIPTION

The site under investigation is located in the picnic area south of Hwy. 401 which is approximately 3.0 km east of Hwy 401 and Folden Road, in the Township of Southwest Oxford.

The site is located in an area where the surface is drumlinized. The topography of the site is generally undulating. The area in the vicinity of the site is rural in nature and primary use of the land is for agricultural purposes. Physiographically, the area is located in the region known as the "Oxford Till Plain".

SUBSURFACE CONDITIONS

The underlying subsoil at this location consists of 6.8 m loose to compact sandy silt underlain by very dense silt. For classification purposes, the soils encountered at this location can be divided into two different zones:

a) Sandy Silt, Trace Gravel, Trace Clay

b) Silt, Trace Sand, Trace Clay

The soils encountered during the course of the investigation, together with the field and laboratory test results are shown on the Record of Borehole Sheet contained in the Appendix of this report. Description of the strata encountered are given below:

Sandy Silt, Trace Gravel, Trace Clay

This deposit was encountered immediately below the topsoil. The thickness of this deposit was observed to be about 6.3 m and extends to elevation 324.4. The results of the Gradation Test carried out on representative soil samples are shown on Figure 1 in an envelope form. These test results indicate that this deposit is predominantly composed of sand (32% to 41%) and silt (46% to 56%). The upper 0.5 m of this deposit was observed to contain organics. Based on Standard Penetration Test results, this deposit may be classified as loose to compact state of denseness down to elevation 326 and below this depth, it may be classified as compact to very dense state of denseness.

Silt, Trace Sand, Trace Clay

The upper boundary of this deposit was encountered at about elevation 324.4. The Gradation Test carried out on one sample is shown on Figure 2. The Standard Penetration Test results in this deposit (over 100 blows/0.3 m) indicate very dense state of denseness. The full extent of this deposit was not proven below El: 321.6.

Groundwater Conditions

The borehole was observed to be dry on completion. However, the water well data obtained from the Ministry of Environment Ontario indicate that the static

groundwater level in the vicinity of the proposed site varies from elevation 309.7 to 300.2 and the flow in the aquifer is in southerly direction. The static groundwater level at some of the wells in the vicinity of the proposed site is as follows:

MOE Well No	Location (UTM)*	Static Water Elevation	Remarks
2333	N 4 768 130 E 516 650	291.0	Supply to Picnic Area
2334	N 4 768 225 E 516 560	309.7	Supply to Service Centre
2335	N 4 767 710 E 516 980	300.2	
2336	N 4 768 180 E 516 500	307.9	
2337	N 4 767 870 E 516 380	Dry	Bottom of Well El. 304.1
2338	N 4 767 240 E 515 750	Dry	Bottom of Well El. 239.1 Bedrock
3891	N 4 768 445 E 515 881	300.3	

* Note: UTM: Universal Transverse Mercator Co-ordinates in Metres.

DISCUSSION AND RECOMMENDATION

It is proposed to improve the facilities at the existing service centre and as a part of this, a detention pond will be constructed to collect the run-off.

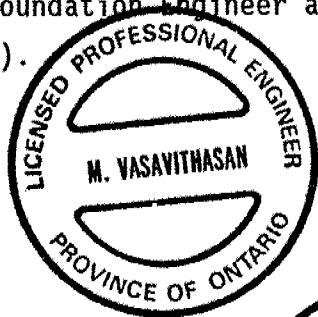
The information provided to us indicate that the detention pond will cover an area of about 0.7 Ha.m. However, details such as depth or width of the pond is not available.

Considering the silt and clay fractions in the sandy silt layer vertical permeability value of 10^{-5} cm/sec may be assumed up to El. 324.4 and below this depth, a permeability value of 10^{-6} cm/sec may be used for the design of the pond. In this type of deposit, horizontal permeability may be taken as 2 to 3 times the vertical permeability. Percolation time of 30 min/cm may be assumed for the soils encountered within the depth of boring.

The proposed depth of excavation is not available, however, no stability problems are anticipated with 2 horizontal to 1 vertical side slopes.

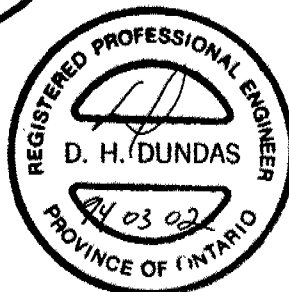
MISCELLANEOUS

The fieldwork for this investigation was carried out under the supervision of M. Vasavithasan. The equipment used was owned and operated by London Soil Test. This report was prepared by M. Vasavithasan, Foundation Engineer, reviewed by Tae C. Kim, Senior Foundation Engineer and approved by D. Dundas, Chief Foundation Engineer (Acting).



M. Vasavithasan

M. Vasavithasan, P. Eng.
Foundation Engineer

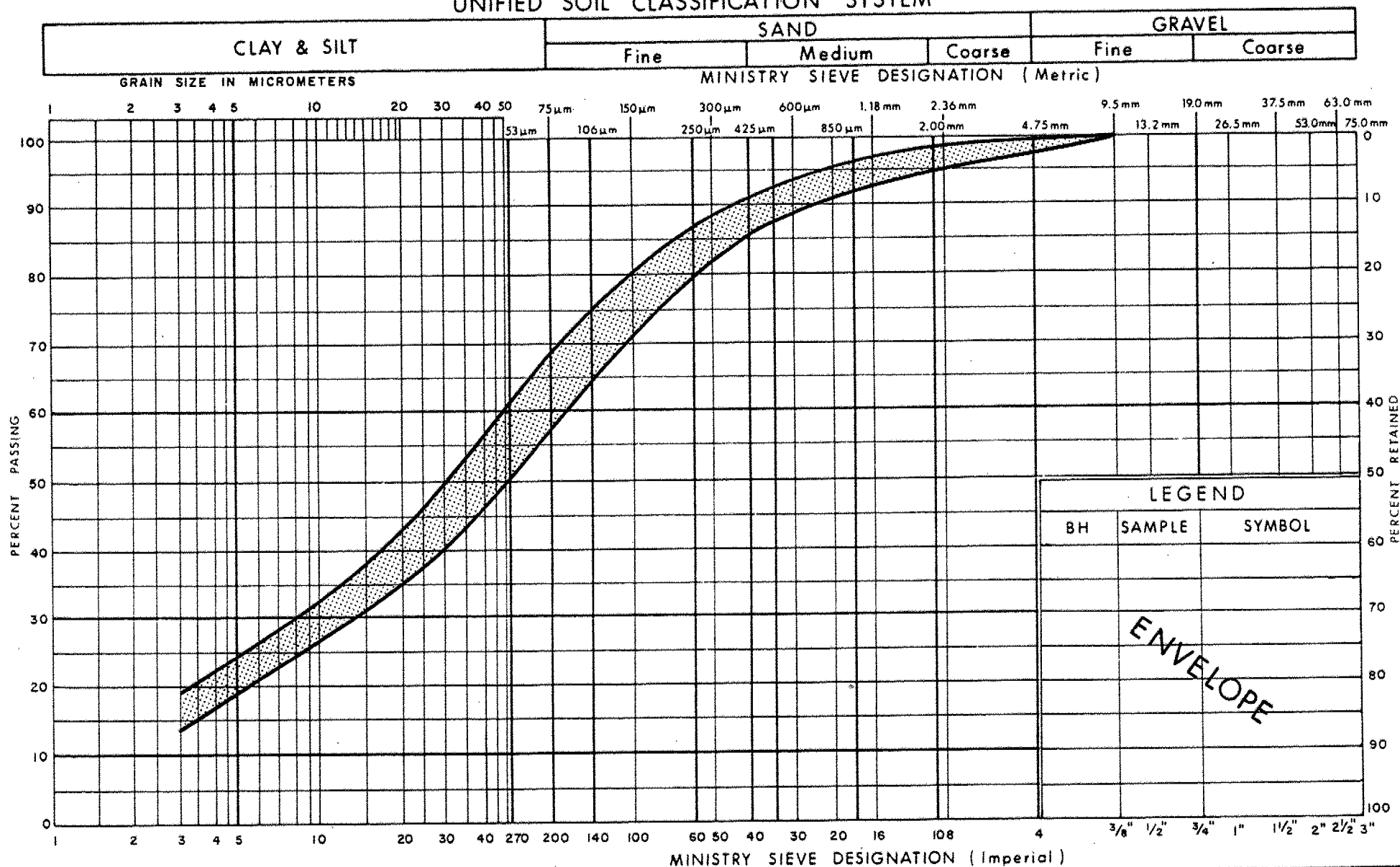


D. Dundas

D. Dundas, P. Eng.
Chief Foundation Engineer
(Acting)

APPENDIX

UNIFIED SOIL CLASSIFICATION SYSTEM



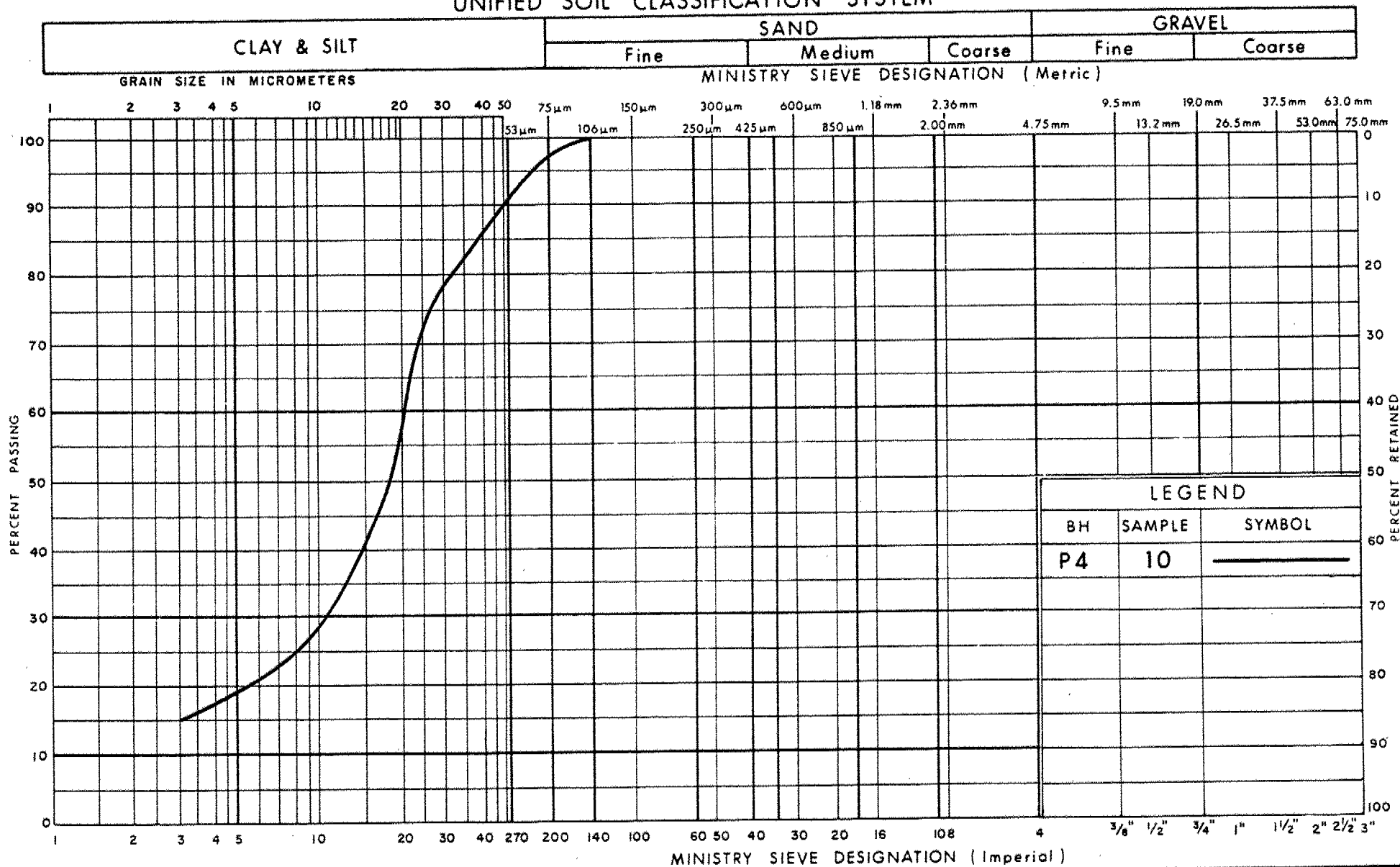
Ministry of
Transportation

GRAIN SIZE DISTRIBUTION
SANDY SILT, TRACE GRAVEL, TRACE CLAY

FIG No 1

W P 2620-90-00(B)

UNIFIED SOIL CLASSIFICATION SYSTEM



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FIG No 2

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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

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

STRESS AND STRAIN

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

PHYSICAL PROPERTIES OF SOIL

ρ_s	kg/m^3	DENSITY OF SOLID PARTICLES	e	1, %	VOID RATIO	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						