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DIST. 6 REGION

W.P. No. 139-79-01

CONT. No. 92-22

W. O. No.

STR. SITE No. 22-149

HWY. No. 12

LOCATION Lyude Creek Bridge

No of PAGES -

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OVERSIZE DRAWINGS TO BE INCLUDED WITH THIS REPORT.

REMARKS:

FOUNDATION INVESTIGATION REPORT

CONTRACT NO. 92-22



Ministry of
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Ontario

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3-16	Foundation Investigation Report for: Lynde Creek W.P. 139-79-01, Site 22-149 Hwy. 12, District 6, Toronto

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

EXPLANATION OF TERMS USED IN REPORT

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

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

SOILS ARE DESCRIBED BY THEIR COMPOSITION AND CONSISTENCY OR DENSENESS.

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

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

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

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

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

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

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

FOUNDATION INVESTIGATION REPORT

For

Lynde Creek Bridge Replacement
W.P. 139-79-01, Site No. 22-149
Highway 12, District 6, Toronto

INTRODUCTION

This report contains the results of a foundation investigation for the proposed Lynde Creek Bridge Replacement on Hwy. 12. This report applies to the structure and the immediate approach fills. This investigation was conducted at the request of the Central Region Structural Section and was carried out between 89 10 16 to 89 10 19.

SITE DESCRIPTION

The site is located on Hwy. 12, 2.3 km south of Brooklyn. Lynde Creek meanders through a flood plain and at the bridge site it is at the north edge of the plain. North of the structure there is a short approach fill 3 to 5 m long which transitions into a cut as Hwy. 12 climbs the side of the Lynde Creek Valley. The valley rises steeply northwest of the structure and has a deciduous brush cover. Near the crest of the valley there are several residences. On the north-east side the valley has a gentler rise and is covered with scrub brush and pasture land.

The south approach fill is more than 150 m long and crosses the flood plain with a fill height of approximately 4 m. The flood plain is relatively flat with pasture land and scrub brush south-east of the structure. On the south-west side of the structure there is a thick mixed brush cover with cedar being the predominate tree.

Along Lynde Creek there are numerous exposed boulders in the river bed and on the river bank.

The existing approach fill at the structure contains boulders and pieces of concrete. The structure is founded on spread footings. The riverbed has been scoured about 0.5 m below the top of the footings, and the exposed south footing has one visible crack. However, there is no apparent distress to the structure.

Drainage is provided by Lynde Creek which flows in a south-westerly direction. It appears that Lynde Creek floods over its banks during storm events.

According to Chapman and Putnam (1984), the site is located at the northern edge of the Iroquois Plain and is composed of till plains with overlying sand deposits.

Investigation Procedures

The investigation was done using a continuous flight auger machine mounted on a truck, equipped with hollow and solid stem augers.

The investigation consisted of 4 sampled boreholes accompanied by dynamic cone penetration tests. BH 3 was split into two parts; BH 3 and BH 3A, with BH 3A slightly south of BH 3. Sampling was done to a maximum depth of 12.3 m (EL. 127.4 m) and the dynamic cone tests to a maximum depth of 6.4 m (EL. 133.4 m). Survey details were obtained by the Foundation Design Section using DHO BM 309-66 as a reference elevation and establishing borehole locations from stations placed by Surveys and Plans on Hwy. 12.

The sampling program for the overburden consisted of split spoon samples at 0.8 m to 1.5 m intervals. These samples provided Standard Penetration Test (N) values for the assessment of the in situ state of compaction of the non-cohesive materials, and for an indication of the shear strength of the cohesive materials.

Groundwater measurements were obtained from a piezometer installed in BH 1. The water levels in the BH's drilled on Hwy. 12 were not obtained as the boreholes were backfilled immediately for safety reasons.

The laboratory testing programme for representative samples consisted of:

- grain size analyses
- natural moisture content determinations
- Atterberg Limit determinations

SUBSURFACE CONDITIONS

The approaches consist of a loose to compact silty sand fill extending from the surface (El. 139.9 m) to El. 134 m. The fill contains boulders, cobbles, concrete and other debris. The fill is underlain by glacial till which consists of a heterogeneous mixture of clayey silt to silt, sand, gravel and occasional cobbles and boulders and is generally cohesive.

The boundaries of the different deposit together with the field and lab test results are shown on the Record of Borehole sheets No's 1 to 4 contained in the Appendix of this report. The stratigraphical sections are shown on Drawing No. 1397901-A*. This drawing also shows the locations and elevations of the borings. A description of the different strata encountered is given below:

Silty Sand, some Gravel, occasional Cobbles, Boulders and Broken Concrete (Fill)

The approach fills have been placed on the flood plain with a short north approach fill and an extensive south approach fill. The depth of fill varies with the road grade and the grade of the flood plain. At the Lynde Creek Bridge the south approach fill is 5.3 to 5.9 m thick with the flood plain encountered at El. 134.0. The north approach fill is 3 to 4.9 m thick with the flood plain encountered at El. 135.0 m.

The approach fill consists of a wet silty sand containing boulders, cobbles, and broken pieces of concrete and other debris. Near the bottom of the fill there are pieces of wood and pockets of organics.

Measured in situ and laboratory properties are as follows:

	<u>Range</u>	<u>Mean</u>
Natural Moisture Content w (%)	5-17.5	10.5
SPT Blows 'N'	6-36	17

NOTE: Refer to Drawing #2 of the contract package.

The Standard Penetration 'N' values range from 6 to 36 blows/30 cm. The blow counts over 30 can be attributed to the split spoon encountering cobbles. The fill acts as a loose to compact deposit even where the blow counts indicate a dense material.

The grain size distribution envelope is shown in Figure 1. The envelope shows a wide variance in the grain size distribution with gravel content ranging from 0 to 36%.

Het. Mixture of Clayey Silt to Silt with Sand, trace Gravel, occasional zones of Sand and Gravel, occasional Cobbles and Boulders (Glacial Till)

The fill is underlain by a glacial till deposit consisting of a heterogeneous mixture of clayey silt to silt with occasional zones of sand and gravel. The depth of this deposit was not determined during this investigation as all the boreholes were terminated in this layer.

South of Lynde Creek the till was encountered at El. 134 m whereas north of Lynde Creek the till was encountered at El. 136.4 m to El. 136.7 m. The till rises north of Lynde Creek as the flood plain changes to valley slope. The till contains non cohesive zones of sand and gravel usually near El. 134.0 and visual observation of Lynde Creek indicates the river bed consists of sand and gravel.

The till also contains boulders and cobbles. In BH 3A, 4.5 m of solid stem augers were left in the hole. The augers are embedded to El. 132.1 m.

The measured in situ and laboratory properties are as follows:

	<u>Range</u>	<u>Mean</u>
Natural Moisture Content w (%)	1 - 13.5	8
Liquid Limit w_L (%)	14.5 - 17	16
Plastic Limit w_p (%)	8 - 9	8.5
Plasticity Index I_p (%)	5.5 - 8	7
SPT Blows 'N'	64 - 175/21 cm	-

The moisture content ranges from 1 to 13.5%. The value of 1% occurred in a gravel deposit and it is not representative of the moisture content of the majority of the till. The plasticity index has an average value of 7% indicating a slightly plastic cohesive till. The typical plasticity characteristics of the material are shown in Figure 2.

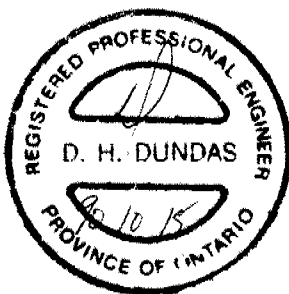
The Standard Penetration Test values indicate a very dense till. The grain size distribution envelope is shown in Figure 3.

Groundwater

A piezometer was installed in BH 1 at El. 135.4 m. The measured water level on 89 11 30 was El. 137.2 m (2.2 m below ground level). This water level is within the fill and is 3.4 m above the water level in Lynde Creek.

MISCELLANEOUS

The field work for this project was supervised by Mr. S. Holmes, Foundation Engineer. The equipment used was owned and operated by Eastern Soil Investigation Limited. This report was prepared by Mr. S. Holmes, Foundation Engineer in conjunction with Mr. D. Dundas, Senior Foundation Engineer, and reviewed by Mr. M. Devata, Chief Foundation Engineer.



D. Dundas
D. Dundas, P. Eng.
Sr. Foundation Engineer

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

A P P E N D I X

RECORD OF BOREHOLE No 1

1 OF 1

METRIC

W.P. 139-79-01 LOCATION Co-ords. N 4 865 891.2 E 348 004.0 ORIGINATED BY SMH
 DIST 6 HWY 12 BOREHOLE TYPE HS Auger, Cone Test COMPILED BY SMH
 DATUM Geodetic DATE 89 10 16 CHECKED BY 42

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT 7 kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL				
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40						60	80	100	20
139.4	Ground Surface																	
0.0	Silty Sand, Some Gravel, occ. Cobbles, Boulders, and Broken Concrete. Loose to Compact. (Fill)		1	SS	6													
	Organics		2	SS	11											21 56 (23)		
			3	SS	25													
136.4			4	SS	77													
3.0	Het. Mixture of Clayey Silt to Silt with Sand, Trace Gravel, occ. zones of Sand and Gravel, occ. Cobbles and Boulders. Hard. (Glacial Till)		5	SS	100	/15cm												
			6	SS	175	/21cm												
			7	SS	139													
	Sand and Gravel		8	SS	92											5 84 10 1		
131.7			9	SS	100	/10cm										72 22 5 1		
7.7	End of Borehole																	
<p>89 11 30</p> <p>* GROUND WATER CONDITIONS</p> <table border="1"> <tr> <td>PIEZO. NO.</td> <td>GROUND WATER ELEVATION (Metres)</td> </tr> <tr> <td>1</td> <td>137.2</td> </tr> </table>															PIEZO. NO.	GROUND WATER ELEVATION (Metres)	1	137.2
PIEZO. NO.	GROUND WATER ELEVATION (Metres)																	
1	137.2																	

RECORD OF BOREHOLE No 2

1 OF 1

METRIC

W.P. 139-79-01 LOCATION Co-ords. N 4 865 864.0 E 347 979.2 ORIGINATED BY SMH
DIST 6 HWY 12 BOREHOLE TYPE HS Auger, Cone Test COMPILED BY SMH
DATUM Geodetic DATE 89 10 16 CHECKED BY 40

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _P	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT 7 KN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
139.7	Road Surface																
0.0	Asphalt					*											
			1	SS	28												
	Silty Sand, Some Gravel, occ. Cobbles, Boulders, and Broken Concrete. Loose to Compact. (Fill)		2	SS	10												20 71 (9)
			3	SS	7												
			4	SS	7												
	Organics		5	SS	17												0 72 (28)
			6	SS	25												26 48 21 5
134.4			7	SS	64												
5.3			8	SS	100	/10cm											7 37 36 20
			9	SS	142												
	Het. Mixture of Clayey Silt to Silt with Sand, Trace Gravel, occ. zones of Sand and Gravel, occ. Cobbles and Boulders. Hard. (Glacial Till)		10	SS	100	/10cm											
			11	SS	100	/13cm											
			12	SS	100	/15cm											
127.4																	
12.3	End of Borehole																
	* Water Level Not Established																

RECORD OF BOREHOLE No 3

1 OF 1

METRIC

W.P. 139-79-01 LOCATION Co-ords. N 4 865 897.5 E 347 989.2 ORIGINATED BY SMH
DIST 5 HWY 12 BOREHOLE TYPE HS Auger, SS Auger, Cone Test COMPILED BY SMH
DATUM Geodetic DATE 89 10 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 γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
139.9	Road Surface																
0.0	Asphalt					*											
	Silty Sand, Some Gravel, occ. Cobbles, Boulders, and Broken Concrete. Compact to Dense (Fill)		1	SS	36												19 60 (21)
			2	SS	19												
			3	SS	36												
136.7			4	SS	129												10 68 (22)
3.2	Het. Mixture of Clayey Silt to Silt with Sand, Trace Gravel, occ. zones of Sand and Gravel, occ. Cobbles and Boulders.		5	SS	100	/10cm											
135.2	Hard. (Glacial Till)		6	SS	100	/15cm											
4.7	End of Borehole																
134.4																	
5.5	End of Cone Test																
	• Water Level Not Established																

RECORD OF BOREHOLE No 3A

1 OF 1

METRIC

W.P. 139-79-01 LOCATION Co-ords. N 4 865 892.7 E 347 987.8 ORIGINATED BY SMH
DIST 5 HWY 12 BOREHOLE TYPE SS Auger, Cone Test COMPILED BY SMH
DATUM Geodetic DATE 89 10 18-19 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 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					
139.9	Road Surface																
0.0	Asphalt					*											
	Silty Sand, Some Gravel, occ. Cobbles, Boulders, and Broken Concrete. Loose to Compact. (Fill)																
			5	SS	18		138										
							137										
							136										
135.0	Organics		6	SS	46		135										34 46 (20)
4.9	Silty Sand																15 49 (36)
			7	SS	100	/15cm											
							134										
			8	SS	100	/15cm											4 39 40 17
							133										
	Het. Mixture of Clayey Silt to Silt with Sand, Trace Gravel, occ. zones of Sand and Gravel, occ. Cobbles and Boulders. Hard. (Glacial Till)		9	SS	100	/15cm	132										14 40 27 19
							131										
			10	SS	150	/26cm	130										
			11	SS	100	/13cm	129										
							128										
127.6			12	SS	100	/15cm											
12.3	End of Borehole																
	* Water Level Not Established																

RECORD OF BOREHOLE No 4

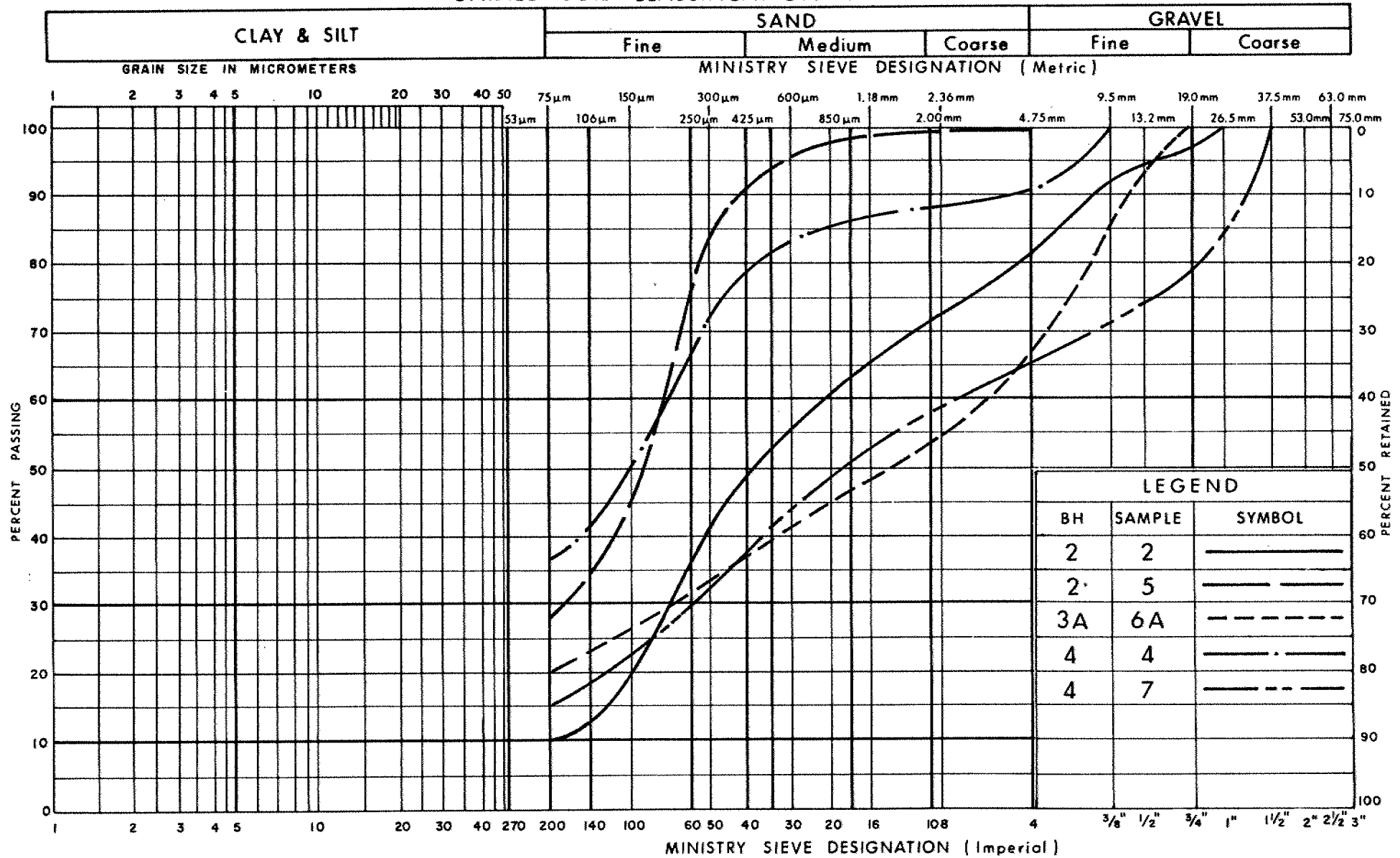
1 OF 1

METRIC

W.P. 139-79-01 LOCATION Co-ords. N 4 865 864.0 E 347 989.9 ORIGINATED BY SMH
DIST 6 HWY 12 BOREHOLE TYPE SS Auger, Cone Test COMPILED BY SMH
DATUM Geodetic DATE 89 10 19 CHECKED BY 40

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT 7 kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
139.8	Road Surface																
0.0	Asphalt																
			1	SS	13												18 60 (22)
			2	SS	12												
	Silty Sand, Some Gravel, occ. Cobbles, Boulders, and Broken Concrete. Loose to Compact. (Fill)		3	SS	9												
			4	SS	12												9 55 (36)
			5	SS	6												
	Organics Pieces of Wood		6	SS	14												
133.9			7	SS	31												36 50 (14)
5.9			8	SS	68												6 65 22 7
	Silty Sand																
			9	SS	100	/15cm											14 29 35 22
	Het. Mixture of Clayey Silt to Silt with Sand, Trace Gravel, occ. zones of Sand and Gravel, occ. Cobbles and Boulders. Hard. (Glacial Till)		10	SS	100	/5cm											
129.0			11	SS	100	/15cm											
10.8	End of Borehole																
	* Water Level Not Established																

UNIFIED SOIL CLASSIFICATION SYSTEM

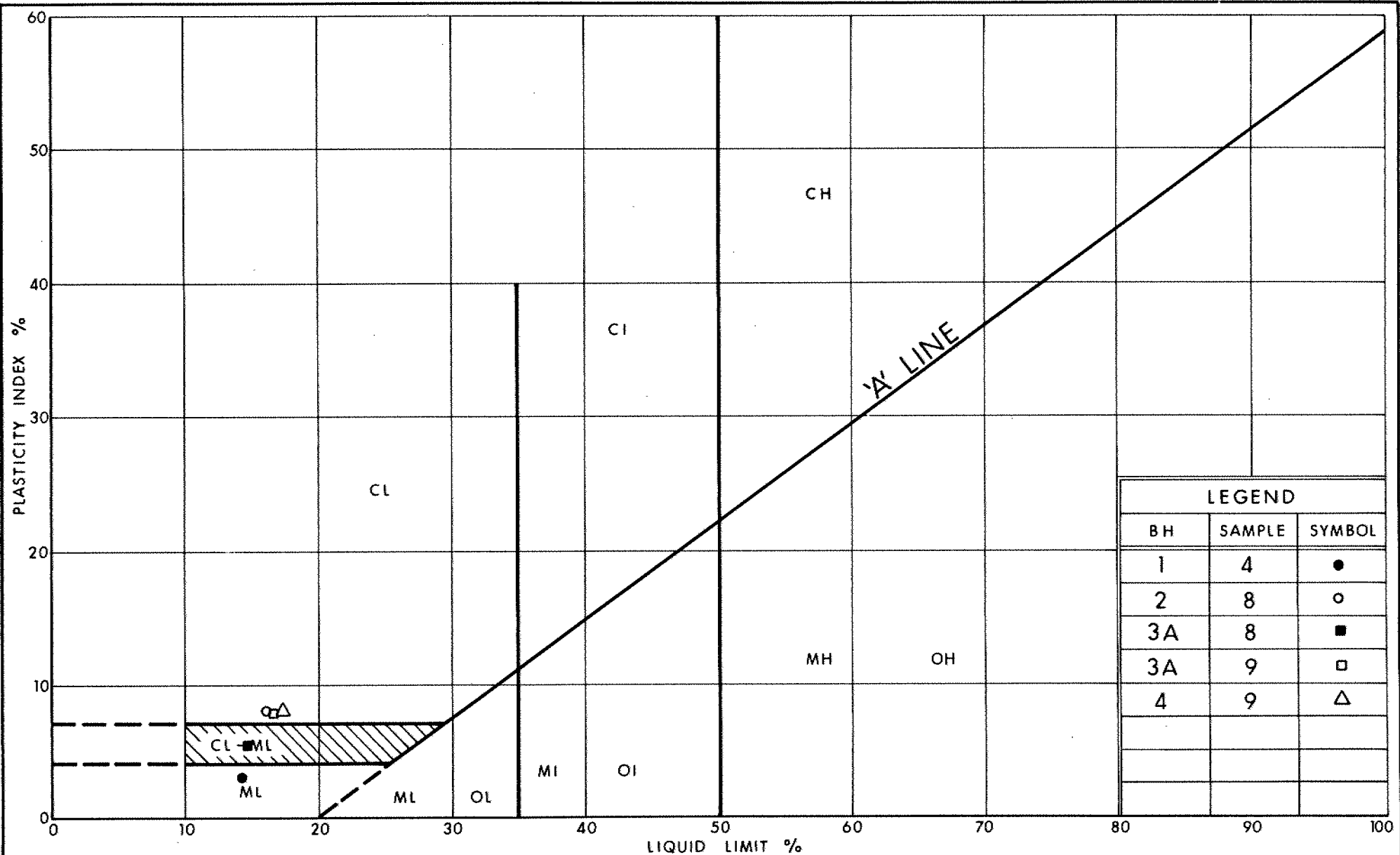


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GRAIN SIZE DISTRIBUTION
SILTY SAND (Fill) SOME GRAVEL, OCC COBBLES,
BOULDERS AND BROKEN CONCRETE

FIG No 1

W P 139-79-01



Ontario

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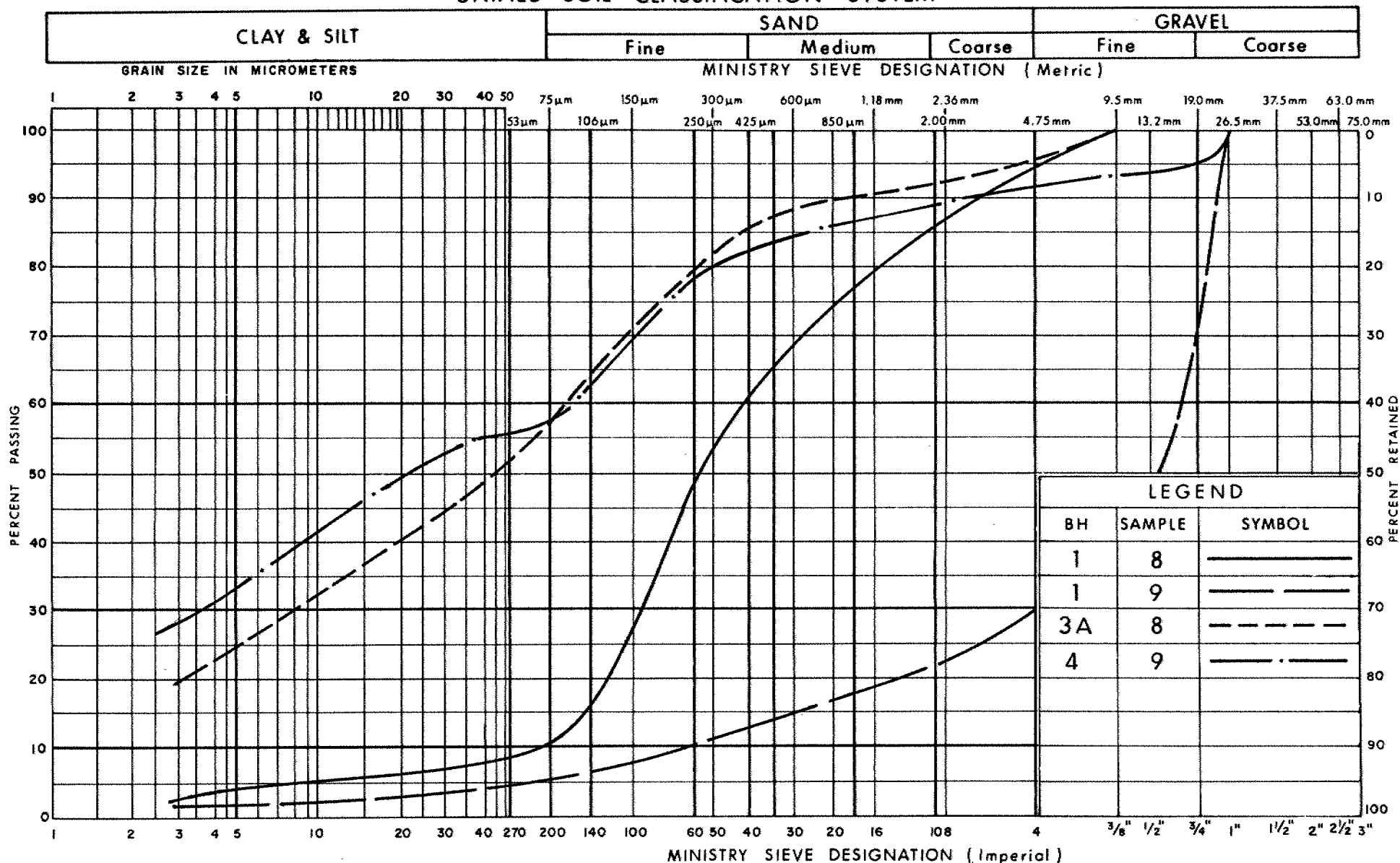
PLASTICITY CHART

HET MIXTURE OF CLAYEY SILT TO SILT WITH SAND, TRACE GRAVEL,
OCC ZONES OF SAND & GRAVEL, OCC COBBLES & BOULDERS
(Glacial Till)

FIG No 2

W P 139-79-01

UNIFIED SOIL CLASSIFICATION SYSTEM



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GRAIN SIZE DISTRIBUTION

HET MIXTURE OF CLAYEY SILT TO SILT, WITH SAND, TRACE GRAVEL,
OCC ZONES OF SAND & GRAVEL, OCC COBBLES & BOULDERS
(Glacial Till)

FIG No 3

W P 139-79-01

ENGINEERING MATERIALS OFFICE
FOUNDATION DESIGN SECTION

WP 139-79-01 DIST 6
HWY 12 STR SITE 22-149
Lynde Creek Bridge Replacement

DISTRIBUTION

V. Boehnke (3)
G. Cautillo
J. Smrcka (2)
A. Wittenberg
K.G. Bassi
S.J. Dunham
G. Szekreny
B. Steeves (Cover Only)
M. MacLean (Cover Only)
File ✓

FOUNDATION INVESTIGATION REPORT

For

Lynde Creek Bridge Replacement

W.P. 139-79-01, Site No. 22-149

Highway 12, District 6, Toronto

INTRODUCTION

This report contains the results of a foundation investigation for the proposed Lynde Creek Bridge Replacement on Hwy. 12. This report applies to the structure and the immediate approach fills. This investigation was conducted at the request of the Central Region Structural Section and was carried out between 89 10 16 to 89 10 19.

SITE DESCRIPTION

The site is located on Hwy. 12, 2.3 km south of Brooklyn. Lynde Creek meanders through a flood plain and at the bridge site it is at the north edge of the plain. North of the structure there is a short approach fill 3 to 5 m long which transitions into a cut as Hwy. 12 climbs the side of the Lynde Creek Valley. The valley rises steeply northwest of the structure and has a deciduous brush cover. Near the crest of the valley there are several residences. On the north-east side the valley has a gentler rise and is covered with scrub brush and pasture land.

The south approach fill is more than 150 m long and crosses the flood plain with a fill height of approximately 4 m. The flood plain is relatively flat with pasture land and scrub brush south-east of the structure. On the south-west side of the structure there is a thick mixed brush cover with cedar being the predominate tree.

Along Lynde Creek there are numerous exposed boulders in the river bed and on the river bank.

The existing approach fill at the structure contains boulders and pieces of concrete. The structure is founded on spread footings. The riverbed has been scoured about 0.5 m below the top of the footings, and the exposed south footing has one visible crack. However, there is no apparent distress to the structure.

Drainage is provided by Lynde Creek which flows in a south-westerly direction. It appears that Lynde Creek floods over its banks during storm events.

According to Chapman and Putnam (1984), the site is located at the northern edge of the Iroquois Plain and is composed of till plains with overlying sand deposits.

Investigation Procedures

The investigation was done using a continuous flight auger machine mounted on a truck, equipped with hollow and solid stem augers.

The investigation consisted of 4 sampled boreholes accompanied by dynamic cone penetration tests. BH 3 was split into two parts; BH 3 and BH 3A, with BH 3A slightly south of BH 3. Sampling was done to a maximum depth of 12.3 m (EL. 127.4 m) and the dynamic cone tests to a maximum depth of 6.4 m (EL. 133.4 m). Survey details were obtained by the Foundation Design Section using DHO BM 309-66 as a reference elevation and establishing borehole locations from stations placed by Surveys and Plans on Hwy. 12.

The sampling program for the overburden consisted of split spoon samples at 0.8 m to 1.5 m intervals. These samples provided Standard Penetration Test (N) values for the assessment of the in situ state of compaction of the non-cohesive materials, and for an indication of the shear strength of the cohesive materials.

Groundwater measurements were obtained from a piezometer installed in BH 1. The water levels in the BH's drilled on Hwy. 12 were not obtained as the boreholes were backfilled immediately for safety reasons.

The laboratory testing programme for representative samples consisted of:

- grain size analyses
- natural moisture content determinations
- Atterberg Limit determinations

SUBSURFACE CONDITIONS

The approaches consist of a loose to compact silty sand fill extending from the surface (El. 139.9 m) to El. 134 m. The fill contains boulders, cobbles, concrete and other debris. The fill is underlain by glacial till which consists of a heterogeneous mixture of clayey silt to silt, sand, gravel and occasional cobbles and boulders and is generally cohesive.

The boundaries of the different deposit together with the field and lab test results are shown on the Record of Borehole sheets No's 1 to 4 contained in the Appendix of this report. The stratigraphical sections are shown on Drawing No. 1397901-A. This drawing also shows the locations and elevations of the borings. A description of the different strata encountered is given below:

Silty Sand, some Gravel, occasional Cobbles, Boulders and Broken Concrete (Fill)

The approach fills have been placed on the flood plain with a short north approach fill and an extensive south approach fill. The depth of fill varies with the road grade and the grade of the flood plain. At the Lynde Creek Bridge the south approach fill is 5.3 to 5.9 m thick with the flood plain encountered at El. 134.0. The north approach fill is 3 to 4.9 m thick with the flood plain encountered at El. 135.0 m.

The approach fill consists of a wet silty sand containing boulders, cobbles, and broken pieces of concrete and other debris. Near the bottom of the fill there are pieces of wood and pockets of organics.

Measured in situ and laboratory properties are as follows:

	<u>Range</u>	<u>Mean</u>
Natural Moisture Content w (%)	5-17.5	10.5
SPT Blows 'N'	6-36	17

The Standard Penetration 'N' values range from 6 to 36 blows/30 cm. The blow counts over 30 can be attributed to the split spoon encountering cobbles. The fill acts as a loose to compact deposit even where the blow counts indicate a dense material.

The grain size distribution envelope is shown in Figure 1. The envelope shows a wide variance in the grain size distribution with gravel content ranging from 0 to 36%.

Het. Mixture of Clayey Silt to Silt with Sand, trace Gravel, occasional zones of Sand and Gravel, occasional Cobbles and Boulders (Glacial Till)

The fill is underlain by a glacial till deposit consisting of a heterogeneous mixture of clayey silt to silt with occasional zones of sand and gravel. The depth of this deposit was not determined during this investigation as all the boreholes were terminated in this layer.

South of Lynde Creek the till was encountered at El. 134 m whereas north of Lynde Creek the till was encountered at El. 136.4 m to El. 136.7 m. The till rises north of Lynde Creek as the flood plain changes to valley slope. The till contains non cohesive zones of sand and gravel usually near El. 134.0 and visual observation of Lynde Creek indicates the river bed consists of sand and gravel.

The till also contains boulders and cobbles. In BH 3A, 4.5 m of solid stem augers were left in the hole. The augers are embedded to El. 132.1 m.

The measured in situ and laboratory properties are as follows:

	<u>Range</u>	<u>Mean</u>
Natural Moisture Content w (%)	1 - 13.5	8
Liquid Limit w _L (%)	14.5 - 17	16
Plastic Limit w _p (%)	8 - 9	8.5
Plasticity Index I _p (%)	5.5 - 8	7
SPT Blows 'N'	64 - 175/21 cm	-

The moisture content ranges from 1 to 13.5%. The value of 1% occurred in a gravel deposit and it is not representative of the moisture content of the majority of the till. The plasticity index has an average value of 7% indicating a slightly plastic cohesive till. The typical plasticity characteristics of the material are shown in Figure 2.

The Standard Penetration Test values indicate a very dense till. The grain size distribution envelope is shown in Figure 3.

Groundwater

A piezometer was installed in BH 1 at El. 135.4 m. The measured water level on 89 11 30 was El. 137.2 m (2.2 m below ground level). This water level is within the fill and is 3.4 m above the water level in Lynde Creek.

DISCUSSION

It was originally proposed to construct a 15 m single span structure over Lynde Creek. The structure would be 20 m wide and the alignment and grade would not change.

Subsequent to the original foundation investigation request an alternative proposal was made by the Structure Office to construct two adjacent 4.5 x 4.5 m cast in place concrete box culverts under the existing structure. These twin box culverts would be 24.3 m long and have an upstream invert elevation of 133.0 m. The existing structure would remain in place while the box culverts were placed under it. The approximate minimum clearances between the proposed box culvert and the existing structure would be 0.7 m. After the box culvert was constructed the existing structure would be removed in two stages, starting with the southbound half.

The east half of the existing structure was built in 1932. It consists of an abutment with a 1.5 m thick spread footing founded at elevation 132.8 m. It has an 8.5 m long wingwall along its west edge which is also founded on a 1.5 m thick spread footing at El. 132.8 m. In 1957 the original structure was widened by the addition of another structure on the west side. According to the bridge drawings for reconstruction the west wingall of the bridge built in 1932 was broken down to El. 138.4 m and left in place, the abutment was widened and a new wingwall was constructed along the new west edge. The abutment and wingwall added in 1957 were both founded on 1.5 m thick footings at El. 132.8 m.

RECOMMENDATIONS

Two alternatives have been proposed; new structure and box culvert. The selection of alternatives will be dependent on staging and cost considerations.

Structure Alternative

Spread Footings on Native Overburden

The proposed location for the new abutment is slightly forward of the existing abutments. In order to provide frost protection and to maintain the width of Lynde Creek, the construction of the proposed footings will involve removal of the existing footings.

Abutments located slightly forward of the existing abutments should be founded on spread footings at El. 132.5 m. The bearing capacities as per the O.H.B.D.C. are as follows:

Factored Capacity at U.L.S.	1000 kPa
Bearing Capacity at S.L.S. Type II	will not govern design

The bearing surface of the excavations should be protected from softening by the placement of 150 mm of mass concrete within 8 hours of exposure.

Spread Footings on Granular 'A' pad

Alternatively the proposed abutment could be located behind the existing abutment and founded on a compacted Granular 'A' pad as shown in Figure 4. This alternative would eliminate the need for unwatering as the spread footing would be placed above the level of Lynde Creek. In this case the existing fill should be removed to the top of the overburden. For the north abutment, excavation would be required approximately to El. 134 m and for the south abutment to El. 133.8 m. Construction staff would have to ensure that all loose material is excavated. There should be a minimum of 1.0 m of Granular 'A' between the base of the proposed abutment and the existing footing.

For the purposes of the O.H.B.D.C. the bearing capacities are as follows:

Factored Capacity at U.L.S.	900 kPa
Bearing Capacity at S.L.S. Type II	350 kPa

Backfill

Backfill to structures should consist of granular material in accordance with Ministry of Transportation Standard Special Provision #109F03.

Computation of earth pressures should be in accordance with Section 6-6.1.2 of the O.H.B.D.C. The active condition will govern earth pressure design for the abutment if it is placed on a Granular 'A' pad. The at rest condition will apply if the abutment is placed on the glacial till at El. 132.5 m. The following properties for backfill are recommended for design:

Material	ϕ	γ	K_A	K_0
Granular 'A'	35°	22.8 kN/m ³	0.27	0.43
Granular 'B'	30°	21.2 kN/m ³	0.33	0.50

Lateral Resistance

For sliding resistance, an unfactored friction angle of 30° can be assumed to apply between the footings and native overburden or granular pads and native overburden. An unfactored friction angle of 35° can be assumed between the base of the footings and the compacted Granular 'A' pads.

Road Protection

Road protection will be required if half of the existing structure is to be removed and replaced while maintaining traffic on the the remaining half of the structure. It is assumed that the west or southbound half of the structure will be removed first. This is assumed because the southbound half was added on to the original structure in 1957.

Therefore, in order to maintain traffic the northbound portion of the approach fill must be retained while the southbound approach fill is excavated. This can be accomplished by installing soldier piles and placing lagging as the fill is excavated. The existing approach fill

silty sand with occasional boulders, concrete and other debris. To penetrate through the boulders the piles must be pre-augered to the required depth of penetration in the underlying till. Tie-backs from the soldier piles to the wingwalls could be considered as a means of supplementing the lateral capacity of the soldier piles. Based on the existing bridge arrangement the soldier piles should be placed left of the centreline such that they avoid the buried wingwall and footing. It is estimated that the buried wingwall extends 0.9 m left of centreline. When planning the traffic staging, consideration should be given to the size of the equipment required for pre-augering the holes for the soldier piles.

For the purposes of design the following parameters can be used for the calculation of earth pressures.

<u>Material</u>	<u>Elevation (m)</u>	<u>ϕ</u>	<u>γ</u>
Silty Sand Fill	Surface to El. 134	29°	21 kN/m ³
Glacial Till	Below El. 134	35°	21 kN/m ³

For design purposes the groundwater level can be assumed as El. 137 m. It should be noted that the forces will be reversed on the lagging when the northbound approach fill is excavated so the lagging will have to be reversed.

The soldier piles will not be removed but will be cut off within the fill.

Detour

To facilitate construction of the new structure consideration should be given to construction of a detour. The detour would eliminate the need for road protection. The detour should consist of an approach fill with 1½:1 side slopes and a temporary Bailey Bridge.

The abutment for the Bailey Bridge detour structure can be supported either on gabion baskets or on timber mats founded on granular pads. If the abutment is supported on a timber mat then the granular pad should be

minimum of 1 m larger all around the plan area than the bearing area. The bearing capacities are the same as for the new structure on a Granular 'A' pad.

If the Bailey Bridge is supported on gabion baskets the baskets may be placed directly on top of the existing soil. For the purposes of the O.H.B.D.C. the following bearing capacities are recommended:

Factored Bearing Capacities at U.L.S.	900 kPa
Bearing Capacities at S.L.S. Type II	350 kPa

For sliding resistance, an unfactored friction angle of 35° can be assumed between the timber mat and the Granular 'A' pad. The unfactored friction angle between the underside of the gabion baskets and the native till may be assumed to be 30° . If a detour is not used and the structure is to be removed and replaced with a new structure then road protection will be required.

Unwatering

If the abutment is founded on the native till at El. 132.5 m then an unwatering scheme will be required as the footing elevation will be below Lynde Creek. It is the responsibility of the Contractor to devise an unwatering scheme and furnish the Ministry with copies of his plan for review. An item for dewatering should be included in the Contract package for this option.

A possible scheme would consist of placing a pre-fabricated box around the bearing surface for the footing. The box would have to be sealed using an impermeable material such as clay.

Alternatively, a culvert with an upstream seal could be used to temporarily divert the stream or an impermeable barrier could be constructed upstream and the stream water could be pumped across the road.

Approach Fills

The approach fills will be approximately 4 m high. They should be constructed with 2:1 forward and side slopes. The fill should consist of noncohesive material to 0.3 m above the high water level.

Frost Protection

The spread footings should have a minimum depth of earth cover of 1.2 m to prevent frost heaving. One metre of rock fill provides frost protection equivalent to 0.5 m of earth cover.

Erosion Protection

The footings should be protected from erosion with 600 mm of rock fill. For the spread footing on a compacted Granular 'A' pad the entire pad should be protected. The rock protection should start at the high water level and extend across the stream bed between the abutments. The rock protection should also extend 5 m upstream and 5 m downstream of the abutments. Hydrology requirements should also be considered and if necessary the amount of rock protection should be increased or gabion mats should be used. The amount of rock protection will also depend on the configuration of the abandoned abutment.

Settlement

Settlement will not be a problem as the grade is not being raised and the bearing stratum is hard.

Box Culvert Alternative

As an alternative to constructing a new single span structure it has been proposed that twin box culverts be constructed. In this case the box culvert should be founded spread footings at El. 132.5 m. The bearing capacity as per the O.H.B.D.C. are as follows:

Factored Capacity at U.L.S.	525 kPa
Bearing Capacity at S.L.S. Type II	350 kPa

The culvert footing should be constructed in the 'dry'. Although it is the responsibility of the contractor to propose an unwatering scheme one alternative would be damming Lynde Creek and pumping the water over Hwy. 12. Any remaining water could be collected in perimeter ditches. Alternatively a temporary stream diversion could be constructed outside the plan limits of the culvert.

The wet fill contained behind the abutments will probably cause some water to drain into the working area. This inflow will gradually be reduced as the water table in the fill drops.

Excavation

In order to maintain the bearing surface of the existing abutment the excavation for the culvert should be no steeper than a 1:1 slope from the base of the existing footing at El. 132.8 m. The existing footing should be protected from scour and undermining during construction of the culvert.

Bedding

The box culverts should be founded on a Granular 'A' pad 150 mm thick. This pad will assist in maintaining a dry working area for constructing the footing.

Backfill

Backfill should be placed according to OPSS 902. Compaction may be difficult to achieve due to the restricted working area under the existing bridge. If compaction equipment is used where the backfill is confined between the existing abutment and the proposed culvert care must be taken

to ensure that excessive lateral loads are not created which could deform the proposed culvert or the existing abutment.

Culvert Inlet

A seal of cohesive material with a minimum thickness of 600 mm is recommended at the culvert inlet. The seal should comply with the requirements outlined in OPSS 1205 'Material Specification for Clay Seal'. It should extend over the backfill to the culvert from the projected high water level down to the channel bed and 1.0 m upstream along the channel bottom. The clay seal will not be required if the proposed inlet wingwall (shown in section provided by Structural Section) extends beyond the limits of the backfill around the culvert.

Road Protection

After the culvert is placed it is proposed to remove the existing bridge deck starting with the southbound half. It is assumed that part of the abutment and wingwalls will also be removed. From the top of the remaining abutments and wingwalls the fill can be temporarily graded at $1\frac{1}{2}:1$ to the road surface with traffic being at least 2 m from the edge of the excavation. If this grade can not be facilitated then road protection will be required and should be as recommended in the road protection section.

Erosion Protection

Erosion protection at the culvert inlet and outlet should consist of 600 mm of rock protection. The rock protection should start at the high water level and should cover the clay seal. It should also extend across the stream between the wingwalls protecting the entire area between the wingwalls. If wingwalls are not constructed then rock protection should extend 5 m upstream from the inlet and 5 m downstream from the outlet.

MISCELLANEOUS

The field work for this project was supervised by Mr. S. Holmes, Foundation Engineer. The equipment used was owned and operated by Eastern Soil Investigation Limited. This report was prepared by Mr. S. Holmes, Foundation Engineer in conjunction with Mr. D. Dundas, Senior Foundation Engineer, and reviewed by Mr. M. Devata, Chief Foundation Engineer.



A handwritten signature in black ink, appearing to read "S. Holmes".

S. Holmes, P.Eng.
Foundation Engineer

A handwritten signature in black ink, appearing to read "M. Devata".

M. Devata, P.Eng.
Chief Foundation Engineer

A P P E N D I X

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
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	%	WATER CONTENT	D	mm	GRAIN DIAMETER
γ_w	kN/m ³	UNIT WEIGHT OF WATER	S	%	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 _L - w _P	%	SHRINKAGE LIMIT	q	m ³ /s	RATE OF DISCHARGE
γ_d	kN/m ³	UNIT WEIGHT OF DRY SOIL	I_p	%	PLASTICITY INDEX = $\frac{w_L - w_P}{I_p}$	v	m/s	DISCHARGE VELOCITY
ρ_{sat}	kg/m ³	DENSITY OF SATURATED SOIL	I_L	%	LIQUIDITY INDEX = $\frac{w - w_P}{I_p}$	i	1	HYDRAULIC GRADIENT
γ_{sat}	kN/m ³	UNIT WEIGHT OF SATURATED SOIL	$\frac{w_L - w}{I_p}$	%	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						

RECORD OF BOREHOLE No 1

1 of 1

METRIC

W.P. 139-79-01 LOCATION Co-ords. N 4 865 891.2 E 348 004.0 ORIGINATED BY SMH
 DIST 5 HWY 12 BOREHOLE TYPE HS Auger, Cone Test COMPILED BY SMH
 DATUM Geodetic DATE 89 10 16 CHECKED BY *AP*

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 7 kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL				
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE									'N' VALUES			
139.4	Ground Surface															
0.0	Silty Sand, Some Gravel, occ. Cobbles, Boulders, and Broken Concrete. Loose to Compact. (Fill)		1	SS	6											
	Organics		2	SS	11							21 56 (23)				
			3	SS	25											
136.4			4	SS	77							1 30 59 10				
3.0	Het. Mixture of Clayey Silt to Silt with Sand, Trace Gravel, occ. zones of Sand and Gravel, occ. Cobbles and Boulders. Hard. (Glacial Till)		5	SS	100	/15cm										
			6	SS	175	/21cm										
			7	SS	139											
	Sand and Gravel		8	SS	92							5 84 10 1				
131.7			9	SS	100	/10cm						72 22 5 1				
7.7	End of Borehole															
<p>89 11 30</p> <p>* GROUND WATER CONDITIONS</p> <table border="1"> <tr> <th>PIEZO. NO.</th> <th>GROUND WATER ELEVATION (Metres)</th> </tr> <tr> <td>1</td> <td>137.2</td> </tr> </table>													PIEZO. NO.	GROUND WATER ELEVATION (Metres)	1	137.2
PIEZO. NO.	GROUND WATER ELEVATION (Metres)															
1	137.2															

RECORD OF BOREHOLE No 2

1 OF 1 METRIC

W.P. 139-79-01 LOCATION Co-ords. N 4 865 864.0 E 347 979.2 ORIGINATED BY SMH
 DIST 6 HWY 12 BOREHOLE TYPE HS Auger, Cone Test COMPILED BY SMH
 DATUM Geodetic DATE 89 10 15 CHECKED BY *AP*

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100	20 40 60 80 100					
139.7	Road Surface													
0.0	Asphalt					*								
	Silty Sand, Some Gravel, occ. Cobbles, Boulders, and Broken Concrete. Loose to Compact. (Fill)		1	SS	28									20 71 (9)
			2	SS	10									
			3	SS	7									
			4	SS	7									
	Organics		5	SS	17									0 72 (28)
			6	SS	25									26 48 21 5
134.4			7	SS	64									
5.3			8	SS	100	/10cm								7 37 36 20
	Het. Mixture of Clayey Silt to Silt with Sand, Trace Gravel, occ. zones of Sand and Gravel, occ. Cobbles and Boulders. Hard. (Glacial Till)		9	SS	142									
			10	SS	100	/10cm								
			11	SS	100	/13cm								
127.4			12	SS	100	/15cm								
12.3	End of Borehole													
	* Water Level Not Established													

+3, x5: Numbers refer to
Sensitivity

20
15-5 (%) STRAIN AT FAILURE
10

RECORD OF BOREHOLE No 3

1 OF 1

METRIC

W.P. 139-79-01 LOCATION Co-ords. N 4 865 897.5 E 347 989.2 ORIGINATED BY SMH
 DIST 6 HWY 12 BOREHOLE TYPE HS Auger, SS Auger, Cone Test COMPILED BY SMH
 DATUM Geodetic DATE 89 10 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 γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES								
139.9	Road Surface												
0.0	Asphalt												
	Silty Sand, Some Gravel, occ. Cobbles, Boulders, and Broken Concrete. Compact to Dense (Fill)		1	SS	36								19 60 (21)
			2	SS	19								
			3	SS	36								
136.7													
3.2	Het. Mixture of Clayey Silt to Silt with Sand, Trace Gravel, occ. zones of Sand and Gravel, occ. Cobbles and Boulders.		4	SS	129								10 68 (22)
			5	SS	100	/10cm							
135.2	Hard. (Glacial Till)												
			6	SS	100	/15cm							
4.7	End of Borehole												
134.4													
5.5	End of Cone Test												
	* Water Level Not Established												

RECORD OF BOREHOLE No 3A

1 OF 1 METRIC

W.P. 139-79-01 LOCATION Co-ords. N 4 865 892.7 E 347 987.8 ORIGINATED BY SMH
 DIST 6 HWY 12 BOREHOLE TYPE SS Auger, Cone Test COMPILED BY SMH
 DATUM Geodetic DATE 89 10 18-19 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 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					
139.9	Road Surface																
0.0	Asphalt					*											
	Silty Sand, Some Gravel, occ. Cobbles, Boulders, and Broken Concrete. Loose to Compact. (Fill)		5	SS	18		136										
							137										
							136										
135.0	Organics		6	SS	46		135						o				34 46 (20)
4.9	Silty Sand		7	SS	100	/15cm							o				15 49 (36)
			8	SS	100	/15cm	134						o				4 39 40 17
			9	SS	100	/15cm	133						o				14 40 27 19
	Het. Mixture of Clayey Silt to Silt with Sand, Trace Gravel, occ. zones of Sand and Gravel, occ. Cobbles and Boulders. Hard. (Glacial Till)		10	SS	160	/26cm	132										
			11	SS	100	/13cm	131										
			12	SS	100	/15cm	130										
127.6							129										
12.3	End of Borehole						128										
	* Water Level Not Established																

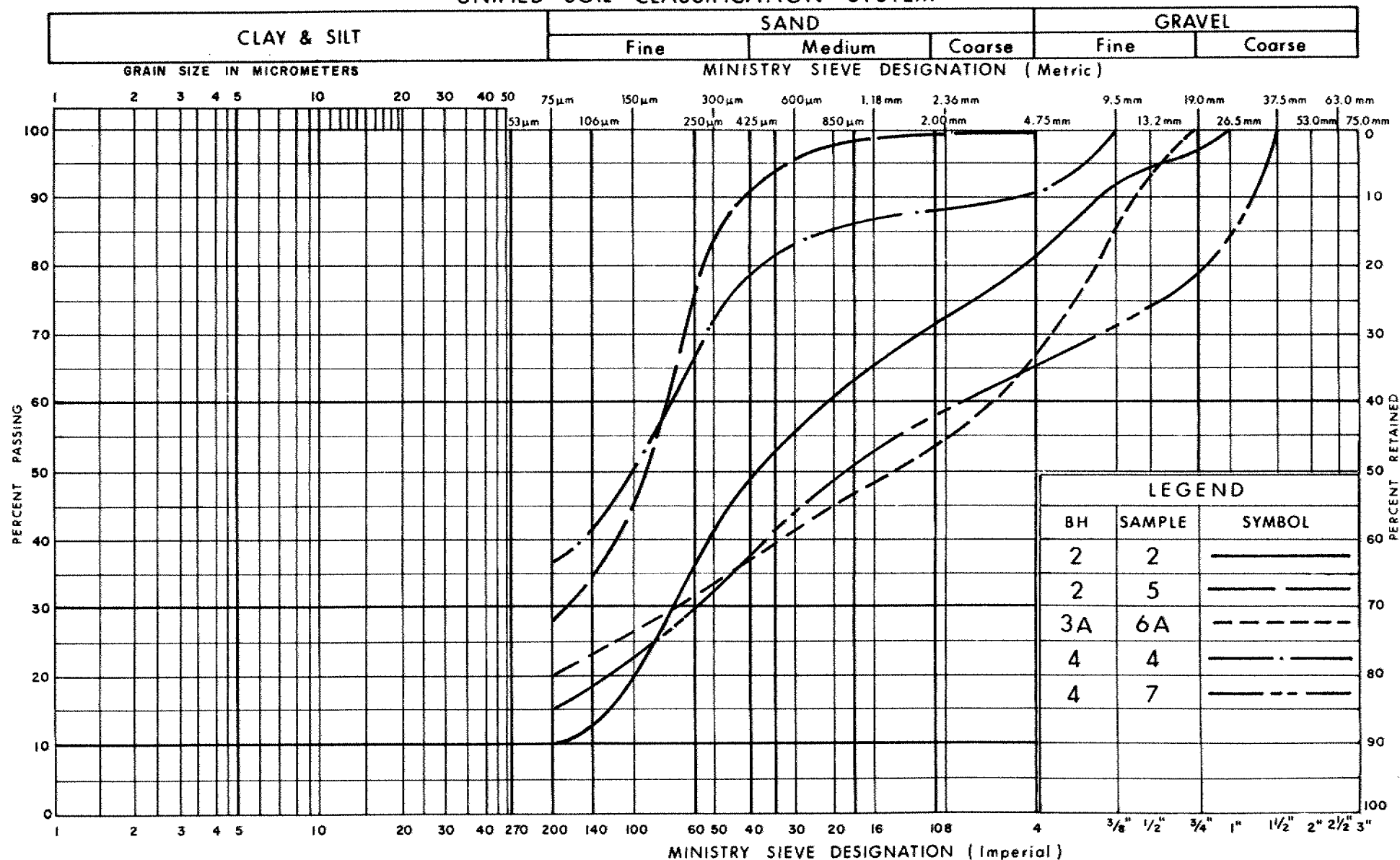
RECORD OF BOREHOLE No 4

1 OF 1 METRIC

W.P. 139-79-01 LOCATION Co-ords. N 4 865 864.0 E 347 989.9 ORIGINATED BY SMH
 DIST 6 HWY 12 BOREHOLE TYPE SS Auger, Cone Test COMPILED BY SMH
 DATUM Geodetic DATE 89 10 19 CHECKED BY *LD*

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
139.8	Road Surface														
0.0	Asphalt														
			1	SS	13									18 60 (22)	
			2	SS	12										
	Silty Sand, Some Gravel, occ. Cobbles, Boulders, and Broken Concrete. Loose to Compact. (Fill)		3	SS	9										
			4	SS	12									9 55 (36)	
			5	SS	6										
	Organics Pieces of Wood		6	SS	14										
133.9			7	SS	31									36 50 (14)	
5.9	Silty Sand		8	SS	68									6 65 22 7	
			9	SS	100	/15cm								14 29 35 22	
	Het. Mixture of Clayey Silt to Silt with Sand, Trace Gravel, occ. zones of Sand and Gravel, occ. Cobbles and Boulders. Hard. (Glacial Till)		10	SS	100	/5cm									
129.0			11	SS	100	/15cm									
10.8	End of Borehole														
	Water Level Not Established														

UNIFIED SOIL CLASSIFICATION SYSTEM

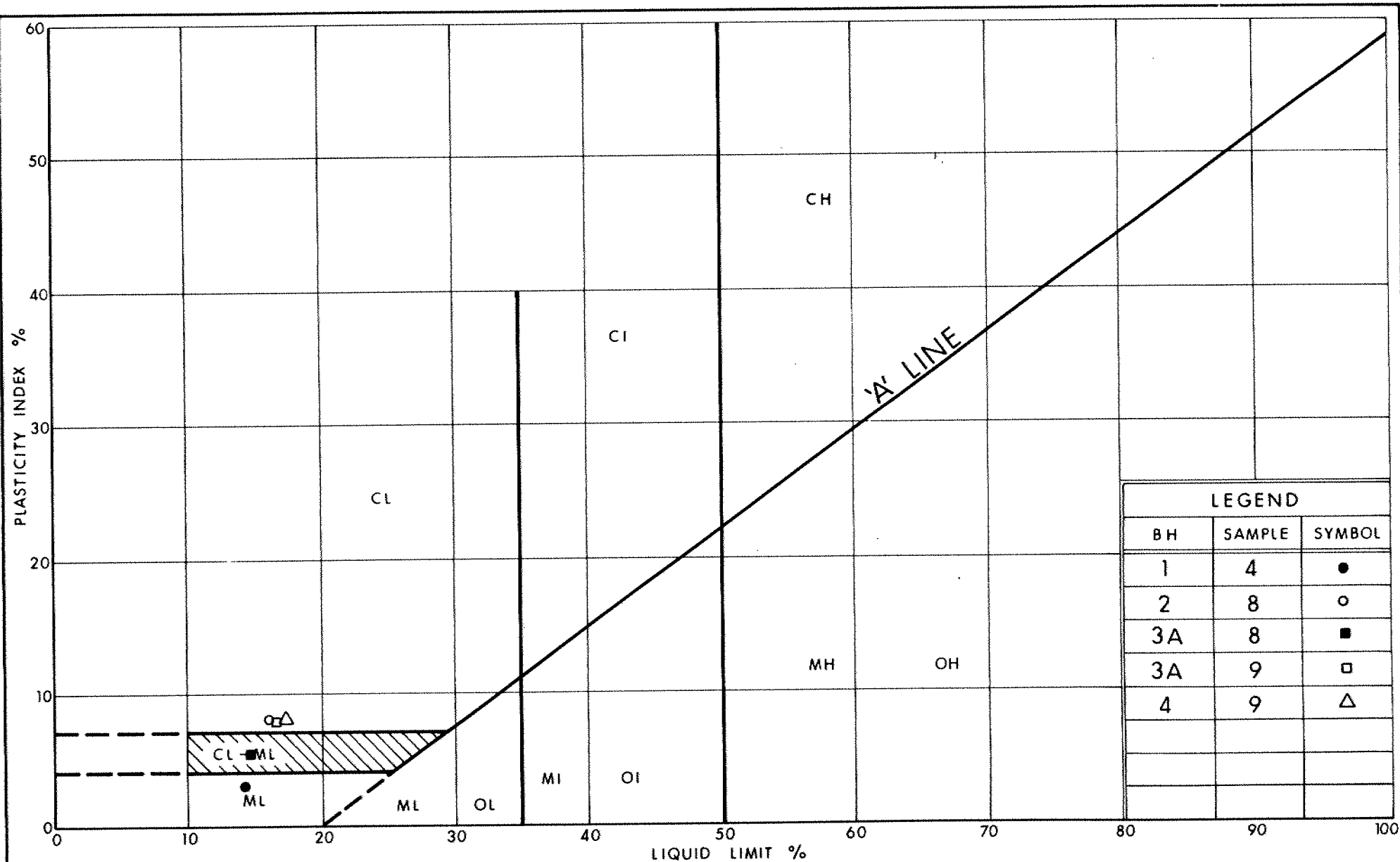


Ministry of
Transportation

GRAIN SIZE DISTRIBUTION
SILTY SAND (Fill) SOME GRAVEL, OCC COBBLES,
BOULDERS AND BROKEN CONCRETE

FIG No 1

W P 139-79-01



Ministry of
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Ontario

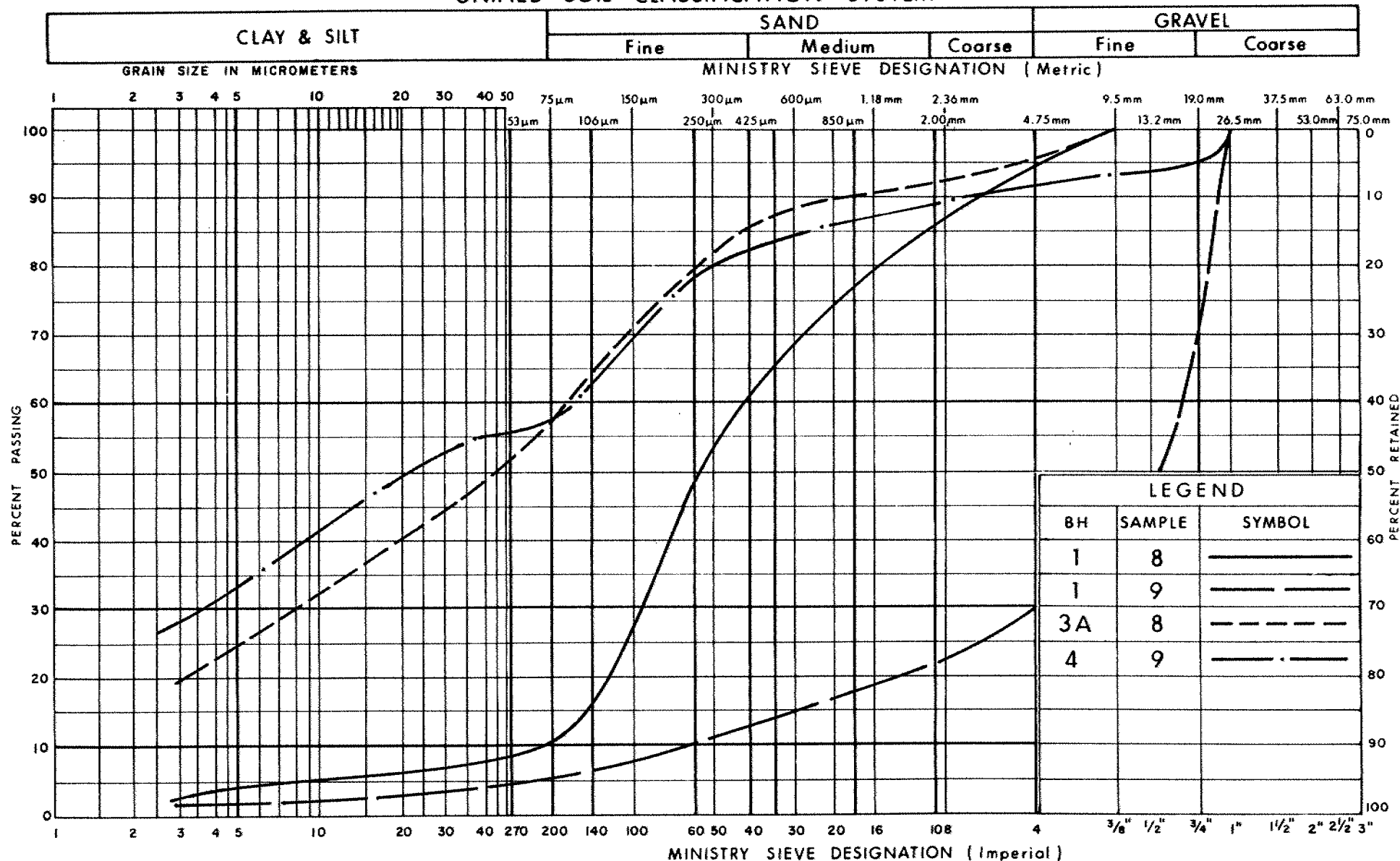
PLASTICITY CHART

HET MIXTURE OF CLAYEY SILT TO SILT WITH SAND, TRACE GRAVEL,
OCC ZONES OF SAND & GRAVEL, OCC COBBLES & BOULDERS
(Glacial Till)

FIG No 2

W P 139-79-01

UNIFIED SOIL CLASSIFICATION SYSTEM



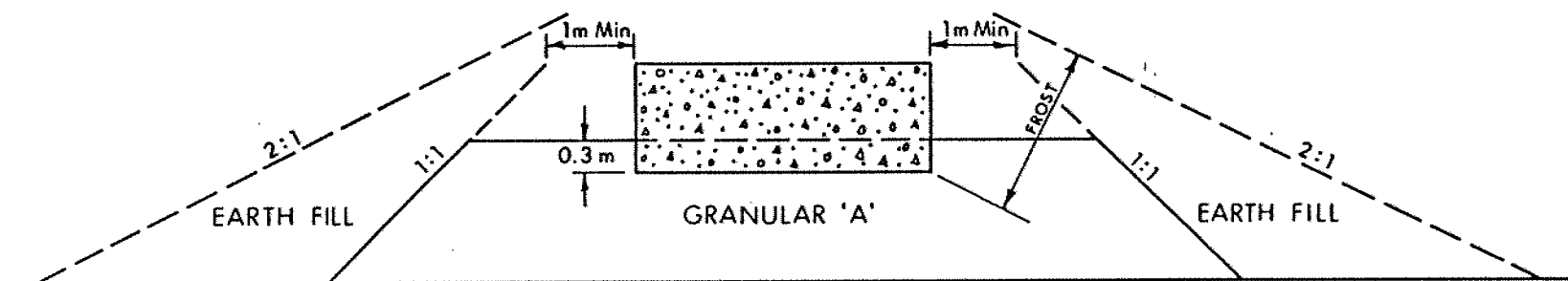
Ministry of
Transportation

GRAIN SIZE DISTRIBUTION

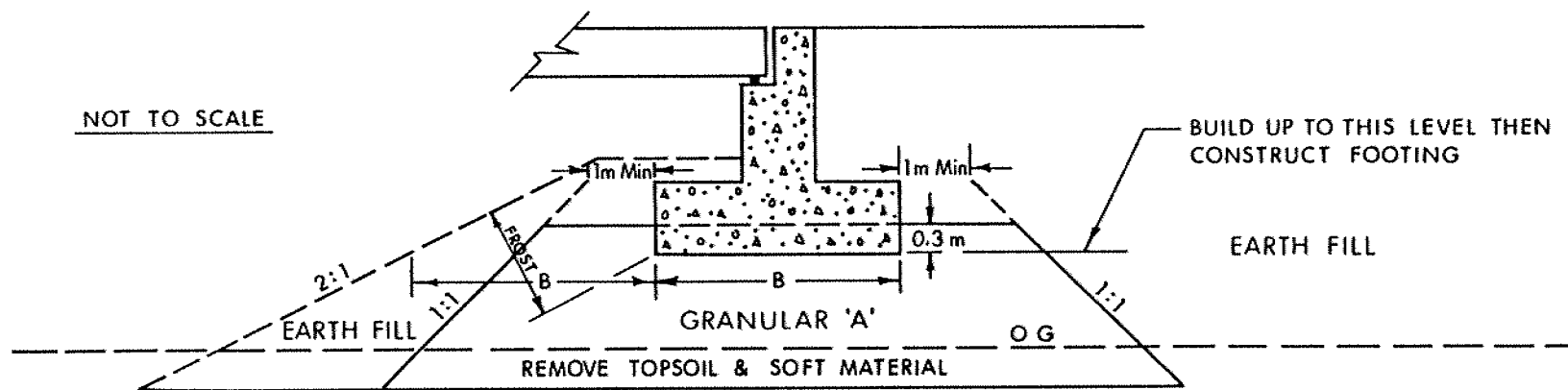
HET MIXTURE OF CLAYEY SILT TO SILT, WITH SAND, TRACE GRAVEL,
OCC ZONES OF SAND & GRAVEL, OCC COBBLES & BOULDERS
(Glacial Till)

FIG No 3

W P 139-79-01



X SECTION



LONGITUDINAL SECTION

NOTES:

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



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Transportation

ABUTMENT ON COMPACTED FILL
SHOWING GRANULAR 'A' CORE

FIG No 4

W P 139-79-01

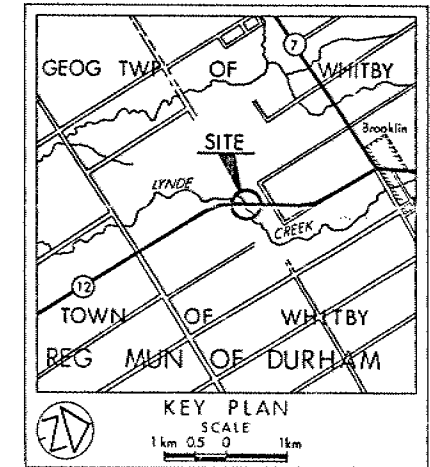
METRIC
DIMENSIONS ARE IN METRES
AND/OR MILLIMETRES UNLESS
OTHERWISE SHOWN. STATIONS
IN KILOMETRES + METRES.

CONT No
WP No 139-79-01



LYNDE CREEK SHEET

BORE HOLE LOCATIONS & SOIL STRATA



LEGEND

- Bore Hole
- ⊕ Dynamic Cone Penetration Test (Cone)
- ⊙ Bore Hole & Cone
- N Blows/0.3m (Std Pen Test, 475 J/blow)
- CONE Blows/0.3m (60° Cone, 475 J/blow)
- WL at time of investigation 8911.
- WL in Piezometer

No	ELEVATION	CO-ORDINATES	
		NORTH	EAST
1	139.4	4 865 891.2	3 48 004.0
2	139.7	4 865 864.0	3 47 979.2
3	139.9	4 865 897.5	3 47 989.2
3A	139.9	4 865 892.7	3 47 967.8
4	139.8	4 865 864.0	3 47 989.9

NOTE

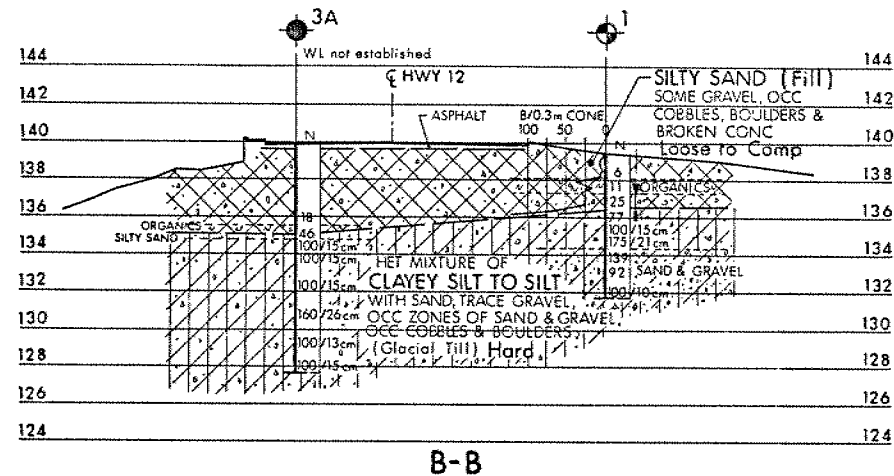
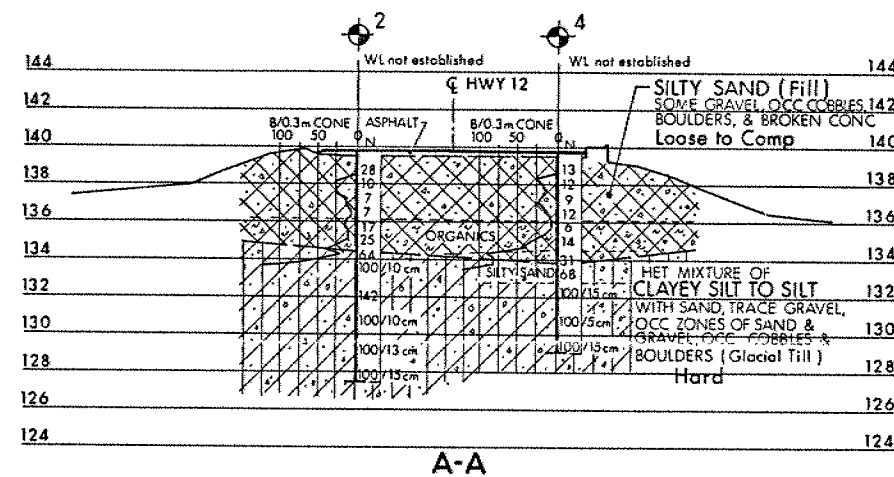
The boundaries between soil strata have been established only at Bore Hole locations. Between Bore Holes the boundaries are assumed from geological evidence.

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

REV	DATE	BY	DESCRIPTION

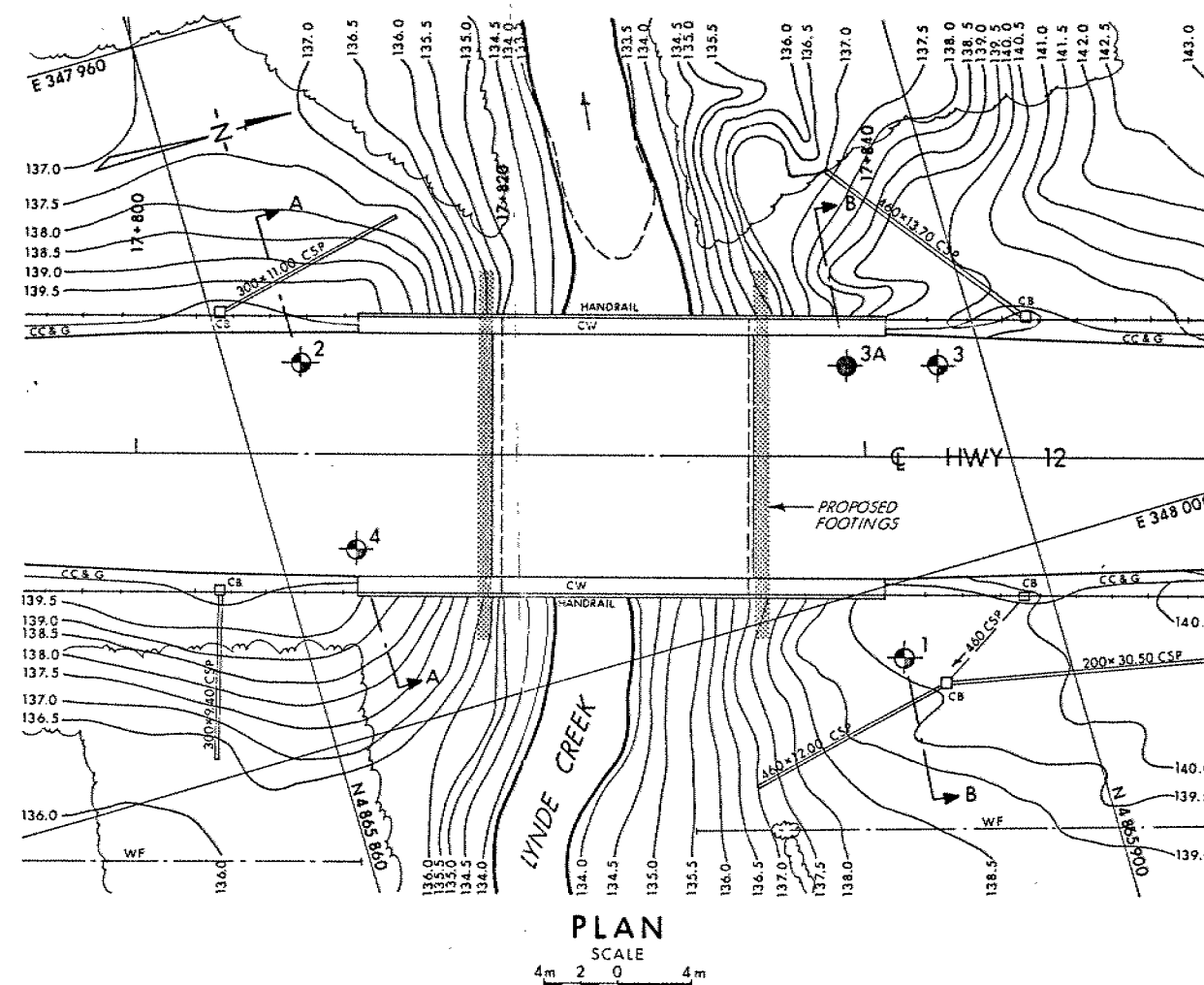
Geocres No 30M15-81

HWY No 12	DIST 6	
SUBMD SH CHECKED	DATE 1990 Q1 25	SITE 22-149
DRAWN SO CHECKED	APPROVED	EWG 1397901-A



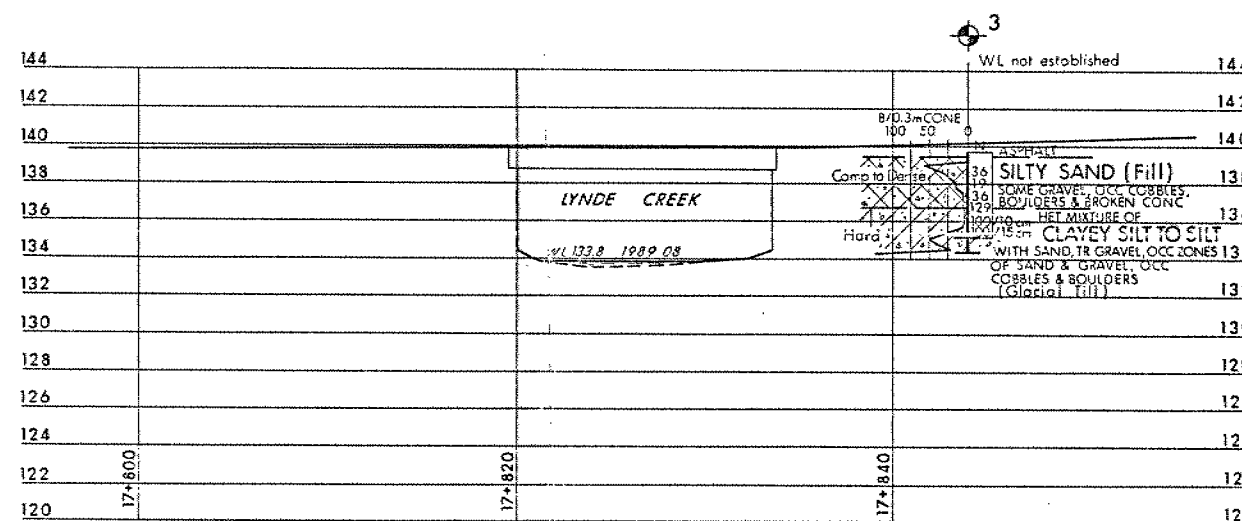
SECTIONS

SCALE
4m 2 0 4m



PROFILE HWY 12

SCALE
4m 2 0 4m



memorandum



To: V. Boehnke
Head, Structural Section
4th Floor, Atrium Tower

FROM: Foundation Design Section
Room 315, Central Building

RE: Final Design Review
Lynde Creek Bridge Replacement
W.P. 139-79-01, Site 22-149
Hwy. 12, District 6, Toronto

Date: 90 10 12

Further to your memo dated October 9, 1990, we have reviewed the final design documents for this project. Our comments are as follows:

- 1) The bases of the footings for the existing abutments appear to be above the proposed excavation for the construction of the culvert. As indicated in the Foundation Report, the existing footings should not be disturbed and any excavation below the existing footings should be outside a 1H:1V plane.
- 2) In order to construct the culvert in the dry, a dewatering scheme will be required. Please refer to pages 10 and 12 of the Foundation Report for our recommendations. In our opinion a non-standard SP will be required instead of Form 902 as is presently the case.

If there are any questions, please advise.

DD/mmj

A handwritten signature in dark ink, appearing to read "D. Dundas".

D. Dundas, P. Eng.
Sr. Foundation Engineer

for

M. Devata, P. Eng.
Chief Foundation Engineer

1989 12 08

To: G.C.E. Burkhardt
Head, Structural Section
Central Region

Attn: L. Mikhailovsky

From: Foundation Design Section
Room 315, Central Building

Subject: Lynde Creek Bridge Replacement
W.P. 139-79-01, Site 22-149
Highway 12, District 6

The following is a summary of the results of our foundation investigation at the above mentioned site. We are also providing complete recommendations for the replacement of existing Lynde Creek Bridge. Should any additional information be required please contact this office immediately. Our complete report will be forwarded in the near future.

SUBSURFACE CONDITIONS

The approaches consist of a loose to compact silty sand fill extending from the surface (El. 139.9) to El. 134 m. The fill contains boulders, cobbles, concrete and other debris. The fill is underlain by glacial till, which consists of a heterogeneous mixture of clayey silt to silt, sand, gravel and occasional cobbles and boulders and is generally cohesive.

DISCUSSION

It was originally proposed to construct a 15 m single span structure over Lynde Creek. The structure will be 20 m wide and the alignment and grade will not change.

Subsequent to the original foundation investigation request an alternative proposal was made by the Structural Office to construct two adjoining 4.5 x 4.5 m cast in place concrete box culverts under the existing structure. These twin box culverts would be 24.3 m long and have an upstream invert elevation of 133.0. The existing structure would remain in place while the box culverts were placed under it. The approximate minimum clearances between the proposed box culvert and the existing structure is 0.7 m. After the box culvert is constructed the existing structure will be removed in two stages, starting with the southbound half.

The east half of the existing structure was built in 1932. It consists of an abutment with a 1.5 m thick spread footing founded at elevation 132.8 m. It has an 8.5 m long wing wall which is also founded on a 1.5 m thick spread footing at elevation 132.8 m. In 1957 the original structure was widened by the addition of another structure on the west side. According to the bridge drawings for reconstruction the west wing wall of the bridge built in 1932 was broken down to El. 138.4 m, the abutment was widened and a new wing wall was constructed. The abutment and wing wall added in 1957 were both founded on 1.5 m thick footings at El. 132.8 m.

RECOMMENDATIONS

Two alternatives have been proposed; new structure and box culvert. The selection of alternatives will be dependent on staging and cost considerations

Structure Alternative

Spread Footings on Native Overburden

The proposed location for the new abutment is slightly forward of the existing abutments. In order to provide frost protection and to maintain the width of Lynde Creek, the construction of the proposed footings will involve removal of the existing footings.

Abutments located slightly forward of the existing abutments should be founded on spread footings at EL. 132.5 m. The bearing capacities as per the O.H.B.D.C. are as follows:

Factored Capacity at U.L.S.	1000 kPa
Bearing Capacity at S.L.S. Type II	will not govern design

The bearing surface of the excavations should be protected from softening by the placement of 150 mm of mass concrete within 8 hours of exposure.

Spread Footings on Granular A pad

Alternatively the proposed abutment could be located behind the existing abutment and founded on a compacted Granular A pad as shown in Figure 1. This alternative would eliminate the need for unwatering as the spread footing would be placed above the level of Lynde Creek. In this case the existing fill should be removed to the top of the overburden. For the north abutment, excavation would be required approximately to El. 134 m and for the south abutment to El. 133.8 m. Construction staff will have to ensure that all loose material is excavated. There should be a minimum of 1.0 m of granular A between the base of the proposed abutment and the existing footing.

For the purposes of the O.H.B.D.C. the bearing capacities are as follows:

Factored Bearing Capacity at U.L.S.	900 kPa
Bearing Capacity at S.L.S. Type II	350 kPa

Backfill

Backfill to structures should consist of granular material in accordance with Ministry of Transportation Standard Special Provision #109F03.

Computation of earth pressures should be in accordance Section 6-6.1.2 of the O.H.B.D.C. The active condition will govern earth pressure design for the abutment if it is placed on a granular A pad. The at rest condition will apply if the abutment is placed on the glacial till at El. 132.5 m. The following properties for backfill are recommended for design:

Material	ϕ		K_A	K_0
Granular A	35°	22.8 kN/m ³	0.27	0.43
Granular B	30°	21.2 kN/m ³	0.33	0.50

Lateral Resistance

For sliding resistance, an unfactored friction angle of 30° can be assumed to apply between the footings and native overburden or granular pads and native overburden. An unfactored friction angle of 35° can be assumed between the base of the footings and the compacted Granular A pads.

Road Protection

Road protection will be required if half of the existing structure is to be removed and replaced while maintaining traffic on the remaining half of the structure. It is assumed that the west or southbound half of the structure will be removed first. This is assumed because the westbound half was added on to the original structure in 1957.

To maintain traffic the northbound portion of the approach fill must be retained while the southbound approach fill is excavated. This can be accomplished by installing soldier piles and placing lagging as the fill is excavated. The existing approach fill consists of wet, loose to compact silty sand with occasional boulders, concrete and other debris. To penetrate through the boulders the piles must be pre-augered to the required depth of penetration in the underlying till. Tie-backs from the soldier piles to the wing walls could be considered as a means of supplementing the lateral capacity of the soldier piles. Based on the existing bridge arrangement the soldier piles should be placed left of the centreline such that they avoid the buried wing wall and footing. It is estimated that the buried wing wall extends 0.9 m left of centreline. When planning the traffic staging, consideration should be given to the size of the equipment required for pre-augering the holes for the soldier piles.

For the purposes of design the following parameters can be used for the calculation of earth pressures.

Material	Elevation (m)	ϕ	kN/m ³
Silty Sand Fill	Surface to El. 134	29°	21
Glacial Till	Below El. 134	35°	21

For design purposes the groundwater level can be assumed as El. 137 m. It should be noted that the forces will be reversed on the lagging when the northbound approach fill is excavated so the lagging will have to be reversed.

The soldier piles will not be removed but will be cut off within the fill.

Detour

To facilitate construction of the new structure consideration should be given to construction of a detour. The detour would eliminate the need for road protection. The detour should consist of an approach fill with $1\frac{1}{2}$:1 side slopes and a temporary Bailey Bridge.

The abutment for the Bailey Bridge detour structure can be supported either on gabion baskets or on timber mats founded on granular pads. If the abutment is supported on a timber mat then the granular pad should be a minimum of 1 m larger all around the plan area than the bearing area. The bearing capacities are the same as for the new structure on a Granular A pad.

If the Bailey Bridge is supported on gabion baskets the baskets may be placed directly on top of the existing soil. For the purposes of the O.H.B.D.C. the following bearing capacities are recommended:

Factored Bearing Capacities at U.L.S.	900 kPa
Bearing Capacities at S.L.S. Type II	350 kPa

For sliding resistance, an unfactored friction angle of 35° can be assumed between the timber mat and the Granular A pad. The unfactored friction angle between the underside of the gabion baskets and the native till may be assumed to be $\tan 30^\circ$. If a detour is not used and the structure is to be removed and replaced with a new structure then road protection will be required.

Unwatering

If the abutment is founded on the native till at El. 132.5 then an unwatering scheme will be required as the footing elevation will be below Lynde Creek. It is the responsibility of the Contractor to devise an unwatering scheme and furnish the Ministry with copies of his plan for review. A possible scheme would consist of placing a prefabricated box around the bearing surface for the footing. The box would have to be sealed using an impermeable material such as clay. This would require one box for the south abutment and another box for the north abutment. Alternatively, a culvert with an upstream seal could be used to provide unwatering for both abutments simultaneously. An item for unwatering should be included in the Contract package.

Approach Fills

The approach fills will be approximately 4 m high. They should be constructed with 2:1 forward and side slopes. The fill should consist of noncohesive material to 0.3 m above the high water level.

Frost Protection

The spread footings should have a minimum depth of earth cover of 1.2 m to prevent frost heaving. One metre of rock fill provides frost protection equivalent to 0.5 m of earth cover.

Erosion Protection

The footings should be protected from erosion with 600 mm of rock fill. For the spread footing on a compacted Granular A pad the entire pad should be protected. The rock protection should start at the high water level and extend across the stream bed between the abutments. The rock protection should also extend 5 m upstream and 5 m downstream of the abutments. Hydrology requirements should also be considered and if necessary the amount of rock protection should be increased or gabion mats should be used. The amount of rock protection will also depend on the configuration of the abandoned abutment.

Settlement

Settlement will not be a problem as the grade is not being raised and the bearing stratum is hard.

Box Culvert Alternative

As an alternative to constructing a new single span structure it has been proposed that twin box culverts be constructed. In this case the box culvert should be founded spread footings at El. 132.5 m. The bearing capacity as per the O.H.B.D.C. are as follows:

Factored Capacity at U.L.S.	525 kPa
Bearing Capacity at S.L.S. Type II	350 kPa

The culvert footing should be constructed in the 'dry'. Although it is the responsibility of the contractor to propose an unwatering scheme one alternative would be damming Lynde Creek and pumping the water over Hwy. 12. Any remaining water could be collected in perimeter ditches or in a central ditch backfilled with clear stone. In this case the clear stone should be covered by 150 mm of granular A on top of which the culvert would be constructed.

The wet fill contained behind the abutments will probably cause some water to drain into the working area. This inflow will gradually be reduced as the water table in the fill drops.

Excavation

In order to maintain the bearing surface of the existing abutment the excavation for the culvert should be no steeper than a 1:1 slope from the base of the existing footing at El. 132.8 m. The existing footing should be protected from snow and undermining during construction of the culvert.

Bedding

The box culverts should be founded on a granular 'A' pad 150 mm thick. This pad will assist in maintaining a dry working area for constructing the footing.

Backfill

Backfill should be placed according to OPSS 902. Compaction may be difficult to achieve due to the restricted working area under the existing bridge. If compaction equipment is used where the backfill is confined between the existing abutment and the proposed culvert care must be taken to ensure that excessive lateral loads are not created which could deform the proposed culvert or the existing abutment.

Culvert Inlet

A seal of cohesive material with a minimum thickness of 600 mm is recommended at the culvert inlet. The seal should comply with the requirements outlined in OPSS 1205 'Material Specification for Clay Seal'. It should extend over the backfill to the culvert from the projected high water level down to the channel bed and 1.0 m upstream along the channel bottom. The clay seal will not be required if the proposed inlet wing wall (shown in section provided by Structural Section) extends beyond the limits of the backfill around the culvert.

Road Protection

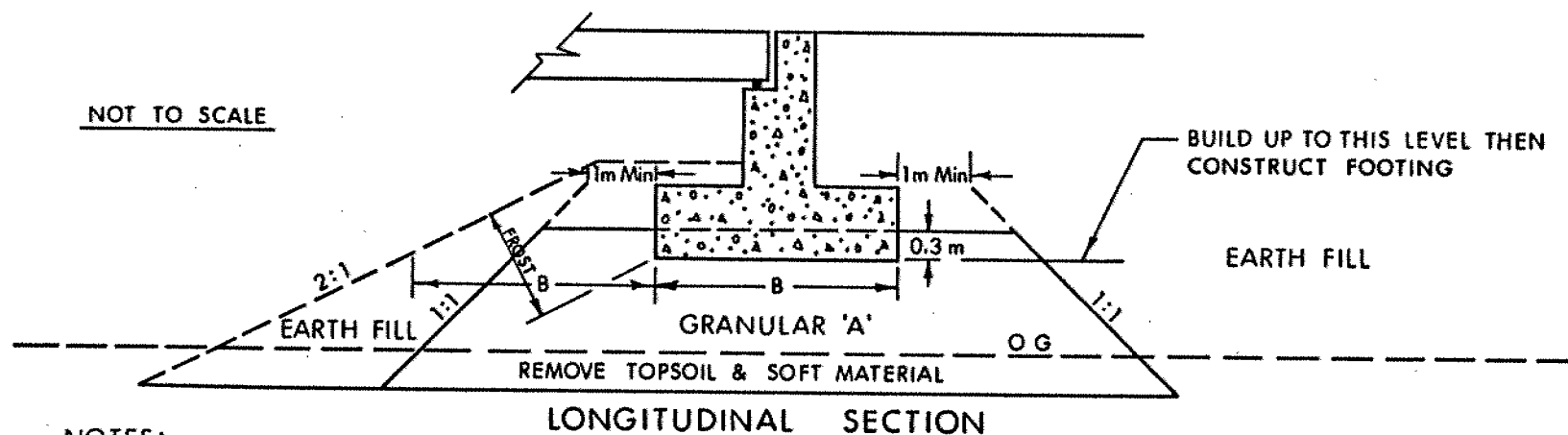
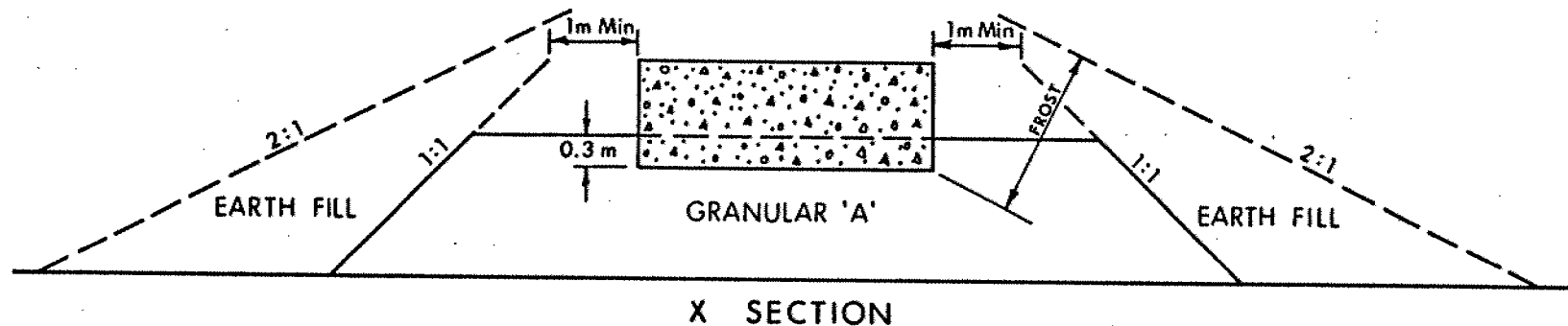
After the culvert is placed it is proposed to remove the existing bridge deck starting with the southbound half. It is assumed that part of the abutment and wing walls will also be removed. From the top of the remaining abutments and wing walls the fill can be graded at $1\frac{1}{2}:1$ to the road surface with traffic being at least 2 m from the edge of the excavation. If this grade can not be facilitated then road protection will be required and should be as recommended in the road protection section.

Erosion Protection

Erosion protection at the culvert inlet and outlet should consist of 600 mm of rock protection. The rock protection should start at the high water level and should cover the clay seal. It should also extend across the stream between the wing walls protecting the entire area between the wing walls. If wing walls are not constructed then rock protection should extend 5 m upstream from the inlet and 5 m downstream from the outlet.



S. Holmes, P.Eng.
Foundation Engineer



NOTES:

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



Ontario

Ministry of
Transportation

ABUTMENT ON COMPACTED FILL
SHOWING GRANULAR 'A' CORE

FIG No 1

W P 139-79-01

METRIC
DIMENSIONS ARE IN METRES
AND/OR MILLIMETRES
UNLESS OTHERWISE SHOWN

DIST No 6
CONT No
WP No 139-79-01



**BRIDGE RECONSTRUCTION
HIGHWAY 12 / LYNDE CREEK
GENERAL ARRANGEMENT**

SHEET

Sandwell Sandwell Inc.
Sandwell Swan Wooster Division

GENERAL NOTES:

- CLASS OF CONCRETE** 30 MPa
- CLEAR COVER TO REINFORCING STEEL**
FOOTINGS 100 ± 25
BOTTOM OF TOP SLAB 40 ± 10
BOTTOM OF BOTTOM SLAB 100 ± 25
REMAINER UNLESS OTHERWISE NOTED
- REINFORCING STEEL**
REINFORCING STEEL SHALL BE GRADE 400
UNLESS OTHERWISE SPECIFIED. BARS MARKED
WITH SUFFIX "D" DENOTE COATED BARS.

CONSTRUCTION NOTES

BACKFILL SHALL BE PLACED SIMULTANEOUSLY
BEHIND BOTH SIDES OF CULVERT KEEPING
THE HEIGHT OF THE BACKFILL APPROXIMATELY
THE SAME. AT NO TIME SHALL THE DIFFERENCE
IN ELEVATION BE GREATER THAN 300 mm.

NO CONCRETE SHALL BE PLACED UNTIL THE
DEPTH OF THE EXCAVATION AND THE CHARACTER
OF THE FOUNDATION HAVE BEEN APPROVED BY
THE ENGINEER.

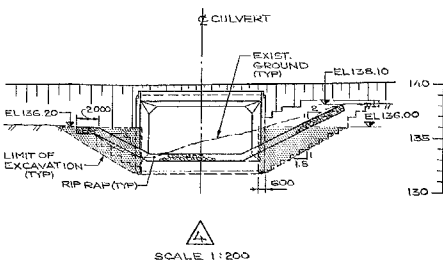
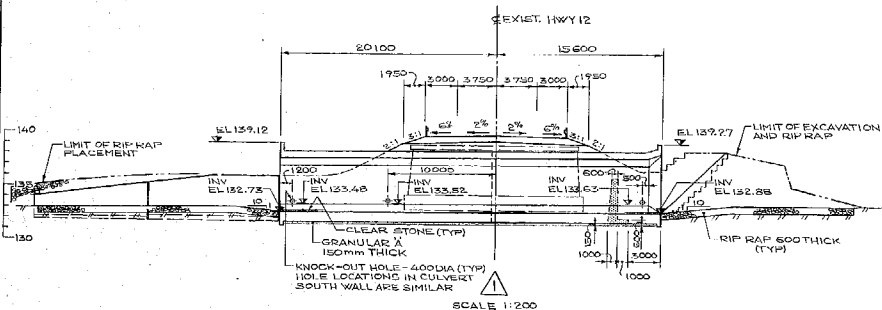
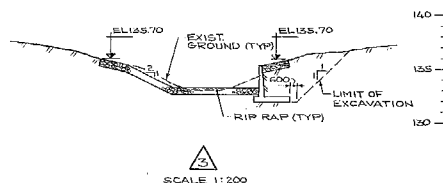
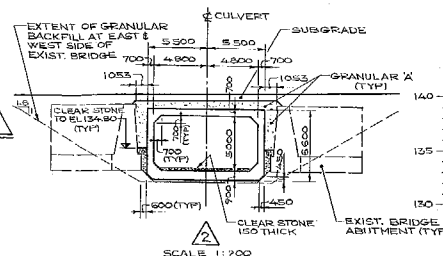
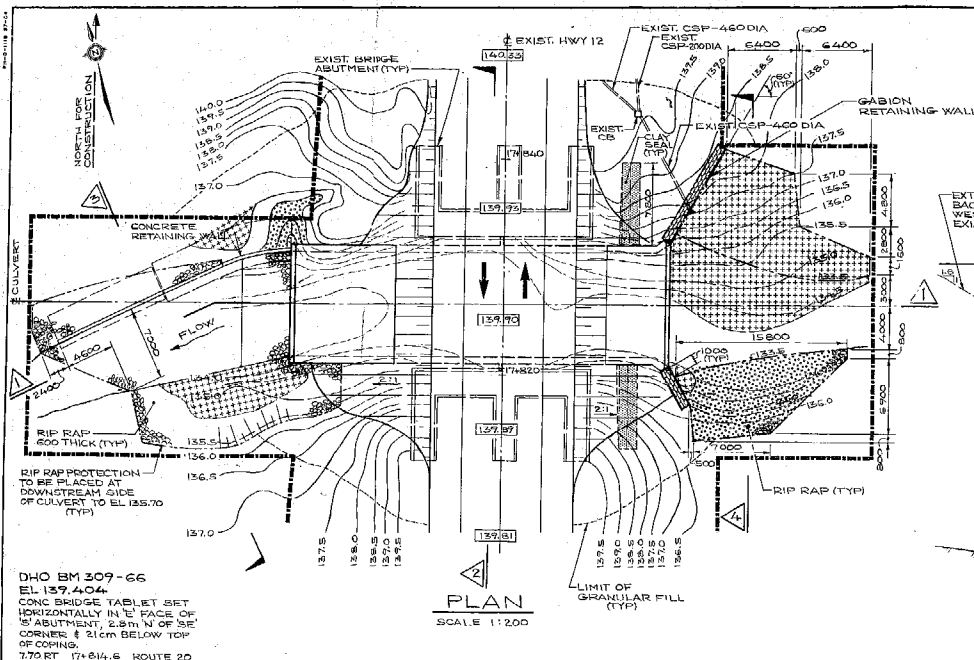
LIST OF DRAWINGS

- GENERAL ARRANGEMENT
- BOREHOLE LOCATIONS AND SOIL STRATA
- CONSTRUCTION STAGES AND DRAINAGE
- CULVERT REINFORCING - DETAIL I
- CULVERT REINFORCING - DETAIL II
- RETAINING & GABION WALLS
- TEMPORARY TIMBER WALL
- QUANTITIES STRUCTURE

LEGEND

- CLAY SEAL
- EXCAVATION
- BACKFILL
- EXIST. ELEVATION AT & HWY 12
- RIGHT OF WAY

SEP 06 1990



DRAWING NOT TO BE SCALED
100 mm ON ORIGINAL DRAWING

DATE	BY	DESCRIPTION
DESIGN 11-K	CHK G.T.	100E OHB60 - 85 (LOAD CLASS A DATE
DRAWN 11-K	CHK G.T.	11-K SITE 22-149 STRUCT 1 SCHEME 1090.1