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DIST. 9 REGION

W.P. No. 121-87-07

CONT. No. 93-66

W. O. No.

STR. SITE No. 3-546

HWY. No. 416

LOCATION Hwy 416 & Knoxdale Rd
Underpass

No of PAGES -

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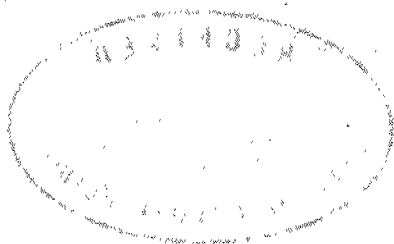
OVERSIZE DRAWINGS TO BE INCLUDED WITH THIS REPORT.

REMARKS:

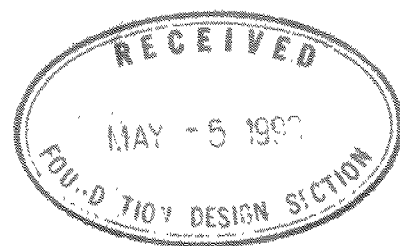
G.I-30 SEPT. 1976

FOUNDATION INVESTIGATION REPORT

CONTRACT NO. 93-66



**Ministry of
Transportation**



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

EXPLANATION OF TERMS USED IN REPORT

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

FOUNDATION INVESTIGATION REPORT

For

Hwy. 416 and Knoxdale Underpass

W.P. 121-87-07

Hwy. 416, District 9, Ottawa, NepeanINTRODUCTION

This report summarizes the results of a foundation investigation conducted at the aforementioned site. A two span structure has been proposed to carry Knoxdale Road over Hwy. 416. The subsurface conditions encountered at the site are included in the scope of this report.

SITE DESCRIPTION

The site is located at the south-west corner at the intersection of Knoxdale Road and Cedarview Road in the City of Nepean, Region Municipality of Ottawa-Carleton.

The topography of the area is generally flat to gently undulating with ditches on either side of Knoxdale Road. Land throughout this area is being used for agricultural and dairy farming with the north side of Knoxdale Road used as a grazing pasture and the south side a cornfield. A dairy farm is located further west of the site. The natural ground level is generally flat with the highest and lowest elevations being 95.86 m at the east approach and 94.25 m at the west abutment.

Physiographically the site lies in the area known as the Ottawa Valley Clay Plains founded in the lowlands of the St. Lawrence, which are characterized by clay plains interrupted by ridges of rock or sand and gravel. The bedrock in the area is of the Gull River formation of the middle ordovician period. It consists of limestone with interbedded shale layers. The overburden is relatively thin and was deposited during and immediately following the Wisconsin Glaciation at which time the area was depressed from the effect of the glaciation. Following the retreat of the glacier, the brackish waters of the champlain sea flooded the area and than gradually receded as the land rebounded with the deposition of sediments to its present level.

INVESTIGATION PROCEDURES

Soil data and inherent properties were obtained by in situ and laboratory testing conducted. The procedures employed are discussed below.

FIELD INVESTIGATION

The fieldwork for the investigation was carried out between 90 08 09 to 90 08 10 and consisted of a total of seven boreholes. Two boreholes at the east/west approach ramps, two boreholes at the east abutments, one centerline pier and two west abutment holes. The surficial deposit was relatively shallow thus refusal ranged from 2.5 m to 4.5 m.

Disturbed split spoon and rock core samples (BXL) were taken using trackmount CME55 equipment employing hollow stem techniques to advance all boreholes in the overburden. Disturbed subsoil samples were retrieved at 0.75 m intervals and two 1.52 m rock core samples were drilled at abutment and pier locations. All samples were identified in the field and then returned to the laboratory for applicable testing.

Sampling was performed for the abutment and pier holes down to 3.5 m into bedrock while the approach ramp holes were terminated upon refusal of augers.

Groundwater levels were obtained by monitoring the levels in the open boreholes throughout the duration of the field investigation. All open boreholes were backfilled at the completion of the fieldwork.

Survey information related to the location and elevation of boreholes was provided by MTO Surveys and Plans, Eastern Region.

Laboratory Analysis

The following laboratory tests were carried out on select soil samples.

- 1) Atterberg Limit Test
- 2) Grain Size Analysis
- 3) Natural Moisture Contents
- 4) Unit Weights

Laboratory test results are given in the following section of this report and are illustrated on figures and borehole logs included in the Appendix.

SUBSURFACE CONDITIONS

General

The subsoil conditions are generally consistent across the site, consisting primarily of 2.5-4.5 metres of a heterogeneous mixture (Glacial Till) of silt, sand, clay and gravel. Pockets of silt were encountered at the surface in three of the seven investigation locations and a greater percentage of gravel and cobbles were encountered at greater depths throughout the site. This stratum was in turn underlain by a dolostone bedrock at depths of 3-4.5 metres, generally following the shape of the natural ground level.

The plan and location of boring and the stratigraphical profile are shown on Drawing No. 1218707-A* in the attached Appendix. The obtained field and laboratory tests are plotted on the Record of Borehole sheets also in the Appendix of this report. A brief description of the different soil types are given below.

Heterogeneous Mixture of Silt, Sand, Clay and Gravel (Glacial Till)

Underlying the site and explored to depths ranging from the original ground surface to depths between 2.5-4.5 metres, is a non-cohesive deposit which is composed of a heterogeneous mixture of silt, sand, clay and gravel (Glacial Till).

Results of Grain Size Distribution tests carried out on select samples are shown on Figure 1 in the Appendix, in envelope form. From the above figure, it is evident that the layer can be classified as described above. The material contained 0-38% gravel, 3-42% sand, 35-90% silt and 2-13% clay with greater percentages of gravel near the bottom of this layer.

The result from the Atterberg Limit test performed on the fine fraction of this material is summarized as follows.

* DWG NO 2 OF THE CONTRACT DWG'S.

	<u>Range</u>	<u>No. of Tests</u>
Natural Moisture Content (w)	7-27.5	12
Liquid Limit (w_L)	14-25	12
Plastic Limit (w_p)	12-20	12
Plastic Index (I_p)	1-8	12

From the plasticity chart (Figure 2) the layer can be classified as inorganic mixtures of silt, sand, clay and gravel with slight plasticity.

In this stratum the 'N' values ranged from 5 blows/0.3 m to 7130 blows/0.3 m. Having a loose to very dense state of relative density.

Bedrock

The above stratum is directly underlain by bedrock of the Gull River Formation and was cored at three abutment locations and one pier by obtaining up to 3.0 metres of sound rock core samples. The bedrock consists mainly of a dolostone, with one borehole (BH 1) at greater depths encountered a quartz sandstone. Detailed descriptions of the rock are attached in the Appendix entitled "Rock Core Description".

Core Recoveries (CR) and Rock Quality Designation (RQD) were determined in situ and also in the laboratory to evaluate the competence and integrity of the rock. Based on these results, the dolostone can be classified as medium strong and predominantly unweathered. The quartz sandstone was classified similarly as medium strong and unweathered.

GROUNDWATER CONDITIONS

Observation of the groundwater level was carried by measuring the water level in the open boreholes. The water level varied from 94.75 m to 92.5 m. Trapped drilling water may have a noticeable affect on water table heights.

Groundwater levels in general are subject to seasonal fluctuations and hence can vary from the values given in this report.

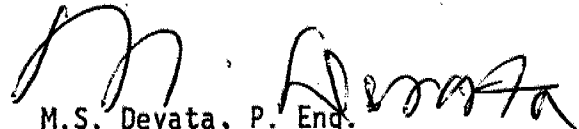
MISCELLANEOUS

The fieldwork for this investigation was carried out under the supervision of Tae C. Kim, Foundation Design Engineer, Martin Michalek, Foundation Engineer Trainee and John LeMessurier, Mike Iampietro, Student Engineers. The equipment was owned and operated by Marathon Drilling Co. Ltd., and F.E. Johnston Drilling Co. Ltd., Ottawa.

This report was written by M. Michalek, Foundation Engineer Trainee, under the general supervision of Dr. Balu Iyer, Senior Foundation Engineer and reviewed by Mr. Murty Devata, Chief Foundation Engineer.



B. Iyer, P. Eng.
Senior Foundation Engineer



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

APPENDIX

ROCK CORE DESCRIPTION
WP 121-87-07

Page 1 of 1

CORE RECOVERY					CORE DESCRIPTION	
BH#	RC#	DEPTH (m)	% CR*	% RQD*	DEPTH (m)	DESCRIPTION
1	4	3.25-5.79	96	96	3.25-5.79	DOLOSTONE (slightly calcitic; cherty, 5.77-5.79 m), light olive grey to medium dark grey; fine crystalline; medium strong; unweathered; wide to close spaced fractures (flat, undulating, rough to smooth).
4	6	4.32-5.69	93	77	4.32-5.69	DOLOSTONE (slightly calcitic), light olive grey to medium dark grey; fine crystalline; medium strong; unweathered; moderately close to very close spaced fractures (flat, undulating, rough to smooth).
5	5	3.33-4.85	100	99	3.33-4.85	DOLOSTONE (slightly calcitic), light olive grey to medium dark grey; fine crystalline; medium strong; unweathered; wide to close spaced fractures (flat, undulating, rough to smooth).
6	6	4.57-6.10	99	89	4.57-6.10	DOLOSTONE (slightly calcitic), light olive grey to medium dark grey; fine crystalline; medium strong; unweathered; moderately close to very close spaced fractures (flat, undulating, smooth to rough).

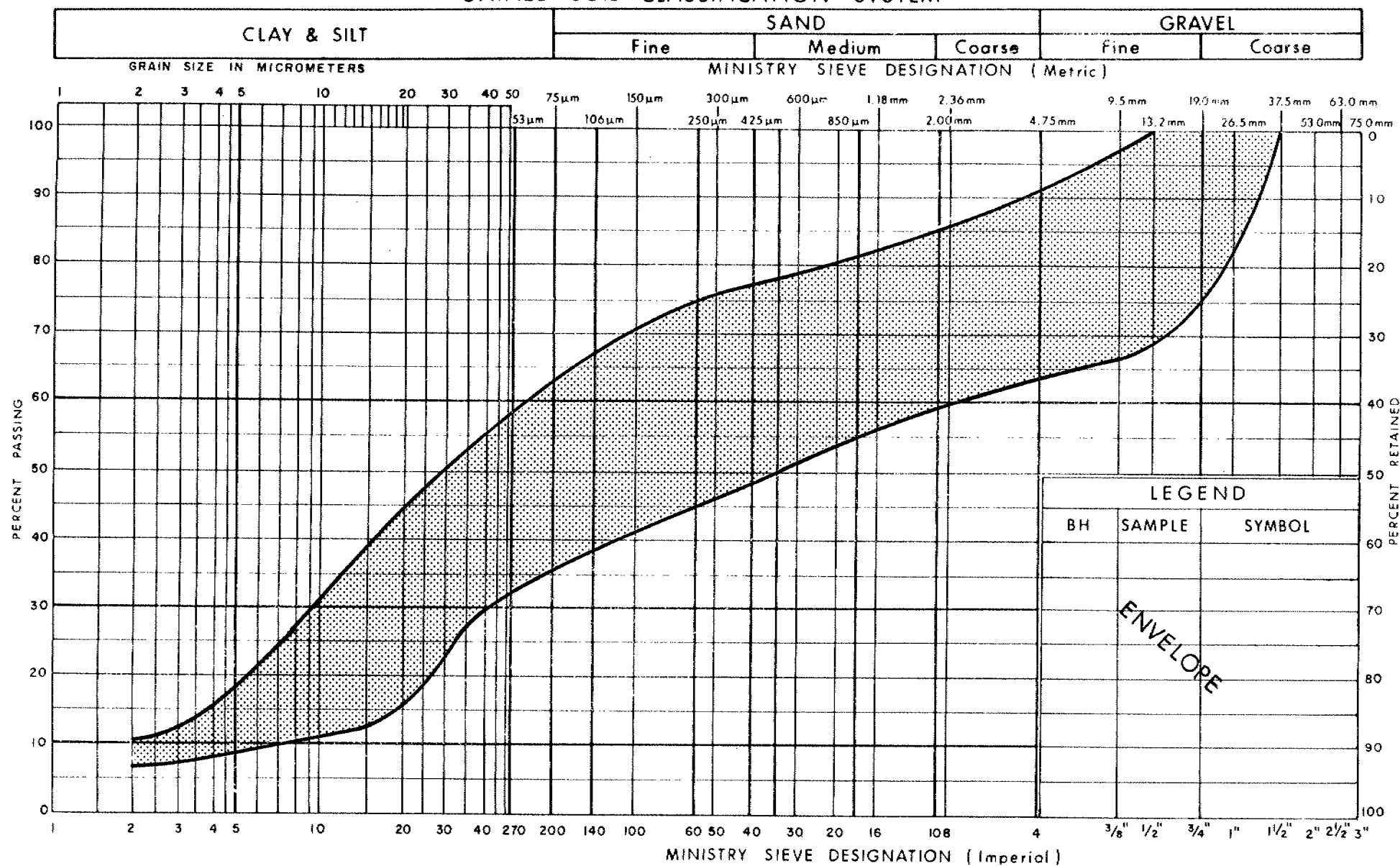
*CR = CORE RECOVERY

*RQD = ROCK QUALITY DESIGNATION

(NOTE: Depths are approximated where core recovery is less than 100%)

Logged by: DAW, Soils and Aggregates Section

UNIFIED SOIL CLASSIFICATION SYSTEM



Ontario

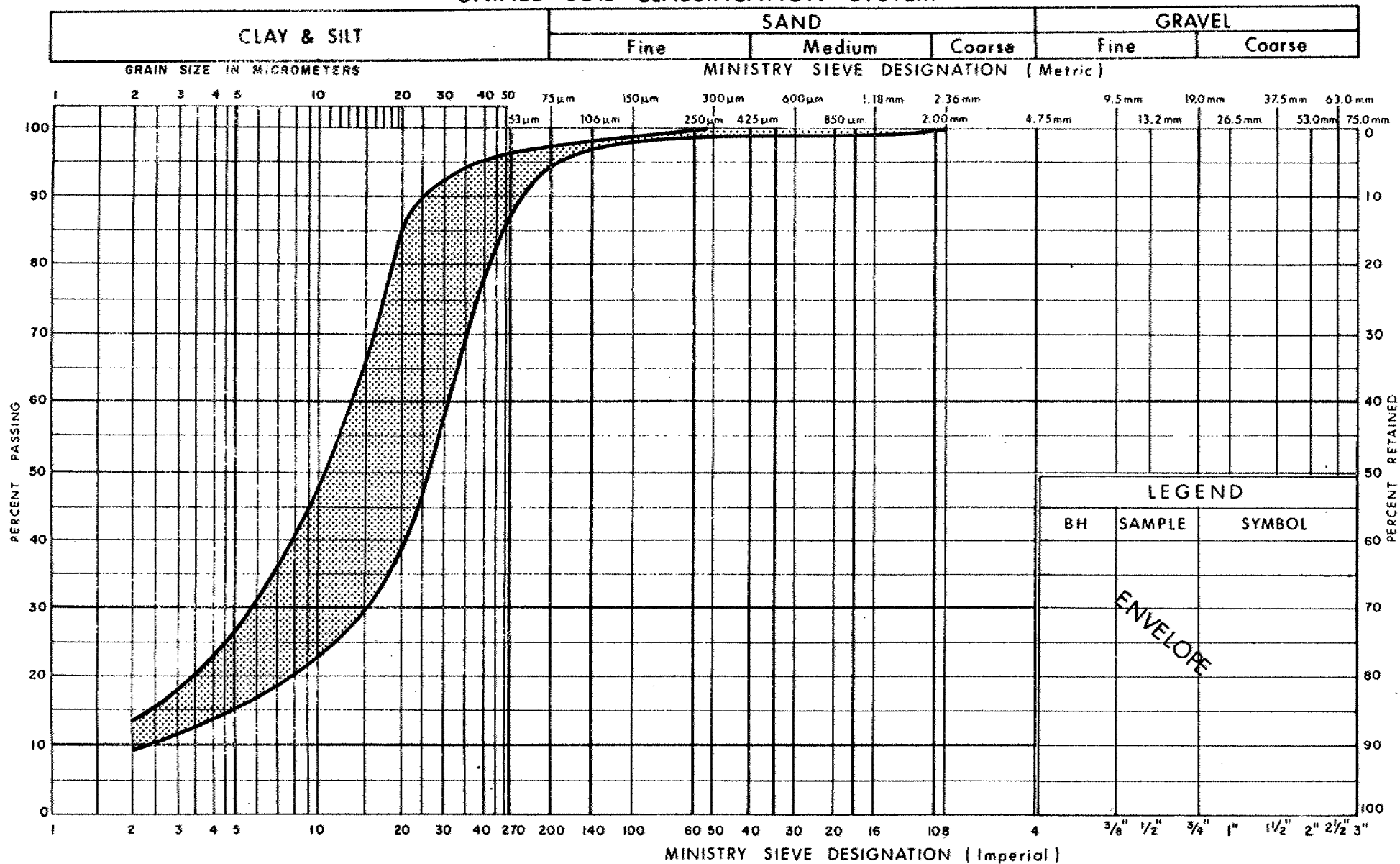
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GRAIN SIZE DISTRIBUTION
HETEROGENEOUS MIXTURE OF SILT, SAND & GRAVEL
TRACE CLAY (GLACIAL TILL)

FIG No 1

W P 121-87-07

UNIFIED SOIL CLASSIFICATION SYSTEM

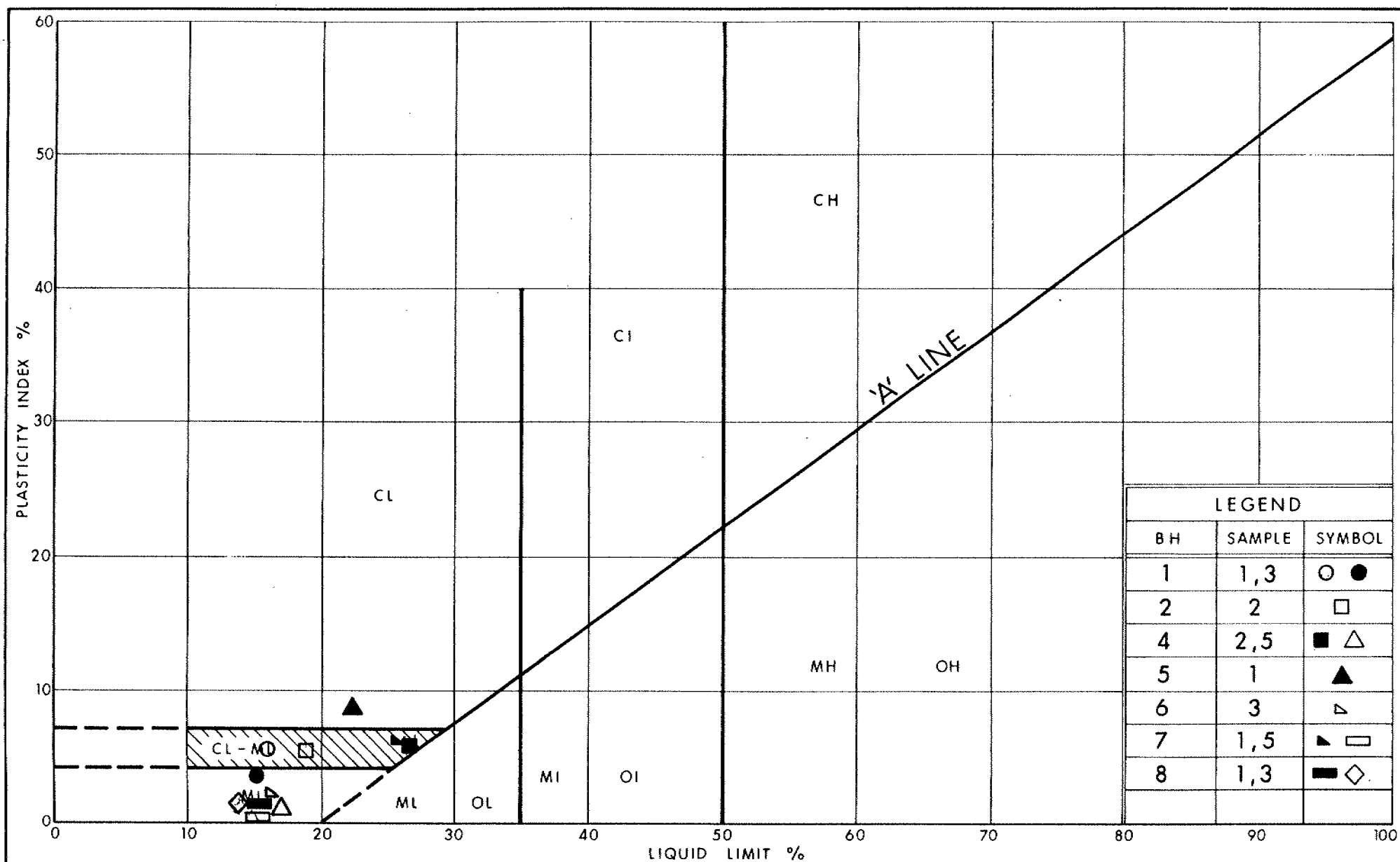


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GRAIN SIZE DISTRIBUTION SANDY SILT

FIG No 2

W P 121-87-07



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Ontario

PLASTICITY CHART
HETEROGENEOUS MIXTURE OF SILT, SAND & GRAVEL
TRACE CLAY, (GLACIAL TILL)

FIG No 3

W P 121-87-07

RECORD OF BOREHOLE No 1

1 OF 1

METRIC 13

W.P. 121-87-07 LOCATION Co-ords: N 5 019 230.7 E 358 493.5 ORIGINATED BY M.M.
DIST 9 HWY 416 BOREHOLE TYPE Hollow Stem Auger, Cone Penetration Test COMPILED BY M.M.
DATUM Geodetic DATE 90/08/30 CHECKED BY B.I.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT 7 kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100	20 40 60 80 100					
95.3	Ground Surface													
0.0	Heterogeneous mixture of Clay, Silt, Sand and Gravel (Glacial Till) Compact to Very Dense		1	SS	18		95						20.9	11 36 50 3
			2	SS	28		94							
			3	SS	65		93						22.4	9 42 39 10
92.1							92							
3.2	Dolostone Bedrock Medium Strong Unweathered		4	RC BXL	REC 96%		91							RQD 96%
89.5							90							
5.8														

RECORD OF BOREHOLE No 2

1 OF 1

METRIC 14

W.P. 121-87-07 LOCATION Co-ords: N 5 019 213.4, E 359 503.5 ORIGINATED BY M.M.
 DIST 9 HWY 416 BOREHOLE TYPE Hollow Stem Auger COMPILED BY M.M.
 DATUM Geodetic DATE 90/08/30 CHECKED BY B.L.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL						
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40						60	80	100	20	40	60
95.0	Ground Surface																			
0.0	Heterogeneous mixture of Clay, Silt, Sand and Gravel (Glacial Till) Compact to Very Dense Brown		1	SS	16															
			2	SS	12															
			3	SS	57															
92.4	End of Borehole Auger refusal at probable bedrock																			
2.6																				

RECORD OF BOREHOLE No 4

1 OF 1 METRIC 15

W.P. 121-87-07 LOCATION Co-ords: N 5 019 231.8, E 359 535.7 ORIGINATED BY M.M.

DIST 9 HWY 416 BOREHOLE TYPE Hollow Stem Auger, Cone Penetration Test COMPILED BY M.M.

DATUM Ceodetic DATE 90/08/30 CHECKED BY D.T.

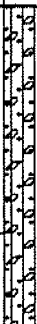
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100	20 40 60 80 100	25 50 75					
95.1	Ground Surface														
0.0	Heterogeneous mixture of Clay, Silt, Sand and Gravel (Glacial Till) Very Loose to Compact <div>Brown ----- Grey</div>		1	SS	5					19.3	0 3 88 9				
			2	SS	5										
			3	SS	21										
			4	SS	26										
			5	SS	9										
90.9	Dolostone Bedrock Medium Strong Unweathered		6	RC	REC 93%	/15cm				23.7	22 33 38 7				
89.4															
5.7	End of Borehole														

RECORD OF BOREHOLE No 5

1 OF 1

METRIC 16

W.P. 121-87-07 LOCATION Co-ords: N 5 019 267.5, E 359 557.8 ORIGINATED BY M.M.
 DIST 9 HWY 416 BOREHOLE TYPE Hollow Stem Auger, Cone Penetration Test COMPILED BY M.M.
 DATUM Geodetic DATE 90/08/30 CHECKED BY D.T.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT w _P	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			SHEAR STRENGTH kPa						
95.2	Ground Surface							20 40 60 80 100	20 40 60 80 100	25 50 75				
0.0	Heterogeneous mixture of Clay, Silt, Sand and Gravel (Glacial Till) Compact to Dense		1	SS	29	/28cm							21.9	14 22 51 13
			2	SS	18									
	With Cobbles		3	SS	33									
91.8			4	SS	36									
3.4	Dolostone Bedrock Medium Strong Unweathered	5	RC BXL	REC 100%										
90.3														
4.9	End of Borehole													

RECORD OF BOREHOLE No 6

1 OF 1

METRIC 17

W.P. 121-87-07 LOCATION N 5 019 250.2, E 359 567.7 ORIGINATED BY M.M.

DIST 9 HWY 416 BOREHOLE TYPE Hollow Stem Auger, Cone Penetration Test COMPILED BY M.M.

DATUM Geodetic DATE 90/08/30 CHECKED BY D.T.

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					
95.1	Ground Surface													
0.0	Heterogeneous mixture of Clay, Silt, Sand and Gravel (Glacial Till) Dense to Very Dense		1	SS	32									
			2	SS	47									
			3	SS	33									
			4	SS	71									
	Brown Gray with Cobbles		5	SS	54									
90.5														
4.6	Dolostone Bedrock Medium Strong Unweathered		6	RC BXL	REC 99%									RQD 89%
89.0														
6.1	End of Borehole													

RECORD OF BOREHOLE No 7

1 OF 1

METRIC 18

W.P. 121-87-07 LOCATION Co-ords: N 5 019 259.2, E 359 591.4 ORIGINATED BY M.M.

DIST 9 HWY 416 BOREHOLE TYPE Hollow Stem Auger COMPILED BY M.M.

DATUM Geodetic DATE 90/08/30 CHECKED BY D.T.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT 7 kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100	W _p	W	W _L		
94.4	Ground Surface																
0.0	Heterogeneous mixture of Clay, Silt, Sand and Gravel (Glacial Till) Compact to Very Dense Brown Grey with Cobbles		1	SS	15										19.5	0 3 87 10	
			2	SS	50												
			3	SS	47												
			4	SS	45												
			5	SS	13												
89.4																	
5.0	End of Borehole																

RECORD OF BOREHOLE No 8

1 OF 1

METRIC 19

W.P. 121-87-07 LOCATION Co-ords: N 5 019 222.2, E 359 470.3 ORIGINATED BY M.M.

DIST 9 HWY 416 BOREHOLE TYPE Hollow Stem Auger COMPILED BY M.M.

DATUM Geodetic DATE 90/08/30 CHECKED BY D.T.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100		
95.9	Ground Surface													
0.0	Heterogeneous mixture of Clay, Silt, Sand and Gravel (Glacial Till) Compact to Dense		1	SS	12		95							0 3 90 7
			2	SS	22		94							
			3	SS	27									
92.8			4	SS	17		93							
3.1	End of Borehole													

Brown
Grey

FOUNDATION INVESTIGATION REPORT
For
Proposed High Mast Lighting
Highway 416/Knoxdale Road to Fallowfield Road
W.P. 122-87-00
Eastern Region
District 9, Kingston

INTRODUCTION

A foundation investigation was carried out at the above-captioned site for proposed high mast lighting along the new Highway 416, at the proposed interchanges for Knoxdale Road and Fallowfield Road.

During this investigation, boreholes were drilled at or adjacent to twenty-six (26) of the 35 proposed locations for the new high mast lights. Subsurface information for seven (7) other proposed locations was obtained from two previous investigations (W.P. 128-87-04 and W.P. 121-87-07). Since access to one borehole was not available at the time of drilling, and one other high mast light pole was added subsequent to our field investigations, these two remaining locations will require some additional field investigation at a later date.

This report contains the factual information obtained from the boreholes, drilled during this investigation, as well as selected boreholes from the two previous investigations, which pertain to the structural foundations for the proposed high mast lights, at the locations shown on Drawing No.'s 1228700-A and 1228700-B.

SITE DESCRIPTION

The field investigations were carried out along the alignment for the new Highway 416 at two proposed interchanges, within the City of Nepean, Regional Municipality of Ottawa-Carleton, Ontario. The topography of the area is generally flat to gently undulating.

The first site, is located at the proposed interchange for Highway 416 along Fallowfield Road between Cedarview Road and Moodie Drive. This site, which will henceforth be referred to as the 'Fallowfield Site', extends from the north face of Dibblee Quarry, to approximately 650 m south of Fallowfield Road.

The second site is located at the proposed interchange for Highway 416 and Knoxdale Road. This site, which will henceforth be referred to as the 'Knoxdale Site', lies directly west of the existing alignment of Cedarview Road and extends from approximately 800 m north of Knoxdale Road, to approximately 900 m to the south of it.

Physiographically, both sites lie in the area known as the Ottawa Valley Clay Plains, which are characterized by glacial till (which occurs as till plains), ice contact stratified drift and ridges of the underlying bedrock. The overburden is relatively thin and was deposited during and immediately following the Wisconsin Glaciation.

At the Fallowfield site, the overburden is underlain by Paleozoic bedrock comprised of interbedded silty dolostone, lithographic to fine crystalline limestone, shale, and fine-grained calcareous quartz sandstone of the Gull River Formation. The overburden at the Knoxdale site is also underlain by Gull River Formation rocks as well as interbedded sandy dolostone, dolostone and quartz sandstone of the March Formation.

PROCEDURES

The fieldwork, for this project, was carried out by this office during the period covering April 4 to 12, 1991 and consisted of twenty-six sampled boreholes advanced to depths of up to 7.7 m, using continuous flight, hollow stem augers driven by a bombardier-mounted drilling rig equipped with standard soil sampling equipment.

When probable bedrock or a large boulder was encountered, most of the boreholes were extended using conventional diamond drilling (BXL) techniques in order to penetrate the boulders and to prove bedrock. Some additional information was obtained from dynamic cone penetration testing, which was carried out adjacent to most of the boreholes. However, in several cases, boulders prevented the cones from being driven to bedrock.

Groundwater levels were measured in the open boreholes immediately upon completion of sampling. Piezometers were then installed in eleven (11) of the

boreholes, in order to measure the long term groundwater conditions and a return visit was made to the site to measure the water levels in them.

The locations of the boreholes were staked in the field, and their elevations determined by the Eastern Region Surveys and Plans Office. However, during the field investigation, it became apparent that several of the high mast light locations had been altered. The boreholes at the locations which had not, as yet, been drilled, were slightly moved to reflect these changes and the Surveys and Plans Office were then asked to re-survey them.

The soil samples obtained in the field were examined in the laboratory by visual and tactile methods. Moisture Content, Atterberg Limits and Grain Size Distribution tests were carried out on selected samples. Pocket penetrometer tests were also carried out on selected samples, where they were applicable.

SUBSURFACE CONDITIONS

Boreholes P1 to P7, P9, P12 to P14 and P16 were drilled at the proposed locations for high mast light pole no.'s at the Fallowfield Site. BH's P-9 to P23 and P26 to P34 were drilled at the proposed locations for several high mast light poles at the Knoxdale Site. It should be noted, however, that the numbering of the light poles at the Knoxdale Site has been reversed subsequent to our field investigations.

Subsurface information for several of the remaining high mast light poles was obtained from the boreholes drilled during this investigation as well as selected boreholes from the two previous investigations (W.P. 128-87-04 and W.P. 121-87-07). The relevant borehole logs and laboratory testing from these investigations, is included in Appendix B at the back of this report. However, it should be noted that, since access to the proposed location for high mast pole P34 (original number) was unavailable at the time of the field investigation, this pole (and P35, which has only recently been added to the list) will be dealt with at a later date.

Since the soil conditions vary somewhat at each of the two sites, brief descriptions of the subsurface conditions at each site followed by more detailed

descriptions of individual strata and the groundwater conditions encountered in the boreholes will be given in separate sections.

Fallowfield Site

BH's P1 to P7, P9, P12 to P14 and P16 were drilled at the locations of the high mast light poles with the same designation. Most of the boreholes were drilled to the south of Fallowfield Road. However, BH's P13 to P17 were drilled to the north of the road on property presently occupied by the Dibblee quarry.

South of Fallowfield Road, a thin layer of topsoil and slightly organic sandy to clayey silt, from 0.3 m to 0.9 m thick, is underlain by a very dense, heterogeneous mixture of silty sand, gravel and a trace of clay (glacial till). Occasional to numerous slabs of rafted rock and boulders occur within this till deposit, at several locations. Limestone or silty dolostone bedrock was encountered, in most boreholes, at depths of 2.9 m to 10.5 m.

To the north of Fallowfield Road, 0.1 m to 1.7 m of topsoil and/or silty sand to sand and gravel fill overlies a heterogeneous mixture of silt, sand and gravel (glacial till). However, at P15 (which is in the quarry itself), the fill lies directly on bedrock. Limestone bedrock occurs at depths of 0.1 m to 4.9 m.

Detailed descriptions of the subsurface conditions are given in the following sections.

Topsoil

A surficial layer of topsoil, from 0.3 m to 0.7 m thick, was encountered in all boreholes on the south side of Fallowfield Road.

Clayey Silt to Sand and Gravel (Fill)

At many locations, the topsoil, south of Fallowfield Road, is underlain by a thin layer of clayey silt to silty sand, which contains traces of topsoil enclosures. Similar material was encountered at BH P16, to the north of

Fallowfield Road. This material has been referred to as fill, since it appears that these soils have been disturbed by past farming activity which has resulted in topsoil enclosures becoming entrained into it.

Crushed and broken limestone bedrock comprised of silt to gravel-sized particles was encountered at the ground surface adjacent to and within Dibblee Quarry at BH's P13 and P16, respectively (see Figure 1). It appears that this material has been placed as fill over the underlying bedrock.

In any case, it should be noted that, in our experience at many sites, the thickness of topsoil, fill and/or soils disturbed by farming activity can vary significantly between boreholes.

Silty Sand to Coarse Sand and Gravel

BH P-6 encountered a deposit of greyish brown to dark grey, silty sand to coarse sand and gravel. This deposit extended to a depth of approximately 4.1 m (or an elevation of about 98.4 m).

A Moisture Content of 12 percent was measured in one of the samples obtained.

Although 'N' values, measured during Standard Penetration Testing (SPT), ranged from 1 to 13 blows/0.3 m, the lowest value recorded was likely to be unrepresentative, due to the unbalanced hydrostatic head and the resulting disturbance of the sand beneath the augers. This soil is considered to be compact.

Heterogeneous Mixture of Silty Sand, some Gravel, Trace of Clay (Glacial Till)

All boreholes contacted a heterogeneous mixture of silty sand, some gravel and a trace of clay containing occasional to numerous boulders at depths of 0.5 m to 4.1 m.

Grain Size Distribution Tests on the samples obtained from this deposit and shown on Figure 2 indicates generally well-graded mixtures of sand, silt, gravel

and clay. These soils are likely to be of glacial origin and therefore, may be considered to be a glacial till.

An Atterberg Limit Test, carried out on a slightly more cohesive sample of soil from BH P4, gave liquid limit and plasticity indices of 16 and 3 percent at a moisture content of 18 percent which indicated a material which behaves as a plastic silt. Although, Moisture Contents ranged from 5 to 18 percent, they averaged about 10 percent.

Measured 'N' values were generally more than 50 blows/0.3 m, indicating very dense conditions. However, lower values were encountered in the upper part of the deposit at P4 (7 blows/0.3 m) and P6 (23 blows/0.3 m).

During drilling, through this deposit, boulders and rafted pieces of the underlying bedrock were encountered at most locations. However, at several locations, notably P1, P4, P5, P12 and P14, boulders became so numerous that the boreholes were extended by coring.

Bedrock

Bedrock was encountered in most of the boreholes at depths of 0.4 to 10.5 m or elevations 96.3 m to 118.1 m.

BH's P2, P3, P6, P12 and the boreholes on the north side of Fallowfield Road near Dibblee Quarry (P13, P14 and P16) contacted a light to dark (or greenish) grey, laminated (and occasionally nodular), medium strong, limestone. The limestone was found to contain numerous thin undulating shaly partings and occasional thin layers of shale (particularly in BH's P1 and P2). BH's P1, P4 and P6, also contacted a dark greenish grey to dark grey, weak to very weak, silty dolostone.

Detailed descriptions of the rock core obtained, during this investigation, are given in Appendix A.

GROUNDWATER

Piezometers installed in several of the boreholes on the south side of Fallowfield Road, have recorded water levels, at least 24 hours after their installation, at depths of 0.2 m to 3.6 m beneath the existing ground surface (or elevations of 101.4 m to 114.8 m).

BH's P13 and P14 were found to be dry. Although, minor water was encountered in the piezometer installed in BH P-16, this water is likely to be the remaining drill water used to core bedrock and that this hole, was, in fact, dry as well.

Knoxdale Site

Generally, at the Knoxdale site, a thin layer of topsoil and/or slightly organic clayey to sandy silt from 0.15 m to 0.8 m thick, is underlain by layers of clayey to sandy silt and/or a firm to hard, heterogeneous mixture of clayey silt, sand, with a trace of gravel (glacial till). Where the till is present, it generally overlies bedrock, which was encountered at depths of 0.5 m to 5.6 m.

Topsoil

A surficial layer of topsoil, from 150 mm to 250 mm thick, was contacted at the ground surface at several of the boreholes.

Sandy Silt

Beneath the topsoil and at the ground surface at many other locations, a layer of fill, containing topsoil enclosures was encountered to depths of 0.4 m to 0.8 m at the boreholes. This material has been referred to as fill, since it appears that these soils have been disturbed by past farming activity which has resulted in topsoil enclosures becoming entrained into it.

Silty Clay to Clayey Silt

Beneath the fill, BH's P20 and P30 to P33 contacted a thin, silty clay to clayey silt layer, at depths of 0.6 m to 1.8 m (or elevations of 93.1 m to 93.9 m). This layer extended to depths of 1.2 m to 2.9 m (or elevations of 92.2 m to 93.3 m).

Atterberg Limit Tests, carried out on two samples of soil from this layer and shown on Figure 3, measured liquid limits of 21 and 49 percent and plasticity indices of 6 and 27 percent, respectively. These test results indicate soils which behave as clayey silt to silt or silty clay soils. Moisture Contents were found to range from 29 to 40 percent in samples obtained from these layers.

A Grain Size Distribution Test carried out on a slightly cohesive sample obtained from this layer was found to have 6 percent sand, 79 percent silt and 15 percent clay (see Figure 4).

'N' values ranged from 7 to 15 blows/0.3 m indicating soils of firm to stiff consistency.

Silt to Sandy Silt

BH's P20, P22 and P29 to P33 contacted a cohesionless deposit of sandy silt to silt at depths of 0.2 m to 2.9 m (or elevations of 91.8 m to 94.5 m) which extended to depths of 1.4 m to 5.6 m (or elevations of 88.9 m to 93.5 m).

The results of a Grain Size Distribution Test, carried out on a sample of soil obtained from this deposit, is shown on Figure 5.

Moisture Content Tests, carried out on samples from this deposit, ranged from 14 to 30 percent.

'N' values, measured during this investigation, ranged from 1 to 42 blows/0.3 m indicating very loose to dense soils. However, it appears that, based on the cone testing carried out adjacent to some of the boreholes, the very low (ie.

less than 2 blows/0.3 m) 'N' values are likely due to unbalanced hydrostatic head (and the resulting disturbance) in the boreholes immediately prior to testing.

Heterogeneous Mixture of Clayey Silt, Sand and a Trace of Gravel (Glacial Till)

A heterogeneous mixture of clayey silt, sand and a trace of gravel was encountered in nearly all of the boreholes (P23, P24, P30 and P33, excluded) at depths of 0.4 m to 4.4 m (or elevations of 90.1 m to 95.0 m). This deposit extended to elevations ranging from about 88.9 m to 94.0 m in the boreholes.

These soils are likely to be of glacial origin and therefore, may be considered to be a glacial till.

The results of Atterberg Limits Tests, which were carried out on several samples of the till, are summarized below and on Figure 6:

	<u>Range %</u>	<u>Average %</u>
Natural Moisture Content (w)	8-14	10.8
Liquid Limit (w_L)	13-23	16.3
Plastic Limit (w_p)	10-15	11.8
Plasticity Index (I_p)	3-8	4.5

These results indicate soils which behave as clayey to plastic silts.

Grain Size Distribution Tests carried out on five samples obtained from this deposit, and shown on Figure 7, reveal a fairly well-graded mixture from 33 to 55 percent silt, 11 to 14 percent clay-sized particles, and from 26 to 42 percent sand and 3 to 14 percent gravel.

'N' values measured during Standard Penetration Testing ranged from 8 to 77 blows/0.3 m indicating soils of stiff to hard consistency.

Bedrock was encountered in most of the boreholes at depths of 0.5 m to 5.6 m (88.9 m to 94.8 m).

The bedrock, at all locations, consisted of a light grey to medium dark grey, medium strong, dolostone which was found to be cherty or vuggy in places. BH P33 also encountered a 1.4 m thick layer of very light grey to medium dark grey, medium strong dolomitic sandstone. Details of the rock core obtained from the boreholes can be found in Appendix A.

GROUNDWATER CONDITIONS

The groundwater levels, when measured in the open boreholes, immediately upon completion of sampling (or prior to coring), were generally found at the ground surface or up to depths of 2.2 m. BH P27, however, was found to be dry.

Groundwater levels, measured in the piezometers installed at the site ranged from the ground surface to depths of about 0.6 m (or elevations of 93.6 m to 95.6 m).

In any case, it should be noted that the groundwater table is always subject to seasonal fluctuations and is expected to rise during the spring freshet and during and immediately following any periods of prolonged heavy rainfall.

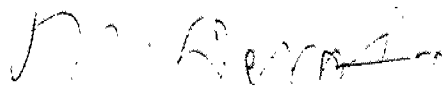
MISCELLANEOUS

The field investigation was supervised by Messrs. J. Blair and F. Tannis, using equipment owned and operated by F. E. Johnston Drilling Co. Ltd.

This report was written by J. Blair, Project Foundation Engineer, reviewed by B. Iyer, Senior Foundation Engineer and approved by M. Devata, Chief Foundation Engineer.



B. Iyer, P. Eng.
Senior Foundation Engineer



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

APPENDIX

Table I

High Mast Light Pole Locations
Interchange at Highway 416 and Fallowfield Road

<u>Pole #</u>	<u>Northing</u>	<u>Easting</u>	<u>Existing G.S.</u> <u>(m)</u>
P1	5 014 062	360 282	112.2
P2	5 014 260	360 265	111.6
P3	5 014 371	360 190	110.8
P4	5 014 412	360 083	110.0
P5	5 014 506	360 200	109.3
P6	5 014 594	360 292	102.5
P7	5 014 559	360 219	106.6
P8	5 014 545	360 087	108.6
P9	5 014 501	359 944	112.4
P10	5 014 654	360 064	107.0
P11	5 014 594	359 948	112.0
P12	5 014 470	359 805	115.4
P13	5 014 615	359 751	118.5
P14	5 014 710	359 900	112.8
P15	5 014 740	359 858	108.5
P16	5 014 886	359 880	110.7
P17	5 014 957	359 732	117.4

Table II

High Mast Light Pole Locations
Interchange at Highway 416 and Knoxdale Road

<u>Pole #</u>	<u>Northing</u>	<u>Easting</u>	<u>Existing G.S. (m)</u>
P18 (P34)	5 019 860	359 276	94.8
P19 (P33)	5 019 742	359 309	94.9
P20 (P32)	5 019 629	359 358	95.1
P21 (P31)	5 019 493	359 344	94.9
P22 (P30)	5 019 515	359 515	94.7
P23 (P29)	5 019 444	359 467	95.2
P24 (P28)	5 019 366	359 350	95.6
P25 (P27)	5 019 260	359 366	95.6
P26 (P26)	5 019 262	359 466	95.6
P27 (P25)	5 019 092	359 339	95.5
P28 (P24)	5 019 148	359 440	94.9
P29 (P23)	5 019 215	359 594	94.6
P30 (P22)	5 019 080	359 584	94.5
P31 (P21)	5 018 953	359 636	94.5
P32 (P20)	5 018 868	359 700	94.5
P33 (P19)	5 018 675	359 815	94.5
P34 (P18)	5 018 554	359 987	94.2
P35	5 019 977	359 250	

*Note: The most recent high mast light pole numbering is shown in brackets.

Table III
Fallowfield Road Site

Pole No.	Ground Surface Elevations		Soil Boundary Elevation		Soil Type	Assumed Water Level (m)	Remarks	Borehole No.
	Original Grade (m)	Finished Grade (m)	Upper (m)	Lower (m)				
P1	112.2	111.6	109.8 109.0 101.7 101.5	109.0 101.7 101.5 <101.5	Cohesive Non-Cohesive Non-Cohesive V. Weak Shale Weak silty Dolostone	109.2	Numerous Boulders	P1
P2	111.6	109.5	107.7 105.8 108.5	105.8 105.0 <105.8	Non-Cohesive V. Weak Shale Medium Strong Limestone	109.3		P2
P3	110.8	110.7	108.9 108.0	107.9 <108.0	Non-Cohesive Medium Strong Limestone	110.6		P3
P4	110.0	108.4	107.3	<107.3	Weak, Silty Dolostone	109.8		P4
P5	109.3	109.3	107.5 102.8	102.8 <102.8	Non-Cohesive Non-Cohesive	108.8	Numerous Boulders	P5
P6	102.5	102.8	101.0 100.4 98.4 96.6 96.3 94.1	100.4 98.4 96.6 96.3 94.1 <94.1	Cohesive Non-Cohesive Non-Cohesive Non-Cohesive Medium Strong Limestone Weak to V. Weak Silty Dolostone	101.4	Numerous Boulders	P6
P7	106.6	106.2	104.4 102.7 99.0	102.7 99.0 <99.0	Non-Cohesive Non-Cohesive Non-Cohesive	106.4		P7
P8	108.6	108.6	106.8 106.5** 102.5**	106.3** 102.5** <102.5**	Non-Cohesive Non-Cohesive Weak Silty Dolostone	107.0	Numerous Boulders	6

Table III .../cont'd
Fallowfield Road Site

Pole No.	Ground Surface Elevations		Soil Boundary Elevation		Soil Type	Assumed Water Level (m)	Remarks	Borehole No.
	Original Grade (m)	Finished Grade (m)	Upper (m)	Lower (m)	Cohesive Non-Cohesive			
P9	112.3	113.2	111.4 109.0	109.0 <109.0**	Non-Cohesive Weak Silty Dolostone	109.7		P9
P10	107.0	109.0	107.2 104.2** 99.4**	104.2** 99.4** <99.4**	Non-Cohesive Non-Cohesive Weak Silty Dolostone	105.8	Numerous Boulders	7/20-8
P11	112.0	111.9	110.1 107.5** 106.0**	107.5** 106.0** <106.0**	Non-Cohesive Non-Cohesive Medium Strong Limestone	110.0*	Numerous Boulders	1,8, 20-1 20-2
P12	115.3	115.1	113.3 112.6 111.7	112.6 111.7 <111.7	Non-Cohesive Non-Cohesive Medium Strong Limestone	114.8	Numerous Boulders	P12
P13	118.5	118.3	118.1	<118.1	Medium Strong Limestone		V. Loose	P13
P14	112.8	111.3	109.5 109.2	109.2 <109.2	Non-Cohesive Medium Strong Limestone	107.5		P14
P15	108.5	108.4	107.3	<107.3	Medium Strong Limestone	107.5	Located on Quarry Floor	
P16	110.7	110.0	108.2 106.6	106.6 <106.6	Non-Cohesive Medium Strong Limestone	106.5		P16
P17	117.4	116.8	115.0** <112.0**	112.0	Non-Cohesive Medium Strong Limestone	Dry 107.5	Located at Quarry Rim	

**Note: Elevations are only approximate since they were based on projections of stratigraphy.

Table IV
Knoxdale Road Site

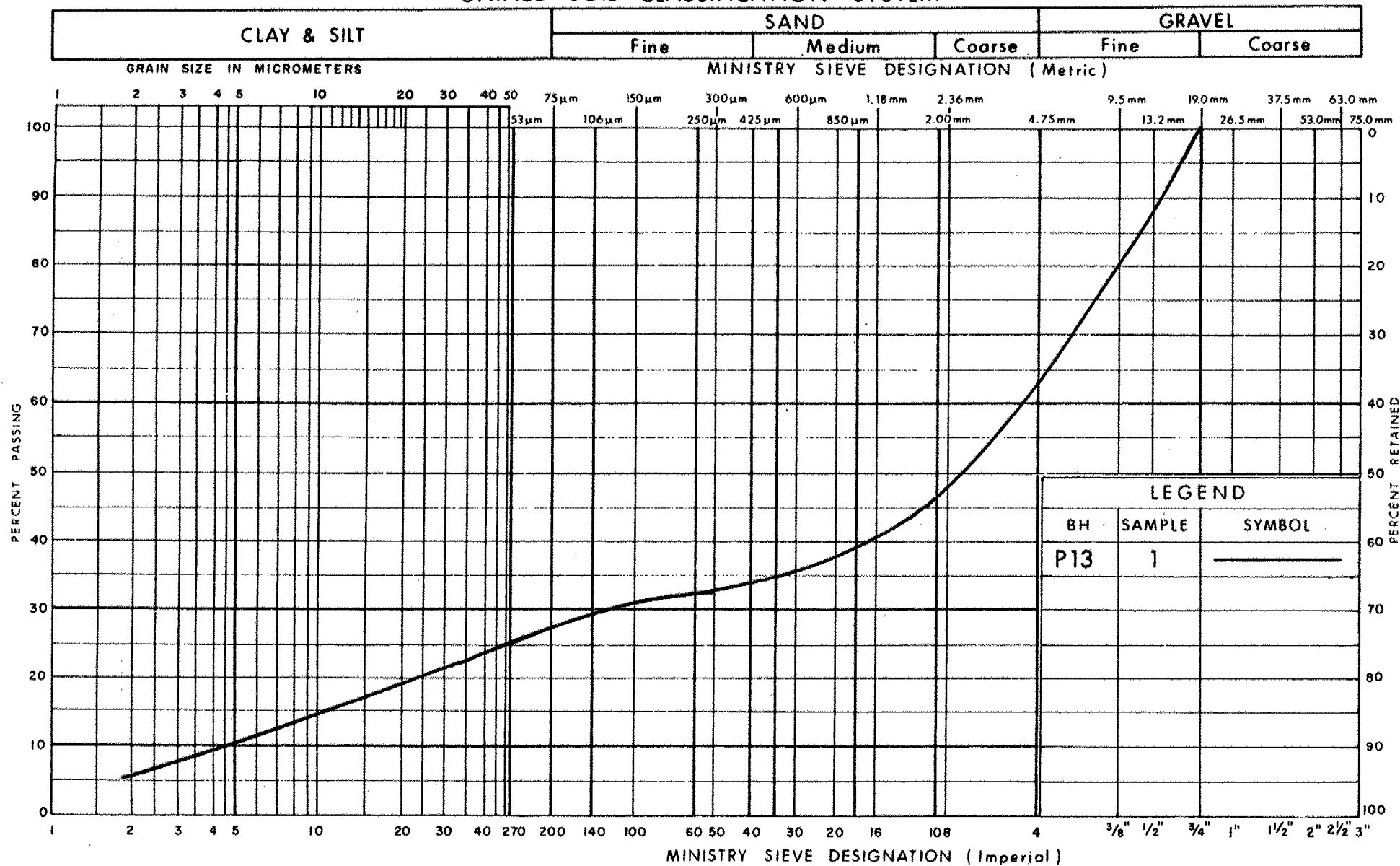
Pole No.	Ground Surface Elevations		Soil Boundary Elevation		Soil Type	Assumed Water Level (m)	Remarks	Borehole No.
	Original Grade (m)	Finished Grade (m)	Upper (m)	Lower (m)	Cohesive Non-Cohesive Cohesive			
P18 (P34)	94.8	94.6	92.8 92.7 91.9 90.3	92.7 91.9 90.3 <90.3	Cohesive Non-Cohesive Cohesive Medium Strong Dolostone	94.4		P18
P19 (P33)	94.9	94.9	93.1 92.9 92.1 90.8	92.9 92.1 90.8 <90.8	Cohesive Non-Cohesive Cohesive Medium Strong Dolostone	94.0		P19
P20 (P32)	95.1	95.0	93.2 92.2 91.6	92.2 91.6 <91.6	Non-Cohesive Cohesive Medium Strong Dolostone	94.5		P20
P21 (P31)	94.9	93.8	93.5	<93.5	Medium Strong Dolostone	94.9		P21
P22 (P30)	94.7	94.3	92.8	<92.8	Medium Strong Dolostone	94.9		P22
P23 (P29)	95.2	95.3	94.7	<94.7	Medium Strong Dolostone	95.2		P23
P24 (P28)	95.6	95.5	94.8	<94.8	Medium Strong Dolostone	95.6		P24
P25 (P27)	95.6	95.5	94.0	<94.0	Medium Strong Dolostone	95.6		P25
P26 (P26)	95.6	95.4	93.6** 92.8**	92.8**	Cohesive Medium Strong Dolostone	95.6		P25/ 5,7
P27 (P25)	95.5	95.8	94.0 93.4	93.4 <93.4	Cohesive Medium Strong Dolostone	95.5		P27

Table IV .../cont'd
Knoxdale Road Site

Pole No.	Ground Surface Elevations		Soil Boundary Elevation		Soil Type	Assumed Water Level (m)	Remarks	Borehole No.
	Original Grade (m)	Finished Grade (m)	Upper (m)	Lower (m)				
P28 (P24)	94.9	95.3	93.5 92.8** 92.0**	92.8** 92.0** <92.0**	Cohesive (C) Non-Cohesive (NC) Cohesive Non-Cohesive Medium Strong Dolostone	94.9		P29, P27
P29 (P23)	94.6	95.2	93.4 92.6 89.7	92.6 89.7 <89.7	Cohesive Non-Cohesive Medium Strong Dolostone	94.3		P29
P30 (P22)	94.5	93.9	92.1 90.8 90.5**	90.8 90.5 <90.5**	Non-Cohesive Cohesive Medium Strong Dolostone	93.0		P30
P31 (P21)	94.5	94.5	92.7 90.8 90.0 88.9	90.8 90.0 88.9 <88.9	Non-Cohesive Non-Cohesive Non-Cohesive Medium Strong Dolostone	94.3		P31
P32 (P20)	94.5	94.5	92.7 90.5 90.1 89.6	90.5 90.1 89.6 <89.6	Non-Cohesive Non-Cohesive Cohesive Medium Strong Dolostone	94.2		P32
P33 (P19)	94.5	94.5	92.7 90.8 88.9	90.8 88.9 <88.9	Non-Cohesive Non-Cohesive Medium Strong Dolostone	93.6		P33

Note: *The most recent high mast light pole numbering is shown in brackets.
 **Elevations are only approximate since they were based on projections of stratigraphy.

UNIFIED SOIL CLASSIFICATION SYSTEM



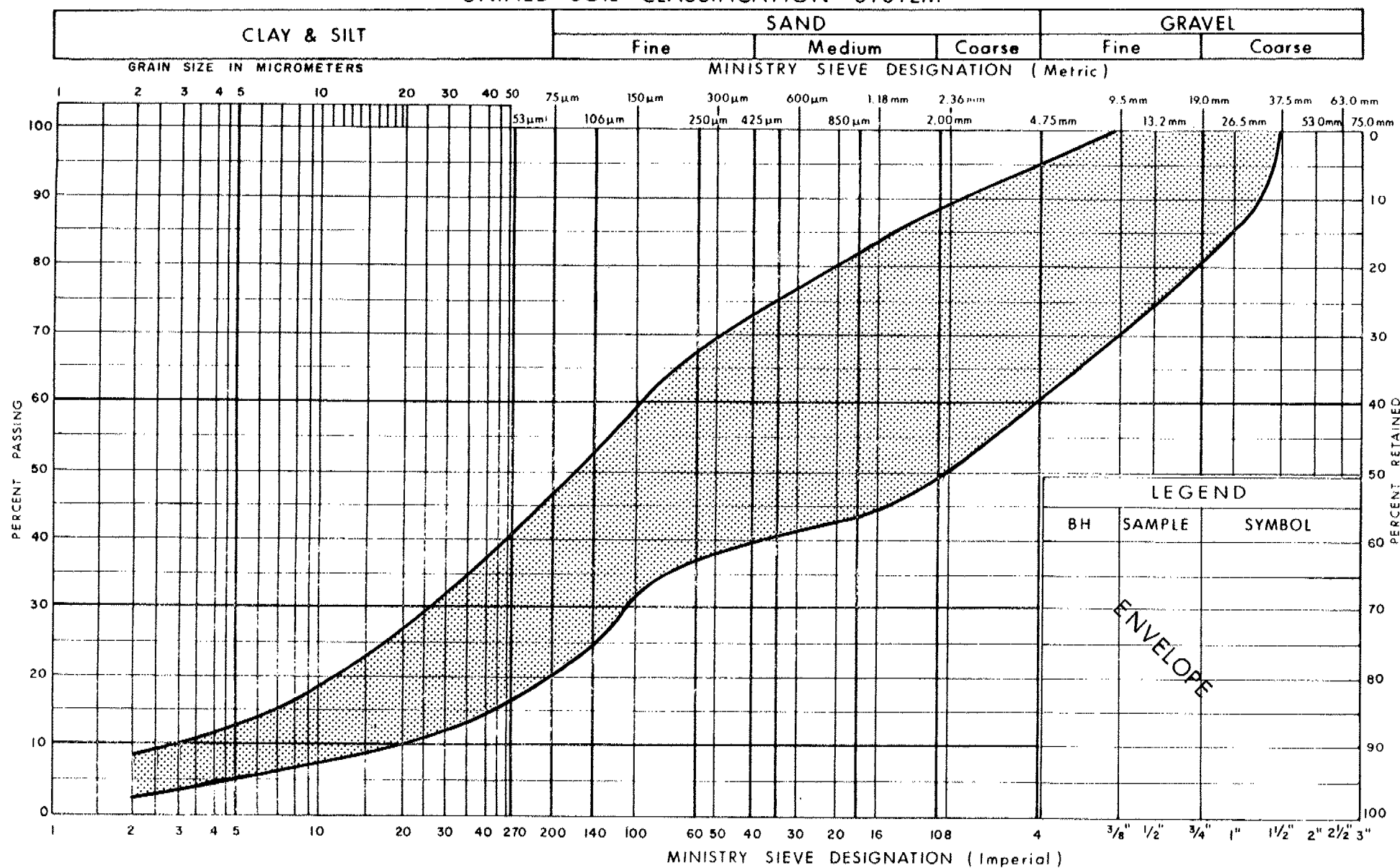
Ministry of
Transportation

GRAIN SIZE DISTRIBUTION
GRAVELLY SAND & SILT (FILL)
 (COMPRISED OF CRUSHED PIECES OF LIMESTONE)

FIG No 1

W P 122-87-00

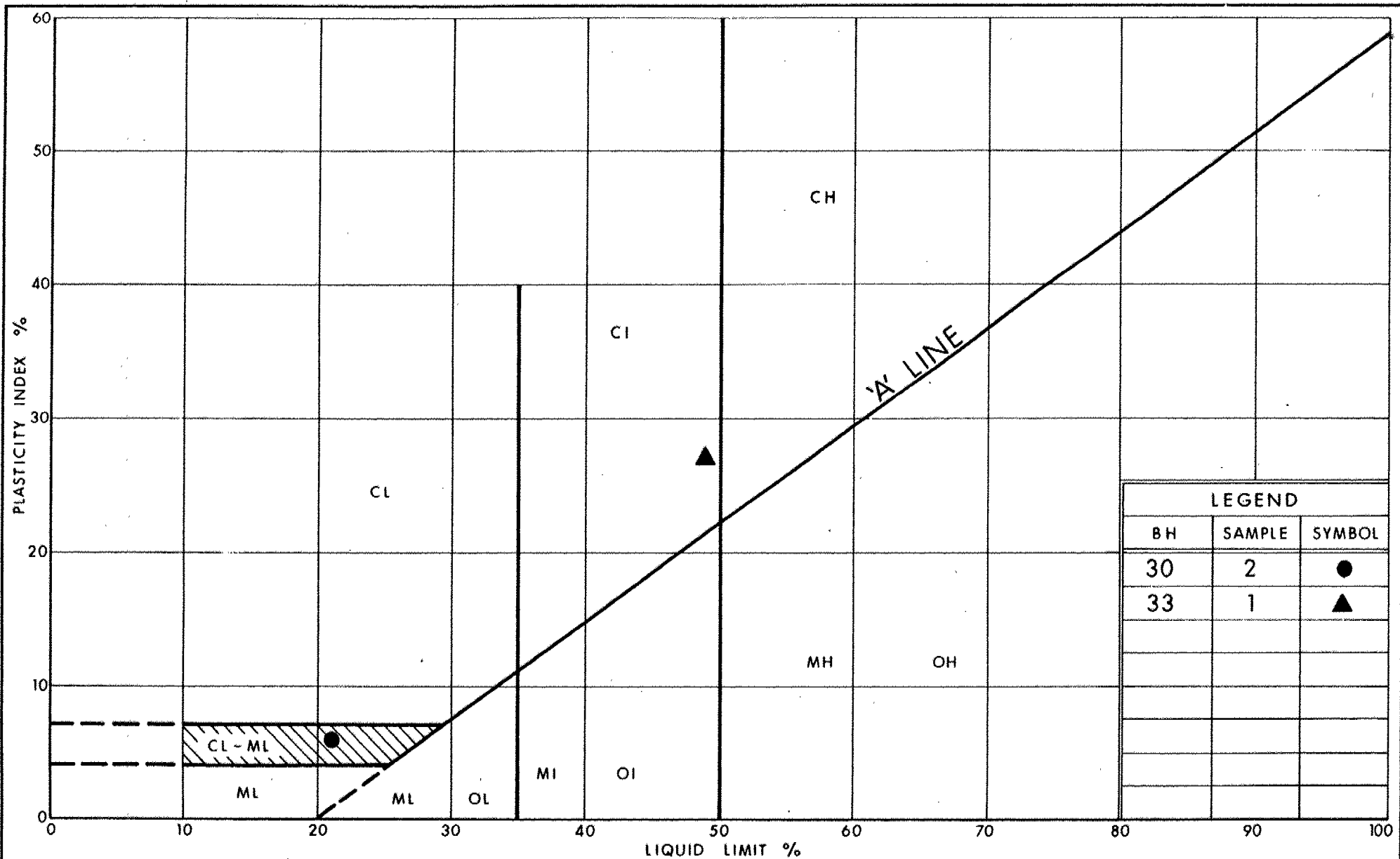
UNIFIED SOIL CLASSIFICATION SYSTEM

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Transportation

GRAIN SIZE DISTRIBUTION
HETEROGENEOUS MIXTURE OF SILTY SAND
SOME GRAVEL, TRACE OF CLAY (GLACIAL TILL)

FIG No 2

W P 122-87-00



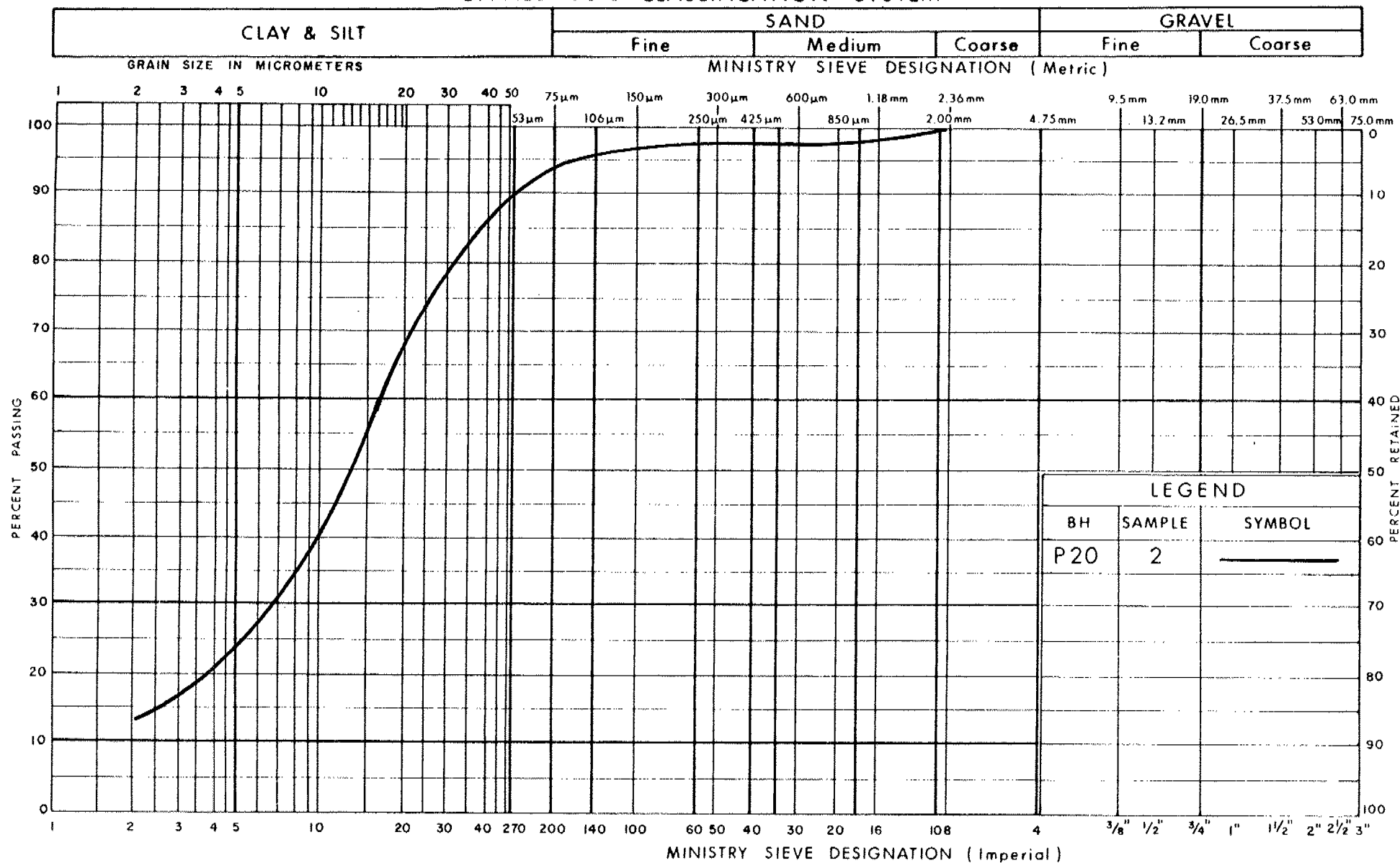
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PLASTICITY CHART SILTY CLAY TO CLAYEY SILT

FIG No 3

W P 122-87-00

UNIFIED SOIL CLASSIFICATION SYSTEM



Ontario

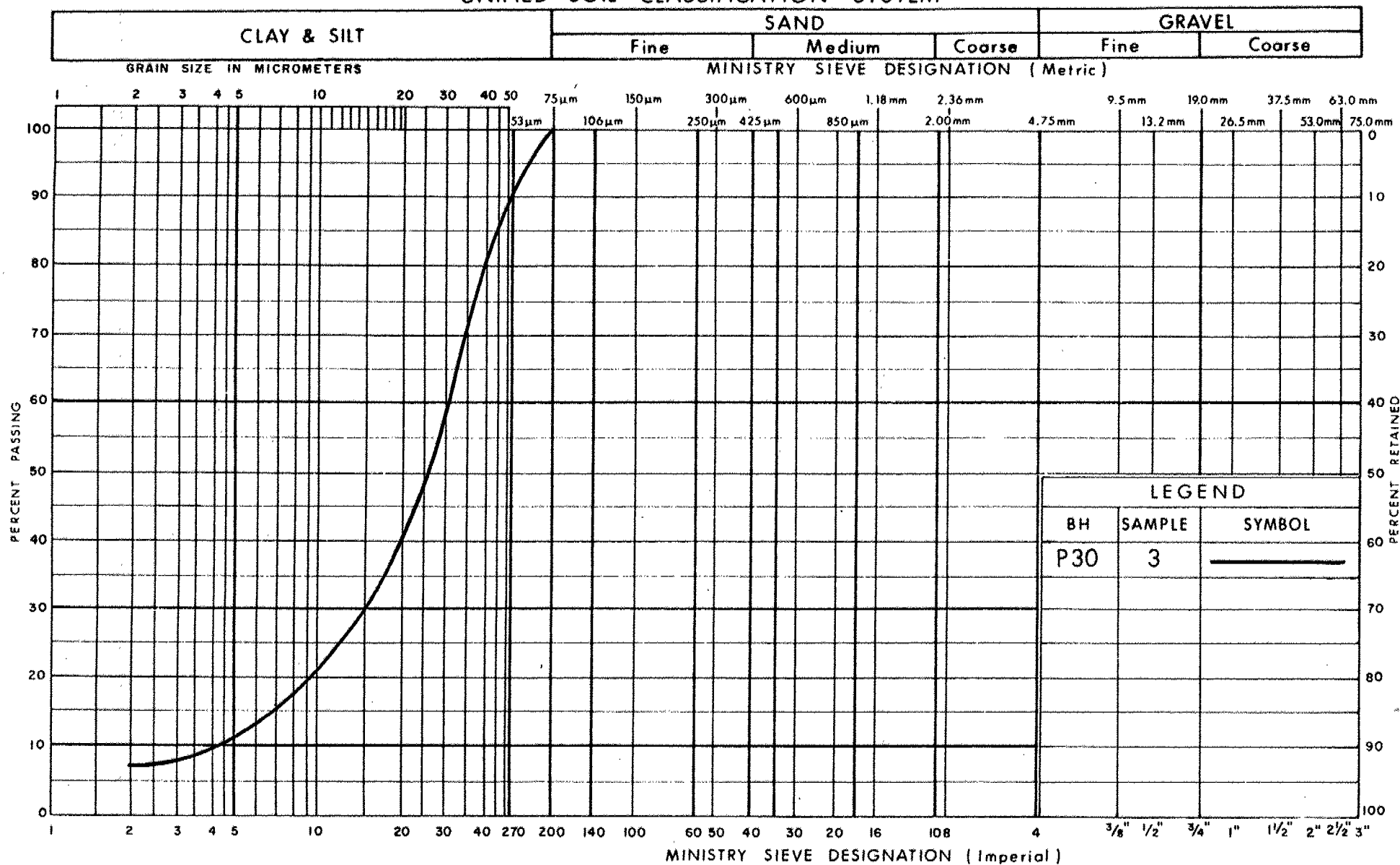
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GRAIN SIZE DISTRIBUTION
SILTY CLAY TO CLAYEY SILT

FIG No 4

W P 122-87-00

UNIFIED SOIL CLASSIFICATION SYSTEM

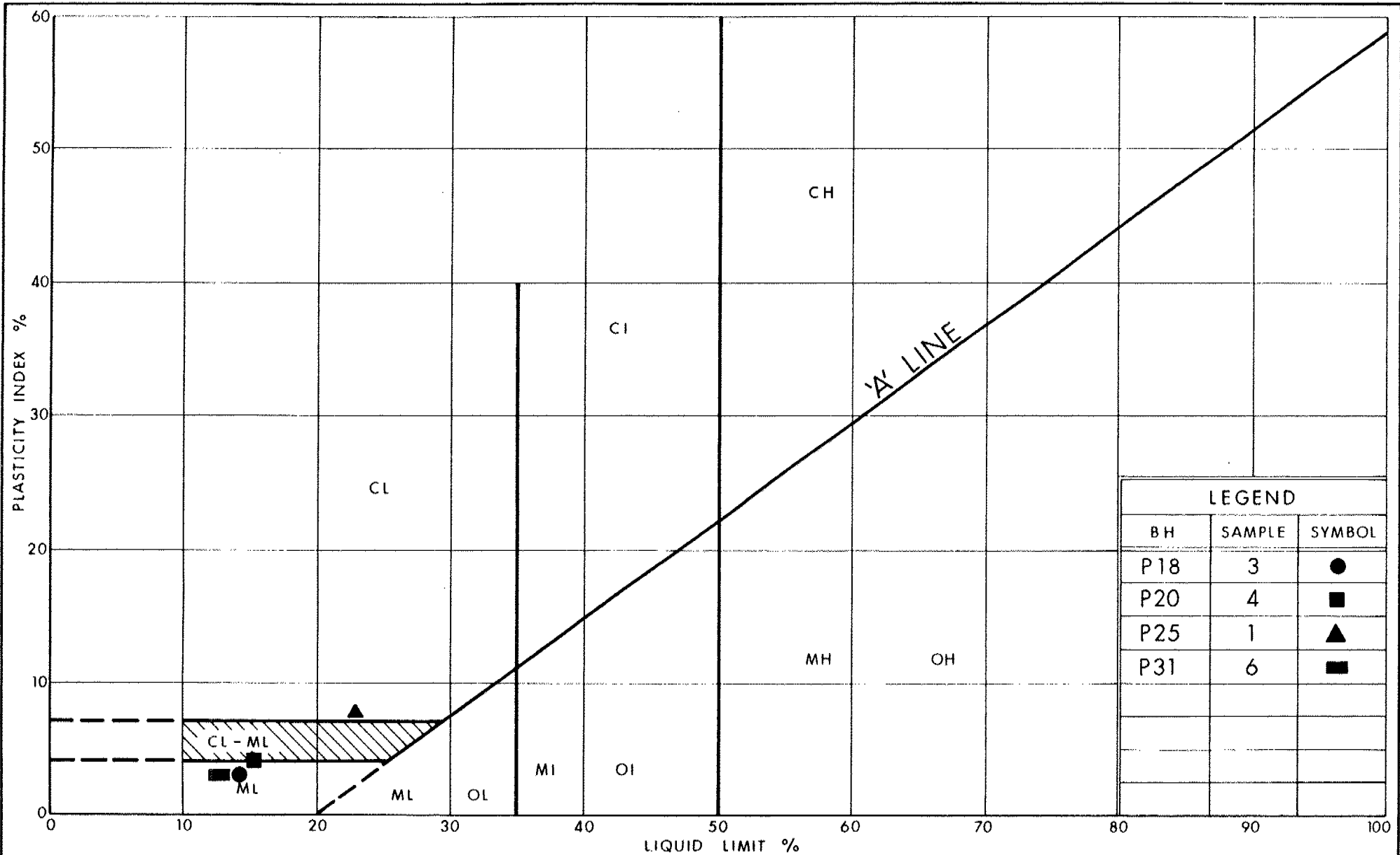


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Transportation

GRAIN SIZE DISTRIBUTION
SILT TO SANDY SILT

FIG No 5

W P 122-87-00



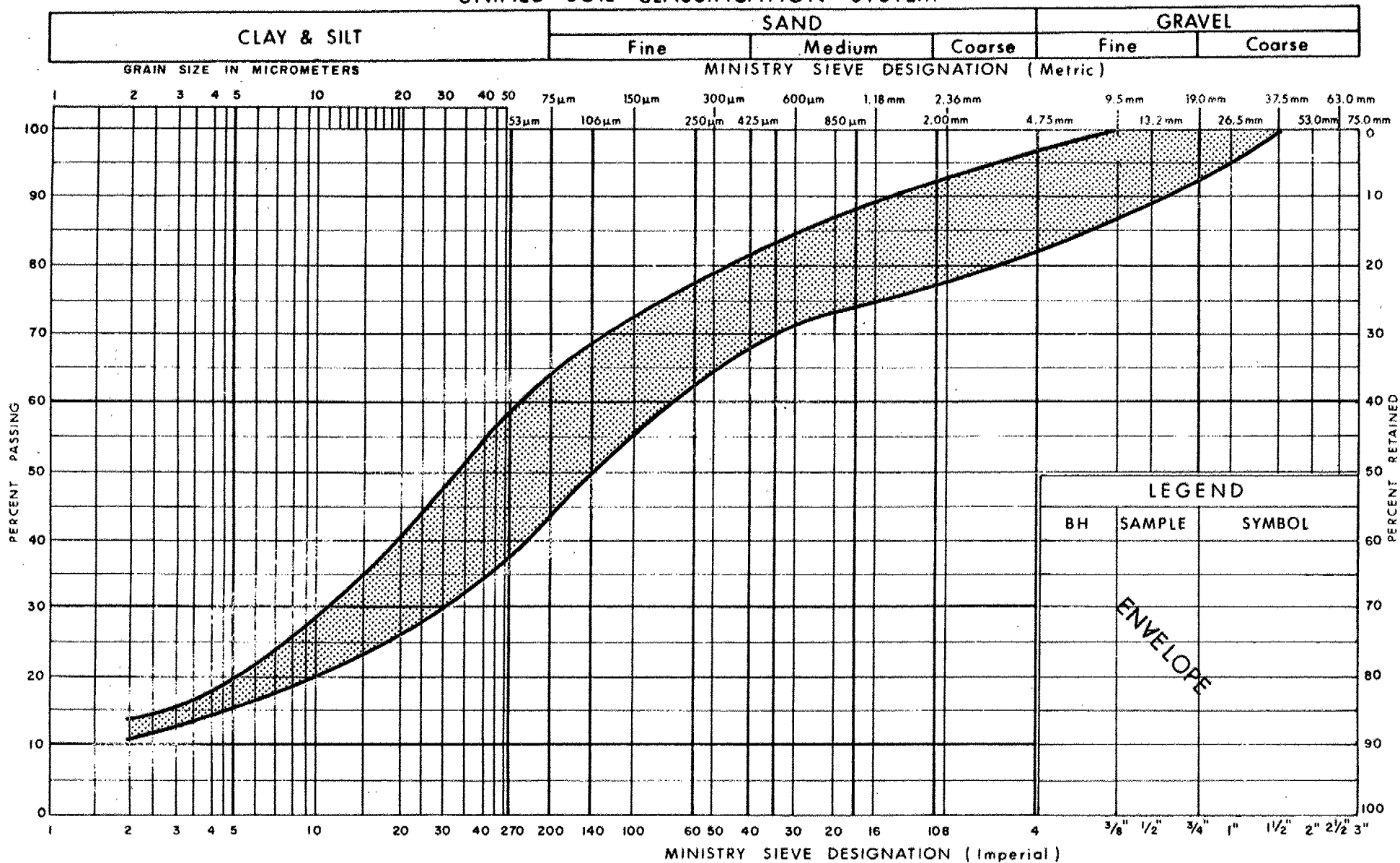
Ministry of
Transportation

PLASTICITY CHART
HETEROGENEOUS MIXTURE OF CLAYEY SILT & SAND
TRACE OF GRAVEL (GLACIAL TILL)

FIG No 6

W P 122-87-00

UNIFIED SOIL CLASSIFICATION SYSTEM



Ministry of
Transportation

GRAIN SIZE DISTRIBUTION
HETEROGENEOUS MIXTURE OF CLAYEY SILT & SAND
 TRACE OF GRAVEL (GLACIAL TILL)

FIG No 7

W P 122-87-00

RECORD OF BOREHOLE No P1

1 OF 1

METRIC 44

W.P. 122-87-00 LOCATION Co-ords. N 5 014 062; E 360 282 ORIGINATED BY JB
DIST 9 HWY 416 BOREHOLE TYPE H.S. Auger, BXL Rock Coring COMPILED BY JB
DATUM Geodetic DATE 91 04 09 CHECKED BY BI

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _P	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT 7 kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100	20 40 60 80 100					
112.2	Ground Surface													
0.0														
111.7	Sandy Silt (Topsoil)		1	SS	7		112							
0.5														
	Heterogeneous Mixture of Silty Sand, Some Gravel, Trace of Clay		2	SS	50 15cm		111							
			3	SS	54/15cm									
	Brown													
	Greyish Brown to Grey		4	SS	50/8cm		110							4 51 39 6
	Occasional Boulders		5	SS	55/15cm		109							
	Numerous Boulders													
			6	BXL RC	REC 83%		108							RQD 28%
	Very Dense		7	BXL RC	REC 94%									RQD 51%
	(Glacial Till)		8	BXL RC	REC 67%		107							RQD 0%
			9	BXL RC	REC 89%									RQD 0%
			10	BXL RC	REC 58%									RQD 0%
			11	BXL RC	REC 99%		106							RQD 21%
			12	BXL RC	REC 83%									RQD 0%
			13	BXL RC	REC 52%		105							RQD 0%
			14	BXL RC	REC 59%									RQD 0%
			15	BXL RC	REC 55%		104							RQD 0%
			16	BXL RC	REC 42%									RQD 0%
							103							RQD 64%
101.7	Greyish Brown to Grey						102							RQD 68%
10.5	Bedrock Greyish Black Shale		18	BXL RC	REC 92%									
101.0	Greenish Grey Dolostone													
11.2	End of Borehole													
91 04 11														
* GROUND WATER CONDITIONS														
PIEZO. NO.		GROUND WATER ELEVATION (Metres)												
1		108.6												

RECORD OF BOREHOLE No P2

1 OF 1

METRIC 45

W.P. 122-87-00 LOCATION Co-ords. N 5 014 261; E 360 265 ORIGINATED BY FT/JB
DIST 9 HWY 416 BOREHOLE TYPE H.S. Auger, BXL Rock Coring COMPILED BY JB
DATUM Geodetic DATE 91 04 05/08 CHECKED BY BI

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					
111.6	Ground Surface																
0.0	400 mm Topsoil		1	SS	5												
110.7	Sandy Silt --- Dark Brown Contains Tr. of Organics (Fill) Loose to Very Dense		2	SS	6/15cm												
0.9	Heterogeneous Mixture of Silty Sand, Some Gravel Trace of Clay Contains Occasional Boulders --- Brown --- Greyish Brown Very Dense (Glacial Till)		3	SS	100/18cm												
			4	SS	109/15cm												
			5	SS	17/8cm												
			6	SS	100/10cm												
			7	SS	129												
105.8																	
5.8	Greyish Brown, Shale Grey, Limestone Bedrock		8	BXL RC	REC 100%												
			9	BXL RC	REC 100%												
102.8																	
8.8	End of Borehole																
91 04 11 * GROUND WATER CONDITIONS PIEZO. NO. GROUND WATER ELEVATION (Metres) 1 109.2																	

RECORD OF BOREHOLE No P3

1 OF 1

METRIC 46

W.P. 122-87-00 LOCATION Co-ords. N 5 014 372; E 360 190
 DIST 9 HWY 416 BOREHOLE TYPE H.S. Auger, BXL Rock Coring
 DATUM Geodetic DATE 91 04 10
 ORIGINATED BY JB
 COMPILED BY JB
 CHECKED BY BI

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	WATER CONTENT (%)
110.8	Ground Surface																	
0.0	Sandy Silt (Topsoil)		1	SS	2													
110.2	Dark Brown		2	SS	35/10cm													
0.6	Brown to Greyish Brown		3	SS	50/13cm													
	Heterogeneous Mixture of Silty Sand, Some Gravel, Trace of Clay		4	SS	50/8cm													
	Occasional Boulders																	
	Very Dense																	
	(Glacial Till)																	
108.0	Brown to Greyish Brown		5	BXL RC	REC 100%													
2.8	Dark to Light Grey		6	BXL RC	REC 100%													
	Bedrock																	
	Limestone																	
105.1																		
5.7	End of Borehole																	
91 04 11 * GROUND WATER CONDITIONS <table border="1"> <tr> <td>PIEZO. NO.</td> <td>GROUND WATER ELEVATION (Metres)</td> </tr> <tr> <td>1</td> <td>110.6</td> </tr> </table>															PIEZO. NO.	GROUND WATER ELEVATION (Metres)	1	110.6
PIEZO. NO.	GROUND WATER ELEVATION (Metres)																	
1	110.6																	

RECORD OF BOREHOLE No P4

1 OF 1

METRIC 47

W.P. 122-87-00 LOCATION Co-ords. N 5 014 412; E 360 082 ORIGINATED BY JB
 DIST 9 HWY 416 BOREHOLE TYPE H.S. Auger, BXL Rock Coring COMPILED BY JB
 DATUM Geodetic DATE 91 04 05 CHECKED BY BI

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT 7 kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100	W _P W W _L	WATER CONTENT (%)				
110.0	Ground Surface													
0.0	Sandy Silt to Silty Sand Topsoil, Dark Brown Loose Traces of Root Fibres, Brown (Fill)		1	SS	2	/5cm								
109.1			2	SS	7									
0.9	Heterogeneous Mixture of Silty Sand, Some Gravel, Trace of Clay Compact (Glacial Till)		3	SS	25									
			4	BXL RC	REC 88%									
107.3	Brown to Greyish Brown Dark Greenish Grey to Dark Grey Bedrock		5	BXL RC	REC 92%									
2.7			6	BXL RC	REC 96%									
105.0	Silty Dolostone													
5.0	End of Borehole													
	* Note: Water level measured in open borehole immediately prior to coring.													

RECORD OF BOREHOLE No P5

1 OF 1

METRIC 48

W.P. 122-87-00 LOCATION Co-ords. N 5 014 506; E 360 200 ORIGINATED BY JB
DIST 9 HWY 416 BOREHOLE TYPE H.S. Auger, BXL Rock Coring COMPILED BY JB
DATUM Geodetic DATE 91 04 08 CHECKED BY BI


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
109.3	Ground Surface																
0.0	Sandy Silt to Silty Sand	Dark Brown, Topsoil	1	SS	2												
108.5	(Fill)	Brown, Traces of Organics	2	SS	55												
0.8		Light Greyish Brown															
	Heterogeneous Mixture of Silty Sand, Some Gravel, Trace of Clay		3	SS	50/13cm									13 49 32 6			
	Occasional Sand Layers and Boulders		4	SS	50/6cm												
	Very Dense (Glacial Till)		5	SS	30/8cm												
	Gravelly Sand Layer		6	SS	50/13cm									21 73 6			
			7	SS	60/15cm												
	Occasional Boulders		8	SS	64/8cm												
	Numerous Boulders		9	BXL RC	REC 67%									RQD 22%			
101.6																	
7.7	End of Borehole																
<p>91 04 11 * GROUND WATER CONDITIONS</p> <table border="1"> <tr> <th>PIEZO. NO.</th> <th>GROUND WATER ELEVATION (Metres)</th> </tr> <tr> <td>1</td> <td>108.9</td> </tr> </table>														PIEZO. NO.	GROUND WATER ELEVATION (Metres)	1	108.9
PIEZO. NO.	GROUND WATER ELEVATION (Metres)																
1	108.9																

RECORD OF BOREHOLE No P6

1 OF 1

METRIC 49

W.P. 122-87-00 LOCATION Co-ords. N 5 014 595; E 360 293
 DIST 9 HWY 416 BOREHOLE TYPE H.S. Auger, BXL Rock Coring
 DATUM Geodetic DATE 91 04 05/06
 ORIGINATED BY JB/FT
 COMPILED BY JB
 CHECKED BY BI

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 ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100
102.5	Ground Surface														
0.0	Clayey Silt (Topsoil)	Dark Brown	1	SS	3		102							** Sand Likely Disturbed Due to Hydro- static Head.	
0.5	Clayey Silt, Some Sand Contains Traces of Root Fibres Firm to Stiff	Brown to Greyish Brown	2	SS	1		101								
100.4	Till-Like		3	SS	12		100								
2.1	Silty Sand to Coarse Sand and Gravel Compact	Light Greyish Brown Light to Dark Grey	4	SS	13		99								
98.4			5	SS	1**		98								
4.1	Heterogeneous Mixture of Silty Sand, Some Gravel, Trace of Clay Very Dense (Glacial Till)		6	SS	23		97								
96.3	Numerous Boulders		7	SS	50		96								
6.2	Bedrock		8	BXL RC	REC 69%		95								
93.2	Limestone Light to Medium Dark Grey Dark Greenish Grey to Dark Grey Silty Dolostone		9	BXL RC	REC 100%		94								
9.3	End of Borehole • Note: Water level in open borehole at a depth of 1.1 m immediately prior to coring														

RECORD OF BOREHOLE No P7

1 OF 1

METRIC 50

W.P. 122-87-00 LOCATION Co-ords. N 5 014 573; E 360 220
 DIST 9 HWY 416 BOREHOLE TYPE H.S. Auger
 DATUM Geodetic DATE 91 04 10
 ORIGINATED BY JB
 COMPILED BY JB
 CHECKED BY BI

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100	W _p W W _L					
106.6	Ground Surface							SHEAR STRENGTH kPa		WATER CONTENT (%)				
0.0	Sandy Silt (Topsoil)		1	SS	1			○ UNCONFINED + FIELD VANE						
106	Dark Greyish Brown		2	SS	77	/22cm	106	● QUICK TRIAXIAL × LAB VANE						
0.6	Brown to Greyish Brown		3	SS	50	/8cm	105							
	Heterogeneous Mixture of Silty Sand, Some Gravel Trace of Clay													
	Contains Occasional Cobbles and Boulders		4	SS	50	/13cm	104							
	Dense to Very Dense						103							
	(Glacial Till)		5	SS	33		102							
							101							
			6	SS	59		100							
99.0							99							
7.6	End of Borehole													
	* Note: water level in open borehole at a depth of 0.3 m (caved at 0.6 m) immediately upon completion of sampling.													

RECORD OF BOREHOLE No P9

1 OF 1

METRIC 51

W.P. 122-87-00 LOCATION Co-ords. N 5 014 501; E 359 945 ORIGINATED BY JB
DIST 9 HWY 416 BOREHOLE TYPE H.S. Auger COMPILED BY JB
DATUM Geodetic DATE 91 04 10 CHECKED BY BI

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 γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES								
112.3	Ground Surface												
0.0	Topsoil												
111.7	Dark Brown												
0.6	Greyish Brown												
	Heterogeneous Mixture of Silty Sand, Some Gravel Trace of Clay												
	Compact to Dense		1	SS	75								
	Very Dense				25cm								
	(Glacial Till)												
	Gravelly												
109.0			2	SS	50	/10cm							40 31 26 3
3.3	End of Borehole												
	Note: The water level in the open borehole was at a depth of 0.3 m immediately upon com- pletion of sampling.												

RECORD OF BOREHOLE No P12

1 OF 1

METRIC 52

W.P. 122-87-00 LOCATION Co-ords. N 5 014 474; E 359 851
DIST 9 HWY 416 BOREHOLE TYPE H.S. Auger, BXL Rock Coring
DATUM Geodetic DATE 91 04 04/05
ORIGINATED BY JB
COMPILED BY JB
CHECKED BY BI

SOIL PROFILE			SAMPLES		GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT	PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL				
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE									'N' VALUES			
115.3	Ground Surface															
0.0	300 mm Sandy Silt (Topsoil) Dark Brown Greyish Brown Heterogeneous Mixture of Silty Sand, Some Gravel, Trace of Clay Contains Occasional Cobbles and Boulders Very Dense (Glacial Till) Numerous Boulders		1	AS												
			2	SS	25 13cm											
			3	SS	50/13cm											
			4	SS	32/8cm											
111.7	Greyish Brown Light to Dark Grey		5	BXL RC	REC 41%							RQD 27%				
3.6	Bedrock		6	BXL RC	REC 97%							RQD 53%				
110.3	Limestone															
5.0	End of Borehole															
<p>91 04 11 * GROUND WATER CONDITIONS</p> <table border="1"> <thead> <tr> <th>PIEZO. NO.</th> <th>GROUND WATER ELEVATION (Metres)</th> </tr> </thead> <tbody> <tr> <td>1</td> <td>114.8</td> </tr> </tbody> </table>													PIEZO. NO.	GROUND WATER ELEVATION (Metres)	1	114.8
PIEZO. NO.	GROUND WATER ELEVATION (Metres)															
1	114.8															

RECORD OF BOREHOLE No P13

1 OF 1

METRIC 53

W.P. 122-87-00 LOCATION Co-ords. N 5 014 615; E 359 751 ORIGINATED BY JB
DIST 9 HWY 416 BOREHOLE TYPE H.S. Auger, BXL Rock Coring COMPILED BY JB
DATUM Geodetic DATE 91 04 04 CHECKED BY BI

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 (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
118.5	Ground Surface																
0.0	Gravelly Sand and Silt (Fill)	Dark Brown Light to Dark Grey	1	AS		DRY *	118	25 / 5cm									40 32 22 6
0.4	Bedrock		2	BXL RC	REC 87%		117										RQD 65%
	Limestone		3	BXL RC	REC 100%		116										RQD 83%
115.6	End of Borehole																
2.9	* Note: Borehole dry immediately prior to coring.																

RECORD OF BOREHOLE No P14

1 OF 1

METRIC 54

W.P. 122-87-00 LOCATION Co-ords. N 5 014 710; E 359 900 ORIGINATED BY FT
DIST 9 HWY 416 BOREHOLE TYPE H.S. Auger, BXL Rock Coring COMPILED BY JB
DATUM Geodetic DATE 91 04 12 CHECKED BY BI

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					
112.8	Ground Surface																
0.0	300 mm Sand and Gravel (Fill) --- Greyish Brown --- Light to Dark Grey		1	AS		DRY *											
	Limestone		2	BXL RC	REC 72%		112										RQD 12%
	Bedrock --- Light to Dark Grey --- Greenish Grey --- Silty Dolostone --- Greenish Grey --- Light to Dark Grey		3	BXL RC	REC 20%		111										RQD 0%
	Limestone		4	BXL RC	REC 90%		110										RQD 50%
107.9							109										
107.9							108										
4.9	End of Borehole																
	* Note: Borehole was found to be dry immediately prior to coring.																

RECORD OF BOREHOLE No P16

1 OF 1

METRIC 55

W.P. 122-87-00 LOCATION Co-ords. N 5 014 886; E 359 880 ORIGINATED BY JB
DIST 9 HWY 416 BOREHOLE TYPE H.S. Auger, BXL Rock Coring COMPILED BY JB
DATUM Geodetic DATE 91 04 04 CHECKED BY BI

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100	20 40 60 80 100					
110.7	Ground Surface													
0.0	Silty Sand (Fill) Contains Traces of Root Fibres and Topsail Enclosures		1	SS	31									
			2	SS	7									
109.0	Brown to Dark Brown Brown to Grey		3	SS	50/54m									
1.7	Heterogeneous Mixture of Silty Sand, Some Gravel, Trace of Clay Contains Numerous Boulders Dense to Very Dense (Glacial Till)		4	RC	REC 74%									
			5	RC	REC 44%									
			6	BXL RC	REC 94%									
			7	BXL RC	REC 92%									
106.6	Brown to Grey Light to Dark Grey		8	BXL RC	REC 84%									
4.1	Bedrock													
105.9	Limestone													
4.8	End of Borehole													
91 04 12 * GROUND WATER CONDITIONS PIEZO. NO. 1 GROUND WATER ELEVATION (Metres) 106.3														

RECORD OF BOREHOLE No P18

1 OF 1

METRIC 56

W.P. 122-87-00 LOCATION Co-ords. N 5 019 860; E 359 276
 DIST 9 HWY 416 BOREHOLE TYPE H.S. Auger, BXL Rock Coring
 DATUM Geodetic DATE 91 04 11
 ORIGINATED BY JB
 COMPILED BY JB
 CHECKED BY BI

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100	20 40 60 80 100					
94.8	Ground Surface													
0.0 94.4	Sandy Silt (Fill) Contains Traces of Organics Dark Brown													
0.4	Greyish Brown													
	Heterogeneous Mixture of Clayey Silt, Sand, Trace of Gravel		1	SS	29									7 26 55 12
	Greyish Brown		2	SS	14									
	Grey													
	Clayey		3	SS	15									
	Loose to Compact (Glacial Till)		4	SS	9									
			5	SS	27									
90.3	Grey													
4.5	Pale Yellowish Brown to Dark Grey													
	Bedrock		6	BXL RC	REC 99%									RQD 89%
	Dolostone													
88.7														
6.1	End of Borehole													
	Note: Water level in open borehole at a depth of 0.4 m (caved at 2.9 m) immediately upon completion of coring. It is unlikely that the water lev- el has had sufficient time to stabilize.													

RECORD OF BOREHOLE No P19

1 OF 1

METRIC 57

W.P. 122-87-00 LOCATION Co-ords. N 5 019 736; E 359 320 ORIGINATED BY FT/JB
 DIST 9 HWY 416 BOREHOLE TYPE H.S. Auger, BXL Rock Coring COMPILED BY JB
 DATUM Geodetic DATE 91 04 11/12 CHECKED BY BI

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT 7 KN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100	20 40 60 80 100					
94.9	Ground Surface													
0.0	Clayey Silt (Fill)													
94.4	Contains Traces of Organics													
0.5	Heterogeneous Mixture of Clayey Silt, Sand, Trace of Gravel		1	SS	8		94							
	Greyish Brown to Brownish Grey		2	SS	34		93							
	Sandy		3	SS	25		92							
	Stiff to Hard (Glacial Till)		4	SS	10		91							
90.8	Grey		5	SS	7	/15cm	90							
4.1	Brownish Grey to Dark Grey		6	BXL RC	REC 98%		89							RQD 92%
	Bedrock													
	Dolostone		7	BXL RC	REC 97%		88							RQD 90%
87.7														
7.2	End of Borehole													
	* Note: Water level in open borehole at a depth of 1.0 m (caved at 2.8 m) approximately 4 hours after completion of coring. The water level may not have had sufficient time to stabilize.													

RECORD OF BOREHOLE No P20

1 OF 1

METRIC 58

W.P. 122-87-00 LOCATION Co-ords. N 5 019 629; E 359 358 ORIGINATED BY FT
DIST 9 HWY 416 BOREHOLE TYPE H.S. Auger, BXL Rock Coring COMPILED BY JB
DATUM Ceodetic DATE 91 04 11 CHECKED BY BI

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
95.1	Ground Surface																
0.0	Clayey Silt (Fill) — 150 mm Topsoil																
94.6	Contains Traces of Organics Dark Brown																
0.5	Greyish Brown																
	Clayey Silt, Some Sand		1	SS	9												
	Firm to Stiff																
93.3			2	SS	5												
1.8	Greyish Brown																
	Sandy Silt																
92.2	Trace of Clay		3	SS	10												
	Loose																
2.9	Heterogeneous Mixture of																
	Clayey Silt, Some Sand																
91.6	Trace of Gravel (Glacial Till) . Very Stiff		4	SS	15												
	Brownish Grey to Dark Grey																
3.5																	
	Badrock		5	BXL RC	REC 94%												
	Dolostone																
			6	BXL RC	REC 89%												
88.5																	
6.6	End of Borehole																
<p>91 04 12</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>94.5</td> </tr> </table>														PIEZO. NO.	GROUND WATER ELEVATION (Metres)	1	94.5
PIEZO. NO.	GROUND WATER ELEVATION (Metres)																
1	94.5																

RECORD OF BOREHOLE No P21

1 OF 1

METRIC 59

W.P. 122-87-00 LOCATION Co-ords. N 5 019 493; E 359 344
 DIST 9 HWY 416 BOREHOLE TYPE H.S. Auger, BXL Rock Coring
 DATUM Geodetic DATE 91 04 10/11
 ORIGINATED BY FT
 COMPILED BY JB
 CHECKED BY BI

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								
94.9	Ground Surface												
0.0	180 mm Topsoil												
94.3	Clayey Silt, Some Sand Traces of Organics (Fill)	Brown to Dark Brown											
0.6	Heterogeneous Mixture of Clayey Silt, Some Sand, Trace of Gravel, Hard (Glacial Till)	Greyish Brown	1	SS	53								
93.5		Greyish Brown											
1.4		Brownish Grey to Dark Grey											
	Bedrock		2	BXL RC	REC 98%								ROD 58%
92.0	Dolostone												
2.9	End of Borehole												
	• Note: Water level at ground surface immediately prior to coring.												

RECORD OF BOREHOLE No P22

1 OF 1

METRIC 60

W.P. 122-87-00 LOCATION Co-ords. N 5 019 516; E 359 514 ORIGINATED BY FT
DIST 9 HWY 416 BOREHOLE TYPE H.S. Auger, BXL Rock Coring COMPILED BY JB
DATUM Geodetic DATE 91 04 10 CHECKED BY BI

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					
94.7	Ground Surface																
0.0	150 mm Topsoil																
93.3	Sandy Silt to Sand and Silt		1	SS	21												
1.4	Heterogeneous Mixture of Clayey Silt, Some Sand, Trace of Gravel (Glacial Till), Hard	Brownish Grey	2	SS	35 / 25cm												
92.8	Pale Yellowish Brown to Dark Brown		3	BXL RC	REC 88%												RQD 59%
1.9	Bedrock		4	BXL RC	REC 95%												RQD 87%
90.0	Dolostone		5	BXL RC	REC 91%												RQD 86%
4.7	End of Borehole																
	*Note: The water level in the open borehole was at the ground surface immediately prior to coring.																

RECORD OF BOREHOLE No P23

1 OF 1

METRIC 61

W.P. 122-87-00 LOCATION Co-ords. N 5 019 445; E 359 467 ORIGINATED BY FT

DIST 9 HWY 416 BOREHOLE TYPE H.S. Auger, BXL Rock Coring COMPILED BY JB

DATUM Geodetic DATE 91 04 10 CHECKED BY BI

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					
95.2	Ground Surface													
0.0	150 mm topsoil Clayey Silt, Some Sand (Fill), Traces of Organics		1	AS										
94.7	Brown to Dark Brown													
0.5	Brownish Grey to Dark Grey													
	Bedrock		2	RC	REC 94%		94							RQD 57%
	Dolostone		3	RC	REC 98%		93							RQD 88%
91.8							92							
3.4	End of Borehole													
	• Note: Water level in open borehole at ground surface immediately upon completion of sampling.													
	AS = Sample obtained from the tip of the auger.													

RECORD OF BOREHOLE No P24

1 OF 1

METRIC 62

W.P. 122-87-00 LOCATION Co-ords. N 5 019 370; E 359 357 ORIGINATED BY FT
DIST 9 HWY 416 BOREHOLE TYPE H.S. Auger, BXL Rock Coring COMPILED BY JB
DATUM Geodetic DATE 91 04 10 CHECKED BY BI

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					
95.6																	
0.0	Sandy Silt — 150 mm topsoil		1	SS	3												
94.8	Trace of Clay and Organics (Fill)																
0.8	Brown to Dark Brown Brownish Grey to Dark Grey		2	BXL RC	REC 100%												RQD 57%
	Bedrock																
	Dolostone		3	BXL RC	REC 90%												RQD 85%
91.7																	
3.9	End of Borehole																
	* Note: Water level in the open borehole, at the ground surface immediately prior to sampling.																

RECORD OF BOREHOLE No P25

1 OF 1 METRIC 63

W.P. 122-87-00 LOCATION Co-ords. N 5 019 261; E 359 371 ORIGINATED BY FT
DIST 9 HWY 416 BOREHOLE TYPE H.S. Auger, BXL Rock Coring COMPILED BY JB
DATUM Geodetic DATE 91 04 09 CHECKED BY BI

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												
95.6	Ground Surface																
0.0	150 mm Topsoil Cloyey Silt, Some Sand, Traces of Organics (Fill)																
0.6	Heterogeneous Mixture of Cloyey Silt, Sand, Tr. Gravel Contains Traces of Root Fibres Compact to Dense (Glacial Till)		1	SS	26												
94.0	Brown																
1.6	Brownish Grey to Dark Grey Bedrock		2	BXL RC	REC 100%								RQD 79%				
92.5	Dolostone																
3.1	End of Borehole * Note: Water level at ground surface																
<p>91 04 12 * GROUND WATER CONDITIONS</p> <table border="1"> <tr> <td>PIEZO. NO.</td> <td>GROUND WATER ELEVATION (Metres)</td> </tr> <tr> <td>1</td> <td>0.0</td> </tr> </table>														PIEZO. NO.	GROUND WATER ELEVATION (Metres)	1	0.0
PIEZO. NO.	GROUND WATER ELEVATION (Metres)																
1	0.0																

RECORD OF BOREHOLE No P27

1 OF 1

METRIC 64

W.P. 122-87-00 LOCATION Co-ords. N 5 019 186; E 359 348 ORIGINATED BY FT
DIST 9 HWY 416 BOREHOLE TYPE H.S. Auger, BXL Rock Coring COMPILED BY JB
DATUM Geodetic DATE 91 09 19 CHECKED BY BI

SOIL PROFILE			SAMPLES			GROUND WATER * CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT		UNIT WEIGHT 7 kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100	20 40 60 80 100	W _P W W _L	10 20 30		
95.5	Ground Surface												
0.0	Topsoil, Dark Brown												
94.9	Clayey Silt, Some Sand Traces of Organics, (Fit)												
0.6	Heterogeneous Mixture of Clayey Silt, Sand, Some Gravel Very Stiff to Hard (Glacial Till)		1	SS	23								
93.4	Brown		2	SS	77								14 41 33 12
2.1	Pale Yellowish Brown to Dark Grey												
	Bedrock		3	BXL RC	REC 100%								RQD 82%
	Dolostone		4	BXL RC	REC 98%								RQD 83%
90.1													
5.4	End of Borehole												
	* Note: Water level in open borehole at the ground surface immediately prior to coring.												

RECORD OF BOREHOLE No P29

1 OF 1

METRIC 65

W.P. 122-87-00 LOCATION Co-ords. N 5 019 194; E 359 605 ORIGINATED BY FT
DIST 9 HWY 416 BOREHOLE TYPE H.S. Auger, BXL Rock Coring COMPILED BY JB
DATUM Geodetic DATE 91 04 08 CHECKED BY BI

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL				
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			SHEAR STRENGTH kPa							WATER CONTENT (%)			
94.6	Ground Surface							20 40 60 80 100										
0.0	Clayey Silt, Some Sand	Topsoil Dark Brown																
94.0	Traces of Organics (Fill)	Brown																
0.6	Heterogeneous Mixture of Clayey Silt, Sand, Tr. of Gravel Stiff to Hard	Brown Brownish Grey	1	SS	38													
	(Glacial Till)		2	SS	10													
			3	SS	8													
91.7		Brownish Grey												3 39 44 14				
2.9	Silty Sand to Sandy Silt	Grey	4	SS	1													
	Loose to Compact		5	SS	0									spoon sunk into the soil under its own weight				
89.7		Grey	6	SS	9 / 20cm													
4.9	Pale Yellowish Brown to Dark Grey		7	BXL RC	REC 91%									RQD 59%				
	Bedrock																	
	Dolostone		8	BXL RC	REC 99%									RQD 93%				
87.3																		
7.3	End of Borehole																	
91 04 12 * GROUND WATER CONDITIONS																		
PIEZO. NO.		GROUND WATER ELEVATION (Metres)																
1		94.3																

1 OF 1

METRIC 66

ORIGINATED BY FT

COMPILED BY JB

CHECKED BY BI

+3, x5: Numbers refer to Sensitivity

RECORD OF BOREHOLE No P31

1 OF 1 METRIC 67

W.P. 122-87-00 LOCATION Co-ords. N 5 018 976; E 359 628 ORIGINATED BY FT

DIST 9 HWY 416 BOREHOLE TYPE H.S. Auger, BXL Rock Coring COMPILED BY JB

DATUM Geodetic DATE 91 04 04/05 CHECKED BY BI

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT W _P NATURAL MOISTURE CONTENT W LIQUID LIMIT W _L WATER CONTENT (%) 10 20 30	UNIT WEIGHT 7 KN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL				
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES										
94.5	Ground Surface														
0.0	Clayey Silt, Some Sand Traces of Organics (Fill)	Topsoil Brown to Dark Brown													
93.9															
0.6	Clayey Silt, Some Sand Very Stiff	Greyish Brown	1	SS	15										
93.3		Greyish Brown													
1.2		Grey													
	Sandy Silt, Trace of Clay and Gravel (Slightly Cohesive)		2	SS	8										
			3	SS	4										
	Loose		4	SS	6										
90.8															
3.7															
	Heterogeneous Mixture of Clayey Silt, Sand, Trace of Gravel Compact to Dense (Glacial Till)		5	SS	10										
			6	SS	40										
88.8		Grey													
5.6		Pale Yellowish Brown to Dark Grey													
	Bedrock		7	BXL RC	REC 92%						14 42 33 11				
	Dolostone		8	BXL RC	REC 60%						RQD 87%				
85.8											RQD 58%				
8.7	End of Borehole														
<p>91 04 12 + GROUND WATER CONDITIONS</p> <table border="1"> <tr> <td>PIEZO. NO.</td> <td>GROUND WATER ELEVATION (Metres)</td> </tr> <tr> <td>1</td> <td>94.3</td> </tr> </table>												PIEZO. NO.	GROUND WATER ELEVATION (Metres)	1	94.3
PIEZO. NO.	GROUND WATER ELEVATION (Metres)														
1	94.3														

RECORD OF BOREHOLE No P32

1 OF 1

METRIC 68

W.P. 122-87-00 LOCATION Co-ords. N 5 018 869; E 359 702 ORIGINATED BY FT
DIST 9 HWY 416 BOREHOLE TYPE H.S. Auger, BXL Rock Coring COMPILED BY JB
DATUM Geodetic DATE 91 04 05 CHECKED BY BI

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					
94.5	Ground Surface																
0.0	250 mm Topsoil																
93.9	Silty Clay, Trace of Sand Tr. of Organics (Fill)																
0.6	Silty Clay, Trace of Sand		1	SS	10												
93.1	Stiff																
1.4	Sandy Silt, Trace of Clay to Silty Sand		2	SS	4												
			3	SS	7												
			4	SS	4												
	Loose		5	SS	18												
90.1	Compact																
4.4	Heterogeneous Mixture of Hard Clayey Silt, Sand, Some Gravel (Glacial Till)		6	SS	25												
89.6	Pale Yellowish Brown to Dark Grey																
4.9	Bedrock		7	BXL RC	REC 100%												12 41 34 13
	Dolostone		8	BXL RC	REC 98%												RQD 73%
86.5																	RQD 90%
8.0	End of Borehole																
	* Note: Water level in open borehole immediately prior to coring.																

RECORD OF BOREHOLE No P33

1 OF 1

METRIC

69

W.P. 122-87-00 LOCATION Co-ords. N 5 018 675; E 359 816 ORIGINATED BY FT
DIST 9 HWY 416 BOREHOLE TYPE H.S. Auger, BXL Rock Coring COMPILED BY JB
DATUM Geodetic DATE 91 04 04 CHECKED BY BI

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
94.5	Ground Surface																	
0.0	230 mm Topsoil																	
93.9	Clayey Silt, Some Sand, Trace of Organics (Fill)																	
0.6	Greyish Brown																	
93.1	Silty Clay, Some Sand Stiff		1	SS	11													
1.4	Greyish Brown																	
	Brownish Grey		2	SS	24													
	Brownish Grey																	
	Grey		3	SS	17													
	Sandy Silt to Silty Sand																	
	Slightly Cohesive		4	SS	13													
			5	SS	42													
	Compact to Dense		6	SS	39													
88.9	Grey																	
5.6	Brownish Grey																	
	Dolostone		7	BXL RC	REC 95%													
	Brownish Grey																	
	Light to Medium Grey																	
	Dolomitic Sandstone		8	BXL RC	REC 93%													
	Dolostone																	
85.9																		
8.6	End of Borehole																	
<p>91 04 12 * GROUND WATER CONDITIONS</p> <table border="1"> <tr> <td>PIEZO. NO.</td> <td>GROUND WATER ELEVATION (Metres)</td> </tr> <tr> <td>1</td> <td>93.6</td> </tr> </table>															PIEZO. NO.	GROUND WATER ELEVATION (Metres)	1	93.6
PIEZO. NO.	GROUND WATER ELEVATION (Metres)																	
1	93.6																	

APPENDIX "A"**ROCK CORE DESCRIPTION**

ROCK CORE DESCRIPTION

WP 122-87-00

Page 1 of 7

CORE RECOVERY					CORE DESCRIPTION	
BH#	RC#	DEPTH (m)	% CR*	% RQD*	DEPTH (m)	DESCRIPTION
P1	6	3.57-3.94	83	28	3.57-10.52	OVERBURDEN (boulder till).
	7	3.94-4.86	94	51	10.52-10.72	SHALE (non-calcareous, ostracod-bearing), greyish black; very fine grained; very weak; unweathered to slightly weathered; fractures close to very close spaced, flat, undulating, smooth.
	8	4.89-5.31	67	0	10.72-11.16	SILTY DOLOSTONE (calcitic), dark greenish grey; very fine grained; weak; unweathered to slightly weathered; fractures close spaced, flat to near vertical, undulating to planar, smooth to rough.
	9	5.31-5.64	89	0		
	10	5.64-5.94	58	0		
	11	5.94-6.43	99	21		
	12	6.43-6.83	83	0		
	13	6.83-7.17	52	0		
	14	7.19-7.85	69	0		
	15	7.85-8.46	54	0		
	16	8.46-8.79	42	0		
	17	8.79-10.29	80	64		
	18	10.29-11.16	92	68		
P2	8	5.92-7.55	100	75	5.92-6.22	SHALE (non-calcareous), greyish black; very fine grained; very weak; unweathered to slightly weathered; fractures close to very close spaced, flat, undulating, smooth.
	9	7.55-8.79	100	87	6.22-8.79	LIMESTONE (undulating shaly partings; nodular, algal laminated, stromatolitic, and burrowed in places), medium dark grey to light grey; very fine grained; medium strong; unweathered to slightly weathered; fractures wide to extremely close spaced, flat, undulating, smooth to rough.

*CR = CORE RECOVERY

*RQD = ROCK QUALITY DESIGNATION

(NOTE: Depths are approximated where core recovery is less than 100%)

ROCK CORE DESCRIPTION WP 122-87-00

Page 2 of 7

CORE RECOVERY					CORE DESCRIPTION	
BH#	RC#	DEPTH (m)	% CR*	% RQD*	DEPTH (m)	DESCRIPTION
P3	5	2.77-4.14	100	51	2.77-5.71	LIMESTONE (undulating shaly partings), medium dark grey to light grey; very fine grained; medium strong; unweathered to slightly weathered; fractures moderately close to extremely close spaced, flat to near vertical, undulating, smooth to rough.
	6	4.14-5.71	100	100		
P4	4	1.58-2.73	88	46	1.58-3.69	OVERBURDEN (boulder till).
	5	2.73-3.69	92	25	3.69-4.95	SILTY DOLOSTONE , dark greenish grey; very fine grained; weak; unweathered to slightly weathered; fractures moderately close to close spaced, flat to near vertical, undulating, smooth to rough.
	6	3.69-4.95	96	96		
P5	9	6.47-7.67	67	22	6.47-7.67	OVERBURDEN (boulder till).
P6	8	5.87-6.22	69	0	5.87-6.22	OVERBURDEN (boulder till).
	9	6.22-7.75	100	100	6.22-8.43	LIMESTONE (undulating shaly partings; nodular in places), medium dark grey to light grey; very fine grained; medium strong; unweathered to slightly weathered; fractures moderately close to very close spaced, flat to dipping, undulating, smooth to rough.
	10	7.75-9.30	100	95		
					8.43-9.30	SILTY DOLOSTONE , dark greenish grey to dark grey, with interbed 28 cm thick of greyish black SHALE ; very fine grained; weak to very weak; unweathered to slightly weathered; fractures moderately close to very close spaced, flat to near vertical, undulating, smooth to rough

*CR = CORE RECOVERY

*RQD = ROCK QUALITY DESIGNATION

(NOTE: Depths are approximated where core recovery is less than 100%)

Logged by: DAW, Soils and Aggregates Section

ROCK CORE DESCRIPTION **WP 122-87-00**

Page 3 of 7

CORE RECOVERY					CORE DESCRIPTION	
BH#	RC#	DEPTH (m)	% CR*	% RQD*	DEPTH (m)	DESCRIPTION
P12	5	2.90-3.61	41	27	2.90-3.63	OVERBURDEN (boulder till).
	6	3.61-5.00	100	55	3.63-5.00	LIMESTONE (shaly partings), medium dark grey to light grey; very fine grained; medium strong; unweathered to slightly weathered; fractures moderately close to extremely close spaced, flat to near vertical, undulating to planar, smooth to rough.
P13	2	0.40-1.91	87	67	0.40-2.87	LIMESTONE (undulating shaly partings), medium dark grey to light grey; very fine grained; medium strong; unweathered to slightly weathered; fractures moderately close to very close spaced, flat to dipping, undulating to planar, smooth to rough.
	3	1.91-2.87	100	83		

*CR = CORE RECOVERY

*RQD = ROCK QUALITY DESIGNATION

(NOTE: Depths are approximated where core recovery is less than 100%)

Logged by: DAW, Soils and Aggregates Section

ROCK CORE DESCRIPTION WP 122-87-00

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CORE RECOVERY					CORE DESCRIPTION	
BH#	RC#	DEPTH (m)	% CR*	% RQD*	DEPTH (m)	DESCRIPTION
P14	2	0.30-1.83	72	12	0.30-2.00	LIMESTONE (undulating shaly partings; oolitic in part), medium dark grey to light grey; very fine to medium grained; medium strong; unweathered to slightly weathered (moderately weathered, 1.30-2.00 m); fractures close to extremely close spaced, flat to near vertical, undulating to planar, smooth to rough.
	3	1.83-3.35	20	0		
	4	3.35-4.88	90	50		
					2.00-2.60	SILTY DOLOSTONE (sandy in part; calcitic), light greenish grey to dark greenish grey; fine to medium grained; weak; moderately weathered; fractures close to very close spaced, flat to near vertical, undulating to planar, smooth to rough.
					2.60-4.88	LIMESTONE (undulating shaly partings), medium dark grey to light grey; very fine grained; medium strong; unweathered to slightly weathered (moderately weathered, 2.60-3.61 m); fractures moderately close to very close spaced, flat to near vertical, undulating to planar, smooth to rough.
P16	4	1.69-1.93	74	0	1.69-4.06	OVERBURDEN (boulder till).
	5	1.93-2.16	44	0	4.06-4.79	LIMESTONE (undulating shaly partings), medium dark grey to light grey; very fine grained; medium strong; unweathered to slightly weathered; fractures moderately close to very close spaced, flat, undulating to planar, smooth to rough.
	6	2.16-2.59	94	0		
	7	2.59-3.20	92	69		
	8	3.20-4.79	84	41		

*CR = CORE RECOVERY

*RQD = ROCK QUALITY DESIGNATION

(NOTE: Depths are approximated where core recovery is less than 100%)

Logged by: DAW, Soils and Aggregates Section

ROCK CORE DESCRIPTION

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CORE RECOVERY					CORE DESCRIPTION	
BH#	RC#	DEPTH (m)	% CR*	% RQD*	DEPTH (m)	DESCRIPTION
P18	6	4.50-6.10	99	89	4.50-6.10	DOLOSTONE (vuggy in part), pale yellowish brown to light grey to medium dark grey; fine to medium grained; medium strong; unweathered to slightly weathered; fractures wide to very close spaced, flat, planar, smooth.
P19	6	4.12-5.69	98	92	4.12-7.24	DOLOSTONE (cherty in places), light grey to medium dark grey to brownish grey; fine to medium grained; medium strong; unweathered to slightly weathered; fractures wide to close spaced, flat, planar to undulating, smooth to rough.
	7	5.69-7.24	100	93		
P20	5	3.51-5.06	96	79	3.51-6.60	DOLOSTONE (cherty in places), light grey to medium dark grey to brownish grey; fine to medium grained; medium strong; unweathered to slightly weathered; fractures moderately close to very close spaced, flat, planar to undulating, smooth to rough.
	6	5.06-6.60	90	87		
P21	2	1.37-2.95	98	58	1.37-2.95	DOLOSTONE , light grey to medium dark grey to brownish grey; fine to medium grained; medium strong; unweathered to slightly weathered; fractures moderately close to very close spaced, flat to near vertical, planar to undulating, smooth to rough.
P22	3	1.93-2.36	88	59	1.93-4.73	DOLOSTONE (vuggy in part and cherty in places), pale yellowish brown to light grey to medium dark grey; fine to medium grained; medium strong; unweathered to slightly weathered; fractures wide to close spaced, flat to near vertical, planar to undulating, smooth to rough.
	4	2.36-3.89	95	87		
	5	3.89-4.73	91	86		

*CR = CORE RECOVERY

*RQD = ROCK QUALITY DESIGNATION

(NOTE: Depths are approximated where core recovery is less than 100%)

Logged by: DAW, Soils and Aggregates Section

ROCK CORE DESCRIPTION

WP 122-87-00

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CORE RECOVERY					CORE DESCRIPTION	
BH#	RC#	DEPTH (m)	% CR*	% RQD*	DEPTH (m)	DESCRIPTION
P23	2	0.61-1.83	94	57	0.61-3.35	DOLOSTONE (cherty in places), light grey to medium dark grey to brownish grey; fine to medium grained; medium strong; unweathered to slightly weathered; fractures moderately close to very close spaced, flat to near vertical, planar to undulating, smooth to rough.
	3	1.83-3.35	98	88		
P24	2	0.76-2.31	100	57	0.76-3.89	DOLOSTONE (cherty in places), light grey to medium dark grey to brownish grey; fine to medium grained; medium strong; unweathered to slightly weathered; fractures wide to close spaced, flat to near vertical, planar to undulating, smooth to rough.
	3	2.31-3.89	90	85		
P25	2	1.60-3.13	100	79	1.60-3.13	DOLOSTONE , medium grey to medium dark grey to brownish grey; fine to medium grained; medium strong; unweathered to slightly weathered; fractures wide to very close spaced, flat, planar to undulating, smooth to rough.
P27	3	2.29-3.86	100	82	2.29-5.39	DOLOSTONE (vuggy in part and cherty in places), pale yellowish brown to light grey to medium dark grey; fine to medium grained; medium strong; unweathered to slightly weathered; fractures moderately close to very close spaced, flat, planar to undulating, smooth to rough.
	4	3.86-5.39	98	83		
P29	7	4.92-5.82	91	59	4.92-7.34	DOLOSTONE (vuggy in part and cherty in places), pale yellowish brown to light grey to medium dark grey; fine to medium grained; medium strong; unweathered to slightly weathered; fractures moderately close to very close spaced, flat to near vertical, undulating to planar, smooth to rough.
	8	5.82-7.34	99	93		

*CR = CORE RECOVERY

*RQD = ROCK QUALITY DESIGNATION

(NOTE: Depths are approximated where core recovery is less than 100%)

Logged by: DAW, Soils and Aggregates Section

ROCK CORE DESCRIPTION **WP 122-87-00**

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CORE RECOVERY					CORE DESCRIPTION	
BH#	RC#	DEPTH (m)	% CR*	% RQD*	DEPTH (m)	DESCRIPTION
P31	7	5.64-7.16	92	87	5.64-8.69	DOLOSTONE (vuggy in part and cherty in places), pale yellowish brown to light grey to medium dark grey; fine to medium grained; medium strong; unweathered to slightly weathered; fractures wide to close spaced, flat, undulating to planar, smooth to rough.
	8	7.16-8.69	60	58		
P32	7	4.93-6.50	100	73	4.93-8.03	DOLOSTONE (vuggy in part and cherty in places), pale yellowish brown to light grey to medium dark grey; fine to medium grained; medium strong; unweathered to slightly weathered; fractures wide to very close spaced, flat to near vertical, undulating to planar, smooth to rough.
	8	6.50-8.03	98	90		
P33	7	5.56-7.09	95	95	5.56-6.55	DOLOSTONE , brownish grey; medium grained; medium strong; unweathered to slightly weathered; fractures wide spaced, flat, undulating, smooth.
	8	7.09-8.61	93	93	6.55-7.90	DOLOMITIC SANDSTONE , very light grey to medium dark grey; fine to medium grained; medium strong; unweathered to slightly weathered; fractures wide spaced, flat, undulating, smooth to rough.
					7.90-8.61	DOLOSTONE , medium grey; fine grained; medium strong; unweathered to slightly weathered; fractures moderately close spaced, flat, planar, smooth.

*CR = CORE RECOVERY

*RQD = ROCK QUALITY DESIGNATION

(NOTE: Depths are approximated where core recovery is less than 100%)

Logged by: DAW, Soils and Aggregates Section

APPENDIX "B"

SELECTED BOREHOLES FROM
PREVIOUS INVESTIGATIONS



RECORD OF BOREHOLE No 20-1

METRIC

W P 128-87-04 LOCATION Co-ords: N 5 014 644.0; E 359 931.4 ORIGINATED BY TK
DIST 9 HWY 416 BOREHOLE TYPE H.S. Auger, BXL Rock Coring & Cone Test COMPILED BY BWS
DATUM Geodetic DATE 89 05 15 CHECKED BY TK

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					
112.8	Ground Surface																
0.0	Sand & Gravel Brown		1	SS	10 /	8 cm	112										
111.6	(Fill)																
1.2	Organic Silty Clay (Topsoil)		2	SS	8		111										
110.8																	
2.0	Het. Mixture of Silt, Sand and Gravel Brown Compact to Very Dense		3	SS	20		110										
			4	SS	17												
108.8	(Glacial Till)		5	SS	55		109										48 26 20 6
4.0	Boulders with Sand And Gravel		6	SS	78		108										34 34 26 6
107.6	(Glacial Till)		7	RC	83% Rec												RQD = 0%
5.2																	
	Limestone Bedrock with Interbedded Shale Layers Sound		8	BXL RC	95% Rec		107										RQD = 88%
105.7							106										
7.1	End of Borehole																
	*Note: Water Must Have Been Trapped in Silty Clay Layer Resulting in a High Water Level																

OFFICE REPORT ON SOIL EXPLORATION

RECORD OF BOREHOLE No 20-2

METRIC

W.P. 128-87-04 LOCATION Co-ords: N 5 014 631.2; E 359 939.1
 DIST 9 HWY 416 BOREHOLE TYPE H.S. Auger & Cone Test
 DATUM Geodetic DATE 89 05 16
 ORIGINATED BY TK
 COMPILED BY SWS
 CHECKED BY TK

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE	PLASTIC LIMIT W _p NATURAL MOISTURE CONTENT W LIQUID LIMIT W _L WATER CONTENT (%) 10 20 30	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	'N' VALUES						
112.6	Ground Surface										
0.0	Sand & Gravel Brown					*	112				
	(Fill)		1	SS	40						
111.2											
1.4	Silty Sand (Topsoil)		2	SS	10		111				
110.5											
2.1	Het. Mixture of Silt, Sand & Gravel Brown, Very Dense		3	SS	60	15 cm	110	82 / 13 cm			14 54 26 6
109.4	(Glacial Till)		4	SS	50	15 cm					
3.2	End of Borehole										25 39 30 6
	Refusal (Probable Boulders)										
	*Borehole Dry										

OFFICE REPORT ON SOIL EXPLORATION

RECORD OF BOREHOLE No 20-4

METRIC

W P 128-87-04 LOCATION Co-ords: N 5 014 651.8; E 359 973.4 ORIGINATED BY TK
 DIST 9 HWY 416 BOREHOLE TYPE H.S. Auger, BXL Rock Coring & Cone Test COMPILED BY BWS
 DATUM Geodetic DATE 89 05 11-12 CHECKED BY TK

OFFICE REPORT ON SOIL EXPLORATION

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 SHEAR STRENGTH σ_p ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE	PLASTIC LIMIT W _p NATURAL MOISTURE CONTENT W LIQUID LIMIT W _L	WATER CONTENT (%) 10 20 30	UNIT WEIGHT Y	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES							
111.0	Ground Surface											
0.0	Sand & Gravel Brown (Fill)		1	SS	19	10 cm						33 46 16 5
109.9	Silty Sand (Topsoil)		2	SS	16							
109.5	Het. Mixture of Silt, Sand & Gravel Compact to V. Dense		3	SS	29	10 cm						14 49 33 4
108.4	(Glacial Till)		4	BXL	57%	Bouncing						RQD = 27%
2.6	Boulders with Sand & Gravel (Glacial Till)		5	BXL	37%							RQD = 0%
			6	RC	90%	Rec						RQD = 0%
			7	RC	42%	Rec						RQD = 0%
			8	RC	65%	Rec						RQD = 35%
			9	BXL	50%							RQD = 27%
			10	RC	100%	Rec						RQD = 0%
106.0	Limestone Bedrock with Interbedded Shale Layers		11	BXL	75%							RQD = 34%
5.0			12	RC	100%	Rec						RQD = 18%
			13	BXL	100%							RQD = 0%
			14	RC	80%	Rec						RQD = 0%
			15	BXL	98%	Rec						RQD = 56%
			16	RC								
			17	BXL								
103.0	End of Borehole											
8.0	Notes: 1. Borehole Dry at 2.6 m below Ground Surface 2. Drilling Water Lost at 6.2 m below Ground Surface (Probable Frac- ture Zone in Bedrock)											

RECORD OF BOREHOLE No 20-5

METRIC

W P 128-87-04 LOCATION Co-ords: N 5 014 682.8; E 359 997.7 ORIGINATED BY TK
DIST 9 HWY 416 BOREHOLE TYPE H.S. Auger & Cone Test COMPILED BY BWS
DATUM Geodetic DATE 89 05 15 CHECKED BY TK

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				
109.7	Ground Surface															
0.0	Sand & Gravel Brown															
	(Fill)		1	SS	39											
108.2	Silty Sand (Topsoil)		2	SS	20 /	8 cm										
1.5	Silty Sand Loose		3	SS	5											
107.7																
2.0																
106.8	Het. Mixture of Silt, Sand and Gravel Dense to Very Dense		4	SS	48											1 46 45 8
2.9	(Glacial Till)		5	SS	50	9 cm										14 52 29 5
106																
105																
104.5			6	SS	55											47 34 14 5
5.2	End of Borehole															

OFFICE REPORT ON SOIL EXPLORATION

RECORD OF BOREHOLE No 20-6

METRIC

W.P. 128-87-04 LOCATION Co-ords: N 5 014 671.4; E 360 004.6 ORIGINATED BY TK
DIST 9 HWY 416 BOREHOLE TYPE H.S. Auger, BXL Rock Coring & Cone Test COMPILED BY BWS
DATUM Geodetic DATE 89 05 12 CHECKED BY TK

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 SHEAR STRENGTH $\times P_0$ ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE	PLASTIC LIMIT W _p NATURAL MOISTURE CONTENT W LIQUID LIMIT W _L WATER CONTENT (%) 10 20 30	UNIT WEIGHT Y	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	'N' VALUES						
109.8	Ground Surface										
0.0	Sand & Gravel Brown (Fill)		1	SS	46		109				
108.4											
1.4	Silty Sand with Gravel, Trace Organics (Topsoil)		2	SS	15		108				27 44 24 5
107.7											
2.1	Het. Mixture of Silt, Sand and Gravel Compact to Very Dense (Glacial Till)		3	SS	10		107				
			4	SS	52						
			5	SS	50		106	72 / 20 cm			21 45 30 4
105.4											
4.4	Boulders with Sand & Gravel (Glacial Till) Sand Seam		6 & 7	BXL RC	63% Rec		105				RQD = 25%
			8	RC	100% Rec						RQD = 56%
			9	BXL RC	78% Rec		104				RQD = 78%
103.3			10	RC	100% Rec						RQD = 0%
6.5	Limestone Bedrock with Interbedded Shale Layers Sound		11	BXL RC	100% Rec		103				RQD = 89%
101.8											
8.0	End of Borehole						102				

RECORD OF BOREHOLE No 20-7

METRIC

W P 128-87-04 LOCATION Co-ords: N 5 014 632.4; E 359 915.0
 DIST 9 HWY 416 BOREHOLE TYPE H.S. Auger & Cone Test
 DATUM Geodetic DATE 89 05 16
 ORIGINATED BY TK
 COMPILED BY BWS
 CHECKED BY TK

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					
113.6	Ground Surface																
0.0	Sand & Gravel Brown																
	(Fill)		1	SS	20												
112.2	Silty Sand (Topsoil)																
1.4																	
111.9			2	SS	51												
1.7	Het. Mixture of Silt, Sand and Gravel Very Dense																
	(Glacial Till)		3	SS	86												
			4	SS	105												
109.5	Sandy Silt		5	SS	12	10 cm											
4.1	End of Borehole																
	Refusal (Probable Boulders)																
	*Borehole Dry																

OFFICE REPORT ON SOIL EXPLORATION

RECORD OF BOREHOLE No 20-8

METRIC

W P 128-87-04

LOCATION Co-ords: N 5 014 697.2; E 360 047.5

ORIGINATED BY TK

DIST 9 HWY 416

BOREHOLE TYPE H.S. Auger & Cone Test

COMPILED BY BWS

DATUM Geodetic

DATE 89 05 12

CHECKED BY TK

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	W _p W W _L					
107.9 0.0	Ground Surface													
	Sand & Gravel Brown													
	(Fill)		1	SS	27		107							
106.3 1.6	Silty Sand (Topsoil)		2	SS	10		106							
105.8 2.1	Clayey Silt with Sand		3	SS	6		105							
105.0 2.9	Het. Mixture of Silt, Sand and Gravel Very Dense		4	SS	Refusal		104							2 33 47 18
	Silty Sand		5	SS	69									18 46 26 10
103.3 4.6	(Glacial Till)		6	SS	15 / 5 cm									0 74 24 2
	End of Borehole													
	Refusal (Probable Boulders)													

OFFICE REPORT ON SOIL EXPLORATION

*3, x⁵: Numbers refer to
Sensitivity

20
15
10
5 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 1

1 OF 1 METRIC 87

W.P. 128-87-04 LOCATION Co-ords: N 5 014 567.4, E 359 984.0 ORIGINATED BY M.M.
 DIST 9 HWY 416 BOREHOLE TYPE Hollow Stem Auger COMPILED BY M.M.
 DATUM Geodetic DATE 90/08/30 CHECKED BY B.L.

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES		20	40	60	80	100	W _p	W	W _L		
110.8	Ground Surface															
0.0	Heterogeneous mixture of Silt, Sand and Gravel trace Clay (Glacial Till) Very Dense		1	SS	*	DRY						0H				17 48 27 8
			2	SS	*											
			3	SS	88							0H				35 34 23 8
			4	SS	114											34 32 24 10
			5	SS	99											
	Gravel		6	SS	79											63 23 9 5
	Boulders		7	RC	REC 32%											RQD 32%
104.8																
6.0	Dolostone Bedrock Unweathered to Slightly Unweathered		8	RC	REC 100%											RQD 80.3%
103.2																
7.6	End of Borehole * Sampler bouncing, probable boulders															

RECORD OF BOREHOLE No 4

1 OF 1

METRIC 88

W.P. 128-87-04 LOCATION Coords: N 5 014 556.4, E 360 031.7 ORIGINATED BY M.M.
DIST 9 HWY 416 BOREHOLE TYPE Hollow Stem Auger COMPILED BY M.M.
DATUM Geodetic DATE 90/08/30 CHECKED BY B.J.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			SHEAR STRENGTH kPa										WATER CONTENT (%)		
								20 40 60 80 100										25 50 75		
109.5	Ground Surface																			
0.0	Heterogeneous mixture of Silt, Sand and Gravel trace Clay (Glacial Till) Very Dense		1	SS	78	/28cm	108													
			2	SS	*		108									49 37 7 7				
			3	SS	*		107													
	No Sample Retrieved		4	SS	*		106													
	Brown		5	SS	*		105													
	Gray/Brown		6	SS	80	/5cm	105									61 33 3 3				
	Gravel		7	RC	REC	96%	104									RQD 48%				
	Boulders		8	RC	REC 100%		103									RQD 52%				
			9	RC	REC 100%		102									RQD 67%				
102.0																				
7.6	End of Borehole • Sampler bouncing, probable boulders																			

RECORD OF BOREHOLE No 6

1 OF 1

METRIC 89

W.P. 128-87-04 LOCATION Coords: N 5 014 563.6, E 360 086.6 ORIGINATED BY M.M.
DIST 9 HWY 416 BOREHOLE TYPE Hollow Stem Auger COMPILED BY M.M.
DATUM Geodetic DATE 90/08/30 CHECKED BY B.I.

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			SHEAR STRENGTH kPa								WATER CONTENT (%)		
								20 40 60 80 100										
108.5	Ground Surface																	
0.0	Heterogeneous mixture of Silt, Sand and Gravel trace Clay Brown Brown/Gray (Glacial Till) Very Dense		1	SS	75													
			2	SS	37													
			3	SS	*										9 54 30 7			
			4	SS	*													
			5	SS	*													
			6	SS	*													
			7	RC	REC 100%										RQD 53%			
			8	RC	REC 53%										RQD 0%			
			9	RC	REC 31%										RQD 0%			
101.7																		
6.8	End of Borehole * Sampler bouncing, probable boulders																	

RECORD OF BOREHOLE No 8

1 OF 1 METRIC 91

W.P. 128-87-04 LOCATION Co-ords: N 5 014 549.0, E 359 966.8 ORIGINATED BY M.M.
 DIST 9 HWY 416 BOREHOLE TYPE Hollow Stem Auger COMPILED BY M.M.
 DATUM Geodetic DATE 90/08/30 CHECKED BY D.T.

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC NATURAL LIQUID LIMIT MOISTURE CONTENT LIMIT			UNIT WEIGHT 7 kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			'N' VALUES	20	40	60	80	100	w _p	w			w _L
111.2	Ground Surface																
0.0	Heterogeneous mixture of Silt, Sand and Gravel (Glacial Till) Compact to Very Dense		1	SS	29												
			2	SS	82												
			3	SS	41												
			4	SS	67												
			5	SS	47												
106.2	Boulders																
5.0	End of Borehole																

RECORD OF BOREHOLE No 1

1 OF 1 METRIC 92

W.P. 121-87-07 LOCATION Co-ords: N 5 019 230.7 E 359 493.5 ORIGINATED BY M.M.
 DIST 9 HWY 416 BOREHOLE TYPE Hollow Stem Auger, Cone Penetration Test COMPILED BY M.M.
 DATUM Geodetic DATE 90/08/30 CHECKED BY B.J.

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			SHEAR STRENGTH kPa							WATER CONTENT (%)			
								20 40 60 80 100								25 50 75		
94.3	Ground Surface																	
0.0	Heterogeneous mixture of Silt, Sand, Clay and Gravel (Glacial Till) Stiff to Very Dense		1	SS	18								20.9	11 36 50 3				
			2	SS	28													
			3	SS	65										22.4	9 42 39 10		
91.1																		
3.2	Dolostone Medium Strong Unweathered		4	RC	REC 96%									ROD 96%				
	Quartz Sandstone Medium Strong Unweathered																	
88.5																		
5.8	End of Borehole																	

RECORD OF BOREHOLE No 2

1 OF 1

METRIC 93

W.P. 121-87-07 LOCATION Co-ords: N 5 019 213.4, E 359 593.5 ORIGINATED BY M.M.
DIST 9 HWY 416 BOREHOLE TYPE Hollow Stem Auger COMPILED BY M.M.
DATUM Geodetic DATE 90/08/30 CHECKED BY B.J.


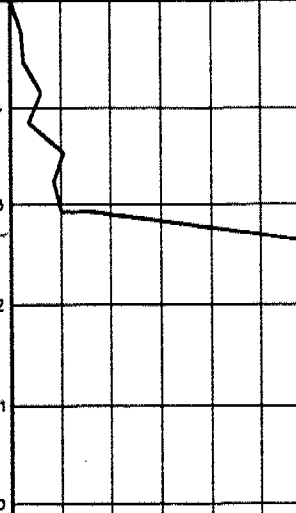

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC NATURAL LIQUID LIMIT MOISTURE CONTENT LIMIT			UNIT WEIGHT 7 kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100	20 40 60 80 100	20 40 60 80 100	20 40 60 80 100	20 40 60 80 100	W _p	W	W _L		
95.0	Ground Surface																
0.0	Heterogeneous mixture of Silt, Sand, Clay and Gravel (Glacial Till) Very Stiff to Hard Brown		1	SS	16		94									24.2	29 20 41 10
			2	SS	12		93										
92.4			3	SS	57	/20cm											
2.6	End of Borehole Auger refusal at probable bedrock																

RECORD OF BOREHOLE No 4

1 OF 1

METRIC 94

W.P. 121-87-07 LOCATION Co-ords: N 5 019 231.8, E 359 535.7 ORIGINATED BY M.M.
 DIST 9 HWY 416 BOREHOLE TYPE Hollow Stem Auger, Cone Penetration Test COMPILED BY M.M.
 DATUM Geodetic DATE 90/08/30 CHECKED BY D.T.



SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT 7 kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100	20 40 60 80 100	W _P W W _L	WATER CONTENT (%) 25 50 75			
95.1	Ground Surface													
0.0	Heterogeneous mixture of Silt, Sand, Clay and Gravel (Glacial Till) Very Loose to Compact		1	SS	5	/15cm							19.3	0 3 88 9
			2	SS	5									
			3	SS	21									
	Brown Grey		4	SS	26									
			5	SS	9									
90.9													23.7	22 33 38 7
4.2	Dolostone Medium Strong Unweathered		6	RC	REC 93%									RQD 77%
89.4														
5.7	End of Borehole													

RECORD OF BOREHOLE No 5

1 OF 1

METRIC 95

W.P. 121-87-07 LOCATION Co-ords: N 5 019 267.525, E 359 525.7 ORIGINATED BY M.M.
 DIST 9 HWY 416 BOREHOLE TYPE Hollow Stem Auger, Cone Penetration Test COMPILED BY M.M.
 DATUM Geodetic DATE 90/08/30 CHECKED BY D.T.

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			SHEAR STRENGTH kPa		WATER CONTENT (%)					
95.2	Ground Surface							20 40 60 80 100	20 40 60 80 100	25 50 75					
0.0	Heterogeneous mixture of Silt, Sand, Clay and Gravel (Glacial Till) Compact to Dense		1	SS	29	/Bcm							21.9	14 22 51 13	
			2	SS	18										
	Cobbles		3	SS	33										
			4	SS	36										
81.8			5	RC	REC	100%								ROD 99%	
3.4	Rock Core Dolomite Medium Strong Unweathered														
90.3															
4.9	End of Borehole														

RECORD OF BOREHOLE No 6

1 OF 1

METRIC 96

W.P. 121-87-07 LOCATION N 5 018 250.2, E 359 567.7 ORIGINATED BY M.M.
DIST 9 HWY 416 BOREHOLE TYPE Hollow Stem Auger, Cone Penetration Test COMPILED BY M.M.
DATUM Geodetic DATE 90/08/30 CHECKED BY D.T.

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			SHEAR STRENGTH kPa	WATER CONTENT (%)					
95.1	Ground Surface													
0.0	Heterogeneous mixture of Silt, Sand, Clay and Gravel (Glacial Till) Dense to Very Dense Brown Gray Cobbles		1	SS	32									
			2	SS	47									
			3	SS	33									
			4	SS	71									
			5	SS	54									
90.5														
4.8	Rock Core Dolostone Medium Strong Unweathered		RC	6	52	/152cm								
89.0														
8.1	End of Borehole													

RECORD OF BOREHOLE No 7

1 OF 1

METRIC 97

W.P. 121-87-07 LOCATION Co-ords: N 5 019 270.4, E 359 584.9 ORIGINATED BY M.M.
 DIST 9 HWY 415 BOREHOLE TYPE Hollow Stem Auger COMPILED BY M.M.
 DATUM Geodetic DATE 90/08/30 CHECKED BY D.T.


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				
94.4	Ground Surface															
0.0	Heterogeneous mixture of Silt, Sand, Clay and Gravel (Glacial Till) Compact to Very Dense		1	SS	15		94								19.5	0 3 87 10
			2	SS	50		93									
			3	SS	47		92									
	Brown		4	SS	45		91									
	Gray															
	Cobbles		5	SS	13		90									
89.4																
5.0	End of Borehole															

RECORD OF BOREHOLE No 8

1 OF 1

METRIC 98

W.P. 121-87-07 LOCATION Co-ords: N 5 019 209.1, E 359 477.8 ORIGINATED BY M.M.
 DIST 9 HWY 416 BOREHOLE TYPE Hollow Stem Auger COMPILED BY M.M.
 DATUM Geodetic DATE 90/08/30 CHECKED BY D.T.

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			SHEAR STRENGTH kPa										WATER CONTENT (%)
								20 40 60 80 100										
95.9	Ground Surface																	
0.0	Heterogeneous mixture of Silt, Sand, Clay and Gravel (Glacial Till) Compact to Dense Brown Grey		1	SS	12												0 3 90 7	
			2	SS	22													
			3	SS	27												24.1	15 40 35 10
92.8			4	SS	12													
3.1	End of Borehole																	

memorandum



To: E.C. Lane
Head, Structural Section
Eastern Region

Date: 1993 01 28


Attn: D. Sproule
Sr. Structural Engineer

From: Foundation Design Section
Room 315, Central Bldg.

Re: W.P. 122-87-00
Highmast Light Pole Foundations
Hwy. 416, Knoxdale Road Interchange
District 9, Ottawa

Due to the relocation of highmast light poles and the addition of pole P19, an additional field investigation was required to obtain the necessary information. Boreholes were advanced for poles P4, P6, P7, P8, P12, P16, P17 and P18 during the recent field investigation since the relocations involved significant offsets.

A plan showing the current pole locations, numbering system and borehole locations are shown on Dwg. No. 1228700-A in the Appendix.


B. Liegler
Engineer in Training

for

B. Iyer, P. Eng.
Sr. Foundation Engineer

BI/BL/jb

APPENDIX

New Pole #	Coordinates		Reference	Ground level
	N	S	Borehole	(m)
P3	5 018 868	359 700	P32*	94.5
P4	5 019 016	359 702	P4-92	94.4
P5	5 019 080	359 584	P30*	94.6
P6	5 019 178	359 525	P6-92	95.0
P7	5 019 146	359 422	P7-92	95.2
P8	5 019 149	359 314	P8-92	95.6
P9	5 019 261	359 474	1,5	95.5
P10	5 019 279	359 360	P25*	95.6
P11	5 019 383	359 360	P24*	95.5
P12	5 019 408	359 470	P12-92/P23*	95.7
P13	5 019 525	359 526	P22*	95.7
P14	5 019 493	359 344	P21*	94.8
P15	5 019 617	359 355	P20*	94.9
P16	5 019 684	359 243	P16-92	95.0
P17	5 019 834	359 268	P17-92	95.0
P18	5 019 952	359 182	P18-92	94.7
P19	5 019 519	359 440	P19-92	95.0

* Previous Borehole

POLE # P3

LOCATION N 5 018 868
E 359 700

ORIGINAL GRADE 94.5 m

FINISHED GRADE 94.5 m

GROUND WATER LEVEL 94.2 m

ELEVATION (m)		DESCRIPTION
92.7	90.5	Non-cohesive sandy silt, trace of clay to silty sand (loose)
90.5	90.1	Non-cohesive sandy silt, trace of clay to silty sand (compact)
90.1	89.6	Cohesive glacial till (very stiff)
89.6	<89.6	Medium strong dolostone bedrock

POLE # P4

LOCATION N 5 019 016
E 359 702

ORIGINAL GRADE 94.4 m

FINISHED GRADE *

GROUND WATER LEVEL 92.4 m

ELEVATION (m)		DESCRIPTION
**92.6	92.3	Silty clay (stiff)
92.3	91.5	Silt (very loose)
91.5	90.4	Cohesive glacial till (firm)
90.4	88.6	Non-cohesive glacial till (very dense)
88.6	88.0	Dolostone bedrock (fractured)
88.0	<88.0	Medium strong dolostone bedrock

NOTE: * Assume Finished Grade = Original Grade
** Elevation = Finished Grade - 1.8 m

POLE # P5

LOCATION N 5 019 080
E 359 584

ORIGINAL GRADE 94.6 m

FINISHED GRADE 93.9 m

GROUND WATER LEVEL 93.0 m

ELEVATION (m)		DESCRIPTION
92.1	90.8	Non-cohesive sandy silt, trace of clay (loose)
90.8	90.5	Cohesive clayey silt, some sand (very stiff)
90.5***	<90.5***	Medium strong dolostone bedrock

NOTE: *** Elevations are only approximate since they were based on projections of stratigraphy

POLE # P6

LOCATION N 5 019 178
E 359 525

ORIGINAL GRADE 95.0 m

FINISHED GRADE *

GROUND WATER LEVEL Not Detected

ELEVATION (m)		DESCRIPTION
**93.2	92.2	Clayey silt (stiff)
92.2	90.4	Cohesive glacial till (very stiff to hard)
90.4	<90.4	Probable dolostone bedrock

POLE # P7

LOCATION N 5 019 146
E 359 422

ORIGINAL GRADE 95.2 m

FINISHED GRADE *

GROUND WATER LEVEL 94.2 m

ELEVATION (m)		DESCRIPTION
**93.4	91.4	Cohesive glacial till (stiff to very stiff)
91.4	<91.4	Medium strong dolostone bedrock

POLE # P8

LOCATION N 5 019 149
E 359 314

ORIGINAL GRADE 95.6 m

FINISHED GRADE *

GROUND WATER LEVEL Not detected

ELEVATION (m)		DESCRIPTION
**93.8	93.2	Non-cohesive glacial till (very dense) with numerous boulders
93.2	<93.2	Medium strong dolostone bedrock

POLE # P9

LOCATION N 5 019 261
E 359 474

ORIGINAL GRADE 95.5 m

FINISHED GRADE 95.4 m

GROUND WATER LEVEL 95.5 m

ELEVATION (m)	DESCRIPTION
93.6*** 92.8***	Cohesive glacial till (very soft)
92.8***	Medium strong dolostone bedrock

POLE # P10

LOCATION N 5 019 279
E 359 360

ORIGINAL GRADE 95.6 m

FINISHED GRADE 95.5 m

GROUND WATER LEVEL 95.6 m

ELEVATION (m)	DESCRIPTION
94.0 <94.0	Medium strong dolostone bedrock

POLE # P11

LOCATION N 5 019 383
E 359 360

ORIGINAL GRADE 95.5 m

FINISHED GRADE 95.5 m

GROUND WATER LEVEL 95.5 m

ELEVATION (m)	DESCRIPTION
94.8 <94.8	Medium strong dolostone bedrock

POLE # P12

LOCATION N 5 019 408
E 359 470

ORIGINAL GRADE 95.7 m

FINISHED GRADE *

GROUND WATER LEVEL 95.5 m

ELEVATION (m)	DESCRIPTION
**94.5 <94.5	Probable medium strong dolostone bedrock

POLE # P13

LOCATION N 5 019 525
E 359 526

ORIGINAL GRADE 95.7 m

FINISHED GRADE 94.3 m

GROUND WATER LEVEL 94.9 m

ELEVATION (m)	DESCRIPTION
---------------	-------------

92.8 <92.8	Medium strong dolostone bedrock
------------	------------------------------------

POLE # P14

LOCATION N 5 019 493
E 359 344

ORIGINAL GRADE 94.8 m

FINISHED GRADE 93.8 m

GROUND WATER LEVEL 94.8 m

ELEVATION (m)	DESCRIPTION
---------------	-------------

93.5 <93.5	Medium strong dolostone bedrock
------------	------------------------------------

POLE # P15

LOCATION N 5 019 617
E 359 355

ORIGINAL GRADE 94.9 m

FINISHED GRADE 95.0 m

GROUND WATER LEVEL 94.5 m

ELEVATION (m)		DESCRIPTION
93.2	92.2	Non-cohesive sandy silt (loose)
92.2	91.6	Cohesive glacial till (stiff)
91.6	<91.6	Medium strong dolostone bedrock

POLE # P16

LOCATION N 5 019 684
E 359 243

ORIGINAL GRADE 95.0 m

FINISHED GRADE *

GROUND WATER LEVEL 94.2 m

ELEVATION (m)		DESCRIPTION
**93.2	92.2	Sandy silt (dense)
92.2	91.1	Cohesive glacial till (very stiff)
91.1	<91.1	Probable dolostone bedrock

POLE # P17

LOCATION N 5 019 834
E 359 268

ORIGINAL GRADE 95.0 m

FINISHED GRADE *

GROUND WATER LEVEL 94.8 m

ELEVATION (m)		DESCRIPTION
93.2	90.7	Cohesive glacial till (very stiff) with numerous boulders
90.7	<90.7	Probable dolostone bedrock

POLE # P18

LOCATION N 5 019 952
E 359 182

ORIGINAL GRADE 94.7 m

FINISHED GRADE *

GROUND WATER LEVEL 94.5 m

ELEVATION (m)	DESCRIPTION
92.9 90.7	Clayey silt to silty clay (soft to firm)
90.7 89.1	Cohesive glacial till (hard)
89.1 <89.1	Medium strong dolostone bedrock

POLE # P19

LOCATION N 5 019 519
E 359 440

ORIGINAL GRADE 95.0 m

FINISHED GRADE *

GROUND WATER LEVEL Not detected

ELEVATION (m)	DESCRIPTION
93.2 <93.2	Medium strong dolostone bedrock

FOUNDATION INVESTIGATION REPORT
For
Hwy. 416 and Log Farm Access Road Underpass
W.P. 122-87-03
Hwy. 416, District 9, Ottawa, Nepean

INTRODUCTION

This report summarizes the results of a foundation investigation conducted at the aforementioned site. A two span structure has been proposed to carry the Log Farm Access Road over Hwy. 416. The subsurface conditions encountered at the site are included in the scope of this report.

SITE DESCRIPTION

The site is located on the Log Farm Access Road, specifically in the gravel parking lots, which lies off Cedarview Road between Knoxdale Road and Fallowfield Road in the City of Nepean Region Municipality of Ottawa-Carleton.

The topography of the area is thickly forested deciduous and coniferous trees with the immediate vicinity being used for a gravel parking lot for a government owned log farm conservation centre open to the public. A small simulation historic farming community is located north of the parking lot on the log farm, to the south is a small residential community and to the east is farm land owned and operated by Agriculture Canada. The natural ground level slopes downwards from the north (west approach) to the south (east approach) with elevations of 100.11 m to 99.03 m respectively.

Physiographically the site lies in the area known as the Ottawa Valley Clay Plains founded in the lowlands of the St. Lawrence, which are characterized by clay plains interrupted by rides of rock or sand and gravel. The bedrock in the area is of the Gull River Formation of the middle ordovician period. It consists of limestone with interbedded shale layers. The overburden is relatively thin and was deposited during and immediately following the wisconsin glaciation at which time the area was deposited during and immediately following the wisconsin glaciation at which time the area was depressed from the effect of the glaciation. Following the retreat of the glacier, the brackish waters of

the champlain sea flooded the area and then gradually receded as the land rebounded with the deposition of sediments to its present level.

Investigation Procedures

Soil data and inherent properties were obtained by in situ and laboratory testing conducted on select samples. The procedures employed are discussed below.

Field Investigation

The fieldwork for the investigation was carried out between 90 08 09 to 90 08 10 and consisted of a total of five boreholes. Two approach ramp holes, two abutment holes and one centreline pier hole were advanced. The surficial deposit was very shallow thus refusal ranged from 0.15 m to 2 m.

The elevations on the boreholes advanced at the site varied from 91.1 m to 100.2 m. The ground slopes down towards the east.

Disturbed split spoon, test pits and rock core samples were taken. Track Mount CME55 equipment employing solid stem techniques was used to advance only one borehole where overburden was too deep for hand digging. Disturbed subsoil samples were retrieved at 0.75 m intervals and Rock Core sampling was performed for the abutment and pier holes down 3.5 metres into bedrock while the approach ramp holes were terminated upon refusal. All other samples were hand dug. Samples were identified in the field and then returned to the laboratory for applicable testing.

Groundwater levels were monitored throughout the duration of the field investigation. All open boreholes were backfilled at the completion of the fieldwork.

Survey information related to the location and elevation of boreholes was provided by MTO Surveys and Plans, Eastern Region.

Laboratory Analysis

To identify the properties of the soil, the following laboratory testing were performed.

- 1) Atterberg Limit Tests
- 2) Grain Size Analysis
- 3) Natural Moisture Content
- 4) Unit Weights

Laboratory test results are given in the following section of this report and are illustrated on figures and borehole logs included in the Appendix.

SUBSURFACE CONDITIONS

The subsoil stratigraphy at the site consists mainly of a thin topsoil layer of a heterogeneous mixture of sand, silt and gravel, trace of clay from a depth ranging from 0.1 to 0.3 metres at all boreholes throughout the site except at the most easterly borehole (BH 7) where this deposit had a depth of 2 m.

A quartz sandstone bedrock was found which was observed to be outcrop at several locations near the site.

The plan and location of boring and the stratigraphical profile are shown on Drawing No. 1228703-A* in the attached appendix. The observed field and laboratory tests are plotted on the Record of Borehole sheets also in the Appendix of this report. A brief description of the different soil types is given below.

Topsoil Het. Mixture of Sand, Silt, trace of Gravel, trace of Clay

Underlying the site and explored to depth ranging from the original ground surface to depths between 0.1 m and 2 m, is a non-cohesive topsoil which is composed of a heterogeneous mixture of sand, silt, trace of gravel, trace of clay.

* DWG NO 2 OF THE CONTRACT DWG'S

Grain Size Distribution tests were carried out, see Figure 1 in the Appendix, showing the results in an envelop form . From the above figure, it is evident that the layer can be classified as having a large percentage of silt and sand with a trace of clay and gravel. This deposit is comprised of 4-59% gravel, 32-53% sand, 7-37% silt and 2-6% clay.

The result from the Atterberg Limit test performed is summarized below.

	<u>Range</u>	<u>Tests</u>
Natural Moisture Content (w)	5.5-23.8	3
Liquid Limit (w_L)	21.5-41.5	3
Plastic Limit (w_p)	18.5-34	3
Plasticity Index (I_p)	3-7.5	3

From the plasticity chart (Figure 2), the layer can be classified as a non-cohesive mixture of silt, sand, with traces of gravel and clay.

In this stratum the 'N' values ranged from 3-17 blows/0.3 m indicating a very loose to compact relative state of density. These values were obtained from BH 7 since all other boreholes were hand dug.

Bedrock

The surficial deposit is directly underlain by bedrock of the Gull River Formation and was cored at two abutment locations by obtaining up to 1.5 metres of sound rock core samples. The bedrock mainly consists of a quartz sandstone, detailed descriptions of the rock are attached in the Appendix entitled "Rock Core Designation".

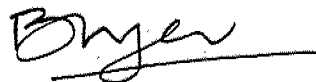
Core Recoveries (CR) and Rock Quality Designation (RQD) were determined in situ and also in the laboratory to evaluate the competence and integrity of the rock. Based on these results, the rock can be classified as medium strong and predominantly unweathered to slightly weathered.

GROUNDWATER CONDITIONS

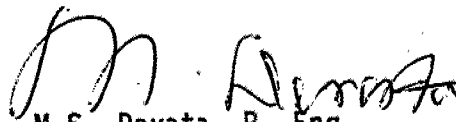
Observation of the groundwater level was carried out by measuring the water level in the open boreholes. Levels obtained at the time of the investigation revealed that the area was completely dry.

The fieldwork for this investigation was carried out under the supervision of Tae C. Kim, Foundation Engineer, Martin Michalek, Foundation Engineer Trainee and John LeMessurier, Mike Lampietro, Student Engineers. The equipment was owned and operated by Marathon Drilling Co. Ltd., and F.E. Johnston Drilling Co. Ltd., Ottawa.

The report was written by M. Michalek, Foundation Engineer Trainee, under the general supervision of Dr. B. Iyer and reviewed by Mr. M. Devata, Chief Foundation Engineer.



B. Iyer, P. Eng.
Senior Foundation Engineer



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

APPENDIX

ROCK CORE DESCRIPTION **WP 122-87-03**

Page 1 of 1

CORE RECOVERY					CORE DESCRIPTION	
BH#	RC#	DEPTH (m)	% CR*	% RQD*	DEPTH (m)	DESCRIPTION
1	2	0.23-1.78	96	51	0.23-3.22	QUARTZ SANDSTONE (calcareous), white to medium light grey to moderate brown; fine grained; medium strong; unweathered to slightly weathered; moderately close to very close spaced fractures (flat, undulating to planar, smooth to rough).
	3	1.78-3.22	100	88		
5	2	0.08-1.52	96	40	0.08-1.52	QUARTZ SANDSTONE (calcareous), very light grey to medium light grey to moderate brown; fine grained; medium strong; unweathered to slightly weathered; moderately close to very close spaced fractures (flat, undulating to planar, smooth to rough).

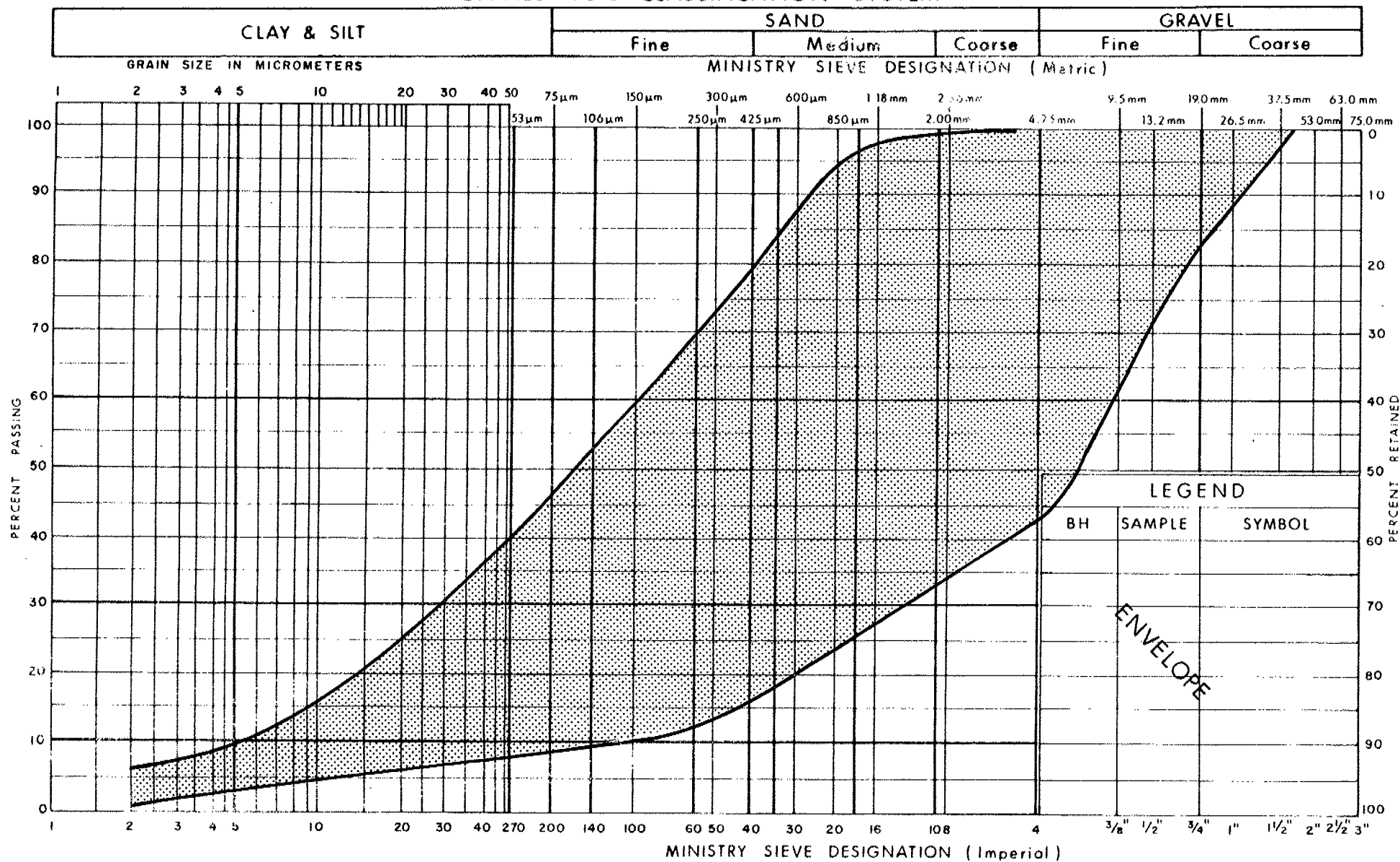
*CR = CORE RECOVERY

*RQD = ROCK QUALITY DESIGNATION

(NOTE: Depths are approximated where core recovery is less than 100%)

Logged by: DAW, Soils and Aggregates Section

UNIFIED SOIL CLASSIFICATION SYSTEM

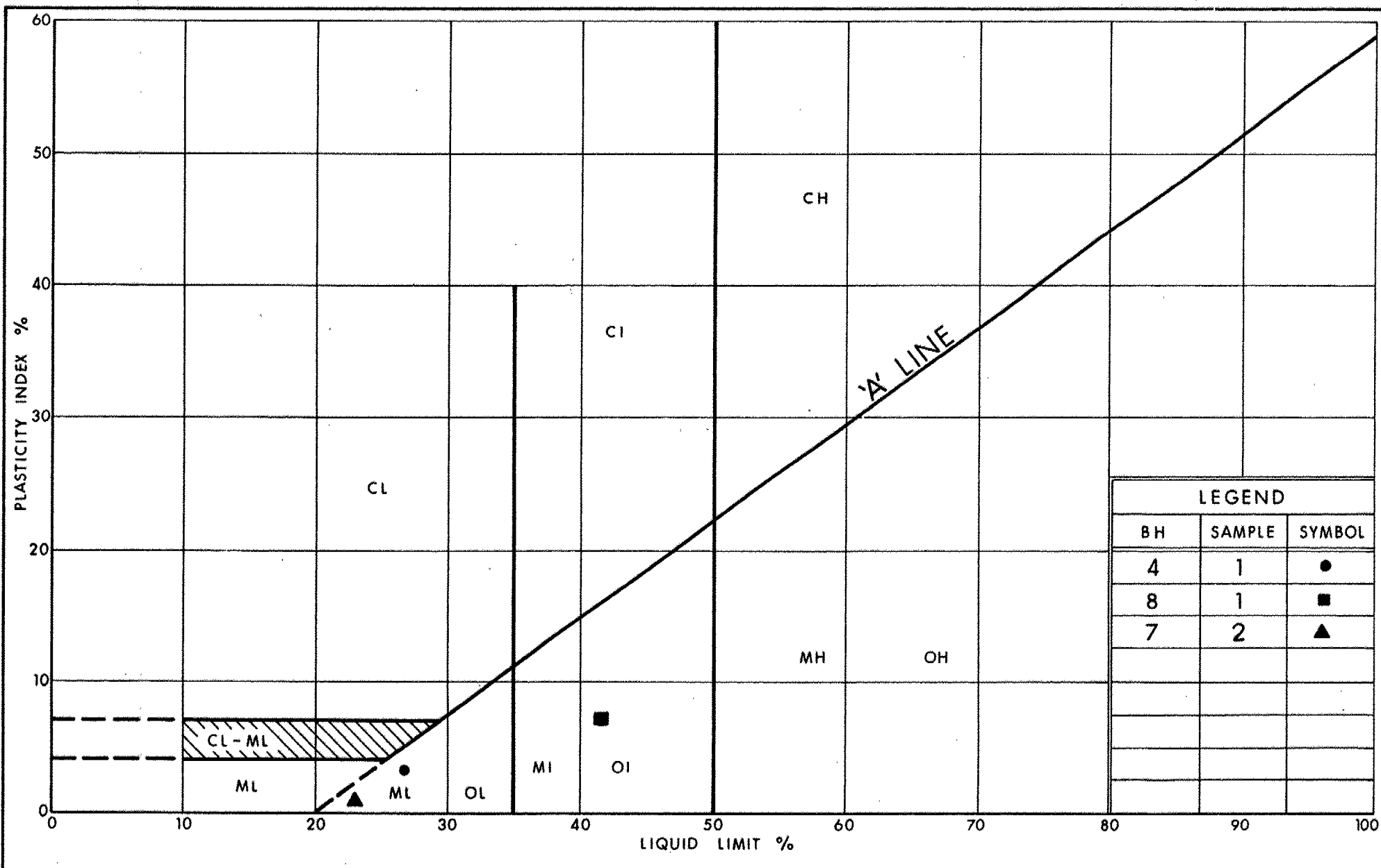


Ministry of
Transportation

GRAIN SIZE DISTRIBUTION
HETEROGENEOUS MIXTURE OF SILTY SAND
 TRACE GRAVEL, TRACE CLAY

FIG No 1

W P 122-87-03



Ministry of
Transportation

PLASTICITY CHART
HETEROGENEOUS MIXTURE OF SILTY SAND,
TRACE GRAVEL, TRACE CLAY

FIG No 2

W P 122-87-03

RECORD OF BOREHOLE No 1

1 OF 1

METRIC 122

W.P. 122-87-03 LOCATION Co-ords: N 5 017 456.1, E 360 170.2 ORIGINATED BY M.M.
 DIST 9 HWY 416 BOREHOLE TYPE Hand Shovel COMPILED BY M.M.
 DATUM Geodetic DATE 90/08/30 CHECKED BY B.I.

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					
100.2	Ground Surface																
100.0	*		1	LS		DRY	100										
0.2	Quartz Sandstone Bedrock Medium Strong Unweathered to Slightly weathered		2	RC	REC 96%		99										RQD 51%
			3	RC	REC 100%		98										RQD 88%
97.0																	
3.2	End of Borehole * Het. mix. of Silty Sand, trace Gravel, trace Clay																

RECORD OF BOREHOLE No 4

1 OF 1

METRIC 123

W.P. 122-87-03 LOCATION Co-ords: N 5 017 434.4, E 360 193.5 ORIGINATED BY M.M.
 DIST 9 HWY 416 BOREHOLE TYPE Hand Shovel COMPILED BY M.M.
 DATUM Geodetic DATE 90/08/30 CHECKED BY B.I.

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					
99.9	Ground Surface		1	LS		DRY								
0.2	End of Borehole * Heterogeneous mixture of Silty Sand, trace Gravel, trace Clay Auger refusal at probable bedrock													

RECORD OF BOREHOLE No 5

1 OF 1 METRIC 124

W.P. 122-87-03 LOCATION Co-ords: N 5 017 425.8, E 360 224.2 ORIGINATED BY M.M.
 DIST 9 HWY 416 BOREHOLE TYPE Hand Shovel COMPILED BY M.M.
 DATUM Geodetic DATE 90/08/30 CHECKED BY B.L.

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					
99.3 99.2	Ground Surface		1	LS													
0.1	Quartz Sandstone Bedrock Medium Strong Unweathered to Slightly Weathered		2	RC	REC 96%	DRY	98										RQD 40%
57.8																	
1.5	End of Borehole * Heterogeneous mixture of Silty Sand, trace Gravel, trace Clay																

RECORD OF BOREHOLE No 7

1 OF 1

METRIC 125

W.P. 122-87-03 LOCATION Co-ords: N 5 017 412.1 E 360 245.7 ORIGINATED BY M.M.
DIST 18 HWY 416 BOREHOLE TYPE Hollow Stem Auger COMPILED BY M.M.
DATUM Geodetic DATE 90/08/30 CHECKED BY D.T.

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 (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
99.1	Ground Surface		1	SS	3	DRY											
0.5	Heterogeneous mixture of Silty Sand, trace Gravel, trace Clay		2	SS	9												4 53 37 6
			3	SS	17												
97.1	Very Loose to Loose		4	SS	4		98										
2.0	End of Borehole Auger refusal at probable bedrock																

RECORD OF BOREHOLE No 8

1 OF 1

METRIC 126

W.P. 122-87-03 LOCATION Co-ords: N 5 017 465.6, E 360 146.1
 DIST 9 HWY 416 BOREHOLE TYPE Hand Shovel
 DATUM Geodetic DATE 90/08/30
 ORIGINATED BY M.M.
 COMPILED BY M.M.
 CHECKED BY B.I.

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT	NATURAL MOISTURE CONTENT	LIQUID LIMIT	UNIT WEIGHT	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			20	40	60	80	100					
100.1	Ground Surface															
99.8	*		1	LS	DRY											GR SA SI CL
0.3	End of Borehole • Heterogeneous mixture of Silty Sand, trace Gravel, trace Clay Auger refusal at probable bedrock															15 51 29 5

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FOUNDATION DESIGN SECTION

**foundation
investigation and
design report**

ENGINEERING MATERIALS OFFICE
FOUNDATION DESIGN SECTION

WP 121-87-07 DIST 9
HWY 416 STR SITE
Hwy. 416 and Knoxdale Underpass

CONT 93-66

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FOUNDATION INVESTIGATION REPORT

For

Hwy. 416 and Knoxdale Underpass

W.P. 121-87-07

Hwy. 416, District 9, Ottawa, Nepean

INTRODUCTION

This report summarizes the results of a foundation investigation conducted at the aforementioned site. A two span structure has been proposed to carry Knoxdale Road over Hwy. 416. The subsurface conditions encountered at the site and recommendations pertaining to structure foundations and related earthworks are included in the scope of this report.

SITE DESCRIPTION

The site is located at the south-west corner at the intersection of Knoxdale Road and Cedarview Road in the City of Nepean, Region Municipality of Ottawa-Carleton.

The topography of the area is generally flat to gently undulating with ditches on either side of Knoxdale Road. Land throughout this area is being used for agricultural and dairy farming with the north side of Knoxdale Road used as a grazing pasture and the south side a cornfield. A dairy farm is located further west of the site. The natural ground level is generally flat with the highest and lowest elevations being 95.86 m at the east approach and 94.25 m at the west abutment.

Physiographically the site lies in the area known as the Ottawa Valley Clay Plains founded in the lowlands of the St. Lawrence, which are characterized by clay plains interrupted by ridges of rock or sand and gravel. The bedrock in the area is of the Gull River formation of the middle ordovician period. It consists of limestone with interbedded shale layers. The overburden is relatively thin and was deposited during and immediately following the Wisconsin Glaciation at which time the area was depressed from the effect of the glaciation. Following the retreat of the glacier, the brackish waters of the champlain sea flooded the area and than gradually receded as the land rebounded with the deposition of sediments to its present level.

INVESTIGATION PROCEDURES

Soil data and inherent properties were obtained by in situ and laboratory testing conducted. The procedures employed are discussed below.

FIELD INVESTIGATION

The fieldwork for the investigation was carried out between 90 08 09 to 90 08 10 and consisted of a total of seven boreholes. Two boreholes at the east/west approach ramps, two boreholes at the east abutments, one centerline pier and two west abutment holes. The surficial deposit was relatively shallow thus refusal ranged from 2.5 m to 4.5 m.

Disturbed split spoon and rock core samples (BXL) were taken using trackmount CME55 equipment employing hollow stem techniques to advance all boreholes in the overburden. Disturbed subsoil samples were retrieved at 0.75 m intervals and two 1.52 m rock core samples were drilled at abutment and pier locations. All samples were identified in the field and then returned to the laboratory for applicable testing.

Sampling was performed for the abutment and pier holes down to 3.5 m into bedrock while the approach ramp holes were terminated upon refusal of augers.

Groundwater levels were obtained by monitoring the levels in the open boreholes throughout the duration of the field investigation. All open boreholes were backfilled at the completion of the fieldwork.

Survey information related to the location and elevation of boreholes was provided by MTO Surveys and Plans, Eastern Region.

Laboratory Analysis

The following laboratory tests were carried out on select soil samples.

- 1) Atterberg Limit Test
- 2) Grain Size Analysis
- 3) Natural Moisture Contents
- 4) Unit Weights

Laboratory test results are given in the following section of this report and are illustrated on figures and borehole logs included in the Appendix.

SUBSURFACE CONDITIONS

General

The subsoil conditions are generally consistent across the site, consisting primarily of 2.5-4.5 metres of a heterogeneous mixture (Glacial Till) of silt, sand, clay and gravel. Pockets of silt were encountered at the surface in three of the seven investigation locations and a greater percentage of gravel and cobbles were encountered at greater depths throughout the site. This stratum was in turn underlain by a dolostone bedrock at depths of 3-4.5 metres, generally following the shape of the natural ground level.

The plan and location of boring and the stratigraphical profile are shown on Drawing No. 1218707-A in the attached Appendix. The obtained field and laboratory tests are plotted on the Record of Borehole sheets also in the Appendix of this report. A brief description of the different soil types are given below.

Heterogeneous Mixture of Silt, Sand, Clay and Gravel (Glacial Till)

Underlying the site and explored to depths ranging from the original ground surface to depths between 2.5-4.5 metres, is a non-cohesive deposit which is composed of a heterogeneous mixture of silt, sand, clay and gravel (Glacial Till).

Results of Grain Size Distribution tests carried out on select samples are shown on Figure 1 in the Appendix, in envelope form. From the above figure, it is evident that the layer can be classified as described above. The material contained 0-38% gravel, 3-42% sand, 35-90% silt and 2-13% clay with greater percentages of gravel near the bottom of this layer.

The result from the Atterberg Limit test performed on the fine fraction of this material is summarized as follows.

	<u>Range</u>	<u>No. of Tests</u>
Natural Moisture Content (w)	7-27.5	12
Liquid Limit (w _L)	14-25	12
Plastic Limit (w _p)	12-20	12
Plastic Index (I _p)	1-8	12

From the plasticity chart (Figure 2) the layer can be classified as inorganic mixtures of silt, sand, clay and gravel with slight plasticity.

In this stratum the 'N' values ranged from 5 blows/0.3 m to 7130 blows/0.3 m. Having a loose to very dense state of relative density.

Bedrock

The above stratum is directly underlain by bedrock of the Gull River Formation and was cored at three abutment locations and one pier by obtaining up to 3.0 metres of sound rock core samples. The bedrock consists mainly of a dolostone, with one borehole (BH 1) at greater depths encountered a quartz sandstone. Detailed descriptions of the rock are attached in the Appendix entitled "Rock Core Description".

Core Recoveries (CR) and Rock Quality Designation (RQD) were determined in situ and also in the laboratory to evaluate the competence and integrity of the rock. Based on these results, the dolostone can be classified as medium strong and predominantly unweathered. The quartz sandstone was classified similarly as medium strong and unweathered.

GROUNDWATER CONDITIONS

Observation of the groundwater level was carried by measuring the water level in the open boreholes. The water level varied from 94.75 m to 92.5 m. Trapped drilling water may have a noticeable affect on water table heights.

Groundwater levels in general are subject to seasonal fluctuations and hence can vary from the values given in this report.

DISCUSSION AND RECOMMENDATIONS

The recommendations in this report apply to the bridge structure and related approaches.

It is proposed to construct an overpass structure that will carry Knoxdale Road over the proposed Hwy. 416 north and south bound lanes. The proposed structure is a two span structure having approximate length and width of 77 m and 23 metres respectively. The proposed profile grade of the Hwy. 416 lanes is approximately 94.4 m which is equivalent to approach fill heights of 6 metres and a 1.5 metre cut at the pier location. The elevation of Knoxdale Road is proposed at 102 m. To facilitate the design and construction of the proposed structure foundations and related earthworks for the approach ramps, the following foundation and geotechnical recommendations are provided in the scope of this report.

- 1) Structure Foundation
- 2) Lateral Earth Pressure
- 3) Slope Stability
- 4) Construction Considerations

1. Structure Foundations

Abutments and Wingwalls

For the abutment locations the addition of 6 metres of fill specified in the design of the approaches will allow the use of spread footings perched within this material.

The surficial glacial till was found to be soft to firm thus the original ground level needs to be proof rolled with any soft soil encountered being excavated and replaced by compacted granular fill.

For spread footings founded on a 1 m Granular 'A' pad with an assumed footing width of 3 m and constructed as per MTO Standards, the following design parameters are recommended.

	Factored Capacity at U.L.S. (kPa)	Allowable Capacity at S.L.S. Type II (kPa)
Spread Footings	900	350

Factored U.L.S. and S.L.S. Type II capacities given above could also be utilized for a 6.5 m wide footing provided the thickness of the granular pad is increased to about 2.5 m.

Piers

Foundations for the centre pier will be supported on spread footings. The pier footing may be supported on bedrock surface placed at an elevation of 90.9 metres. Some excavation below the bedrock surface may be required especially towards the north side of the pier foundation. Alternatively, pier footings may also be supported on mass concrete placed above the bedrock surface.

For purposes of the O.H.B.D.C., the following bearing capacities shall be used.

	Factored U.L.S. kPa	S.L.S. kPa
Footing on Bedrock	3000	*
Footing on Mass Concrete	3000	*

*These foundations are considered to be unyielding and hence the bearing capacity at S.L.S. Type II will not govern the design.

2. Lateral Earth Pressure on Structures

Free draining material such as Granular 'A' or Granular 'B' is recommended as appropriate backfill to the abutments to prevent hydrostatic pressure build-up.

Design parameters of the soil are given below for purposes of the O.H.B.D.C..

	<u>Granular 'A'</u>	<u>Granular 'B'</u>
Angle of Internal Friction (ϕ)	35°	30°
Unit Weight (kN/m^3)	22.8	21.2
*Coefficient of Active Earth Pressure (K_a)		
- S.L.S.	0.27	0.33
- U.L.S.	0.33	0.4
*Coefficient of Earth Pressure at Rest (K_o)		
- S.L.S.	0.43	0.5
- U.L.S.	0.5	0.58

*Horizontal surface backfill only. Appropriate consideration must be given to sloping backfill.

The earth pressure coefficient at rest is to be used in design if the abutment walls are rigid and unyielding weep holes in the abutment walls should be designed to drain any accumulation of water in the backfill.

The backfill should be constructed in 300 mm lifts on alternating sides of the rigid frame structure so that the maximum differential in backfill heights at no time exceeds 300 mm. OPSD 803 series illustrates the applicable backfill standards and specifications.

3. Approach Embankments

The proposed finished grade is set at about 6 metres above the finished grade. No stability problems are anticipated for the approach embankments constructed with 2H:1V side slopes. The fill material should consist of well compacted acceptable material.

It is anticipated that approximately 45 mm of the total settlement can be realized as a result of elastic settlements induced within the fill itself and the elastic recompression of the native subsoil. It is expected that the majority of these settlements will be realized during or immediately following construction.

4. Construction Considerations

Excavations for pier foundations would extend below the groundwater level. It is expected that the groundwater inflow into excavations would be relatively small. Water entering the excavations may be handled by means of oversized excavations together with pumping from sumps.

NSSP for dewatering will not be required provided the existence of high groundwater level and the need to keep excavations dry are identified in the contract documents.

For the perched abutment locations no dewatering will be required.

Unfactored coefficient of friction of 0.58 and 0.70 shall be used for footings located on granular pad and bedrock respectively.

The footings should be placed so as to have a minimum earth cover of 1.8 metres for frost protection.

Within the limits of the approach fills, if soft soil is encountered this should be excavated and replaced by compacted granular fill.

Presence of till indicates boulders and cobbles may be encountered.

MISCELLANEOUS

The fieldwork for this investigation was carried out under the supervision of Tae C. Kim, Foundation Design Engineer, Martin Michalek, Foundation Engineer Trainee and John LeMessurier, Mike Iampietro, Student Engineers. The equipment was owned and operated by Marathon Drilling Co. Ltd., and F.E. Johnston Drilling Co. Ltd., Ottawa.

This report was written by M. Michalek, Foundation Engineer Trainee, under the general supervision of Dr. Balu Iyer, Senior Foundation Engineer and reviewed by Mr. Murty Devata, Chief Foundation Engineer.



M. Michalek

M. Michalek
Foundation Trainee Engineer

M. Devata

M. Devata, P.Eng.
Chief Foundation Engineer

APPENDIX

ROCK CORE DESCRIPTION

WP 121-87-07

Page 1 of 1

CORE RECOVERY					CORE DESCRIPTION	
BH#	RC#	DEPTH (m)	% CR*	% RQD*	DEPTH (m)	DESCRIPTION
1	4	3.25-5.79	96	96	3.25-5.79	DOLOSTONE (slightly calcitic; cherty, 5.77-5.79 m), light olive grey to medium dark grey; fine crystalline; medium strong; unweathered; wide to close spaced fractures (flat, undulating, rough to smooth).
4	6	4.32-5.69	93	77	4.32-5.69	DOLOSTONE (slightly calcitic), light olive grey to medium dark grey; fine crystalline; medium strong; unweathered; moderately close to very close spaced fractures (flat, undulating, rough to smooth).
5	5	3.33-4.85	100	99	3.33-4.85	DOLOSTONE (slightly calcitic), light olive grey to medium dark grey; fine crystalline; medium strong; unweathered; wide to close spaced fractures (flat, undulating, rough to smooth).
6	6	4.57-6.10	99	89	4.57-6.10	DOLOSTONE (slightly calcitic), light olive grey to medium dark grey; fine crystalline; medium strong; unweathered; moderately close to very close spaced fractures (flat, undulating, smooth to rough).

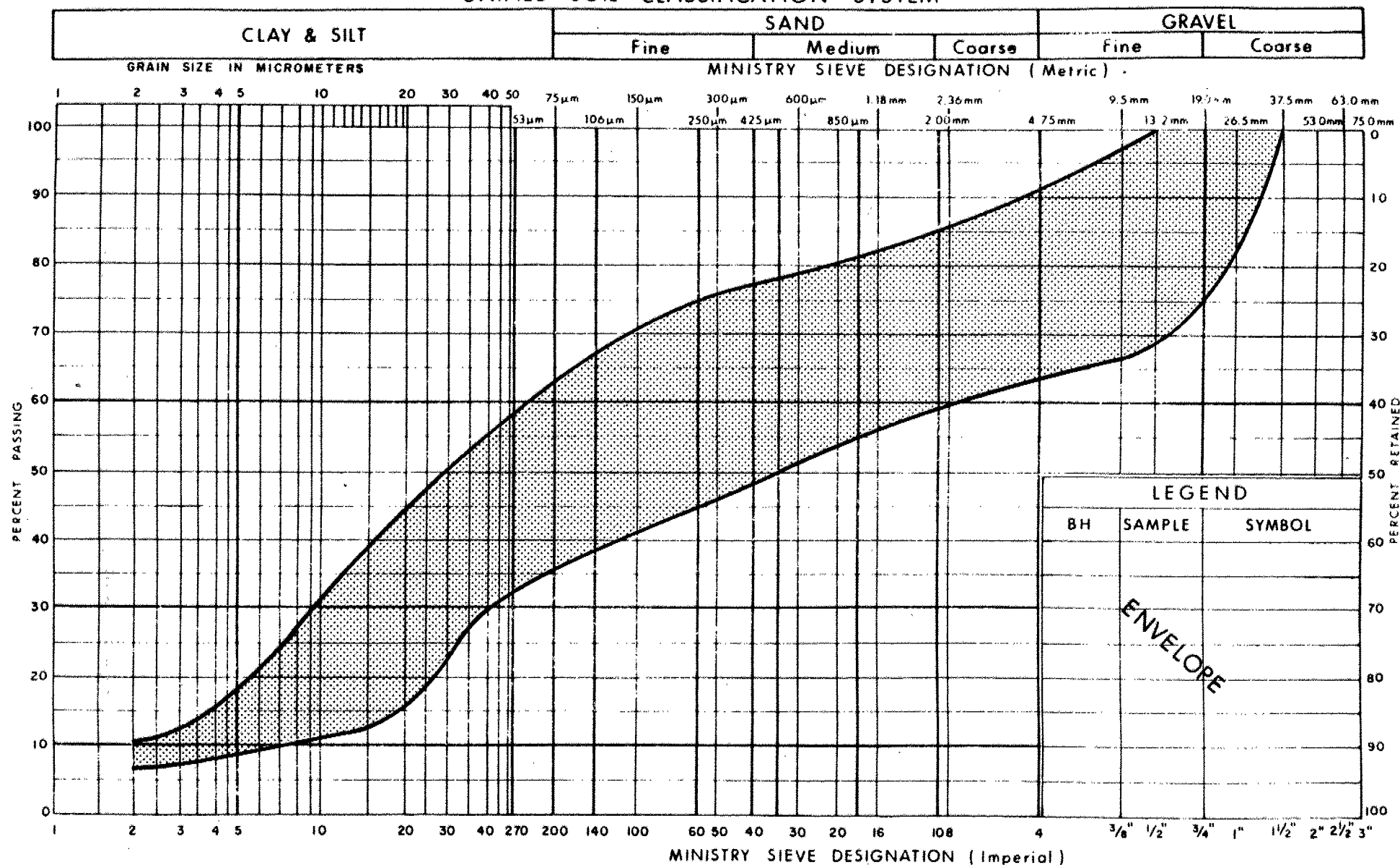
*CR = CORE RECOVERY

*RQD = ROCK QUALITY DESIGNATION

(NOTE: Depths are approximated where core recovery is less than 100%)

Logged by: DAW, Soils and Aggregates Section

UNIFIED SOIL CLASSIFICATION SYSTEM



Ontario

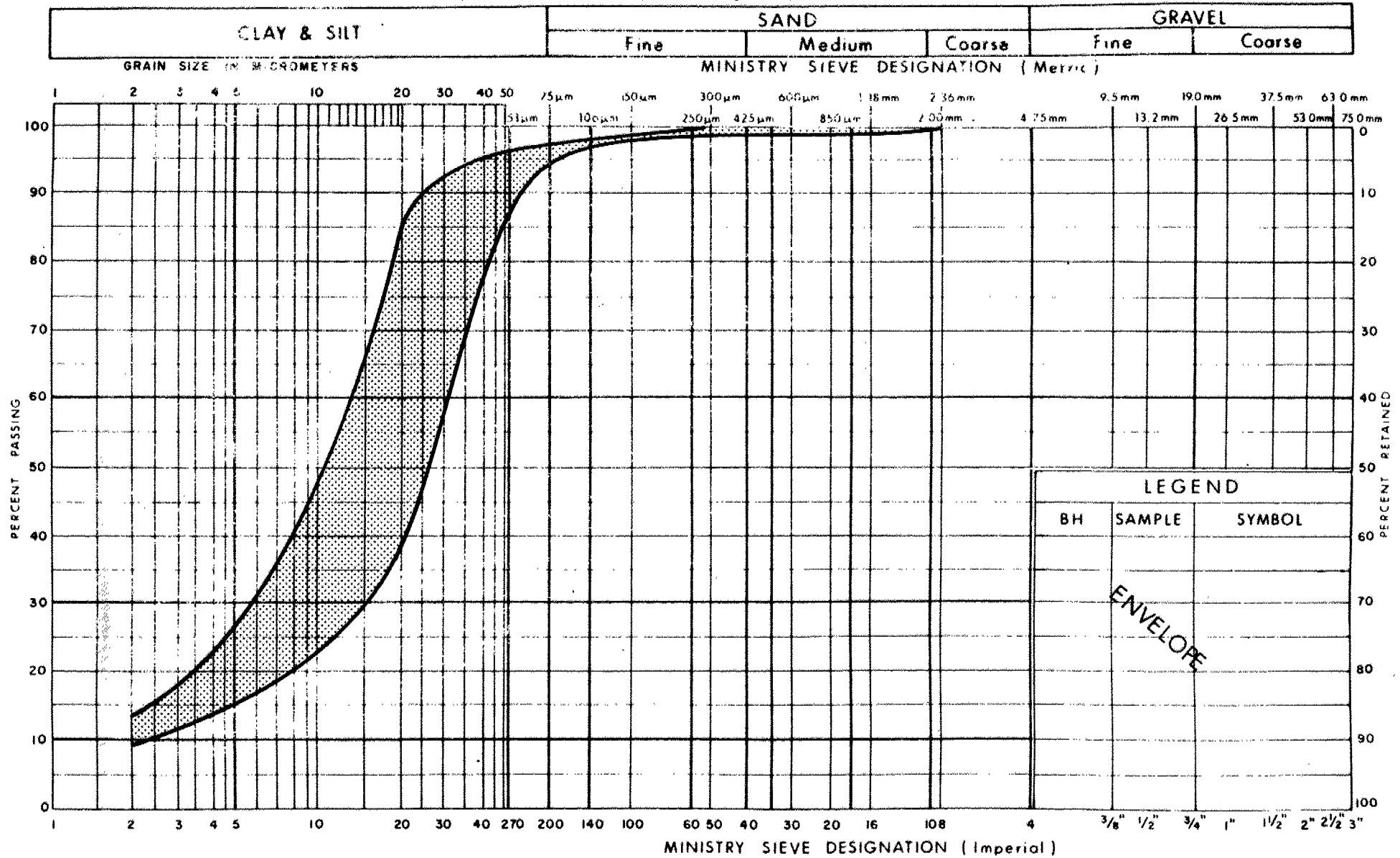
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GRAIN SIZE DISTRIBUTION
HETEROGENEOUS MIXTURE OF SILT, SAND & GRAVEL
TRACE CLAY (GLACIAL TILL)

FIG No 1

W P 121-87-07

UNIFIED SOIL CLASSIFICATION SYSTEM

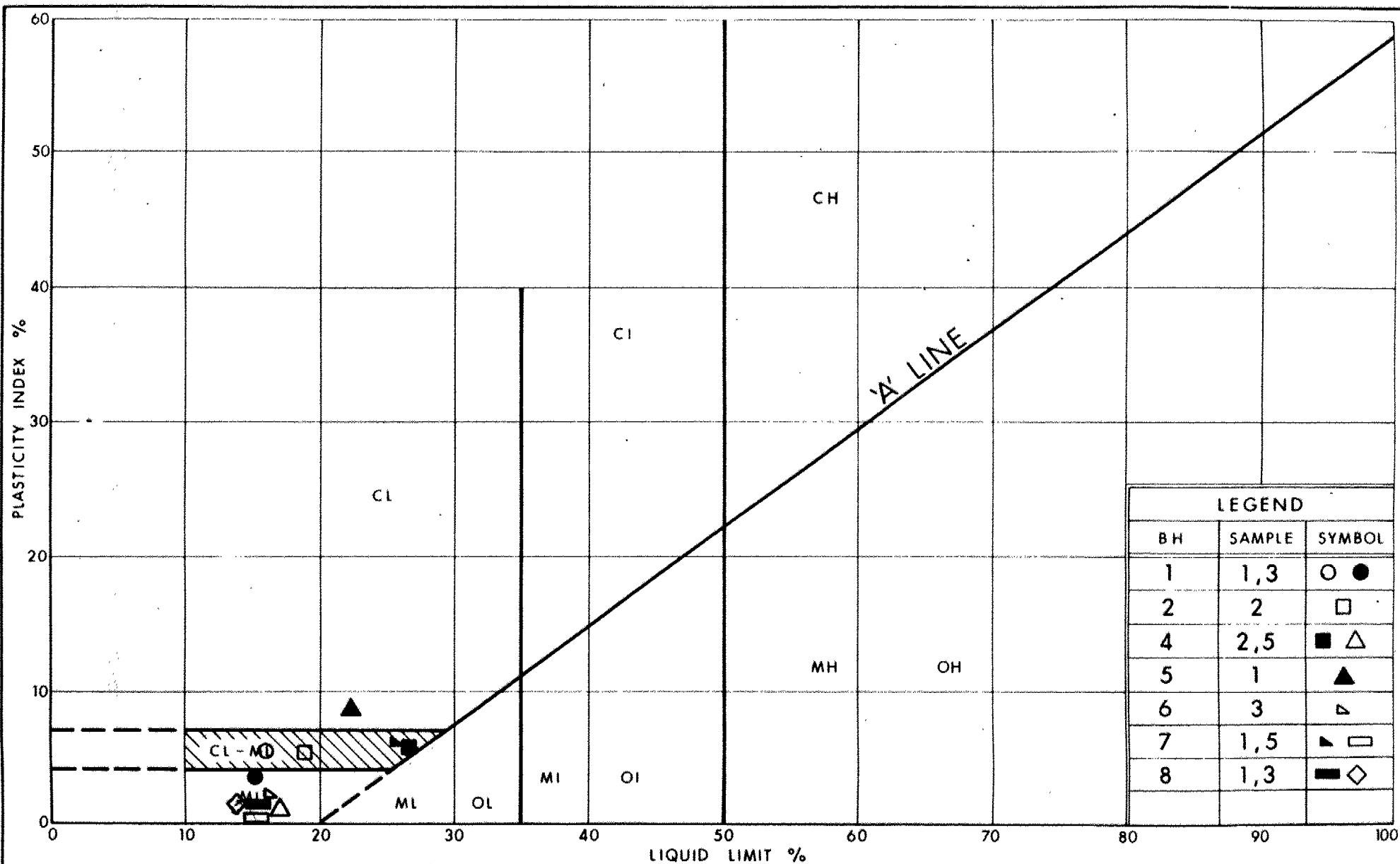


Ontario

Ministry of
TransportationGRAIN SIZE DISTRIBUTION
SANDY SILT

FIG No 2

W P 121-87-07



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PLASTICITY CHART
HETEROGENEOUS MIXTURE OF SILT, SAND & GRAVEL
TRACE CLAY, (GLACIAL TILL)

FIG No 3

W P 121-87-07

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
WS	WASH SAMPLE	OS	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_f	kPa	REMOULDED SHEAR STRENGTH
S_t	1	SENSITIVITY = $\frac{c_u}{\tau_f}$

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

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						

RECORD OF BOREHOLE No 1

1 OF 1

METRIC

W.P. 121-87-07 LOCATION Co-ords: N 5 019 230.7 E 359 493.5 ORIGINATED BY M.M.
 DIST 9 HWY 416 BOREHOLE TYPE Hollow Stem Auger, Cone Penetration Test COMPILED BY M.M.
 DATUM Geodetic DATE 90/08/30 CHECKED BY B.I.

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC NATURAL LIQUID LIMIT MOISTURE CONTENT			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	W _p	W		
95.3	Ground Surface												
0.0	Heterogeneous mixture of Clay, Silt, Sand and Gravel (Glacial Till) Compact to Very Dense		1	SS	18							20.9	11 36 50 3
			2	SS	28								
			3	SS	65							22.4	9 42 39 10
92.1													
3.2	Dolostone Bedrock Medium Strong Unweathered		4	RC BXL	REC 96%								RQD 96%
89.5													
5.8													

RECORD OF BOREHOLE No 2

1 OF 1

METRIC

W.P. 121-B7-07 LOCATION Co-ords: N 5 019 213.4, E 359 503.5 ORIGINATED BY M.M.
 DIST 9 HWY 416 BOREHOLE TYPE Hollow Stem Auger COMPILED BY M.M.
 DATUM Geodetic DATE 90/08/30 CHECKED BY B.L.

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					
95.0	Ground Surface																
0.0	Heterogeneous mixture of Clay, Silt, Sand and Gravel (Glacial Till) Compact to Very Dense Brown		1	SS	16		94										
			2	SS	12		93									24.2	29 20 41 10
92.4			3	SS	57	/20cm											
2.6	End of Borehole Auger refusal at probable bedrock																

+3, x5: Numbers refer to
Sensitivity

20
15-5 (%) STRAIN AT FAILURE
10

RECORD OF BOREHOLE No 4

1 OF 1

METRIC

W.P. 121-87-07

LOCATION Co-ords: N 5 019 231.8, E 359 535.7

ORIGINATED BY M.M.

DIST 9 HWY 416

BOREHOLE TYPE Hollow Stem Auger, Cone Penetration Test

COMPILED BY M.M.

DATUM Geodetic

DATE 90/08/30

CHECKED BY D.T.


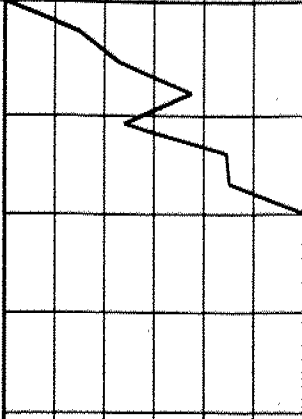
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		NATURAL MOISTURE CONTENT			UNIT WEIGHT 7 kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100	20 40 60 80 100	W _p	W	W _L		
95.1	Ground Surface													
0.0	Heterogeneous mixture of Clay, Silt, Sand and Gravel (Glacial Till) Very Loose to Compact		1	SS	5									
			2	SS	5									
			3	SS	21									
	Brown Grey		4	SS	26									
90.9			5	SS	9	/15cm								
4.2	Dolostone Bedrock Medium Strong Unweathered		6	RC	REC 93%									
89.4														
5.7	End of Borehole													

RECORD OF BOREHOLE No 5

1 OF 1

METRIC

W.P. 121-87-07 LOCATION Co-ords: N 5 019 267.5, E 359 557.8 ORIGINATED BY M.M.
 DIST 9 HWY 416 BOREHOLE TYPE Hollow Stem Auger, Cone Penetration Test COMPILED BY M.M.
 DATUM Geodetic DATE 90/08/30 CHECKED BY D.T.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			SHEAR STRENGTH kPa						
95.2	Ground Surface							20 40 60 80 100	20 40 60 80 100					
0.0	Heterogeneous mixture of Clay, Silt, Sand and Gravel (Glacial Till) Compact to Dense		1	SS	29	/28cm						21.9	14 22 51 13	
			2	SS	18									
	With Cobbles		3	SS	33									
91.8			4	SS	36									
3.4	Dolostone Bedrock Medium Strong Unweathered	5	RC BXL	REC 100%										
90.3														
4.9	End of Borehole													

RECORD OF BOREHOLE No 6

1 OF 1

METRIC

W.P. 121-87-07 LOCATION N 5 019 250.2, E 358 567.7 ORIGINATED BY M.M.
 DIST 9 HWY 416 BOREHOLE TYPE Hollow Stem Auger, Cone Penetration Test COMPILED BY M.M.
 DATUM Geodetic DATE 90/08/30 CHECKED BY O.T.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			SHEAR STRENGTH kPa	WATER CONTENT (%)					
99.1	Ground Surface													
0.0	Heterogeneous mixture of Clay, Silt, Sand and Gravel (Glacial Till) Dense to Very Dense Brown Gray with Cobbles		1	SS	32								22.7	38 26 30 6
			2	SS	47									
			3	SS	33									
			4	SS	71									
			5	SS	54									
90.5	Dolostone Bedrock Medium Strong Unweathered		6	RC 8XL	REC 99%									RQD 89%
4.6														
89.0	End of Borehole													
6.1														

RECORD OF BOREHOLE No 7

1 OF 1

METRIC

W.P. 121-87-07

LOCATION Co-ords: N 5 019 259.2, E 359 591.4

ORIGINATED BY M.M.

DIST 9 HWY 416

BOREHOLE TYPE Hollow Stem Auger

COMPILED BY M.M.

DATUM Geodetic

DATE 90/08/30

CHECKED BY D.T.

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT NATURAL MOISTURE CONTENT			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		
94.4	Ground Surface															
0.0	Heterogeneous mixture of Clay, Silt, Sand and Gravel (Glacial Till) Compact to Very Dense Brown ----- Grey with Cobbles		1	SS	15											
			2	SS	50											
			3	SS	47											
			4	SS	45											
			5	SS	13											
89.4																
5.0	End of Borehole															

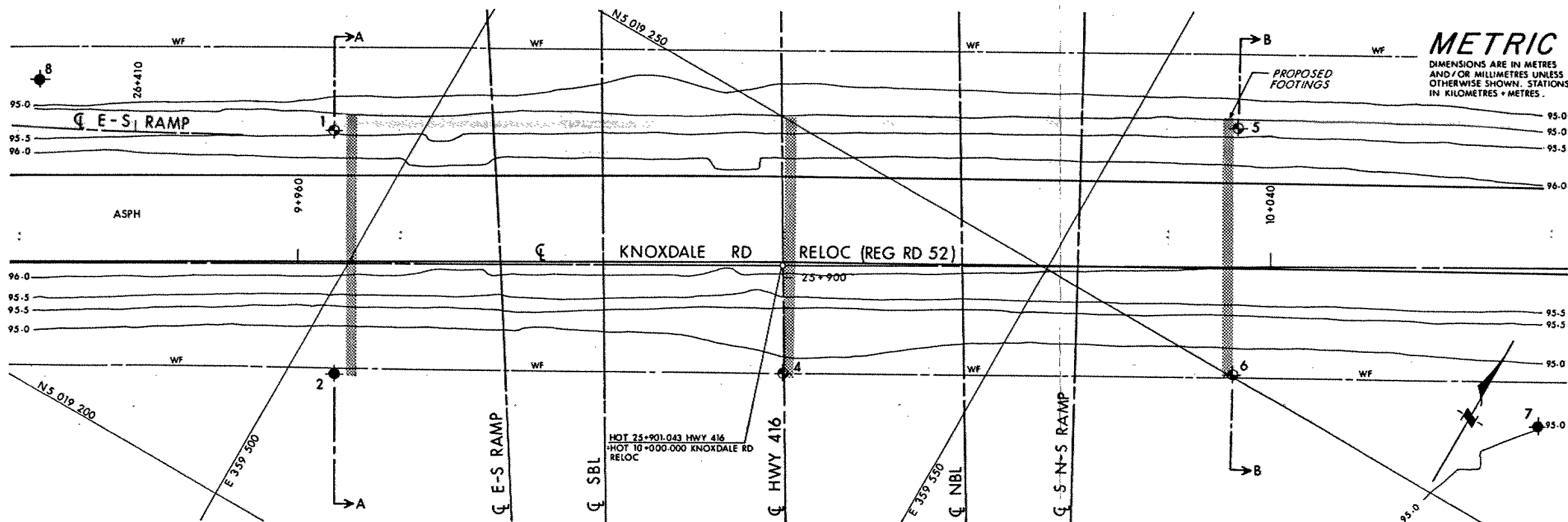
RECORD OF BOREHOLE No 8

1 OF 1

METRIC

W.P. 121-87-07 LOCATION Co-ords: N 5 019 222.2, E 359 470.3 ORIGINATED BY M.M.
 DIST 9 HWY 416 BOREHOLE TYPE Hollow Stem Auger COMPILED BY M.M.
 DATUM Geodetic DATE 90/08/30 CHECKED BY D.T.

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			SHEAR STRENGTH kPa					WATER CONTENT (%)				
								20 40 60 80 100					25 50 75				
95.9	Ground Surface																
0.0	Heterogeneous mixture of Clay, Silt, Sand and Gravel (Glacial Till) Compact to Dense Brown Grey		1	SS	12		95									0 3 90 7	
			2	SS	22		94										
			3	SS	27												
92.8			4	SS	12		93										24.1
3.1	End of Borehole																



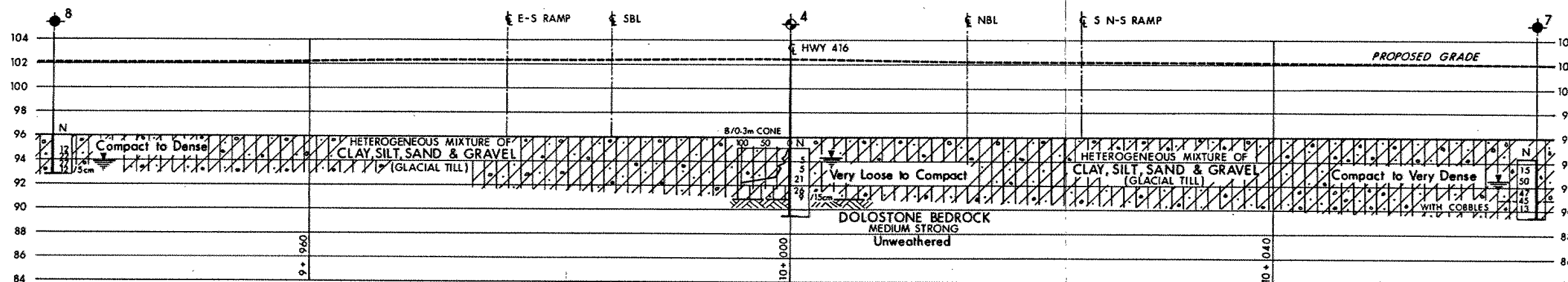
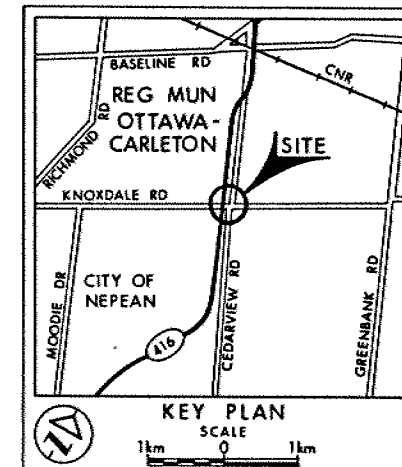
METRIC
DIMENSIONS ARE IN METRES
AND/OR MILLIMETRES UNLESS
OTHERWISE SHOWN. STATIONS
IN KILOMETRES + METRES.

CONT No
WP No 121-87-07

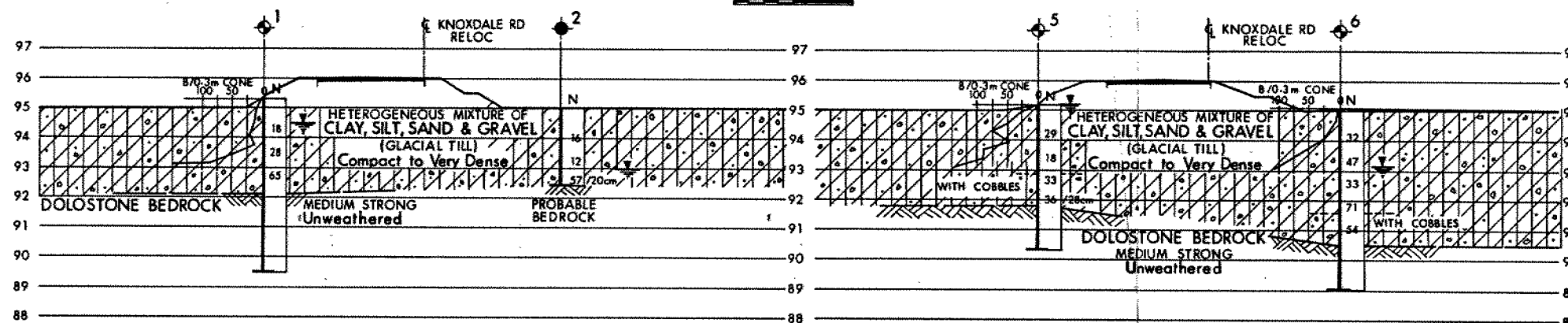
KNOXDALE RD UNDERPASS

SHEET

BORE HOLE LOCATIONS & SOIL STRATA



PROFILE KNOXDALE RD RELOC



A-A

B-B

SECTIONS

SCALE
4m 2m 0 4m Hor
2m 1m 0 2m Vert

LEGEND

- Bore Hole
- ⊕ Dynamic Cone Penetration Test (Cone)
- ⊕ Bore Hole & Cone
- N Blows/0.3m (Std Pen Test, 475 J/blow)
- CONE Blows/0.3m (60° Cone, 475 J/blow)
- W.L. at time of investigation 90 08

No	ELEVATION	CO-ORDINATES NORTH	EAST
1	95.3	5 019 230.7	359 493.5
2	95.0	5 019 213.4	359 503.5
4	95.1	5 019 231.8	359 535.7
5	95.2	5 019 267.5	359 557.8
6	95.1	5 019 250.2	359 567.7
7	94.4	5 019 259.2	359 591.4
8	95.9	5 019 222.2	359 470.3

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 31G5-183

HWY No 416	CHECKED	DATE 91 07 03	DIST 9
SUBMIT MM	CHECKED	APPROVED	SITE 3-546
DRAWN DT	CHECKED	APPROVED	DWG 1218707-A

METRIC

DIMENSIONS ARE IN METRES
AND/OR MILLIMETRES
UNLESS OTHERWISE SHOWN

ST. 9
CONT No
WP No 121-87-07

KNOXDALE ROAD INTERCHANGE
UNDERPASS
GENERAL ARRANGEMENT



SHEET
262

GEODETTIC DATUM
BM. ELEV. 95.540
N&W in root of 0.2 twin birch
10.96 Rt. 25+916.5

GENERAL NOTES

CLASS OF CONCRETE

DECK & PIER COLUMNS 35 MPa
REMAINDER 30 MPa
UNLESS NOTED OTHERWISE

CLEAR COVER TO REINFORCING STEEL

FOOTINGS 100 ± 20
ABUTMENTS & WINGWALLS: FRONT FACE 80 ± 20
BACK FACE 70 ± 20
PIER 80 ± 20
DECK: TOP 70 ± 20
BOTTOM 50 ± 10
WEBS 50 ± 10
REMAINDER 70 ± 20
UNLESS NOTED OTHERWISE

REINFORCING STEEL

REINFORCING STEEL SHALL BE GRADE 400
UNLESS NOTED OTHERWISE - BAR MARKS WITH
SUFFIX 'C' DENOTE COATED BARS.

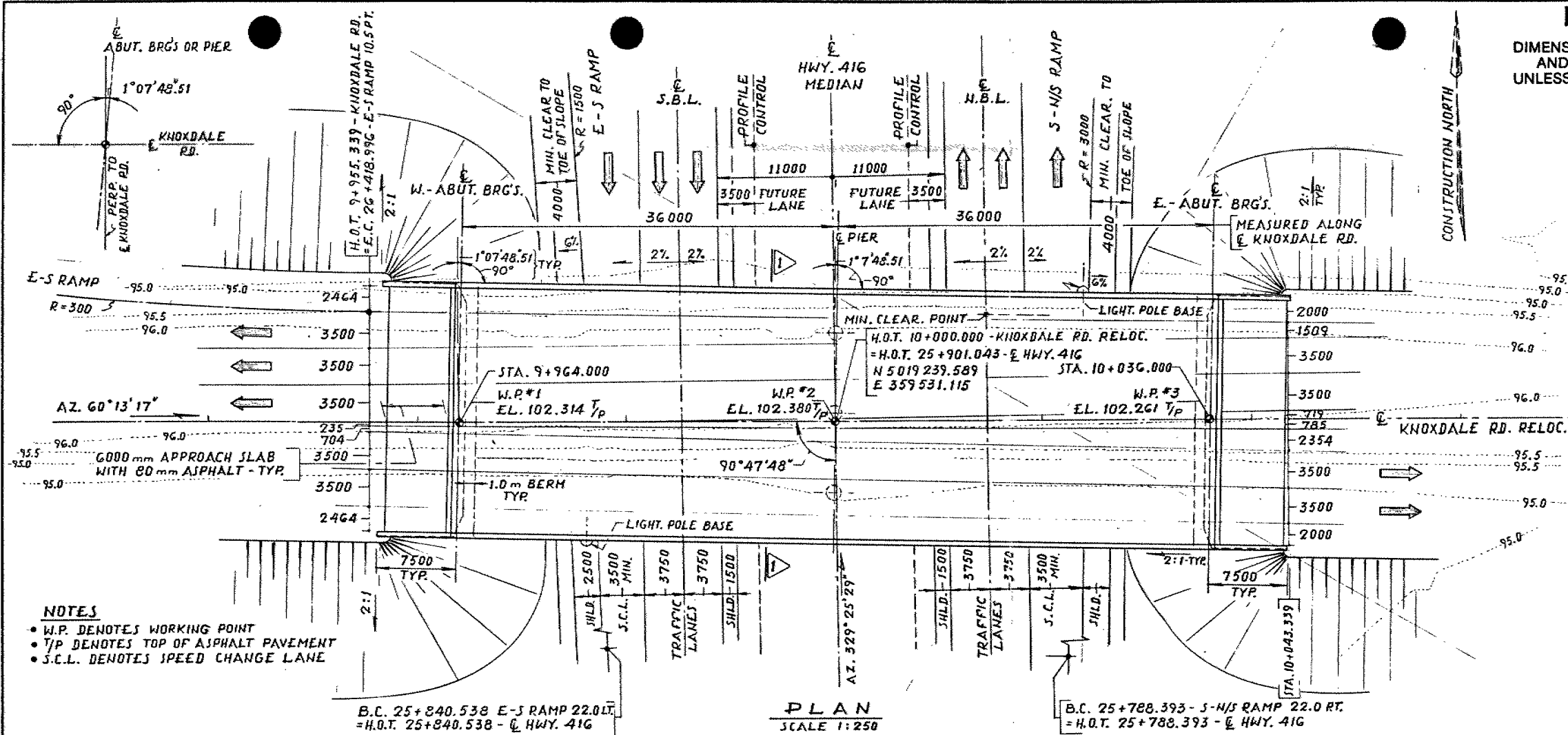
CONSTRUCTION NOTES

IF THE ACTUAL BEARING THICKNESSES ARE
DIFFERENT FROM THOSE GIVEN IN THE BEARING
DESIGN DATA THE CONTRACTOR SHALL ADJUST
THE BEARING SEAT ELEVATIONS AND THE
REINFORCING STEEL TO SUIT.

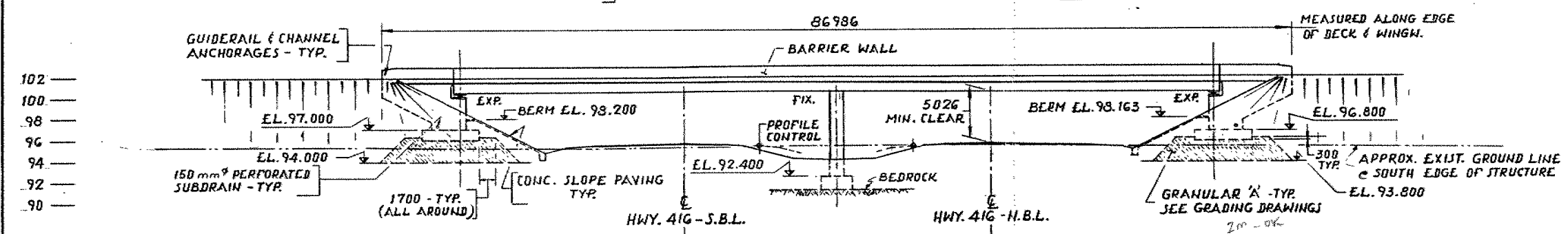
LIST OF DRAWINGS

- 1-GENERAL ARRANGEMENT
- 2-BORE HOLE LOCATIONS & SOIL STRATA
- 3-FOOTING LAYOUT & REINFORCING
- 4-WEST ABUTMENT
- 5-EAST ABUTMENT
- 6-WINGWALLS
- 7-PIER DETAILS & BEARINGS
- 8-DECK DETAILS
- 9-LONGIT. TENDONS I
- 10-LONGIT. TENDONS II
- 11-TRANSVERSE TENDONS I
- 12-TRANSVERSE TENDONS II
- 13-DECK REINFORCING I
- 14-DECK REINFORCING II
- 15-DECK REINFORCING III
- 16-DECK REINFORCING IV
- 17-JOINT ANCHORAGE & ARMOURING
- 18-BARRIER WALLS
- 19-EXTERIOR RAIL FOR BARRIER WALL
- 20-6000 mm APPROACH SLAB
- 21-DETAILS OF CONC. SLOPE PAVING
- 22-AS CONSTRUCTED ELEV. & DIM.
- 23-STANDARD DETAILS
- 24-ELECTRICAL EMBEDDED WORK
- 25-QUANTITIES - STRUCTURE I
- 26-QUANTITIES - STRUCTURE II

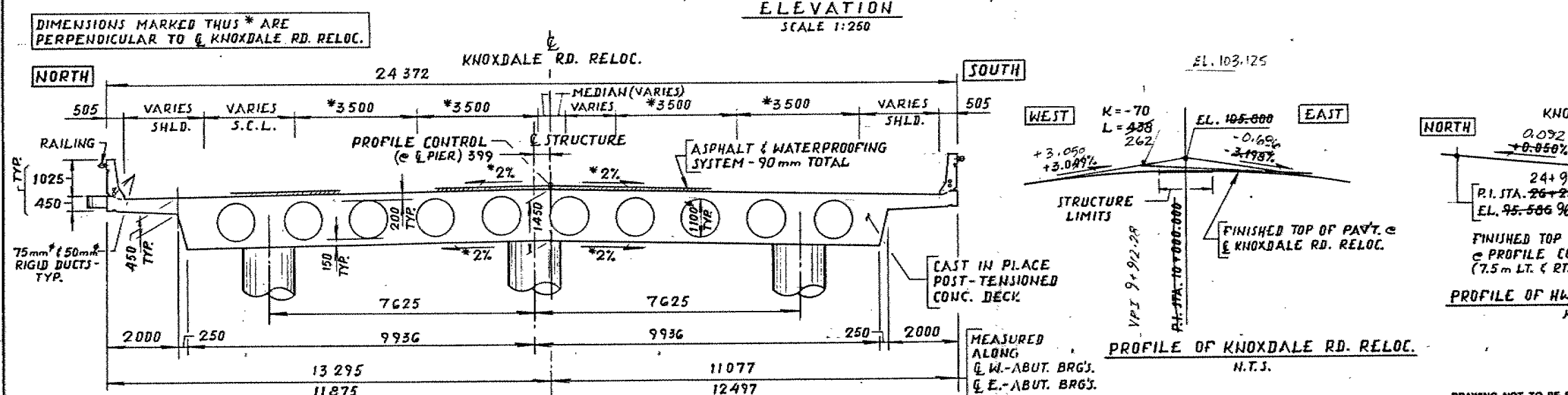
APPLICABLE STANDARD DRAWINGS
DD-3503 MIN. GRANULAR BACKFILL
REQUIREMENTS.



PLAN
SCALE 1:250



ELEVATION
SCALE 1:250



PROFILE OF KNOXDALE RD. RELOC.
N.T.S.

PROFILE OF HWY. 416 - N.B.L. & S.B.L.
N.T.S.

DRAWING NOT TO BE SCALED
100 mm ON ORIGINAL DRAWING

REVISIONS	DATE	BY	DESCRIPTION
1	NOV. '91	CHK M.G.	DESIGN
2	NOV. '91	CHK M.G.	DESIGN
3	NOV. '91	CHK M.G.	DESIGN
4	NOV. '91	CHK M.G.	DESIGN
5	NOV. '91	CHK M.G.	DESIGN
6	NOV. '91	CHK M.G.	DESIGN
7	NOV. '91	CHK M.G.	DESIGN
8	NOV. '91	CHK M.G.	DESIGN
9	NOV. '91	CHK M.G.	DESIGN
10	NOV. '91	CHK M.G.	DESIGN

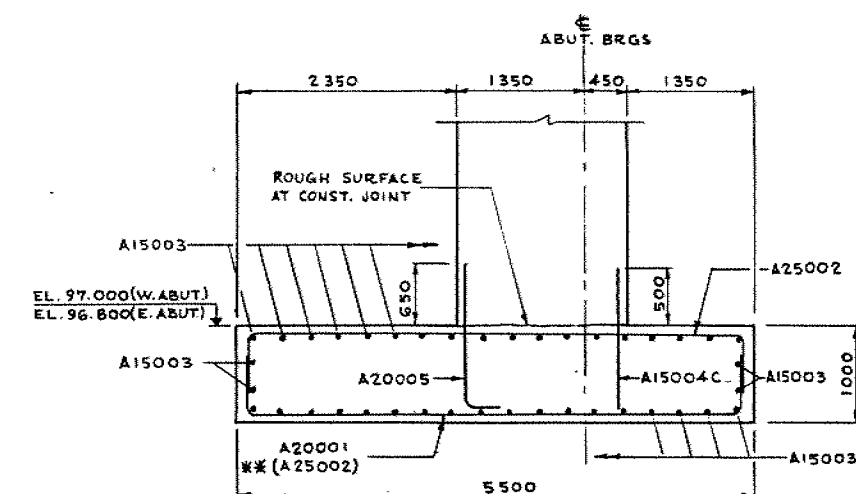
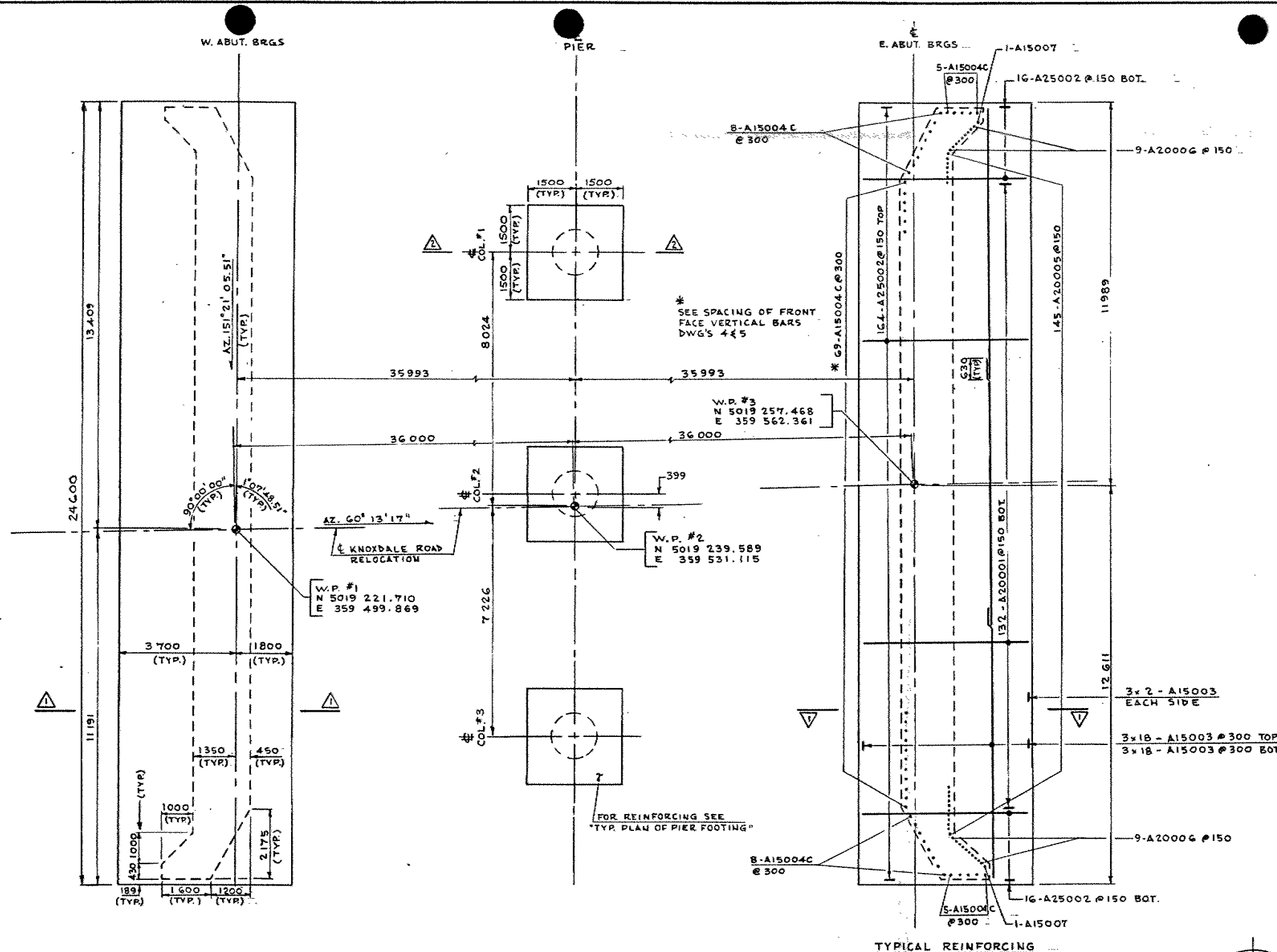
METRIC

DIMENSIONS ARE IN METRES
AND/OR MILLIMETRES
UNLESS OTHERWISE SHOWN

CONT No
WP No 121-87-07

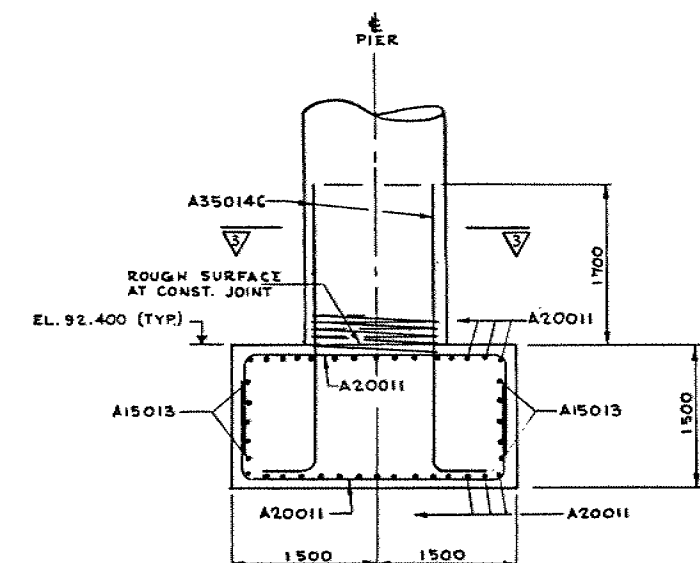
KNOXDALE ROAD INTERCHANGE
UNDERPASS
FOOTING LAYOUT & REINFORCING

SHEET
264

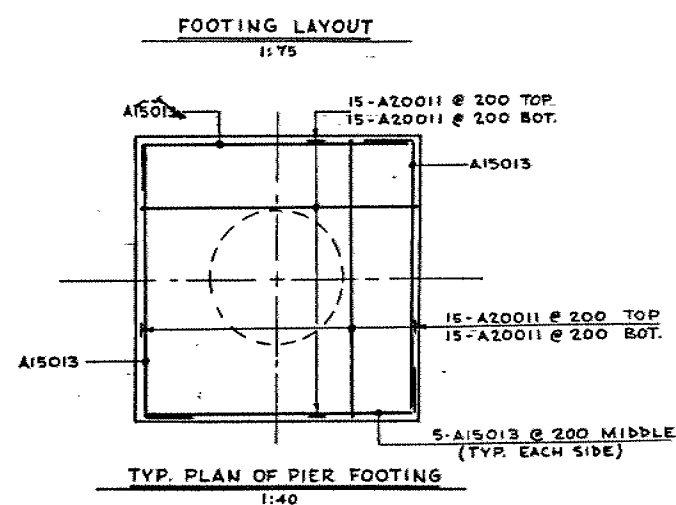
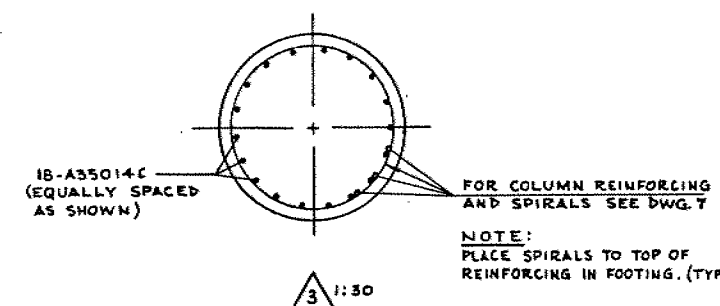


** SEE FOOTING LAYOUT

1:40



2:40



DRAWING NOT TO BE SCALED
100 mm ON ORIGINAL DRAWING

REVISIONS	DATE	BY	DESCRIPTION
DESIGN M.G. CHK			CODE 0H56C-B3 LOAD CLASS A DATE NOV. 91
DRAWN G.F.M. CHK M.G.			SITE 3-546 STRUCT SCHEME DWG. 3

METRIC

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

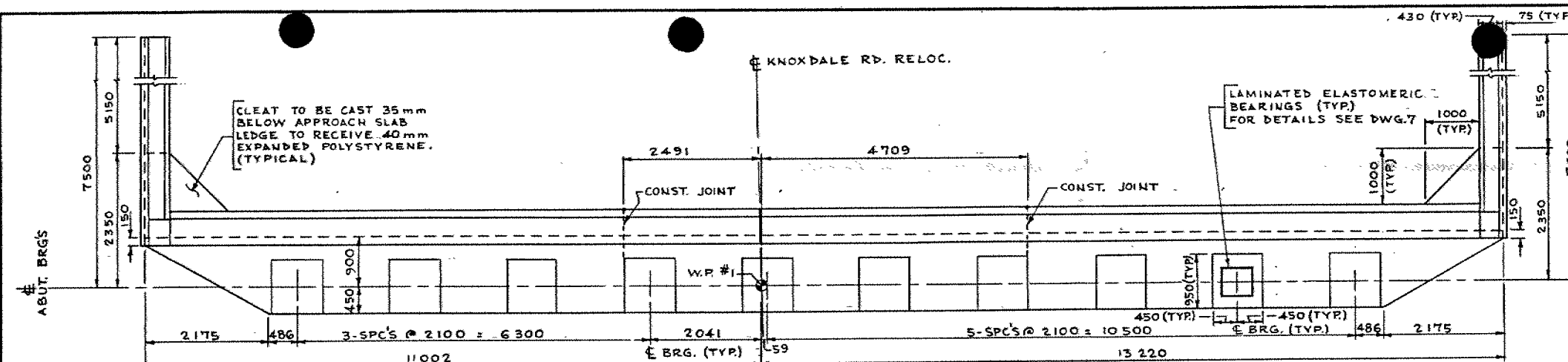
CONT No
WP No 121-87-07

SHEET
265

KNOXDALE ROAD INTERCHANGE
UNDERPASS
WEST ABUTMENT

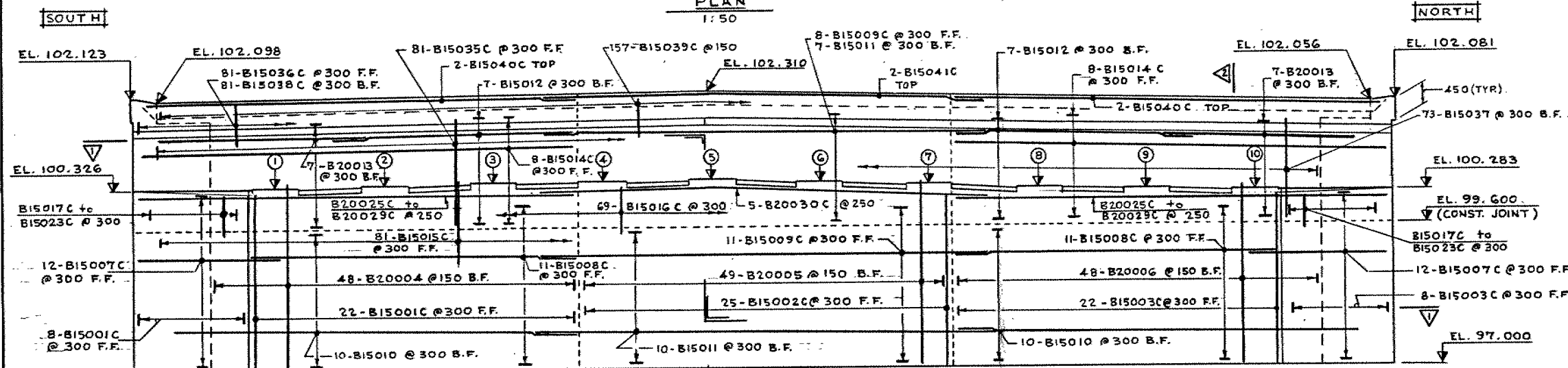
*
CAST TOP OF BALLAST WALL
TO SUIT PAVEMENT PROFILE

VARIES TO PROVIDE 'J' GAP
BETWEEN DECK AND
BALLAST WALL AT TIME
OF CASTING BALLAST.
WALL



PLAN

150



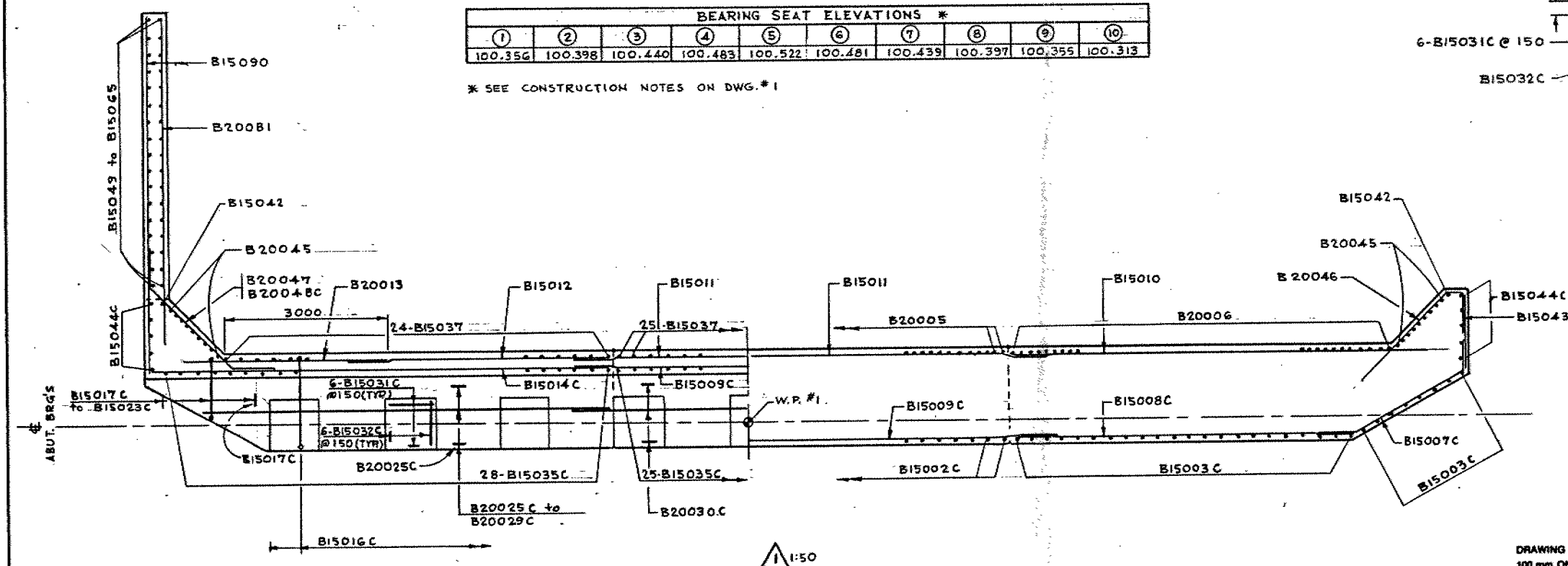
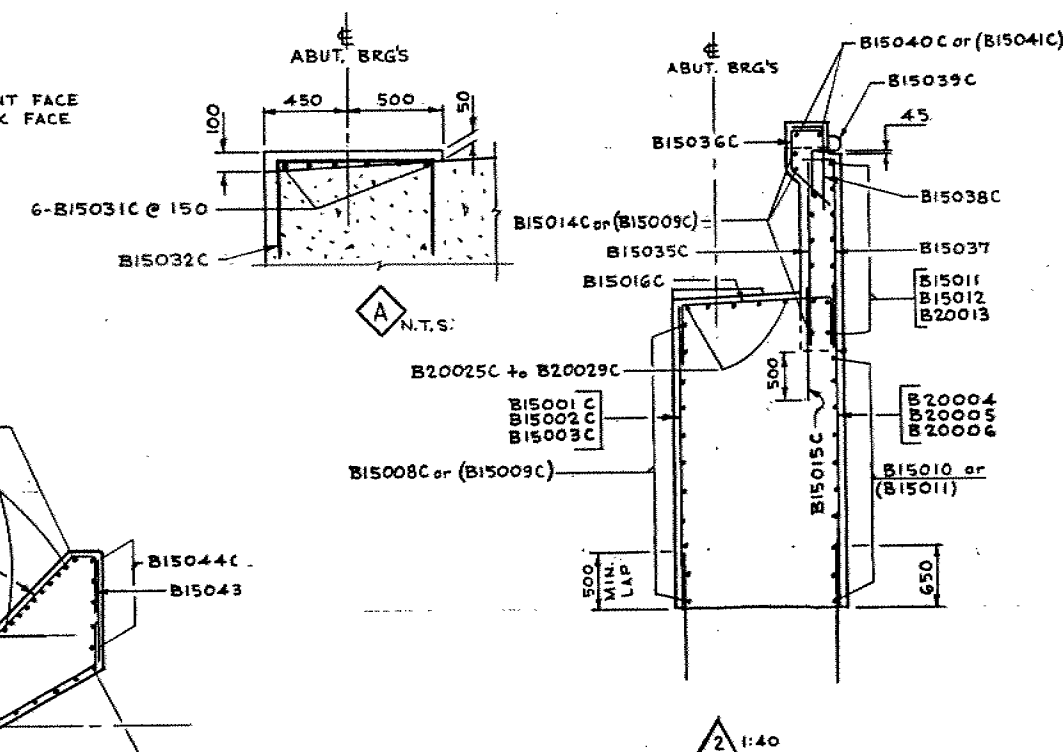
ELEVATION

1:50

BEARING SEAT ELEVATIONS *									
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
100.356	100.398	100.440	100.483	100.522	100.481	100.439	100.397	100.355	100.313

* SEE CONSTRUCTION NOTES ON DWG. # 1

NOTE :
F.F. DENOTES FRONT FACE
B.F. DENOTES BACK FACE



DRAWING NOT TO BE SCALED
100 mm ON ORIGINAL DRAWING

[illegible]

KNOXDALE RD. RELOC

METRIC

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

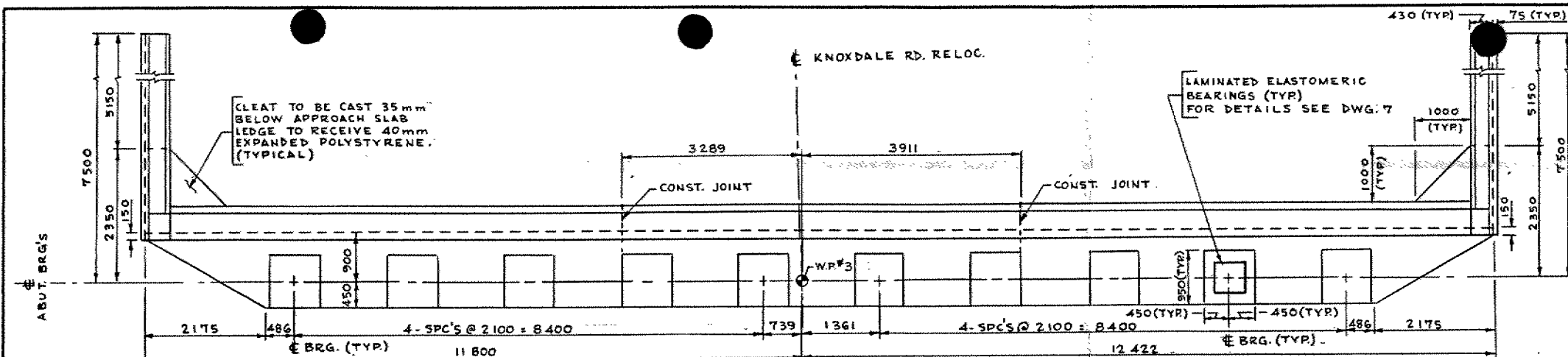
CONT No
WP No 121-87-07

KNOXDALE ROAD INTERCHANGE
UNDERPASS
EAST ABUTMENT

SHEET
266

*
CAST TOP OF BALLAST WALL
TO SUIT PAVEMENT PROFILE

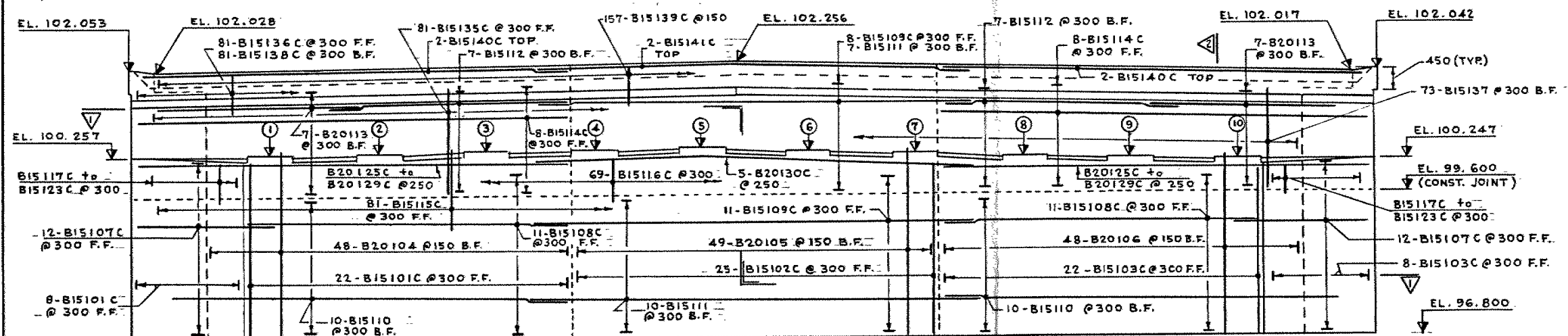
ABUT. BRG'S VARIES TO PROVIDE 1" GAP
BETWEEN DECK AND
BALLAST WALL AT TIME
OF CASTING BALLAST
WALL.



NORTH

PLAN
1:50

SOUTH

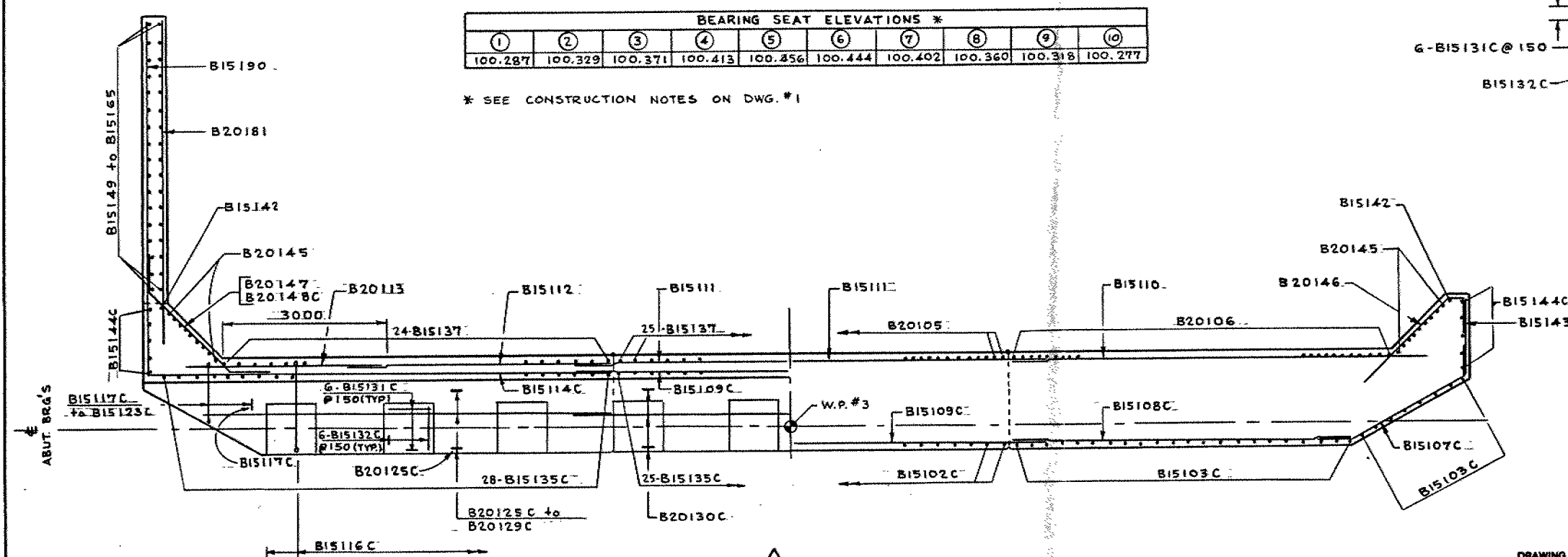


ELEVATION
1:50

BEARING SEAT ELEVATIONS *									
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
100.287	100.329	100.371	100.413	100.456	100.444	100.402	100.360	100.318	100.277

* SEE CONSTRUCTION NOTES ON DWG. #1

NOTE :-
F.F. DENOTES FRONT FACE
B.F. DENOTES BACK FACE



DRAWING NOT TO BE SCALED
100 mm ON ORIGINAL DRAWING

REVISIONS					
DATE	BY	DESCRIPTION			
DESIGN M.G. CHK		CODE 01WDC-83 LOAD CLASS A DATE Nov. 91			
DESIGN GFM:CHK M.G.		SITE 03-546 ISTRUCT SCHEME DWG. 5			

METRIC

DIMENSIONS ARE IN METRES
AND/OR MILLIMETRES
UNLESS OTHERWISE SHOWN

CONT No
WP No 121-87-07

KNOXDALE ROAD INTERCHANGE
UNDERPASS
PIER DETAILS & BEARINGS

SHEET
268

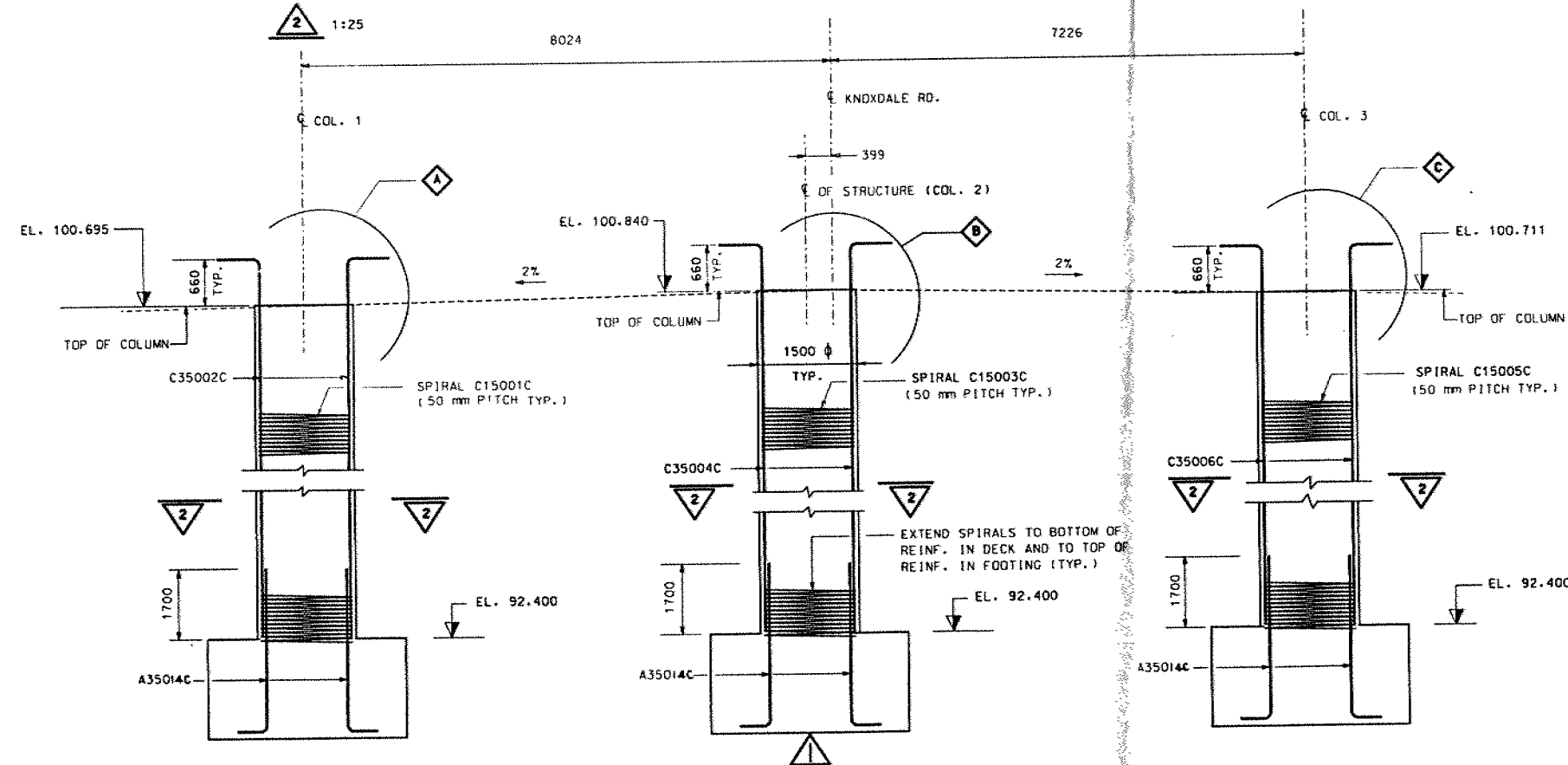
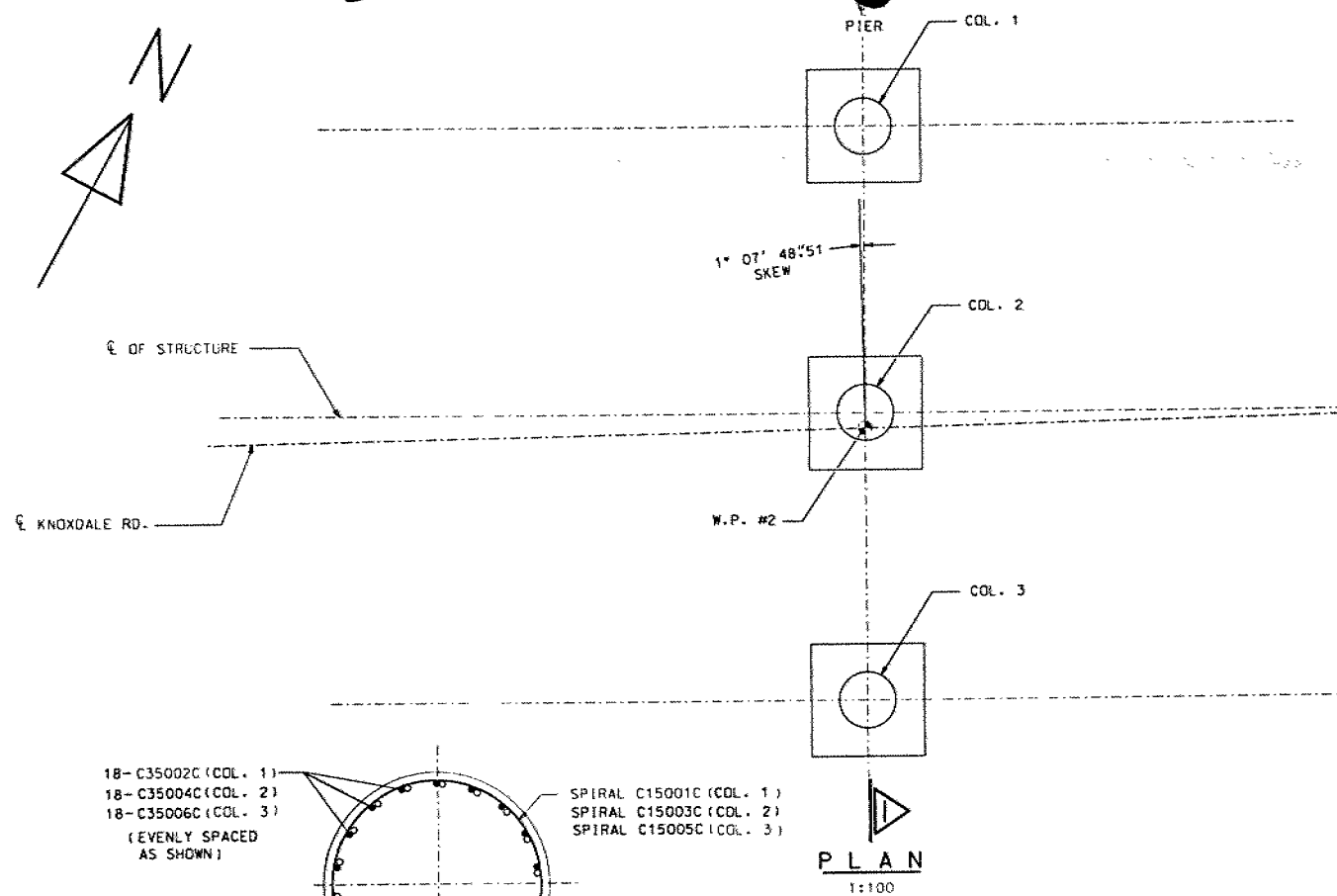
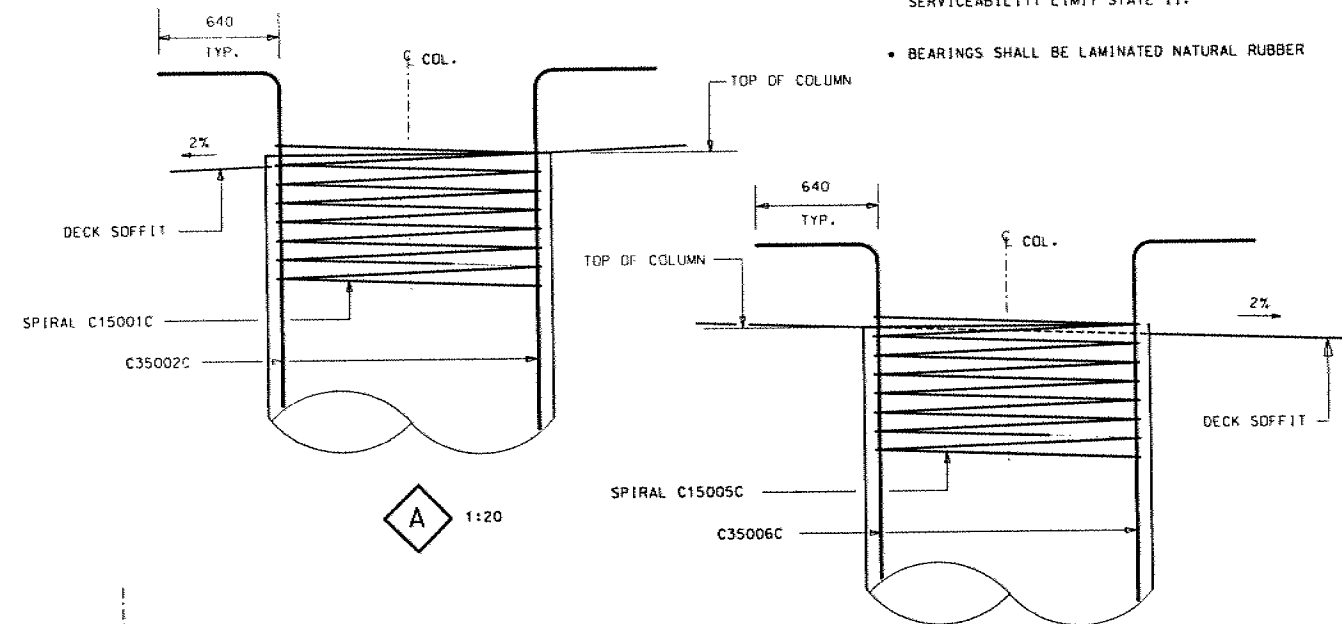
ELASTOMERIC BEARING DESIGN DATA

LOCATION	LOADING (kN)		MAXIMUM MOVEMENT (mm)	MAX. ALLOW. SHEAR RATE (kN/mm)	No. REQ'D	SIZE (mm)
	D	D+L+I				
WEST ABUT.	1050.	1470.	± 55	2.01	10	500X600X150
EAST ABUT.	1050.	1470.	± 55	2.01	10	500X600X150

NOTES :

ABUTMENT BEARING DETAILS

- GIVEN LOADS, PER BEARING, ARE AT SERVICEABILITY LIMIT STATE II.
- BEARINGS SHALL BE LAMINATED NATURAL RUBBER



DRAWING NOT TO BE SCALED
100 mm ON ORIGINAL DRAWING

REVISIONS	DESCRIPTION
DESIGN M.G.C.HK	CODE DHRDC-A5
DRAWN M.G.C.HK	SITE 3-546
STRUCT	SCHEME
DWG	7

MEMORANDUM



To: T. Lane
Head, Structural Section
Eastern Region

Date: October 21, 1994

Atten: David Kerr

From: Pavements and Foundations
Room 315, Central Building

Tel: 235-3731
Fax: 235-5240

Re: High Mast Lighting Pole No. P4 Footing
Contract 93-66/W.P. 122-87-00
Highway 416, District 9, Ottawa

The above high mast pole footing was inspected on 94 10 19 by M. Vasavithasan, Foundation Engineer along with David Kerr, Structural Engineer, Structural Section, Eastern Region.

The excavation for the construction of the caisson as well as drilling of eight 100 mm dia. holes for the dowels have been completed. The holes for the dowels have been advanced to a depth of about 3.6 m below the founding level of the caisson.

It was observed that the rock on the southwest quadrant of the excavation was heavily fractured and the holes for the dowels are filled with loose material to a depth of about 0.8 to 1.0 m. In addition, an attempt to lower the steel rod in two of the holes on the southwest quadrant was not successful.

Based on the observation made at the site, the following measures are suggested:

1. The holes should be cleaned prior to grouting.
2. The fractured part of the rock may be grouted through one of the holes with a maximum grouting pressure of about 40 to 50 kPa and redrilled to install the dowels.
3. The dowels on the southwest quadrant (3 dowels) of the caisson may be redesigned assuming a bond stress of about 175 kPa between the grout and the rock.

M. Vasavithasan

M. Vasavithasan, P. Eng.
Foundation Engineer
for

P. Payer, P. Eng.
Sr. Foundation Engineer

MV/PP/mmj

memorandum



To: E.C. Lane, P. Eng.
Head, Structural Section
Eastern Region

Attn: Darwyn Sproule, P. Eng.

From: Foundation Design Section
Room 315, Central Building

Subject: Falsework Support
Hwy 416, Log Farm Structure
Contract 93-66, Site #3-547
District 9, Ottawa

Date: 94 09 07

We refer to your memorandum dated 94 08 24 and the supplementary falsework support design report by Golder Associates Ltd. enclosed therein, and a subsequent faxgram from D. Kerr on 94 09 02 attached with Golder's original falsework support design report for our reference.

The supplementary report deals primarily with treatments in the ditch areas. The report has been reviewed and is found to be acceptable in general. For the gabion stone fill alternative, there should be contingency measures such as sump pumping in case the system clogs up.

A handwritten signature in black ink, appearing to read "David Kwok", with a long horizontal stroke extending to the right.

David Kwok, P. Eng.
Project Foundation Engineer
for
Paul Payer, P. Eng.
Senior Foundation Engineer

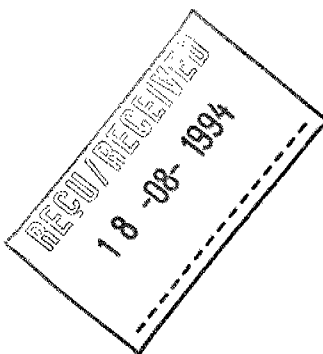
Golder Associates Ltd.

1796 Courtwood Crescent
Ottawa, Ontario, Canada K2C 2B5
Telephone (613) 224-5864
Fax (613) 224-9928



August 18, 1994

931-2319



Tarcon Ltd.
5597 Power Road
Gloucester, Ontario
K1G 3N4

Attention: Mr. G. Corriveau

RE: FALSEWORK SUPPORT
STRUCTURE 319, SITE 3-547
LOG FARM STRUCTURE
HIGHWAY 416, CONTRACT 93-66
NEPEAN, ONTARIO

Dear Sirs:

This letter provides additional guidelines on the falsework support for the above noted structure. This letter supplements the guidelines provided in our letter dated July 20, 1994 on this subject and should be read in conjunction with that letter.

An examination of the ditch areas along the sides and centre of the roadway indicates that a significant flow of water exists in these areas. To prevent damming of this water flow due to fill placement it is suggested that the ditch areas be filled with a compacted, coarse gabion stone (150 to 200 millimetre in size) or that a concrete pipe be installed in the middle of the ditch areas.

For the gabion stone fill alternative, it is suggested that all loose or disturbed material be removed from the areas beneath the gabion stone fill. To prevent migration of fine material into the gabion stone, with consequent settlement at ground, it is suggested that the gabion stone be fully wrapped (top, bottom, and sides but exclusive of the exposed ends) in a loosely placed, non-woven geotextile, such as Terrafix 600R, or approved equivalent. The gabion stone should extend across the wetted ditch area and at least 0.3 metres above the maximum expected water level in the ditch.

Prior to placement of additional fill to raise the grade adjacent to the ditches, it is suggested that the exposed existing, well graded blast rock fill be compacted with a large steel drum roller. Any soft areas should be subexcavated and replaced with compacted OPSS Granular B Type II. The grade adjacent to the ditches and above the gabion stone should then be raised with granular material meeting OPSS Granular B Type II, topped with at least 150 millimetres of OPSS Granular A. The granular materials should be compacted to at least 98 percent of the standard Proctor maximum dry density using suitable vibratory equipment.

To provide a levelling surface for the falsework sills, it is considered appropriate to use a thin, levelling layer of stone dust above the Granular A in the ditch areas and directly on top of the Granular O roadway base which is already in place.

Provided that all disturbed or soft material is removed from the ditch areas prior to placing the gabion stone and Granular B Type II, and that the imported materials are recompacted to the required densities, it is considered that the settlement of the falsework sills founded above the ditch and roadway areas should be less than 10 millimetres for an allowable sill bearing pressure of less than 200 kilopascals.

The following inspections should be carried out by geotechnical personnel:

- Examination of subgrade surfaces in the ditch areas prior to placing the filter geotextile and gabion stone
- Observation of compaction of the existing well graded crushed stone adjacent to the ditch areas, including approval of the subgrade surface prior to placing Granular B Type II
- Inspection of the installation of the filter geotextile
- In situ density testing on the imported granular materials. Testing should be carried out on each lift of material placed.

We trust that this letter provides sufficient information for your purposes. Should you have any questions concerning this letter, please call us.

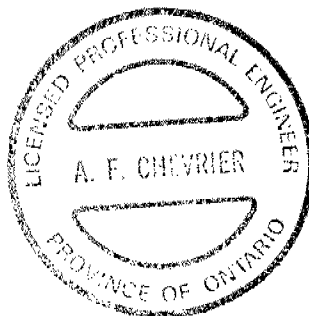
Yours truly,

GOLDER ASSOCIATES LTD.



A.F. Chevrier, P.Eng.
Associate

AFC:cn
LCN16



Golder Associates Ltd.

1796 Courtwood Crescent
Ottawa, Ontario, Canada K2C 2B5
Telephone (613) 224-5864
Fax (613) 224-9928



July 20, 1994

931-2316

Tarcon Ltd.
5597 Power Road
Gloucester, Ontario
K1G 3N4

Attention: Mr. G. Corriveau

RE: FALSEWORK SUPPORT
STRUCTURE #19, SITE #3-547
LOGFARM STRUCTURE
HIGHWAY 416, CONTRACT 93-66
NEPEAN, ONTARIO

Dear Sirs:

Further to our recent meeting on site, this letter provides our assessment of the subsurface conditions at the above site, and provides our guidelines for the support of falsework during the placement of concrete for the bridge deck.

Based on a visual inspection of the site, the falsework will be constructed over the ditches on either side of the highway, in the median, and across the highway driving platform. The subgrade consists of bedrock.

Filling at the abutments, however, will be required to fill excavations made during construction of the abutments. These excavations should be filled with 100 millimetre minus crushed stone meeting the specifications for OPSS Granular B Type II. The crushed stone should be compacted in maximum 300 millimetre lifts, to 98 percent of the standard Proctor maximum dry density using suitable vibratory compaction equipment. The 100 millimetre minus crushed stone should be topped with a minimum 150 millimetres of OPSS Granular A which will act as support for the falsework sills. The Granular A should be compacted to at least 98 percent of the standard Proctor maximum dry density using suitable vibratory equipment.

Within the median, the falsework should be supported on a levelled mat of 100 millimetre minus crushed stone topped with 150 millimetres of Granular A compacted and placed as discussed above. The 100 millimetre minus crushed stone in the ditches, at the abutments, and in the median will provide a suitable free draining zone through which surface runoff can occur along the ditches and still provide adequate support for the falsework.

Over the roadway sections, the sills for the falsework can be placed directly on top of the Granular O base which is already in place.

Tarcon Ltd.
Mr. G. Corriveau

-2-


July 20, 1994
931-2316

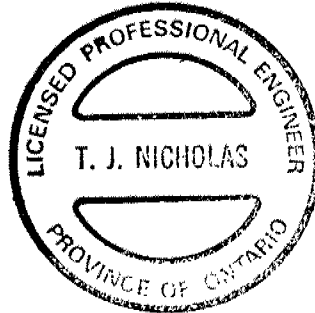
Settlement of the falsework is expected to be negligible to less than 10 millimetres over the roadway structure and ditches respectively, for allowable bearing pressures less than about 200 kilopascals.

We trust that this letter contains sufficient information for your present purposes. Should you have any questions regarding this letter, please call us.

Yours truly,

GOLDER ASSOCIATES LTD.


T.J. Nicholas, P.Eng.
Associate



TJN:cn
LCN15

M E M O R A N D U M



Ontario

To: T.C. Tam
Head, Construction Reviews
Approvals Section
7th Floor, Atrium Tower

Date: 94 07 19

From: Foundation Design Section
Room 315, Central Bldg.

Re: Contract 93-66, Knoxdale Rd. U'Pass
Falsework Foundation Report
W.P. 121-87-06, Site 3-546
District 9, Ottawa

We have reviewed the Falsework Foundation Report as submitted by Golder Associates for the above mentioned structure. The report has been found to be acceptable and hence we have no further comments.

A handwritten signature in black ink, appearing to read 'T. Sangiuliano'.

T. Sangiuliano, P. Eng.
Foundation Engineer

for

P. Payer, P. Eng.
Sr. Foundation Engineer

PP/TS/jb

Golder Associates Ltd.

1796 Courtwood Crescent
Ottawa, Ontario, Canada K2C 2B5
Telephone (613) 224 5864
Fax (613) 224 9928



June 6, 1994

931-2319

Tarcon Limited
5597 Power Road
Gloucester, Ontario
K1G 3N4

Attention: Mr. G. Corriveau

RE: ENGINEERED FILL
FALSEWORK SUPPORT
KNOXDALE ROAD UNDERPASS
SITE 3-546, HWY 416, DISTRICT 9
OTTAWA, ONTARIO

Dear Sirs:

This letter provides the results of the inspection and testing which was carried out on a per call basis at the above site during backfilling around the piers and the construction of an engineered fill on which to support falsework.

Golder Associates letter dated May 25, 1994 indicated that the excavation around the piers should be backfilled with a well compacted crushed stone meeting the requirements of OPSS Granular A or Granular B Type II. Due to wet conditions at the bottom of the excavation, however, approval was given by phone to use a well graded blastrock to provide support on the wet subgrade. The placing of this blastrock was observed by Mr. R. Legroulx on May 26, 1994 while he was on site for a concrete inspection. The blastrock used consisted of well graded limestone compacted in place using a vibratory plate wacker. The blastrock was placed to about 0.3 metres above the top of the pier footings. The remainder of the pier excavation and the engineered fill was constructed using a combination of available Granular A material obtained from the area around the abutments and Granular B Type II obtained from R.W. Tomlinson Limited. Prior to placing the crushed limestone fill, wet and loose material was stripped from the area. Subexcavation of softened material was carried out as required.

A sample of the Granular B Type II from R.W. Tomlinson Limited was obtained for laboratory testing to determine the moisture density relationship as indicated by the standard Proctor test. The results of the laboratory testing are shown on Figure 1 attached to this letter.

During the course of construction compaction testing was carried out on a per call basis. The results of the compaction testing are attached to this letter and indicate the level of compaction achieved during construction varied from about 97 to 100 percent of the measured standard Proctor maximum dry density.

U 8 -00- 1994

Based on the results of the compaction testing, the material used, and the method of compaction, it is considered that the engineered fill has been constructed in accordance with our letter dated May 25, 1994 and is considered acceptable and capable of supporting an allowable bearing pressure of 200 kilopascals.

We trust that this letter contains sufficient information for your present purposes. Should you have any questions regarding this letter, please call us.

Yours truly,

GOLDER ASSOCIATES LTD.



T.J. Nicholas, P. Eng.
Associate



TJN:cr
LCR9

Attachments:

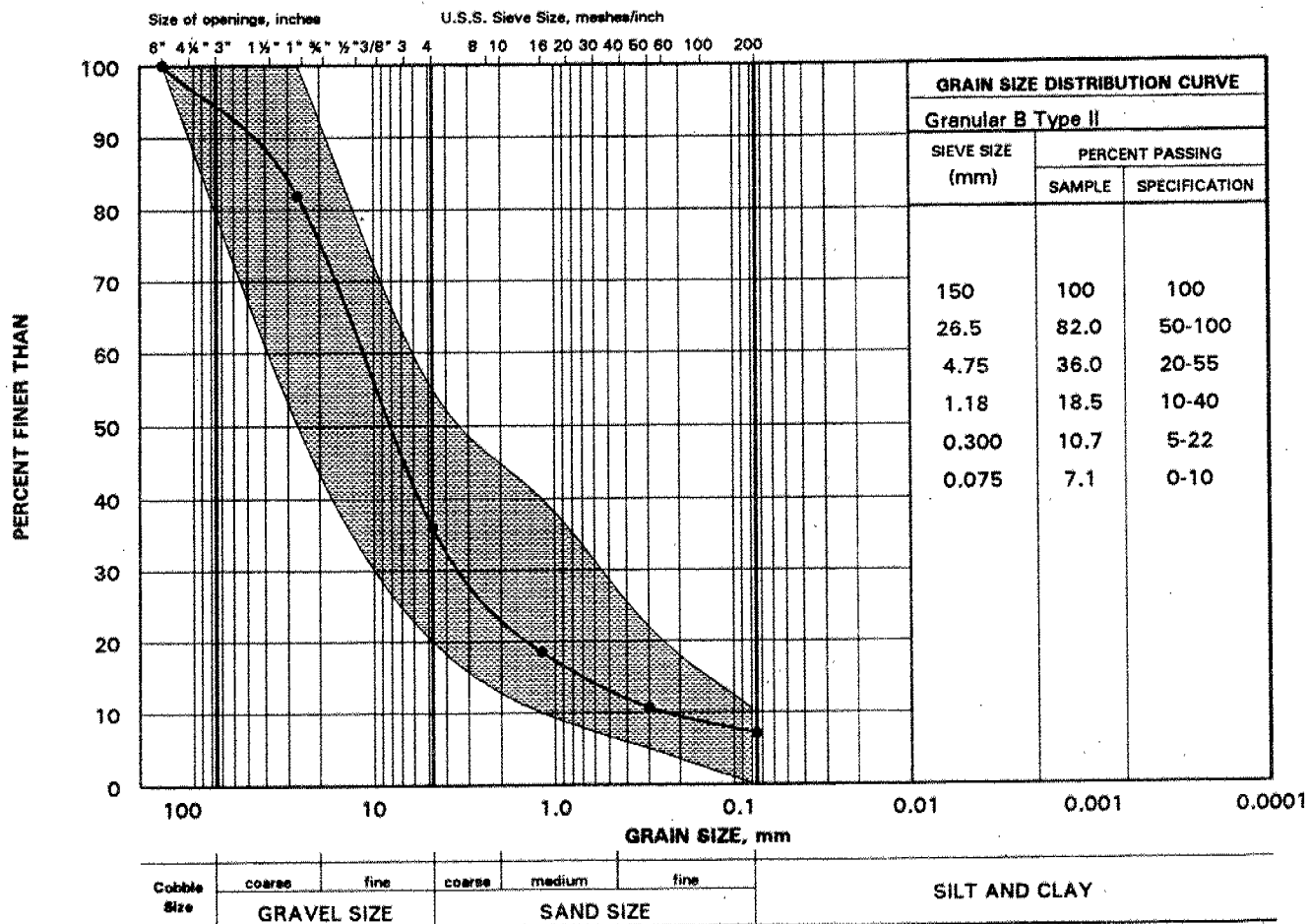
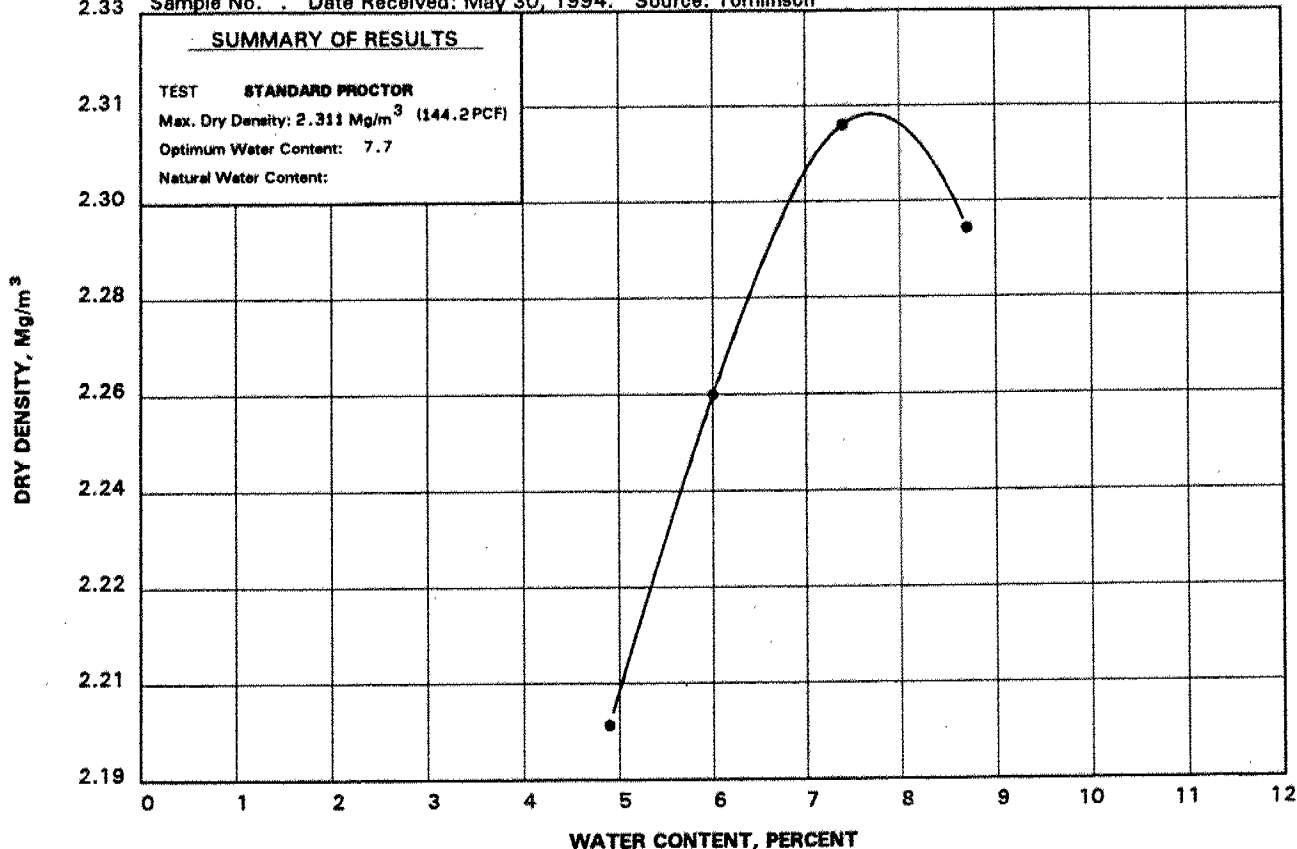
Figure 1
Field Nuclear Density Test Report Sheets

LABORATORY COMPACTION TEST RESULTS

FIGURE 1

Project No. 931-2319

2.33 Sample No. . Date Received: May 30, 1994. Source: Tomlinson



ProGrain ver. 2.01

FIELD NUCLEAR DENSITY TEST REPORT

R. J.

PROJECT No. 931-231-9 TEST DATE (S) JUNE 1, 1994 TESTED BY LEE R. ONLY

PROJECT TARLON / 416 QFT / NEPEAN

DESCRIPTION KNOXDALE SCAFFOLDING

CLIENT TARLON CONTRACTOR TARLON

FIELD COMPACTION METHOD RIDING VIB. ROLLER

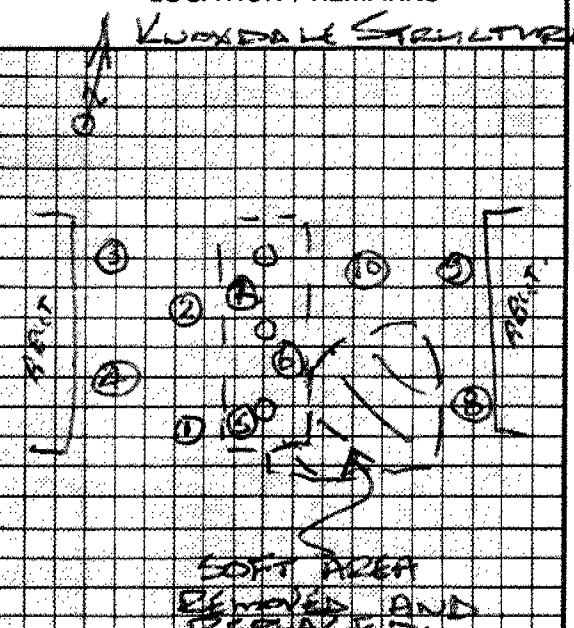
TYPE OF MATERIAL & SOURCE LOMLINSON BII'

☒ STANDARD
MODIFIED PROCTOR MAX. DENSITY 142 p.c.f. OPT. WATER CONTENT 8 %

SPECIFIED COMPACTION 98 % ☒ STANDARD
MODIFIED PROCTOR VALUE

☒ ESTIMATED VALUE

☐ LABORATORY VALUE

TEST NO.	ELEV. OF TEST	DRY DENSITY p.c.f.	WATER CONTENT %	% OF PROCTOR MAX. DENSITY	LOCATION / REMARKS
1	W/S SCAFFOLDING	142.4	3.4	100+	
2		139.4	4.0	98.2	
3		141.5	2.7	99.6	
4		147.8	3.8	100+	
5	100mm W/S	139.3	3.1	98.1	
6	SCAFFOLDING	142.2	3.4	100+	
7		141.6	2.7	99.7	
8	W/S SCAFFOLDING	142.3	2.5	100+	
9		144.1	3.1	100+	
10		141.5	3.6	99.6	

NOTE: Tests 1-7 (7:45 AM to 8:40 AM)
Tests 8-10 (9:30 AM to 10:00 AM)

Time 2.5 hrs
Mileage 30 km

RECEIVED BY

ISSUED BY

FIELD NUCLEAR DENSITY TEST REPORT

PROJECT No. 731-239 TEST DATE (SK) June 3/94 TESTED BY Ron J. LeComin

PROJECT TARLON / 416 QFT / NEPEAN 1200R

DESCRIPTION _____

CLIENT TARLON CONTRACTOR TARLON

FIELD COMPACTION METHOD Riding VIB. POWER

TYPE OF MATERIAL & SOURCE 2" c/s (Tomlinson)

STANDARD PROCTOR MAX. DENSITY... 142 p.c.f. OPT. WATER CONTENT... 8 %

MODIFIED

SPECIFIED COMPACTION... 98 % STANDARD PROCTOR VALUE

MODIFIED

☒ ESTIMATED VALUE

☐ LABORATORY VALUE

TEST NO.	ELEV. OF TEST	DRY DENSITY p.c.f.	WATER CONTENT %	% OF PROCTOR MAX. DENSITY	LOCATION / REMARKS
1	<u>415</u> <u>SLAB FOUND.</u>	<u>140.8</u>	<u>1.4</u>	<u>99.2</u>	<u>KNOWLEDGE ABUT</u> <u>STEPS</u>
2		<u>139.9</u>	<u>2.2</u>	<u>98.5</u>	
3		<u>141.7</u>	<u>1.7</u>	<u>99.8</u>	
4		<u>140.1</u>	<u>2.0</u>	<u>98.7</u>	
5		<u>141.6</u>	<u>2.3</u>	<u>99.7</u>	
6		<u>143.2</u>	<u>1.6</u>	<u>100+</u>	
7		<u>143.2</u>	<u>1.4</u>	<u>100+</u>	
8	<u>4</u>	<u>142.1</u>	<u>1.7</u>	<u>100+</u>	
Time: <u>10 hrs</u>					
MILEAGE: <u>15 km</u>					

NOTE :

RECEIVED BY _____

ISSUED BY [Signature]

memorandum



Tel. (613) 545-4793
Fax. (613) 545-4821

TO: T. Julian
Senior Project Supervisor
Construction Office
Ottawa, Ontario

FROM: Structural Section
Eastern Region - Kingston

RE: Contract 93-66
Knoxdale & Log Farm Structures
Highway 416, District 9, Ottawa

DATE: December 2, 1993

As discussed with Sonya Skinner on December 1st, 1993, the exposed footings/excavations at Knoxdale/Log Farm require protection against freezing conditions during the winter months. Although various methods of protection are available to the Contractor, the following were discussed:

Knoxdale - soil beneath the abutment spread footings must not be allowed to freeze. Protection could be provided by backfilling to the top of footing, and then placing straw or insulating blankets over the footing and 1m beyond on all sides. Freezing of the Granular "A" pad could result in heaving and/or loss of compaction. The Contractor should consider implications on falsework foundations resulting from the protection method selected.

Log Farm - to preserve the rock surfaces' seams beneath and behind the footings must also be protected against freezing. Since the footings will not be placed until next year, the excavation could be backfilled and protected with granular. Placing sufficient granular cover would avoid the need for straw or insulating blankets. The requirement for protection results from the delay over the winter months in completing the structures and final grading.

93 12 07

.../2

Suggested to Darwyn S that a clause should be added to inspect the foundation excavations next spring, after the gran. blanket is removed. There should also be provision to handle any damage caused because of frost penetration, in spite of frost protection.



T. Julian
December 2, 1993
Page 2

Please advise if additional information is required.

ORIGINAL SIGNED BY:

D.G. Sproule, P. Eng.
Sr. Structural Engineer
Highway 416

DGS:bd

c.c. G. Edwards
B. Finner
✓B. Iyer

memorandum



To: K.G. Bassi
Head, Structural Office
7th Floor, Atrium Tower

Date: 1992 05 13

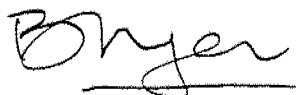
Attention: I. Husain

From: Foundation Design Section
Room 315, Central Building

Re: Review of Final Drawings and Documents
Knoxdale Rd I/C U'Pass, Hwy 416
W.P. 121-87-07, Site 03-546
District 9, Ottawa

We have reviewed the final drawings and documents on the above project and find that they conform to the recommendations provided by this Section.

We have no other comments.


Balu Iyer, P.Eng.
Sr. Foundation Engineer

for

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

cc. E.C. Lane

memorandum



To: M. S. Devata
Chief Foundation Engineer
Foundation Design Section
Room 315, Central Building

Date: 90-09-04

File No: 3162-2-4-113

Attn: M. Michalek

From: Soils and Aggregates Section
Engineering Materials Office
Room 311, Central Building

Re: Borehole Core Descriptions
Highway 416/Knoxdale Road, Nepean
WP 121-87-07

As requested by your section, core from four (4) boreholes was logged, and a description is appended. Depth to bedrock and depth to top of unweathered rock in each borehole are tabulated below:

Borehole Number	Depth to Bedrock in meters below ground surface	Depth to Unweathered Rock (including slightly weath- ered) in meters below ground surface
1	3.25	3.25
4	4.32	4.32
5	3.33	3.33
6	4.57	4.57

Bedrock is **DOLOSTONE** of the Oxford Formation. If you have any questions, please contact me.

D. A. Williams

D. A. Williams
Petrographer

Attachment

memorandum



To: I. Husain

Date: 91/08/06

Att: M. Gergely

Frm: Foundation Design Section
Rm 315, Central Building

Re: Revisions to Hwy 416 - Knoxdale U' Pass
Wp 121-87-07, District 9, Ottawa

This memo is to confirm and clarify the items discussed with Mr. Gergely by telephone on Aug. 7/91

1. The statement on page 8 (4th paragraph) of the Foundation Report should be corrected to read,

"THE UNFACTORED COEFFICIENT OF FRICTION OF 0.7 AND 0.58 SHALL BE USED FOR FOOTINGS LOCATED ON GRANULAR PAD AND BEDROCK RESPECTIVELY."

-This error has been rectified in our files, please make a note for future reference in any copies of the report in your possession.

I apologize if this error has caused any delay.

2. For a 5.5 m wide abutment footing a 2 m thick granular pad is recommended.

If you have any questions please do not hesitate to contact this office.

A handwritten signature in dark ink, appearing to read "M. Michalek".

M. Michalek
Jr. Foundation Engineer
For:
Dr. B. Iyer, P. Eng.
Sr. Foundation Engineer

memorandum



To: I. Husain
Design Engineer
Structural Office
7 th Floor Atrium Tower

Date: 91/06/20

Fm: Foundation Design Section
Room 315, Central Building

Re: Knoxdale Road I/C U'Pass
W.P. 121-87-07, Site 03-546
District 9, Ottawa

Comments concerning the General Arrangement Drawing 03-546-P1 are as following:

1. The pier footing may be supported on the bedrock surface placed at an elevation of 90.9 metres. This was satisfactorily indicated. Also note, pier footings may be alternatively supported on Mass Concrete placed above the bedrock surface.
2. The abutments were to be placed on a Granular pad which we specified to have a 1 m thickness for a footing width of 3 m. Alternatively the pad thickness would have to be 2.5 m thick for a 6.5 m wide footing. By scaling the width of the footings off the general arrangement drawing we found the footings to be 5 m, however the pad thickness was only 1 m. We were notified that the footing width was to be 6.5 m, please check.
3. Subexcavation of any loose material and proof rolling of the surface is not indicated on the drawing, we are assuming this will be indicated on the final drawing.
4. The foundation investigation report indicated that there are no stability problems for the 6 m approach embankments constructed with 2H : 1V side slopes. Scaling off the General Arrangement Drawing we found the approach embankments to be closer to 7 m high, for which 2H : 1V side slopes are also acceptable.

If you have any questions please do not hesitate to contact this office.

MARTIN MICHALEK

M. Michalek

Jr. Foudation Engineer

For:

Dr. B. Iyer, P. Eng

Sr. Foundation Eng.

memorandum



To: I. Husain
Design Engineer, Structural Office
7th Floor, Atrium Tower

Date: 1991 06 17

Attn: M. Gergely

From: Foundation Design Section
Room 315, Central Bldg.

Re: Hwy. 416 - Knoxdale U'Pass
W.P. 121-87-07
District 9, Ottawa

This memo is to confirm the items discussed during the meeting of June 10, 1991.

✓ 1. The pier footings may be founded on bedrock at elevation 90.9 m. Some excavation below the bedrock surface may be required especially towards the north side of the pier foundation.

✓ 2. Excavations for pier foundations would extend below the groundwater level. It is expected that the groundwater inflow into excavations would be relatively small. Water entering the excavations may be handled by means of oversized excavations together with pumping from sumps.

NSSP for dewatering will not be required provided the existence of high groundwater level and the need to keep excavations dry are identified in the contract documents.

✓ 3. Unfactored coefficient of friction of 0.58 and 0.70 shall be used for footings located on granular pad and bedrock respectively.

✓ 4. Recommendations regarding design bearing capacities were given to you earlier for a 3 m wide footing on a minimum 1 m thick granular pad.

may be used ~~were recommended~~ for a 6.5 m wide footing, the thickness of the granular pad ~~should be~~ about 2.5 m. *provided*

We trust that the recommendations given in this memo are sufficient for your immediate design needs.

Dr. B. Iyer, P. Eng.
Sr. Foundation Engineer

BI/jb

MEMORANDUM

To: I. HUSAIN
Design Engineer
Structural Office,
7th Floor, Atrium tower

Atten: M. N. GERGELY

From: Foundation Design Section
Rm 315, Central Building

Re: Knoxdale Rd/Hwy 416, W.P. 121-87-07, District 9, Ottawa.

This memo is in response to your recent request regarding certain foundation aspects related to the pier and abutment footings.

1. At the pier location, bedrock was encountered at elevation 91.2 m; or 3.8 m below existing grade.
2. The overburden soils encountered at the abutment locations are competent. Bedrock was encountered at shallow depths in these areas. Based on the above data it is considered that shallow spread footings located on 1 m thick granular 'A' material shall be designed using the bearing capacity values quoted in our preliminary report.

If there are any further questions regarding this project please do not hesitate to contact this office

MARTIN MICHALEK

M. Michalek,
Jr. Foundation Engineer
For: Dr. B. Iyer, P. Eng.
Senior Foundation Eng.

cc E.C. Lane

memorandum



To: E.C. Lane
Head, Structural Section
Kingston

Date: 1990 09 21

Atten: B. Loken, Trainee Engineer

From: Foundation Design Section
Room 315, Central Building

Re: Knoxdale Road Underpass
W.P. 121-87-07, Site 3-546
Hwy. 416, District 9, Nepean (Ottawa)

This memorandum summarizes the results of a foundation investigation conducted at the aforementioned site and provides preliminary comments pertaining to the structure foundations and related earthworks. These comments have been submitted in advance of the final report to assist in expediting the design so that conformance to project scheduling can be met. The final report will be submitted in the near future.

Proposed Structure

It is proposed to construct a two span structure which will carry Knoxdale Road over the proposed Highway 416 at Cedarview Road in the City of Nepean, Regional Municipality of Ottawa-Carleton. Approach fills in the order of magnitude of 6 will be required. At the pier locations about 1.5 m cut will be involved.

Site Description and Geology

The topography of the area is generally flat to gently undulating with ditches on either side of Knoxdale Road. Land throughout this area is being used for agricultural and dairy farming with the north side of Knoxdale Road used as a grazing pasture and the south side a cornfield. A dairy farm is located further west of the site. The natural ground level is generally flat with the highest and lowest elevations being 95.86 m at the east approach and 94.25 m at the west abutment.

Seven boreholes were carried out at this site. Rockcores and cone penetration tests were taken at abutment and pier locations.

The subsoil stratigraphy at the site consisted of 2.5 - 4.9 metres of a sandy-clayey silt till which had a higher percentage of gravel particularly at lower depths below an elevation of 932.5 m where probable boulders are present. This stratum was in turn underlain by a dolostone bedrock at an elevation of 91.4 m - 93 m, generally following the shape of the natural ground level. Groundwater levels observed at the time of the investigation varied from 93 m to 94.75 m corresponding to a depth of 40 cm - 2 m below the natural ground surface.

Discussion and Recommendations

The following foundation/geotechnical items are hereby discussed.

- 1) Structure Foundation
- 2) Approach Embankments
- 3) Construction Considerations

Structure Foundations

For the abutment locations the addition of 6 metres of fill specified in the design of the approaches will allow the use of spread footings perched within this material. The surficial till was found to be soft to firm thus the original ground level needs to be proof rolled with any soft soil encountered being excavated and replaced by compacted granular fill.

For spread footings founded on a granular 'A' core and constructed as per MTO standards, the following design parameters are recommended:

	<u>Factored Capacity</u> <u>at U.L.S. (kPa)</u>	<u>Allowable Capacity</u> <u>at S.L.S. Type II (kPa)</u>
Spread Footings	900	350

The piers are located within a 1.5 metre cut within the surficial till. Since this material was found to be unacceptable to support the pier foundation, the footing should be placed directly on the surface of the bedrock.

For purposes of the O.H.B.D.C., it is recommended that the footings located on bedrock be designed using a factored capacity at U.L.S. of 3000 kPa. The bedrock is considered to be an unyielding foundation base and hence the bearing capacity at S.L.S. Type II will not govern design.

The foundations should be provided with a minimum of 1.8 m of earth cover for frost protection purposes.

Approach Embankments

The proposed finished grade is set at about 6 m above the finished grade. No stability problems are anticipated for the approach embankments constructed with 2 horizontal to 1 vertical side slopes. The fill material should consist of well compacted acceptable material.

It is anticipated that approximately 45 mm of total settlement can be realized as a result of elastic settlements induced within the fill itself and the elastic recompression of the native subsoil. It is expected that the majority of these settlements will be realized during or immediately following construction.

Construction Consideration

Within the limits of the approach fills, if soft soil is encountered this should be excavated and replaced by compacted granular fill.

Advanced dewatering of the site may be necessary at pier locations.

No other construction problems are anticipated at this site.

If you have any questions regarding the above comments or require additional information, please do not hesitate to contact this office.



M. Michalek, P. Eng.
Trainee Engineer

for

Dr. B. Iyer, P. Eng.
Sr. Foundation Engineer

MM/BI/mmj