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DIST. 6 REGION

W.P. No. 54-82-14 & 17

CONT. No. 93-45

W. O. No.

STR. SITE No. 24-194

HWY. No. 401

LOCATION Hwy 401 & Towden Rd. Overpass
E.B. & W.B. Core Lanes

No of PAGES - —

OVERSIZE DRAWINGS TO BE INCLUDED WITH THIS REPORT.

REMARKS:

FOUNDATION INVESTIGATION REPORT

CONTRACT NO. 93-45

Ontario

Ministry of
Transportation

INDEX

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

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 (R Q D), FOR MODIFIED RECOVERY, IS:

R Q D (%)	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
γ_s	kN/m^3	UNIT WEIGHT OF SOLID PARTICLES
ρ_w	kg/m^3	DENSITY OF WATER
γ_w	kN/m^3	UNIT WEIGHT OF WATER
ρ	kg/m^3	DENSITY OF SOIL
γ	kN/m^3	UNIT WEIGHT OF SOIL
ρ_d	kg/m^3	DENSITY OF DRY SOIL
γ_d	kN/m^3	UNIT WEIGHT OF DRY SOIL
ρ_{sat}	kg/m^3	DENSITY OF SATURATED SOIL
γ_{sat}	kN/m^3	UNIT WEIGHT OF SATURATED SOIL
ρ'	kg/m^3	DENSITY OF SUBMERGED SOIL
γ'	kN/m^3	UNIT WEIGHT OF SUBMERGED SOIL

e	1, %	VOID RATIO
n	1, %	POROSITY
w	1, %	WATER CONTENT
S_r	%	DEGREE OF SATURATION
w_L	%	LIQUID LIMIT
w_P	%	PLASTIC LIMIT
w_S	%	SHRINKAGE LIMIT
I_P	%	PLASTICITY INDEX = $w_L - w_P$
I_L	1	LIQUIDITY INDEX = $\frac{w - w_P}{I_P}$
I_C	1	CONSISTENCY INDEX = $\frac{w_L - w}{I_P}$
e_{max}	1, %	VOID RATIO IN LOOSEST STATE

e_{min}	1, %	VOID RATIO IN DENSEST STATE
I_D	1	DENSITY INDEX = $\frac{e_{max} - e}{e_{max} - e_{min}}$
D	mm	GRAIN DIAMETER
D_n	mm	n PERCENT - DIAMETER
C_U	1	UNIFORMITY COEFFICIENT
h	m	HYDRAULIC HEAD OR POTENTIAL
q	m^3/s	RATE OF DISCHARGE
v	m/s	DISCHARGE VELOCITY
i	1	HYDRAULIC GRADIENT
k	m/s	HYDRAULIC CONDUCTIVITY
j	kN/m^3	SEEPAGE FORCE

FOUNDATION INVESTIGAION REPORT
For
Bridge #50
Hwy. 401 - Tomken Road Overpass
Eastbound Core Lanes/Westbound Core Lanes
W.P. 54-82-14 and 17 , Site No. 24-194
District 6, Toronto

INTRODUCTION

This report summarizes the information obtained from a foundation investigation carried out at the above mentioned site where three span twin structures are proposed to carry the Highway 401 over the Tomken Road.

The fieldwork was carried out between 89 09 18 and 89 09 21. Four boreholes (BH#50-1 to BH #50-4) were advanced and sampled as part of this project by means of solid stem augers with a conventional diamond drill (BW Casing and BXL Core barrel) adopted for rock sampling purposes. These boreholes extended down to depths of 2.8 and 6.4 metres below the existing ground surface.

This report contains factual information obtained from this investigation pertaining to structure No. 50 shown on Drawing No. 548214/17-A.*

SITE DESCRIPTION AND GEOLOGY

The site is located on the proposed alignment of Highway 401 core where it crosses the existing Tomken Road in the City of Mississauga, Regional Municipality of Peel. The proposed structures are located immediately north of the existing Highway 403 E.B. Core (Bridge #54) and immediately south of the existing Highway 403 W.B. Core (Bridge #24) which were constructed as part of the Highway 401/403 interchange complex. The topography in the area is generally flat to gently undulating with ground surface sloping gradually towards Lake Ontario. Land use in the vicinity of the site is primarily commercial and industrial subdivision development.

* SHEET NO 107-1 OF THE CONTRACT DWG'S

Physiographically, the site lies in the area known as the "Peel Plain" (Ref: Chapman and Putnam, 1984). The characteristic deposit, in the vicinity of the area under investigation, is composed of cohesive heterogeneous mixture of silty clay, sand and gravel, whose thickness varies from nil to 1.8 metres. The overburden is underlain by shale and dolostone bedrock. The bedrock is of the Georgian Bay Formation of the Ordovician period.

FIELD INVESTIGATION AND LABORATORY ANALYSES

The fieldwork for the site investigation was carried out between 89 09 18 and 89 09 21 and consisted of four (4) sampled boreholes accompanied by dynamic cone penetration tests. Among these, two (2) boreholes were put down on the existing Tomken Road. Two boreholes were driven at the abutment locations. Soil samples were retrieved generally at 1.5 m intervals by a split spoon sampler with the Standard Penetration Test (ASTM D1586). Samples were identified in the field and then returned to the laboratory for appropriate testing. Bedrock was cored at four borehole locations from about 1.5 metre to 4.7 metre depths using conventional rock coring methods.

Water levels were obtained in the open boreholes during the fieldwork. Survey information related to location and elevation of boreholes was provided by Central Region Surveys and Plans.

To identify the properties of the soil, the following laboratory tests were performed:

1) Atterberg Limit Tests
2) Grain Size Analyses
3) Natural Moisture Contents

Laboratory test results have been summarized and are included in the Appendix of this report.

SUBSURFACE CONDITIONS

The subsoil conditions are generally uniform across the site. The overburden consists of a shallow deposit of cohesive glacial till composed of a Heterogeneous mixture of silty clay, sand and gravel underlain by shale and dolostone bedrock. The maximum proven thickness of this deposit was found to be about 1.8 metres at BH 50-1 and 50-4. The upper portion of the shale was found to be weathered. In previous cut areas on the existing Tomken Road, exposed shale has been covered with a thin veneer of fill.

The boundaries between the various soil types, in situ and laboratory test results are shown the attached Record of Borehole Sheets in Appendix. The locations and elevations of the boreholes, along with a profile showing a soil stratigraphy based on borehole data, are shown on Drawing No. 548214/16-A.*

A detailed description of the subsurface conditions and road fill material is given below.

Fill Material

As previously mentioned, two (2) boreholes were driven at pier locations on the existing Tomken Road. These boreholes encountered some 1.1 metres of fill material whose composition ranged from a grey reworked cohesive glacial till and highly fragmented shale mixture to a brown sand and gravel.

Grain size distribution tests were carried out on some representative samples. Figures 1 and 3 in the Appendix show the results. Through visual observation and grain size distribution analyses, it is apparent that the road fill materials can be classified as a heterogeneous mixture of silty clay, sand and gravel (cohesive glacial till) and/or sand and gravel with some silt. The fill material extend from the existing road surface to a depth of 1.1 metres.

In sand and gravel stratum, the 'N' values ranged from 28 to over 100 blows/0.3 metres indicating a state of compaction described as compact to very dense. The

* SHEET NO 107-1 OF THE CONTRACT DWG'S

fill materials appear to have undergone a relatively high degree of compactive effort.

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

The natural surficial deposit overlying most of the site consists of a shallow deposit of cohesive glacial till composed of a heterogeneous mixture of silty clay of intermediate plasticity with varying amounts of gravel and some sand. The thickness of this layer was found to be about 1.8 metres.

Grain size distribution tests were carried out on cohesive glacial till material. Figure 3 in Appendix shows the results. An increasing frequency of fragments and detached slabs of weathered shale and dolostone were encountered within the lower portion of this till.

The results from the Atterberg Limit tests performed on cohesive material are summarized as follows:

	No. of Tests	Range (%)	Average (%)
Natural Moisture Content (w)	3	7-19	12.3
Liquid Limit (w_L)	3	31-42	36.1
Plastic Limit (w_P)	3	17-20.5	18.5
Plasticity Index (I_P)	3	12.5-21.5	17.6

From the plasticity chart (Figure 2), the layer can be classified as a heterogeneous mixture of silty clay with some sand and gravel with intermediate plasticty (CI).

In this stratum, the 'N' values ranged from 13 to over 100 blows/0.3 metres indicating the consistency of this deposit described as stiff to hard.

Bedrock

The shale and dolostone bedrock was encountered immediately beneath the glacial till deposit across the site. The upper 0.1 to 2.6 metres of the bedrock is in a weathered condition. The natural bedrock surface is about elevtion 170.5 metres corresponding to depth of approximately 1.8 metres below ground surface prior to cut excavations for the existing Tomken Road.

The existing bedrock surface along the Tomken Road is fairly level and is found between 0.9 and 1.1 metres below the ground or pavement surface. This corresponds to elevations ranging between 162.4 and 162.9 metres. Generally, however, the bedrock surface is found at about elevation 162.5 metres.

The bedrock is described as a dark grey to medium grey black, very fine grained very thinly laminated weak shale interbedded with thin layers of medium grey, fine grained, medium strong dolostone. This formation is generally weathered in the upper layers and frequently transitional with the overlying till layer containing frequent fragments and detached slabs of shale and dolostone. Detailed descriptions of the rock are attached in the Appendix entitled "Rock Core Description".

Core recoveries (CR) and Rock Quality Designation (RQD) values were determined in situ and also in the laboratory to evaluate the competence and integrity of the rock. Core recoveries range between 33 and 100 percent and Rock Quality Designation (RQD) values range from 0 to 10 percent. Based on these results, the rock can be classified as weak to very weak rock and slightly to moderately weathered.

GROUNDWATER CONDITIONS

No natural groundwater level was encountered during the site investigation in all boreholes. Upon completion of rock coring, the induced drill water remained

perched within the boreholes, indicating a low permeability for both the till and shale strata. The depressed profile grades of the existing Hwy. 401/Tomken Road geometry effectively drains the immediate structure location to the respective roadway grades.

MISCELLANEOUS

The fieldwork for this investigation was carried out under the supervision of Dale Colquhoun, Visiting Engineer from Jamaica. The equipment was owned and operated by Longyear Canada Ltd., Toronto.

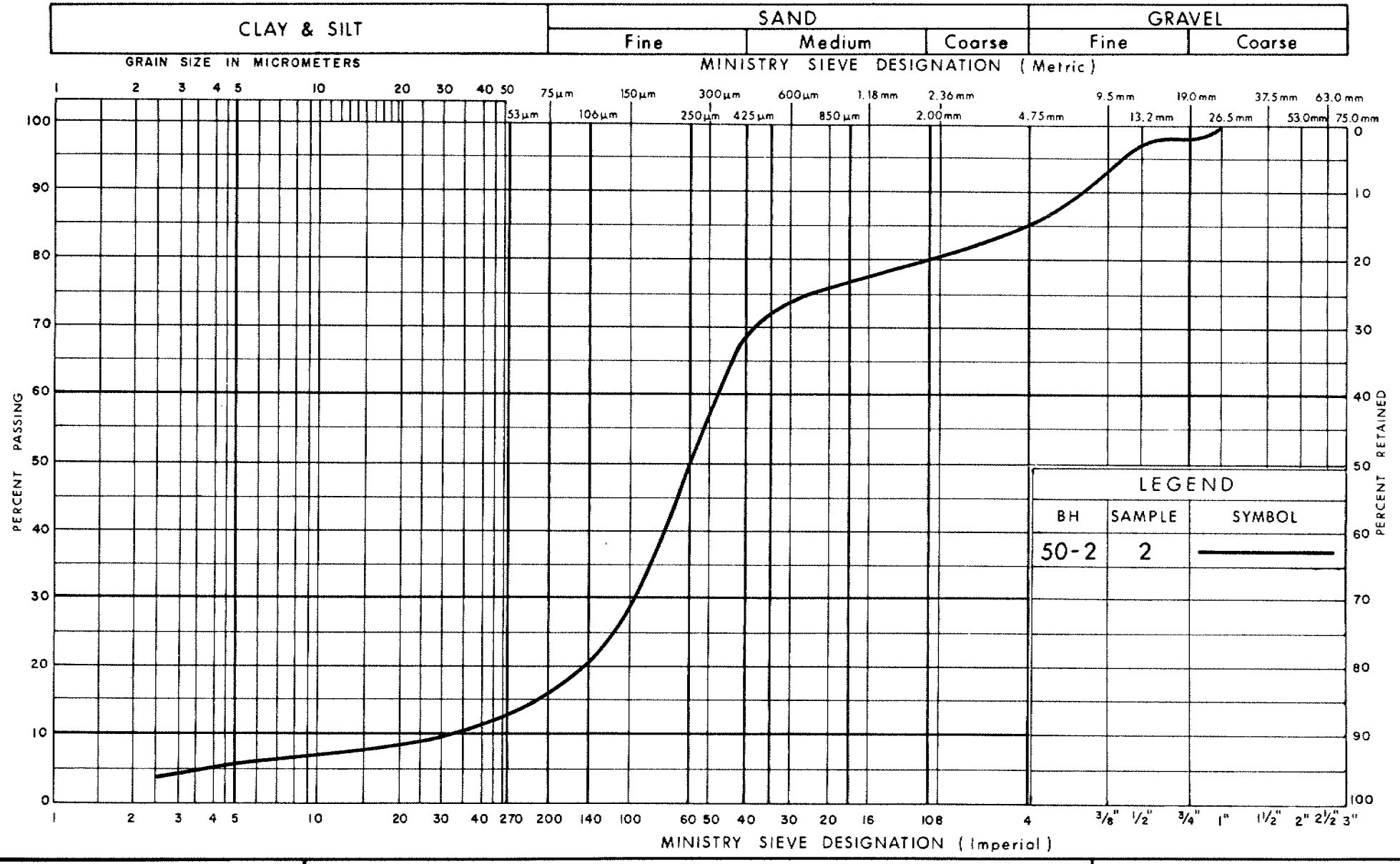
This project was carried out by Tae C. Kim under the general supervision of B. Iyer. This report was written by Tae C. Kim, Foundation Design Engineer, reviewed by Balu Iyer, Sr. Foundation Engineer, and approved by Murty Devata, Chief Foundation Engineer.

B. Iyer, P. Eng.
Senior Foundation Engineer

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

APPENDIX

UNIFIED SOIL CLASSIFICATION SYSTEM



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GRAIN SIZE DISTRIBUTION

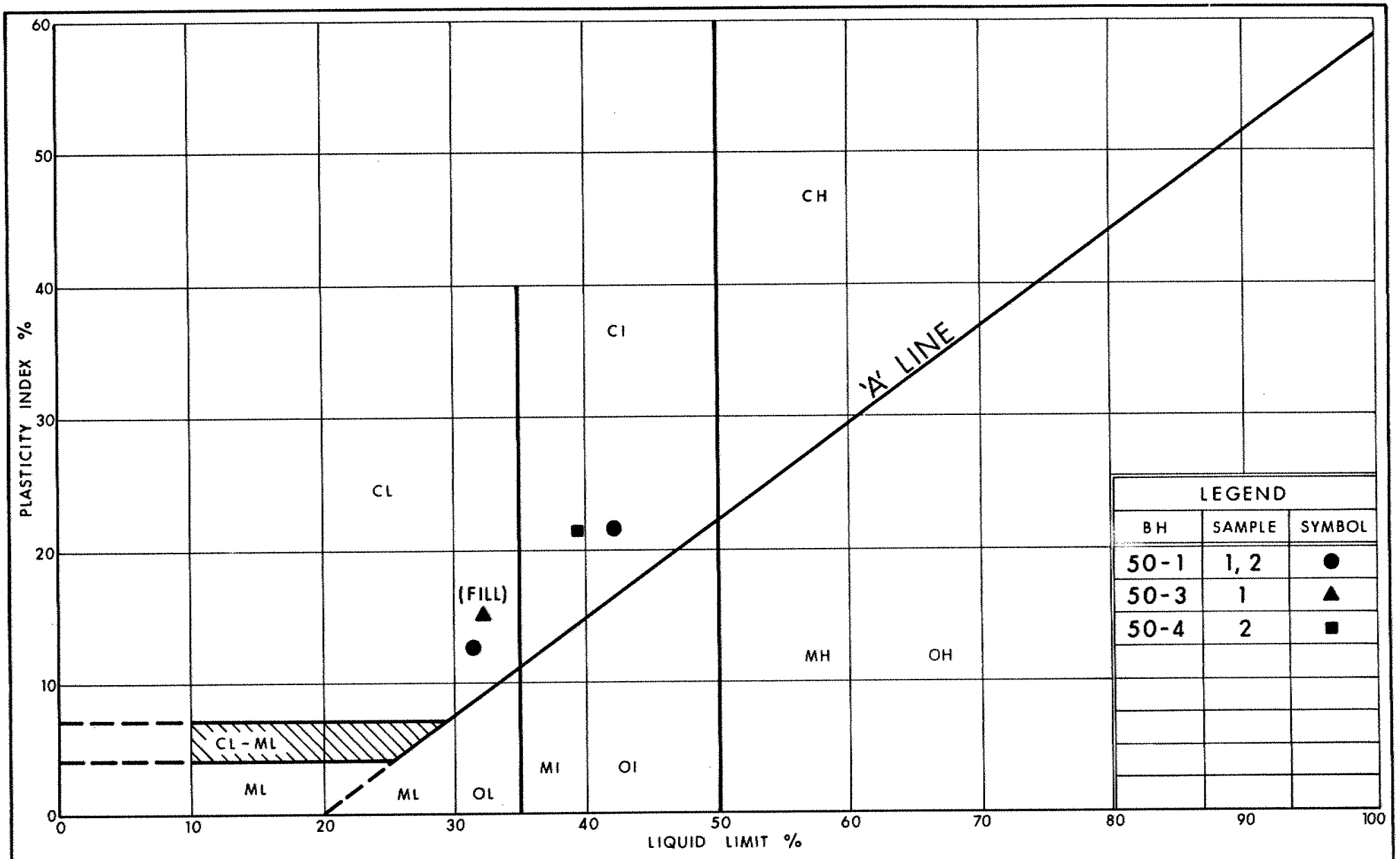
SAND & GRAVEL, SOME SILT (Fill)

FIG No 1

W P 54-82-14/17

10

Oct 75, FF-S-21



LEGEND		
BH	SAMPLE	SYMBOL
50-1	1, 2	●
50-3	1	▲
50-4	2	■

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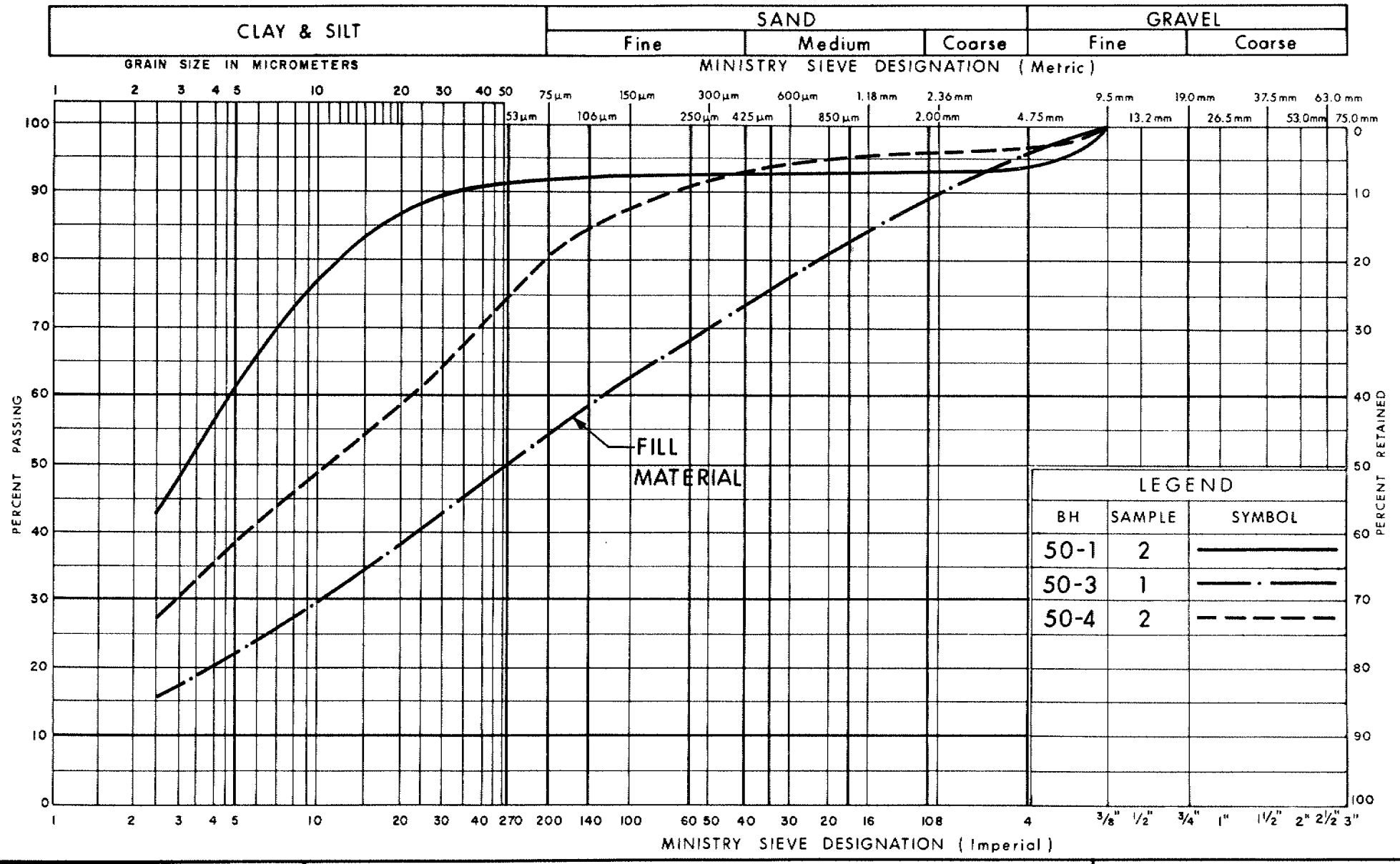
PLASTICITY CHART
HET MIXTURE OF SILTY CLAY, SAND & GRAVEL
(Glacial Till and Fill)

FIG No 2
W P 54-82-14/17
11

UNIFIED SOIL CLASSIFICATION SYSTEM



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GRAIN SIZE DISTRIBUTION
HET MIXTURE OF SILTY CLAY, SAND & GRAVEL
(Glacial Till and Fill)

FIG No 3

W P 54-82-14/17

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BOREHOLE CORE DESCRIPTION
WP 54-82-14/17

	CORE RECOVERY				CORE DESCRIPTION	
BH #	RC #	DEPTH (m)	CR* (%)	RQD* (%)	DEPTH (m)	DESCRIPTION
50-1	4	3.30-4.26	74	0	3.30-4.44	DOLOSTONE, medium grey, fine grained; interbedded with dark grey to greyish black shale seams (21%); medium strong rock; unweathered to slightly weathered; very closely spaced fractures: horizontal, irregular.
	5	4.26-5.74	100	0	4.44-5.74	SHALE, dark grey to medium grey black, very fine grained very thinly laminated; weak to very weak rock; slightly weathered; very close to extremely close spaced fractures: horizontal partings along laminae.
50-2	3	1.22-2.74	33	0	1.22-4.27	SHALE, dark grey to medium grey black, very fine grained very thinly laminated; interbedded with **DOLOSTONE** beds (14%) up to 15 cm; weak to very weak rock; slightly weathered; very close to extremely close spaced fractures: horizontal partings along laminae.
	4	2.74-4.27	97	10		
50-3	3	1.28-1.36	100	0	1.28-2.76	SHALE, dark grey to medium grey black, very fine grained very thinly laminated; interbedded with **DOLOSTONE** (22%) up to 8 cm; weak to very weak rock; slightly weathered; very close to extremely close spaced fractures: horizontal partings along laminae.
	4	1.36-2.76	95	0		
50-4	3	1.83-3.35	72	0	1.83-3.05	SHALE, greyish yellow green with weathered fragments of DOLOSTONE (5%); weak to very weak rock; intensely to completely weathered, very close to extremely close spaced fractures.
	4	3.35-4.88	88	0	3.05-6.46	SHALE, dark grey to medium grey black, very fine grained very thinly laminated; minor interbeds of **DOLOSTONE** (8%) up to 8 cm; weak to very weak rock; slightly to moderately weathered; close to extremely close spaced fractures: horizontal partings along laminae.
	5	4.88-6.46	98	0		

***CR = CORE RECOVERY** (NOTE: Depths are approximated in zones of poor core recovery.)
***RQD = ROCK QUALITY DESIGNATION**
Logged by: SAS, Soils and Aggregates Section.

RECORD OF BOREHOLE No 50-1 METRIC

W P 54-82-14/17 LOCATION Co-ords: N 4 833 331.2 ; E 292 405.2 ORIGINATED BY DC

DIST 6 HWY 401 BOREHOLE TYPE Solid Stem Auger, BW Casing, BXL Core Barrel & Cone Test COMPILED BY DC

DATUM Geodetic DATE 89 09 20 to 21 CHECKED BY TCK

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) SHEAR STRENGTH kPa ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE	PLASTIC LIMIT Wp — NATURAL MOISTURE CONTENT W — LIQUID LIMIT WL WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES						
172.8	Ground Level										
0.0	Heterogeneous Mixture of Silty Clay, Sand and Gravel Brown to Grey (Glacial Till) Stiff to Hard		1	SS	13	*	172		○		
171.0			2	SS	39		171		○		8 3 52 37
1.8	Bedrock Shale and Weathered / Unweathered Dolostone Medium to Dark Grey		3	SS	29		170	140			
			4	BXL RC	REC 74%		169				RQD = 0%
			5	BXL RC	REC 100%		168				RQD = 0%
167.0											
5.8	End of Borehole										

* Note

Water Level was not Encountered during the Site Investigation

+3, ×5 : Numbers refer to Sensitivity

20 / 15 ◇ 5 / 10 (%) STRAIN AT FAILURE

OFFICE REPORT ON SOIL EXPLORATION

RECORD OF BOREHOLE No 50-2 METRIC

W P 54-82-14/17 LOCATION Co-ords: N 4 833 365.2; E 292 403.3 ORIGINATED BY DC

DIST 6 HWY 401 BOREHOLE TYPE Solid Stem Auger, BW Casing, BXL Core Barrel & Cone Test COMPILED BY DC

DATUM Geodetic DATE 89 09 19 CHECKED BY TCK

SOIL PROFILE ELEV/DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (o UNCONFINED, • QUICK TRIAXIAL, + FIELD VANE, × LAB VANE)	PLASTIC LIMIT Wp / NATURAL MOISTURE CONTENT W / LIQUID LIMIT W_L / WATER CONTENT (%)	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
164.0	Ground Level							20 40 60 80 100	10 20 30		
0.0	Sand and Gravel Some Silt (Fill)		1	SS	28						
162.9			2	SS	88	*	163		o		15 68 14 3
1.1	Weathered / Unweathered Bedrock Shale and Dolostone Dark Grey to Medium Black		3	BXL RC	REC 33%		162	100/8cm			RQD = 0%
			4	BXL RC	REC 97%		161				RQD = 10%
159.7							160				
4.3	End of Borehole										

*
Note
Water Level was not Encountered during the Site Investigation

OFFICE REPORT ON SOIL EXPLORATION

+3, ×5 : Numbers refer to Sensitivity

15 ⊹ 5 (%) STRAIN AT FAILURE (20 / 10)

Ministry of Transportation Ontario

RECORD OF BOREHOLE No 50-3 METRIC

W P 54-82-14/17 LOCATION Co-ords: N 4 833 350.6; E 292 441.4 ORIGINATED BY DC

DIST 6 HWY 401 BOREHOLE TYPE Solid Stem Auger, BW Casing, BXL Core Barrel & Cone Test COMPILED BY DC

DATUM Geodetic DATE 89 09 18 CHECKED BY TCK

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa	PLASTIC LIMIT Wp / NATURAL MOISTURE CONTENT W / LIQUID LIMIT WL / WATER CONTENT (%)	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100; o UNCONFINED + FIELD VANE; • QUICK TRIAXIAL × LAB VANE	10 20 30		GR SA SI CL
163.3	Ground Level										
0.0 / 163.0	Silty Clay (Fill)		1	SS	27	*	163		o		4 40 44 12
0.3	Sand and Gravel (Fill)										
162.4			2	SS	150/ 28cm			100/ 24cm			
0.9	Weathered / Unweathered Bedrock: Shale and Dolostone, Dark Grey and Medium Black		3	RC	100% REC		162				RQD = 0%
160.5			4	BXL RC	REC 95%		161				RQD = 0%
2.8	End of Borehole										

* Note

Water Level was not Encountered during the Site Investigation

+3, ×5 : Numbers refer to Sensitivity

20 / 15 ◇ 5 / 10 (%) STRAIN AT FAILURE

OFFICE REPORT ON SOIL EXPLORATION

RECORD OF BOREHOLE No 50-4 METRIC

W P 54-82-14/17 LOCATION Co-ords: N 4 833 386.3; E 292 442.3 ORIGINATED BY DC
DIST 6 HWY 401 BOREHOLE TYPE Solid Stem Auger, BW Casing, BXL Core Barrel & Cone Test COMPILED BY DC
DATUM Geodetic DATE 89 09 19 CHECKED BY TCK

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa	WATER CONTENT (%)	UNIT WEIGHT	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100; o UNCONFINED + FIELD VANE; • QUICK TRIAXIAL × LAB VANE	PLASTIC LIMIT W_p — NATURAL MOISTURE CONTENT W — LIQUID LIMIT W_l; 10 20 30	γ	GR SA SI CL
172.2	Ground Level										
0.0	Heterogeneous Mixture of Silty Clay, Sand and Gravel					*	172				
	Brown to Grey		1	SS	19						
	(Glacial Till)						171	150/20cm			
170.4	Stiff to Hard		2	SS	90/ 10cm						3 14 58 25
1.8	Bedrock										
	Shale and Dolostone		3	BXL RC	REC 72%		170				RQD = 0%
	Dark Grey to Medium Black						169				
	Weathered / Unweathered		4	BXL RC	REC 88%		168				RQD = 0%
			5	BXL RC	REC 98%		167				RQD = 0%
165.8							166				
6.4	End of Borehole										

* Note

Water level was not Encountered during the Site Investigation

OFFICE REPORT ON SOIL EXPLORATION

+3, ×5 : Numbers refer to Sensitivity

20
15 ⊹ 5 (%) STRAIN AT FAILURE
10

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FOUNDATION DESIGN SECTION

foundation investigation and design report

CONT 93-45

ENGINEERING MATERIALS OFFICE
FOUNDATION DESIGN SECTION

WP 54-82-14 and ~~16~~ 17 DIST 6

HWY 401 STR SITE 24-194

Bridge #50
Hwy. 401 - Tomken Road Overpass
Eastbound Core Lanes/Westbound Core Lanes

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GEOCRES 30M12-210

DATE NOV 0 1 1989

FOUNDATION INVESTIGAION REPORT

For

Bridge #50

Hwy. 401 - Tomken Road Overpass

Eastbound Core Lanes/Westbound Core Lanes

W.P. 54-82-14 and 16, Site No. 24-194

District 6, Toronto

INTRODUCTION

This report summarizes the information obtained from a foundation investigation carried out at the above mentioned site where three span twin structures are proposed to carry the Highway 401 over the Tomken Road.

The fieldwork was carried out between 89 09 18 and 89 09 21. Four boreholes (BH#50-1 to BH #50-4) were advanced and sampled as part of this project by means of solid stem augers with a conventional diamond drill (BW Casing and BXL Core barrel) adopted for rock sampling purposes. These boreholes extended down to depths of 2.8 and 6.4 metres below the existing ground surface.

This report contains factual information obtained from this investigation together with discussion and recommendations pertaining to structure foundations, approach embankments and related earthworks for the structure No. 50 shown on Drawing No. 548214/16-A.

SITE DESCRIPTION AND GEOLOGY

The site is located on the proposed alignment of Highway 401 core where it crosses the existing Tomken Road in the City of Mississauga, Regional Municipality of Peel. The proposed structures are located immediately north of the existing Highway 403 E.B. Core (Bridge #54) and immediately south of the existing Highway 403 W.B. Core (Bridge #24) which were constructed as part of the Highway 401/403 interchange complex. The topography in the area is generally flat to gently undulating with ground surface sloping gradually towards Lake Ontario. Land use in the vicinity of the site is primarily commercial and industrial subdivision development.

Physiographically, the site lies in the area known as the "Peel Plain" (Ref: Chapman and Putnam, 1984). The characteristic deposit, in the vicinity of the area under investigation, is composed of cohesive heterogeneous mixture of silty clay, sand and gravel, whose thickness varies from nil to 1.8 metres. The overburden is underlain by shale and dolostone bedrock. The bedrock is of the Georgian Bay Formation of the Ordovician period.

FIELD INVESTIGATION AND LABORATORY ANALYSES

The fieldwork for the site investigation was carried out between 89 09 18 and 89 09 21 and consisted of four (4) sampled boreholes accompanied by dynamic cone penetration tests. Among these, two (2) boreholes were put down on the existing Tomken Road. Two boreholes were driven at the abutment locations. Soil samples were retrieved generally at 1.5 m intervals by a split spoon sampler with the Standard Penetration Test (ASTM D1586). Samples were identified in the field and then returned to the laboratory for appropriate testing. Bedrock was cored at four borehole locations from about 1.5 metre to 4.7 metre depths using conventional rock coring methods.

Water levels were obtained in the open boreholes during the fieldwork. Survey information related to location and elevation of boreholes was provided by Central Region Surveys and Plans.

To identify the properties of the soil, the following laboratory tests were performed:

1) Atterberg Limit Tests
2) Grain Size Analyses
3) Natural Moisture Contents

Laboratory test results have been summarized and are included in the Appendix of this report.

SUBSURFACE CONDITIONS

The subsoil conditions are generally uniform across the site. The overburden consists of a shallow deposit of cohesive glacial till composed of a Heterogeneous mixture of silty clay, sand and gravel underlain by shale and dolostone bedrock. The maximum proven thickness of this deposit was found to be about 1.8 metres at BH 50-1 and 50-4. The upper portion of the shale was found to be weathered. In previous cut areas on the existing Tomken Road, exposed shale has been covered with a thin veneer of fill.

The boundaries between the various soil types, in situ and laboratory test results are shown the attached Record of Borehole Sheets in Appendix. The locations and elevations of the boreholes, along with a profile showing a soil stratigraphy based on borehole data, are shown on Drawing No. 548214/16-A.

A detailed description of the subsurface conditions and road fill material is given below.

Fill Material

As previously mentioned, two (2) boreholes were driven at pier locations on the existing Tomken Road. These boreholes encountered some 1.1 metres of fill material whose composition ranged from a grey reworked cohesive glacial till and highly fragmented shale mixture to a brown sand and gravel.

Grain size distribution tests were carried out on some representative samples. Figures 1 and 3 in the Appendix show the results. Through visual observation and grain size distribution analyses, it is apparent that the road fill materials can be classified as a heterogeneous mixture of silty clay, sand and gravel (cohesive glacial till) and/or sand and gravel with some silt. The fill material extend from the existing road surface to a depth of 1.1 metres.

In sand and gravel stratum, the 'N' values ranged from 28 to over 100 blows/0.3 metres indicating a state of compaction described as compact to very dense. The

fill materials appear to have undergone a relatively high degree of compactive effort.

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

The natural surficial deposit overlying most of the site consists of a shallow deposit of cohesive glacial till composed of a heterogeneous mixture of silty clay of intermediate plasticity with varying amounts of gravel and some sand. The thickness of this layer was found to be about 1.8 metres.

Grain size distribution tests were carried out on cohesive glacial till material. Figure 3 in Appendix shows the results. An increasing frequency of fragments and detached slabs of weathered shale and dolostone were encountered within the lower portion of this till.

The results from the Atterberg Limit tests performed on cohesive material are summarized as follows:

	No. of Tests	Range (%)	Average (%)
Natural Moisture Content (w)	3	7-19	12.3
Liquid Limit (w_L)	3	31-42	36.1
Plastic Limit (w_P)	3	17-20.5	18.5
Plasticity Index (I_P)	3	12.5-21.5	17.6

From the plasticity chart (Figure 2), the layer can be classified as a heterogeneous mixture of silty clay with some sand and gravel with intermediate plasticty (CI).

In this stratum, the 'N' values ranged from 13 to over 100 blows/0.3 metres indicating the consistency of this deposit described as stiff to hard.

Bedrock

The shale and dolostone bedrock was encountered immediately beneath the glacial till deposit across the site. The upper 0.1 to 2.6 metres of the bedrock is in a weathered condition. The natural bedrock surface is about elevtion 170.5 metres corresponding to depth of approximately 1.8 metres below ground surface prior to cut excavations for the existing Tomken Road.

The existing bedrock surface along the Tomken Road is fairly level and is found between 0.9 and 1.1 metres below the ground or pavement surface. This corresponds to elevations ranging between 162.4 and 162.9 metres. Generally, however, the bedrock surface is found at about elevation 162.5 metres.

The bedrock is described as a dark grey to medium grey black, very fine grained very thinly laminated weak shale interbedded with thin layers of medium grey, fine grained, medium strong dolostone. This formation is generally weathered in the upper layers and frequently transitional with the overlying till layer containing frequent fragments and detached slabs of shale and dolostone. Detailed descriptions of the rock are attached in the Appendix entitled "Rock Core Description".

Core recoveries (CR) and Rock Quality Designation (RQD) values were determined in situ and also in the laboratory to evaluate the competence and integrity of the rock. Core recoveries range between 33 and 100 percent and Rock Quality Designation (RQD) values range from 0 to 10 percent. Based on these results, the rock can be classified as weak to very weak rock and slightly to moderately weathered.

GROUNDWATER CONDITIONS

No natural groundwater level was encountered during the site investigation in all boreholes. Upon completion of rock coring, the induced drill water remained

perched within the boreholes, indicating a low permeability for both the till and shale strata. The depressed profile grades of the existing Hwy. 401/Tomken Road geometry effectively drains the immediate structure location to the respective roadway grades.

DISCUSSION AND RECOMMENDATIONS

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

It is proposed to construct overpass structures that will carry the proposed Hwy. 401 Eastbound and Westbound core lanes over the existing Tomken road. The proposed structure is a twin three span bridge. The decks will accomodate two 3.75 m lanes and one 3.5 m passing lane with 2.5 m shoulders on each side.

A proposed Hwy. 401 profile grade ranging from 170 m east abutment to 171 m at west abutment and average natural ground surface elevation of approximately 172 m will necessitate minimum approach cuts in the order of 3.2 m at east abutment and 2.2 m at west abutment which will be approximate subgrade depth.

In consideration of the proximity of competent shale and dolostone bedrock to ground surface across the site, recommendations pertaining to the foundations of the new structure and related earthworks are summarized as below:

Structure Foundations

Abutments and Piers

The design of shallow foundations founded on an unyielding type of medium such as shale and dolostone bedrock will not be governed by settlement since the bearing capacity at the S.L.S. Type II is much larger than the factored capacity at U.L.S. Perched abutments can be supported on spread footings founded within the slightly weathered shale and dolostone bedrock for a factored bearing capacity at the U.L.S. of 1,000 kPa.

For piers, footings can be supported on shallow spread footings located and designed within the intact shale for a factored capacity at the U.L.S. of 1,500 kPa.

Resistance to sliding of the abutment footings can be calculated assuming a coefficient of friction of 0.7 between the underside of the concrete footings and the rough shale and dolostone surface.

Other Considerations

Lateral Earth Pressures 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 purpose of the O.H.B.D.C.:

	Granular 'A'	Granular 'B'
Angle of Internal Friction (ϕ)	35°	30°
Unit Weight (kN/m^3), γ	22.8	21.2
Coefficient of Active Earth Pressure (K_A)	0.27	0.33
Coefficient of Earth Pressure at Rest (K_O)	0.43	0.50

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.

Dewatering

No major dewatering difficulties are anticipated for footing excavations in consideration of the relatively low permeability fo the shale and dolostone bedrock. However, if localized seepage or surface water do accumulate in excavations, it can be controlled by perimeter ditches and pumping from sumps.

Frost Protection

The footings should be placed so as to have a minimum earth cover of 1.2 m to allow for frost protection, since the shale is considered susceptible to frost action.

Approaches and Excavations

The base of all footing excavations should be covered immediately upon exposure with a working slab of lean concrete to protect the exposed shale from weathering and softening. Any and all organic and softened material should be stripped from within the plan limits of the immediate approach embankments prior to placement of any fill. In addition, all new fill material should be properly benched in the existing slope as per current MTO standards.

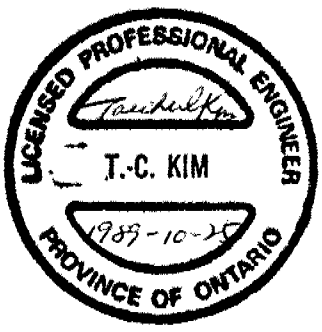
Provided the bridge is constructed prior to the roadway excavations for Hwy. 401 Core and an interim ground line is specified, the site should be properly graded and ditched to allow for free drainage in order to prevent ponding of water around the structure and possible softening of the founding shale.

No stability problems are anticipated for permanent embankment and cut slopes constructed to a 2H:1V geometry. Temporary cut slopes will stand at a 1H:1V geometry or steeper, however, these slopes will weather rapidly and show signs of surficial distress if they are not protected for an extended period of time.

MISCELLANEOUS

The fieldwork for this investigation was carried out under the supervision of Dale Colquhoun, Visiting Engineer from Jamaica. The equipment was owned and operated by Longyear Canada Ltd., Toronto.

This project was carried out by Tae C. Kim under the general supervision of Dr. B. Iyer. This report was written by Tae C. Kim, Foundation Design Engineer, reviewed by Dr. Balu Iyer, Sr. Foundation Engineer, and approved by Murty Devata, Chief Foundation Engineer.



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

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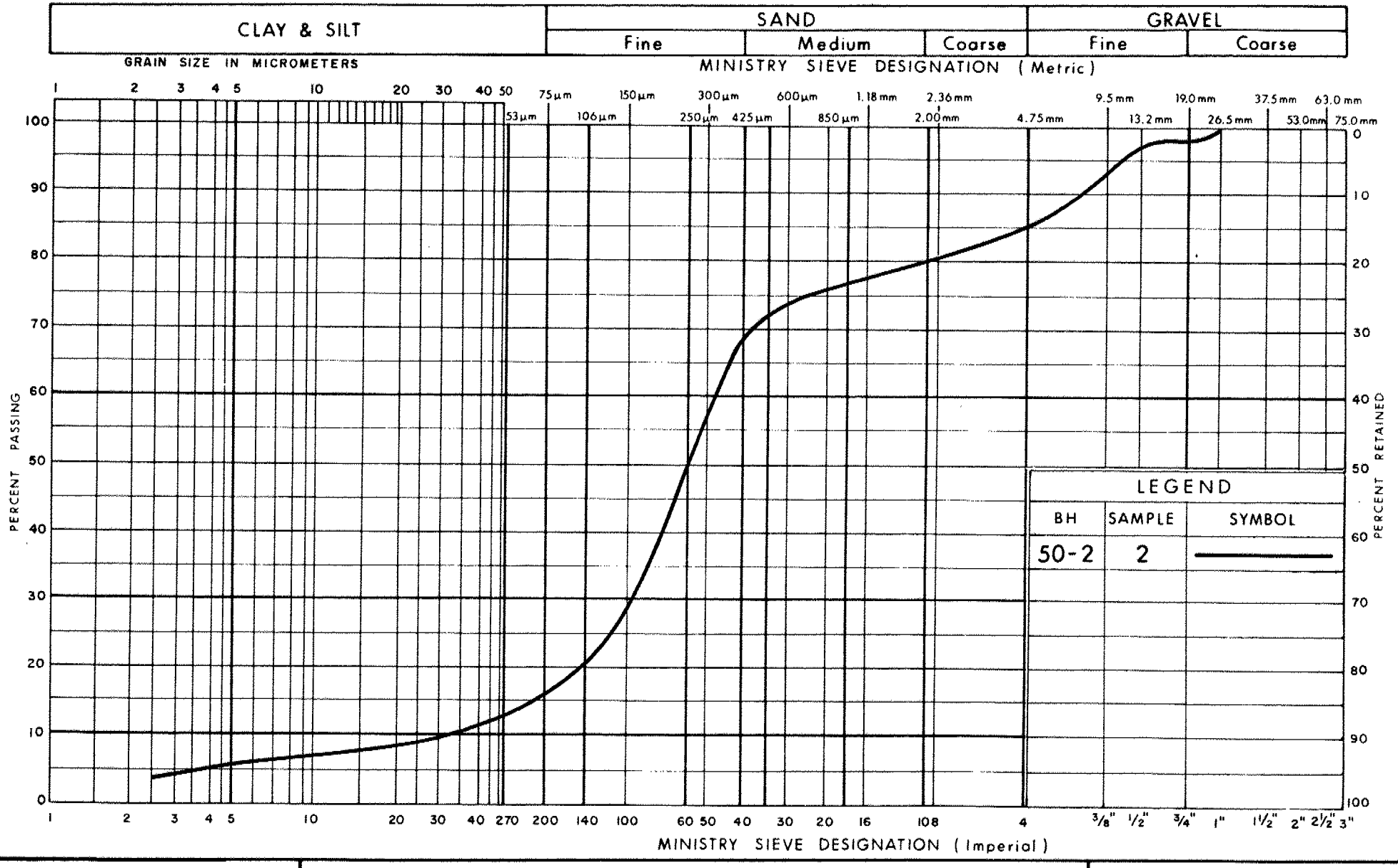
Chief Foundation Engineer

APPENDIX

78 12 M

UNIFIED SOIL CLASSIFICATION SYSTEM



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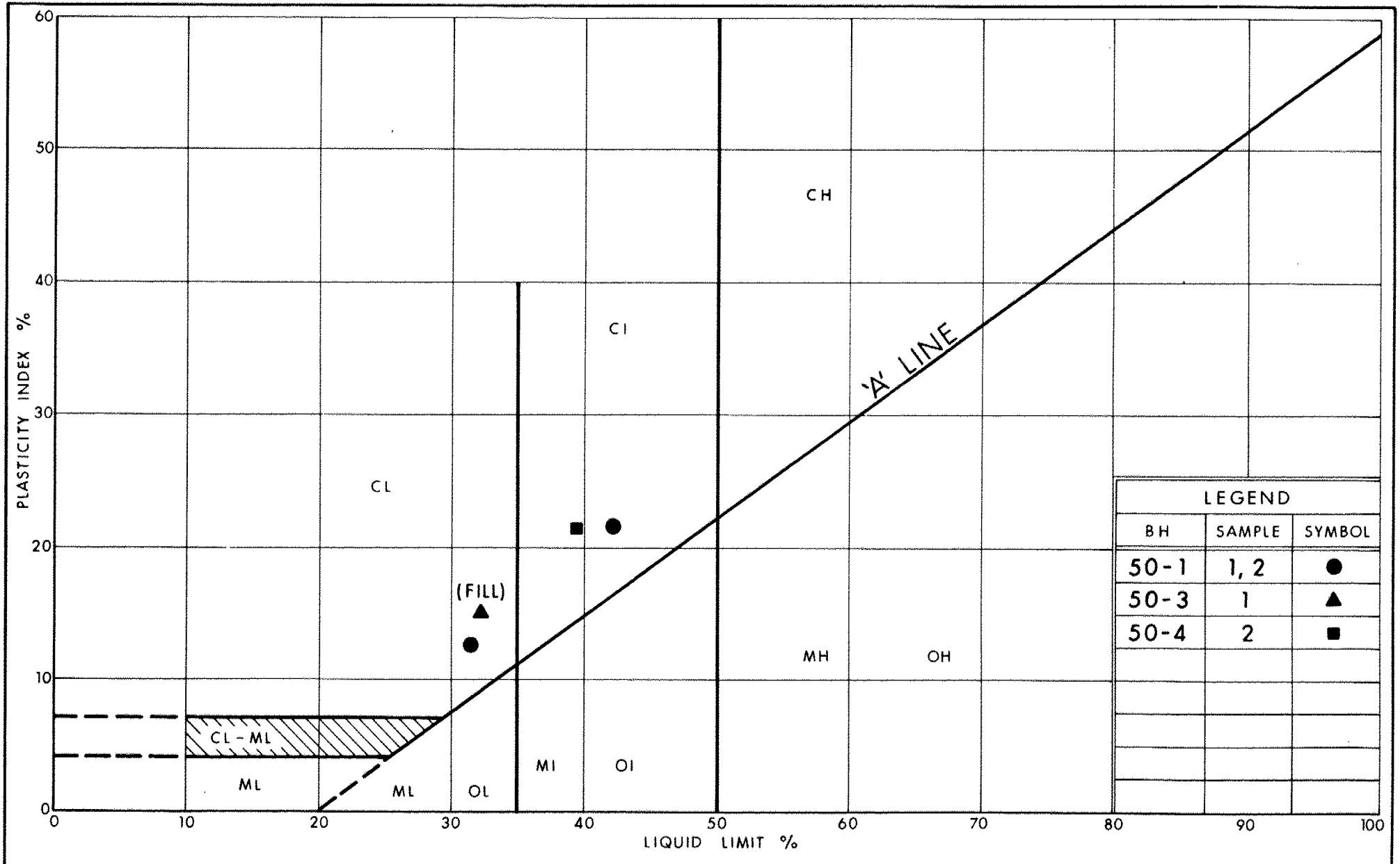
GRAIN SIZE DISTRIBUTION

SAND & GRAVEL, SOME SILT (Fill)

FIG No 1

W P 54-82-14/16

Oct 75, FF-S-21



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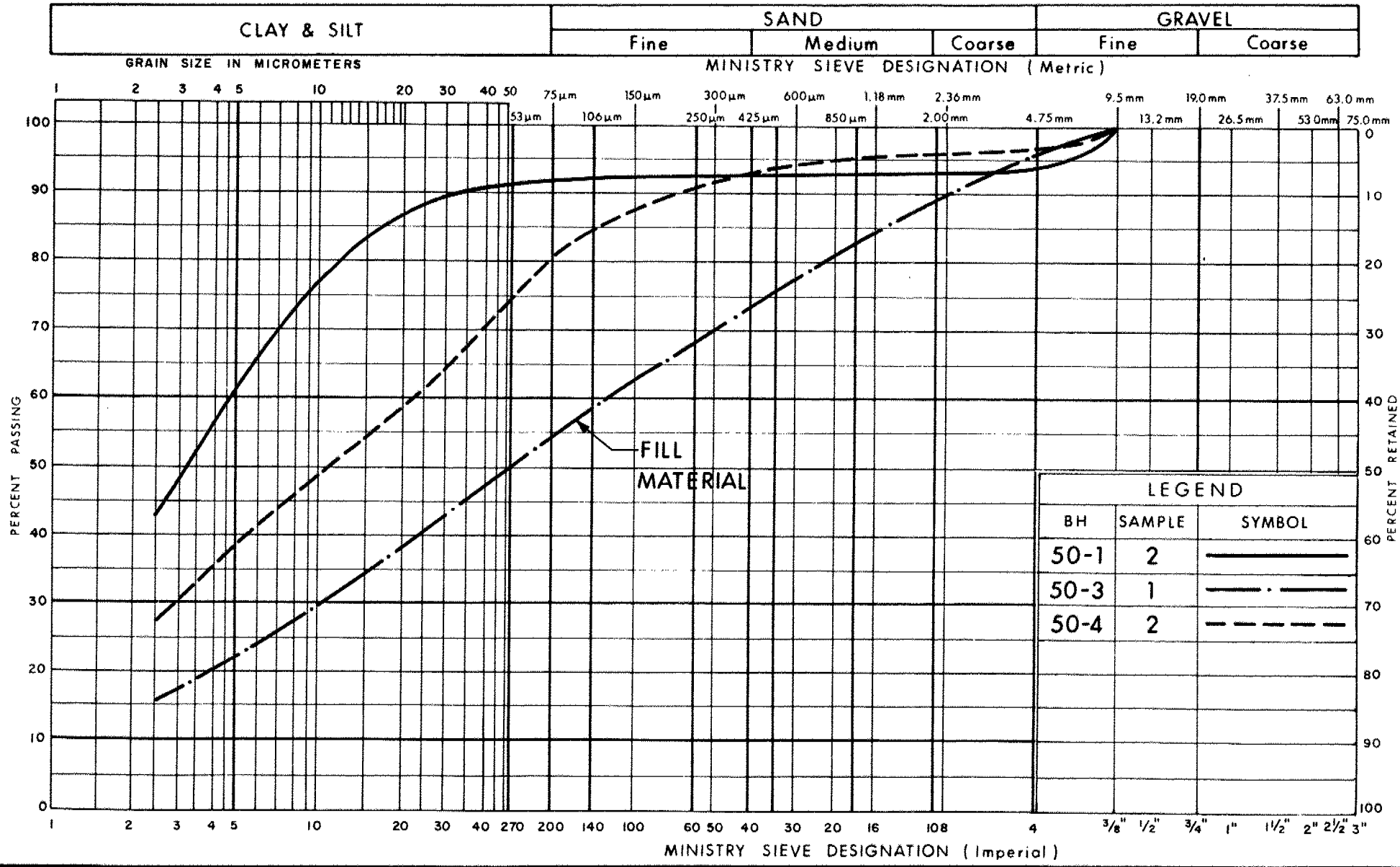
PLASTICITY CHART
HET MIXTURE OF SILTY CLAY, SAND & GRAVEL
(Glacial Till and Fill)

FIG No 2
W P 54-82-14/16

78 12 M

UNIFIED SOIL CLASSIFICATION SYSTEM



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GRAIN SIZE DISTRIBUTION
HET MIXTURE OF SILTY CLAY, SAND & GRAVEL
(Glacial Till and Fill)

FIG No 3
W P 54-82-14/16

BOREHOLE CORE DESCRIPTION
WP 54-82-14/16

CORE RECOVERY					CORE DESCRIPTION	
BH - #	RC #	DEPTH (m)	CR* (%)	RQD* (%)	DEPTH (m)	DESCRIPTION
50-1	4	3.30-4.26	74	0	3.30-4.44	DOLOSTONE, medium grey, fine grained; interbedded with dark grey to greyish black shale seams (21%); medium strong rock; unweathered to slightly weathered; very closely spaced fractures: horizontal, irregular.
	5	4.26-5.74	100	0	4.44-5.74	SHALE, dark grey to medium grey black, very fine grained very thinly laminated; weak to very weak rock; slightly weathered; very close to extremely close spaced fractures: horizontal partings along laminae.
50-2	3	1.22-2.74	33	0	1.22-4.27	SHALE, dark grey to medium grey black, very fine grained very thinly laminated; interbedded with **DOLOSTONE** beds (14%) up to 15 cm; weak to very weak rock; slightly weathered; very close to extremely close spaced fractures: horizontal partings along laminae.
	4	2.74-4.27	97	10		
50-3	3	1.28-1.36	100	0	1.28-2.76	SHALE, dark grey to medium grey black, very fine grained very thinly laminated; interbedded with **DOLOSTONE** (22%) up to 8 cm; weak to very weak rock; slightly weathered; very close to extremely close spaced fractures: horizontal partings along laminae.
	4	1.36-2.76	95	0		
50-4	3	1.83-3.35	72	0	1.83-3.05	SHALE, greyish yellow green with weathered fragments of DOLOSTONE (5%); weak to very weak rock; intensely to completely weathered, very close to extremely close spaced fractures.
	4	3.35-4.88	88	0	3.05-6.46	SHALE, dark grey to medium grey black, very fine grained very thinly laminated; minor interbeds of **DOLOSTONE** (8%) up to 8 cm; weak to very weak rock; slightly to moderately weathered; close to extremely close spaced fractures: horizontal partings along laminae.
	5	4.88-6.46	98	0		

***CR = CORE RECOVERY** (NOTE: Depths are approximated in zones of poor core recovery.)
***RQD = ROCK QUALITY DESIGNATION**
Logged by: SAS, Soils and Aggregates Section.

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 (R Q D), 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
γ_s	kN/m^3	UNIT WEIGHT OF SOLID PARTICLES
ρ_w	kg/m^3	DENSITY OF WATER
γ_w	kN/m^3	UNIT WEIGHT OF WATER
ρ	kg/m^3	DENSITY OF SOIL
γ	kN/m^3	UNIT WEIGHT OF SOIL
ρ_d	kg/m^3	DENSITY OF DRY SOIL
γ_d	kN/m^3	UNIT WEIGHT OF DRY SOIL
ρ_{sat}	kg/m^3	DENSITY OF SATURATED SOIL
γ_{sat}	kN/m^3	UNIT WEIGHT OF SATURATED SOIL
ρ'	kg/m^3	DENSITY OF SUBMERGED SOIL
γ'	kN/m^3	UNIT WEIGHT OF SUBMERGED SOIL

e	1,%	VOID RATIO
n	1,%	POROSITY
w	1,%	WATER CONTENT
S_r	%	DEGREE OF SATURATION
w_L	%	LIQUID LIMIT
w_p	%	PLASTIC LIMIT
w_S	%	SHRINKAGE LIMIT
I_p	%	PLASTICITY INDEX = $w_L - w_p$
I_L	1	LIQUIDITY INDEX = $\frac{w - w_p}{I_p}$
I_C	1	CONSISTENCY INDEX = $\frac{w_L - w}{I_p}$
e_{max}	1,%	VOID RATIO IN LOOSEST STATE
e_{min}	1,%	VOID RATIO IN DENSEST STATE
I_D	1	DENSITY INDEX = $\frac{e_{max} - e}{e_{max} - e_{min}}$
D	mm	GRAIN DIAMETER
D_n	mm	n PERCENT - DIAMETER
C_U	1	UNIFORMITY COEFFICIENT
h	m	HYDRAULIC HEAD OR POTENTIAL
q	m^3/s	RATE OF DISCHARGE
v	m/s	DISCHARGE VELOCITY
i	1	HYDRAULIC GRADIENT
k	m/s	HYDRAULIC CONDUCTIVITY
j	kN/m^3	SEEPAGE FORCE

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RECORD OF BOREHOLE No 50-1 METRIC

W P 54-82-14/16 LOCATION Co-ords: N 4 833 331.2 ; E 292 405.2 ORIGINATED BY DC
DIST 6 HWY 401 BOREHOLE TYPE Solid Stem Auger, BW Casing, BXL Core Barrel & Cone Test COMPILED BY DC
DATUM Geodetic DATE 89 09 20 to 21 CHECKED BY TCK

SOIL PROFILE ELEV/DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPo ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE	PLASTIC LIMIT Wp / NATURAL MOISTURE CONTENT W / LIQUID LIMIT WL / WATER CONTENT (%) 10 20 30	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
172.8	Ground Level										
0.0	Heterogeneous Mixture of Silty Clay, Sand and Gravel Brown to Grey (Glacial Till) Stiff to Hard		1	SS	13	*	172		○		
171.0			2	SS	39		171		○		8 3 52 37
1.8	Bedrock Shale and Weathered Unweathered Dolostone Medium to Dark Grey		3	SS	29			140			
			4	BXL RC	REC 74%		170				RQD = 0%
167.0			5	BXL RC	REC 100%		169				RQD = 0%
5.8	End of Borehole						168				

* Note
Water Level was not Encountered during the Site Investigation

OFFICE REPORT ON SOIL EXPLORATION

+3, ×5 : Numbers refer to Sensitivity

20
15 ◇ 5 (%) STRAIN AT FAILURE
10

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RECORD OF BOREHOLE No 50-2 METRIC

W P 54-82-14/16 LOCATION Co-ords: N 4 833 365.2; E 292 403.3 ORIGINATED BY DC
DIST 6 HWY 401 BOREHOLE TYPE Solid Stem Auger, BW Casing, BXL Core Barrel & Cone Test COMPILED BY DC
DATUM Geodetic DATE 89 09 19 CHECKED BY TCK

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE)	PLASTIC LIMIT Wp / NATURAL MOISTURE CONTENT W / LIQUID LIMIT Wl — WATER CONTENT (%) 10 20 30	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES						
164.0	Ground Level										
0.0	Sand and Gravel Some Silt (Fill)		1	SS	28						
162.9			2	SS	88	*	163		○		15 68 14 3
1.1	Weathered / Unweathered Bedrock Shale and Dolostone Dark Grey to Medium Black		3	BXL RC	REC 33%			100/8cm			RQD = 0%
							162				
			4	BXL RC	REC 97%						RQD = 10%
							161				
159.7							160				
4.3	End of Borehole										

*
Note
Water Level was not Encountered during the Site Investigation

OFFICE REPORT ON SOIL EXPLORATION

+3, ×5 : Numbers refer to Sensitivity

20
15 ◇ 5 (%) STRAIN AT FAILURE
10

Ministry of Transportation
Ontario

RECORD OF BOREHOLE No 50-3 METRIC

W P 54-82-14/16 LOCATION Co-ords: N 4 833 350.6; E 292 441.4 ORIGINATED BY DC
DIST 6 HWY 401 BOREHOLE TYPE Solid Stem Auger, BW Casing, BXL Core Barrel & Cone Test COMPILED BY DC
DATUM Geodetic DATE 89 09 18 CHECKED BY TCK

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × 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						
163.3	Ground Level										
0.0 / 163.0	Silty Clay (Fill)		1	SS	27	*	163		○		4 40 44 12
0.3 / 162.4	Sand and Gravel (Fill)		2	SS	150/ 28cm			100/ 24cm			
0.9	Weathered / Unweathered Bedrock Shale and Dolostone Dark Grey and Medium Black		3	RC	100% REC		162				RQD = 0%
160.5			4	BXL RC	REC 95%		161				RQD = 0%
2.8	End of Borehole										

* Note
Water Level was not Encountered during the Site Investigation

OFFICE REPORT ON SOIL EXPLORATION

+3, ×5 : Numbers refer to Sensitivity

20
15 ⊹ 5 (%) STRAIN AT FAILURE
10

Ministry of Transportation
Ontario

RECORD OF BOREHOLE No 50-4 METRIC

W P 54-82-14/16 LOCATION Co-ords: N 4 833 386.3; E 292 442.3 ORIGINATED BY DC
DIST 6 HWY 401 BOREHOLE TYPE Solid Stem Auger, BW Casing, BXL Core Barrel & Cone Test COMPILED BY DC
DATUM Geodetic DATE 89 09 19 CHECKED BY TCK

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES 'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE)	PLASTIC LIMIT Wp / NATURAL MOISTURE CONTENT W / LIQUID LIMIT Wl / WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
172.2	Ground Level										
0.0	Heterogeneous Mixture of Silty Clay, Sand and Gravel					*	172				
	Brown to Grey		1	SS	19						
	(Glacial Till)						171	150/20cm			
170.4	Stiff to Hard		2	SS	90/ 10cm						3 14 58 25
1.8	Bedrock Shale and Dolostone Dark Grey to Medium Black		3	BXL RC	REC 72%		170				RQD = 0%
	Weathered / Unweathered		4	BXL RC	REC 88%		169				RQD = 0%
			5	BXL RC	REC 98%		168				RQD = 0%
165.8							167				
6.4	End of Borehole						166				

* Note
Water level was not Encountered during the Site Investigation

OFFICE REPORT ON SOIL EXPLORATION

+3, ×5 : Numbers refer to Sensitivity

15 20 10 ◇ 5 (%) STRAIN AT FAILURE

MINISTRY OF TRANSPORTATION, ONTARIO PH-0-207 88 10

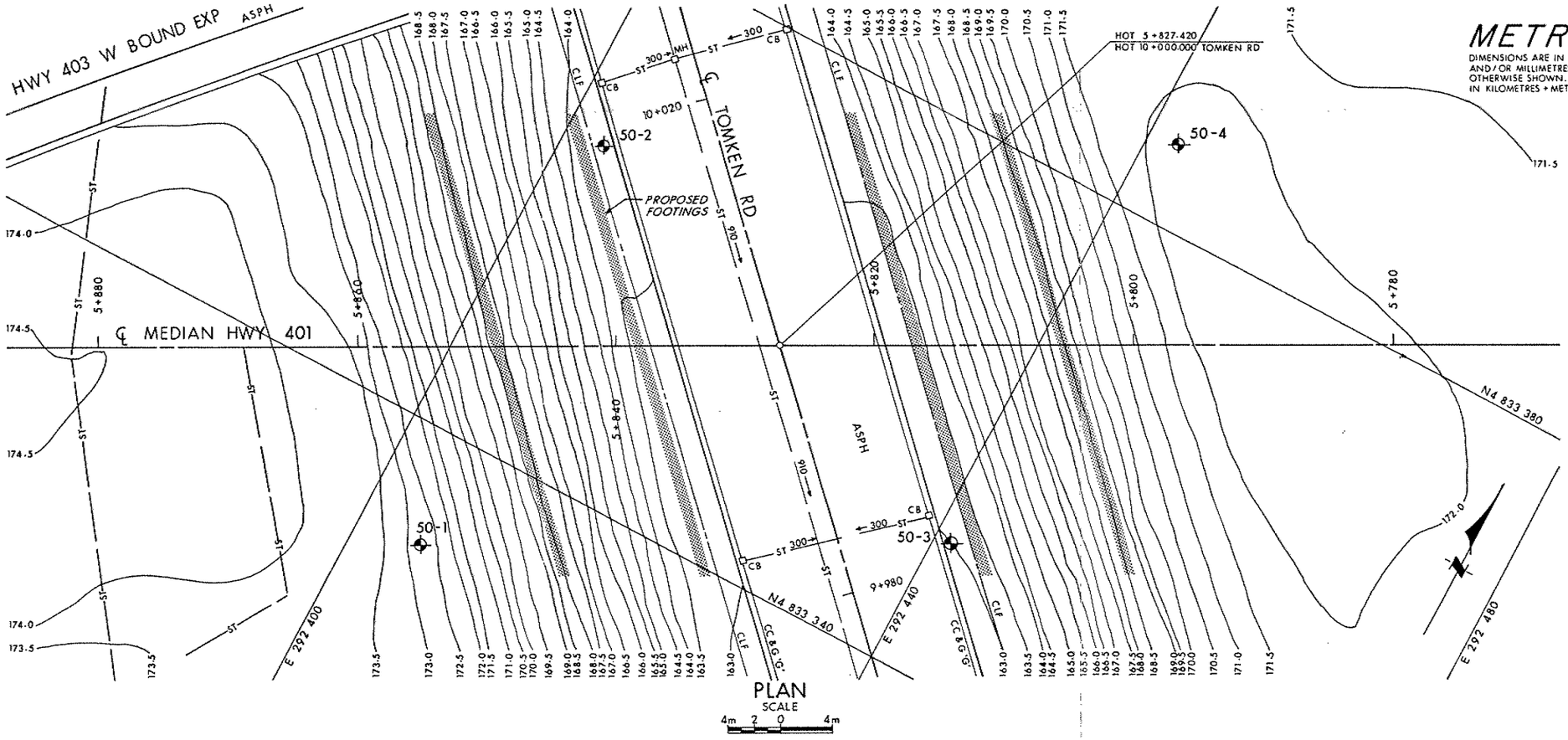
METRIC

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

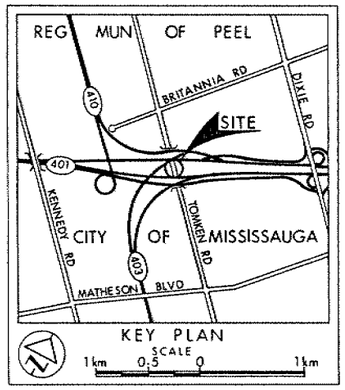
CONT No
WP No 54-82-14/16

TOMKEN RD OVERPASS
(STRUCTURE-50)
BORE HOLE LOCATIONS & SOIL STRATA

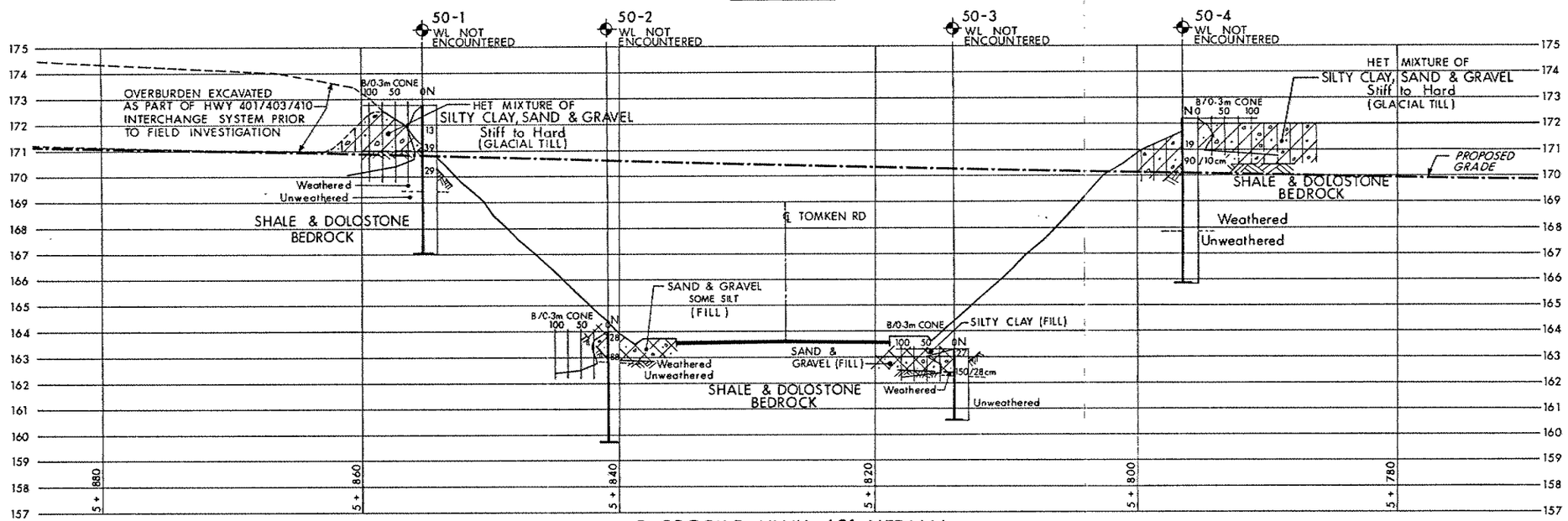
SHEET



PLAN
SCALE
4m 2 0 4m



KEY PLAN
SCALE
1km 0.5 0 1km



℄ PROFILE HWY 401 MEDIAN
SCALE
4m 2 0 4m Hor
2m 1 0 2m Vert

No	ELEVATION	CO-ORDINATES NORTH	EAST
50-1	172.8	4 833 331.2	292 405.2
50-2	164.0	4 833 365.2	292 403.3
50-3	163.3	4 833 350.6	292 441.4
50-4	172.2	4 833 386.3	292 442.3

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 89 09

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 30M12-210

REF No E-81-401-1, 89 01

HWY No 401			DIST 6
SUBM'D TCK	CHECKED TCK	DATE 89 10 27	SITE 24-194
DRAWN DT	CHECKED CP	APPROVED	DWG 54821416-A

METRIC

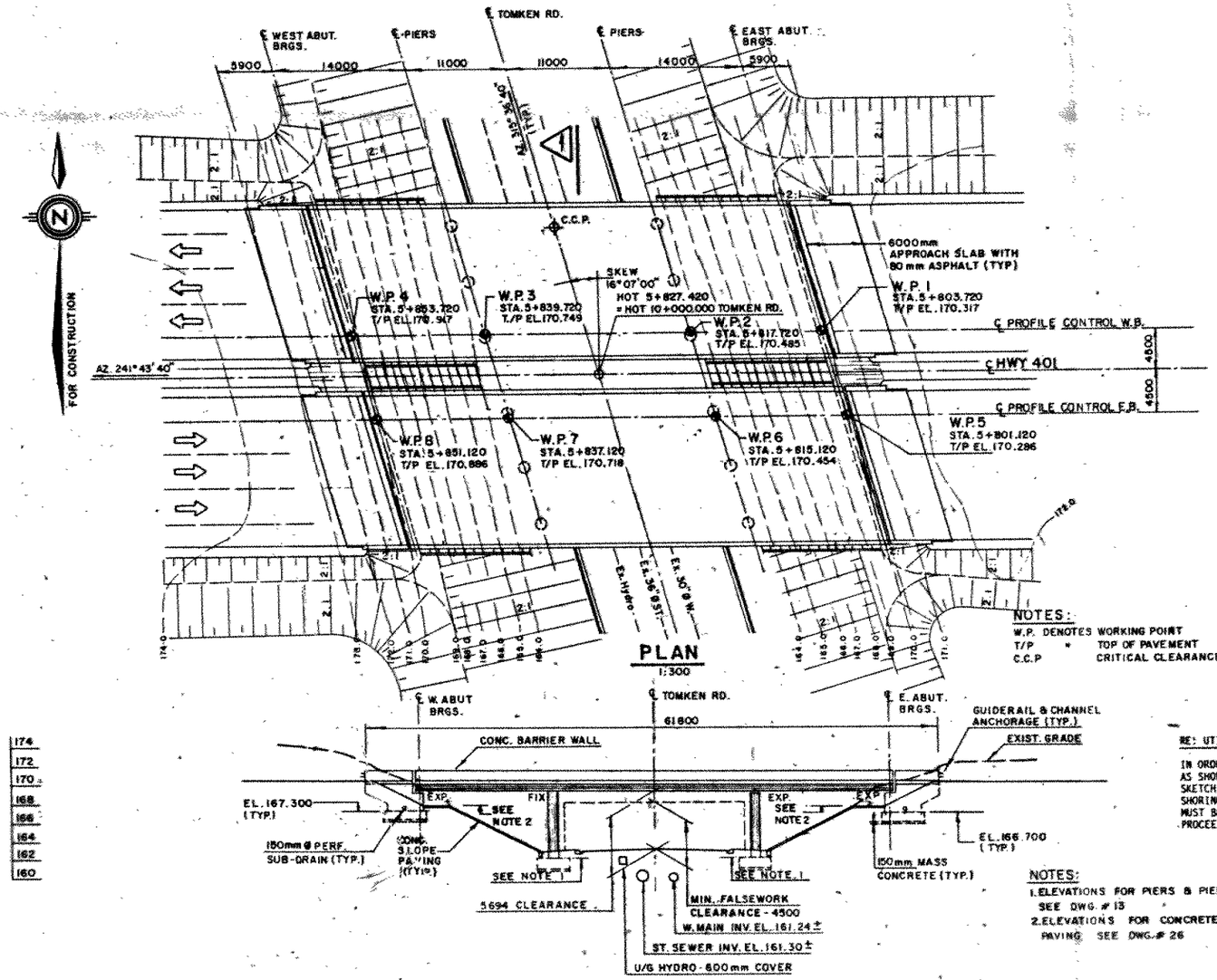
DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN

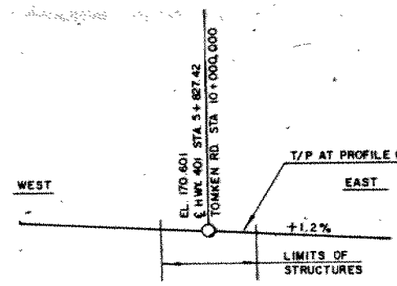
DIST No 6
CONT No
WP No 54-82-14 W.B. 54-82-17 E.B.

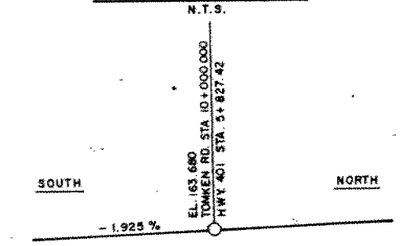
HWY 401 - TOMKEN RD. OVERPASS
HWY 401 - CORE LANE STRUCTURES
(BRIDGE No 50)
GENERAL ARRANGEMENT

SHEET

Wyllie & Ufnal
consulting engineers







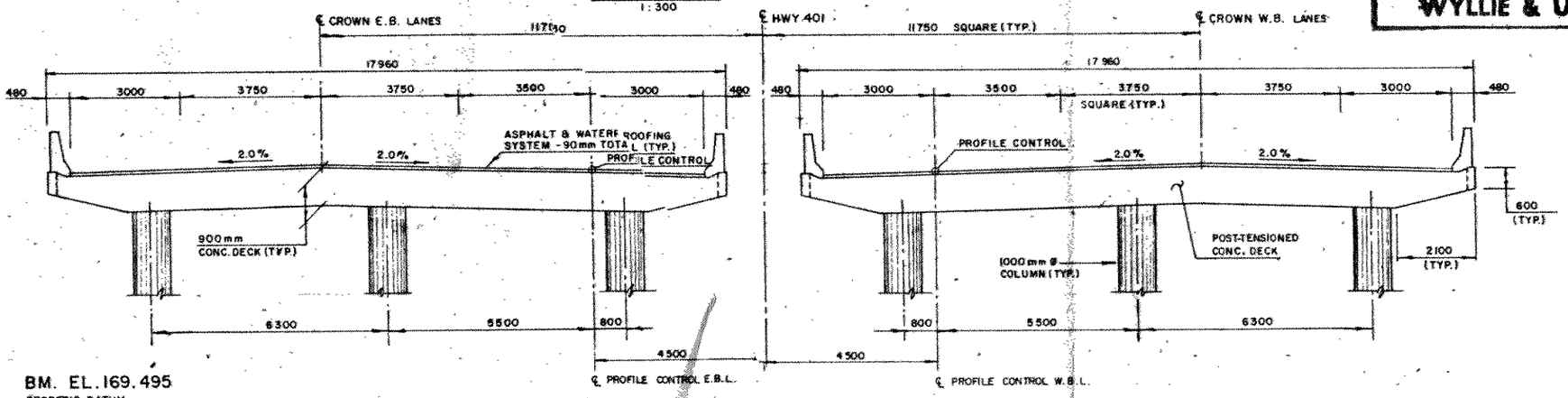
NOTES:
W.P. DENOTES WORKING POINT
T/P " TOP OF PAVEMENT
C.C.P " CRITICAL CLEARANCE POINT

ELEVATION
1:300

NOTES:
1. ELEVATIONS FOR PIERS & PIER FOOTINGS SEE DWG. # 13
2. ELEVATIONS FOR CONCRETE SLOPE PAVING SEE DWG. # 26

RE: UTILITIES

IN ORDER TO ENSURE THE SAFETY OF UNDERGROUND UTILITIES AS SHOWN ON THIS DRAWING THE CONTRACTOR WILL SUBMIT A SKETCH INDICATING THE LOCATION AND MAGNITUDE OF DECK SHORING LOADS TO A STRUCTURAL CONSULTANT. THIS SKETCH MUST BE APPROVED BY THE CONSULTANT BEFORE SHORING CAN PROCEED.



BM. EL. 169.495
GEODETIC DATUM
CC on top of SE handrail of Dixie Rd
exit bridge over Tomken Rd
168.0 Lt Sta 5+775.8

1:75

GENERAL NOTES:

1. CLASS OF CONCRETE
   - PRESTRESSED DECK AND PIER 35 MPa.
   - REMAINDER 30 MPa
2. CLEAR COVER TO REINFORCING STEEL
   - FOOTINGS 100 ± 25 mm.
     PIERS, ABUTMENTS AND WINGWALLS FRONT SURFACES 80 ± 20 mm.
     ABUTMENTS AND WINGWALLS BACK SURFACES 70 ± 20 mm.
   - DECK TOP 70 ± 20 mm.
   - DECK BOTTOM 50 ± 10 mm.
   - REMAINDER, UNLESS OTHERWISE NOTED 70 ± 20 mm.
3. REINFORCING STEEL
   - REINFORCING STEEL SHALL BE GRADE 400 UNLESS OTHERWISE SPECIFIED. • BAR MARKS WITH SUFFIX 'C' DENOTE COATED BARS.
4. CONSTRUCTION NOTE
   - IF THE ACTUAL BEARING HEIGHTS ARE DIFFERENT FROM THE ASSUMED HEIGHTS GIVEN WITH THE BEARING DESIGN DATA, THE CONTRACTOR SHALL ADJUST THE BEARING SEAT ELEVATIONS AND THE REINFORCING STEEL TO SUIT THE ACTUAL HEIGHTS.

LIST OF DRAWINGS

ISSUED
AUG 14 1990
WYLLIE & UFNAL LIMITED

LICENSED PROFESSIONAL ENGINEER TOMASZ ZENIUK PROVINCE OF ONTARIO

REGISTERED PROFESSIONAL ENGINEER M. G. SHERLOCK PROVINCE OF ONTARIO

APPLICABLE STANDARD DRAWINGS:
OD-3503 MINIMUM GRANULAR BACKFILL REQUIREMENTS
OD-4602 FALSEWORK CLEARANCES

DRAWING NOT TO BE SCALED
100 mm ON ORIGINAL DRAWING

REVISIONS	DATE	BY	DESCRIPTION

DESIGN M.G.S.	CHK T.Z.	CODE OHBDC - 83	LOAD CL - A	DATE JULY 1990	
DRAWN G.S.	CHK J.C.S.	SITE 24-194	STRUCT	SCHEME	DWG. 1

METRIC

DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN

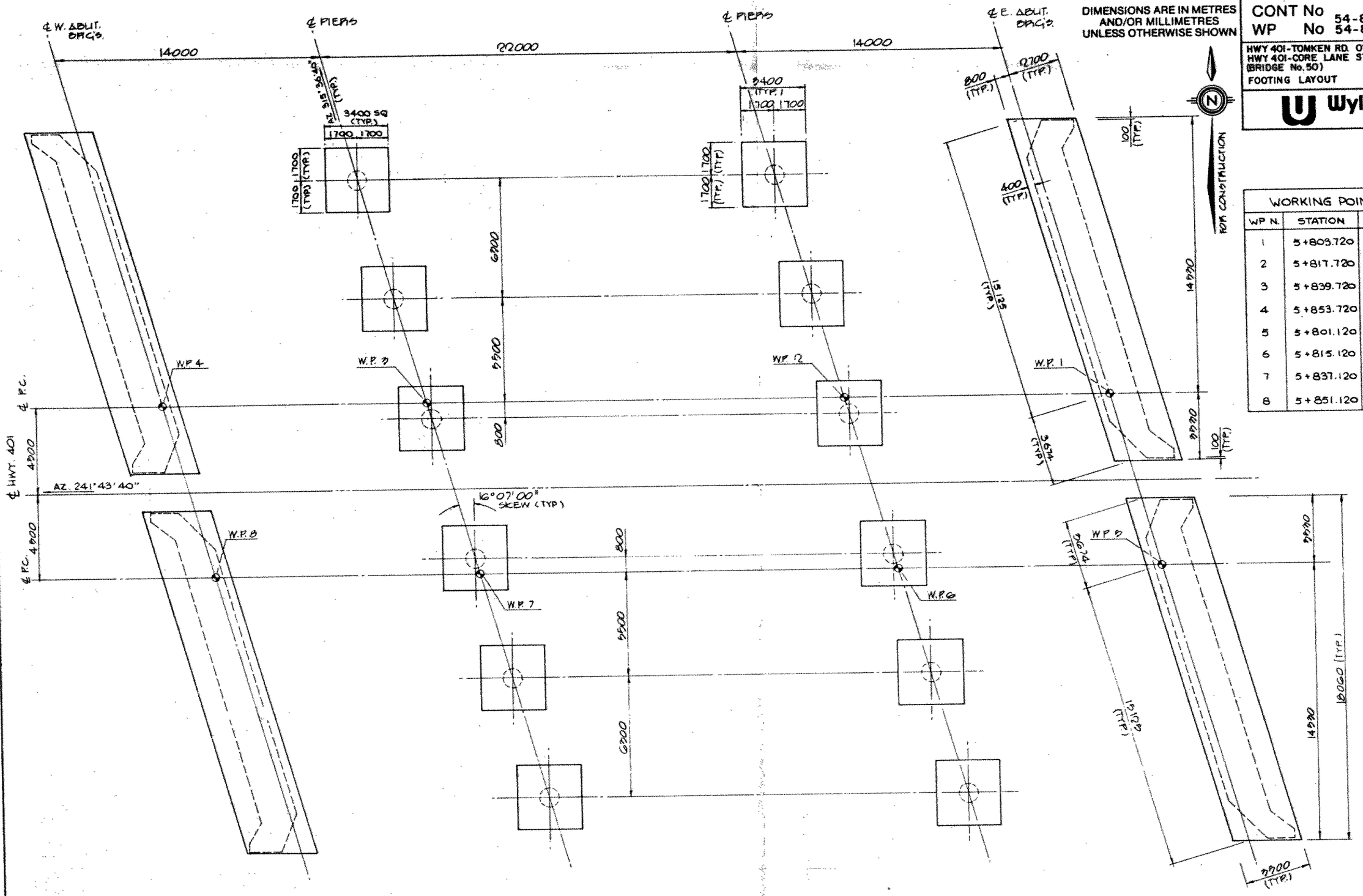
CONT No 54-82-14
WP No 54-82-17

SHEET

HWY 401-TOMKEN RD. OVERPASS
HWY 401-CORE LANE STRUCTURE
(BRIDGE No. 50)
FOOTING LAYOUT

Wyllie & Ufnal
consulting engineers

WORKING POINT LOCATIONS		
WP N.	STATION	CO-ORDINATES
1	5+809.720	N 4 833 373.149 E 292 441.180
2	5+817.720	N 4 833 366.518 E 292 428.850
3	5+839.720	N 4 833 356.097 E 292 409.475
4	5+853.720	N 4 833 349.466 E 292 397.145
5	5+801.120	N 4 833 366.454 E 292 447.733
6	5+815.120	N 4 833 359.823 E 292 435.403
7	5+837.120	N 4 833 349.402 E 292 416.028
8	5+851.120	N 4 833 342.771 E 292 403.698



FOOTING LAYOUT
1:100

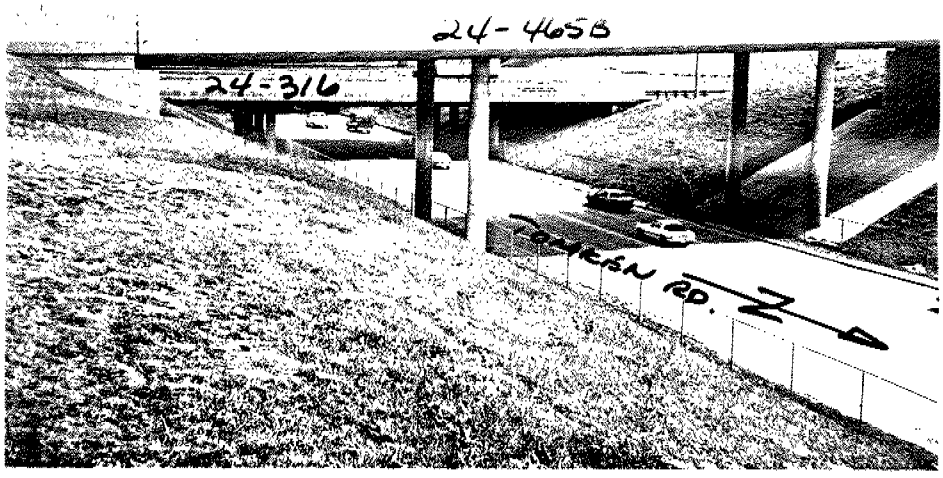
DRAWING NOT TO BE SCALED
100 mm ON ORIGINAL DRAWING

REVISIONS		
DATE	BY	DESCRIPTION

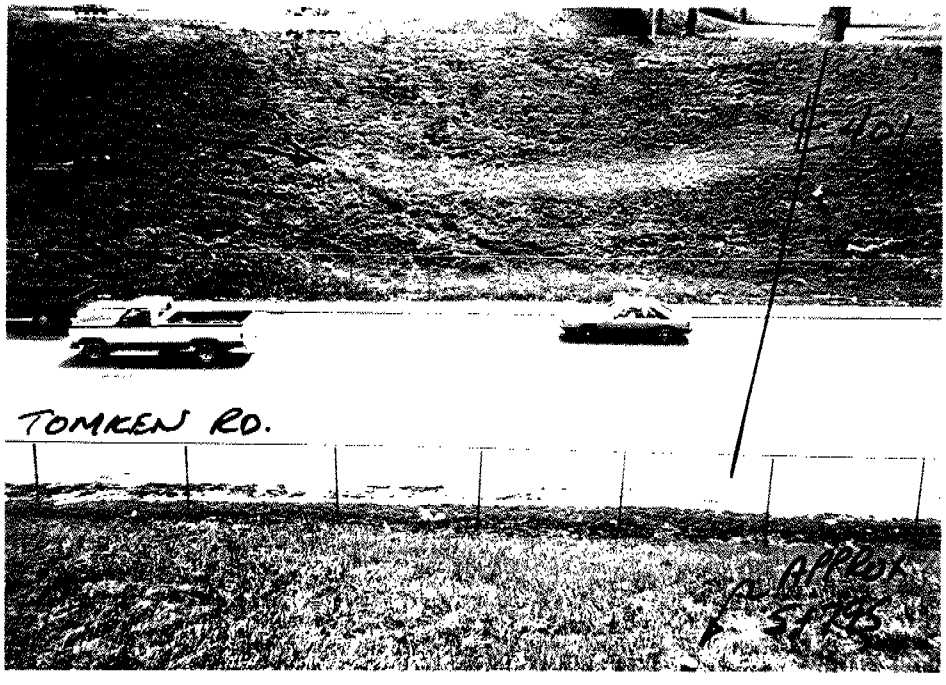
DESIGN M.S.	CHK T.Z.	CODE OHBDC - 83	LOAD CL. 'A'	DATE JULY 1990	
DRAWN A.D.G	CHK M.S.	SITE 24-194	STRUCT	SCHEME	DWG 3

LICENSED PROFESSIONAL ENGINEER
TOMASZ ZENIUK
PROVINCE OF ONTARIO

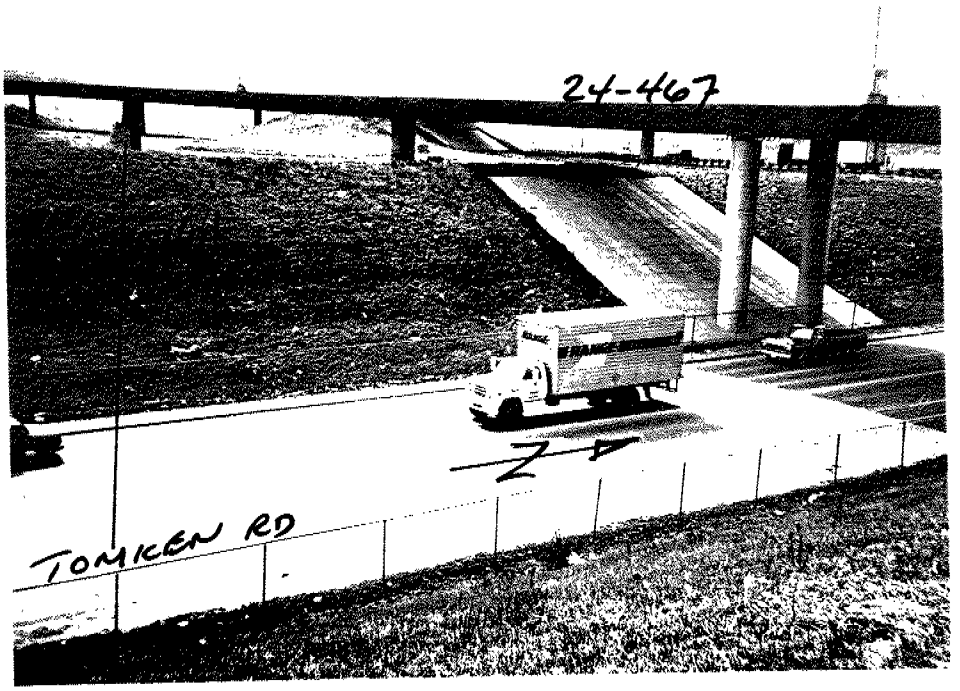
REGISTERED PROFESSIONAL ENGINEER
M. G. SHENLOCK
PROVINCE OF ONTARIO



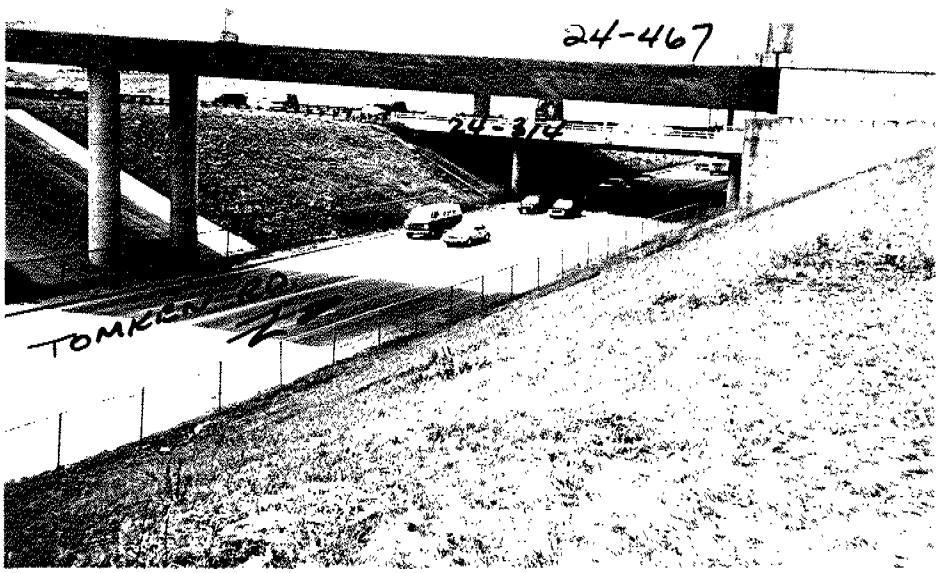
1. VIEW FROM EAST EMBANKMENT TOWARD STRUCTURES TO THE SOUTH



2. VIEW FROM EAST EMBANKMENT



3. VIEW FROM EAST EMBANKMENT



4. VIEW FROM EAST EMBANKMENT TOWARD STRUCTURES TO THE NORTH