DOCUMENT MICROFILMING IDENTIFICATION

G.I.-30 SEPT. 1976

GEOCRES No. 30M12-145

DIST. 6 REGION

W.P. No. 67-77-01

CONT. No. 86-72

W. O. No.

STR. SITE No. 10-98

HWY. No. 401

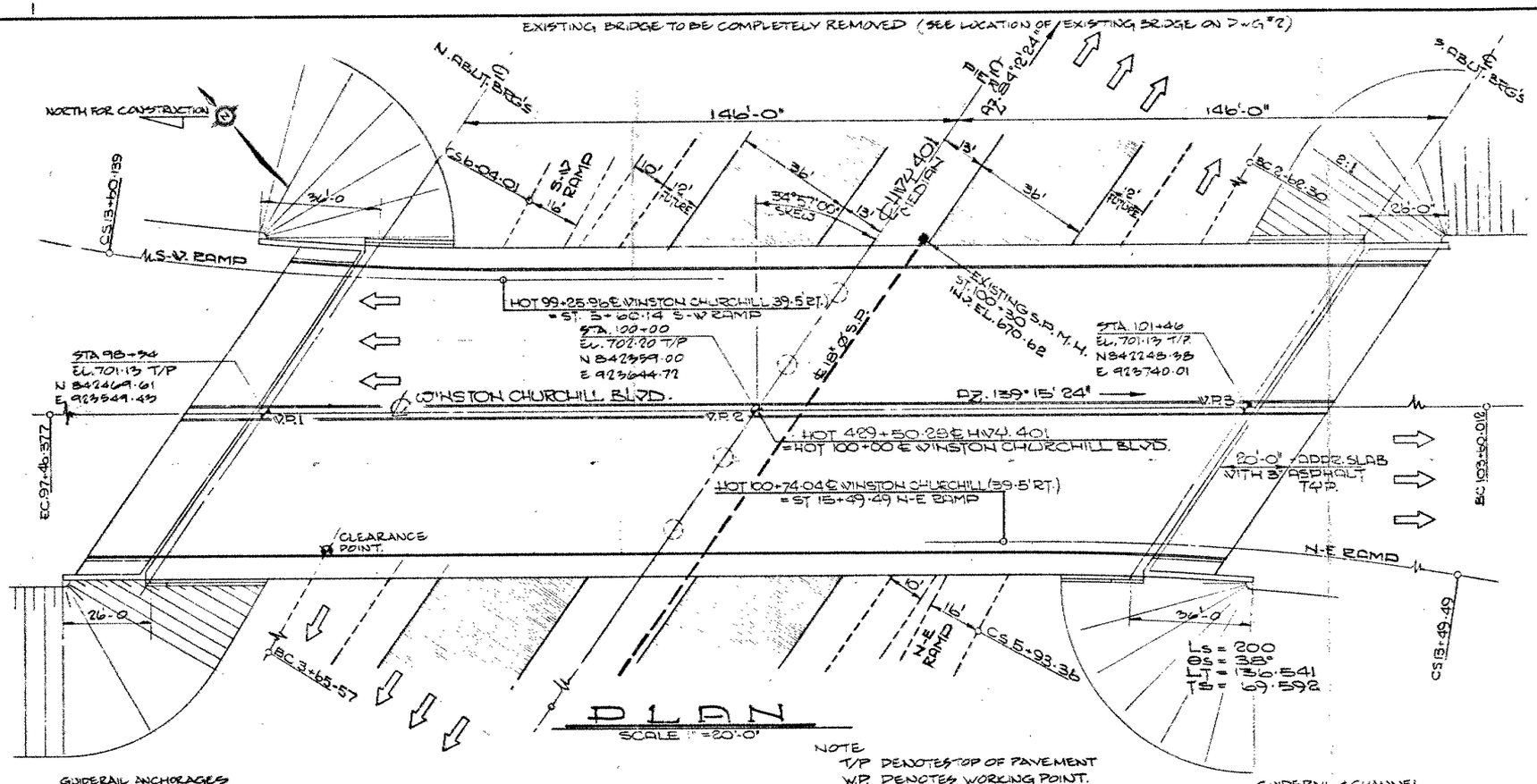
LOCATION Winston Churchill Blvd.

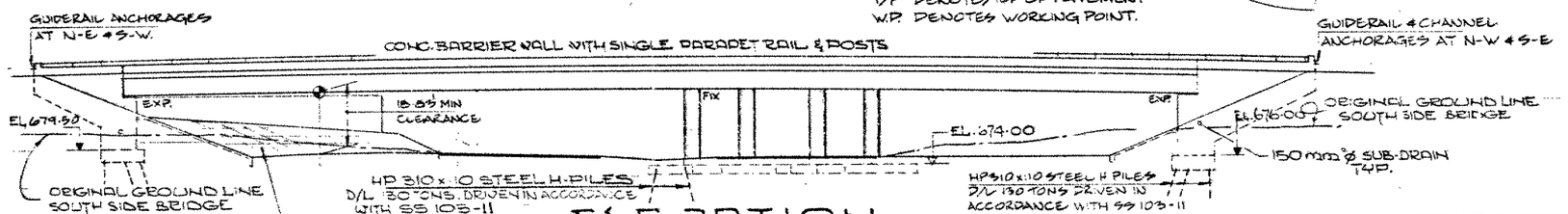
No of PAGES - 1

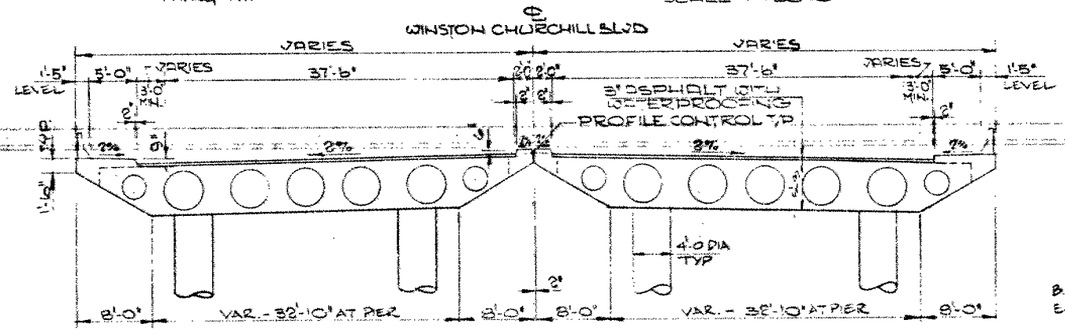
OVERSIZE DRAWINGS TO BE INCLUDED WITH THIS REPORT.

REMARKS:

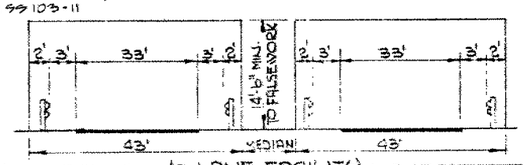
DIST. 6	
CONT No	
WP No 167-77-01	
WINSTON CHURCHILL BLVD. U/ PASS	SHEET
GENERAL ARRANGEMENT	



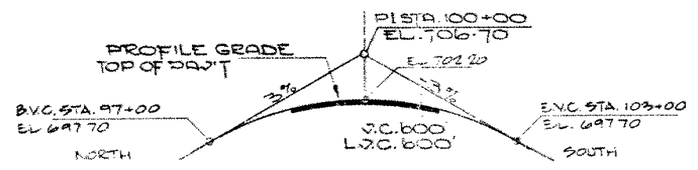




T/P DECK CROSS-SECTION
SCALE: 1/8" = 1'-0"



6 LANE FACILITY
(3 LANE IN EACH DIRECTION)
NOTE: ALL HORIZ. DIM. ARE MIN. DIM. REQUIRED



PROFILE OF WINSTON CHURCHILL BOULEVARD
NOT TO SCALE

GENERAL NOTES

CLASS OF CONCRETE

DECK & PIERS	35 MPa
ABUTMENTS, WINGWALLS, BARRIER WALLS & PIER & ABUTMENT FOOTINGS	30 MPa
REMAINDER	20 MPa

GRADE OF REINFORCING STEEL

REINFORCING SHALL BE GRADE 400
BAR MARKS WITH THE SUFFIX 'C' SHALL BE COATED BARS.

CLEAR COVER TO REINFORCING STEEL

FOOTINGS & ABUTMENTS — 3"
COLUMNS — 3"
DECK: TOP 2" BOTT. 1"
BARRIER WALLS — AS NOTED
APPROACH SLABS — 2"

CONSTRUCTION NOTES

- THE CONTRACTOR IS RESPONSIBLE FOR FINISHING THE BEARING SEATS DEAD LEVEL TO THE SPECIFIED ELEVATIONS WITH A TOLERANCE OF ± 1/8"
- NO CONCRETE SHALL BE PLACED ABOVE THE ABUTMENT BEARING SEATS UNTIL THE CONCRETE IN DECK HAS BEEN PLACED, STRESSED AND GROUTED.

CONCRETE QUANTITIES

CONCRETE QUANTITIES ARE LISTED BELOW FOR THE APPROPIATE CONCRETE LUMP SUM TENDER ITEMS.

CONCRETE IN ABUTMENTS & WINGWALLS	911 C.Y.
CONCRETE IN PIER	42 C.Y.
CONCRETE IN PRESTRESSED CONC. BRIDGE DECK	3580 C.Y.
CONCRETE IN APPROACH SLABS	114 C.Y.
CONCRETE IN BARRIER WALL	54 C.Y.
CONCRETE IN SLOPED PAVING	1170 C.Y.

LIST OF DRAWINGS

J.D. LEE ENGINEERING LIMITED

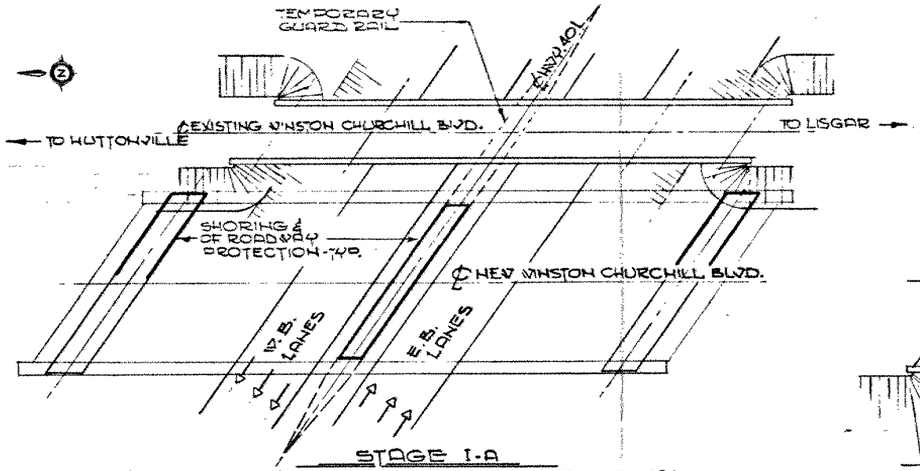
REGISTERED PROFESSIONAL ENGINEER D.C. BATCHELOR PROVINCE OF ONTARIO

FOR REDUCED PLAN
USE SCALE BELOW
10 11 12 13
3 INCHES ON ORIGINAL PLAN

REVISIONS			
DATE	BY	DESCRIPTION	
DESIGN	CHECK	LOADING	DATE
DRAWING	CHECK	SITE No	DWG 1

H:\0-1075_000\41\9

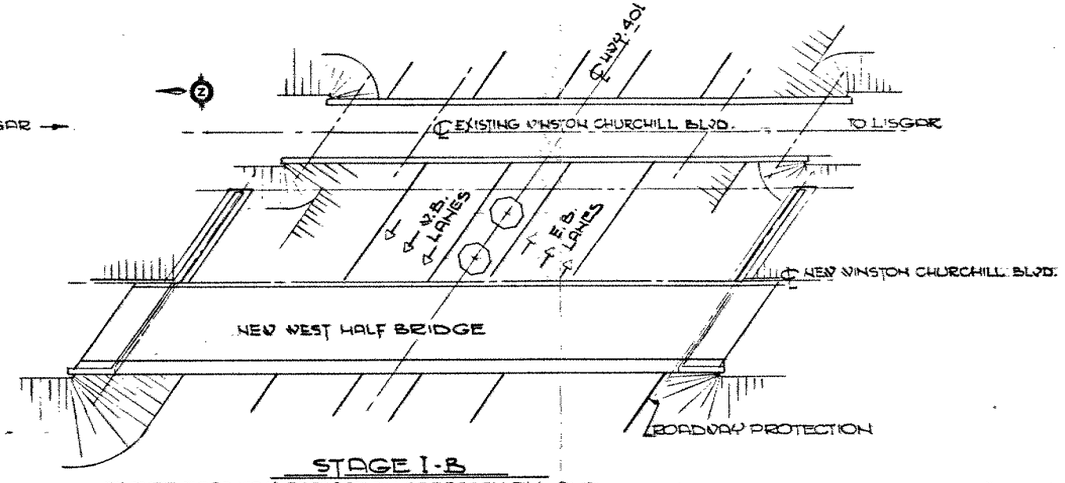
CONT No	
WP No	157-77-01
WINSTON CHURCHILL BLVD. U'PASS	SHEET
CONSTRUCTION STAGES	



STAGE I-A

PLACE ROADWAY PROTECTION AND CONSTRUCT FOOTINGS, ABUTMENTS AND PIERS FOR BOTH HALVES NEW BRIDGE. CONSTRUCT SUPERSTRUCTURE FOR WEST HALF

HWY. 401 TRAFFIC UNCHANGED
WINSTON CHURCHILL BLVD. TRAFFIC UNCHANGED



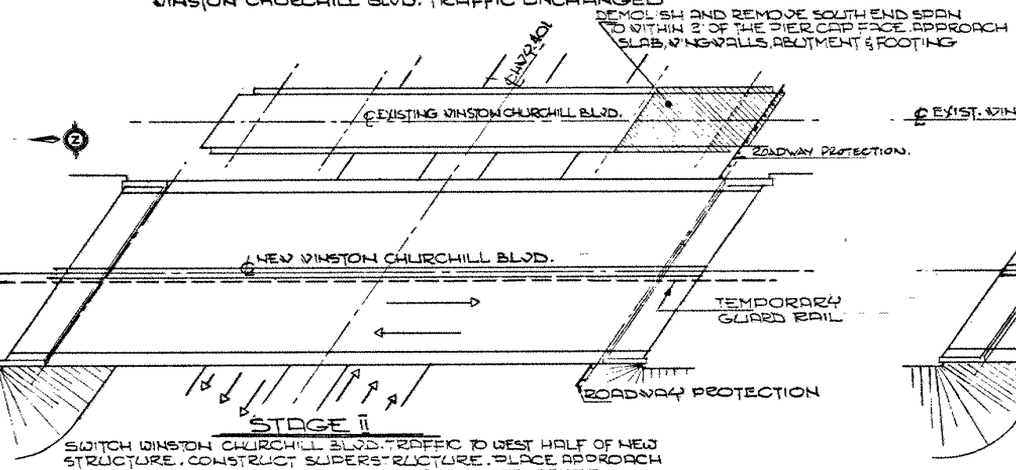
STAGE I-B

PLACE ROADWAY PROTECTION APPROACH FILL AND APPROACH SLABS WEST SIDE.

HWY. 401 & WINSTON CHURCHILL BLVD. TRAFFIC UNCHANGED

NOTES:

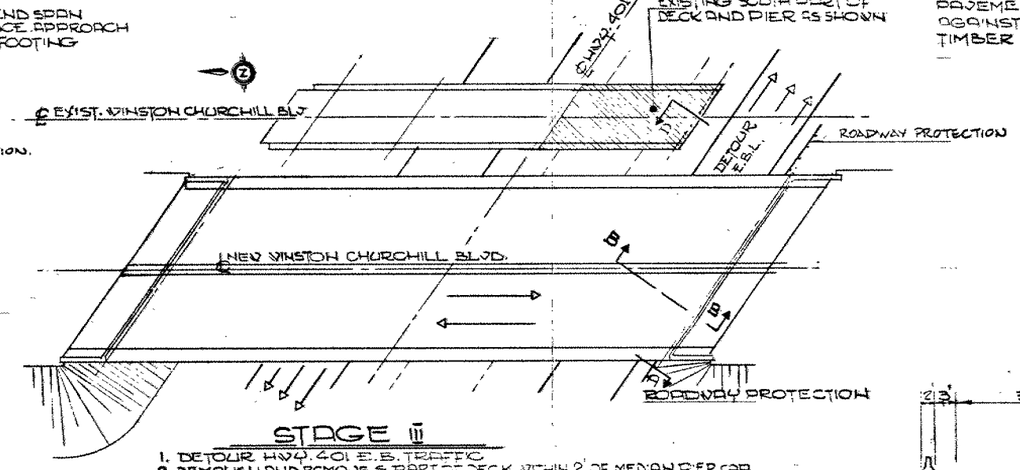
DURING DEMOLITION OF THE DECK THE PAVEMENT ON THE HWY. 401 SHALL BE PROTECTED AGAINST DAMAGE, BY MEANS OF A SAND/OR TIMBER BLANKET AS APPROVED BY THE ENGINEER.



STAGE II

SWITCH WINSTON CHURCHILL BLVD. TRAFFIC TO WEST HALF OF NEW STRUCTURE. CONSTRUCT SUPERSTRUCTURE. PLACE APPROACH FILL AND APPROACH SLABS FOR EAST HALF OF STRUCTURE.

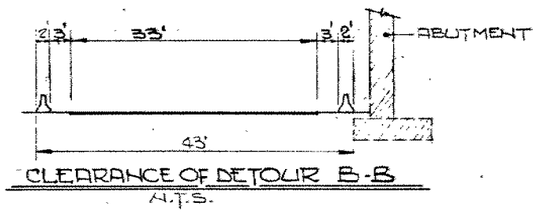
HWY. 401 TRAFFIC UNCHANGED
WINSTON CHURCHILL BLVD TRAFFIC ON WEST HALF OF NEW BRIDGE



STAGE III

1. DETOUR HWY. 401 E.B. TRAFFIC.
2. DEMOLISH AND REMOVE S. PART OF DECK WITHIN 2' OF MEDIAN PIER CAP AND SHOULDER PIER

HWY. 401 W.B.L. TRAFFIC ON EXISTING W.B.L.
HWY. 401 E.B.L. TRAFFIC ON DETOUR
WINSTON CHURCHILL BLVD. TRAFFIC ON WEST HALF OF NEW BRIDGE



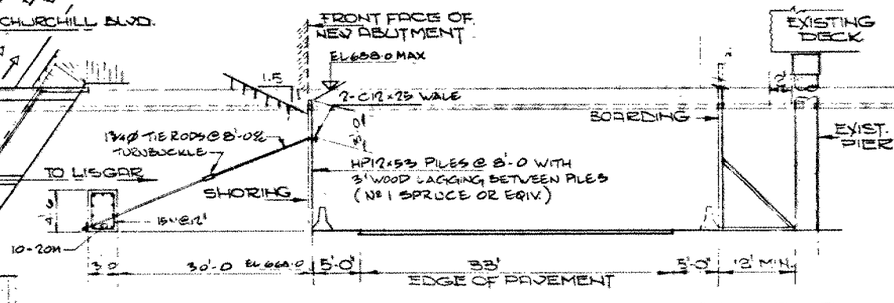
CLEARANCE OF DETOUR B-B
N.T.S.

STAGE IV

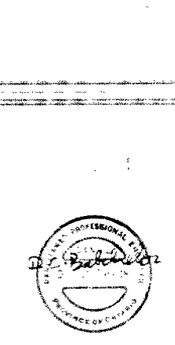
1. DETOUR HWY. 401 W.B.L. TRAFFIC TO THE EXISTING E.B.L.
2. DEMOLISH AND REMOVE REMAINDER OF EXISTING BRIDGE

HWY 401 TRAFFIC ON DETOUR
WINSTON CHURCHILL BLVD. TRAFFIC ON WEST HALF OF NEW BRIDGE

FINAL STAGE: SWITCH BACK HWY. 401 TRAFFIC TO HWY. 401
HWY. 401 TRAFFIC HWY. 401
WINSTON CHURCHILL BLVD. TRAFFIC ON NEW BRIDGE



CLEARANCE OF DETOURS A-A TYP
N.T.S.



J.D. LEE ENGINEERING LIMITED
Consulting Engineers

FOR REDUCED PLAN
USE SCALE BELOW
0 1 2 3
3 INCHES ON ORIGINAL PLAN

REVISIONS			
DATE	BY	DESCRIPTION	
DESIGN	CHECK	LOADING	DATE
DRAWING	CHECK	SITE No	DWG 2

1-8-1075, 500-9/78

DIST Nº 6
CONT No
WP No 167-77-01

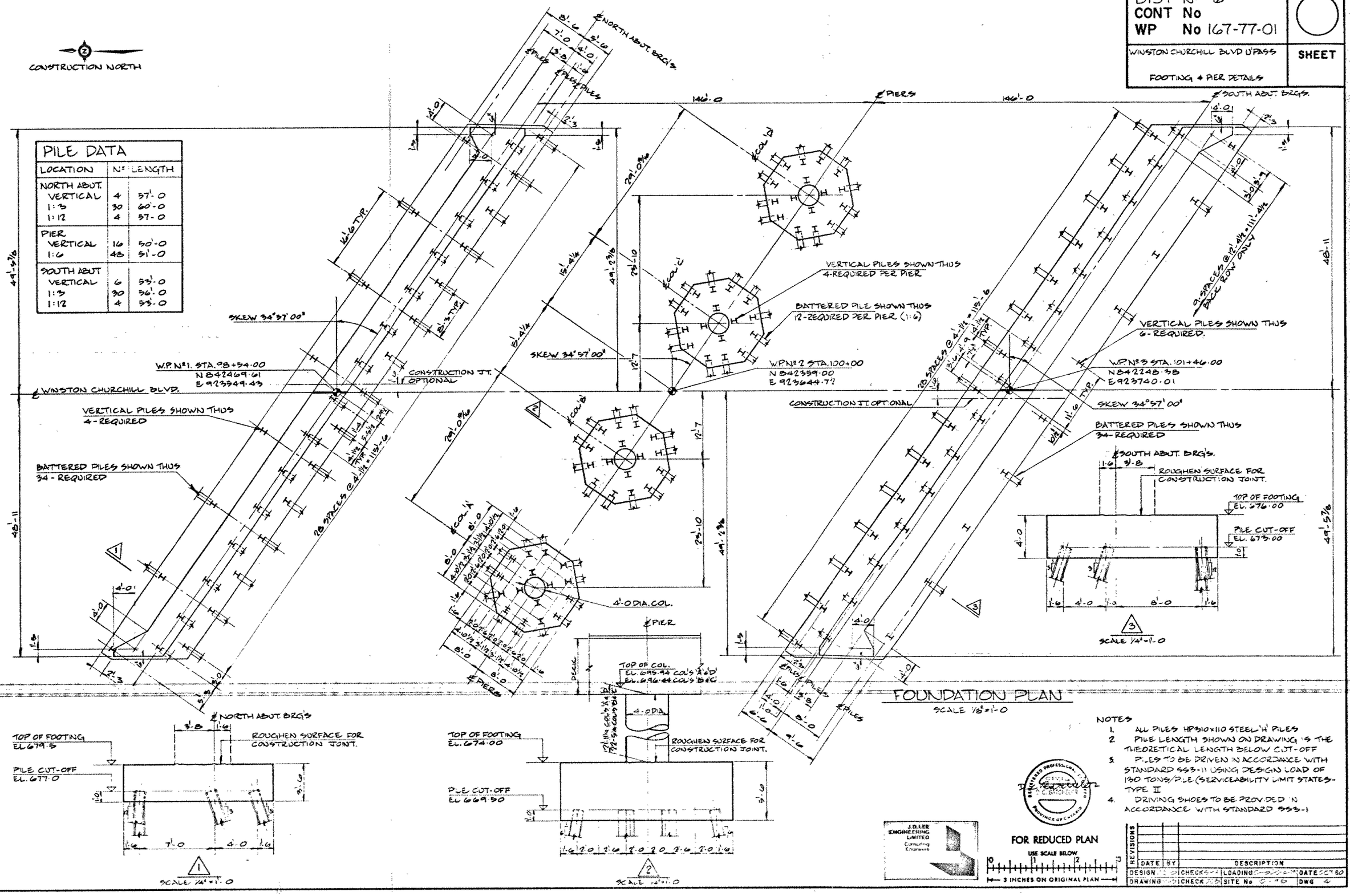
WINSTON CHURCHILL BLVD U'PASS

FOOTING & PIER DETAILS

SHEET

CONSTRUCTION NORTH

PILE DATA		
LOCATION	Nº	LENGTH
NORTH ABUT.		
VERTICAL	4	57'-0
1:3	30	60'-0
1:12	4	57'-0
PIER		
VERTICAL	16	50'-0
1:6	48	51'-0
SOUTH ABUT		
VERTICAL	6	55'-0
1:3	30	56'-0
1:12	4	55'-0



FOUNDATION PLAN

SCALE 1/8"=1'-0

NOTES

1. ALL PILES HP310x110 STEEL 'H' PILES
2. PILE LENGTH SHOWN ON DRAWING IS THE THEORETICAL LENGTH BELOW CUT-OFF
3. PILES TO BE DRIVEN IN ACCORDANCE WITH STANDARD SS3-11 USING DESIGN LOAD OF 130 TONS/PILE (SERVICEABILITY LIMIT STATES-TYPE II
4. DRIVING SHOES TO BE PROVIDED IN ACCORDANCE WITH STANDARD SS3-1

J.D. LEE ENGINEERING LIMITED
Consulting Engineers

REGISTERED PROFESSIONAL ENGINEER
J. BACHERT
PROVINCE OF ONTARIO

FOR REDUCED PLAN
USE SCALE BELOW
0 1 2 3
3 INCHES ON ORIGINAL PLAN

REVISIONS			
	DATE	BY	DESCRIPTION
DESIGN	CHECK	LOADING	DATE
DRAWING	CHECK	SITE No	DWG 4

FOUNDATION INVESTIGATION REPORT

CONTRACT NO 86-72

Ontario
Ministry of
Transportation and
Communications

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 (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
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 INVESTIGATION REPORT

for

Winston Churchill Blvd. Interchange
W.P. 167-77-01, Site 10-98
Hwy. 401, District 6, Toronto

INTRODUCTION

This report presents the results of a foundation investigation program carried out at the above-mentioned site. The fieldwork for this program was carried out under 3 separate investigations during the following periods:

1. Oct. 17, 1979 (B.H. 1, B.H. 2)
2. Jan. 7-8,1980 (B.H. 3, B.H. 4)
3. Apr. 28 - May 5, 1980 (B.H. 5, B.H. 6, B.H. 7)

The first investigation consisted of two sampled boreholes and one dynamic cone penetration test advanced through the median of Hwy. 401 to a depth of 41 feet. The second investigation consisted of two additional sampled boreholes at the proposed abutment locations and advanced to depths of 46.5 and 50.5 feet. The third investigation consisted of a further three sampled boreholes advanced to depths 95, 100 and 119 feet.

SITE DESCRIPTION AND GEOLOGY

The site is located immediately west of the existing Hwy. 401 underpass structure at Winston Churchill Blvd. in the Town of Halton Hills, Regional Municipality of Halton.

The topography in the immediate area is flat to gently undulating with the predominate land use being agricultural.

Presently Hwy. 401 traverses the site in a 10 to 12 foot cut through the surficial overburden with stable cut slopes of 2:1.

Physiographically, the site is situated in the 'Peel Plain' region of the West St. Lawrence Lowlands which is characterized by a modified veneer of clay underlain by glacial till containing large amounts of Upper Ordovician Paleozoic shale. Underlying the glacial deposit are the red (Queenston) shales from which the till's reddish colour is derived.

SUBSURFACE CONDITIONS

General

The site is underlain by a uniform deposit of glacial till consisting of silty clay, with sand and a trace of gravel which was explored to a maximum depth of 111 feet (in B.H. 7).

Granular fill material consisting of sand and gravel was encountered only in roadway borings for a depth of some 3.5 feet. Silty clay fill was encountered in B.H. 5 and B.H. 7 for depths of 12 feet below the existing ground surface. Bedrock was encountered in two boreholes (B.H. 6, B.H. 7).

The boundaries between the various soil types are shown on the attached Record of Borehole Sheets. The locations and elevations of the borings, along with an estimated stratigraphical profile based on borehole data, is shown on Drawing No. 3 of the Contract Drawings.

The major subsoil type encountered is described briefly in the following paragraph.

Silty Clay, With Sand, Trace of Gravel (Glacial Till)

Underlying the site and explored for depths ranging from 40.9 to 111 feet is a cohesive glacial till deposit consisting of a heterogeneous mixture of silty clay, with sand and trace of gravel.

Occasional sand seams and pockets of sandy silt were encountered within this deposit. Grain size analysis for this cohesive stratum of samples from B.H. 1 - B.H. 4 are shown on the grain size distribution chart, Figure No. 1. In general, the gravel content was also found to increase in the lower portion of this deposit below elevation 642, as indicated by the two curves on Figure No. 1. The results of grain size distribution tests carried out on samples from B.H. 5, B.H. 6, and B.H. 7 are indicated on the log sheets and not included in Figure 1.

Typical Atterberg Limits and identity indices performed on selected representative samples from B.H. 1 - B.H. 4 are summarized in the following table and plotted on the Plasticity Chart, Figure No. 2.

	Range	Average
Moisture Content (W) %	6 - 14	13
Liquid Limit (W_L)%	15 - 27	22
Plastic Limit (W_p)%	9 - 15	10
Plasticity Index (I_p)%	6 - 14	11

The results of Atterberg Limits tests conducted on samples from B.H. 5 - 7 are not included on Figure 2. However, the results are indicated on the appropriate log sheets.

The results indicate this glacial deposit to be generally an inorganic silty clay of low plasticity (CL) becoming less plastic with depth (CL - ML).

It is to be noted that below Elev. 620, this deposit becomes non-cohesive and very dense as indicated by the high Standard Penetration Test 'N' values.

Based on Standard Penetration Test 'N' values ranging generally from 10 to over 100 blows per foot, this material is considered to be in a stiff to hard state.

Bedrock

Shale bedrock was encountered in B.H. 6 and B.H. 7 at Elev. 584.6 and 583.6 respectively. In B.H. 6, the upper weathered bedrock was augered and a sample of the shale was taken by driving the split-spoon sampler 2 inches. In B.H. 7, the upper 3 or 4 feet of weathered bedrock was augered and a sample taken by driving a split-spoon 2 inches. Three feet of BXL rock core was also taken with 85% recovery.

Groundwater Conditions

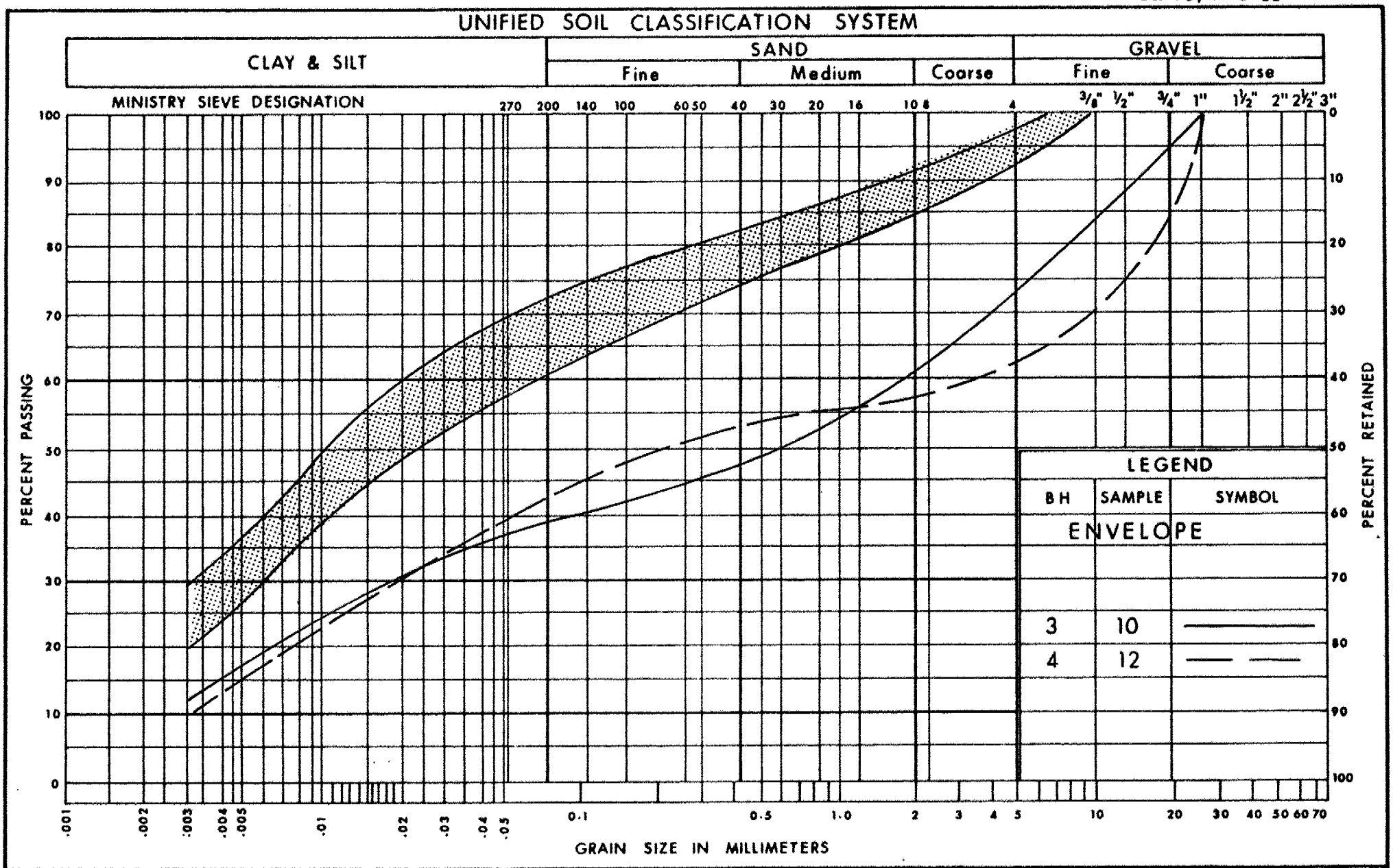
Overnight groundwater level readings taken in one open borehole indicated a groundwater depth of 34.5 feet corresponding to elevation 649.5. Localized seepage was also encountered at a depth of 5 feet (elev. 670.5) in one of the borings advanced through the median.

L. Politano, P. Eng.
Project Foundations Engineer

M. Devata, P. Eng.
Chief Foundations Engineer
(East)

REGISTERED PROFESSIONAL ENGINEER
M. DEVATA
PROVINCE OF ONTARIO

APPENDIX

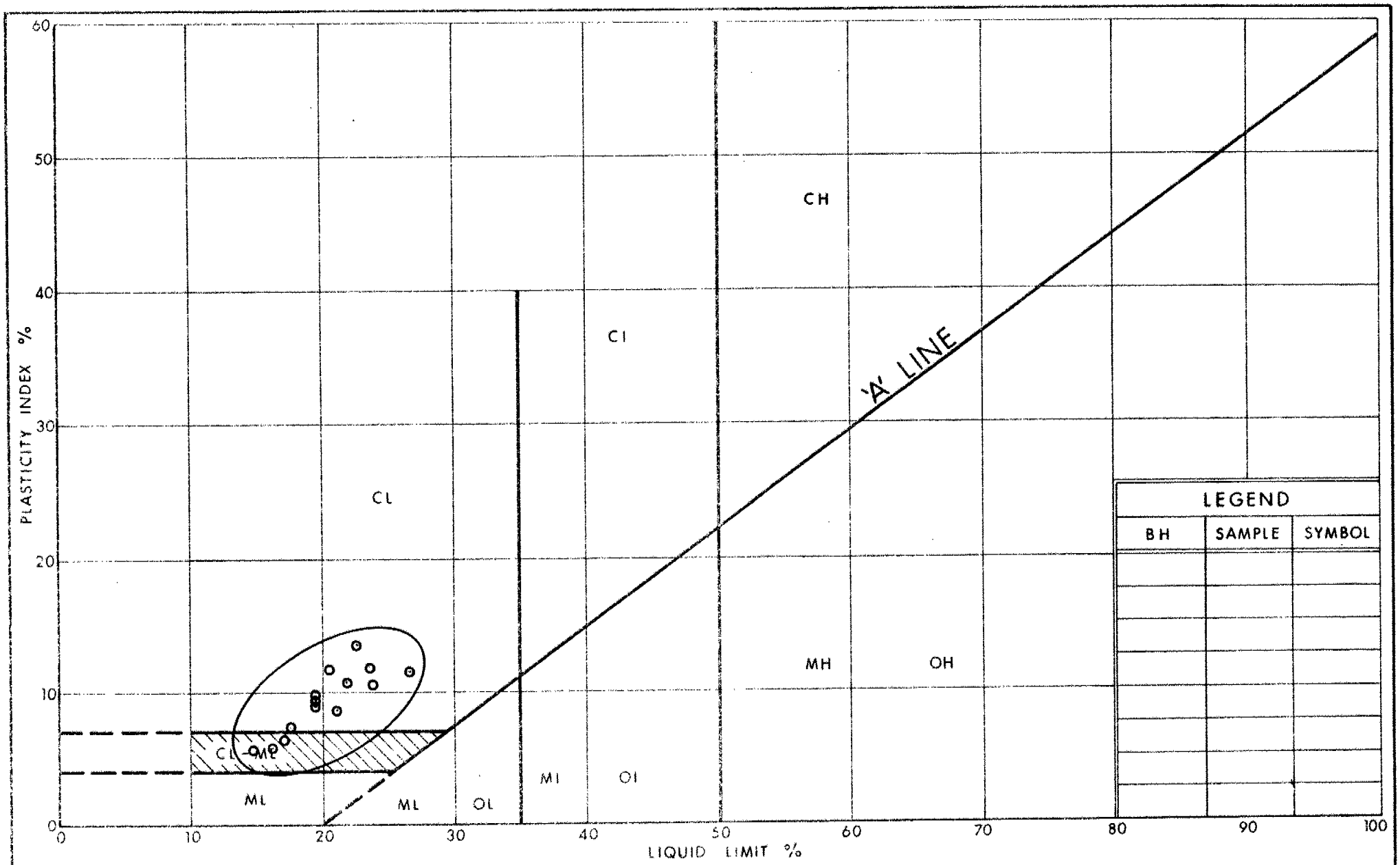


Ministry of Transportation and Communications
Ontario

GRAIN SIZE DISTRIBUTION
SILTY CLAY
WITH SAND TRACE OF GRAVEL

FIG No 1
W P 167-77-01

7



Ministry of Transportation and Communications
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PLASTICITY CHART
SILTY CLAY
WITH SAND TRACE OF GRAVEL LOW PLASTICITY

FIG No 2
W P 167-77-01

Ministry of Transportation and Communications
Ontario

OFFICE REPORT ON SOIL EXPLORATION

RECORD OF BOREHOLE No 1

W P 167-77-01 LOCATION Co-ords. N 15 842 366; E 923 695 ORIGINATED BY BL
DIST 6 HWY 401 BOREHOLE TYPE Hollow Stem Augers COMPILED BY TJK
DATUM Geodetic DATE October 17, 1979 CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT N (20 40 60 80 100) / SHEAR STRENGTH (o UNCONFINED, • FIELD VANE, ● QUICK TRIAXIAL, x 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						
675.5	Ground Surface										
0.0 / 672.0	Granular Fill										
3.5	Brownish Grey Weathered — Grey — Silty Clay With Sand, Trace of Gravel Low Plasticity		1	SS	9		670				
			2	SS	19						
			3	SS	28		660				
			4	SS	20						
			5	SS	30		650				
			6	SS	24						
	Stiff to Very Stiff — Hard		7	SS	105/ 9"		640				
	Excess of Gravel		8	SS	90/ 4"						
634.6 / 40.9	End of Borehole										

Note: Localized Seepage into B.H. Encountered at a Depth of 5.0 ft.

+3, x5 : Numbers refer to Sensitivity

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

Ministry of Transportation and Communications
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RECORD OF BOREHOLE No 2

W P 167-77-01 LOCATION Co-ords. N 15 842 363; E 923 652 ORIGINATED BY BL
DIST 6 HWY 401 BOREHOLE TYPE Hollow Stem Augers COMPILED BY TJK
DATUM Geodetic DATE October 17, 1979 CHECKED BY

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES 'N' VALUES	GROUND WATER CONDITIONS
675.5	Ground Surface					
0.0 / 672.0	Granular Fill					
3.5	Occasional Sand Seams		1	SS	39	
	Hard					
	Grey Silty Clay With Sand, Trace of Gravel (Glacial Till) Low Plasticity		2	SS	17	
			3	SS	14	
			4	SS	16	
			5	SS	18	
	Stiff to Very Stiff		6	SS	22	
	Hard		7	SS	92	
	Excess of Gravel		8	SS	60/4"	
634.6						
40.9	End of Borehole					

ELEVATION SCALE: 670, 660, 650, 640

DYNAMIC CONE PENETRATION RESISTANCE PLOT: 20 40 60 80 100

SHEAR STRENGTH
o UNCONFINED + FIELD VANE
● QUICK TRIAXIAL x 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

$+^3$, x^5 : Numbers refer to Sensitivity

20
15 ◇ 5 (%) STRAIN AT FAILURE
10

OFFICE REPORT ON SOIL EXPLORATION

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RECORD OF BOREHOLE No 3

W P 167-77-01 LOCATION Co-ords. N 15 842 462; E 923 520 ORIGINATED BY TJK
DIST 6 HWY 401 BOREHOLE TYPE Hollow Stem Augers COMPILED BY TJK
DATUM Geodetic DATE Jan. 7, 1980 CHECKED BY

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 ○ 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
684.0	Ground Surface										
0.0	Sand & Gravel Weathered		1	SS	13		680				
			2	SS	37						
			3	SS	29						
	Grey Silty Clay With Sand, Trace of Gravel (Glacial Till) Low Plasticity Very Stiff to Hard		4	SS	34						
			5	SS	33		670				
			6	SS	17						
			7	SS	19						
			8	SS	16		660				
			9	SS	26	▽	650				
	Hard										
637.5	Excess of Gravel		10	SS	53		640				
46.5	End of Borehole										

+3, ×5 : Numbers refer to Sensitivity

20
15 ◇ 5 (%) STRAIN AT FAILURE
10

OFFICE REPORT ON SOIL EXPLORATION

Ministry of Transportation and Communications
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RECORD OF BOREHOLE No 4

W P 167-77-01 LOCATION Co-ords. N 15 842 238; E 923 706 ORIGINATED BY TJK
DIST 6 HWY 401 BOREHOLE TYPE Hollow Stem Augers COMPILED BY TJK
DATUM Geodetic DATE Jan. 7, 1980 CHECKED BY

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 (○ 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
684.4	Ground Surface										
0.0	Weathered		1	SS	14		680				
			2	SS	4						
			3	SS	37						
			4	SS	88						
	Brown ⇐ Grey		5	SS	65		670				
			6	SS	31						
	Silty Clay With Sand, Trace of Gravel (Glacial Till) Low Plasticity		7	SS	13						
			8	SS	18		660				
			9	SS	21						
	Stiff to Very Stiff		10	SS	21		650				
	— Hard —										
			11	SS	68		640				
633.9			12	SS	67						
50.5	End of Borehole										

+3, ×5 : Numbers refer to Sensitivity

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

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RECORD OF BOREHOLE No 5

W P 167-77-01 LOCATION Co-ords. N 15 842 250; E 923 812 ORIGINATED BY PJS
DIST 6 HWY 401 BOREHOLE TYPE Hollow Stem Augers COMPILED BY PJS
DATUM Geodetic DATE April 28th & 29th, 1980 CHECKED BY

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 (○ 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
695.4	Ground Surface										
0.0	Fill										
	Silty Clay of Low Plasticity Stiff		1	SS	4		690				
			2	SS	9						
683.4			3	SS	5						
12.0	Silty Clay (Low Plasticity) With Sand Trace of Gravel Very Stiff to Hard (Glacial Till)		4	SS	12		680				
			5	SS	16						
			6	SS	54						
			7	SS	79						
			8	SS	70		670				
			9	SS	42						
			10	SS	29						
			11	SS	29						
			12	SS	25						
			13	SS	25		660				
			14	SS	19						
			15	SS	21		650				
			16	SS	19						
			17	SS	35		640				
			18	SS	110/ 6"						
			19	SS	100/ 8"		630				
			20	SS	61						
	Occasional Layers and Pockets of Sandy Silt Very Dense		21	SS	100/ 7"		620				
			22	SS	100/ 7"						
			23	SS	116		610				
			24	SS	100/ 8"						
594.7			25	SS	100/ 8"		600				
100.7	End of Borehole										

+3, ×5 : Numbers refer to Sensitivity

15 20/10 5 (%) STRAIN AT FAILURE

OFFICE REPORT ON SOIL EXPLORATION

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RECORD OF BOREHOLE No 6

W P 167-77-01 LOCATION Co-ords. N 15 842 162; E 923 598 ORIGINATED BY PJS
DIST 6 HWY 401 BOREHOLE TYPE Solid Auger COMPILED BY PJS
DATUM Geodetic DATE May 1, 1980 CHECKED BY

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 (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE)	PLASTIC LIMIT Wp / NATURAL MOISTURE CONTENT W / LIQUID LIMIT W_L — WATER CONTENT (%) 10 20 30	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
675.6	Ground Level										
0.0 / 672.1	Fill										
3.5	Silty Clay (Low Plasticity) With Sand Trace of Gravel Very Stiff to Hard (Glacial Till)		1	SS	25		670				
			2	SS	20						
			3	SS	18		660				
			4	SS	22						
			5	SS	19		650				
			6	SS	18						
			7	SS	15		640				
			8	SS	44						
			9	SS	80		630				
			10	SS	116/ 10"						
			11	SS	120		620				
	Occasional Layers and Pockets of Sandy Silt Very Dense		12	SS	93						
			13	SS	61		610				6 47 35 12
			14	SS	105						
			15	SS	100/ 5"		600				
			16	SS	100/ 8"						
			17	SS	43		590				
			18	SS	60						
584.6				Very Hard Augering							
91.0	Shale Bedrock						580				
580.5	Weathered		19	SS	150/ 2"						
95.1	End of Borehole										

+3, ×5 : Numbers refer to Sensitivity

20
15 ◇ 5 (%) STRAIN AT FAILURE
10

OFFICE REPORT ON SOIL EXPLORATION

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RECORD OF BOREHOLE No 7

W P 167-77-01 LOCATION Co-ords. N 15 842 478; E 923 614 ORIGINATED BY PJS
DIST 6 HWY 401 BOREHOLE TYPE Solid Auger COMPILED BY PJS
DATUM Geodetic DATE May 1st to 5th, 1980 CHECKED BY

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES 'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE
694.6	Ground Level						
0.0	Fill						
	Silty Clay of Low Plasticity Stiff to Very Stiff		1	SS	7		690
682.6			2	SS	11		
12.0	Silty Clay (Low Plasticity) With Sand Trace of Gravel Very Stiff to Hard (Glacial Till)		3	SS	35		680
			4	SS	48		
			5	SS	38		670
			6	SS	26		
			7	SS	23		660
			8	SS	24		
			9	SS	25		650
			10	SS	40		
			11	SS	54		640
			12	SS	71		
			13	SS	100/ 8"		630
			14	SS	50		
	Occasional Layers and Pockets of Sandy Silt Very Dense		15	SS	100/ 8"		620
			16	SS	100/ 6"		
			17	SS	100/ 5"		610
			18	SS	100/ 2"		600
			19	SS	100/ 7"		590
583.6							
111.0	Shale Bedrock		20	SS	100/ 2"		580
575.2			21	BXL RC	85% REC		
119.4	End of Borehole						

DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100
SHEAR STRENGTH ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE
PLASTIC LIMIT Wp | NATURAL MOISTURE CONTENT W | LIQUID LIMIT W_L
WATER CONTENT (%) 10 20 30
UNIT WEIGHT γ

REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL

11 23 43 23

17 45 31 7

$+^3$, $\times^5$: Numbers refer to Sensitivity

20
15 ◇ 5 (%) STRAIN AT FAILURE
10

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foundation investigation and design report

ENGINEERING MATERIALS OFFICE
PAVEMENT & FOUNDATION DESIGN SECTION

WP 167-77-~~00~~ 01 DIST #6

HWY 401 STR SITE 10-98

Winston Churchill Blvd. Interchange

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DATE FEB 19 1980

FOUNDATION INVESTIGATION REPORT
For
Winston Churchill Blvd. Interchange
W.P. 167-77-02, Site 10-98
Hwy. 401, District 6, Toronto

INTRODUCTION

This report presents the results of a foundation investigation program carried out at the above mentioned project site. The fieldwork proceeded during the periods of Oct. 17, 1979 and Jan. 7 to Jan. 8, 1980, utilizing continuous flight hollow stem augers. The initial investigation consisted of two sampled boreholes and one dynamic cone penetration test advanced through the median of Hwy. 401 to a depth of 41 feet. The recent fieldwork consisted of 2 additional sampled boreholes at the proposed abutment locations advanced to depths ranging from 46.5 to 50.5 feet.

SITE DESCRIPTION AND GEOLOGY

The site is located immediately west of the existing Hwy. 401 underpass structure at Winston Churchill Blvd. in the Town of Halton Hills, Regional Municipality of Halton.

The topography in the immediate area is flat to gently undulating with the predominate land use being agricultural.

Presently Hwy. 401 traverses the site in a 10 to 12 foot cut through the surficial overburden with stable cut slopes of 2:1.

Physiographically, the site is situated in the 'Peel Plain' region of the West St. Lawrence Lowlands which is characterized by a modified veneer of clay underlain by glacial till containing large amounts of Upper Ordovician Paleozoic shale. Underlying the glacial deposit are the red (Queenston) shales from which the till's reddish colour is derived.

SUBSURFACE CONDITIONS

General

The site is underlain by a uniform deposit of glacial till consisting of silty clay, with sand and a trace of gravel which was explored to a maximum depth of 50.5 feet.

Granular fill material consisting of sand and gravel was encountered only in roadway borings for a depth of some 3.5 feet. Bedrock was not encountered in any of the borings.

The boundaries between the various soil types are shown on the attached Record of Borehole Sheets. The locations and elevations of the borings, along with an estimated stratigraphical profile based on borehole data, is shown on Drawing No. 1677702-A.

The major subsoil type encountered is described briefly in the following paragraph.

Silty Clay, With Sand, Trace of Gravel (Glacial Till)

Underlying the site and explored for depths ranging from 40.9 to 50.5 feet is a cohesive glacial till deposit consisting of a heterogeneous mixture of silty clay, with sand and trace of gravel.

Occasional sand seams were encountered in the upper portions of this deposit. Grain size analysis for this cohesive stratum are shown in envelope form on the grain size distribution chart, Figure No. 1. In general, the gravel content was also found to increase in the lower portion of this deposit below elevation 642, as indicated by the two curves on Figure No. 1. Typical Atterberg Limits and identity indices performed on selected representative samples are summarized in the following table and plotted on the Plasticity Chart, Figure No. 2.

	Range	Average
Moisture Content (W) %	6 - 14	13
Liquid Limit (W_L)%	15 - 27	22
Plastic Limit (W_p)%	9 - 15	10
Plasticity Index (I_p)%	6 - 14	11

These results indicate this glacial deposit to be generally an inorganic silty clay of low plasticity (CL) becoming less plastic with depth (CL-ML).

Standard Penetration Test 'N' values range from 4 to in excess of 100 blows in the upper weathered portion, approx. 20 blows for the next 20 feet, and then in excess of 50 blows/foot below this depth (elev. 642±). The consistency of the cohesive till deposit based on visual identification and interpretation of the 'N' values may be considered as very stiff to hard for the upper weathered portion, stiff to very stiff between elevations 670 and 642, and then hard below elevation 642.

Groundwater Conditions

Overnight groundwater level readings taken in one open borehole indicated a groundwater depth of 34.5 feet corresponding to elevation 649.5. Localized seepage was also encountered at a depth of 5 feet (elev. 670.5) in one of the borings advanced through the median.

DISCUSSION AND RECOMMENDATIONS

General

As part of the Winston Churchill Blvd./Hwy. 401 Interchange development scheme, it is proposed to replace the existing two lane underpass structure with a two span four lane underpass structure.

The planned structure will have a combined span length of some 250 feet and a deck width of 98 feet. At the proposed centreline intersection the profile grade of Hwy. 401 will be at elevation 676± and that of W.C.B. will be at elevation 703±. Assuming an average ground elevation of 684 behind the proposed abutments, the required earth work will entail approach fills in the order of 20 feet.

In summary, a uniform glacial till deposit consisting of stiff to hard silty clay, with sand, and a trace of gravel was found to extend over the site.

Our recommendations for the foundations of the structure and related earthworks are as follows.

Structure Foundations

Abutments

In consideration of the competent nature of the subsoils at the abutment locations and the anticipated fill heights, abutments can be founded on spread footings. For spread footings founded at or below elevation 678, an allowable bearing capacity of 2.5 t.s.f. can be used for design purposes.

Depending on the design elevation for spread footings, all organic or softened material beneath the planned limits of the abutment footings, particularly at the existing drainage ditch locations, should be subexcavated for their full depth and backfilled with well compacted granular 'A' material.

In order to resist lateral forces acting on the abutment foundations, frictional forces between the footing bases and foundation soil can be calculated using a coefficient of friction of 0.7 for the granular 'A'

pad and an adhesion value of 2,000 p.s.f. against sliding for the natural ground conditions. Backfill behind the abutments should be composed of well compacted free-draining granular material with provisions made for adequate drainage. The lateral earth pressure exerted on the abutment walls by the granular backfill can be computed assuming a unit weight of 130 pcf for the backfill and a coefficient of earth pressure of:

K_a - 0.35 for the "active" case where rotation about the base is allowed

K_o = 0.5 for the "at rest" case where no rotation or translation about the base is permitted

Piers

Foundations for the piers should be supported on displacement piles driven into the hard till stratum. For design purposes precast reinforced concrete piles, i.e. hardrive pile or equivalent, driven to an approx. tip elevation of 635 can be designed for an allowable capacity of 70 tons per pile.

Alternatively 12 3/4" O.D. steel tube piles driven with a closed end to elevation 635 can be designed for an allowable capacity of 50 tons per tube pile.

Regardless of the pile type used, piles in the field should be driven using a pile driving hammer rated at 29,000 ft. lbs/blow or equivalent rated energy to a pile set of 10 blows/inch.

Piles driven within a distance of 5 feet to any utilities should be preaugered using a 10" diameter auger to a depth of 5 feet below the invert of the utility line. Pile driving can then commence from this elevation. A recommendation for the safe bearing capacity of these pre-augered piles will be given by this Section upon receipt of utility elevations.

Due to the cohesive nature of the subsoils and the proximity of the individual piles, driving operations may result in disturbance and heaving of previously driven piles. It is recommended that the sequence of pile driving be such that only alternative piles are driven in succession if heaving becomes apparent. In addition, all heaved piles

should be redriven to the specified driving criteria.

OTHER CONSIDERATIONS

For frost protection purposes, the underside of the pile caps and footings should have a minimum of 4 feet of earth cover.

No dewatering difficulties are anticipated for excavations of the pile caps and spread footings due to the relatively low permeability of the cohesive till deposit. Localized seepage into the excavations can be controlled by pumping from perimeter sumps.

Approaches

Approach fills, in the order of 20 feet, for the W.C.B. can be safely constructed with standard 2:1 slopes with no anticipated stability problems. Prior to placement of the earth fills, all organic and softened material particularly in the existing drainage ditches should be subexcavated to their full depth for a minimum of 100 feet behind the abutments and replaced with well-compacted earth fill.

MISCELLANEOUS

The fieldwork for this investigation was carried out under the supervision of Messrs. B. Ly, Foundations Engineer and T.J. Kazmierowski, Project Foundation Engineer. The equipment used was owned and operated by Dominion Soils Investigation Ltd., Toronto.

This report was written by Mr. T.J. Kazmierowski and reviewed by Mr. M. Devata, Senior Foundations Engineer.

T. Kazmierowski
Project Foundation Engineer

M. Devata
Senior Foundations Engineer

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Ministry of Transportation and Communications
Ontario

HIGHWAY ENGINEERING DIVISION - ENGINEERING MATERIALS OFFICE - SOIL MECHANICS SECTION

RECORD OF BOREHOLE No 1

W P 167-77-02 LOCATION Co-ords. N 15 842 366, E 923 695 ORIGINATED BY B.L.

DIST 6 HWY 401 BOREHOLE TYPE Hollow Stem Augers COMPILED BY T.J.K.

DATUM Geodetic DATE October 17, 1979 CHECKED BY

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 (o 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
675.5	Roadway Surface										
0.0	Granular Fill										
672.0											
3.5	Weathered										
	Brownish Grey		1	SS	9		670				
	Grey		2	SS	19						5-27-43-25
	Silty Clay With Sand Trace of Gravel		3	SS	28		660				
	Low Plasticity (Glacial Till) Stiff to Very Stiff		4	SS	20						
			5	SS	30		650				
			6	SS	24						
	Hard		7	SS	105/ 9"		640				
	- Excess of Gravel										
634.6			8	SS	90/ 4"						3-35-43-17
40.9	End of Borehole										

Note: Localized seepage into B.H. encountered at a depth of 5.0 feet.

+3, ×5 : Numbers refer to Sensitivity

15 20 5 10 (%) STRAIN AT FAILURE

Ministry of Transportation and Communications
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HIGHWAY ENGINEERING DIVISION - ENGINEERING MATERIALS OFFICE - SOIL MECHANICS SECTION

RECORD OF BOREHOLE No 2

W P 167-77-02 LOCATION Co-ords. N 15 842 363, E 923 662 ORIGINATED BY B.L.

DIST 6 HWY 401 BOREHOLE TYPE Hollow Stem Augers COMPILED BY T.J.K.

DATUM Geodetic DATE October 17, 1979 CHECKED BY W.J.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH (○ 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						
675.5	Roadway Surface										
0.0	Granular Fill										
672.0											
3.5	– occasional sand seams		1	SS	39		670				
	Hard										
	Grey										
	Silty Clay		2	SS	17						7-27-46-20
	With Sand										
	Trace of Gravel										
	Low Plasticity		3	SS	14		660				
	(Glacial Till)										
	Stiff to Very Stiff		4	SS	16						
			5	SS	18		650				
			6	SS	22			100/6"			
	Hard		7	SS	92		640				
	– Excess of Gravel										
634.6			8	SS	60/4"						
40.9	End of Borehole										

+3, ×5 : Numbers refer to Sensitivity

$\frac{220}{15 \pm 5}$ (%) STRAIN AT FAILURE

Ministry of Transportation and Communications
Ontario

HIGHWAY ENGINEERING DIVISION - ENGINEERING MATERIALS OFFICE - SOIL MECHANICS SECTION

RECORD OF BOREHOLE No 3

W P 167-77-02 LOCATION Co-ords. N 15 842 462, E 923 520 ORIGINATED BY T.J.K.

DIST 6 HWY 401 BOREHOLE TYPE Hollow Stem Augers COMPILED BY T.J.K.

DATUM Geodetic DATE January 7, 1980 CHECKED BY M. J.

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 (○ 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
684.0	Ground Surface										
0.0	Silty Clay with Sand Trace gravel		1	SS	13		680				
	Sand & Gravel Seam		2	SS	37						42-42-11-5
	Weathered		3	SS	29						
			4	SS	34						8-20-49-23
	Grey Silty Clay With Sand Trace of Gravel Low Plasticity (Glacial Till) Very Stiff to Hard		5	SS	33		670				
			6	SS	17						
			7	SS	19		660				
			8	SS	16						
			9	SS	26	▼	650				
	Hard –Excess of Gravel						640				
637.5			10	SS	53						28-22-28-11
46.5	End of Borehole										

+3, ×5 : Numbers refer to Sensitivity

15 20 5 (%) STRAIN AT FAILURE 10

Ministry of Transportation and Communications
Ontario

HIGHWAY ENGINEERING DIVISION - ENGINEERING MATERIALS OFFICE - SOIL MECHANICS SECTION

RECORD OF BOREHOLE No 4

W P 167-77-02 LOCATION Co-ords. N 15 842 238, E 923 706 ORIGINATED BY T.J.K.

DIST 6 HWY 401 BOREHOLE TYPE Hollow Stem Augers COMPILED BY T.J.K.

DATUM Geodetic DATE January 7, 1980 CHECKED BY [illegible]

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 (o 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
684.4	Ground Surface										
0.0	Weathered Silty Clay with Sand Trace of Gravel Low Plasticity Firm to Hard		1	SS	14						
			2	SS	4		680				7-29-43-21
			3	SS	37						5-27-49-19
			4	SS	88						
	Brown — Grey		5	SS	65						4-32-46-18
			6	SS	31		670				
	Silty Clay With Sand Trace of Gravel Low Plasticity (Glacial Till)		7	SS	13						
	Stiff to Very Stiff		8	SS	18		660				
			9	SS	21						
			10	SS	21		650				
	Hard										
	- Occasional Fine Sand Seams		11	SS	68		640				
633.9			12	SS	67						37-21-32-10
50.5	End of Borehole										

+3, ×5 : Numbers refer to Sensitivity

15 20 5 10 (%) STRAIN AT FAILURE

Ministry of Transportation and Communications
Ontario

RECORD OF BOREHOLE No 5

W P 167-77-02 LOCATION Co-ords. N 15 842 250; E 923 812 ORIGINATED BY PJS

DIST 6 HWY 401 BOREHOLE TYPE Hollow Stem Augers COMPILED BY PJS

DATUM Geodetic DATE April 28th & 29th, 1980 CHECKED BY

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 (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE)	PLASTIC LIMIT Wp / NATURAL MOISTURE CONTENT W / LIQUID LIMIT W_L — WATER CONTENT (%) 10 20 30	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
695.4	Ground Surface										
0.0	Fill										
	Silty Clay of Low Plasticity Stiff		1	SS	4		690				
			2	SS	9						
683.4			3	SS	5						
12.0	Silty Clay (Low Plasticity) With Sand Trace of Gravel Very Stiff to Hard (Glacial Till)		4	SS	12		680				
			5	SS	16						
			6	SS	54						
			7	SS	79						
			8	SS	70		670				
			9	SS	42						
			10	SS	29						
			11	SS	29						
			12	SS	25						
			13	SS	25		660				
			14	SS	19						
			15	SS	21		650				
			16	SS	19						
			17	SS	35		640				
			18	SS	110/ 6"						
			19	SS	100/ 8"		630				
			20	SS	61						
	Occasional Layers and Pockets of Sandy Silt Very Dense		21	SS	100/ 7"		620				
			22	SS	100/ 7"						
			23	SS	116		610				
			24	SS	100/ 8"						
594.7			25	SS	100/ 8"		600				
100.7	End of Borehole										

+3, ×5 : Numbers refer to Sensitivity

15 20 10 5 (%) STRAIN AT FAILURE

OFFICE REPORT ON SOIL EXPLORATION

Ministry of Transportation and Communications
Ontario

RECORD OF BOREHOLE No 6

W P 167-77-02 LOCATION Co-ords. N 15 842 162; E 923 598 ORIGINATED BY PJS
DIST 6 HWY 401 BOREHOLE TYPE Solid Auger COMPILED BY PJS
DATUM Geodetic DATE May 1, 1980 CHECKED BY

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 (○ 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
675.6	Ground Level						670				
0.0 / 672.1	Fill										
3.5	Silty Clay (Low Plasticity) With Sand Trace of Gravel Very Stiff to Hard (Glacial Till)		1	SS	25						
			2	SS	20						
			3	SS	18		660				
			4	SS	22						
			5	SS	19						
			6	SS	18		650				
			7	SS	15						
			8	SS	44		640				
			9	SS	80						
			10	SS	116/	10"	630				
			11	SS	120						
	Occasional Layers and Pockets of Sandy Silt Very Dense		12	SS	93		620				
			13	SS	61						6 47 35 12
			14	SS	105		610				
			15	SS	100/	5"					
			16	SS	100/	8"	600				
			17	SS	43						
			18	SS	60		590				
584.6				Very Hard Augering							
91.0	Shale Bedrock										
580.5	Weathered		19	66	150/	2"	580				
95.1	End of Borehole										

+3, ×5 : Numbers refer to Sensitivity

20
15 ◇ 5 (%) STRAIN AT FAILURE
10

OFFICE REPORT ON SOIL EXPLORATION

Ministry of Transportation and Communications
Ontario

RECORD OF BOREHOLE No 7

W P 167-77-02 LOCATION Co-ords. N 15 842 478; E 923 614 ORIGINATED BY PJS
DIST 6 HWY 401 BOREHOLE TYPE Solid Auger COMPILED BY PJS
DATUM Geodetic DATE May 1st to 5th, 1980 CHECKED BY

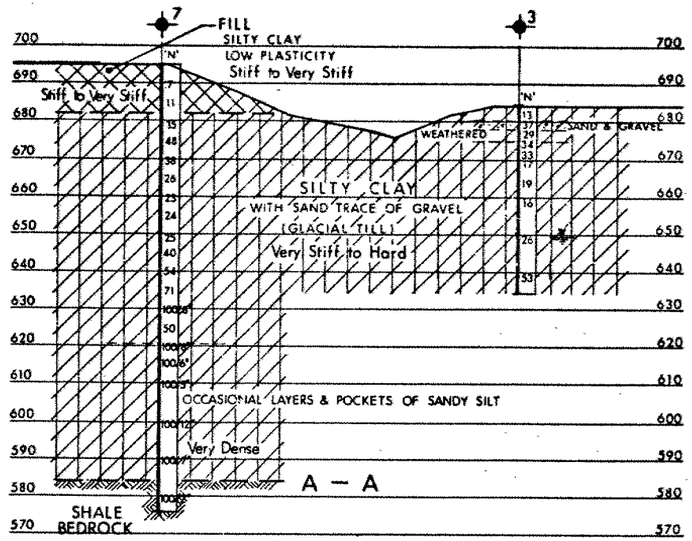
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
694.6	Ground Level							
0.0	Fill							
	Silty Clay of Low Plasticity Stiff to Very Stiff		1	SS	7		690	
682.6			2	SS	11			
12.0	Silty Clay (Low Plasticity) With Sand Trace of Gravel Very Stiff to Hard (Glacial Till)		3	SS	35		680	
			4	SS	48			
			5	SS	38		670	
			6	SS	26			
			7	SS	23		660	
			8	SS	24			11 23 43 23
			9	SS	25		650	
			10	SS	40			
			11	SS	54		640	
			12	SS	71			
			13	SS	100/	8"	630	
			14	SS	50			
			15	SS	100/	8"	620	
	Occasional Layers and Pockets of Sandy Silt Very Dense		16	SS	100/	6"		
			17	SS	100/	5"	610	
			18	SS	100/	/2"	600	17 45 31 7
			19	SS	100/	7"	590	
583.6								
111.0	Shale Bedrock		20	SS	100/	2"	580	
575.2			21	BXL RC	85% REC			
119.4	End of Borehole							

DYNAMIC CONE PENETRATION RESISTANCE PLOT 'N' 20 40 60 80 100
SHEAR STRENGTH o UNCONFINED • QUICK TRIAXIAL + FIELD VANE × LAB VANE
PLASTIC LIMIT Wp | NATURAL MOISTURE CONTENT W | LIQUID LIMIT W_L
WATER CONTENT (%) 10 20 30
UNIT WEIGHT γ

$+^3$, $\times^5$: Numbers refer to Sensitivity

20
15 ⊹ 5 (%) STRAIN AT FAILURE
10

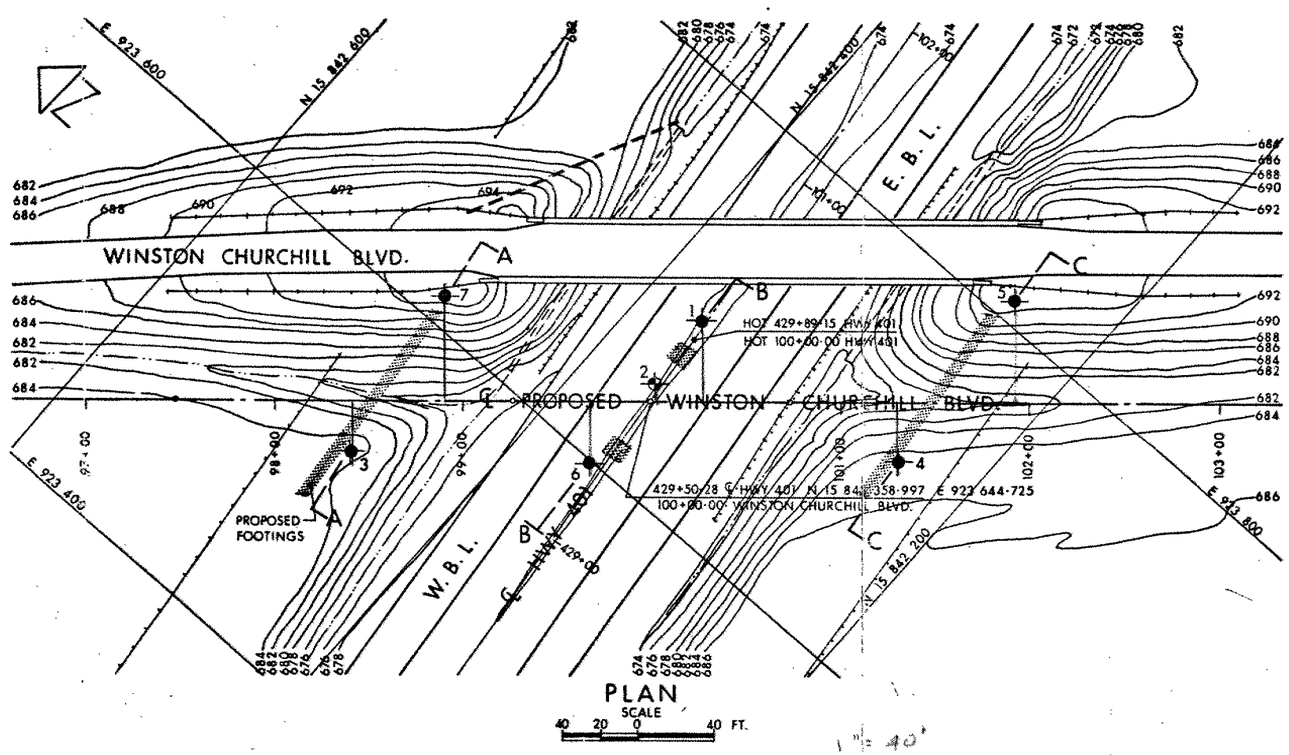
OFFICE REPORT ON SOIL EXPLORATION



SECTIONS

SCALE

20 10 0 20 FT.

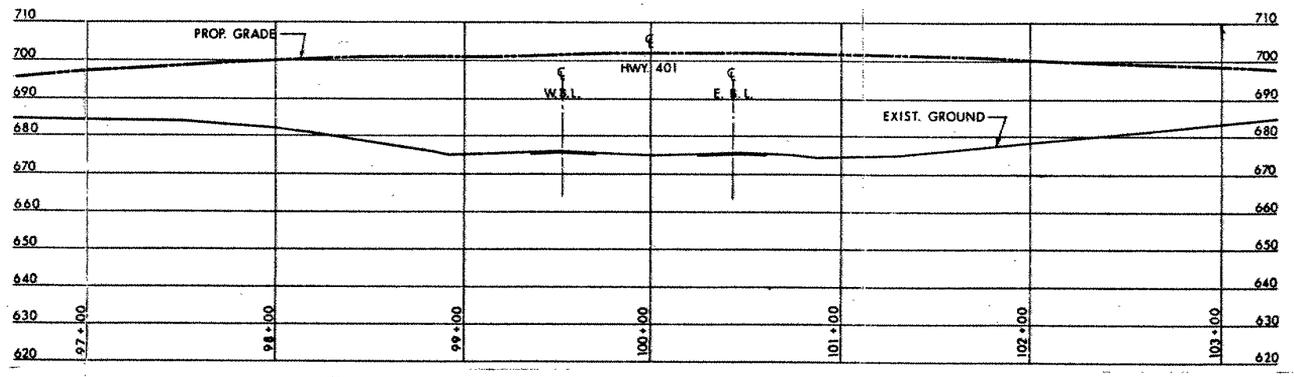


PLAN

SCALE

40 20 0 40 FT.

1" = 40'



℄ PROFILE PROPOSED WINSTON CHURCHILL BLVD.

SCALE

HOR 40 20 0 40 FT.

VERT. 20 10 0 20

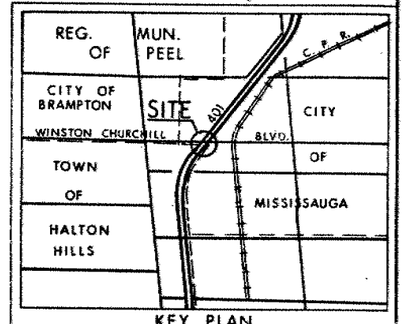
CONT No

WP No 167-77-02

HWY 401 & WINSTON CHURCHILL BLVD. INTERCHANGE

BORE HOLE LOCATIONS & SOIL STRATA

SHEET



LEGEND

- Bore Hole
- Dynamic Cone Penetration Test (Cone)
- Bore Hole & Cone
- 'N' Blows/ft (Std Pen Test 350 ft lbs energy)
- CONE Blows/ft (60° Cone, 350 ft lbs energy)
- WL at time of investigation 80 01 07
- NQ WL Established in BH No 1, 2, & 4

No	ELEVATION	CO-ORDINATES NORTH	CO-ORDINATES EAST
1	675·5	15 842 366	923 695
2	675·5	15 842 363	923 652
3	684·0	15 842 462	923 520
4	684·4	15 842 238	923 706
5	695·4	15 842 250	923 812
6	675·6	15 842 162	923 598
7	694·6	15 842 478	923 614

-NOTE-

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

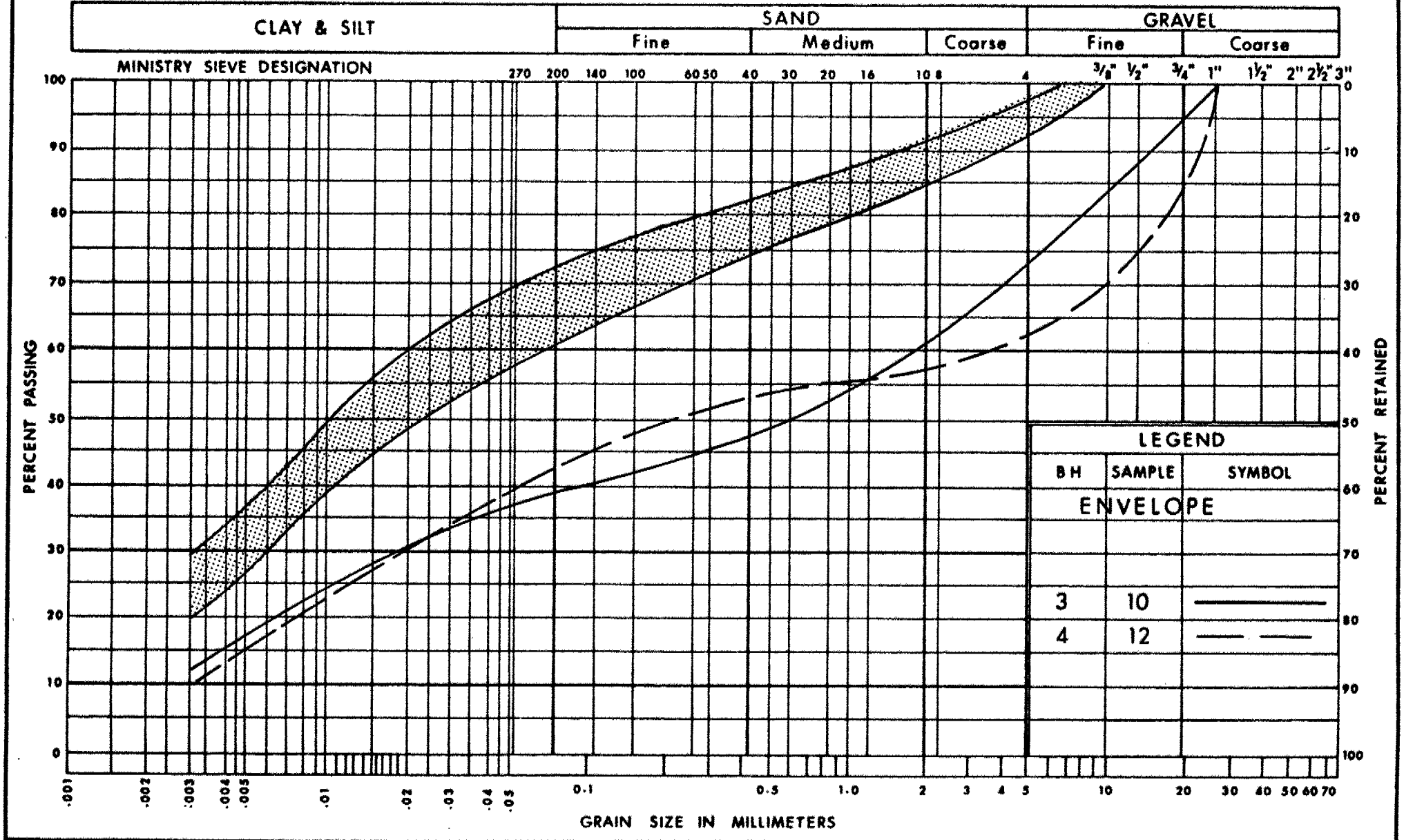
REVISIONS

DATE	BY	DESCRIPTION

GEOCRES No 30M12-145

HWY No 401			DIST 6
SUBMD T. K.	CHECKED	DATE 80 02 08	SITE 10-98
DRAWN O. J.	CHECKED	APPROVED	DWG 1677702-A

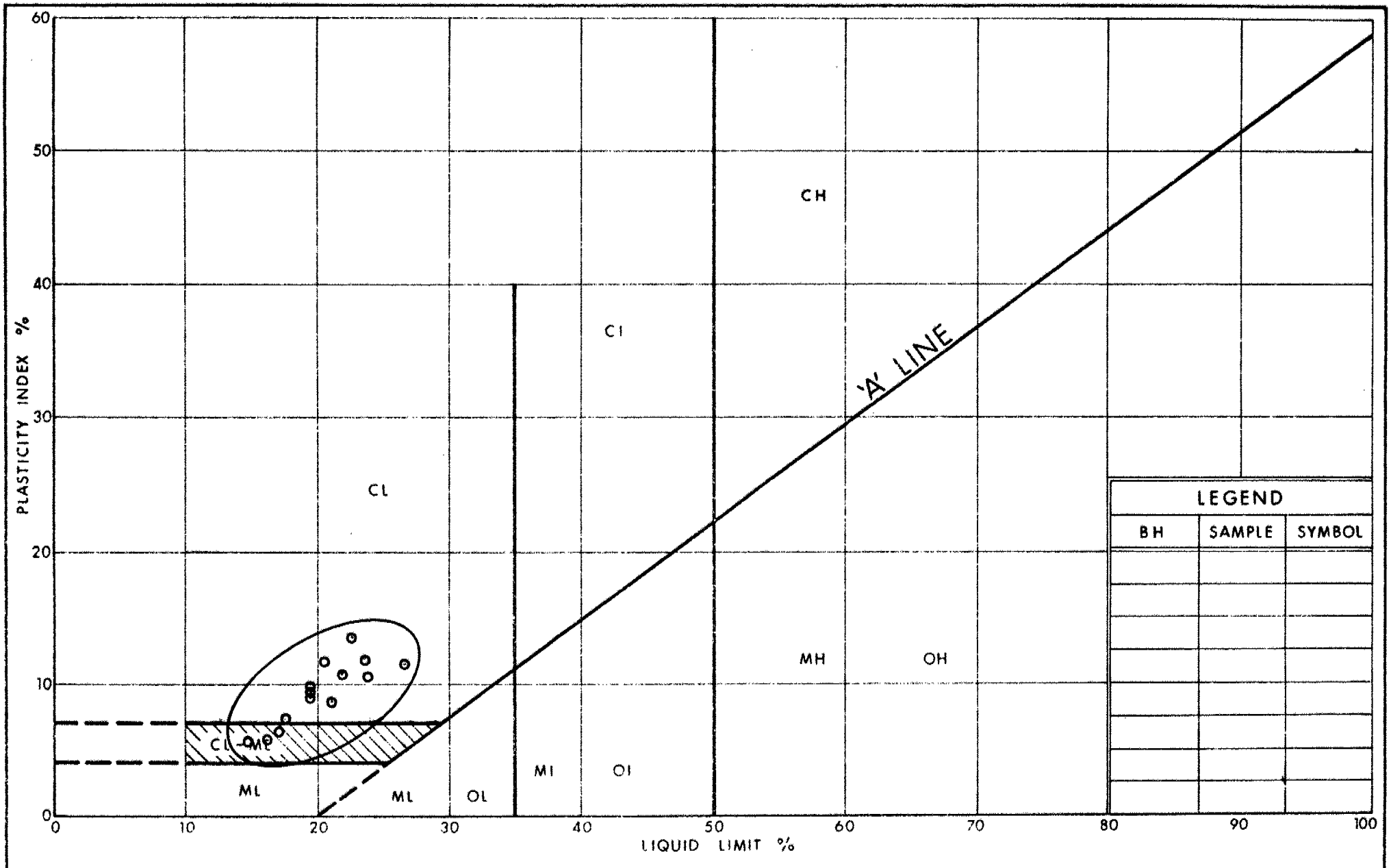
UNIFIED SOIL CLASSIFICATION SYSTEM



Ministry of Transportation and Communications
Ontario

GRAIN SIZE DISTRIBUTION
SILTY CLAY
WITH SAND TRACE OF GRAVEL

FIG No 1
W P 167-77-02



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Ontario

PLASTICITY CHART
SILTY CLAY
WITH SAND TRACE OF GRAVEL LOW PLASTICITY

FIG No 2
W P 167-77-02

EXPLANATION OF TERMS USED IN REPORT

'N' VALUE: AN INDICATOR OF SUBSOIL QUALITY. IT IS OBTAINED FROM THE STANDARD PENETRATION TEST (CSA STD. A119.1). SPT 'N' VALUE IS THE NUMBER OF BLOWS REQUIRED TO CAUSE A STANDARD 2 INCH O.D. SPLIT-BARREL SAMPLER TO PENETRATE 12 INCHES INTO UNDISTURBED GROUND IN A BOREHOLE WHEN DRIVEN BY A HAMMER WEIGHING 140 POUNDS, FALLING FREELY A DISTANCE OF 30 INCHES. FOR PENETRATIONS OF LESS THAN 12 INCHES 'N' VALUES ARE INDICATED AS THE NUMBER OF BLOWS FOR THE PENETRATION ACHIEVED. 'N' VALUES CORRECTED FOR OVERBURDEN PRESSURE ARE DENOTED THUS $\overline{N}$.

DYNAMIC CONE PENETRATION TEST (CSA STD. A119.3): CONTINUOUS PENETRATION OF A CONICAL STEEL POINT (2" O.D. 60 CONE ANGLE) DRIVEN BY 350 FT-LB IMPACTS ON 'A' SIZE DRILL RODS. THE RESISTANCE TO CONE PENETRATION IS MEASURED AS THE NUMBER OF BLOWS FOR EACH 12 INCH ADVANCE OF THE CONICAL POINT INTO THE UNDISTURBED GROUND.

SOIL QUALITY: SOILS ARE DESCRIBED BY THEIR COMPOSITION AND CONSISTENCY OR DENSITY.

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

S_u (PSF)	0 - 250	250 - 500	500 - 1000	1000 - 2000	2000 - 4000	> 4000
	VERY SOFT	*SOFT*	*FIRM*	*STIFF*	*VERY STIFF*	*HARD*

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

'N' (BLOW/FT)	0 - 5	5 - 10	10 - 30	30 - 50	> 50
	VERY LOOSE	*LOOSE*	*COMPACT*	*DENSE*	*VERY DENSE*

ROCK QUALITY: 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 DRILLED IN THAT CORING RUN.

MODIFIED RECOVERY: SUM OF THOSE NATURALLY FRACTURED CORE PIECES, 4"+ 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	2"	2" - 12"	1' - 3'	3' - 10'	> 10'
JOINTING	*VERY CLOSE*	*CLOSE*	*MOD. CLOSE*	*WIDE*	*VERY WIDE*
BEDDING	*VERY THIN*	*THIN*	*MEDIUM*	*THICK*	*VERY THICK*

ABBREVIATIONS & SYMBOLS

LABORATORY TESTING

TRIAXIAL TESTS ARE DESCRIBED IN TERMS OF WHETHER
THEY ARE CONSOLIDATED (C) OR NOT (U)
ISOTROPICALLY (I) OR NOT (A)
AND SHEARED DRAINED (D) OR UNDRAINED (U)
WITH PORE PRESSURE MEASUREMENTS (BAR OVER SYMBOLS)
EG. $\overline{CIU}$ = CONSOLIDATED ISOTROPIC UNDRAINED
TRIAXIAL WITH PORE PRESSURE MEASUREMENT

UNLESS OTHERWISE SPECIFIED IN REPORT ALL TESTS ARE IN COMPRESSION

FIELD SAMPLING

S S	SPLIT SPOON
W S	WASH SAMPLE
S T	SLOTTED TUBE SAMPLE
B S	BLOCK SAMPLE
C S	CHUNK SAMPLE
T W	THINWALL OPEN
T P	THINWALL PISTON
O S	OSTERBERG SAMPLE
F S	FOIL SAMPLE
R C	ROCK CORE
P H	T.W. ADVANCED HYDRAULICALLY
P M	T.W. ADVANCED MANUALLY

EARTH PRESSURE TERMS

μ	COEFFICIENT OF FRICTION
δ	ANGLE OF WALL FRICTION
k_o	COEFFICIENT OF EARTH PRESSURE AT REST
k_A	COEFFICIENT OF ACTIVE EARTH PRESSURE
k_p	COEFFICIENT OF PASSIVE EARTH PRESSURE
i	ANGLE OF INCLINATION OF SURCHARGE
w	SLOPE ANGLE-BACKFACE OF WALL
β	ANGLE OF SLOPE
N_γ, N_q, N_c	BEARING CAPACITY FACTORS
D_f	DEPTH OF FOOTING
B,L	FOOTING DIMENSIONS

INDEX PROPERTIES

γ	UNIT WEIGHT OF SOIL (BULK DENSITY)
γ_w	UNIT WEIGHT OF WATER
γ_d	UNIT DRY WEIGHT OF SOIL (DRY DENSITY)
γ'	UNIT WEIGHT OF SUBMERGED SOIL
G_s	SPECIFIC GRAVITY OF SOLIDS
e	VOIDS RATIO
e_o	INITIAL VOIDS RATIO
e_{max}	e IN LOOSEST STATE
e_{min}	e IN DENSEST STATE
D_r	RELATIVE DENSITY = $\frac{e_{max} - e}{e_{max} - e_{min}}$
n	POROSITY
w	WATER CONTENT
w_L	LIQUID LIMIT
w_P	PLASTIC LIMIT
w_S	SHRINKAGE LIMIT
I_P	PLASTICITY INDEX = $w_L - w_P$
I_L	LIQUIDITY INDEX = $\frac{w - w_P}{I_P}$
I_c	CONSISTENCY INDEX = $\frac{w_L - w}{I_P}$
A_c	ACTIVITY = $\frac{I_P \text{ of soil}}{\% < 2\mu m \text{ Soil Fraction}}$
Om	ORGANIC MATTER CONTENT
S_r	DEGREE OF SATURATION
S	SENSITIVITY = $\frac{S_u \text{ (undisturbed)}}{S_u \text{ (remoulded)}}$

STRENGTH PARAMETERS

ϕ	ANGLE OF SHEARING RESISTANCE
τ_f	PEAK SHEAR STRENGTH
τ_R	RESIDUAL SHEAR STRENGTH
c	COHESION INTERCEPT
$\sigma_1, \sigma_2, \sigma_3$	NORMAL PRINCIPAL STRESSES
u	PORE WATER PRESSURE
u_e	EXCESS u
r_u	PORE PRESSURE RATIO
q_u	UNCONFINED COMPRESSIVE STRENGTH
s_u	UNDRAINED SHEAR STRENGTH
ϵ	LINEAR STRAIN
γ	SHEAR STRAIN
ν	POISSON'S RATIO
E	MODULUS OF ELASTICITY
G	MODULUS OF SHEAR DEFORMATION
k_s	MODULUS OF SUBGRADE REACTION
m,n	STABILITY COEFFICIENTS
A,B	PORE PRESSURE COEFFICIENTS

NOTE: EFFECTIVE STRESS PARAMETERS ARE DENOTED BY USE OF APOSTROPHE ABOVE THE SYMBOL, THUS:
ϕ' = EFFECTIVE ANGLE OF SHEARING RESISTANCE;
σ' = EFFECTIVE NORMAL STRESS

HYDRAULIC TERMS

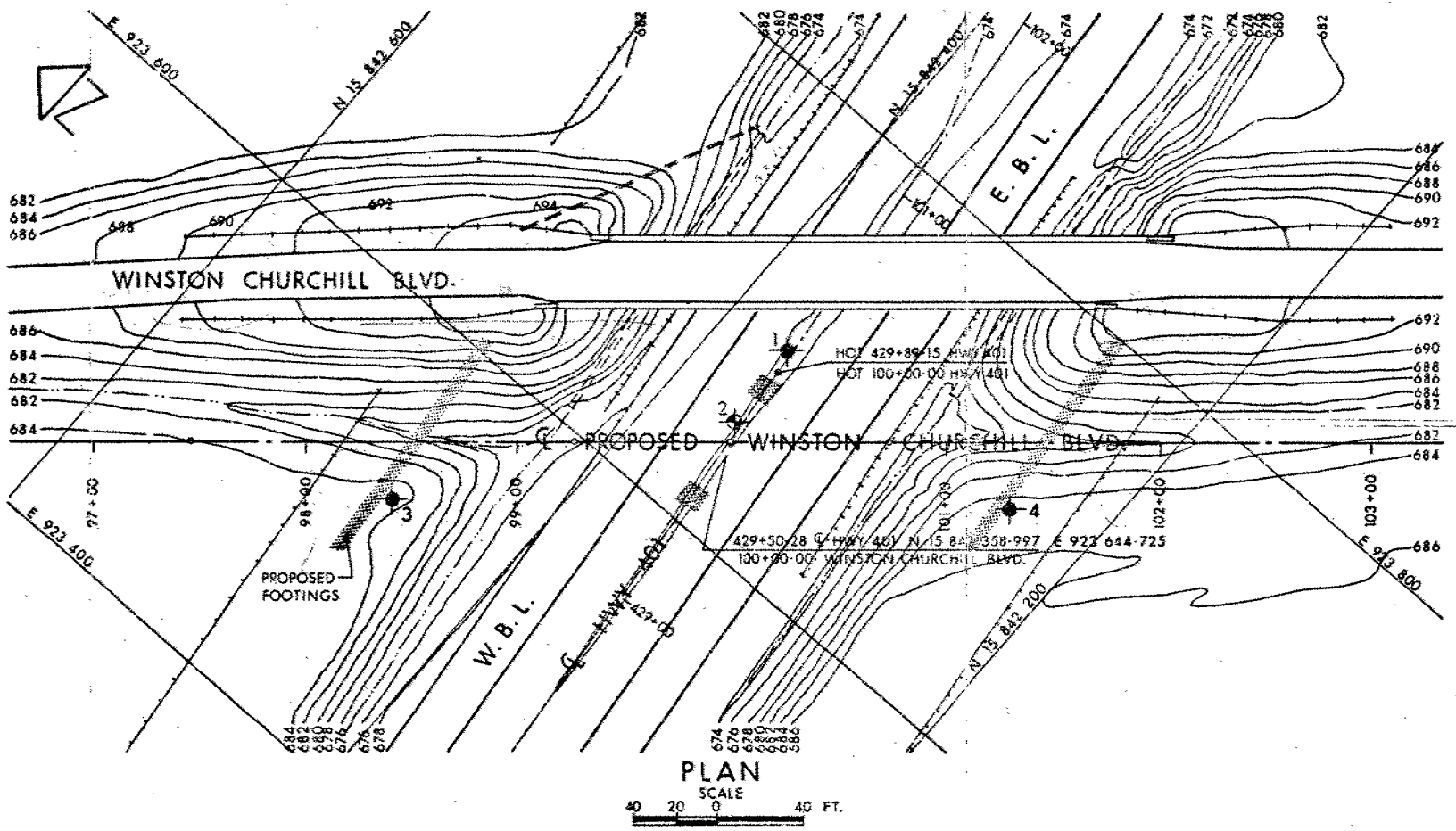
h	HYDRAULIC HEAD OR POTENTIAL
q	RATE OF DISCHARGE
v	VELOCITY OF FLOW
i	HYDRAULIC GRADIENT
j	SEEPAGE FORCE PER UNIT VOLUME
η	COEFFICIENT OF VISCOSITY
k	COEFFICIENT OF HYDRAULIC CONDUCTIVITY
k_h	k IN HORIZONTAL DIRECTION
k_v	k IN VERTICAL DIRECTION
m_v	COEFFICIENT OF VOLUME CHANGE
c_v	COEFFICIENT OF CONSOLIDATION
C_c	COMPRESSION INDEX
C_r	RECOMPRESSION INDEX
d	DRAINAGE PATH DISTANCE
T_v	TIME FACTOR
U	DEGREE OF CONSOLIDATION
OCR	OVERCONSOLIDATION RATIO (OCR)

CONT No
W.P No 167-77-02

HWY 401 & WINSTON CHURCHILL BLVD. INTERCHANGE

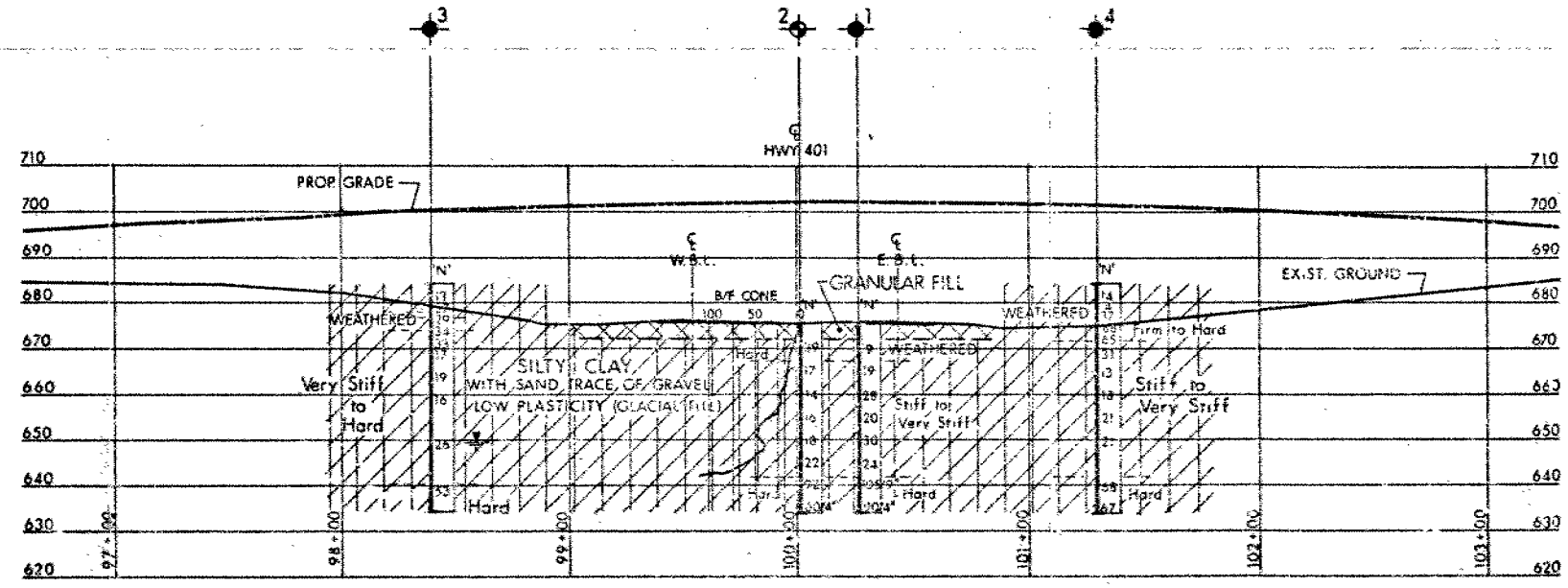
BORE HOLE LOCATIONS & SOIL STRATA

SHEET



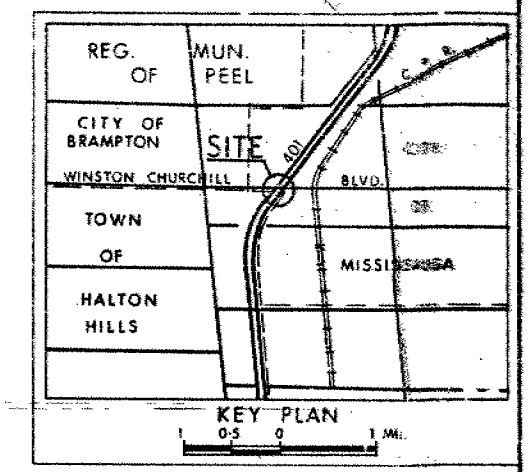
PLAN

SCALE
40 20 0 40 FT.



℄ PROFILE PROPOSED WINSTON CHURCHILL BLVD.

SCALE
HOR 40 20 0 40 FT.
VERT. 20 10 0 20



LEGEND

- Bore Hole
- Dynamic Cone Penetration Test (Cone)
- Bore Hole & Cone
- 'N' Blows/ft (Std Pen Test 350 ft lbs energy)
- CONE Blows/ft (60° Cone, 350 ft lbs energy)
- W.L at time of investigation 80 01 07
- NO W.L Established in BH No 1, 2, & 4

No	ELEVATION	CO-ORDINATES NORTH	EAST
1	675·5	15 842 366	923 695
2	675·5	15 842 363	923 652
3	684·0	15 842 462	923 520
4	684·4	15 842 238	923 706

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

REVISIONS

DATE	BY	DESCRIPTION

GEOCRES No 30M12-165

HWY No 401 DIST
SUBMITTED DATE 80 02 08 SITE 0-98

Mr. W. L. Lin,
Design Engineer (Central)
Operating Section
Structural Office

81 03 11

From: Pavement & Foundation Design Section
Room 315, Central Building

Re: Winston Churchill Boulevard Underpass,
W.P. 167-77-01, Site 10-98,
Highway 401, District 6

We have reviewed the final drawings for the above mentioned structure and submit the following comments:

Pile driving should be controlled in the field by M.T.C. Modified Hiley Formula utilizing a pile driving hammer rated at a minimum energy of 39,000 ft/lbs. per blow.

Yours truly,

Murty Devata,
Senior Foundations Engineer

MD:bcs

memorandum

Ontario

To: Mr. W. Lin
Structural Office
West Building

Date: 1980-05-12

From: Pavement & Foundation Design Section
Room 313, Central Building
Downsview

Re: Winston Churchill Interchange
W.P. 167-77-01, Site 10-98
Highway 401, District 6, Toronto

To satisfy the requirements of the present design for this structure, which involves full height abutments, deep borings were advanced at the site. They reveal that the subsoil consists of approximately 100 feet of very stiff to hard silty clay with sand and a trace of gravel and is of glacial origin. It is underlain at approximate elevation 584 by shale bedrock.

The structure may be founded on spread footings at elevation 670 or above with a design loading of 2½ tons per square foot. Resistance to sliding may be calculated employing a design adhesion value of 2000 pounds per square foot. It is estimated that settlement of the footings will not exceed 1 inch.

As an alternative to be considered on an economic basis, any or all of the footings may be supported on steel H-piles with driving controlled by SS 3-11. It is estimated that a 74 lb. section will achieve a design load of 130 tons at approximate elevation 620. Due to the natural variability of the soil deposit, considerable difference in pile tip elevations may be expected. The pile tips should be reinforced with standard flange plates to protect the piles from damage due to boulders in the glacial till deposit.

Peter J. Stuart
Foundations Engineer

PJS:ea

cc: F.I. Hewson