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W.P. No. 20-87-01

CONT. No.

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STR. SITE No. N/A

HWY. No. 401

LOCATION HWY 401 CULVERTS & REST AREA (2.0 KM WEST OF MISSISSAUGA RD.)

OVERSIZE DRAWINGS TO BE INCLUDED WITH THIS REPORT.

REMARKS:

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OVERSIZE DRAWING(S)

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Ontario

FOUNDATION DESIGN SECTION

foundation investigation and design report

ENGINEERING MATERIALS OFFICE
FOUNDATION DESIGN SECTION

WP 20-87-01-2 DIST 6

HWY 401 STR SITE NA

High Mast Lighting
for
Travel Information Centre

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GEOCRES 30M12-202

DATE ~~Dec 10~~ Nov. 26, 1987

FOUNDATION INVESTIGATION REPORT
For
High Mast Lighting
for
Travel Information Centre
@ Hwy 401
WP 20-87-01
District 6, Toronto

INTRODUCTION

This report summarizes the foundation investigation results for the High Mast Lighting (HML) at the Travel Information Centre.

The field investigation was conducted between 87-10-05 and 87-10-09 utilizing a continuous flight auger machine equipped with 83 mm I.D. hollow stem augers and BX rock coring techniques.

This work consisted of advancing sampled boreholes at or near all proposed HML locations. Boreholes pertaining to this project are numbered BH 14 to 18, corresponding to the associated HML number of 1 to 5. Borehole locations are summarized in Table 1 and shown in plan on Dwg. No. 208701-D in the Appendix. However, Borehole 15 was moved about 6.5 m northerly from the HML location (HML 2), since the drill rig could not be approached the proposed location.

Site Description

The site is located in the physiographic region known as the "PEEL PLAIN" as described by the Physiography of Southern Ontario (Chapman and Putnam, 1984). The deposit characterizing this area consists of a glacial till containing large amounts of Palaeozoic Shale and limestone. The original ground surface in this region can be described as level to undulating in relief. Specifically, the site under investigation has an undulating topography.

This area is drained by the Credit River. At the site, water drains from the south ends of the culverts along a ditch and through a farm land. During the investigation, the drainage channel was completely dry.

SUBSURFACE CONDITIONS

General

The subsoil consists mainly of Gravelly Sand to Sandy Gravel with varying amounts of cobbles and boulders (Glacial till), overlying up to 0.6 m thick silty clay topsoil layer. The full extent of the glacial till stratum was not investigated, but was found to extend to a maximum depth of 12.7 m below the ground surface. Occasional shaly zones and cohesive zones were encountered in the lower portion of the glacial till stratum. Weathered Shaly slab was encountered in two locations, BH's #16 and #17, at approximate elevation of 185 m. A large size boulder was encountered in BH #18 as shown on borehole log. Groundwater was observed in the boreholes at approximate elevations between 191.8 m and 195.2 m as shown on Borehole logs in the Appendix.

The following is a detailed description of the soils encountered at the site.

Topsoil

The site is covered by a thin 0.6 m layer of silty clay topsoil.

Atterberg Limits tests and grain size distribution test was carried out on the sample and the results are listed below:

	%		%
Moisture Content (w)	15.5	Gravel	2
Liquid Limit (w_L)	28.5	Sand	40
Plastic Limit (wp)	16.5	Silt	42
Plasticity Index (Ip)	12.0	Clay	16

The topsoil can be described as Silty Clay with random pockets or layers of sand and gravel. The fines are of low plasticity (CL Group).

Gravelly Sand to sandy gravel (Glacial till)

The topsoil is underlain by a glacial till deposit. This material was encountered in all boreholes immediately below the topsoil. Within the glacial till stratum, occasional cohesive zones and occasional cobbles were encountered at the lower portion of the glacial till. Large size boulders was encountered in Borehole #18 as shown on borehole log. Shaly slabs were enountered at an approximate elevation of 185 m in Boreholes #16 and #17. The full extent of the glacial till was not investigated.

Atterberg Limits tests were performed on this material as shown on Figure 1, and the results are summarized below:

	Range %
Moisture Content (w)	4.5 - 17
Liquid Limit (w_L)	16.5 - 33.5
Plastic Limit (w_P)	13 - 17.5
Plasticity Index (I_P)	3.5 - 17

Grain size distribution tests were carried out on the glacial till and the results are summarized below. Figure 2 in the Appendix shows the results in envelope form.

	Range %
Gravel	1 - 59
Sand	21 - 83
Silt	5 - 49
Clay	1 - 10

The glacial till can be described as gravelly sand to sandy gravel with some silt, trace of clay and occasional cobbles and boulders. The matrix is composed primarily of non-cohesive material with occasional cohesive zones that exhibit low plasticity (CL Group).

In this glacial till stratum, the 'N' values ranged from 2 to 112 blows/0.3 m, indicating the deposit may be described as very loose to very dense.

GROUNDWATER CONDITIONS

The groundwater level was measured in open boreholes few days after the boreholes were completed. The groundwater elevation was found to range between elev. 191.8 m and 195.2 m which corresponds to some 2.2 m to 6.4 m below the existing ground surface. The observed groundwater levels for each borehole are indicated on the Record of Borehole Sheets in the Appendix.

DISCUSSION AND RECOMMENDATIONS

A foundation investigation was carried out at the above-noted site in order to establish soil parameters for the design of the 5 HML foundations. The investigation consisted of advancing 1 borehole at each of the HML locations to a depth ranging between 9.4 and 12.7 m below the ground level.

Table 1 indicates the proposed location of each of the 30 m high HML and the appropriate locations of the boreholes. Since the proposed HML location is situated on the mid slope and further permission to enter the private property could not be obtained within the limited time, the borehole location for HML #2 (B.H. No. 15) was moved towards the Hwy. 401 some 6.5 m from the proposed HML location.

Design Consideration

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

Broms, B.B.
Later Resistance of Piles in Cohesive Soils,
Journal of the Soil Mechanics and Foundations Division, ASCE,
Vol. 90, No. SM2
Paper 3825, March 1964

and

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

The soil parameters provided in Table 2 are recommended for the design of the HML foundations. The following notation has been adopted:

ϕ = apparent angle of friction for cohesionless soils

qu = unconfined compressive strength in kPa (qu = 2 x Cu) for cohesive soils

γ = bulk unit weight in kN/m^3

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

Construction Considerations

The investigation revealed that the subsurface conditions across the site are generally uniform and consist of gravelly sand to sandy gravel with varying amounts of cobbles and boulders (Glacial Till). At BH #18 boulders up to 0.5 m in size were encountered where HML #5 is situated as shown on borehole log.

Caissons will be located below the prevailing groundwater in granular subsoil. In view of this, the following special provision should be included in the contract:

> "The contractor shall install concrete footings in earth for high mast poles. At the various pole locations,soil deposits consist of mixtures of silts, sands and gravels with occasional cobbles and boulders. Groundwater is likely to be encountered from two to six metres below the existing ground surface. The soil is highly susceptiable to conditions of unbalanced hydrostatic head and seepage forces and is likely to 'boil' and become unstable under such conditions. The contractor shall maintain the stability of the soil in the sides and bases of the holes for the concrete footings at all times from commencement of their construction to the placing of concrete".

MISCELLANEOUS

The fieldwork for this investigation was carried out during the period of 87-10-05 to 87-10-09, under the supervision of John Petruzziello (Senior Technician). The equipment was owned and operated by Malone's Soil Samples Co. Ltd. of Etobicoke.

This report was written by T. C. Kim and reviewed by M. Devata, Chief Foundations Engineer (East).

Tae C. Kim, P.Eng.
Project Foundations Engineer

Murty Devata, P.Eng.
Chief Foundation's Engineer (East)

TABLE 1 - HML AND BOREHOLE LOCATIONS

Proposed HML Locations			Actual Borehole Locations		
HML #	STATION NO.	O/S Fr. Property Line	BH No.	STATION NO.	O/S Fr. Property Line
1	11 + 203.0	11.1 m Lt.	14	11 + 202.9	11.1 m Lt.
2	11 + 351.5	3.7 m Lt.	15	11 + 352.0	10.2 m Lt.
3	11 + 558.5	58.7 m Rt.	16	11 + 560.0	55.6 m Rt.
4	11 + 808.5	6.1 m Lt.	17	11 + 808.4	6.1 m Lt.
5	11 + 959.0	11.6 m Lt.	18	11 + 959.0	11.6 m Lt.

TABLE 2 - Soil Parameters

Pole	Elev. (m) From - to	Type of Soil	Denseness or Consistency	ϕ Degree	qu kPa	γ kN/m^3
1	199.4 - 198.8	Cohesive	-	-	-	19.3
(BH 14)		(Top Soil)				
	198.8 - 197.3	Non-Cohesive	Compact	31	-	20.1
	197.3 - 196.5	Non-Cohesive	Dense	35	-	20.7
	196.5 - 195.0	Non-Cohesive	Very Dense	43	-	21.2
	195.0 - 191.9	Non-Cohesive	Dense	35	-	21.0
	191.9 - 186.7	Non-Cohesive	Very Dense	43	-	21.2
2	198.2 - 197.6	Cohesive	-	-	-	19.3
(BH 15)		(Top Soil)				
	197.6 - 195.3	Non-Cohesive	Loose	26	-	19.3
	195.3 - 192.6	Non-Cohesive	Dense	36	-	21.0
	192.6 - 191.0	Non-Cohesive	Very Dense	43	-	21.2
	191.0 - 188.0	Non-Cohesive	Dense	34	-	20.7
	188.0 - 185.5	Non-Cohesive	Very Dense	39	-	21.2
3	196.6 - 196.0	Cohesive	-	-	-	19.3
(BH 16)		(Top Soil)				
	196.0 - 193.7	Non-Cohesive	Loose	27	-	19.3
	193.7 - 188.3	Non-Cohesive	Dense	34	-	20.4
	188.3 - 185.6	Non-Cohesive	Very Dense	39	-	21.2
	185.6 - 184.3	Weathered Shale	Hard	43	-	21.2
4	194.5 - 193.9	Cohesive	-	-	-	19.3
(BH 17)		(Top Soil)				
	193.9 - 192.3	Non-Cohesive	Dense	35	-	20.7
	192.3 - 190.1	Non-Cohesive	Compact	32	-	20.1
	190.1 - 188.6	Non-Cohesive	Dense	37	-	21.2
	188.6 - 186.3	Non-Cohesive	Very Dense	39	-	21.2
	186.3 - 185.4	Non-Cohesive	Dense	34	-	20.7
	185.4 - 184.4	Weathered Shale	Hard	43	-	21.2
5	194.7 - 194.2	Cohesive	-	-	-	19.3
(BH 18)		(Top Soil)				
	194.2 - 185.3	Non-Cohesive	Very Dense	43	-	21.2

APPENDIX

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

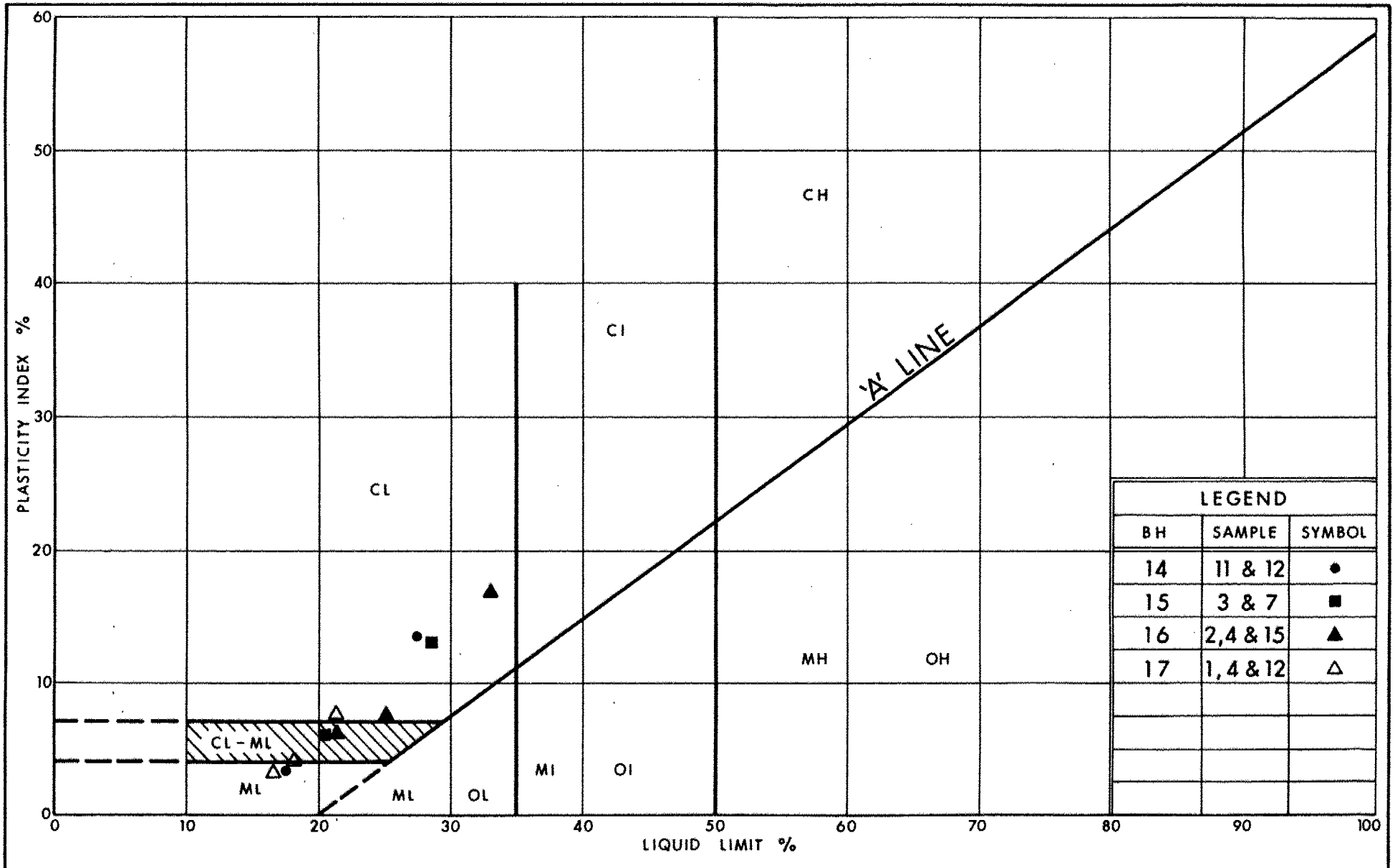
u_w	kPa	PORE WATER PRESSURE
r_u	1	PORE PRESSURE RATIO
σ	kPa	TOTAL NORMAL STRESS
σ'	kPa	EFFECTIVE NORMAL STRESS
τ	kPa	SHEAR STRESS
$\sigma_1, \sigma_2, \sigma_3$	kPa	PRINCIPAL STRESSES
ϵ	%	LINEAR STRAIN
$\epsilon_1, \epsilon_2, \epsilon_3$	%	PRINCIPAL STRAINS
E	kPa	MODULUS OF LINEAR DEFORMATION
G	kPa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



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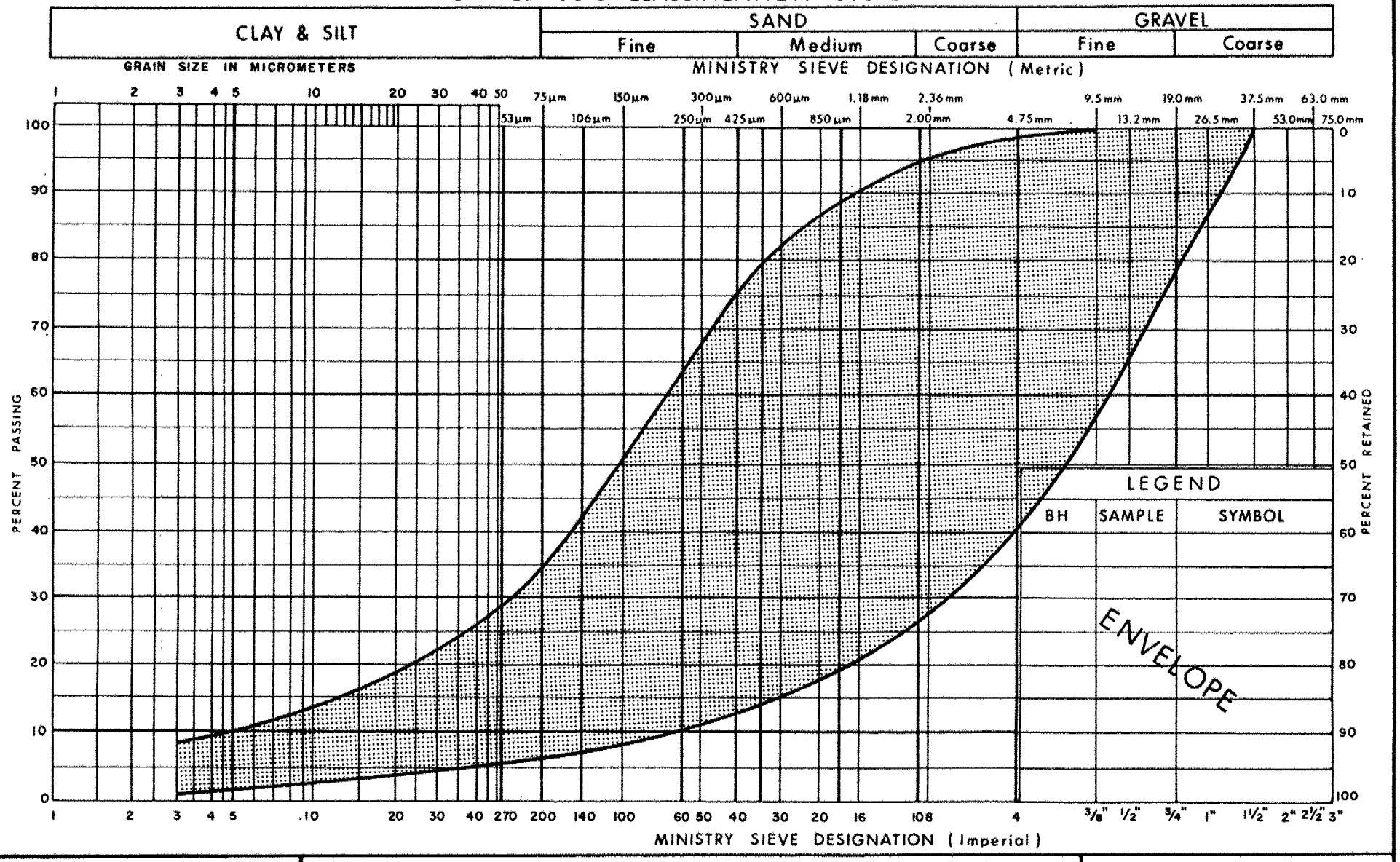
PLASTICITY CHART

GRAVELLY SAND TO SANDY GRAVEL (Glacial Till)
WITH SOME SILT, TRACE OF CLAY, OCC COHESIVE ZONES

FIG No 1
W P 20-87-01
(H M L)

UNIFIED SOIL CLASSIFICATION SYSTEM



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GRAIN SIZE DISTRIBUTION

GRAVELLY SAND TO SANDY GRAVEL (Glacial Till)
WITH SOME SILT, TRACE OF CLAY, OCC COHESIVE ZONES

FIG No 2
W P 20 - 87 - 01
(H M L)

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RECORD OF BOREHOLE No 14 METRIC

W P 20-87-01 LOCATION Sta. 11 + 202.9; O/S 11.1 m Lt. of Property Line ORIGINATED BY TCK
DIST 6 HWY 401 BOREHOLE TYPE HS Auger and Cone Test COMPILED BY TCK
DATUM Geodetic DATE 1987 10 05 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 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
199.4	Ground Level										
0.0 / 198.8	Silty Clay with Sand trace gravel (Top Soil)		1	AS*							2 40 42 16
0.6	Gravelly Sand to Sandy Gravel with some Silt trace of clay Compact to Very Dense (Glacial Till) Occ. Cohesive Zones Occ. Cobbles		2	SS	19		198				3 80 14 3
			3	SS	26						
			4	SS	39						36 47 13 4
			5	SS	72		196				
			6	SS	112						14 63 17 6
			7	SS	31						
			8	SS	42		194				2 80 15 3
			9	SS	42	87 10 9					4 82 12 2
			10	SS	43						
			11	SS	103		192				32 47 16 5
			12	SS	66						
			13	SS	62		190				
			14	SS	43						
186.7			15	SS	90		188				37 41 18 4
12.7	End of Borehole										

* AS: Auger Sample

OFFICE REPORT ON SOIL EXPLORATION

+3, ×5 : Numbers refer to Sensitivity

20
15 ◇ 5 (%) STRAIN AT FAILURE
10

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Ontario

RECORD OF BOREHOLE No 15 METRIC

W P 20-87-01 LOCATION Sta. 11 + 352.0; O/S 10.2 m Lt. of Property Line ORIGINATED BY TCK
DIST 6 HWY 401 BOREHOLE TYPE HS Auger and Cone Test COMPILED BY TCK
DATUM Geodetic DATE 1987 10 09 CHECKED BY

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 (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES						GR SA SI CL
198.2	Ground Level										
0.0 / 197.6	Silty Clay (Top Soil)						198				
0.6	Gravelly Sand to Sandy Gravel with some Silt trace of clay (Very loose)		1	SS	11				○		16 58 17 9
			2	SS	2						
			3	SS	3		196		○		21 60 15 4
	Compact to Very Dense (Glacial Till)		4	SS	36	87 10 9					
			5	SS	48		194	120/18 cm			
			6	SS	45				○		5 78 13 4
191.8 / 6.4	Weathered Shaly Slab		7	SS	104		192		○		52 33 12 3
	Occ. Cohesive Zones		8	SS	32				○		13 73 14 0
	Occ. Cobbles		9	SS	37		190				
			10	SS	50		188		○		5 81 10 4
185.5 / 12.7	End of Borehole		11	SS	67		186				

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

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

OFFICE REPORT ON SOIL EXPLORATION

Ministry of Transportation and Communications
Ontario

RECORD OF BOREHOLE No 16 METRIC

W P 20-87-01 LOCATION Sta. 11 + 560.0; O/S 55.6 m Rt. of Property Line ORIGINATED BY TCK

DIST 6 HWY 401 BOREHOLE TYPE HS Auger and Cone Test COMPILED BY TCK

DATUM Geodetic DATE 1987 10 05 & 06 CHECKED BY

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 W_P / NATURAL MOISTURE CONTENT W / LIQUID LIMIT W_L — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES						GR SA SI CL
196.6 / 0.0	Ground Level										
196.0 / 0.6	Silty Clay (Top Soil)		1	AS*							
	Gravelly Sand to Sandy Gravel with some Silt; trace of clay; Compact to Very Dense; (Glacial Till); Occ. Cohesive Zones; Occ. Cobbles	Very Loose	2	SS	18		196		○		14 43 39 4
			3	SS	3						
			4	SS	2		194		○		7 66 18 9
			5	SS	22				○		1 81 9 9
			6	SS	30				○		12 73 9 6
			7	SS	31	87 10 9	192				
			8	SS	32						
			9	SS	31				○		35 52 12 1
			10	SS	38		190				
			11	SS	44						
			12	SS	59				○		14 71 11 4
			13	SS	57		188				
185.6 / 11.0	Weathered Shaly Slab		14	SS	120		186	120/8 cm			
			15	SS	125/20 cm				○		20 21 49 10
184.3 / 12.3	End of Borehole		16	SS	105/12 cm						

* AS: Auger Sample

OFFICE REPORT ON SOIL EXPLORATION

+3, ×5 : Numbers refer to Sensitivity

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

Ministry of Transportation and Communications
Ontario

RECORD OF BOREHOLE No 17 METRIC

W P 20-87-01 LOCATION Sta. 11 + 808.4; O/S 6.1 m Lt. of Property Line ORIGINATED BY TCK
DIST 6 HWY 401 BOREHOLE TYPE HS Auger and Cone Test COMPILED BY TCK
DATUM Geodetic DATE 1987 10 07 CHECKED BY

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 W_p / NATURAL MOISTURE CONTENT W / LIQUID LIMIT W_L — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES						GR SA SI CL
194.5	Ground Level										
0.0 / 193.9	Silty Clay (Topsoil)										
0.6	Gravelly Sand to Sandy Gravel with some Silt; trace of clay; Compact to Very Dense (Glacial Till); Occ. Cohesive Zones; Occ. Cobbles		1	SS	30		194		○ —		8 66 21 5
			2	SS	46						
			3	SS	29	87 10 9	192		○		6 83 8 3
			4	SS	32				○ —		34 49 12 5
			5	SS	19						
			6	SS	45		190				
			7	SS	49			140	○		28 64 4 4
			8	SS	50		188				
			9	SS	62				○		10 60 26 4
			10	SS	70				○		32 41 22 5
			11	SS	34		186				
185.2 / 9.3			12	SS	100/15 cm				○ —		16 49 30 5
184.4	Weathered Shaly Slab		13	SS	120/15 cm						
10.1	End of Borehole										

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

$\frac{20}{15 \diamond 5}$ (%) STRAIN AT FAILURE
10

OFFICE REPORT ON SOIL EXPLORATION

Ministry of Transportation and Communications
Ontario

RECORD OF BOREHOLE No 18 METRIC

W P 20-87-01 LOCATION Sta. 11 + 959.0; O/S 11.6 m Lt. of Property Line ORIGINATED BY TCK
DIST 6 HWY 401 BOREHOLE TYPE HS Auger and BX Casing, Cone Tests COMPILED BY TCK
DATUM Geodetic DATE 1987 10 06, 07 & 08 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 W_L — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
194.7	Ground Level										
0.0 / 194.2	Silty Clay (Top Soil)										
0.5			1	SS	98/23 cm		194	120/15 cm	○		45 38 12 5
			2	SS	92/20 cm						
			3	SS	70						50 32 13 5
			4	SS	*	▽	192		○		
	Limestone Boulder		5	RC	80%	87 10 9					
			6	SS	60/5 cm				○		59 33 7 1
	Limestone Boulder		7	RC	75%						
	Gravelly Sand to Sandy Gravel some Silt trace of clay Very Dense (Glacial Till) Occ. Cobbles and Boulder		8	SS	70/10 cm		190		○		51 34 11 4
			9	SS	93				○		47 38 14 1
			10	SS	75/15 cm		188				
	Limestone Boulders with Sand and Gravel		11	RC	REC 20%						
185.3			12	SS	75/10 cm		186		○		10 71 14 5
9.4	End of Borehole										

* Spoon Bouncing
No Sample Recovered

OFFICE REPORT ON SOIL EXPLORATION

+3, ×5 : Numbers refer to Sensitivity

20
15 ◇ 5 (%) STRAIN AT FAILURE
10

MINISTRY OF TRANSPORTATION AND COMMUNICATIONS, ONTARIO PH-0-207 82 04

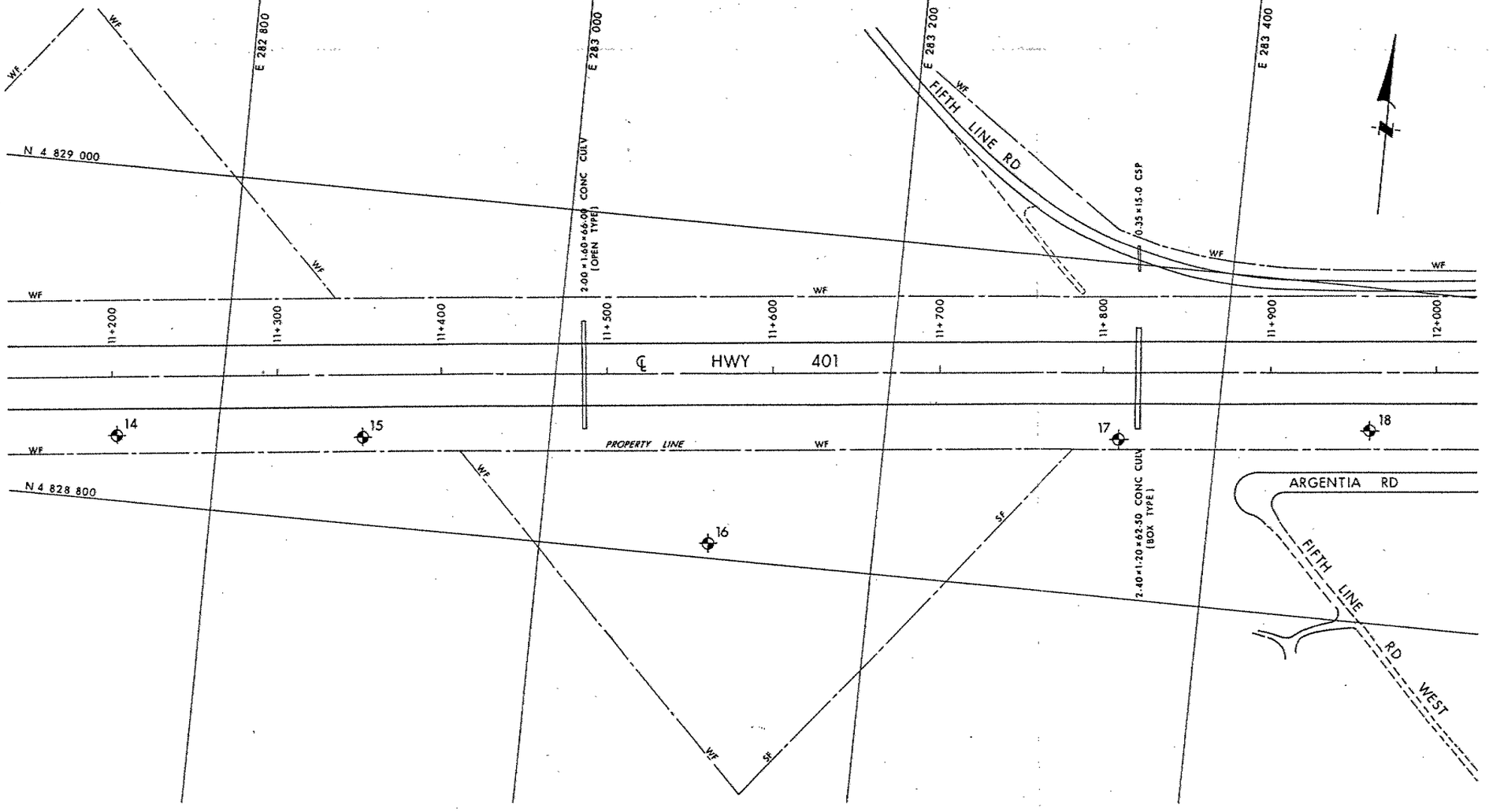
METRIC

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

CONT No
WP No 20-87-01

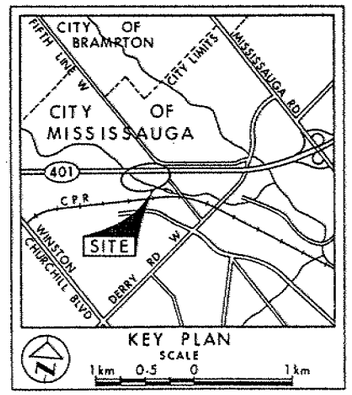
HIGH MAST LIGHTING
(FOR TRAVEL INFORMATION CENTRE)
BORE HOLE LOCATIONS & SOIL STRATA

SHEET



PLAN
SCALE
20m 10 0 20m

NOTE :
For Subsurface details refer to Record of Borehole sheets.



KEY PLAN
SCALE
1km 0.5 0 1km

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 87 10

No	ELEVATION	STATION	* OFFSET
14	199.4	11+202.9	11.1m Lt
15	198.2	11+352.0	10.2m Lt
16	196.6	11+560.0	55.6m Rt
17	194.5	11+808.4	6.1m Lt
18	194.7	11+959.0	11.6m Lt

* OFFSET MEASURED FROM (WF) SOUTH PROPERTY LINE

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 30M12-202

REF No B-81-401-29, 82 09

HWY No 401			DIST 6
SUBM'D TCK	CHECKED	DATE 87 11 26	SITE
DRAWN DT	CHECKED	APPROVED	DWG 208701-D

ENGINEERING MATERIALS OFFICE
FOUNDATION DESIGN SECTION

WP 20-87-01 DIST 6

HWY 401 STR SITE NA

Culvert Extensions
Roadside Rest/Travel
Information Centre

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GEOCRES 30M12-200

DATE JUL 15 1987

FOUNDATION INVESTIGATION REPORT
For
Culvert Extensions @ Hwy. 401
WP 20-87-01
District 6, Toronto

INTRODUCTION

This report summarizes the information obtained from a foundation investigation carried out at the above mentioned site between 87-06-30 to 87-07-02 and on 87-07-10. It is proposed to extend two culverts at this site to facilitate the entrance and exit ramps of a Roadside Rest/Travel Information Centre. This report is applicable to the culvert extensions at Sta. 11+497.1 o/s 47.5 m RT from the centreline of Hwy. 401 and Sta. 11+824.8 o/s 37.6 m RT of the centreline of Hwy. 401. This report contains recommendations pertaining to the foundations of the proposed culvert extensions.

SITE DESCRIPTION AND GEOLOGY

This site is located on Hwy. 401, 2.0 km west of Mississauga Road. At present, there are two concrete culverts located at the site. The first culvert, 65 metres in length, is located at Sta. 11+486 and has an outlet elevation of approximately 195.8 metres. The second culvert, 61.5 metres in length, is located at Sta. 11+822 and has an outlet elevation of approximately 194.3 metres. The site is located in the City of Mississauga, Regional Municipality of Peel.

The land use in this area is predominantly industrial and agricultural. Highway 401 runs from east to west along the northern boundary of the site and a farmers field is located to the south of the site. Industrial buildings have been constructed to the east of the site and are under construction on the north side of the 401. To the west of the site, the land is undeveloped and is used for agricultural purposes.

The site is located in the physiographic region known as the "Peel Plain" as described by The Physiography of Southern Ontario (Chapman and Putnam, 1984). The deposit characterizing this area consists of a glacial till containing large amounts of Palaeozoic shale and limestone. The surface in this region can be described as level to undulating in relief. Specifically, the site under investigation has an undulating topography. This area is drained by the Credit River. At the site, water drains from

the south end of the culvert at Sta. 11+486 easterly along a ditch for approximately 70 metres and then southerly through a farm field. This drainage runs parallel to a hill, which is situated between the two culverts. Water on the east side of the hill drains into a ditch which flows easterly towards the culvert at Sta. 11+822. The runoff from the south end of this culvert flows into the ditch, which proceeds easterly for 30 metres before changing course and heading south. During the investigation, ponded water could be founded at a depth of approximately 50 mm in the ditch, at the outlet to the culvert at Sta. 11+822.

The two existing culverts are in good condition showing little or no deterioration. Very little erosion has occurred at the culvert outlets and along the drainage ditches.

Field Investigation

The field investigation was conducted between 87-06-30 and 87-07-02 and on 87-07-10. Two boreholes were advanced; one near the end of each proposed culvert extension. Borehole 1 at Sta. 11+497.1 was advanced to a depth of 14.2 metres, and borehole 2 at Sta. 11+824.8 was advanced to a depth of 9.6 metres below ground level. Dynamic cone penetration tests accompanied each of the boreholes. The borings were advanced by an 87 mm hollow stem augering machine. Soil sampling was performed at 0.76 metre intervals using a 50 mm OD split spoon sampler. Bedrock was not encountered in either borehole.

Groundwater elevations were measured in the boreholes and test pits were excavated to determine if a dewatering scheme was necessary for the excavations. The pits were located at Sta. 11+800, O/S 40 metres RT of Hwy. 401 centreline and Sta. 11+525, O/S 40 metres RT of Hwy. 401 centreline. The pits were 1.2 x 1.2 metres in area. At Sta. 11+800, the test pit reached a depth of 1.9 metres below ground level, and at Sta. 11+525, the test pit reached a depth of 1.8 metres below the ground level. The approximate elevations at the bottom of the excavations are 193.1 and 194.0 respectively.

Lab Work

The engineering properties of the soils were determined by performing grain size distribution and Atterberg Limits Tests on 10 of the samples

obtained. Natural moisture content and bulk density tests were also performed on 7 samples.

The results of laboratory tests are plotted on the record of Borehole Sheets and summarized in the Figures contained in the Appendix.

SUBSURFACE CONDITIONS

General

The stratigraphy across the site is fairly uniform and consists mainly of a sandy glacial till with varying amounts of gravel and cobbles. Underlying an up to 1.0 metre thick sandy topsoil layer, the predominant material across the site, the sandy glacial till stratum, is encountered. The full extent of the glacial till stratum was not investigated, but was found to extend to a maximum depth of 14.2 m below the ground level. Occasional shaly zones, seams of grey silt and grey silty fine sand were encountered between 6 and 14 metres below ground level, in the glacial till stratum. These seams range in thickness from 50 to 75 mm. Bedrock was not encountered in any of the boreholes.

The boundaries of the subsoil types, insitu and laboratory test results, as well as groundwater levels, are shown in the Record of Borehole sheets in the Appendix. The location of each borehole is shown in plan on Dwg. No. 208701-A together with a stratigraphical section.

The following is a detailed description of the soils encountered at the site.

Topsoil

The site is covered in a layer of sandy topsoil with the thickness varying across the site. This material was encountered in BH 1 at a depth of 1.0 metre below the ground level.

Atterberg Limits tests and a grain size distribution test were performed on the sample and the results are listed below.

		%		%
Moisture Content	W	9.5	Gravel	8.5
Liquid Limit	W_L	25.5	Sand	42.5
Plastic Limit	W_p	14.5	Silt	36.5
Plasticity Index	I_p	11	Clay	12.5

The topsoil can be described as a silty sand, some clay, trace gravel. The fines are of low plasticity (CL group). A Standard Penetration 'N' value of 14 indicates the topsoil is in a compact state.

Glacial Till

The topsoil deposit is underlain by a sandy glacial till deposit. The material was encountered in both boreholes; just below ground level in BH 2, and 1.5 metres below ground level in BH 1. Within the glacial till stratum, some silt and silty fine sand seams and occasional pink shaly zones were encountered from 13.7 to 14.2 metres below ground level in Borehole 1, and from 6.5 to 8.7 metres below ground level in Borehole 2. The full extent of the glacial till deposit was not investigated.

Grain size distribution tests were carried out on the glacial till and the results are summarized below. Figure 1 in the Appendix shows the results in envelope form.

	Range %
Gravel	0 - 49.5
Sand	34 - 68.5
Silt	8.5 - 38.5
Clay	1 - 10

Atterberg Limits tests were performed on this material, and the results are summarized below.

		Avg. %	% Range
Moisture Content	W	10	7 - 12
Liquid Limit	W_L	22.2	20 - 25.5
Plastic Limit	W_p	15.2	14.5 - 16.5
Plasticity Index	I_p	7.0	4.5 - 11

To the west, in the vicinity of BH 1, numerous cobbles were encountered during the excavation of the test pit. Easterly, at BH 2, the glacial till stratum contained occasional cobbles.

The glacial till can be described as sand, trace/with gravel, some/with silt, trace clay, with numerous cobbles in the west to occasional cobbles in the east. The matrix is composed primarily of non-cohesive sand with

occasional zones that exhibit low plasticity (CL-ML group or CL group). With depth, the glacial till changed from brown to pink in color.

The silt and silty sand seams and occasional shaly zones yielded 'N' values ranging between 70 and greater than 120 blows/0.3 m, indicating a hard consistency for the cohesive zones and very dense state for the non-cohesive zones.

In the glacial till stratum, the SPT 'N' values ranged from 7 to over 120 blows/0.3 m indicating a state of compaction described as loose to very dense.

GROUNDWATER CONDITIONS

Water levels were measured during the time of the investigation in the open boreholes. In BH 1, the water level was at an elevation of 196.1, and in BH 2, the water level was 190.30. Water was used to advance BH 1 and it is believed the established water level is not representative of the stabilized water level. Test pit #2 in the vicinity of BH 1, was completed to an elevation of 194.0 and the water table was not encountered. Test pit #1, in the vicinity of BH 2, was advanced to an elevation of 193.1 without encountering the water table.

DISCUSSION AND RECOMMENDATIONS

It is proposed to extend two culverts on the south side of the 401, 2.0 km west of Mississauga Road, to facilitate the construction of entrance and exit ramps at a proposed Roadside Rest/Travel Information Centre. The culvert at Sta. 11+486, a 1.8 x 2.24 x 66 m (HxWxL) open culvert, will be extended approximately 18 metres. The culvert at Sta. 11+822, a 1.6 x 2.84 x 61.5 m (HxWxL) box culvert, will be extended approximately 4 metres. The dimensions of the existing culverts have been determined in the field since site plans were not available.

It is proposed to construct the extensions as box culverts, cast against the existing culverts, with construction joints providing a non rigid connection.

The soil stratigraphy at the site consists of a sandy glacial till. This deposit extends to a depth of 14.2 m below ground level (the extent of this investigation). Seams of silty fine sand, shaly zones and grey silt are encountered in the till deposit at elevations 185.2 and 188.0 metres (in BH 1 and 2 respectively).

The glacial till is predominantly sand with numerous cobbles towards the west end of the site and occasional cobbles towards the east.

The natural groundwater elevation is believed to be at an elevation of 190.3 metres in BH 2. A test pit in the vicinity of BH 1 indicates the water table to be lower than the elevation measured in BH 1 after drilling was completed. The test pit was completed to an elevation of 194.0 metres without encountering the water table. It is believed, therefore, that the natural water table elevation is below 194 metres in the vicinity of BH 1.

The following are our foundation recommendations for the design and construction of the two culvert extensions located at Sta. 11+497.1 and Sta. 11+824.8 on Hwy. 401, 2.0 km east of Mississauga Road.

Culvert Foundations

The following table provides details for the design of the box culvert extensions.

Culvert Extension Location	Ref. BH	Approx. Base of Culvert Elev.	Factored Bearing Capacity at U.L.S. kPa	Bearing Capacity @ S.L.S II kPa
Sta. 11+497.1 O/S 47.5 m RT	1	195.7	490	350
Sta. 11+824.8 O/S 37.6 m RT	2	194.0	280	200

The founding material is a sandy glacial till with numerous to occasional cobbles. It is recommended to excavate an additional 150 mm below the approximate base of culvert elevation to facilitate a granular pad, in order to alleviate the problem of boulders or cobbles providing an uneven surface for the culvert foundation.

Frost Protection

Normally 1.2m of earth cover or equivalent, to the base of the foundation is required for frost protection. However, in this case, it has been proposed to match the culvert extensions to the existing culvert foundations.

Settlement - A construction joint between the culverts and culvert extensions is recommended to facilitate any differential settlement that occurs. Due to the nature of the material, settlement problems are not expected.

Earth Pressures

Backfill to the culverts should consist of granular material in accordance with MTC Standard Special Provision #121 (83-10) and placed in accordance with OPSD 803.02. For design purposes, the following physical properties can be assumed for backfill.

Material	ϕ	γ
Granular "A"	35°	22.0 kN/m^3
Granular "B"	30°	21.2 kN/m^3

Computation of earth pressures should be in accordance with Section 6-6.1.2 of the O.H.B.D.C.

Sliding Resistance

Sliding resistance between concrete and the granular pad should be calculated in accordance with Section 6-7.3.3.2 of the O.H.B.D.C. assuming and unfactored ϕ value of 35° for granular "A". Within the native material, sliding should also be calculated in accordance with Section 6-7.3.3.2.

Dewatering

The groundwater levels measured in BH 1 and 2 were 196.1 metres and 190.3 metres respectively. Two test pits were excavated at Sta. 11+800 O/S 40 m RT and 11+525 O/S 40 m RT. Since the water table was not encountered at either location, no major dewatering problems are anticipated. If the water table is low, no problems will occur. However, any minor seepage or surface runoffs into the excavation can be handled by oversized excavation with perimeter drainage ditches and sump pumps.

The upstream flow from the culverts should be diverted during construction to avoid runoff into the open excavation.

Stability of Slopes

For fill heights in the order of 3 metres, stability problems are not anticipated if slopes are constructed with 2H:1V slope.

Construction

During excavation, care should be exercised to prevent undermining the existing culvert foundations. Dewatering during the excavation should be provided if required, and no excavation should be done under the existing slab. Immediately after the excavation, backfill to the base of the existing slab with granular "A" is required for a distance of 2 metres.

MISCELLANEOUS

The fieldwork for this investigation was carried out during the period from 87-06-30 to 87-07-02 and also on 87-07-10, under the supervision of Mary Lou Pauly. The equipment was owned and operated by Eastern Soil of Scarborough.

This report was written by M. L. Pauly and reviewed by D. Dundas, Sr. Foundation Engineer and M. Devata, Chief Foundation Engineer (East).

Mary Lou Pauly.

Mary Lou Pauly
Project Foundation Engineer

D. H. Dundas

D. H. Dundas, P.Eng.
Senior Foundations Engineer

APPENDIX

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

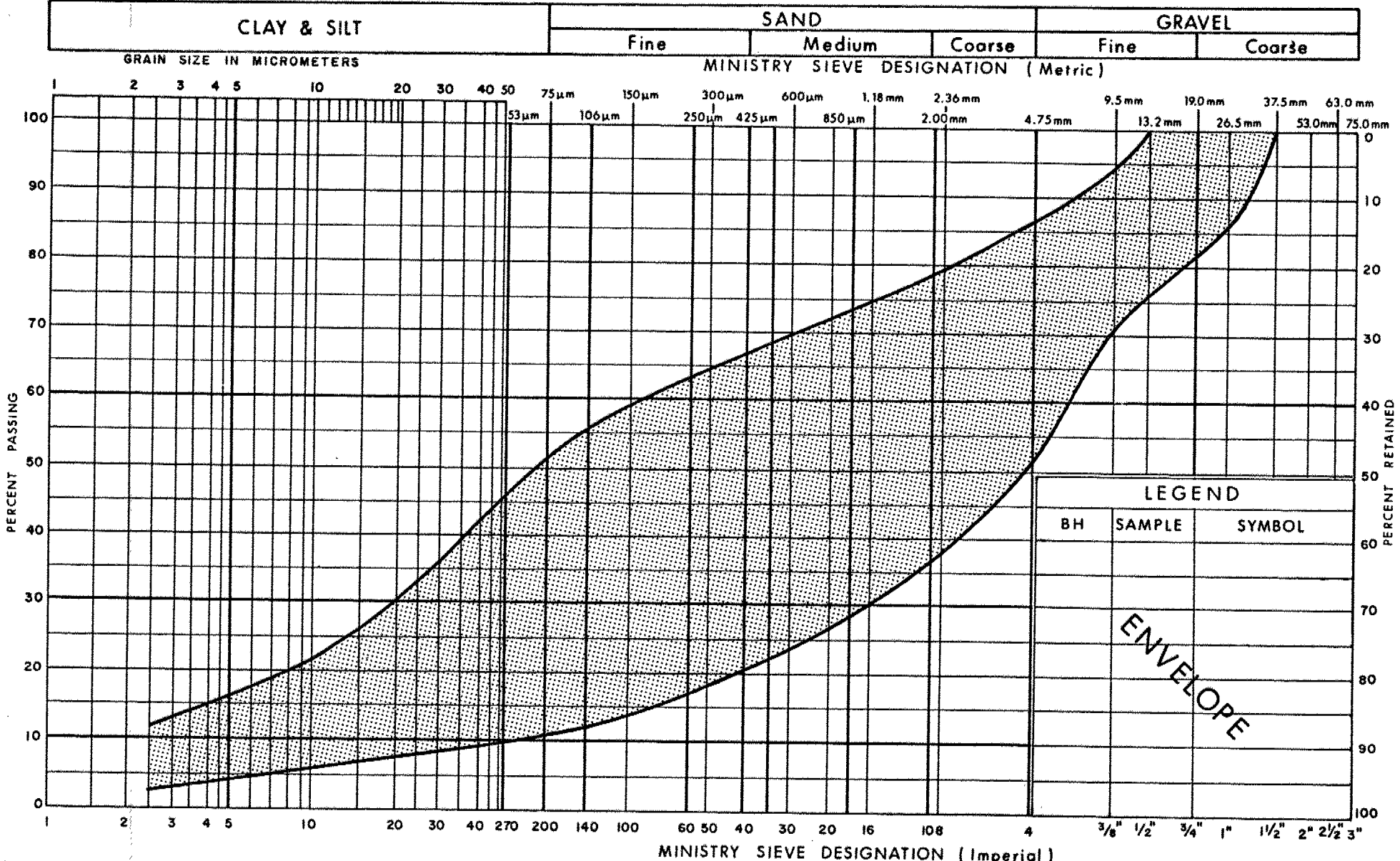
PHYSICAL PROPERTIES OF SOIL

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

UNIFIED SOIL CLASSIFICATION SYSTEM



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GRAIN SIZE DISTRIBUTION

SAND, TRACE/WITH GRAVEL, SOME/WITH SILT, TRACE/SOME CLAY
(Glacial Till)

FIG No 1

W P 20-87-01

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RECORD OF BOREHOLE No 1 METRIC

W P 20-87-01 LOCATION Sta. 11 + 497.1; O/S 47.5 m Rt. ℄ Hwy. 401 ORIGINATED BY MLP
DIST 6 HWY 401 BOREHOLE TYPE HS Auger and Cone Test COMPILED BY MLP
DATUM Geodetic DATE 1987 06 30 & 1987 07 02 CHECKED BY DD

SOIL PROFILE ELEV/DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE)	PLASTIC LIMIT Wp / NATURAL MOISTURE CONTENT W / LIQUID LIMIT WL / WATER CONTENT (%)	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
199.0	Ground Level										
0.0 198.1	Sand Some Clay Trace Gravel (Topsoil)										
0.9	Loose to Compact		1	SS	14		198				8 43 36 13
			2	SS	9						33 48 14 5
			3	SS	32	▼*		120/25 cm	np		26 58 11 5
			4	SS	61		196				
			5	SS	100	87 07 02					
	Sand Trace/with Gravel Some/with Silt Trace to Some Clay Numerous Cobbles Dense to Very Dense (Glacial Till) Occ. slightly Cohesive Zones		6	SS	95/	13 cm	194				
			7	SS	100/	8 cm					
			8	SS	88						
			9	SS	50		192				
			10	SS	46						49 37 10 4
			11	SS	86						
			12	SS	67		190				
			14	SS	52						
			15	SS	74						
			16	SS	89		188				
			17	SS	103						
			18	SS	120/	18 cm	186				
184.8	Shaly Zone & Seams of Silt		19	SS	120/	20 cm					18 34 38 10
14.2	End of Borehole										

* WL established immediately after drilling with water
Water Level indicated may not be stabilized

+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 2 METRIC

W P 20-87-01 LOCATION Sta. 11 + 824.8; O/S 37.6 m Rt. of ℄ Hwy. 401 ORIGINATED BY MLP
DIST 6 HWY 401 BOREHOLE TYPE HS Auger and Cone Test COMPILED BY MLP
DATUM Geodetic DATE 1987 06 30 CHECKED BY DD

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 Wp / NATURAL MOISTURE CONTENT W / LIQUID LIMIT WL — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
194.5	Ground Level										
0.0	Loose to Compact Sand Trace/with Gravel Some/with Silt Trace/Some Clay Occasional Cobbles Dense to Very Dense (Glacial Till) Occ. slightly Cohesive Zones		1	SS	7		194		o np		13 69 14 4
			2	SS	13						0 67 29 4
			3	SS	30		192				37 52 9 2
			4	SS	43						
			5	SS	39	▼					
			6	SS	57	87 07 02	190	120/28 cm	o np		29 60 10 1
			7	SS	88						
			8	SS	70		188				
	Seams of Silt and Shaly Zones		9	SS	120/	29 cm					
			10	SS	69						
			11B	SS	120/	20 cm	186		o np		5 63 27 5
184.9			12	SS	120/	23 cm					
9.6	End of Borehole										

+3, ×5 : Numbers refer to Sensitivity

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

OFFICE REPORT ON SOIL EXPLORATION

Ministry of Transportation and Communications
Ontario

RECORD OF TEST PIT No 1

METRIC

W P 20-87-01 LOCATION Sta. 11 + 800; O/S 40.0 m Rt. of ℄ Hwy. 401 ORIGINATED BY MLP

DIST 6 HWY 401 BOREHOLE TYPE Test Pit (1.2m x 1.2m) COMPILED BY MLP

DATUM Geodetic DATE 1987 07 10 CHECKED BY DD

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 W_P / NATURAL MOISTURE CONTENT W / LIQUID LIMIT W_L — WATER CONTENT (%)	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES						
195.0	Ground Level										
0.0	Sand with Silt Trace to Some Gravel Trace Clay					*	194				
193.1	Occ. Cobbles										
1.9	End of Test Pit * Water Table not encountered										

+3, ×5 : Numbers refer to Sensitivity

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

OFFICE REPORT ON SOIL EXPLORATION

Ministry of Transportation and Communications
Ontario

RECORD OF TEST PIT No 2

METRIC

W P 20-87-01 LOCATION Sta. 11 + 525; O/S 40.0 m Rt. of ℄ Hwy. 401 ORIGINATED BY MLP

DIST 6 HWY 401 BOREHOLE TYPE Test Pit (1.2m x 1.2m) COMPILED BY MLP

DATUM Geodetic DATE 1987 07 10 CHECKED BY DD

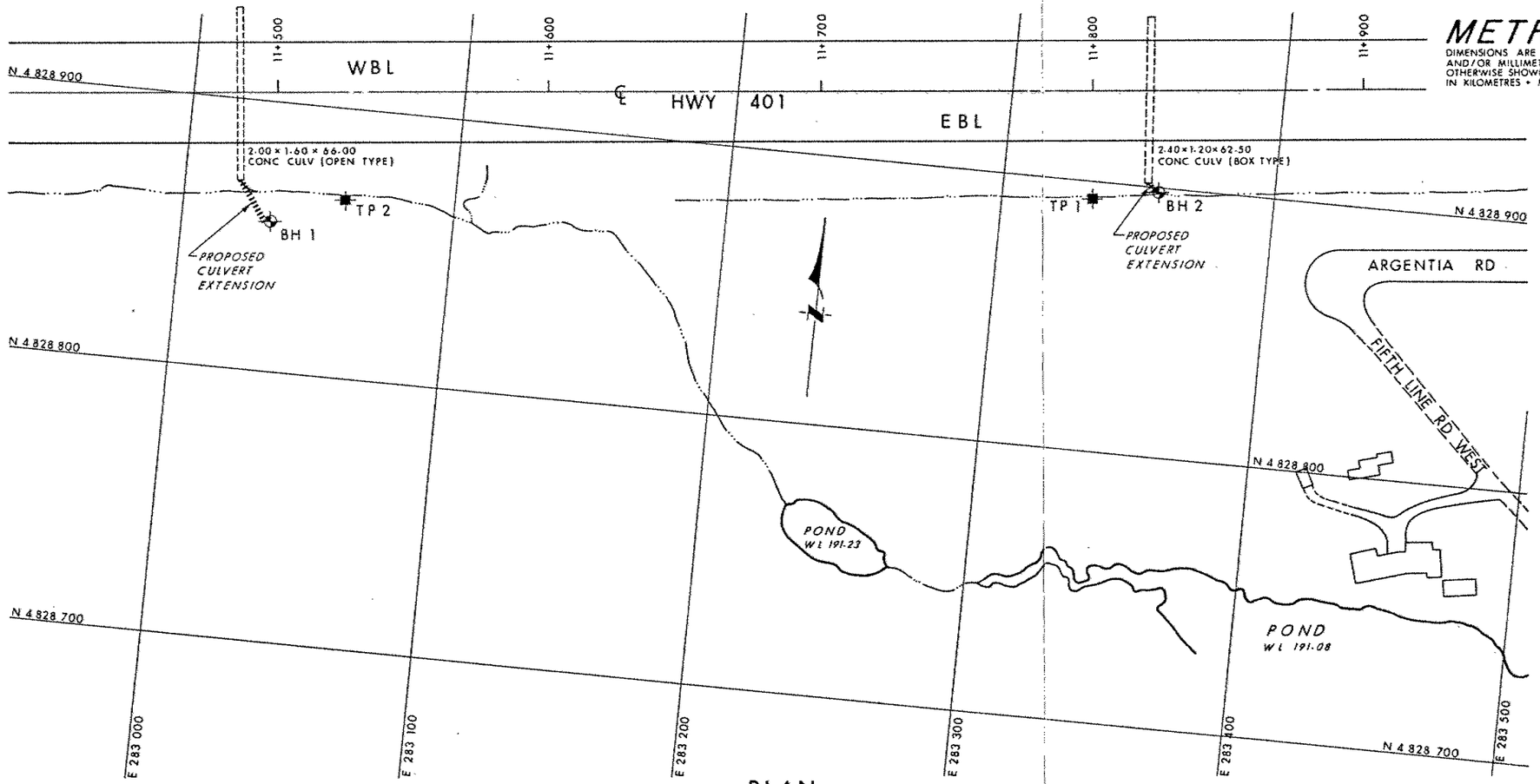
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE)	PLASTIC LIMIT Wp / NATURAL MOISTURE CONTENT W / LIQUID LIMIT W_L — WATER CONTENT (%)	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES						
195.8	Ground Level										
0.0	Sand with Gravel Trace/Some Silt/Clay Numerous Cobbles					*	195				
194.0											
1.8	End of Test Pit										
	* Water Table not encountered										

OFFICE REPORT ON SOIL EXPLORATION

+3, ×5 : Numbers refer to Sensitivity

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

MINISTRY OF TRANSPORTATION AND COMMUNICATIONS, ONTARIO MH-0-207 82 04



PLAN
SCALE
10m 0 10 20m

NOTE :
For Subsurface details refer to Record of Borehole Sheets.

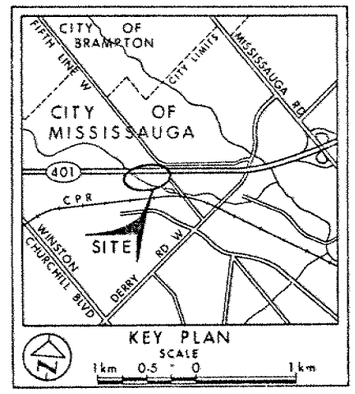
METRIC
DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN. STATIONS IN KILOMETRES + METRES.

CONT No
WP No 20-87-01

CULVERT EXTENSIONS

BORE HOLE LOCATIONS & SOIL STRATA

SHEET



KEY PLAN
SCALE
1km 0.5 0 1km

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 87 07
- Test Pit

No	ELEVATION	STATION	OFFSET
BH 1	199.0	11+497.1	47.5m Rt
BH 2	194.5	11+824.8	37.6m Rt
TP 1	195.0	11+800.0	40.0m Rt
TP 2	195.8	11+525.0	40.0m Rt

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 30M12-200

HWY No 401			DIST 6
SUBM'D MLP	CHECKED	DATE 87 07 14	SITE
DRAWN	CHECKED	APPROVED	DWG 208701-A

ENGINEERING MATERIALS OFFICE
FOUNDATION DESIGN SECTION

WP 20-87-01 DIST 6

HWY 401 STR SITE NA

Pedestrian Bridge and
Concrete Culvert at
Travel Information Centre

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DATE 87 12 01

FOUNDATION INVESTIGATION REPORT
For
The Pedestrian Bridge
And
Concrete Culvert
At
The Travel Information Centre
@ Hwy 401
WP 20-87-01
District 6, Toronto

INTRODUCTION

This report summarizes the information obtained from a foundation investigation carried out at the above mentioned site between 87-10-14 and 87-10-15. This report contains factual information together with recommendations pertaining to the foundations of the proposed pedestrian bridge and concrete culvert at the Travel Information Centre as shown on Drawing No. 208701-E.

SITE DESCRIPTION

This site is located on Hwy 401, 2.0 km West of Mississauga Rd. in the city of Mississauga, Regional Municipality of Peel. At present, there are no buildings except two culverts are located north of the site immediately south of Hwy 401.

The site is located in the physiographic region known as the "PEEL PLAIN" as described by the Physiography of Southern Ontario (Chapman and Putnam, 1984). The deposit characterizing this area consists of a glacial till containing large amounts of Palaeozoic shale and limestone. The original ground surface in this region can be described as level to undulating in relief. Specifically, the site under investigation has an undulating topography. However, it should be noted that the existing ground surface for the proposed pedestrian bridge and concrete culvert at the Travel Information Centre consists of various fill material placed during the early construction of Hwy. 401.

This area is drained by the Credit River. At the site, water drains from the south end of the culvert at sta. 11 + 486 of Hwy. 401 easterly along a ditch for approximately 70 metres and then southerly through a farm land. this drainage runs parallel to the proposed building site. During the investigation, the drainage channel was completely dry.

Field Investigation

The field investigation was conducted between 87-10-14 and 87-10-15. Three boreholes were advanced within the foundation areas of the Pedestrian bridge and concrete culvert as shown on Drawing No. 208701-E. Borehole No's 19 to 21 were advanced to a depth of 8.1 m to 11.2 m as shown on borehole logs.

Dynamic cone penetration tests accompanied each of the boreholes. The borings were advanced by means of 83 mm hollow stem augering machine. Soil sampling was performed at 0.76 m intervals using a 50 mm OD split spoon sampler. Bedrock was not proven in any of the borehole by coring methods except weathered shaly slabs were encountered at a depth between 7.5 m and 10.1 m below the ground surface, approximate elevation of 186.0 m, in two boreholes as shown on borehole logs (Section E-E, Figure 1).

Laboratory Work

The engineering properties of the soils were determined by performing grain size distribution and Atterberg Limits Tests. In addition, natural moisture content was also performed.

The results of laboratory tests are plotted on the record of Borehole Sheets and summarized in the Figures contained in the Appendix.

SUBSURFACE CONDITIONS

General

The soil stratigraphy at the site consists of fill material which consists of a mixture of silt, sand and gravel with random pockets or layers of silty clay, underlain by a compact to very dense gravelly sand to sandy gravel with some silt and trace of clay.

The fill material contains various amounts of old concrete slabs, tree trunk and steel debris. The thickness of the fill varies from 1.4 metre at Borehole 19 up to 3.7 metre at Borehole 20. A tree trunk of about 0.6 m in thickness was encountered within the fill material at Borehole 20.

The glacial till is predominantly sand with various amounts of gravel and occasional cobbles. Seams of silty fine sand, Shaly slabs and occasional cohesive zones are encountered within this glacial till deposit. This deposit extends to a depth of at least 10.1 m below ground level, underlain by weathered Shaly slabs.

The boundary of the Subsoil types and laboratory tests results, as well as groundwater levels, are shown in the Record of Borehole Sheets in the Appendix. The location of each borehole is shown in plan on Dwg. No. 208701-E. A stratigraphical section is shown on Figure 1.

The following is a detailed description of the soils encountered at the site.

Fill Materials

The site is covered with fill material which also contains various amounts of old concrete slabs, tree trunks and steel debris, and the overall thickness varies across the site. This material was encountered in all boreholes ranging in depth from 1.4 metres up to 3.7 metres as shown on Section E-E (Figure 1). Two different types of fill material can be categorized as follows:

i) Mixture of silt, Sand and Gravel (Fill Material)

A mixture of silt, sand and gravel was encountered in Boreholes 19 and 21. This fill material is extended to a depth of approximately 2.1 m below the existing ground surface.

Atterberg Limits tests and grain size distribution tests were performed on the samples and the results are shown on Figures 2 and 4 and listed below:

	Range %
Moisture Content (w)	16 - 17.5
Liquid Limit (w_L)	24.5 - 30.0
Plastic Limit (w_P)	17 - 21.5
Plasticity Index (I_P)	7.5 - 8.5

	Range %
Gravel	24 - 64.5
Sand	19 - 47
Silt	10 - 21
Clay	5 - 8

This material can be described as a mixture of silt, sand and gravel with random pockets or layers of silty clay. Based on the results of Atterberg Limits tests, these pockets can generally be considered to be CL or CI material.

Based on the interpretation of Standard penetration Test 'N' values ranging between generally 6 and 11 blows/0.3 m, this fill material is generally subjected to poor compaction.

ii) Silty clay (Fill Material)

In Borehole #20 the fill material is cohesive consisting of Silty clay extending to a depth of approximately 3.7 m below the existing ground surface.

Atterberg Limits tests and grain size distribution tests were carried out on the samples and the results are shown on Figures 2 and 4 and listed below:

	Range %
Moisture Content (w)	16.5 - 24.5
Liquid Limit (w_L)	30 - 43.0
Plastic Limit (wp)	15 - 25.0
Plasticity Index (Ip)	15 - 19.5

	Range %
Gravel	5 - 9
Sand	18 - 39
Silt	39 - 46
Clay	13 - 30

This fill material can be described as Silty clay with random pockets or layers of sand and gravel. The plasticity is generally low or medium (CL or CI). Standard Penetration 'N' values between 7 and 15 indicate the cohesive fill is in a firm to stiff state.

Gravelly Sand to Sandy Gravel (Glacial Till)

The fill material is underlain by a glacial till deposit. This material was encountered in all boreholes immediately below the fill material, about 1.4 m below ground level in BH 19, and about 3.7 m below ground level in BH 20. Within the glacial till stratum, occasional cohesive zones and occasional cobbles were encountered at the lower portion of the glacial till. Shaly slabs were encountered at an approximate elevation 186.0 m in Borehole Nos. 19 and 20 as shown on borehole logs. The full extent of the glacial till deposit was not investigated.

Atterberg Limits tests were performed on this material as shown on Figure 3, and the results are summarized below:

	Range %
Moisture Content (W)	8 - 21
Liquid Limit (w_L)	19.5 - 31
Plastic Limit (wp)	3.5 - 17
Plasticity Index (Ip)	7 - 10

Grain size distribution tests were carried out on the glacial till and the results are summarized below. Figure 5 in the Appendix shows the result in envelope form.

	Range %
Gravel	3 - 84.5
Sand	14 - 85.5
Silt	2 - 20
Clay	1 - 10

The glacial till can be described as gravelly sand to sandy gravel with some silt, trace of clay and occasional cobbles. The matrix is composed primarily on non-cohesive sand with occasional cohesive zones that exhibit low plasticity (CL- ML Group). With depth, the glacial till changed from brown to pink in color.

In the glacial till stratum, the 'N' values ranged from 3 to 51 blows/0.3 m indicating that the deposit is loose to very dense.

GROUNDWATER CONDITIONS

The groundwater level was measured in open boreholes few days after the boreholes were completed. The groundwater elevation was found to range between Elev. 192.0 m and 192.5 m, which corresponds to some 1.4 to 4.4 m below the existing ground surface. The observed groundwater levels are indicated on the Record of Borehole Sheets in the Appendix and are shown on the stratigraphical section (Figure 1).

DISCUSSION AND RECOMMENDATIONS

As mentioned above, the soil stratigraphy at the site consists of a mixture of fill material, underlain by a sandy glacial till. The fill material contains various amounts of old concrete slabs, tree trunks and steel debris. The thickness of this fill varies from 1.4 m at Borehole 19 up to 3.7 m at Borehole 20. The glacial till is predominantly sand with various amounts of gravel and occasional cobbles. Occasional cohesive zones encountered within this glacial till deposit. This deposit extends to a depth of about 10 m below ground level, underlain by Weathered Shaly slab at an approximate elevation of 186.0 m.

The groundwater elevation is believed to be at an elevation of approximately 192.0 m at the location of the bridge, which is slightly higher than that of pond water of 191. 2 m. The groundwater elevation at the proposed culvert location is approximately 192.5 m.

Our foundation recommendations for the design and construction of the Pedestrian Bridge and Concrete Culvert at the Travel Information Centre as follows:

1. Foundations for Pedestrian Bridge

Spread Footings

It is recommended that the new pedestrain bridge structure be supported on spread footing type of foundations placed within the natural subsoil of compact to very dense granular natural soil or on well compacted Granular 'A' material. The founding elevations and the parameters for the footing design are as follows:

Location	Footing Elev. (m)	Factored U.L.S. (kPa)	S.L.S. Type II (kPa)
East and West Abutments	191.5 or below	700	300

The abutments can alternatively be perched within a well-compacted core of Granular 'A' provided that the existing fill material is removed. The details of this engineered fill are shown on Figure 6. If this scheme is adopted, loadings of 900 kPa at U.L.S. and 350 kPa S.L.S. Type II can be used in the design.

Resistance to sliding of the footings can be calculated assuming a coefficient of friction of 0.6 between the underside of the concrete footing and granular type material and that of 0.7 between the underside of the concrete footing and the Granular 'A' core.

Piles

Alternatively, the bridge structure can be supported on end bearing steel 'H' piles (310 HP 110) driven into the weathered shaly slab using the following design values and tip elevations:

Location	Footing Tip Elev. (m)	Factored U.L.S. (kPa)	S.L.S. Type II (kPa)
East and West Abutments	185.0	1600	980

2. Foundation for Concrete Culvert

Based on the site investigation, the proposed concrete culvert may be constructed on a Granular 'A' pad and the following table provides details for the design of the concrete culvert.

Ref. BH	Approx. Base of Culvert Elev. m	Factored U.L.S. (kPa)	S.L.S. Type II (kPa)
21	193.3	600	250

All fill material should be removed to its full depth within the foundation area to approximate Elev. 192.0 m.

The excavated area should be backfilled with well compacted Granular 'A' material to the base of the culvert as shown on Figure 7.

Earth Pressures

The Granular 'A' or 'B' backfill to the abutments of the bridge as well as the culvert should be in accordance with Special Provision No. 121 (dated October, 1983).

The following parameters are recommended for the granular backfill:

	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	0.5

Computation of earth pressure should be in accordance with Section 6.6.1.2. of the O.H.B.D.C.

Frost Protection

The footings should be placed so as to have a minimum earth cover of 1.2 m to allow for frost protection.

Construction

During excavation, care shall be exercised by not leaving any old fill material underneath the proposed footings. Dewatering for the footing excavations may be a problem, since excavations will be carried out below the water level in granular subsoil. One method of achieving this is carrying out excavations by means of oversize perimeter ditches and constantly pumping out water from the ditches as shown on Figure 7.

Slope Stability

For fill heights in the order of 4 metres, stability problems are not anticipated if slopes are constructed at 2H:1V. However, erosion protection for the toe of the slope would be required along the relocated channel. Armor stones or Gabion stones would be appropriate for this purposes.

MISCELLANEOUS

The fieldwork for this investigation was carried out during the period of 87-10-14 to 87-10-15, under the supervision of Mike Shenarr (Student Engineer). The equipment was owned and operated by Master Soil Investigation Ltd. of Toronto.

This report was written by T.C. Kim and reviewed by M. Devata, Chief Foundation Engineer (East).

Taechulkim

Tae C. Kim, P.Eng.
Project Foundations Engineer

Murty Devata

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

APPENDIX

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

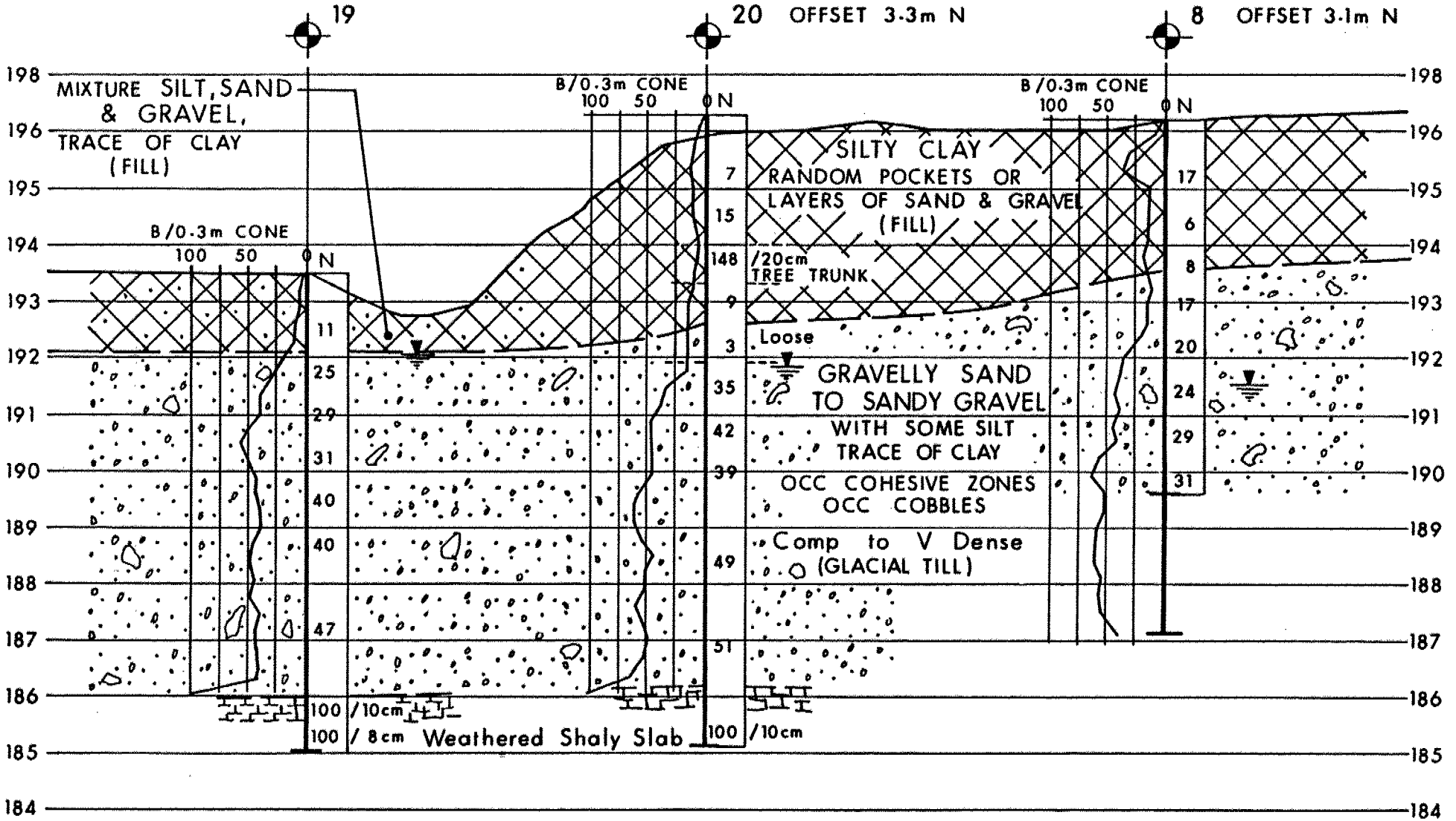
m_v	kPa^{-1}	COEFFICIENT OF VOLUME CHANGE
C_c	1	COMPRESSION INDEX
C_s	1	SWELLING INDEX
C_α	1	RATE OF SECONDARY CONSOLIDATION
c_v	m^2/s	COEFFICIENT OF CONSOLIDATION
H	m	DRAINAGE PATH
T_v	1	TIME FACTOR
U	%	DEGREE OF CONSOLIDATION
σ'_{vo}	kPa	EFFECTIVE OVERBURDEN PRESSURE
σ'_p	kPa	PRECONSOLIDATION PRESSURE
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



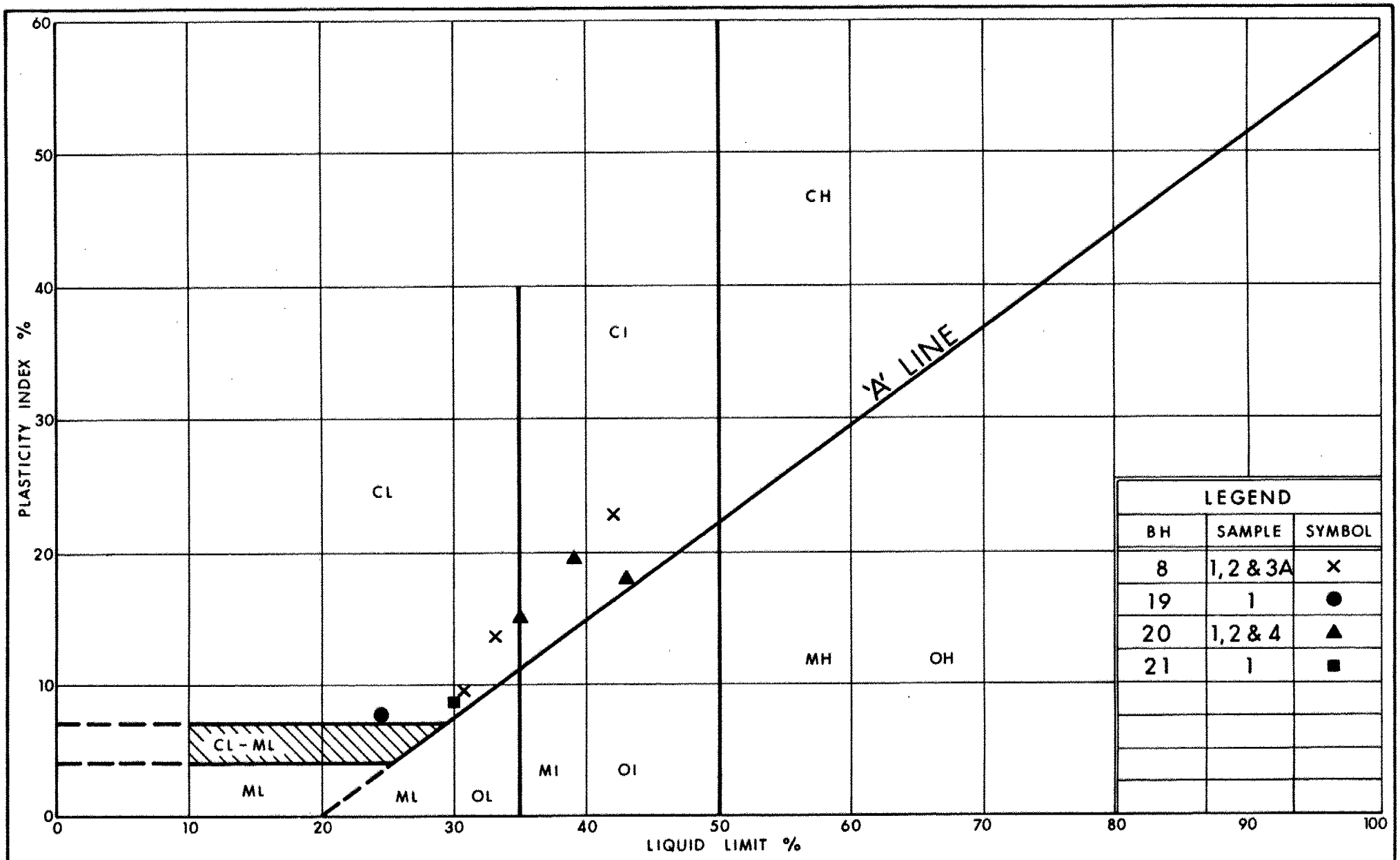
SECTION E-E (PEDESTRIAN BRIDGE LOCATION)

SCALE

4m 2 0 4m Hor

2m 1 0 2m Vert

Fig 1
WP 20-87-01



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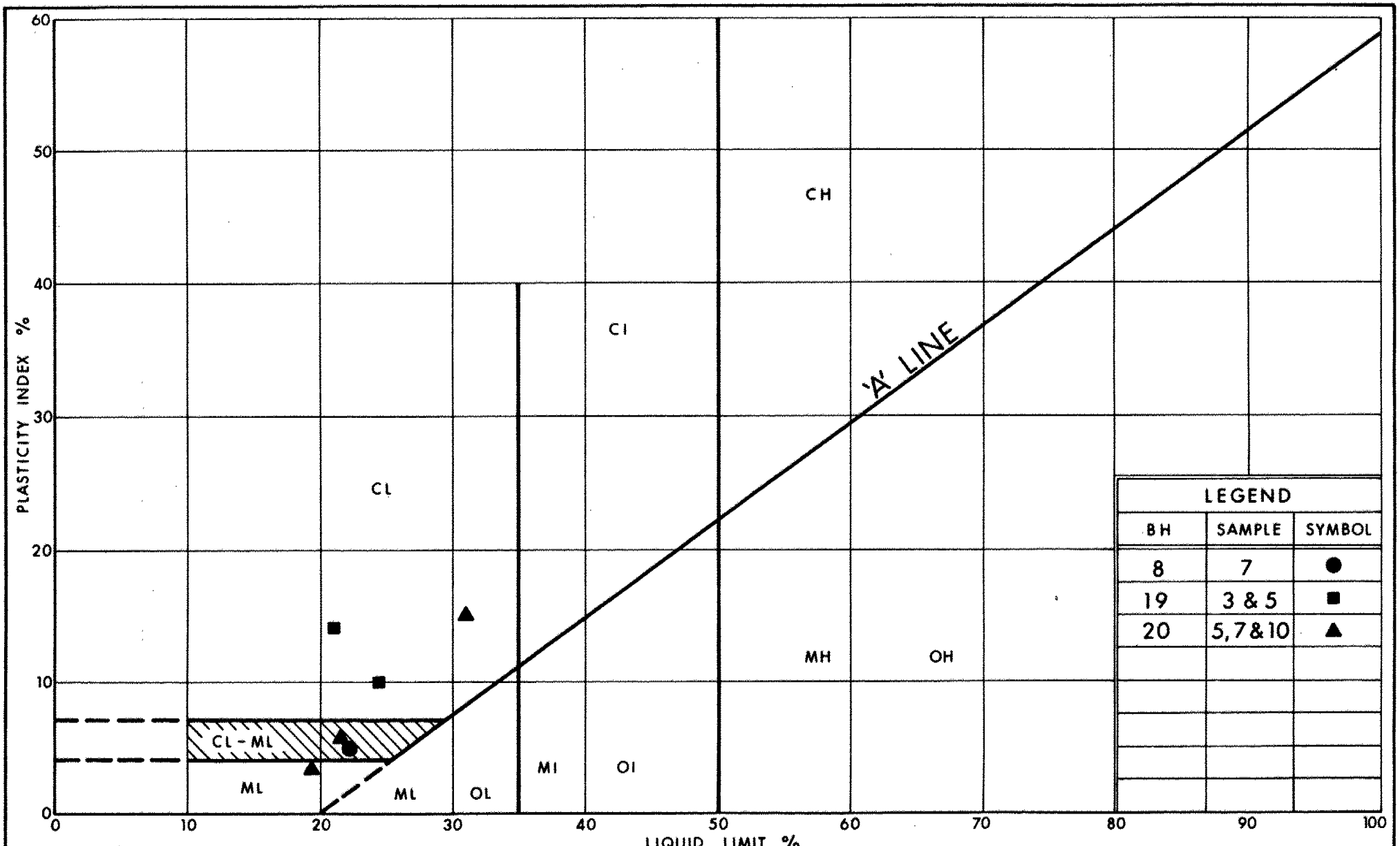
PLASTICITY CHART
FILL MATERIAL

FIG No 2
W P 20 - 87 - 01
(BRIDGE & CULVERT)



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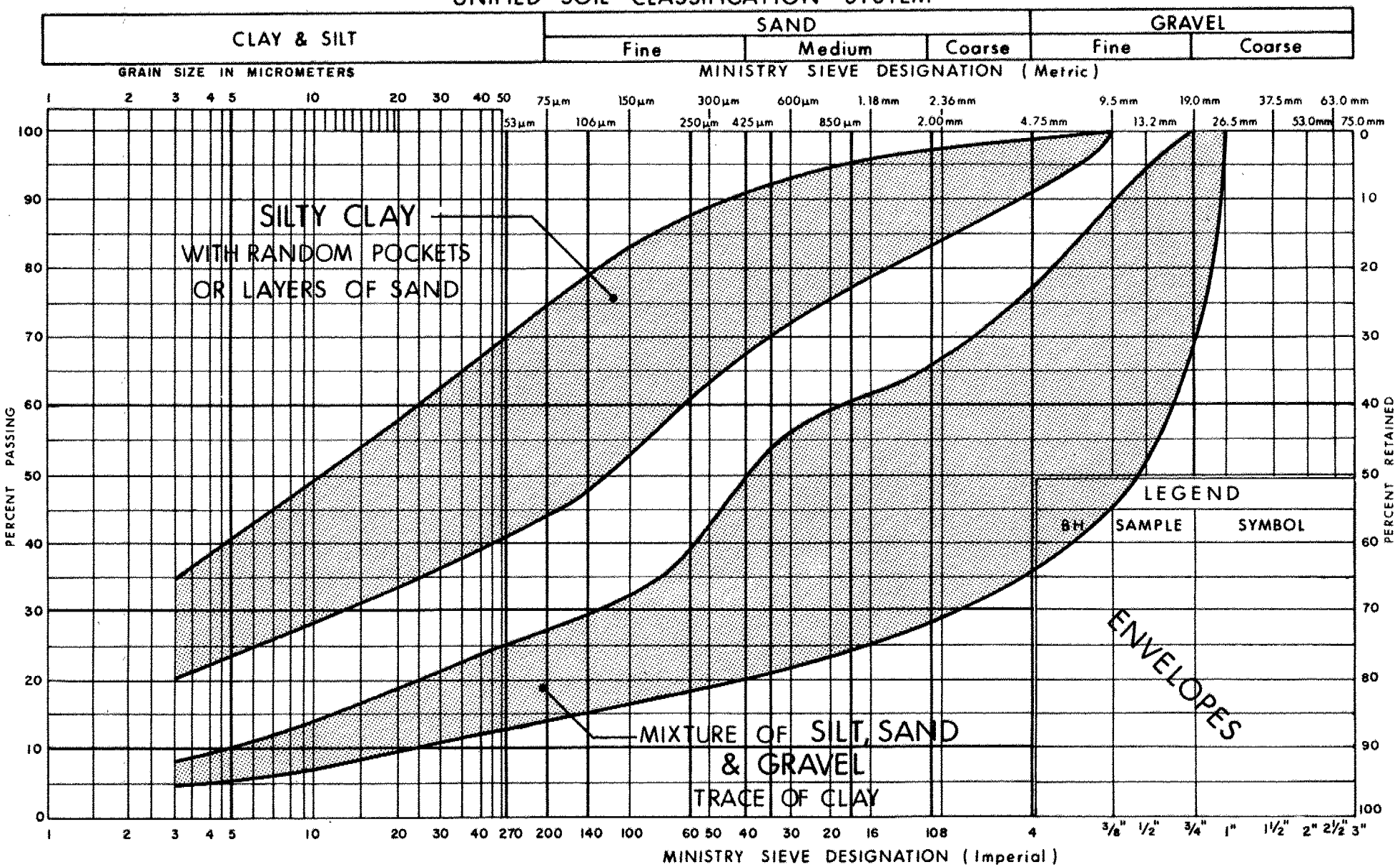
PLASTICITY CHART
GRAVELLY SAND TO SANDY GRAVEL (Glacial Till)
WITH SOME SILT, TRACE OF CLAY, OCC COHESIVE ZONES

FIG No 3
W P 20-87-01
(BRIDGE & CULVERT)

UNIFIED SOIL CLASSIFICATION SYSTEM



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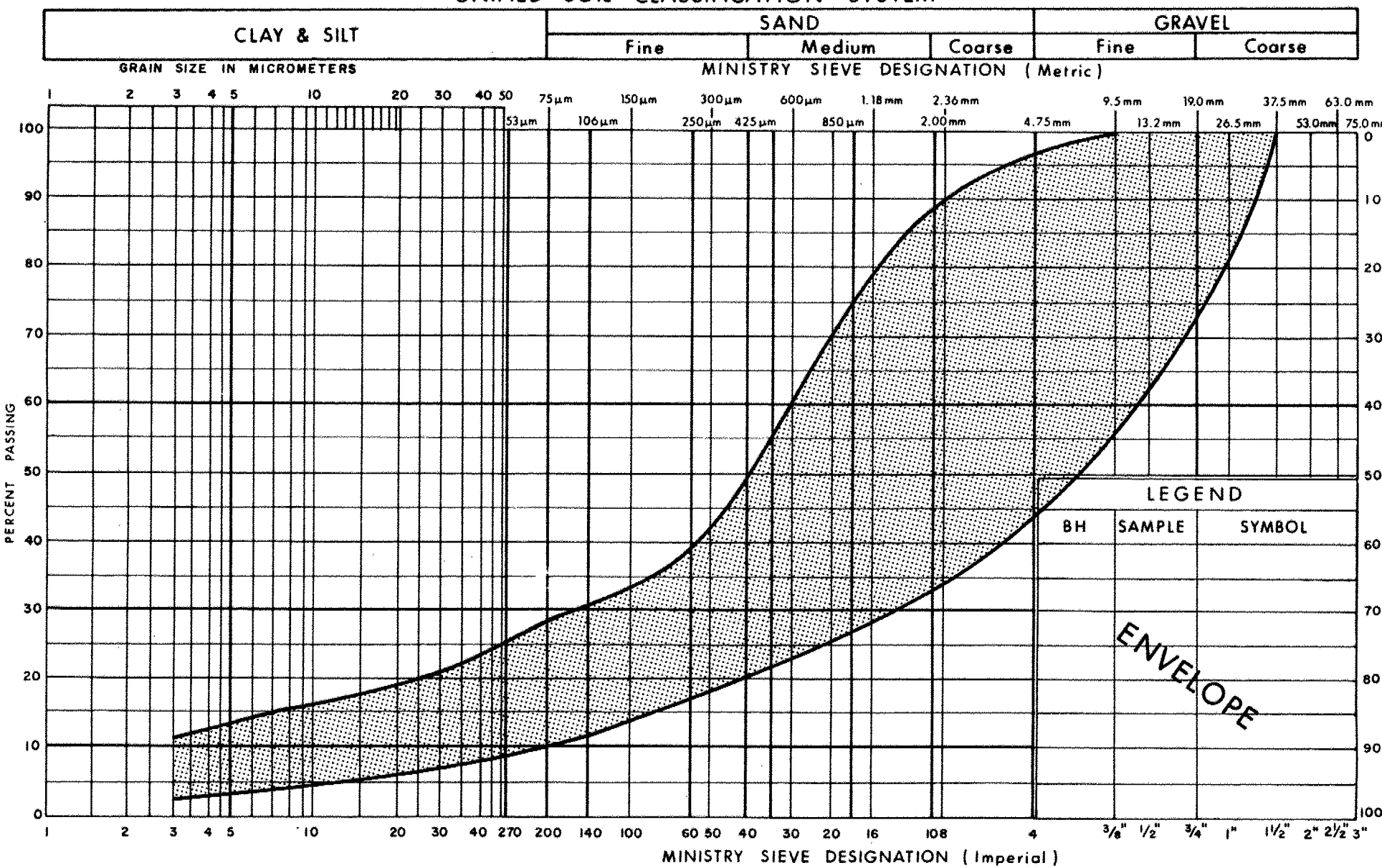
GRAIN SIZE DISTRIBUTION
FILL MATERIAL

FIG No 4
W P 20-87-01
(BRIDGE & CULVERT)

UNIFIED SOIL CLASSIFICATION SYSTEM



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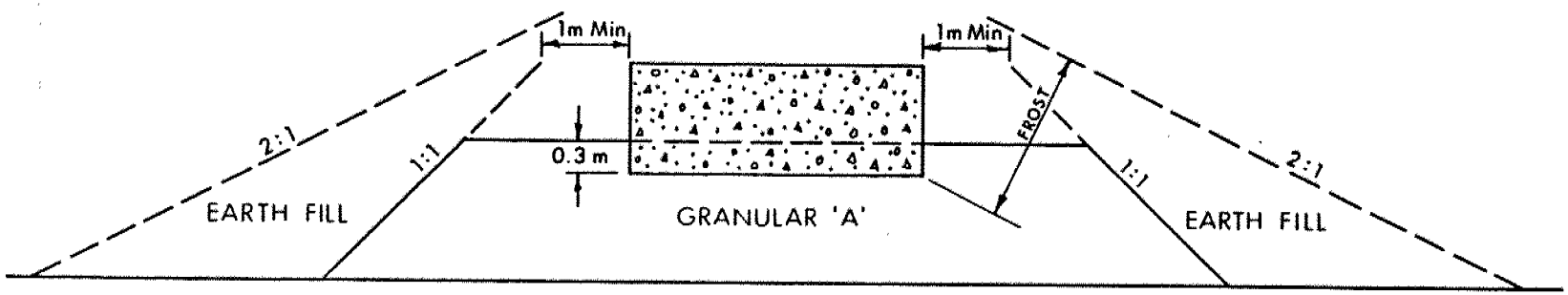
GRAIN SIZE DISTRIBUTION

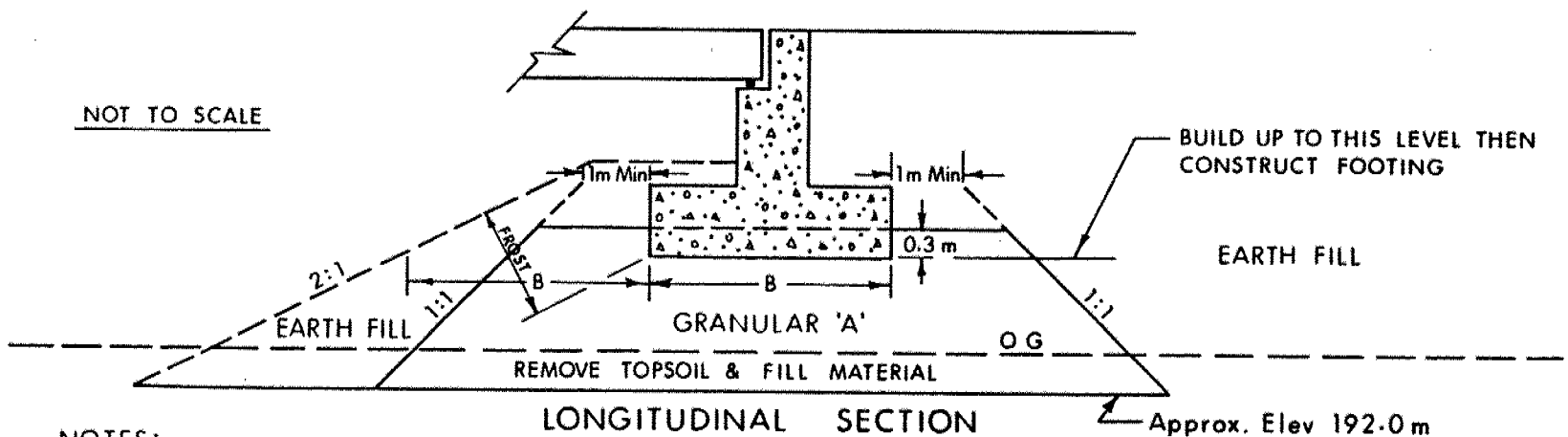
GRAVELLY SAND TO SANDY GRAVEL (Glacial Till)
WITH SOME SILT, TRACE OF CLAY, OCC COHESIVE ZONES

FIG No 5
W P 20 - 87 - 01
(BRIDGE & CULVERT)



X SECTION

NOT TO SCALE



LONGITUDINAL SECTION

NOTES:

1 - REMOVE TOPSOIL &/OR SOFT SUBSOIL UNDER AREA OF COMPACTED GRANULAR 'A' & EARTH FILL.

2 - PLACE GRANULAR 'A' & EARTH FILL TO BOTTOM OF FOOTING LEVEL, COMPACTED ACCORDING TO CURRENT M T C STANDARDS.

3 - CONSTRUCT CONCRETE FOOTING.

4 - PLACE REMAINDER OF GRANULAR 'A' & EARTH FILL AS REQUIRED.

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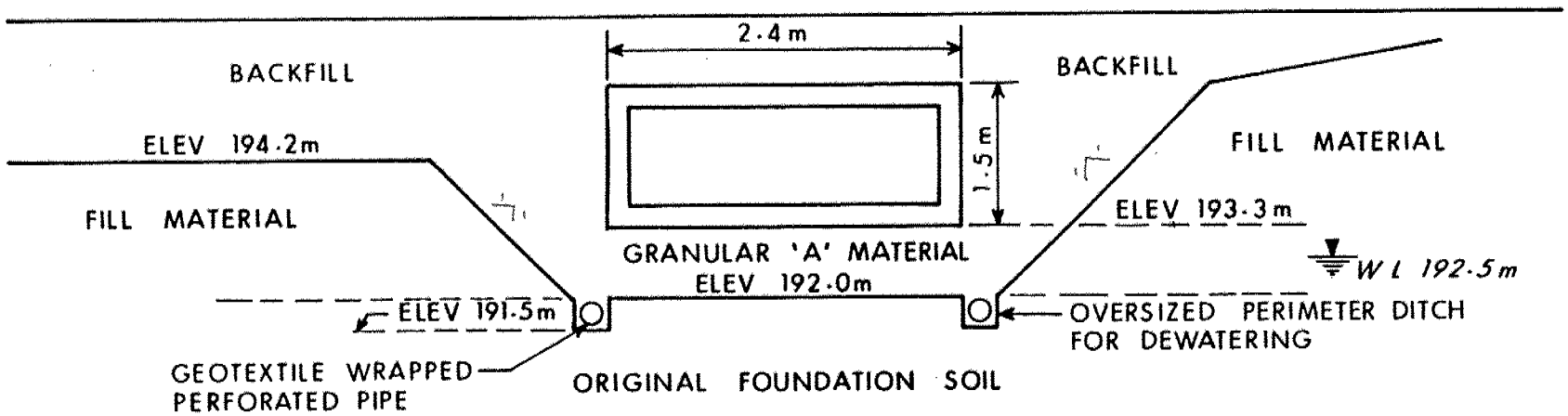
ABUTMENT ON COMPACTED FILL SHOWING GRANULAR 'A' CORE

FIG No 6

WP 20-87-01



SKETCH OF CONCRETE CULVERT
(NOT TO SCALE)

Fig 7
WP 20-87-01

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Ontario

RECORD OF BOREHOLE No 8 METRIC

W P 20-87-01 LOCATION NS Baseline Sta. 0 + 053.0; O/S 16.8 m Rt. ORIGINATED BY TCK
DIST 6 HWY 401 BOREHOLE TYPE HS Auger and Cone Test COMPILED BY TCK
DATUM Geodetic DATE 1987 09 10 CHECKED BY

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 W_p / NATURAL MOISTURE CONTENT W / LIQUID LIMIT W_L — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES						
196.2	Ground Level										
0.0	Silty Clay with random pockets or layers of Sand and Gravel (Fill)		1	AS*			196				GR SA SI CL
			1	SS	17				o		8 25 52 15
			2	SS	6						5 31 49 15
193.6							194		o		
2.6	Gravelly Sand to Sandy Gravel with some Silt trace of clay		3	SS	8						2 54 24 20
			4	SS	17				o		9 73 12 6
			5	SS	20						
	Compact to Dense (Glacial Till)		6	SS	24	87 9 16	192				
	Occ. Cohesive Zones										
	Occ. Cobbles		7	SS	29				o		32 52 14 2
189.6			8	SS	31		190				
6.6	End of Borehole										
187.1							188				
9.1	End of Cone Test										

* AS: Auger Sample

OFFICE REPORT ON SOIL EXPLORATION

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

20
15 ◇ 5 (%) STRAIN AT FAILURE
10

Ministry of Transportation and Communications
Ontario

RECORD OF BOREHOLE No 19 METRIC

W P 20-87-01 LOCATION NS Baseline Sta. 0 + 057.0; O/S 46.8 m Rt. ORIGINATED BY TCK
DIST 6 HWY 401 BOREHOLE TYPE HS Auger and Cone Test COMPILED BY TCK
DATUM Geodetic DATE 1987 10 15 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
193.5	Ground Level										
0.0 / 192.1	Mixture Silt, Sand and Gravel, trace of clay (Fill)		1	SS	11						24 47 21 8
1.4	Gravelly Sand to Sandy Gravel with some Silt trace of clay Compact to Dense (Glacial Till) Occ. Cohesive Zones Occ. Cobbles		2	SS	25	87 10 26	192				
			3	SS	29						50 34 11 5
			4	SS	31		190				
			5	SS	40						
			6	SS	40						
			7	AS*			188				84 13 2 1
			8	SS	47						12 72 14 2
186.0											
7.5 / 185.0	Weathered Shaly Slab		9	SS	100/10 cm		186	100/28 cm			
			10	SS	100/8 cm						
8.5	End of Borehole		11	AS*							0 13 57 30

* AS: Sample taken from the Tip of Auger

+3, ×5 : Numbers refer to Sensitivity

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

OFFICE REPORT ON SOIL EXPLORATION

Ministry of Transportation and Communications
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RECORD OF BOREHOLE No 20 METRIC

W P 20-87-01 LOCATION NS Baseline Sta. 0 + 053.5; O/S 32.7 m Rt. ORIGINATED BY TCK
DIST 6 HWY 401 BOREHOLE TYPE HS Auger and Cone Test COMPILED BY TCK
DATUM Geodetic DATE 1987 10 15 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
196.3	Ground Level										
0.0	Silty Clay with random pockets or layers of Sand and Gravel (Fill)		1	SS	7		196				5 37 39 19
			2	SS	15						7 18 46 29
	Tree Trunk		3	SS	148/20 cm		194				
192.6			4	SS	9						9 39 39 13
3.7	Loose		5	SS	3						14 57 20 9
	Gravelly Sand to Sandy Gravel with some Silt trace of clay Dense to Very Dense (Glacial Till)		6	SS	35	87 10 26	192				
			7	SS	42						24 56 15 5
			8	SS	39		190				
	Occ. Cohesive Zones Occ. Cobbles		9	SS	49						
			10	SS	51		188				34 48 14 4
186.2											
10.1	Weathered Shaly Slab		11	SS	100/10 cm		186				0 7 76 17
185.1											
11.2	End of Borehole										

$+^3$, $\times^5$: 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 21 METRIC

W P 20-87-01 LOCATION NS Baseline Sta. 0 + 020.3; O/S 50.5 m Rt. ORIGINATED BY TCK
DIST 6 HWY 401 BOREHOLE TYPE HS Auger and Cone Test COMPILED BY TCK
DATUM Geodetic DATE 1987 10 14 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
194.2	Ground Level										
0.0	Mixture Silt, Sand and Gravel with random pockets or layers of Silty Clay (Fill)		1	SS	10						62 19 13 6
192.1			2	SS	6	87 10 26					64 21 10 5
2.1	Sandy Gravel to Gravelly Sand with some Silt trace of clay Dense (Glacial Till) Occ. Cohesive Zones Occ. Cobbles		3	SS	35		194				56 31 10 3
			4	SS	31		192				4 85 10 1
			5	SS	35						3 76 17 4
			6	SS	44		190				
			7	SS	46						22 63 13 2
			8	SS	44		188				
186.1			9	SS	37						
8.1	End of Borehole						186	100/2.5 cm			
184.5											
9.7	End of Cone Test										

OFFICE REPORT ON SOIL EXPLORATION

+3, ×5 : Numbers refer to Sensitivity

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

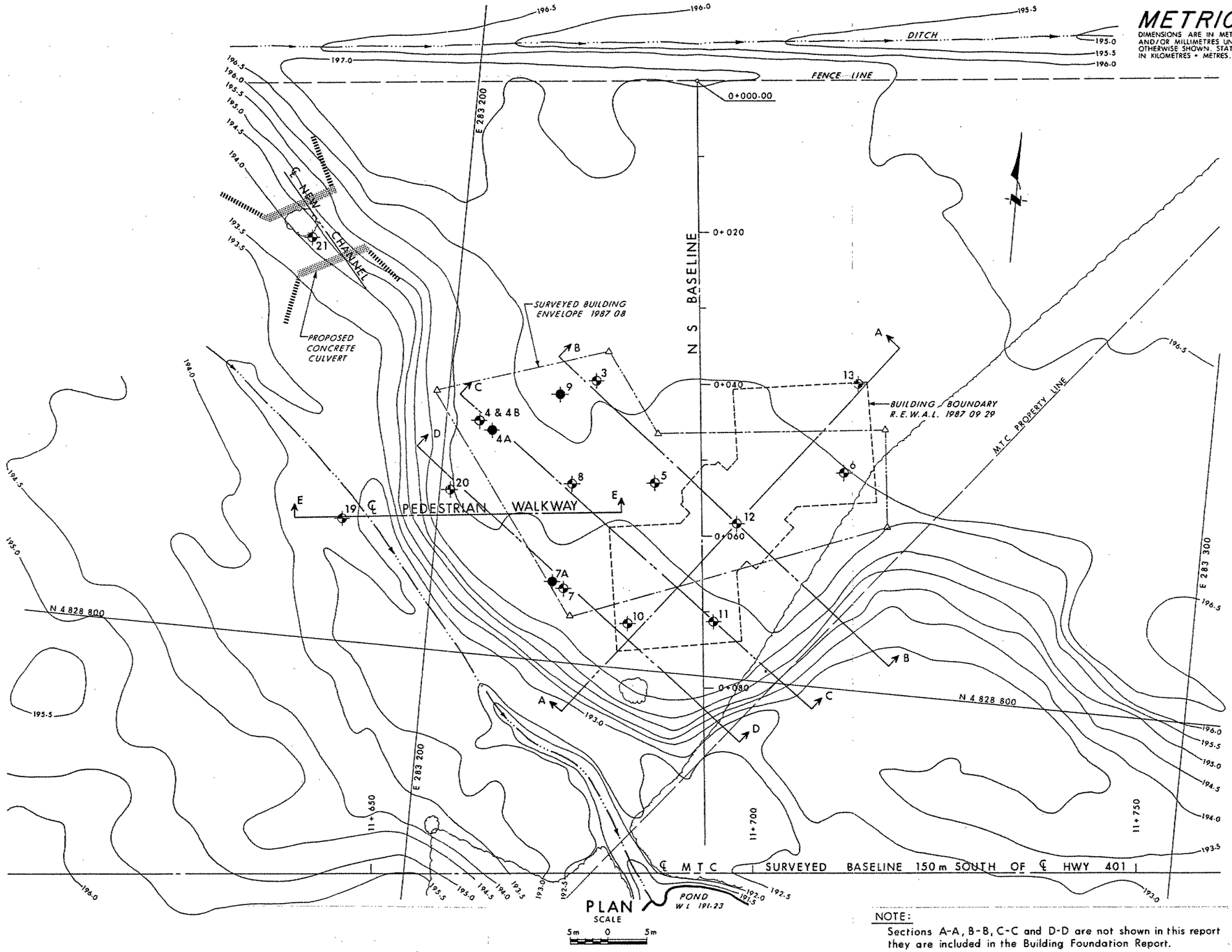
MINISTRY OF TRANSPORTATION AND COMMUNICATIONS, ONTARIO PH-D-207 82 04

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

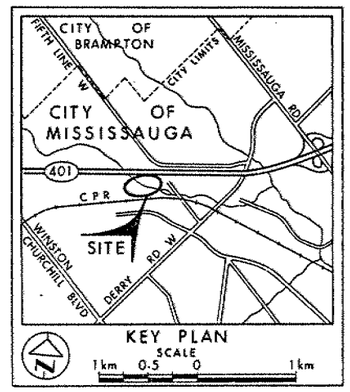
CONT No
WP No 20-87-01

PEDESTRIAN BRIDGE & CONC CULVERT
AT TRAVEL INFORMATION CENTRE
BORE HOLE LOCATIONS & SOIL STRATA

SHEET



PLAN
SCALE
5m 0 5m



KEY PLAN
SCALE
1km 0.5 0 1km

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

No	ELEVATION	N S BASELINE STATION	N S BASELINE OFFSET
3	196.7	0+039.5	13.5m Rt
4 & 4B	196.2	0+044.5	28.8m Rt
4A	196.3	0+045.4	27.2m Rt
5	196.2	0+051.9	5.9m Rt
6	196.4	0+051.9	18.8m Lt
7	195.8	0+066.7	18.1m Rt
7A	195.9	0+065.8	19.5m Rt
8	196.2	0+053.0	16.8m Rt
9	196.6	0+041.3	18.2m Rt
10	195.7	0+071.4	9.8m Rt
11	195.8	0+071.2	1.4m Lt
12	196.3	0+058.3	4.7m Lt
13	196.6	0+040.1	20.7m Lt
19	193.5	0+057.0	46.8m Rt
20	196.3	0+053.5	32.7m Rt
21	194.2	0+020.3	50.5m Rt

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:
Sections A-A, B-B, C-C and D-D are not shown in this report they are included in the Building Foundation Report.

For Section E-E refer to Fig 1 in the Appendix of this report.

For Borehole 21 refer to Record of Borehole Sheet.

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 30M12-203

HWY No 401		DIST 6
SUBMD T.C.K.	CHECKED	SITE
DRAWN C.M.	CHECKED	DWG 208701-E
	DATE 1987 11 18 APPROVED	

ENGINEERING MATERIALS OFFICE
FOUNDATION DESIGN SECTION

WP 20-87-01 DIST 6

HWY 401 STR SITE

Travel Information Centre

DISTRIBUTION

G.C.E. Burkhardt (3)
R.D. Gunter
A. Wittenberg
J. Smrcka (2)
K. Bassi
J.H. Peer
T. Yakutchuk
G. Szekreny
W. Lankinen (2)
B. Steeves (Cover Only)
M. MacLean (Cover Only)
File

GEOCRES 30M12-201 DATE

FOUNDATION INVESTIGATION REPORT
For
Building Foundations
for
Travel Information Centre
@ Hwy 401
WP 20-87-01
District 6, Toronto

INTRODUCTION

This report summarizes the information obtained from a foundation investigation carried out at the above mentioned site between 87-09-02 and 87-10-02. This report contains factual information together with recommendations pertaining to the foundations of the proposed Travel Information Centre shown on Drawing No. 208701-B.

SITE DESCRIPTION AND GEOLOGY

This site is located on Hwy 401, 2.0 km West of Mississauga Rd. in the city of Mississauga, Regional Municipality of Peel. At present, there are no buildings except two culverts are located north of the site immediately south of Hwy 401.

The land use in this area is predominantly industrial and agricultural. Hwy 401 runs from east to west along the north boundary of the site and a farmland is located to the west of the site. A pond and wooded area are located to the south of the site. Industrial buildings have been constructed to the east of the site and several are under construction on the northeast side of the Hwy 401.

The site is located in the physiographic region known as the "PEEL PLAIN" as described by the Physiography of Southern Ontario (Chapman and Putnam, 1984). The deposit characterizing this area consists of a glacial till containing large amounts of Palaeozoic shale and limestone. The original ground surface in this region can be described as level to undulating in relief. Specifically, the

site under investigation has an undulating topography. However, it should be noted that the existing ground surface for the proposed Travel Information Centre consists of various fill material placed during the early construction of Hwy. 401.

This area is drained by the Credit River. At the site, water drains from the south end of the culvert at sta. 11 + 486 of Hwy. 401 easterly along a ditch for approximately 70 metres and then southerly through a farm field. This drainage runs parallel to the proposed building site. During the investigation, the drainage channel was completely dry.

FIELD INVESTIGATION

The field investigation was conducted between 87-09-02 and 87-10-02. Seven boreholes were advanced within the initial building envelope between 87-09-02 and 87-09-10 as shown on Drawing B. Boreholes No's 3 to 9 were advanced to a depth of 3.5 m to 10.4 m as shown in borehole logs.

It should be noted that there was some discrepancy with the regards to borehole locations and the initial staking out of the building in the field by R.E. Winters and Associates. These problems were finally resolved and the pertinent information was provided to this office by R.W. Winters and Associates in memo dated 87-10-01.

In addition to the survey errors, the information centre building was relocated and the revised one is rotated by about 90 degrees parallel to east property line as shown on Drawing B. Consequently, only one borehole (Borehole 6) is located within the newly revised building boundary. As a result of this additional investigation consisting of four more boreholes were advanced within the boundary of new building between 87-10-01 and 87-10-02 as shown on Drawing B. Boreholes #10 to #13 were advance to a depth of 9.6m below the ground surface.

Dynamic cone penetration tests accompanied each of the boreholes. The borings were advanced by means of a 83mm hollow stem augering machine. Soil sampling was performed at 0.76 metre intervals using a 50mm OD split spoon sampler. Shelby tube samples were taken from two boreholes (BH's #4a and #7a).

In-situ vane tests were performed at Boreholes #4b and #7a in order to obtain undrained shear strength of soils. Bedrock was not proven in any of the borehole by coring methods except weathered shaly slab was encountered at a depth between 7.8m and 10.2m below the ground surface in eight boreholes as shown on borehole logs.

Laboratory Work

The engineering properties of the soils were determined by performing grain size distribution and Atterberg Limits Tests. In addition natural moisture content was also performed. Two unconfined Compression Tests were performed on organic silty clay taken from Borehole 4a.

The results of laboratory tests are plotted on the record of Borehole Sheets and summarized in the Figures contained in the Appendix.

SUBSURFACE CONDITIONS

General

The soil stratigraphy at the site consists of fill material which consists of a mixture of silt, sand and gravel with random pockets or layers of silty clay, underlain by a compact to very dense gravelly sand to sandy gravel with some silt and trace of clay.

The fill material contains various amounts of old concrete slabs, tree trunk and steel debris. The thickness of this fill varies from 1.1 metre easterly at Borehole 6 up to 4 metre westerly towards the creek at Borehole 11.

The glacial till is predominantly sand with various amounts of gravel and occasional cobbles. Seams of silty fine sand, Shaly slabs and occasional cohesive zones are encountered within this glacial till deposit. This deposit extends to a depth of at least 10.2m below ground level, underlain by weathered Shaly slab.

The boundary of the Subsoil types, insitu and laboratory test results, as well as groundwater levels, are shown in the Record of Borehole Sheets in the Appendix. The location of each borehole is shown in plan on Dwg. No. 208701-B. Four stratigraphical sections are shown on Dwg. 208701-C.

The following is a detailed description of the soils encountered at the site.

Fill Materials

The site is covered with fill material which also contains various amounts of old concrete slabs, tree trunks and steel debris, and the overall thickness varies across the site. This material was encountered in all boreholes ranging in depth from 1 metre easterly up to 4 metres westerly toward the Creek as shown on Section A-A (Drawing 208701-C). The various types of fill material can be categorized as follows:

i) Mixture silt, Sand and Gravel (Fill Material)

A mixture of silt, sand and gravel was encountered in Boreholes 3, 4, 5, 6, 9, 10 and 12. This fill material is extended to a depth of approximately 3.7m below the existing ground surface.

Atterberg Limits tests and grain size distribution tests were performed on the samples and the results are shown on Figures 1 and 5 and listed below:

	Range %
Moisture Content (W)	6.5 - 16.5
Liquid Limit (W_L)	25 - 38.5
Plastic Limit (Wp)	15.5 - 22
Plasticity Index (Ip)	9.5 - 17.5

	Range %
Gravel	3 - 41
Sand	18 - 57
Silt	18 - 51
Clay	7 - 26

iii) Organic silty clay (Surficial Fill Material)

A localized surficial deposit of grey organic silty clay was encountered in Boreholes 4, 4A, 7, 7A, 10, 11 with the thickness varying from 0.7m to 1.8m overlying the original ground surface.

Atterberg Limits and grain size distribution tests were performed on the samples as shown on Figures 3 and 7.

The results are listed as follows:

	Range %
Moisture Content (W)	15 - 30.5
Liquid Limit (W_L)	28.5 - 42.0
Plastic Limit (Wp)	15.5 - 29.0
Plasticity Index (Ip)	11.0 - 21.5

	Range %
Gravel	1 - 14
Sand	16 - 50
Silt	24 - 55
Clay	11 - 29

Organic content tests were also carried out on two samples from Boreholes 4A and 7A. The results shows that the organic content ranges between 2.2 and 6.4% by weight.

This fill material can be described as an organic silty clay with random pockets or layers of sand and gravel. The organic silty clay can be considered to be low or medium plasticity (CL or CI Group). Standard penetration 'N' values between 2 and 13 indicated that the organic silty clay is in a soft to stiff state.

Glacial Till (Gravelly Sand to Sandy Gravel)

The fill material is underlain by a glacial till deposit. This material was encountered in all boreholes immediately below the fill material, about 1m below ground level in BH5, and about 4m below ground level in BH11. Within the glacial till stratum, occasional cohesive zones and occasional cobbles were encountered at the lower portion of the glacial till. Shaly slabs were encountered between elevation 188.5 and 187.7 in BH12, and below the elevations between 187.1 and 185.6m in the other boreholes as shown on boreholes logs. It appears that these shaly slabs have been disturbed by glacial action. Sand and gravel were forced between these slabs and its bedrock. The full extent of the glacial till deposit was not investigated.

Atterberg Limits tests were performed on this material as shown on Figure 4, and the results are summarized below:

	Range %
Moisture Content (W)	3.5 - 18.5
Liquid Limit (W_L)	15.5 - 34.5
Plastic Limit (Wp)	13.0 - 18.5
Plasticity Index (Ip)	1.5 - 16.0

Grain size distribution tests were carried out on the glacial till and the results are summarized below. Figure 8 in the Appendix shows the result in envelope form.

	Range %
Gravel	2 - 47
Sand	22 - 87
Silt	3 - 18
Clay	1 - 9

The glacial till can be described as gravelly sand to sandy gravel with some silt, trace of clay and occasional cobbles. The matrix is composed primarily on non-cohesive sand with occasional zones that exhibit low plasticity (CL- ML Group). With depth, the glacial till changed from brown to pink in color.

Occasional weathered shaly slabs yielded 'N' values ranging from 36 and 220 blows/0.3m, indicating a hard consistency.

In the glacial till stratum, the 'N' values ranged from 4 to 100 blows/0.1m indicating a state of compaction described as loose to very dense.

GROUNDWATER CONDITIONS

The groundwater level was measured in open boreholes few days after the boreholes were completed. The groundwater elevation was found to range between Elev. 191.5 and 192.0m, which corresponds to some 4 to 5m below the existing ground surface. The observed groundwater levels are indicated on the Record of Borehole Sheets in the Appendix and are shown on the stratigraphical sections (Dwg. No. 208701-C).

DISCUSSION AND RECOMMENDATIONS

As mentioned above, the soil stratigraphy at the site consists of a mixture of fill material, underlain by a sandy glacial till. The fill material contains various amounts of old concrete slabs, tree trunks and steel debris. The thickness of this fill varies from 1 metre easterly up to 4 metres westerly towards the creek. The glacial till is predominantly sand with various amounts of gravel and occasional cobbles. Seams of silty fine sand, shaly slabs and occasional cohesive zones are also present within this glacial till deposit. This deposit extends to a depth of at least 10.2m below ground level, underlain by weathered shale.

The groundwater elevation is believed to be at an elevation of approximately 191.5 metres in most boreholes, which is slightly higher than that of pond water of 191.2 m.

It is proposed to construct a new building for the Travel Information Centre.The following are our foundation recommendations for the design and construction of the new building and the related patio roof columns.

Foundation for Building

It is recommended that the new building structure be supported on a spread footing type of foundations placed on well compacted granular 'A' material or within natural subsoil of compact to very dense natural foundation soil. It is necessary that all the fill material be removed at the building location prior to the construction of new foundations.

The bearing capacity requirements for these foundation soils using working stress method are as follows:

Allowable bearing pressure up to 250 kPa may be used for building foundations at or below the proposed footing elevation on the granular subsoil provided the sub-excavation of the existing loose fill being removed and replaced with well compacted Granular 'A' at certain locations. The proposed footing elevation with the basement to about

elev. 193.5 m, while that without basement is proposed to be at elev. 196.0 m.The pertinent details including the limits of sub-excavation are shown on the enclosed figures 10 and 11. The above bearing capacity was based on the assumption that the footing width of the wall be 0.61 m (2 ft.) and the differential settlement will not exceed 25 mm.

For sliding resistance between the footing and granular subsoil, a coefficient of friction of 0.6 may be used. The footing should have a minimum of earth cover of 1.2 m to the underside of the footing to provide adequate frost protection.

In the event that the structure is designed as per O.H.B.D.C., the following parameters shall be used for the footing design:

	Factored Capacity at U.L.S. (kPa)	Allowable Capacity at S.L.S. Type II (kPa)
Spread Footings	600	250

Resistance to sliding of the footings can be calculated assuming a coefficient of friction of 0.6 between the underside of the concrete footing and the granular type material.

In designing the basement walls, the following parameters should be used in computing the lateral earth pressures for the granular type of backfill:

	Granular Type of Material
Angle of Internal Friction (ϕ)	30°
Unit Weight (KN/m^3) (γ)	19.0
Coefficient of Earth Pressure at Rest (K_o)	0.5

Foundation for Patio Columns

Columns for the patio outside of the building can be also designed on square or rectanuglar units using the above-mentioned design bearing capacities with appropriate dimensions to satisfy the design.

Sub-Excavation Details

As discussed above, all mixed fill material should be sub-excavated and replaced with well compacted granular 'A' material.
Two options can be considered as follows:

With Basement

If a basement is included in building scheme, the fill material in the vicinity of Boreholes 10 and 11 should be excavated down to elevation of 191.5m. The excavation boundary should be back sloping towards Boreholes 12, and then extending to the basement floor elevation of 194.5m near Boreholes 6 and 13 as shown on Section A-A (Figure 9).

Immediately after the excavation in deep excavated area, backfill to the base of the proposed footing elevation 193.5m, with well compacted Granular 'A' is required for the foundations.

In the Shallow excavated areas near Boreholes 6 and 13, the footings for the wall may be placed on the natural subsoil (granular material) after the trench for the footing is excavated to elevation 193.5 m as shown on the attached sketch (Figure 10).

Without Basement

If the basement is eliminated for the proposed buildings, the fill material into area near Boreholes 10 and 11 should be excavated down to elevation of 192.0 m along the boundary between fill material and original ground surface. The excavation boundary should be back sloping along the boundary between the fill material and original ground toward Borehole 12 with 3 (H) to 1 (V) slope, and then extending to the boundary elevation of 195.0 m near Borehole 6 and 13 as shown on Section A-A.

In the excavated areas, granular 'A' material should be backfilled to elevation 196.0 m as shown on Figure 11.

It should be emphasized that all fill material be excavated within the base width of the foundations prior to the construction of the footings.

Stability of slopes

Excavation depth is in the order of 4.5 m and consequently stability problems are not anticipated provided slopes are maintained with 2H:1V.

Construction

During excavation, care shall be exercised by not leaving any old fill material underneath the proposed footings. Dewatering during the excavation should not

be a major problem since excavation will be carried above the prevailing water level. However, any minor seepage or surface run-off into the excavations for foundations could be readily handled by pumping sumps.

Miscellaneous

The fieldwork for this investigation was carried out during the period of 87-09-02 to 87-10-02, under the supervision of Tae C. Kim and Mike Shenarr (Student Engineer). The equipment was owned and operated by Malone's Soil Samples Co. Ltd. of Etobicoke.

This report was written by T.C. Kim and reviewed by M. Devata, Chief Foundations Engineer (East).

Tae C. Kim, P.Eng.
Projects Foundations Engineer

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

APPENDIX

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

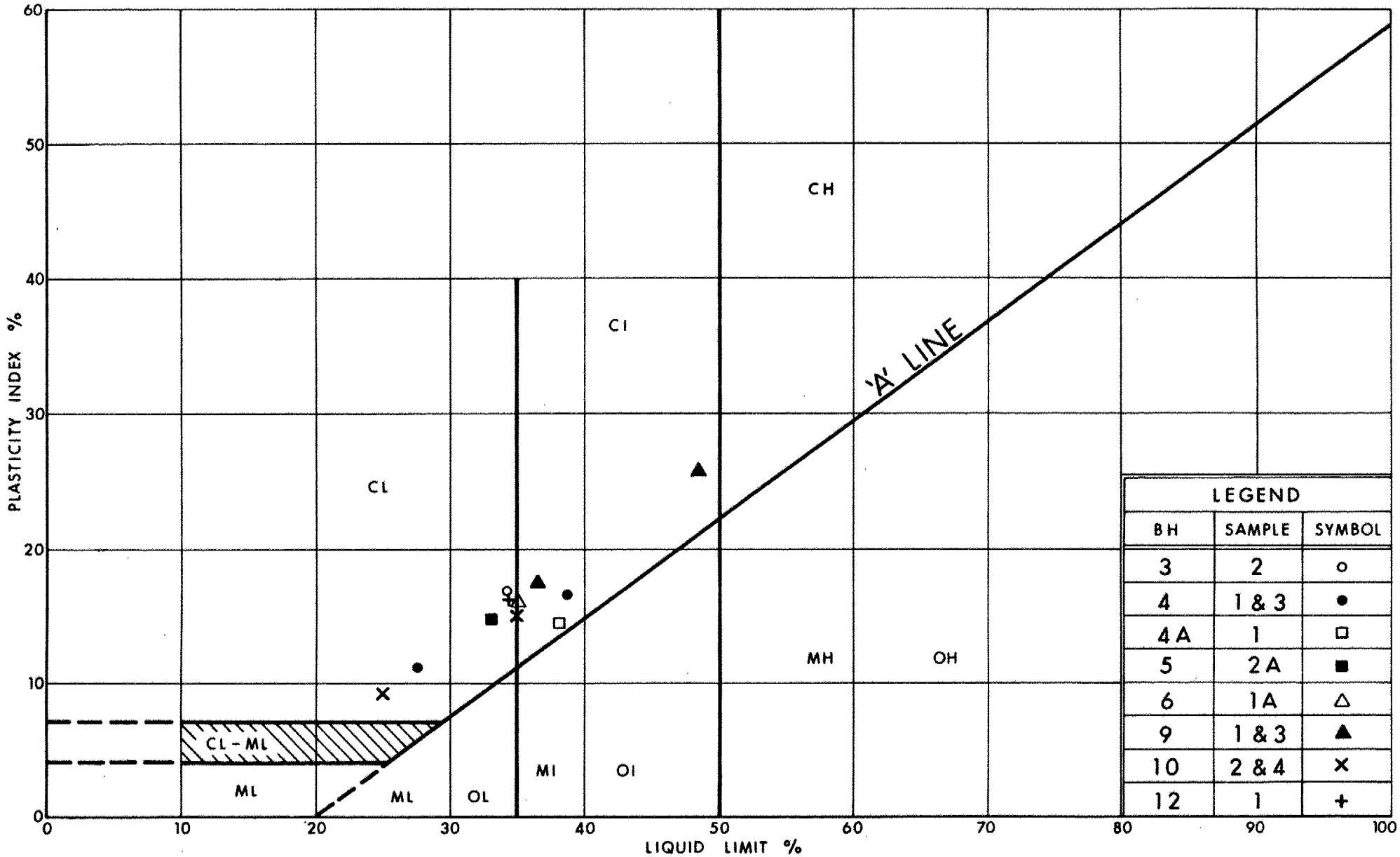
MECHANICAL PROPERTIES OF SOIL

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'	$-^\circ$	EFFECTIVE ANGLE OF INTERNAL FRICTION
c_u	kPa	APPARENT COHESION INTERCEPT
ϕ_u	$-^\circ$	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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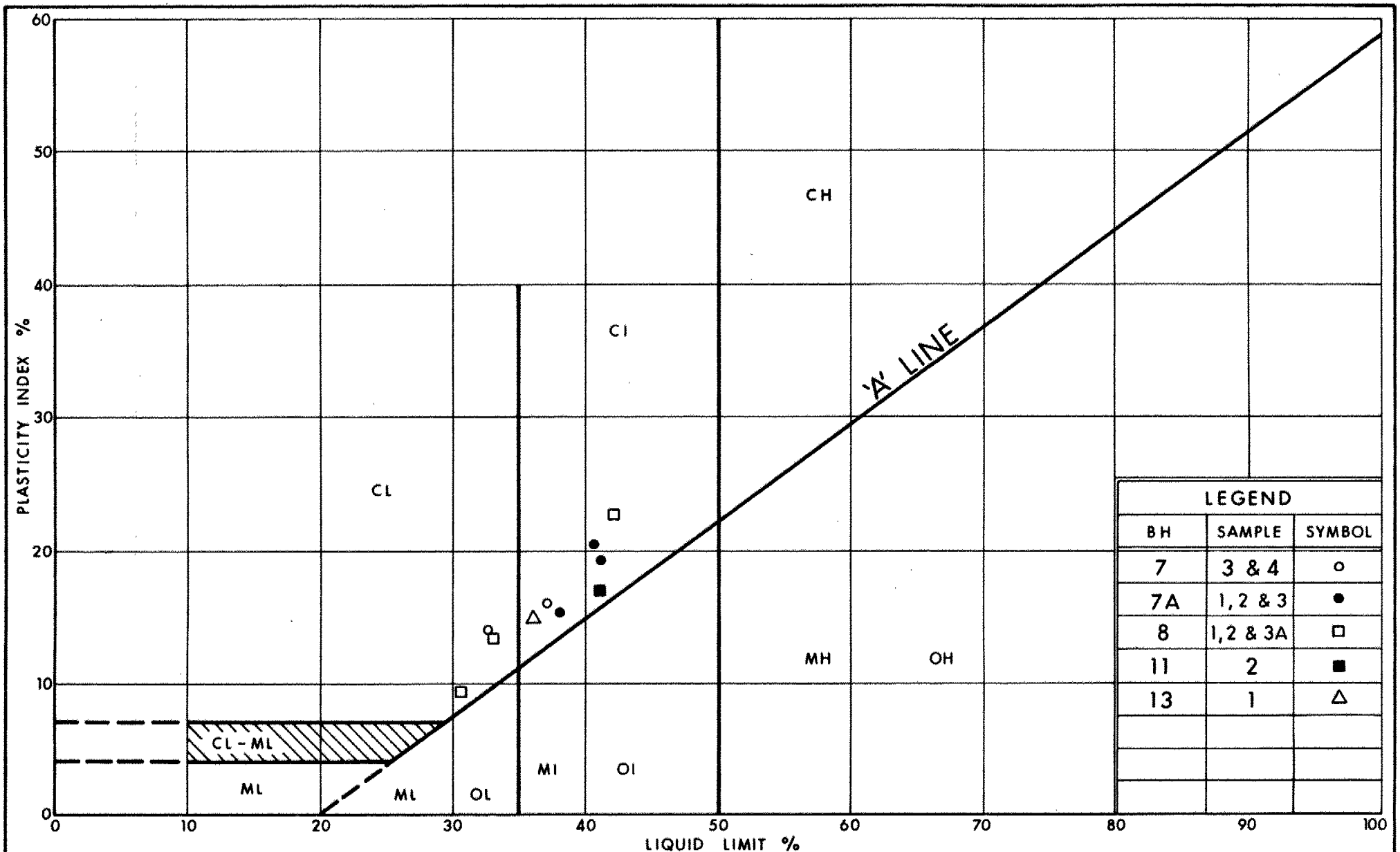
PLASTICITY CHART
MIXTURE OF SILT, SAND & GRAVEL (FILL) WITH RANDOM POCKETS & LAYERS OF SILTY CLAY

FIG No 1
WP 20-87-01



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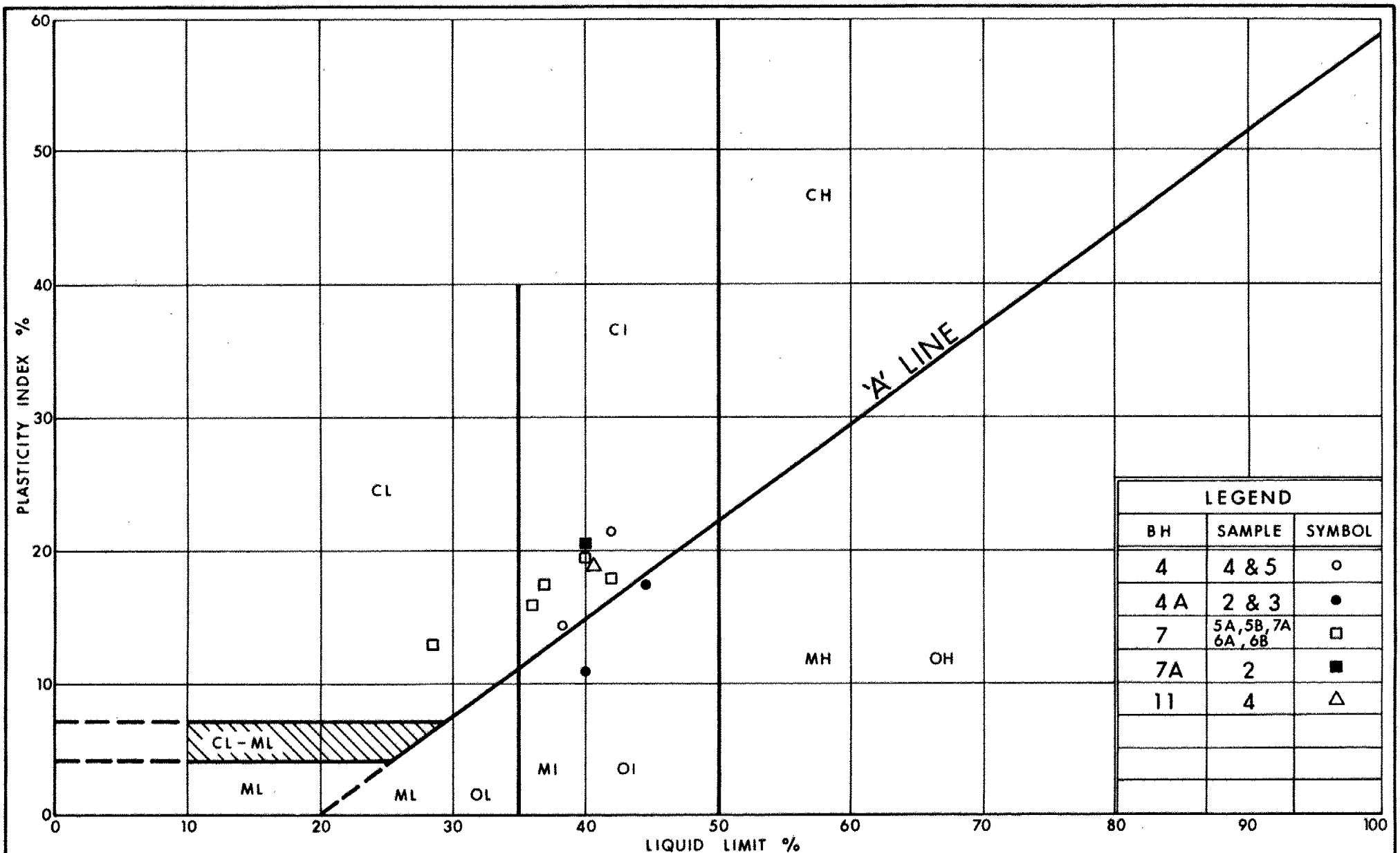
PLASTICITY CHART
SILTY CLAY (FILL)
WITH RANDOM POCKETS OR LAYERS OF SAND & GRAVEL

FIG No 2
W P 20-87-01



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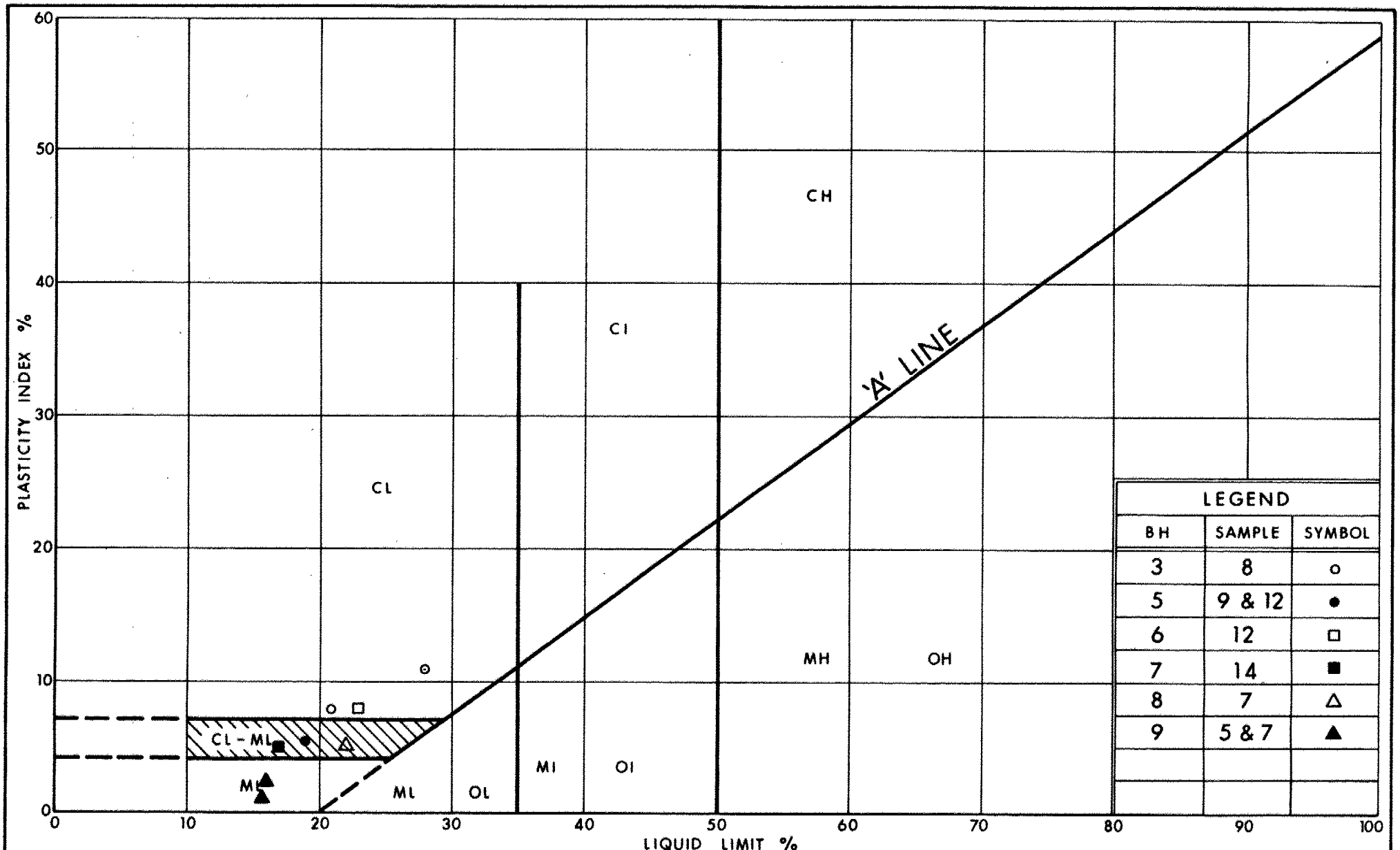
PLASTICITY CHART
ORGANIC SILTY CLAY (FILL)

FIG No 3
WP 20-87-01

Oct 75, FF-5-21



LEGEND		
BH	SAMPLE	SYMBOL
3	8	○
5	9 & 12	●
6	12	□
7	14	■
8	7	△
9	5 & 7	▲

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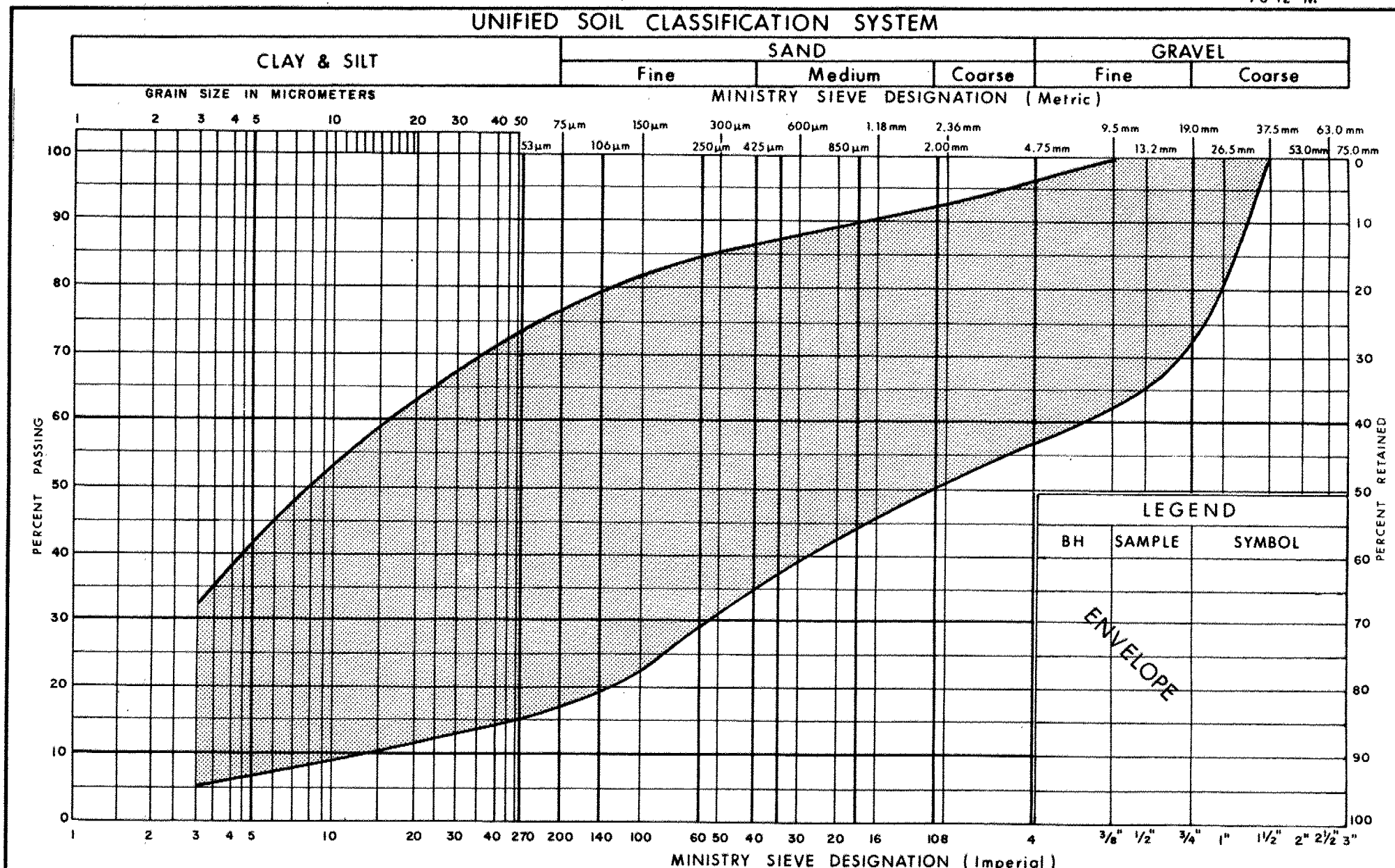
PLASTICITY CHART
GRAVELLY SAND TO SANDY GRAVEL (Glacial Till)
WITH SOME SILT, TRACE OF CLAY, OCC. COHESIVE ZONES

FIG No 4
W P 20-87-01



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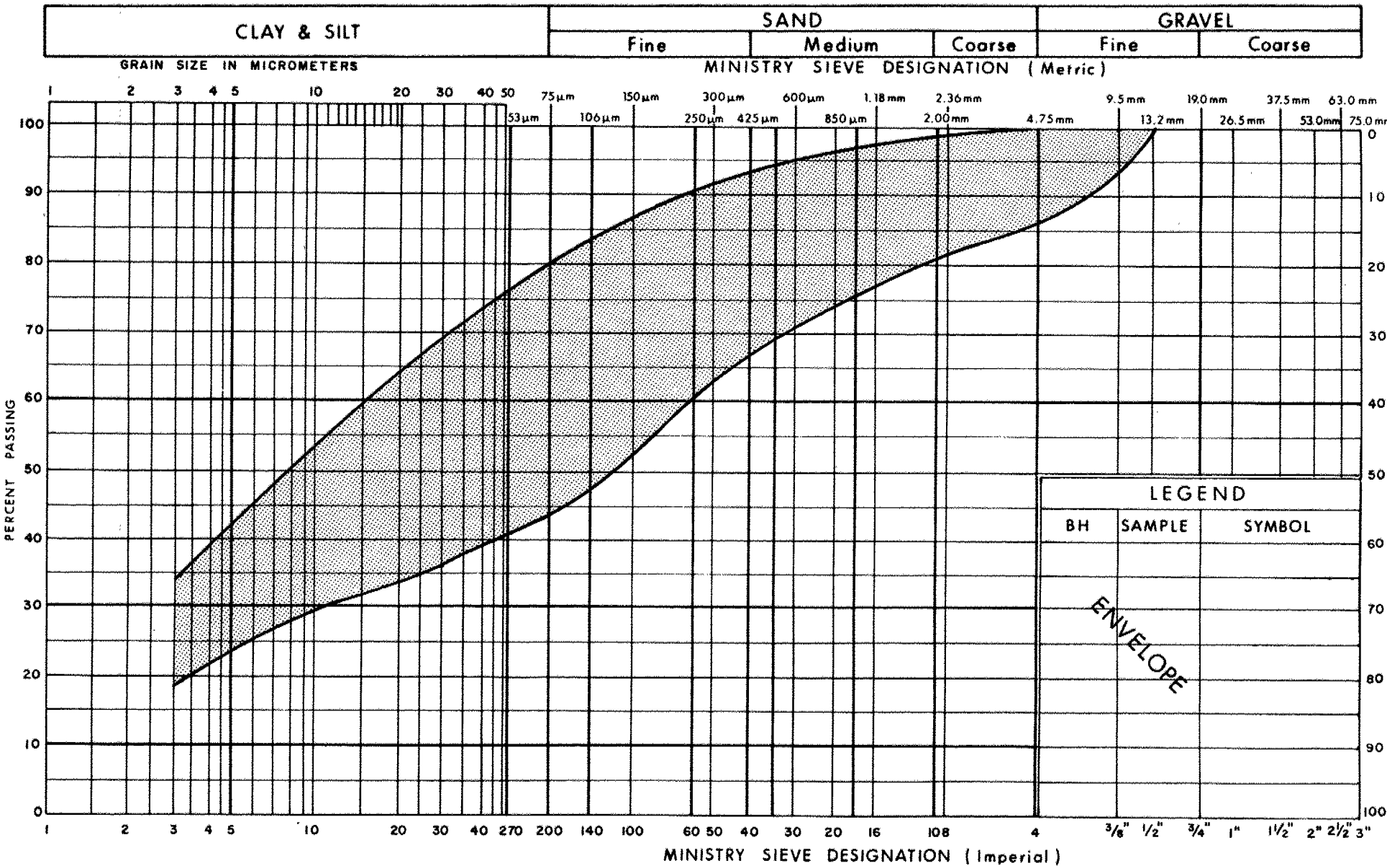
GRAIN SIZE DISTRIBUTION
MIXTURE OF SILT, SAND & GRAVEL (FILL)
WITH RANDOM POCKETS & LAYERS OF SILTY CLAY

FIG No 5

W P 20-87-01

UNIFIED SOIL CLASSIFICATION SYSTEM



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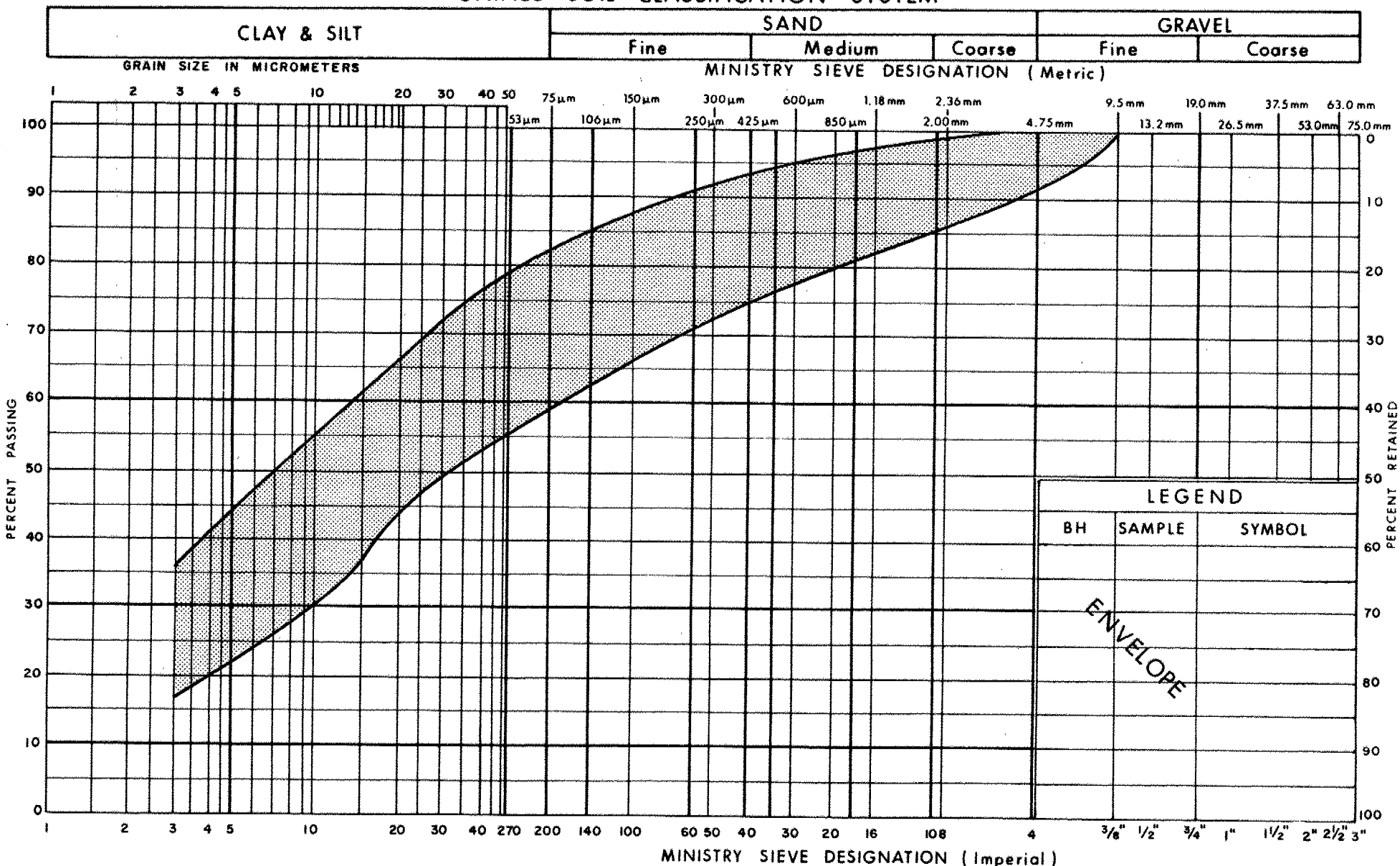
GRAIN SIZE DISTRIBUTION
SILTY CLAY (FILL)
WITH RANDOM POCKETS OR LAYERS OF SAND & GRAVEL

FIG No 6
W P 20 - 87 - 01

UNIFIED SOIL CLASSIFICATION SYSTEM



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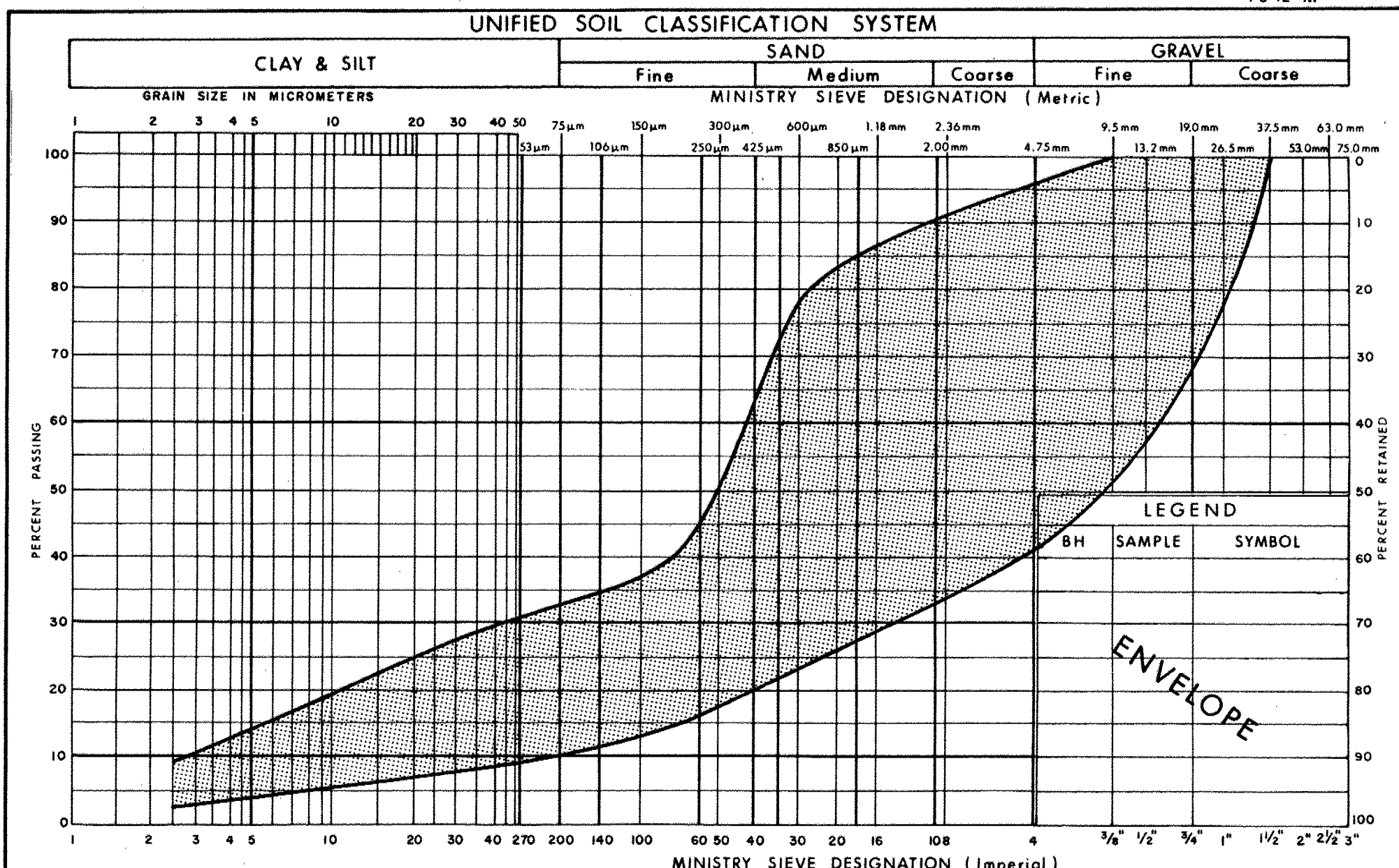
GRAIN SIZE DISTRIBUTION
ORGANIC SILTY CLAY
(FILL)

FIG No 7

W P 20-87-01



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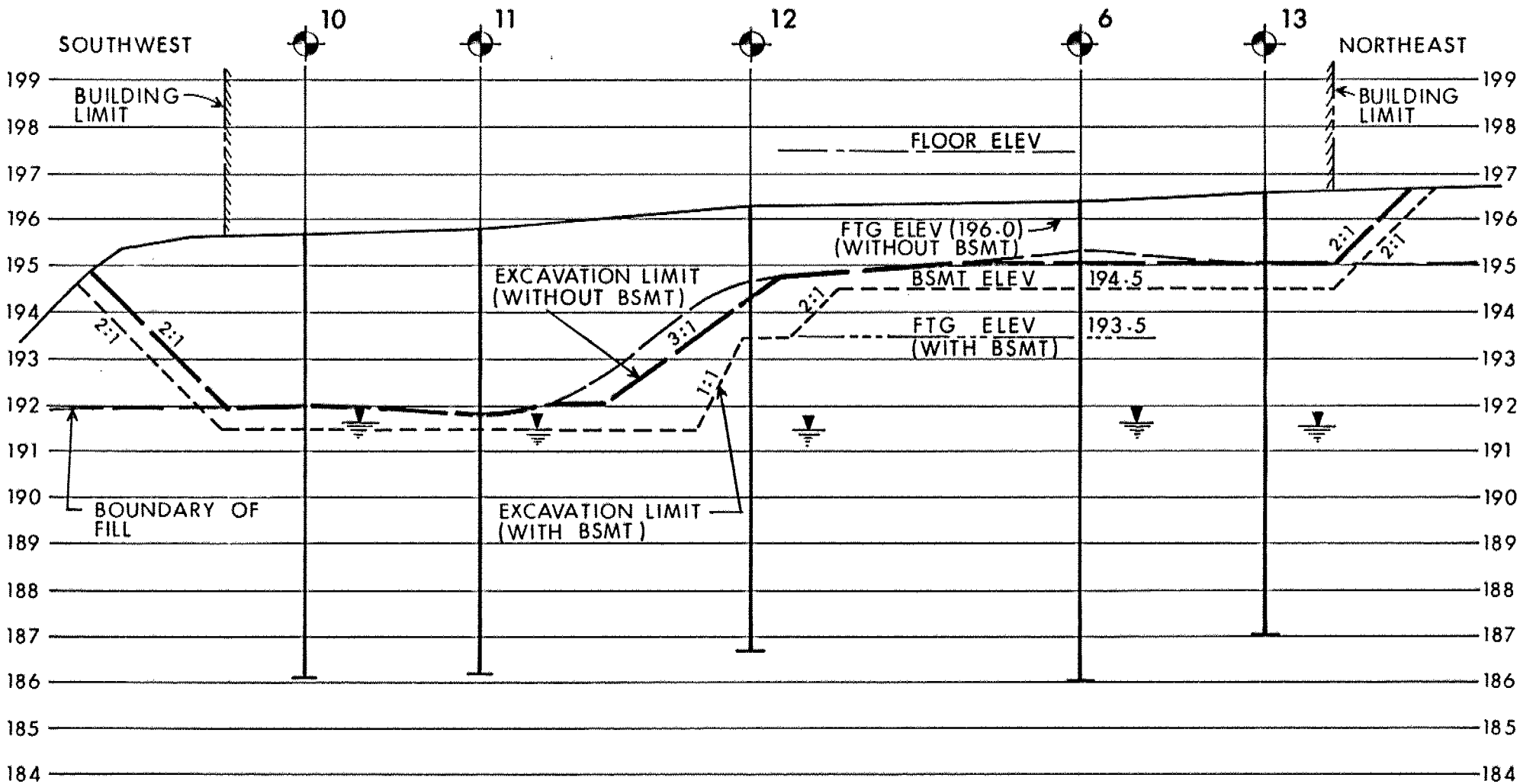
GRAIN SIZE DISTRIBUTION

GRAVELLY SAND TO SANDY GRAVEL (Glacial Till)

WITH SOME SILT, TRACE OF CLAY, OCC. COHESIVE ZONES

FIG No 8

W P 20-87-01



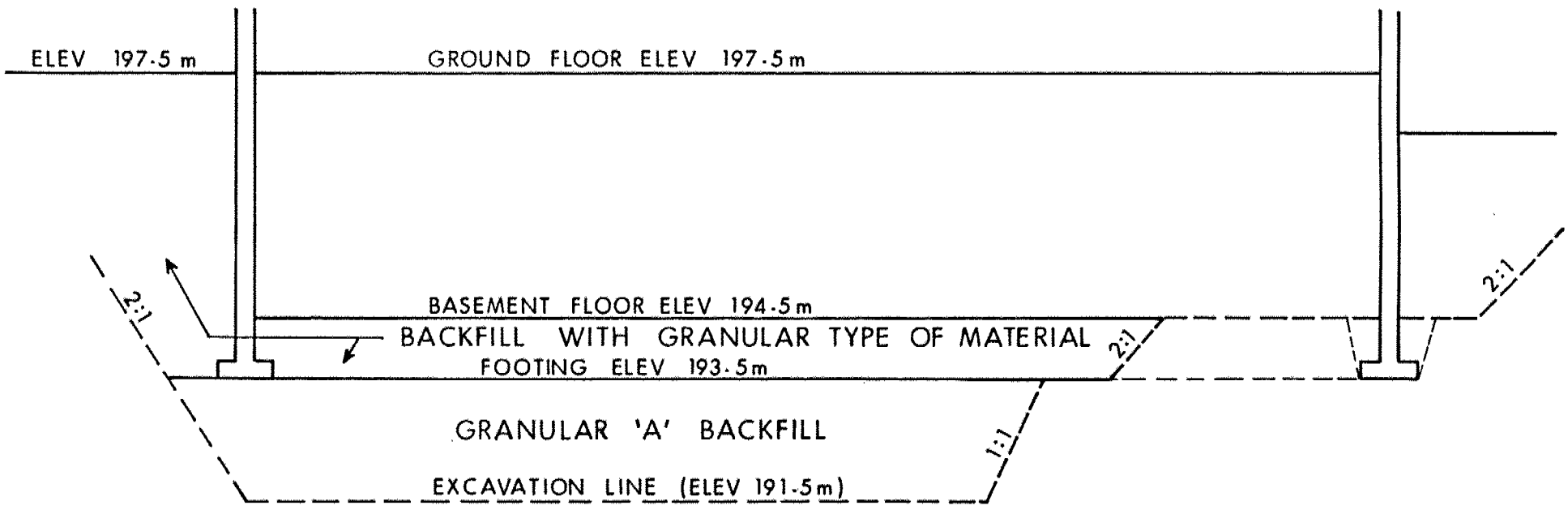
PROPOSED EXCAVATION RECOMMENDATIONS ALONG SECTION A-A

SCALE

4m 2 0 4m Hor

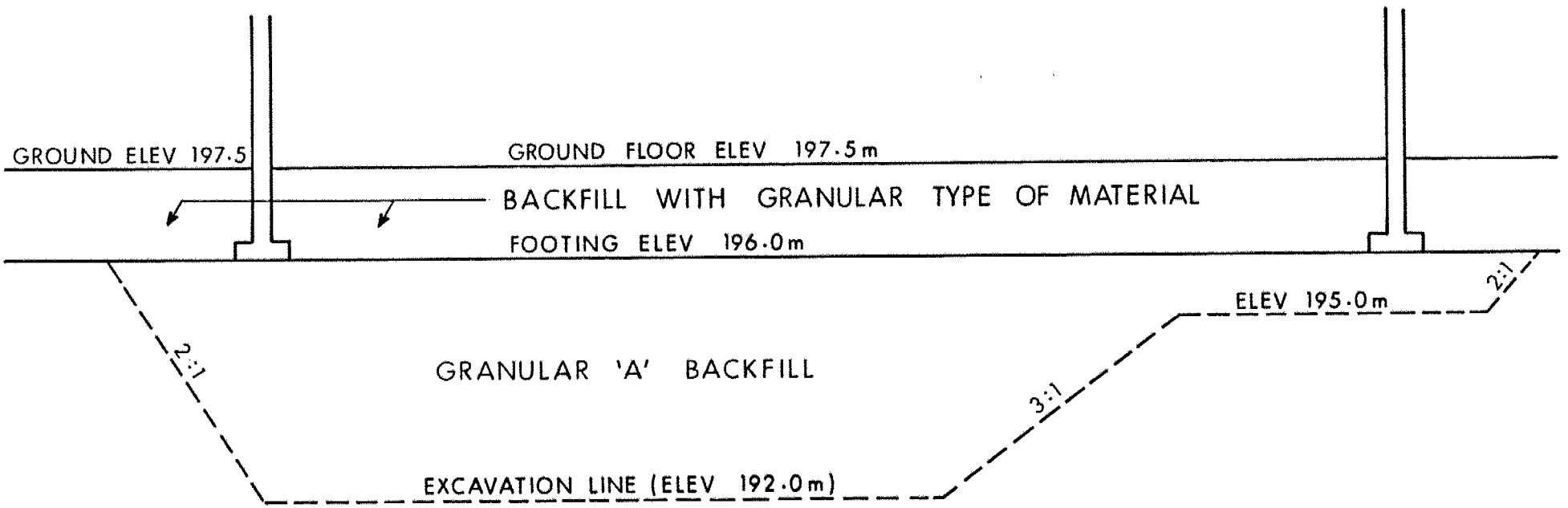
2m 1 0 2m Vert

Fig 9
WP 20-87-01



SKETCH FOR EXCAVATION & BACKFILL (WITH BASEMENT)

Fig 10
WP 20-87-01



SKETCH FOR EXCAVATION & BACKFILL
(WITHOUT BASEMENT)

Fig 11
WP 20-87-01

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RECORD OF BOREHOLE No 3 METRIC

W P 20-87-01 LOCATION NS Baseline Sta. 0 + 039.5; O/S 13.5 m RT ORIGINATED BY TCK
DIST 6 HWY 401 BOREHOLE TYPE HS Auger and Cone Test COMPILED BY TCK
DATUM Geodetic DATE 1987 09 02 & 03 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 Wl — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
196.7	Ground Level										
0.0	Mixture Silt, Sand and Gravel with random pockets or layers of Silty Clay (Fill)		1	SS	38/8 cm		196		○ np		41 18 34 7
195.3			2	SS	12				○		24 20 40 16
1.4			3	SS	32						
			4	SS	21		194				
	Gravelly Sand to Sandy Gravel with some silt trace of clay		5	SS	41			142	○ np		13 80 4 3
			6	SS	36						
			7	SS	35	87 09 11	192				
	Compact to Very Dense (Glacial Till) Occ. Cohesive Zones Occ. Cobbles		8	SS	44				○		41 38 17 4
			9	SS	31						
			10	SS	36		190				
			11	SS	42						
187.2	Weathered Shaly Slab						188				
9.5			12	SS	220				np		28 50 18 4
187.1	End of Borehole										
9.6											

OFFICE REPORT ON SOIL EXPLORATION

+3, ×5 : Numbers refer to Sensitivity

15 20/10 5 (%) STRAIN AT FAILURE

Ministry of Transportation and Communications
Ontario

RECORD OF BOREHOLE No 4 & 4B METRIC

W P 20-87-01 LOCATION NS Baseline Sta. 0 + 044.5; O/S 28.8 m Rt. ORIGINATED BY TCK
DIST 6 HWY 401 BOREHOLE TYPE HS Auger and Cone Test (Vane Test at BH 4B) COMPILED BY TCK
DATUM Geodetic DATE 1987 09 02 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 kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE) (20 40 60 80 100)	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
196.2	Ground Level										
0.0	Mixture Silt, Sand and Gravel with random pockets or layers of Silty Clay (Fill)		1	AS*							
			1	SS	110/15 cm		196				40 20 29 11
			2	SS	21						40 32 18 10
194.3											
1.9	Organic Silty Clay		3	SS	28			+1.5 1.4			20 46 25 9
			4	SS	8		194	+2			1 23 53 23
192.8			5	SS	7			+2.7			14 44 24 18
3.4	Gravelly Sand to Sandy Gravel with some Silt, trace of clay, Compact to Very Dense (Glacial Till), Occ. Cohesive Zones, Occ. Cobbles					87 09 16	192				
			6	SS	20						
			7	SS	27						40 48 9 3
			8	SS	15		190				
			9	SS	35						
			10	SS	41						19 63 15 3
							188				
			11	SS	31/18 cm						
186.1											
10.1	Weathered Shaly Slab		12	SS	59		186				55 15 25 5
185.8	End of Borehole										
10.4											

* AS: Auger Sample

+3, ×5 : Numbers refer to Sensitivity

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

OFFICE REPORT ON SOIL EXPLORATION

Ministry of Transportation and Communications
Ontario

RECORD OF BOREHOLE No 4A METRIC

W P 20-87-01 LOCATION NS Baseline Sta.0 + 045.4; O/S 27.2 m Rt ORIGINATED BY TCK
DIST 6 HWY 401 BOREHOLE TYPE HS Auger COMPILED BY TCK
DATUM Geodetic DATE 1987 09 10 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 kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT Wp / NATURAL MOISTURE CONTENT W / LIQUID LIMIT W_L WATER CONTENT (%) 10 20 30	UNIT WEIGHT γ KN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
196.3	Ground Level										
0.0	Mixture of Silt, Sand and Gravel, with random pockets or layers of Silty Clay (Fill)					*	196				
194.5 1.8	Organic Silty Clay		1	TW	PH						8 22 49 21
			2	TW	PH	**	194			18.5	0 23 53 24
192.9 3.4	Sand with Gravel		3	TW	PH					18.9	5 36 48 11
			4	TW	PH						32 55 8 5
192.5 3.8	End of Borehole										

* Note: Borehole Dry

** Organic Content by Weight 6.4%

OFFICE REPORT ON SOIL EXPLORATION

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

20
15 ◇ 5 (%) STRAIN AT FAILURE
10

Ministry of Transportation and Communications
Ontario

RECORD OF BOREHOLE No 5 METRIC

W P 20-87-01 LOCATION NS Baseline Sta. 0 + 051.9; O/S 5.9 m Rt. ORIGINATED BY TCK
DIST 6 HWY 401 BOREHOLE TYPE HS Auger and Cone Test COMPILED BY TCK
DATUM Geodetic DATE 1987 09 04 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
196.2	Ground Level										
0.0	Mixture Silt, Sand and Gravel with random pockets and layers of Silty Clay (Fill)		1	AS*			196				
195.2 / 1.0			1	SS	28						3 28 44 25
			2	SS	23						6 76 15 3
			3	SS	17						
			4	SS	17		194				
	Gravelly Sand to Sandy Gravel with some Silt trace of clay Compact to Dense (Glacial Till)		5	SS	32						
			6	SS	22						
						87 09 10	192				21 64 13 2
			7	SS	26						
			8	SS	23						
			9	SS	20		190				
	Occ. Cohesive Zones										38 48 11 3
	Occ. Cobbles		10	SS	21						
			11	SS	29						
							188	160/23 cm			
186.8 / 9.4	Weathered Shaly Slab		12	SS	75						41 25 27 7
186.6 / 9.6	End of Borehole										

* AS: Auger Sample

+3, ×5 ; Numbers refer to Sensitivity

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

OFFICE REPORT ON SOIL EXPLORATION

Ministry of Transportation and Communications
Ontario

RECORD OF BOREHOLE No 6 METRIC

W P 20-87-01 LOCATION NS Baseline Sta. 0 + 051.9; O/S 18.8 m Lt. ORIGINATED BY TCK
DIST 6 HWY 401 BOREHOLE TYPE HS Auger and Cone Test COMPILED BY TCK
DATUM Geodetic DATE 1987 09 04 and 09 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 WL — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
196.4	Ground Level										
0.0	Mixture Silt, Sand and Gravel with random pockets and layers of Silty Clay (Fill)		1	AS*							
195.3 / 1.1			1	SS	36		196				4 19 51 26
			2	SS	41						
	Gravelly Sand to Sandy Gravel with some Silt		3	SS	31		194				5 76 15 4
	trace of clay		4	SS	32			120/25 cm			
	Compact to Dense (Glacial Till)		5	SS	33						
			6	SS	23	87 09 16	192				
	Occ. Cohesive Zones		7	SS	32				onp		30 54 13 3
	Occ. Cobbles		8	SS	34						
			9	SS	49		190				
			10	SS	35						
187.3 / 9.1			11	SS	26		188				
186.4	Weathered Shaly Slab		12	SS	62						12 30 47 11
10.0	Sand and Gravel		13	SS	40						
186.0 / 10.4	End of Borehole										

* AS: Auger Sample

+3, ×5 : Numbers refer to Sensitivity

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

OFFICE REPORT ON SOIL EXPLORATION

Ministry of Transportation and Communications
Ontario

RECORD OF BOREHOLE No 7

METRIC

W P 20-87-01 LOCATION NS Baseline Sta. 0 + 066.7; O/S 18.1 m Rt. ORIGINATED BY TCK

DIST 6 HWY 401 BOREHOLE TYPE HS Auger and Cone Test COMPILED BY TCK

DATUM Geodetic DATE 1987 09 09 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 kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE) (20 40 60 80 100)	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
195.8	Ground Level										
0.0	Silty Clay with random pockets or layers of Sand and Gravel (Fill)		1	AS*							
			2	SS	17						14 31 41 14
			3	SS	12						
193.7			4	SS	6		194				2 18 57 23
2.1	Organic Silty Clay		5	SS	5			+6			2 18 56 24
											1 16 54 29
191.9			6	SS	10			4.8+			1 28 47 24
3.9	Loose		7	SS	7	87 09 16	192				2 50 35 13
	Gravelly Sand to Sandy Gravel with some Silt trace of clay Compact to Dense (Glacial Till) Occ. Cohesive Zones Occ. Cobbles		8	SS	26						5 30 44 21
			9	SS	27						17 55 18 10
			10	SS	21		190				
			11	SS	25						4 79 14 3
			12	SS	31		188				
			13	SS	24						
185.6	Weathered Shaly Slab		14	SS	40		186				22 33 38 7
10.2	End of Borehole										
185.4											
10.4											

* AS: Auger Sample

OFFICE REPORT ON SOIL EXPLORATION

+3, ×5 : Numbers refer to Sensitivity

20
15 ◇ 5 (%) STRAIN AT FAILURE
10

Ministry of Transportation and Communications
Ontario

RECORD OF BOREHOLE No 7A

METRIC

W P 20-87-01 LOCATION NS Baseline Sta. 0 + 065.8; O/S 19.5 m Rt. ORIGINATED BY TCK

DIST 6 HWY 401 BOREHOLE TYPE HS Auger COMPILED BY TCK

DATUM Geodetic DATE 1987 09 09 CHECKED BY

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 20 40 60 80 100	PLASTIC LIMIT Wp / NATURAL MOISTURE CONTENT W / LIQUID LIMIT W_L WATER CONTENT (%) 10 20 30	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES						
195.9	Ground Level										
0.0	Silty Clay with random pockets or layers of Sand and Gravel (Fill)		1	TW	PH	*	194				2 18 55 25
193.5											5 15 51 29
2.4	Organic Silty Clay		2	TW	PH	**		+6		19.5	1 18 54 27
192.8								+ 4.8			14 56 17 13
3.1	End of Borehole at Sand Layer		3	TW	PH						5 41 39 15
192.4											
3.5											

* Note: Borehole Dry

** Organic Content by Weight 2.2%

OFFICE REPORT ON SOIL EXPLORATION

+³, x⁵ : Numbers refer to Sensitivity

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

Ministry of Transportation and Communications
Ontario

RECORD OF BOREHOLE No 8 METRIC

W P 20-87-01 LOCATION NS Baseline Sta. 0 + 053.0; O/S 16.8 m Rt. ORIGINATED BY TCK
DIST 6 HWY 401 BOREHOLE TYPE HS Auger and Cone Test COMPILED BY TCK
DATUM Geodetic DATE 1987 09 10 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
196.2	Ground Level						196				
0.0	Silty Clay with random pockets or layers of Sand and Gravel (Fill)		1	AS*							
			1	SS	17						8 25 52 15
			2	SS	6						5 31 49 15
193.6							194				
2.6	Gravelly Sand to Sandy Gravel with some Silt trace of clay		3	SS	8						2 54 24 20
			4	SS	17						9 73 12 6
			5	SS	20						
	Compact to Dense (Glacial Till)		6	SS	24	87 9 16	192				
	Occ. Cohesive Zones		7	SS	29						
189.6	Occ. Cobbles		8	SS	31						32 52 14 2
6.6	End of Borehole						190				
187.1							188				
9.1	End of Cone Test										

* AS: Auger Sample

OFFICE REPORT ON SOIL EXPLORATION

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

20
15 ◇ 5 (%) STRAIN AT FAILURE
10

Ministry of Transportation and Communications
Ontario

RECORD OF BOREHOLE No 9 METRIC

W P 20-87-01 LOCATION NS Baseline Sta. 0 + 041.3; O/S 18.2 m Rt. ORIGINATED BY TCK
DIST 6 HWY 401 BOREHOLE TYPE HS Auger COMPILED BY TCK
DATUM Geodetic DATE 1987 09 10 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 W_L / WATER CONTENT (%) 10 20 30	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
196.6	Ground Level										
0.0	Mixture Silt, Sand and Gravel with random pockets or layers of Silty Clay (Fill)		1	AS*			196				
			1	SS	36				○		16 26 45 13
			2	SS	8						
193.4			3	SS	7		194		○		11 46 17 26
3.2	Gravelly Sand to Sandy Gravel with some silt trace of clay Compact to Dense (Glacial Till) Occ. Cohesive Zones Occ. Cobbles		4	SS	18						
			5	SS	28				○ H		9 72 14 5
			6	SS	27		192				
			7	SS	30	87 9 16			○ H		45 44 8 3
190.0			8	SS	26						
6.6	End of Borehole										

* AS: Auger Sample

+3, ×5 : Numbers refer to Sensitivity

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

OFFICE REPORT ON SOIL EXPLORATION

Ministry of Transportation and Communications
Ontario

RECORD OF BOREHOLE No 10 METRIC

W P 20-87-01 LOCATION NS Baseline Sta. 0 + 071.4; O/S 9.8 m Rt. ORIGINATED BY TCK
DIST 6 HWY 401 BOREHOLE TYPE HS Auger and Cone Test COMPILED BY TCK
DATUM Geodetic DATE 1987 10 02 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
195.7	Ground Level										
0.0	Mixture Silt, Sand and Gravel with random pockets or layers of Silty Clay (Fill)		1	SS	12						
193.6			2	SS	14		194				7 19 51 23
2.1	Organic Silty Clay		3	SS	13						
192.0			4	SS	11						12 57 21 10
3.7	Gravelly Sand with some silt trace of clay Compact to Dense (Glacial Till) Occ. Cohesive Zones Occ. Cobbles		5	SS	17	▼ 87 10 5	192				
			6	SS	25						29 54 12 5
			7	SS	31		190				
			8	SS	20						12 78 7 3
			9	SS	33		188				
186.1			10	SS	36			75/2.5 cm			16 64 15 5
9.6	End of Borehole										

OFFICE REPORT ON SOIL EXPLORATION

+3, ×5 : Numbers refer to Sensitivity

20
15 ◇ 5 (%) STRAIN AT FAILURE
10

Ministry of Transportation and Communications
Ontario

RECORD OF BOREHOLE No 11 METRIC

W P 20-87-01 LOCATION NS Baseline Sta. 0 + 071.2; O/S 1.4 m Lt. ORIGINATED BY TCK
DIST 6 HWY 401 BOREHOLE TYPE HS Auger and Cone Test COMPILED BY TCK
DATUM Geodetic DATE 1987 10 01 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
195.8	Ground Level										
0.0	Silty Clay with random pockets or layers of sand and Gravel (Fill)		1	SS	21						
			2	SS	9		194				3 21 59 17
192.6			3	SS	3						
3.2											
191.8	Organic Silty Clay		4	SS	2						0 23 47 30
4.0			5	SS	14		192				
	Gravelly Sand to Sandy Gravel with some silt trace of clay Compact to Dense (Glacial Till) Occ. Cohesive Zones Occ. Cobbles		6	SS	23	87 10 5					10 66 17 7
			7	SS	43						
			8	SS	34		190				44 42 12 2
			9	SS	36		188	75/25 cm			44 41 12 3
186.3	Weathered Shaly Slab		10	SS	106						
9.5	End of Borehole										
186.2											
9.6											

+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 12 METRIC

W P 20-87-01 LOCATION NS Baseline Sta. 0 + 058.3; O/S 4.7 m Lt. ORIGINATED BY TCK
DIST 6 HWY 401 BOREHOLE TYPE HS Auger and Cone Tests COMPILED BY TCK
DATUM Geodetic DATE 1987 10 02 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
196.3	Ground Level										
0.0	Mixture Silt, Sand and Gravel with random pockets and layers of Silty Clay (Fill)		1	SS	18						
194.7			2	SS	4						15 66 11 8
1.6	Gravelly Sand to Sandy Gravel with some Silt trace of clay Compact to Dense (Glacial Till) Occ. Cohesive Zones Occ. Cobbles		3	SS	8						2 87 6 5
			4	SS	24						
			5	SS	22						5 83 11 1
			6	SS	20						12 72 10 6
			7	SS	27	87 10 5					
			8	SS	40						
188.5											
7.8	Weathered Shaly Slab		9	SS	36						39 44 14 3
187.7											
8.6	Gravelly Sand with some Silt, trace of clay		10	SS	*						
186.7											
9.6	End of Borehole										

Note: * Blow Counts were not attainable

$+^3$, $\times^5$: 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 13 METRIC

W P 20-87-01 LOCATION NS Baseline Sta. 0 + 040.1; O/S 20.7 m Lt. ORIGINATED BY TCK
DIST 6 HWY 401 BOREHOLE TYPE HS Auger and Cone Tests COMPILED BY TCK
DATUM Geodetic DATE 1987 10 01 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
196.6	Ground Level										
0.0	Silty Clay with Sand trace of gravel (Fill)		1	SS	21		196				6 32 41 21
195.0			2	SS	29						20 63 12 5
1.6	Gravelly Sand to Sandy Gravel with some Silt trace of clay Compact to Very Dense (Glacial Till) Occ. Cohesive Zones Occ. Cobbles		3	SS	35		194				
			4	SS	100/10 cm			105/25cm			45 38 15 2
			5	SS	42						
			6	SS	27		192				47 35 13 5
			7	SS	49	87 10.5					
			8	SS	38						31 51 13 5
188.7							190				
7.9	Weathered Shaly Slab		9	SS	42						
187.1	Weathered Shaly Slab		10	SS	55		188				59 22 15 4
9.5	End of Borehole										
187.0											
9.6											

+3, ×5 : Numbers refer to Sensitivity

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

OFFICE REPORT ON SOIL EXPLORATION

Ministry of Transportation and Communications
Ontario

RECORD OF BOREHOLE No 20 METRIC

W P 20-87-01 LOCATION NS Baseline Sta. 0 + 053.5; O/S 32.7 m Rt. ORIGINATED BY TCK
DIST 6 HWY 401 BOREHOLE TYPE HS Auger and Cone Test COMPILED BY TCK
DATUM Geodetic DATE 1987 10 15 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
196.3	Ground Level						196				
0.0	Silty Clay with random pockets or layers of Sand and Gravel (Fill)		1	SS	7						5 37 39 19
			2	SS	15						7 18 46 29
	Tree Trunk		3	SS	148/20 cm		194				
192.6			4	SS	9						9 39 39 13
3.7	Loose		5	SS	3						14 57 20 9
	Gravelly Sand to Sandy Gravel with some Silt trace of clay		6	SS	35	87 10	192 26				
	Dense to Very Dense (Glacial Till)		7	SS	42						24 56 15 5
			8	SS	39		190				
	Occ. Cohesive Zones		9	SS	49						
	Occ. Cobbles						188				
186.2			10	SS	51						34 48 14 4
10.1	Weathered Shaly Slab						186				
185.1			11	SS	100/10 cm						0 7 76 17
11.2	End of Borehole										

OFFICE REPORT ON SOIL EXPLORATION

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

20
15 ⊹ 5 (%) STRAIN AT FAILURE
10

MINISTRY OF TRANSPORTATION AND COMMUNICATIONS, ONTARIO PH-0-207 82 04

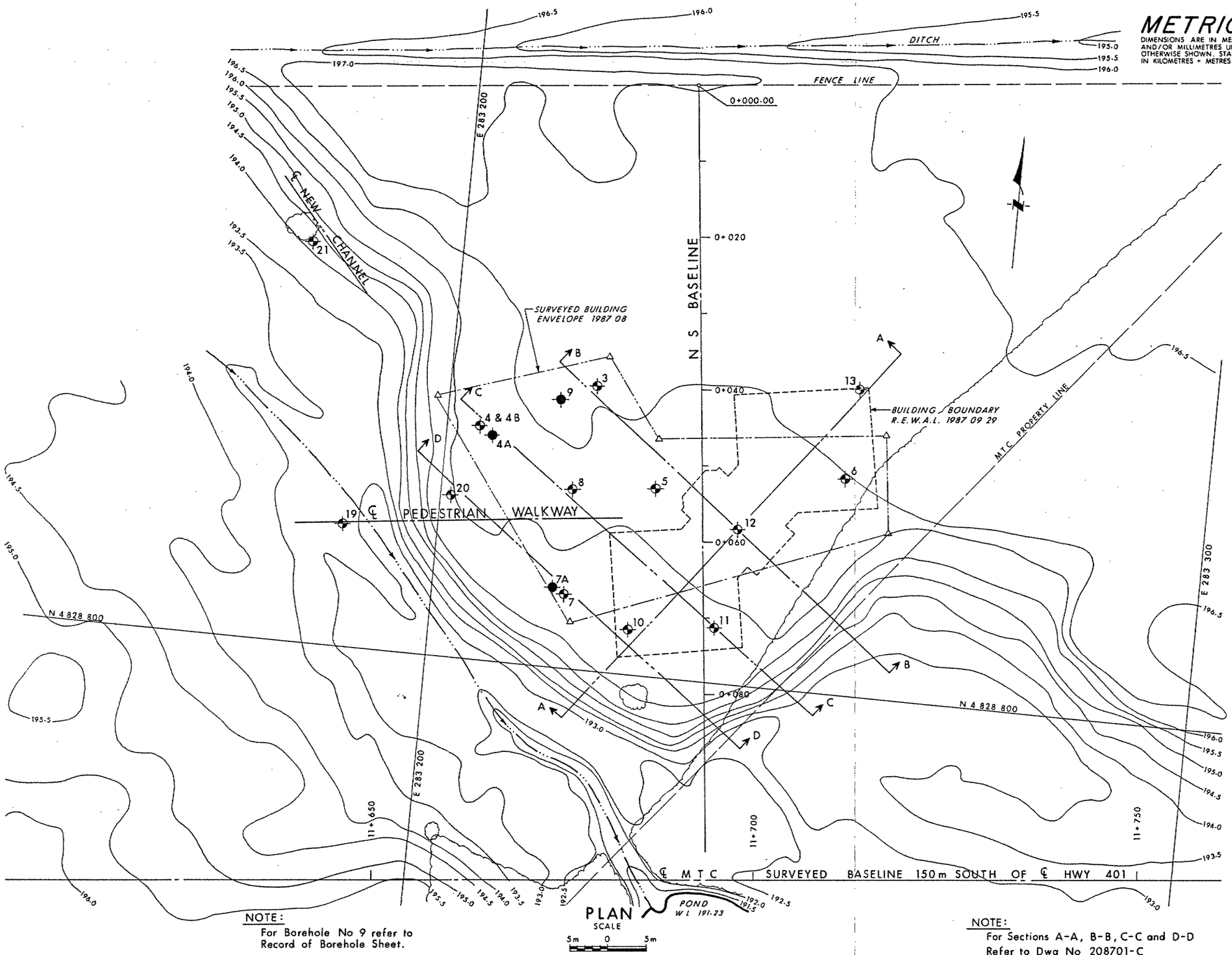
METRIC

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

CONT No
WP No 20-87-01

BUILDING FOUNDATIONS FOR
TRAVEL INFORMATION CENTRE
BORE HOLE LOCATIONS & SOIL STRATA

SHEET

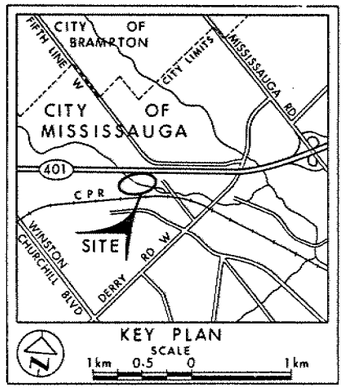


PLAN
SCALE
5m 0 5m

NOTE:
For Borehole No 9 refer to Record of Borehole Sheet.

Boreholes No 19 and 21 will be included in the report for the Pedestrian Bridge and Concrete Culvert.

NOTE:
For Sections A-A, B-B, C-C and D-D Refer to Dwg No 208701-C



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

No	ELEVATION	N S BASELINE STATION	N S BASELINE OFFSET
3	196.7	0+039.5	13.5m Rt
4&4B	196.2	0+044.5	28.8m Rt
4A	196.3	0+045.4	27.2m Rt
5	196.2	0+051.9	5.9m Rt
6	196.4	0+051.9	18.8m Lt
7	195.8	0+066.7	18.1m Rt
7A	195.9	0+065.8	19.5m Rt
8	196.2	0+053.0	16.8m Rt
9	196.6	0+041.3	18.2m Rt
10	195.7	0+071.4	9.8m Rt
11	195.8	0+071.2	1.4m Lt
12	196.3	0+058.3	4.7m Lt
13	196.6	0+040.1	20.7m Lt
19	193.5	0+057.0	46.8m Rt
20	196.3	0+053.5	32.7m Rt
21	194.2	0+020.3	50.5m Rt

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 30M12-201

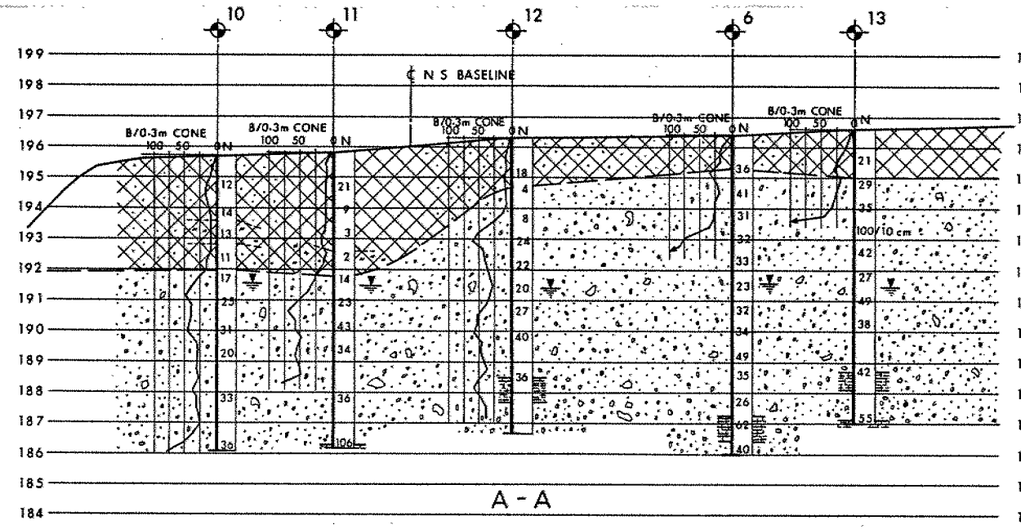
HWY No 401			DIST 6
SUBM'D TCK	CHECKED	DATE 1987 11 18	SITE
DRAWN CM	CHECKED	APPROVED	DWG 208701-B

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

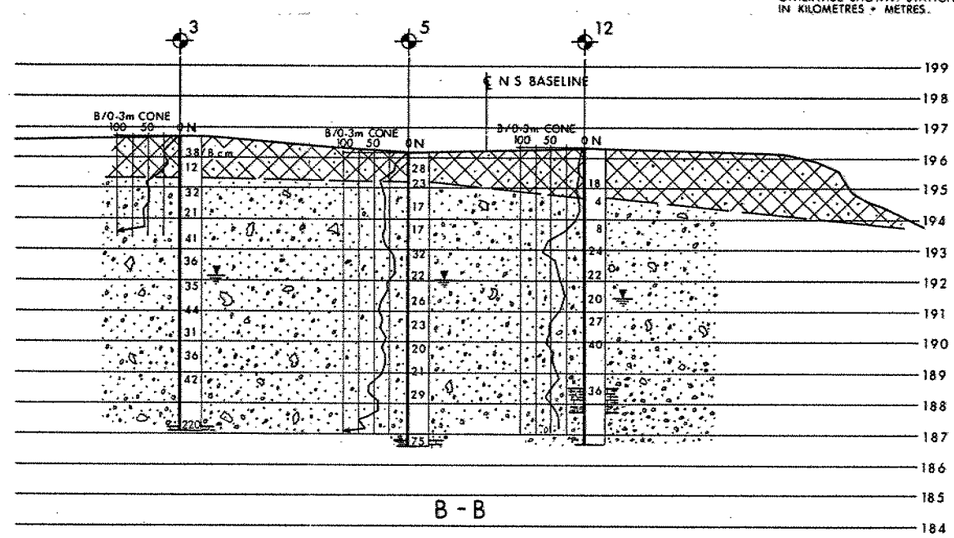
CONT No
WP No 20-87-01

BUILDING FOUNDATION FOR
TRAVEL INFORMATION CENTRE
BORE HOLE LOCATIONS & SOIL STRATA

SHEET



A - A



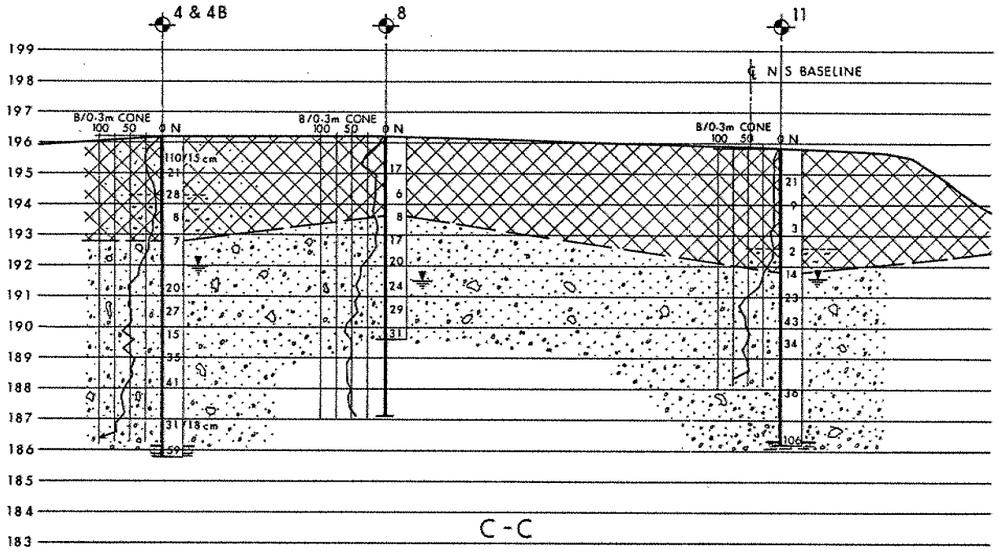
B - B

SEE DWG 208701-B

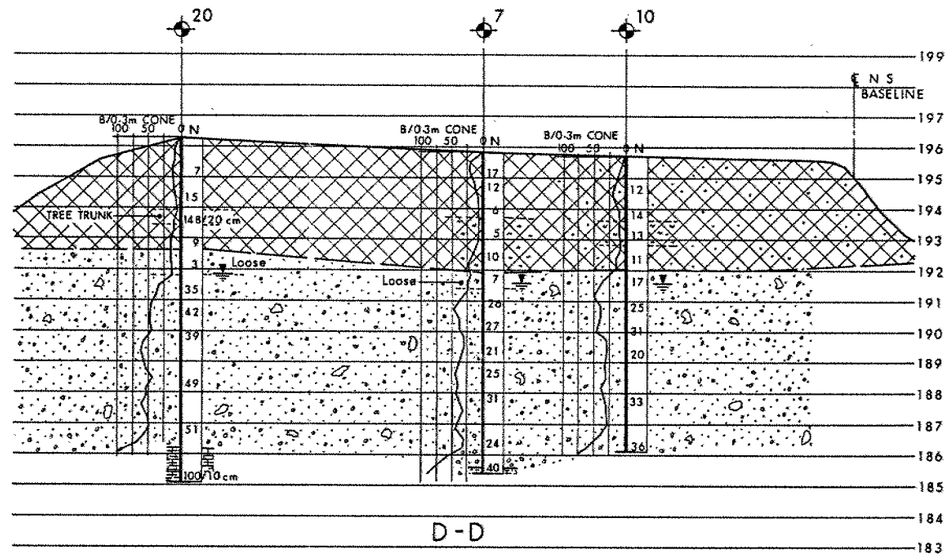
KEY PLAN
SCALE

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 87 09 and 87 10



C - C



D - D

No	ELEVATION		
3	196.7		
4 & 4B	196.2		
5	196.2		
6	196.4		
7	195.8		
8	196.2		
10	195.7		
11	195.8		
12	196.3		
13	196.6		
20	196.3		

SOIL STRATIGRAPHY LEGEND

- MIXTURE SILT, SAND & GRAVEL WITH RANDOM POCKETS AND/OR LAYERS OF SILTY CLAY (FILL)
- SILTY CLAY WITH RANDOM POCKETS OR LAYERS OF SAND & GRAVEL (WITH SAND, TR GRAVEL) (FILL)
- ORGANIC SILTY CLAY (FILL)
- GRAVELLY SAND TO SANDY GRAVEL WITH SOME SILT, TR OF CLAY, OCC COHESIVE ZONES, OCC COBBLES Comp to V Dense (GLACIAL TILL)
- WEATHERED SHALY SLAB

SECTIONS

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

Note:
For Plan Refer to
Dwg No 208701-B

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 30M12-201

HWY No 401			DIST 6
SUBM'D TCK	CHECKED	DATE 87 11 16	SITE
DRAWN DT	CHECKED	APPROVED	DWG 208701-C

memorandum

Ontario

Tel: 235-3731

To: A. Wittenberg
Head, Planning and
Design Section
5000 Yonge Street

Date: 1988 02 16

Atten: W.K. Lankinen

From: Foundation Design Section
Room 315, Central Building

RE: Culvert at Travel Information Centre
Hwy. 401, 2.0 km West of Mississauga Road
W.P. 20-87-01
District 6, Toronto

We have reviewed the letter from R.E. Winter & Associates Limited on February 10, 1988, regarding the culvert foundation at the Travel Information Centre, Highway 401, 2 km West of Mississauga Road.

We agree that OPSS Specification 902.10.02 Unwatering Structure Foundations should be applied. It should be noted that a method suggested in our Foundation report is only one method which can be utilized. However, other methods can be used for unwatering.

We are not in agreement with any other recommendations contained in R.E. Winter Associate's letter. Our original recommendations remain unchanged.

If you wish further discussion, we will be happy to answer any questions you may have.

T.C. Kim, P. Eng.
Project Foundation Engineer

TCK/mmj

c.c. - G.C.E. Burkhardt
R. Kawaguchi (Winter Assoc.)

Winter
Associates

Consulting Engineers, Architects,
Planners & Landscape Architects

February 10, 1988

The Ministry of Transportation
Engineering Materials Office
Foundation Design Section
Room 315 Central Building
1201 Wilson Avenue
Downsview, Ontario
M3M 1J8

Attention: Mr. T.C. Kim
Project Foundation Engineer

Dear Sir:

W.P. 20-87-01 HIGHWAY 401
PROVINCIAL ROADSIDE REST AND
TRAVEL INFORMATION CENTRE
TREATMENT CONCRETE CULVERT
REWAL PROJECT 8109X4

Significant recommendations for the method of installing the concrete culvert on the internal access roadway will require modifications to your recommendations.

Proposed treatment was prepared utilizing your recommendations contained in the foundation investigation and design report dated December 1, 1988.

However, the recommendations and methodology of installation was reviewed during the project review meeting held at Central Region on February 4, 1988. Representatives of Regional Geotechnical and Construction provided input suggesting adjustment to the method of construction utilizing proven empirical procedures.

T0535/ltrs.14

Recommendations:

- subexcavation of existing fill material to elevation 192.0 should be excavated to a vertical face 0.3m outside of the culvert walls

- excavation for the wingwall should be to a vertical face 0.3m from the outside edge of the wingwall footing

- the excavation should be sloped 1 1/4:1 from above the top of concrete culvert or top of wingwall

- required dewatering during construction should be by utilizing OPSS specification 902.10.02 Unwatering Structure Foundations, instead of illustrating requirements on the contract drawings

- when backfilling excavated area to the bottom of concrete culvert or footing of wingwall, utilize crushed stone, Class 2 Aggregate instead of Granular A. Regional Construction have expressed their concern with compacting the fines in the gradation of Granular A where seepages of water is probably a likelihood, although the excavation is to be dewatered

- under the base of the wingwall footing provide a minimum of 150mm (6 inches) of granular

Necessary adjustments to the treatment will be incorporated into the final design, if you are in concurrence with those adjustments recommended by Regional Representatives.

Yours very truly,

R.E. WINTER & ASSOCIATES LTD.

Per: R. K. Kawaguchi
Project Manager

RKK:rs

c.c.: W.R. Lankinen

T0535/ltrs.14

memorandum

Ontario

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

Date: 1988 01 22

Atten: M.D. Bendayan

From: Foundation Design Section
Room 315, Central Building

RE: Culvert at Travel Information Centre
Hwy. 401, 2.0 km West of Mississauga Road
W.P. 20-87-01
District 6, Toronto

Further to your memorandum on 1988 01 14, this letter present our review for the above culvert.

Based on our review, it is concluded that the preliminary design drawing has generally complied with our recommendations. However, it should be noted that all fill material be removed to its full depth within the foundation area to approximate Elev. 192.0 m as discussed in our report. We have no further comments.

If you have any questions, please contact us.

Taechul Kim

T.C. Kim, P. Eng.
Project Foundation Engineer

for

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

TCK/mmj

c.c. - K. Bassi
B. Steeves
W. Lankinen

memorandum

Ontario

Tel: 3731

To: G.C.E. Burkhardt
Head, Structural Section
5000 Yonge Street

Date: 1987 12 01

Atten: M.D. Bendayan

From: Foundation Design Section
Room 315, Central Building

RE: Revised Location of
High Mast Lighting #3
at Travel Information Centre
W.P. 20-87-01
District 6, Toronto

Further to the telephone conversation between your M.D. Bendayan and our T.C. Kim, on 1987 11 30, this memorandum presents our review for the revised H.M.L. #3 location.

It is understood that the H.M.L. #3 will be moved to a new location since the raised island location will be re-located as discussed in a memorandum by R.E. Winter & Associates dated 1987 11 20.

Our T.C. Kim inspected the new location of H.M.L. #3 in the field and concluded that the existing terrain slopes upwards to the west. In view of this, we are satisfied that there will be no detrimental impact by relocating the H.M.L. #3 to a new location by 3.44 m south westerly from the borehole location.

Original H.M.L. #3 Location:

Sta. 11 + 558.0 Highway 401
54.60 m Rt. of Hwy. 401 R.O.W.
and 27.3 m west of R.O.W. monument 170

Actual Borehole Location (B.H. #16):

Sta. 11 + 560 Highway 401
55.60 m Rt. of Hwy. 401 R.O.W. and
25.3 m west of R.O.W. monument 170

New H.M.L. #3 Location:

Sta. 11 + 558.5 Highway 401
58.7 m Rt. of Hwy. 401 R.O.W. and
27.7 m west of R.O.W. monument 170

We believe that this memorandum meets with your present requirements. If you have any questions, please contact us.

Taechul Kim
T.C. Kim, P. Eng.
Project Foundations Engineer
for
M. Devata, P. Eng.
Chief Foundations Engineer
(East)

c.c. - W.R. Lankinen
M. O'Sullivan
R.K. Kawaguchi

T.C.Kim

Winter
Associates

Consulting Engineers, Architects, Planners & Landscape Architects

MEMORANDUM

To: File

From: R.K. Kawaguchi

Date: November 20, 1987

W.P. 20-87-01 HIGHWAY 401
TRAVEL INFORMATION CENTRE
HIGH MAST POLE
REWAL PROJECT 8109

Resulting from changes to the CV parking lot, the raised island where HML pole 3 is located will require adjustment.

Mr. T.C. Kim, Head Office Foundations inspected the new pole location in the field.

The existing terrain slopes gently to the east and Mr. Kim is satisfied that there will be no detrimental impact by relocating the HML pole to a new location by 3.44m south westerly from the borehole location.

Original HML pole location:

Sta. 11+558.0 Highway 401
54.60m RT. of Highway 401 R.O.W.
and 27.3m west of
R.O.W. monument 170

Actual borehole location
Sta. 11+560 Highway 401
55.60m RT. of Highway 401 R.O.W.
and 25.3m west of R.O.W.
monument 170

T0324/ltrs.8

R.E. Winter & Associates Limited
4255 Sherwoodtowne Boulevard, Mississauga, Ontario L4Z 1Y5 • Tel. (416) 270-0110 • Telex 06-986766 TOR

New Location

Sta. 11+558.5 Highway 401
58.7m RT. of existing
Highway 401 R.O.W. and
27.7m west of R.O.W.
monument 170

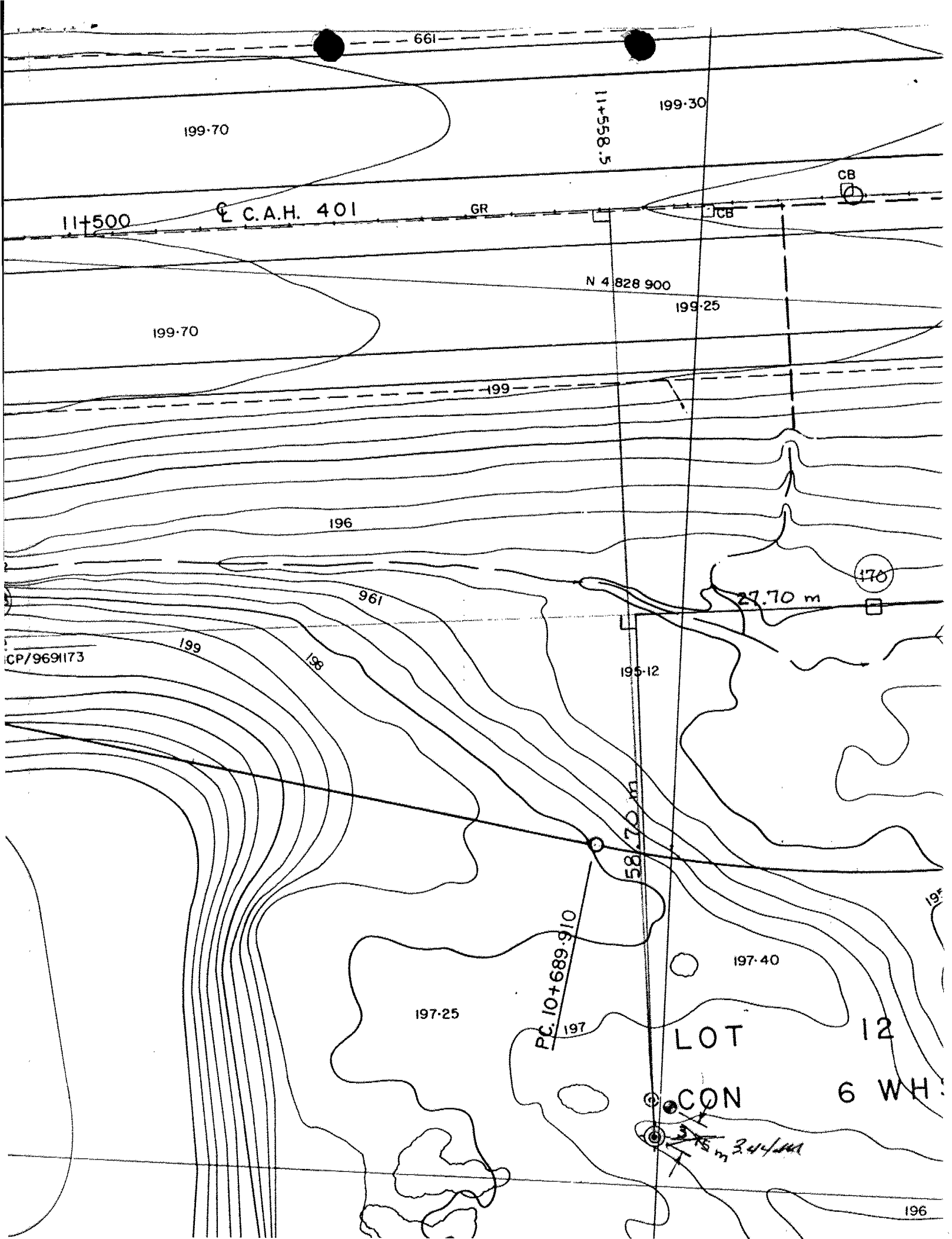
Approximate original ground elevation at new location is 196.8.

Mr. Kim will confirm in writing concurrence to relocate HML pole 3 to the new location.

RKK/rs

c.c.: T.C. Kim
W.R. Lankinen ✓
M. Bendayan
M. O'Sullivan ✓ - electrical (required)
R.I. Weir (written)
R.W.A. Jamieson (written)

T0324/ltrs.8


661
199·70
11+558.5
199·30
CB
11+500
℄ C.A.H. 401
GR
CB
N 4 828 900
199·25
199·70
199
196
961
199
198
CP/9691173
170
29.70 m
195·12
58.70 m
PC. 10+689.910
197·40
197·25
197
LOT 12
CON 6 WH
196

memorandum

Ontario

To: G.C.E. Burkhardt
Head, Structural Section
5000 Yonge Street
Central Region

Date: 1987 11 13

Atten: M.D. Bendayan

From: Foundation Design Section
Room 315, Central Building

RE: Foundation Recommendations
for the Pedestrian Bridge
and Concrete Culvert at
Travel Information Centre
W.P. 20-87-01
District 6, Toronto

We have completed the Field Investigation for the Pedestrian Bridge and concrete culvert at the crossing of the relocated channel and the internal access roadway for the proposed Travel Information Centre (Figure 1). The subsoil consists of fill material which consists of a mixture of silt, sand and gravel with random pockets or layers of silty clay, underlain by a compact to very dense gravelly sand to sandy gravel with some silt and trace of clay (sandy glacial till) as shown on Figure 2. A tree trunk of about 0.6 m in thickness was encountered within the fill material at Borehole 20. Groundwater was observed to be at approximate elevation of 192.0 m as shown on Borehole Logs attached.

Based on the site investigation, we present the following discussion and recommendations for the foundations of the Pedestrian Bridge and Concrete Culvert at the Travel Information Centre.

DISCUSSION AND RECOMMENDATIONS

As mentioned above, the soil stratigraphy at the site consists of a mixture of fill material, underlain by a sandy glacial till. The fill material contains various amounts of old concrete slabs, tree trunks and steel debris. The thickness of this fill varies from 1.4 m at Borehole 19 up to 3.7 m at Borehole 20. The glacial till is predominantly sand with various amounts of gravel and occasional cobbles. Occasional cohesive zones are encountered within this glacial till deposit. This deposit extends to a depth of about 10 m below ground level, underlain by Weathered Shale at an approximate elevation of 186.0 m.

The groundwater elevation is believed to be at an elevation of approximately 192.0 m at the location of the bridge, which is slightly higher than that of pond water of 191.2 m. The groundwater elevation at the proposed culvert location is approximately 192.5 m.

.....2

Our foundation recommendations for the design and construction of the Pedestrian Bridge and Concrete Culvert at the Travel Information Centre are as follows:

1. Foundations for Pedestrian Bridge

Spread Footings

It is recommended that the new pedestrain bridge structure be supported on spread footing type of foundations placed within the natural subsoil of compact to very dense granular natural soil or on well compacted Granular 'A' material. The founding elevations and the parameters for the footing design are as follows:

Location	Footing Elev. (m)	Factored U.L.S. (kPa)	S.L.S. Type II (kPa)
East and West Abutments	191.5 or below	700	300

The abutments can alternatively be perched within a well-compacted core of Granular 'A' provided that the existing fill material is removed. The details of this engineered fill are shown on Figure 3. If this scheme is adopted, loadings of 900 kPa at U.L.S. and 350 kPa S.L.S. Type II can be used in the design.

Resistance to sliding of the footings can be calculated assuming a coefficient of friction of 0.6 between the underside of the concrete footing and granular type material and that of 0.7 between the underside of the concrete footing and the Granular 'A' core.

Piles

Alternatively, the bridge structure can be supported on end bearing steel 'H' piles (310 HP 110) driven into the weathered shale using the following design values and tip elevations.

Location	Estimated Tip Elev. m	Factored U.L.S. (kPa)	S.L.S. Type II (kPa)
East and West Abutments	185.0	1600	980

2. Foundation for Concrete Culvert

Based on the site investigation the proposed concrete culvert may be constructed on a Granular 'A' pad and the following table provides details for the design of the concrete culvert.

.....3

Ref. BH	Approx. Base of Culvert Elev. m	Factored U.L.S. (kPa)	S.L.S. Type II (kPa)
21	193.3	600	250

All fill material should be removed to its full depth within the foundation area to approximate Elev. 192.0 m. The excavated area should be backfilled with well compacted Granular 'A' material to the base of the culvert as shown on Figure 4.

Earth Pressures

The Granular 'A' or 'B' backfill to the abutments of the bridge as well as the culvert should be in accordance with Special Provision No. 121 (dated October, 1983).

The following parameters are recommended for the granular backfill:

	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 (Ko)	0.43	0.5

Computation of earth pressure should be in accordance with Section 6.6.1.2 of the O.H.B.D.C.

Frost Protection

The footings should be placed so as to have a minimum earth cover of 1.2 m to allow for frost protection.

Construction

During excavation, care shall be exercised by not leaving any old fill material underneath the proposed footings. Dewatering for the footing excavations may be a problem, since excavations will be carried out below the water level in granular subsoil. One method of achieving this is carrying out excavations by means of oversize perimeter ditches and constantly pumping out water from the ditches.

.....4

For fill heights in the order of 4 metres, stability problems are not anticipated if slopes are constructed at 2H:1V.

Our complete foundation investigation and design report will be submitted after the laboratory and drafting work is completed.

We believe that this memorandum meets with your present requirements. If you have any questions, please contact us.

Taechul Kim

T.C. Kim, P. Eng.
Project Foundations Engineer

for

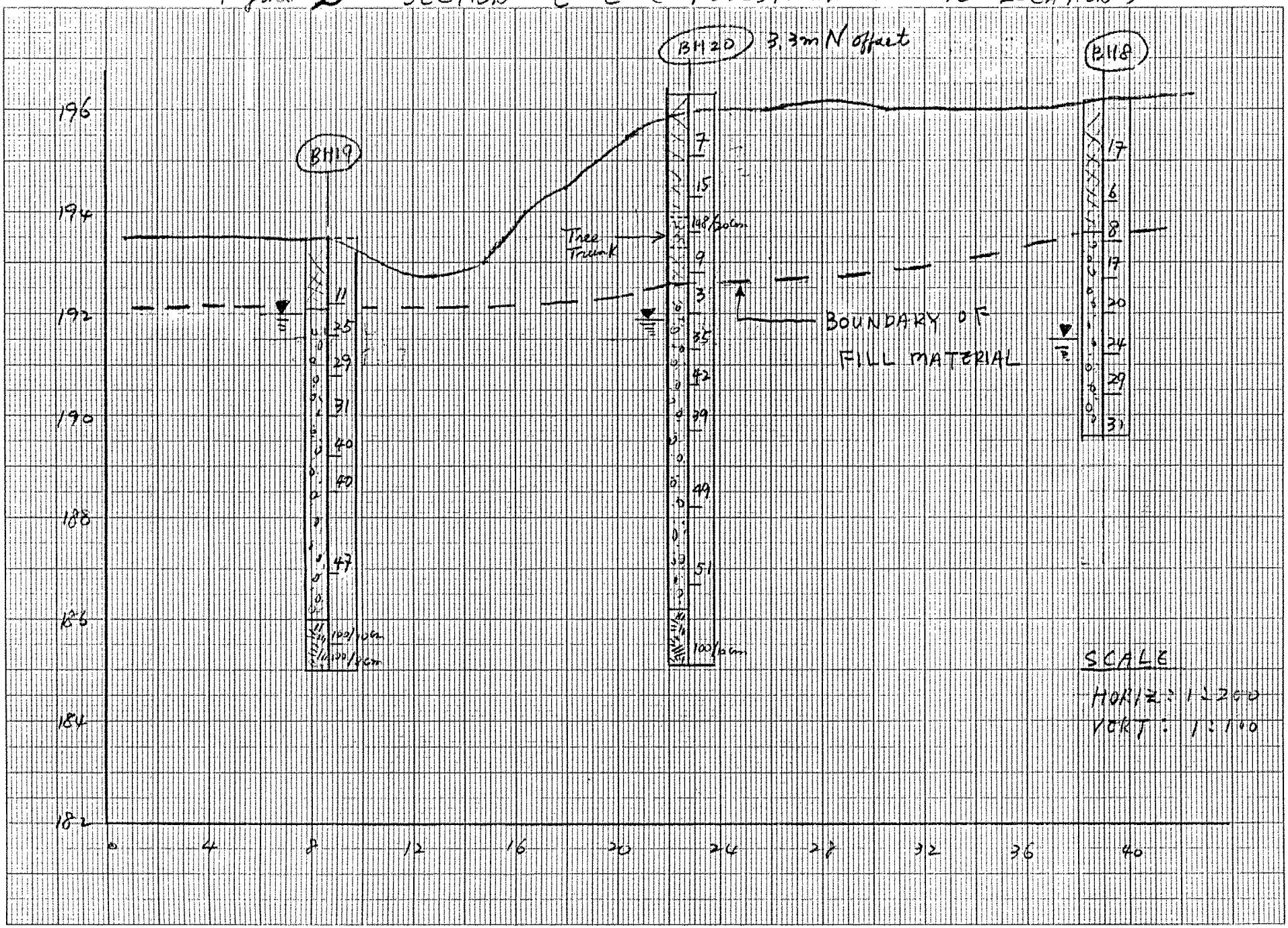
M. Devata, P. Eng.
Chief Foundations Engineer
(East)

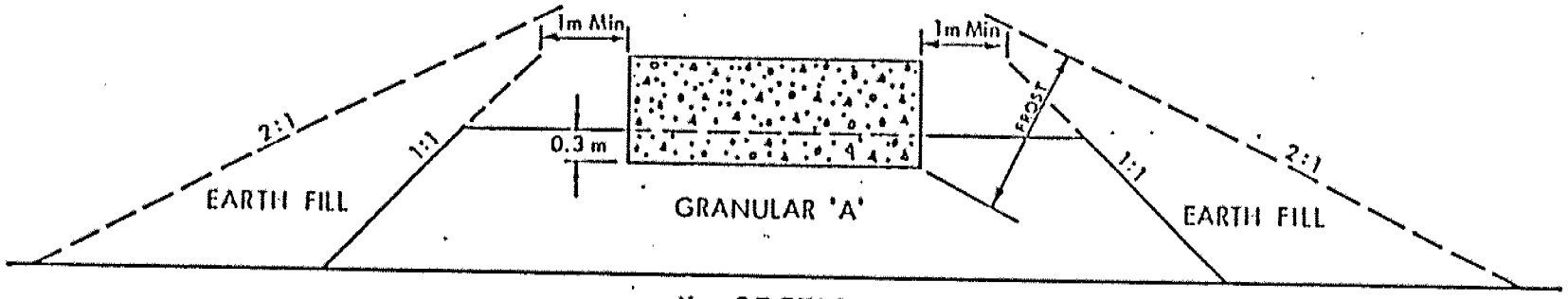
TCK/mmj

Encl.

c.c. - W. Lankinen
R.D. Gunter
J. Cullen
R. Kawaguchi

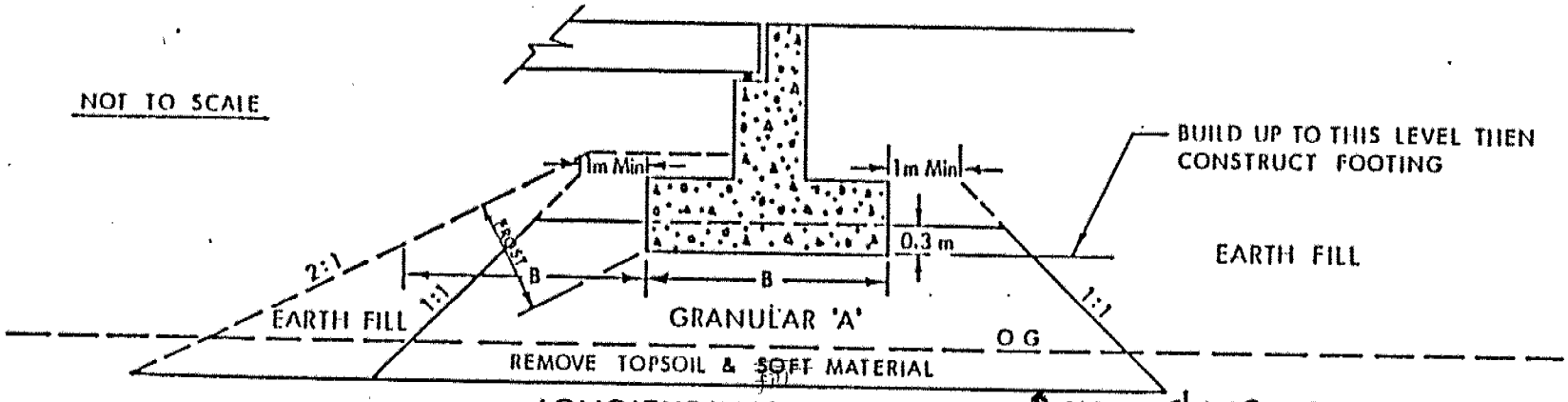
Figure 2 SECTION E-E (PEDESTRIAN BRIDGE LOCATION)





X SECTION

NOT TO SCALE



LONGITUDINAL SECTION ± approx. elev. 192.0m

NOTES:

1 - REMOVE TOPSOIL &/OR SOFT SUBSOIL UNDER AREA OF COMPACTED GRANULAR 'A' & EARTH FILL.

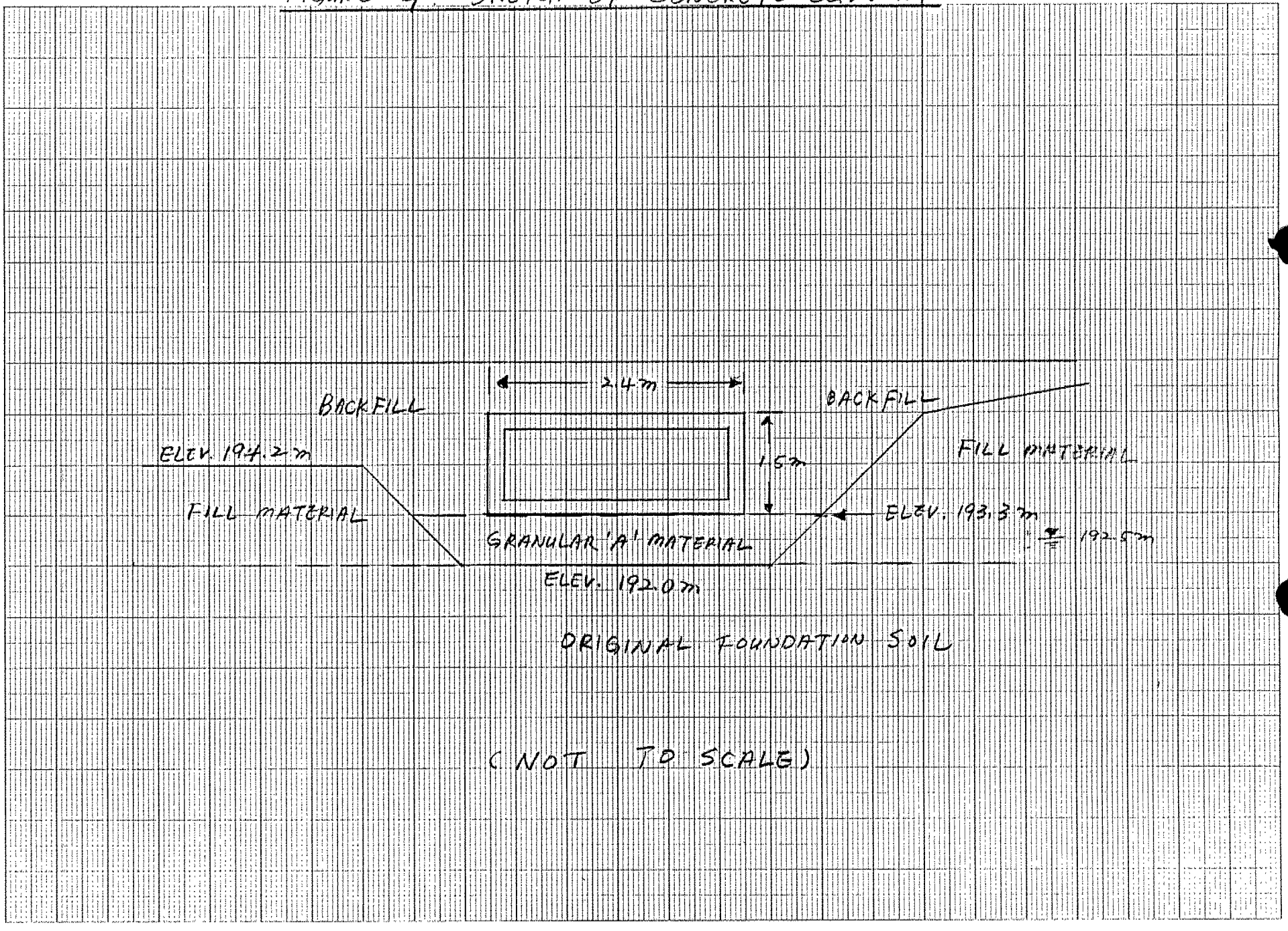
2 - PLACE GRANULAR 'A' & EARTH FILL TO BOTTOM OF FOOTING LEVEL, COMPACTED ACCORDING TO CURRENT M T C STANDARDS.

3 - CONSTRUCT CONCRETE FOOTING.

4 - PLACE REMAINDER OF GRANULAR 'A' & EARTH FILL AS REQUIRED.

Ministry of Transportation and Communications · Ontario	ABUTMENT ON COMPACTED FILL SHOWING GRANULAR 'A' CORE	FIG No 3 WP 20-87-01

FIGURE 4 SKETCH OF CONCRETE CULVERT



(NOT TO SCALE)

memorandum

Ontario

Tel: 3731

To: G.C.E. Burkhardt
Head, Structural Section
5000 Yonge Street
Central Region

Date: 1987 11 06

Atten: M.D. Bendayan

From: Foundation Design Section
Room 315, Central Building

RE: Foundation Recommendations
For High Mast Lighting
For Travel Information Centre
W.P. 20-87-01
District 6, Toronto

We have completed the Field Investigation for High Mast Lighting at the above site. The subsoil consists mainly of Gravelly Sand to Sandy Gravel with varying amounts of cobbles and boulders (Glacial Till) overlying up to 0.6 m thick silty clay topsoil layer. The full extent of the glacial till stratum was not investigated, but was found to extend to a maximum depth of 12.7 m below the ground surface. Occasional shaly zones and cohesive zones were encountered in the lower portions of glacial till stratum. Weathered shale was encountered in two locations, BH's 16 and 17, at approximate elevation of 185 m. Groundwater was observed in the boreholes at approximate elevations between 191.8m and 195.2 m as shown on Borehole logs attached.

Based on the site investigation, we present the following discussion and recommendations for the High Mast Lighting at the Travel Information Centre.

Discussion and Recommendations

A foundation investigation was carried out at the above-noted site in order to establish soil parameters for the design of the 5 HML foundations. The investigation consisted of advancing 1 borehole at each of the HML locations to a depth ranging between 9.4 and 12.7m below the ground level.

Table 1 indicates the proposed location of each of the 30 m high HML and the appropriate locations of the boreholes. As shown on Table 1, since the proposed HML location is situated on the middle of the slope and further permission to enter the private property could not be obtained within the limited time, actual borehole location for HML #2 (B.H. No. 15) moved towards Hwy. 401 about 6.5 m from the proposed HML location.

.....2

Design Consideration

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

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

and

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

The soil parameters provided in Table 2 are recommended for the design of the HML foundations. The following notation has been adopted:

ϕ = apparent angle of friction for cohesionless soils

qu = unconfined compressive strength in kPa (qu = 2 x Cu) for cohesive soils

γ = bulk unit weight in kN/m^3

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

Construction Considerations

The investigation revealed that the subsurface conditions across the site are generally uniform and consist of gravelly sand to sandy gravel with varying amounts of cobbles and boulders (Glacial Till). At BH #18 boulders up to 0.5 m in size were encountered where HML #5 location as shown on borehole log.

Caissons will be located below the prevailing groundwater in granular subsoil. In view of this, the following special provision should be included in the contract.

> " The contractor shall install concrete footings in earth for high mast poles. At the various pole locations, soil deposits consist of mixtures of silts, sands and gravels with occasional cobbles and boulders. Groundwater is likely to be encountered from two to six metres below the existing ground surface. The soil is highly susceptible to conditions of unbalanced hydrostatic head and seepage forces and is likely to 'boil' and become unstable under such conditions. The contractor shall maintain the stability of the soil in the sides and bases of the holes for the concrete footings at all times from commencement of their construction to the placing of concrete."

.....3

Our complete foundation investigation and design report will be submitted after the laboratory and drafting work is completed.

We believe that this memorandum meets with your present requirements. If you have any questions, please contact us.

Taechul Kim

T.C. Kim, P. Eng.
Project Foundations Engineer

for

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

TCK/mmj

Encl.

c.c. - W. Lankinen
R.D. Gunter
J. Cullen
R. Kawaguchi

TABLE 1 - HML and Borehole Locations

Proposed HML Locations			Actual Borehole Locations		
HML #	STATION NO.	O/S Fr. Property Line	BH No.	STATION NO.	O/S Fr. Property Line
1	11 + 203.0	11.1 m Lt.	14	11 + 202.9	11.1 m Lt.
2	11 + 351.5	3.7 m Lt.	15	11 + 352.0	10.2 m Lt.
3	11 + 558.0	54.6 m Rt.	16	11 + 560.0	55.6 m Rt.
4	11 + 808.5	6.1 m Lt.	17	11 + 808.4	6.1 m Lt.
5	11 + 959.0	11.6 m Lt.	18	11 + 595.0	11.6 m Lt.

TABLE 2 - Soil Parameters

Pole	Elev. (m) From - To	Type of Soil	Denseness or Consistency	ϕ	qu kPa	γ kN/m^3
1 (BH 14)	199.4 - 198.8	Cohesive (Top Soil)	-	-	-	19.3
	198.8 - 197.3	Non-Cohesive	Compact	31	-	20.1
	197.3 - 196.5	Non-Cohesive	Dense	35	-	20.7
	196.5 - 195.0	Non-Cohesive	Very Dense	43	-	21.2
	195.0 - 191.9	Non-Cohesive	Dense	35	-	21.0
	191.9 - 186.7	Non-Cohesive	Very Dense	43	-	21.2
2 (BH 15)	198.2 - 197.6	Cohesive (Top Soil)	-	-	-	19.3
	197.6 - 195.3	Non-Cohesive	Loose	26	-	19.3
	195.3 - 192.6	Non-Cohesive	Dense	36	-	21.0
	192.6 - 191.0	Non-Cohesive	Very Dense	43	-	21.2
	191.0 - 188.0	Non-Cohesive	Dense	34	-	20.7
	188.0 - 185.5	Non-Cohesive	Very Dense	39	-	21.2
3 (BH 16)	196.6 - 196.0	Cohesive (Top Soil)	-	-	-	19.3
	196.0 - 193.7	Non-Cohesive	Loose	27	-	19.3
	193.7 - 188.3	Non-Cohesive	Dense	34	-	20.4
	188.3 - 185.6	Non-Cohesive	Very Dense	39	-	21.2
	185.6 - 184.3	Weathered Shale	Very Hard	43	-	21.2
4 (BH 17)	194.5 - 193.9	Cohesive (Top Soil)	-	-	-	19.3
	193.9 - 192.3	Non-Cohesive	Dense	35	-	20.7
	192.3 - 190.1	Non-Cohesive	Compact	32	-	20.1
	190.1 - 188.6	Non-Cohesive	Dense	37	-	21.2
	188.6 - 186.3	Non-Cohesive	Very Dense	39	-	21.2
	186.3 - 185.4	Non-Cohesive	Dense	34	-	20.7
	185.4 - 184.4	Weathered Shale	Very Hard	43	-	21.2
5 (BH 18)	194.7 - 194.2	Cohesive (Top Soil)	-	-	-	19.3
	194.2 - 185.3	Non-Cohesive	Very Dense	43	-	21.2

memorandum

File

Ontario

To: A. Wittenberg
Head, Planning and
Design Section
5000 Yonge Street

Date: 1987 10 30

Atten: W.K. Lankinen

From: Foundation Design Section
Room 315, Central Building

RE: Foundation Recommendations
For Travel Information Centre
W.P. 20-87-01
District 6, Toronto

We have completed the Field Investigation for the above site. The subsoil consists of fill material which consists of a mixture of silt, sand and gravel with random pockets or layers of silty clay, underlain by a compact to very dense gravelly sand to sandy gravel with some silt and trace of clay stratum. Groundwater was observed in the boreholes at approximate elevation of 191.5 m as shown on Borehole logs attached.

Based on the site investigation, we present the following discussion and recommendations for the foundations of the Travel Information Centre.

Discussion and Recommendations

As mentioned above, the soil stratigraphy at the site consists of a mixture of fill material, underlain by a sandy glacial till. The fill material contains various amounts of old concrete slabs, tree trunks and steel debris. The thickness of this fill varies from 1 metre easterly up to 4 metres westerly towards the creek. The glacial till is predominantly sand with various amounts of gravel and occasional cobbles. Seams of silty fine sand, shaly zones and occasional cohesive zones are encountered within this glacial till deposit. This deposit extends to a depth of at least 10.2 m below ground level, underlain by weathered shale.

The natural groundwater elevation is believed to be at an elevation of approximately 191.5 metres in most boreholes, which is slightly higher than that of pond water of 191.2 m.

The following are our foundation recommendations for the design and construction of the Travel Information Centre building and the related patio roof columns.

.....2

Foundation for Building

It is recommended that the new building structure be supported on spread footing type of foundations placed on well compacted granular 'A' material or within natural subsoil of compact to very dense natural foundation soil. It is necessary that all the fill material should be removed at the building location prior to the construction of new foundations.

The bearing capacity requirements for these foundation soils using working stress method are as follows:

Allowable bearing pressure up to 250 kPa may be used for building foundations at or below elev. 193.5 m on the granular subsoil provided the sub-excavation of the existing loose fill being removed and replaced with well compacted Granular 'A' at certain locations. The pertinent details including the limits of sub-excavation are shown on the enclosed Figure 1. The above bearing capacity was based on the assumption that the footing width of the wall be 0.61 m (2 ft.) and the differential settlement will not exceed 25 mm.

For sliding resistance between the footing and granular subsoil, a value of 0.6 may be used. The footing should have a minimum of earth cover of 1.2 m to the underside of the footing to provide adequate frost protection.

In the event that the structure is designed as per O.H.B.D.C., the following parameters shall be used for the footing design:

	Factored Capacity at U.L.S. (kPa)	Allowable Capacity at S.L.S. Type II (kPa)
Spread Footings	600	250

Resistance to sliding of the footings can be calculated assuming a coefficient of friction of 0.6 between the underside of the concrete footing and the granular type material.

In designing the basement walls, the following parameters should be used in computing the lateral earth pressures for the granular type of backfill:

Granular Type of Material

Angle of Internal Friction	30°
Unit Weight (KN/m^3)	19.0
Coefficient of Earth Pressure at Rest	0.5

.....3

Foundation for Patio Columns

Columns for the patio outside of the building can be also designed on square or rectangular units using the above-mentioned design bearing capacities with appropriate dimensions to satisfy the design loads.

Sub-Excavation Details

As discussed above, all mixed fill material should be sub-excavated and replaced with well compacted granular 'A' material. The details are as shown on Section A-A, and the fill material near Boreholes 10 and 11 should be excavated down to elevation of 191.5 m. The excavation boundary should be back sloping towards Borehole 12, and then extending to the basement floor elevation of 194.5 m near Boreholes 6 and 13 as shown on the figure.

In the shallow excavation areas near Boreholes 6 and 13, the footings for the wall may be placed on the natural subsoil (granular material) after the trench for the footing is excavated to elevation 193.5m as shown on the attached sketch.

It should be emphasized that all fill material be excavated within the base width of the foundations prior to the construction of the wall footings.

Construction

During excavation, care shall be exercised by not leaving any old fill material underneath the proposed footings. Dewatering during the excavation should not be a major problem, however, any minor seepage or surface run-off into the excavations for foundations could be readily handled by pumping sumps.

Immediately after the excavation in deep excavation area, backfill to the base of the proposed footing elevation of 193.5, with Granular 'A' is required for the building foundations.

Our complete foundation investigation and design report will be submitted after the laboratory and drafting work is completed.

We believe that this memorandum meets with you present requirements. If you have any questions, please contact us.

T.C. Kim, P. Eng.
Project Foundations Engineer

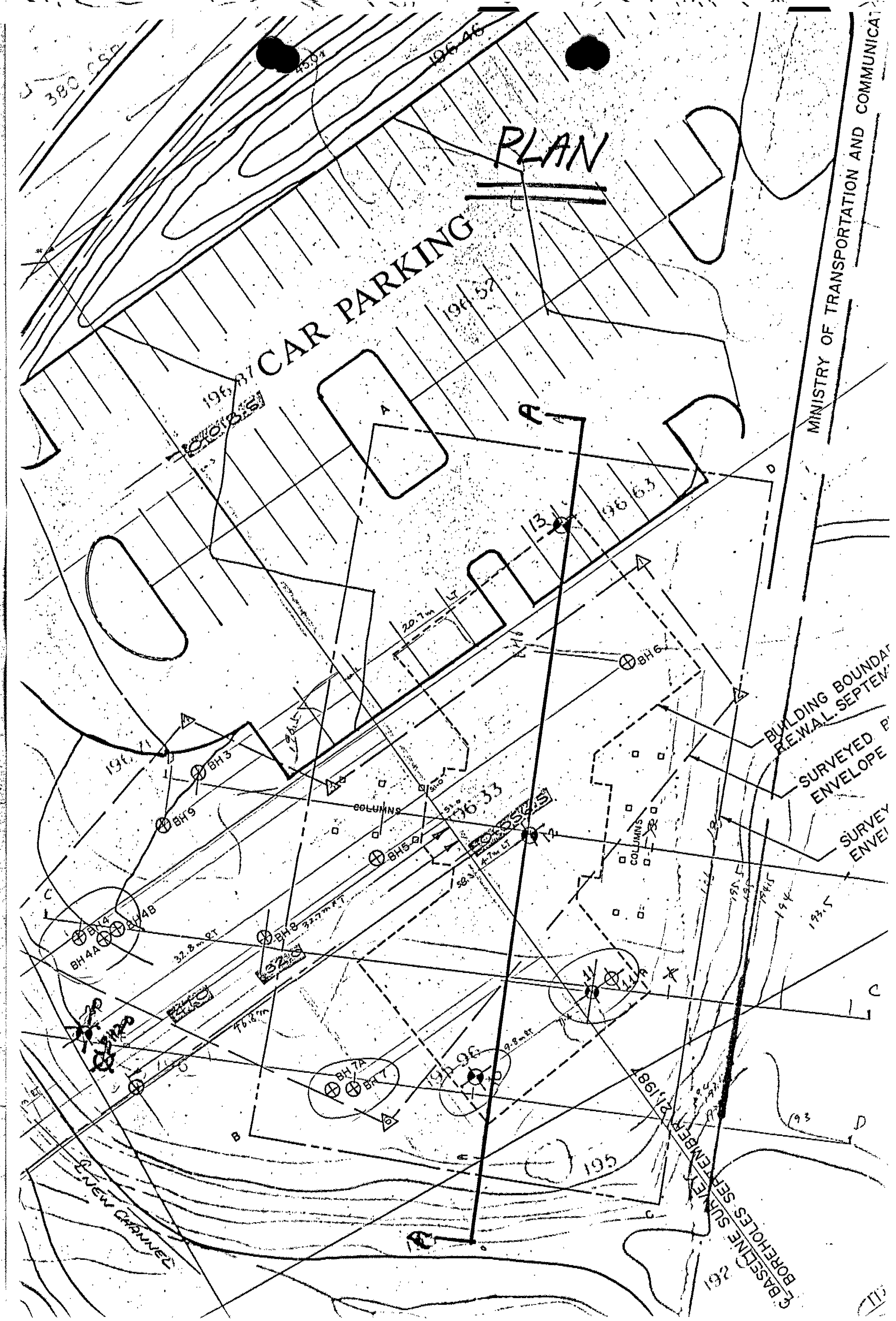
for

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

TCK/MD/mmj

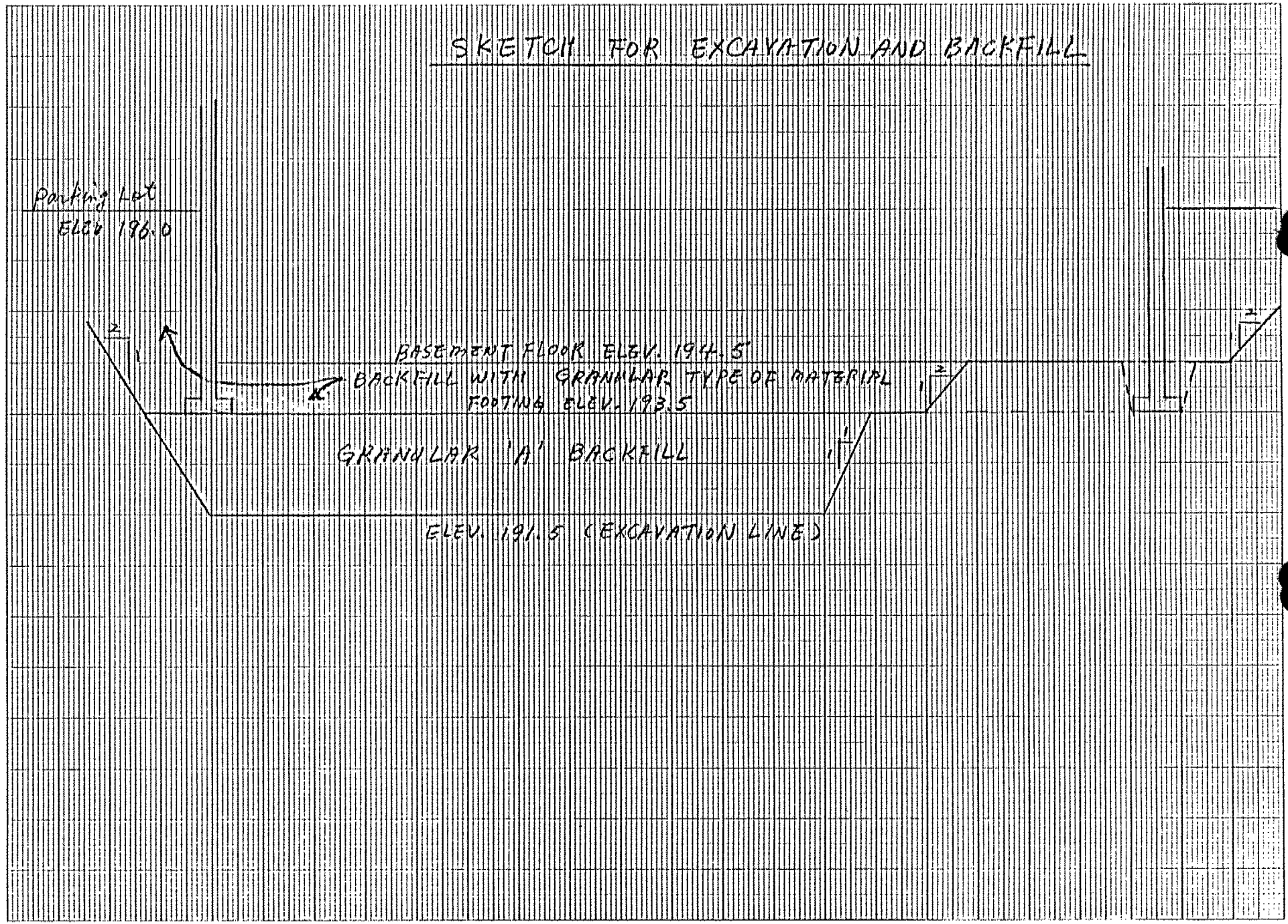
c.c. - G.C.E. Burkhardt
R.D. Gunter
J. Cullen
R. Kawaguchi

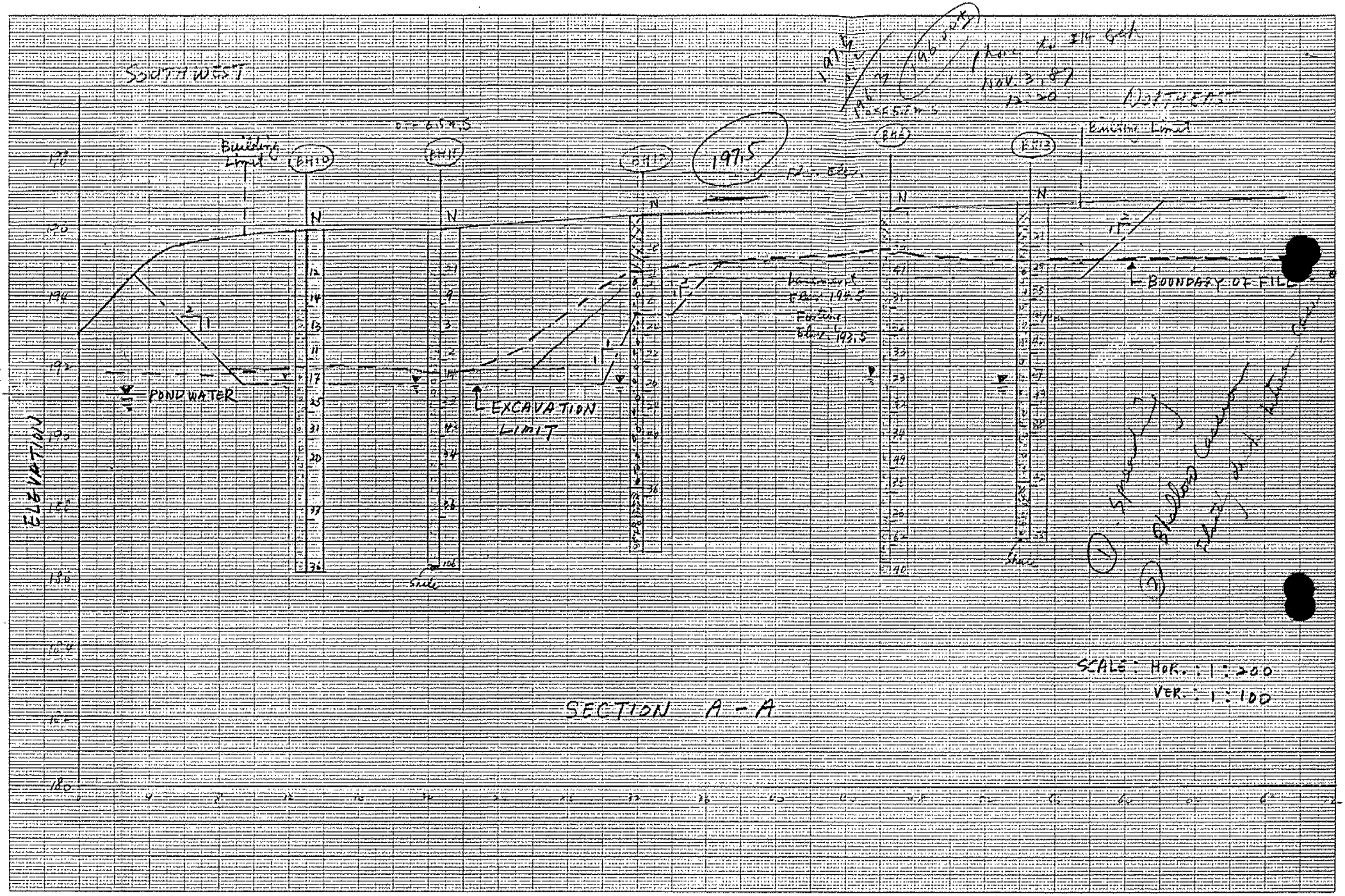
Attach.



PLAN
CAR PARKING
MINISTRY OF TRANSPORTATION AND COMMUNICA
BUILDING BOUNDA
R.E.W.A.L. SEPTEM
SURVEYED
ENVELOPE
COLUMNS
BH3
BH9
BH4
BH4A
BH4B
BH5
BH6
BH7
BH7A
BH8
20.7m LT
32.8m RT
195
NEW CHANNEL
BASELINE SURVEY SEPTEMBER
BOREHOLES SEPTEMBER

SKETCH FOR EXCAVATION AND BACKFILL





memorandum

Ontario

To: File Date: 1987 08 12

From: D. Dundas

RE: Roadside Rest/Picnic/Information Centre
W.P. 20-87-01, Site N/A
Hwy. 401, District 6, Toronto

On 1987 07 29, Mary Lou Pauly of this Section attended a meeting at which R.E. Winter Associates Ltd. (REWAL) identified a need for a hydrogeological study for the above-noted project. Ms. Pauly advised that if the Foundation Design Section was to be requested to carry out the study, the request, with a well-defined problem statement, should be submitted through the Central Region Planning and Design Section.

On 1987 08 05, I returned a call to Ron Kawaguchi of REWAL. During our conversation Mr. Kawaguchi advised me that a hdrogeological study for the above-noted project was required as an extremely high priority, and that he had arranged for a hydrogeological study proposal to be presented at a meeting scheduled for 1987 08 06. I advised Mr. Kawaguchi that we would consult Central Region Planning and Design for direction.

At this time both Bill Lankinen and Len Dutchak of P & D were away. However, I had a discussion with Margot Sheppard who invited us to the meeting on behalf of P & D.

At the meeting Mr. Kawaguchi stated that Mr. Dutchak had authorized him to proceed with obtaining a proposal for a hydrogeological study, a copy of which was provided to me.

After the meeting we immediately attempted to contact P & D, which subsequently led to my telephone conversation of 1987 08 10 with Bill Lankinen in which Murty Devata of this office participated. During the conversation we advised Mr. Lankinen that geotechnical investigations of this nature are normally carried out through this office. We also agreed that any further requests for our involvement in this project would be from the P & D Section, as we are not aware of REWAL's authority to request our services.

However, on 1987 08 11 we were invited to another meeting by Mr. Kawaguchi. When I contacted Mr. Lankinen for clarification he advised me that REWAL was acting as project manager for this project and was calling on his behalf. He also advised that the purpose of the meeting was to discuss a proposal for a hydrogeological study prepared by REWAL's geotechnical consultant.

I responded that we could not contribute to a meeting involving a review of the REWAL geotechnical consultant's proposal for a hydrogeological study.

.....2

In order to avoid further inconsistencies, I again clarified our position as follows.

- A hydrogeological study is a geotechnical investigation. Normal MTC policy is to arrange such studies through this office. The study would either be conducted in house or assigned to a geotechnical consultant under our technical supervision. In this way we can ensure both the technical integrity and cost effectiveness of the study.

- If we can be of assistance with any aspect of this project related to geotechnical engineering, P & D should contact this office.

D.H. Dundas

D.H. Dundas, P. Eng.
Sr. Foundations Engineer

DHD/pb

c.c.: M. Devata
D.R. Brohm

MINISTRY OF TRANSPORTATION AND COMMUNICATIONS ONTARIO

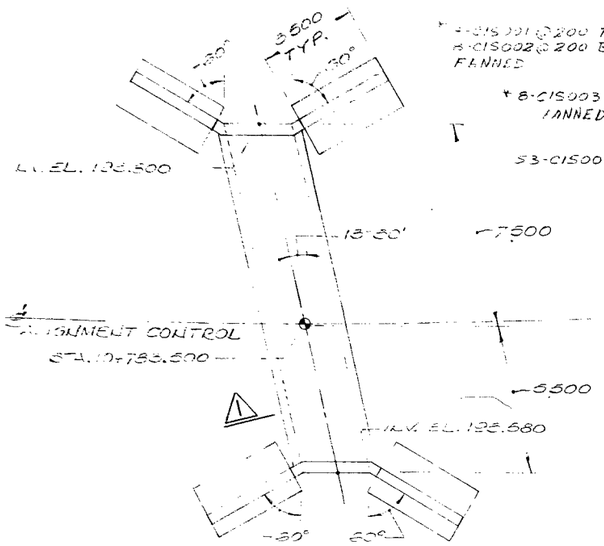
METRIC

DIMENSIONS ARE IN MILLIMETRES UNLESS OTHERWISE SHOWN.
ELEVATIONS, COORDINATES, CURVE AND ALIGNMENT DATA ARE IN METRES.
STATIONS ARE IN KILOMETRES + METRES.

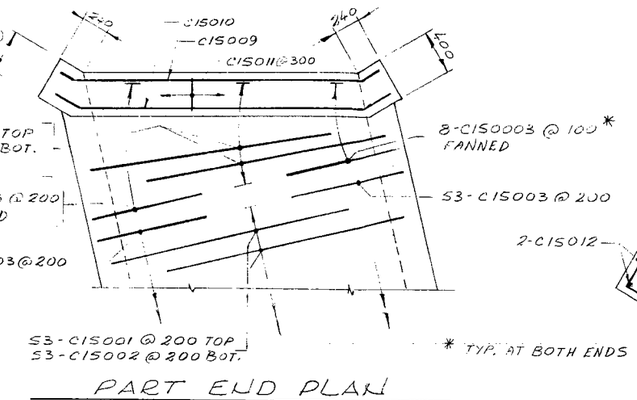
CONT No
WP No 21-87-01

CULVERT AT HWY. 401
TRAVEL INFORMATION CENTRE
STATION 10+783.500

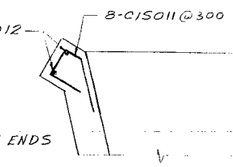
SHEET

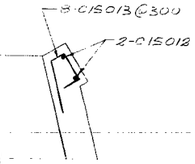


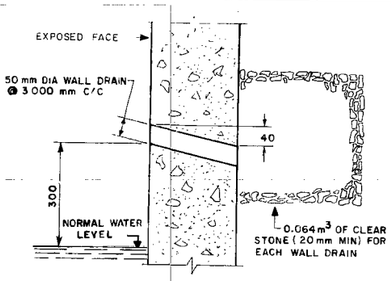
PLAN

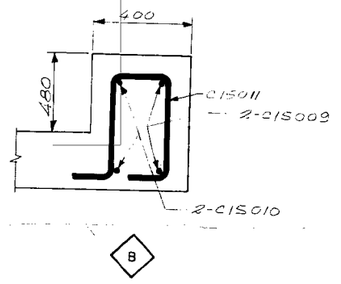


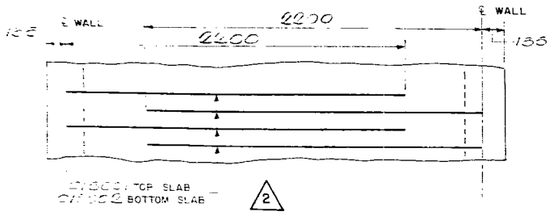
PART END PLAN

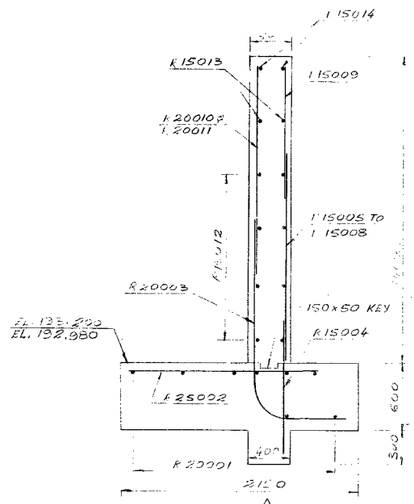


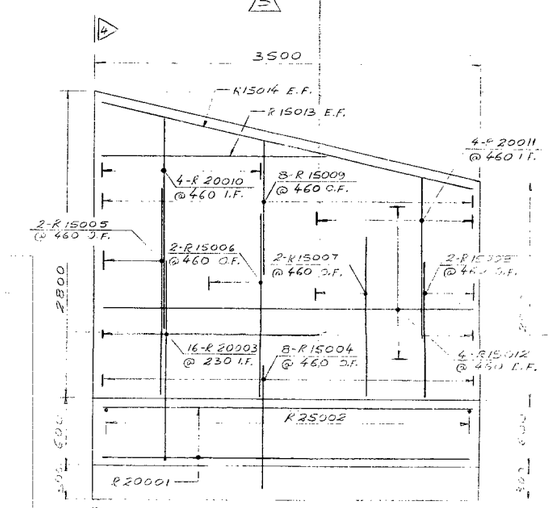




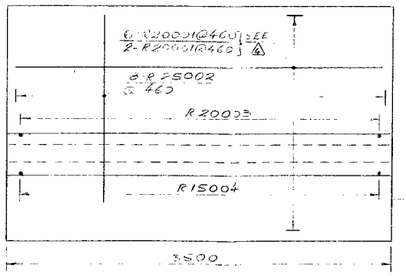








4 ELEVATION OF RET. WALL

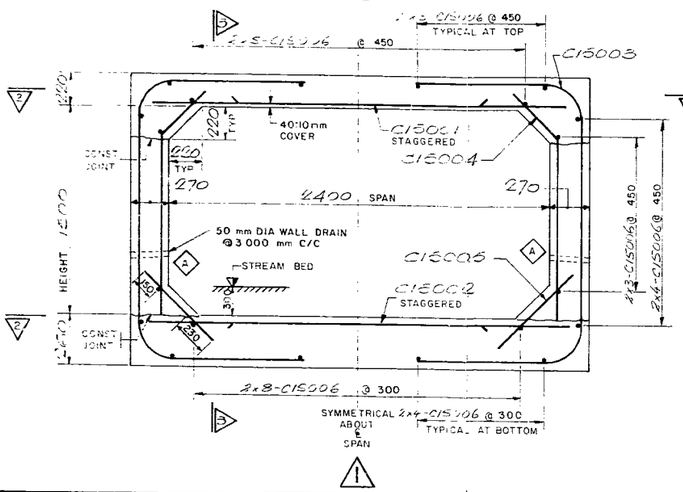


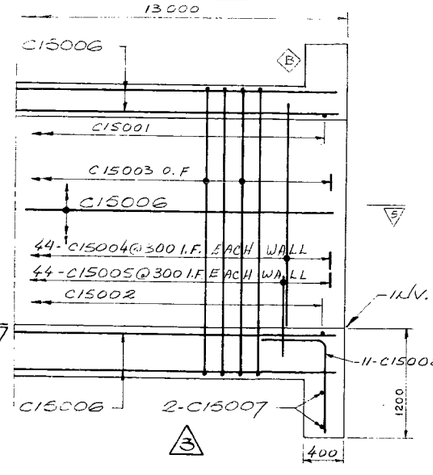
PLAN VIEW OF RET. WALL FOOTING

GENERAL NOTES

- CLASS OF CONCRETE 20 MPa
- CLEAR COVER TO REINFORCING STEEL 70±20mm EXCEPT AS NOTED
- ALL EXPOSED CORNERS TO BE CHAMFERED 20 mm
- NO CONCRETE SHALL BE PLACED IN BOTTOM SLABS, UNTIL THE DEPTH OF THE EXCAVATION AND CHARACTER OF THE FOUNDATION MATERIAL HAVE BEEN APPROVED BY THE ENGINEER
- FILL SHALL BE PLACED AT BOTH SIDES OF CULVERT SIMULTANEOUSLY
- CULVERTS AND RETAINING WALLS (WHERE APPLICABLE) SHALL BE BUILT IN ACCORDANCE WITH O.P.S.S. 904.
- REINFORCING STEEL SHALL BE HARD GRADE
- STEEL FOR EACH CULVERT (INCLUDING RETAINING WALLS WHERE APPLICABLE) SHALL BE BUNDLED SEPARATELY AND MARKED WITH STATION NUMBER
- WALL DRAIN OPENINGS TO BE FORMED USING NON-METALLIC MATERIAL VERTICAL LOCATION OF WALL DRAINS SHALL BE DETERMINED IN FIELD BY THE ENGINEER
- I F DENOTES INSIDE FACE
- O F DENOTES OUTSIDE FACE
- E F DENOTES EACH FACE

QUANTITIES			
ITEM	WALLS & SLABS	RETAINING WALL	TOTAL
MASS OF REINF STL tonnes			
VOL OF CONCRETE cubic metres			





STD RIGID FRAME BOX CULVERT AT STATION 10+783.500

SPAN 2400 HEIGHT 1500 LENGTH 13000 FILL HEIGHT ____

REG. MUN. OF PEEL	
CITY OF MISSISSAUGA	
LOT 12	CON. 6 W.H.S.
HWY 401	DIST. 6

STANDARD DRAWING MARCH 1982	SS 114-5

DRAWING NOT TO BE SCALED
100 mm ON ORIGINAL DRAWING

REVISIONS		
DATE	BY	DESCRIPTION

DESIGN	CHECK B.S.	LOADING	DATE 88-01
DRAWING B.S./R.B.	CHECK B.S.	SITE No 24-43/C	DWG 1