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W. O. No.

STR. SITE No. 37-700

HWY. No. 404

LOCATION C.N.R. Overhead @ Hwy 404

No of PAGES - —

OVERSIZE DRAWINGS TO BE INCLUDED WITH THIS REPORT.

REMARKS:

FOUNDATION INVESTIGATION REPORT

CONTRACT NO 82-74

Ontario
Ministry of
Transportation and
Communications

INDEX

NOTE: For purposes of the contract these reports supersede all other foundation reports prepared by or for the Ministry in connection with the above-mentioned projects.

EXPLANATION OF TERMS USED IN REPORT

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

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

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

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

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

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

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

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

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

MODIFIED RECOVERY: SUM OF THOSE NATURALLY FRACTURED CORE PIECES, 4"+ IN LENGTH EXPRESSED AS A PERCENT OF THE LENGTH OF THE CORING RUN. THE ROCK QUALITY DESIGNATION (RQD), FOR MODIFIED RECOVERY, IS:

RQD (%)	0 - 25	25 - 50	50 - 75	75 - 90	90 - 100
	VERY POOR	*POOR*	*FAIR*	*GOOD*	*EXCELLENT*

JOINTING AND BEDDING:

SPACING	2"	2" - 12"	1' - 3'	3' - 10'	> 10'
JOINTING	*VERY CLOSE*	*CLOSE*	*MOD. CLOSE*	*WIDE*	*VERY WIDE*
BEDDING	*VERY THIN*	*THIN*	*MEDIUM*	*THICK*	*VERY THICK*

ABBREVIATIONS & SYMBOLS

LABORATORY TESTING

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

FIELD SAMPLING

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

EARTH PRESSURE TERMS

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

INDEX PROPERTIES

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

STRENGTH PARAMETERS

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

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

HYDRAULIC TERMS

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

EXTENDED CASAGRANDE SOIL CLASSIFICATION SYSTEM

FIELD IDENTIFICATION PROCEDURES

(EXCLUDING PARTICLES LARGER THAN 75 mm AND BASING FRACTIONS ON ESTIMATED MASS)

					GRP SYMB	TYPICAL NAMES
COARSE GRAINED SOILS — MORE THAN HALF OF MATERIAL IS LARGER THAN 75 μm	GRAVELS — MORE THAN HALF OF COARSE FRACTION IS LARGER THAN 4.75 mm	CLEAN GRAVELS (LITTLE OR NO FINES)	WIDE RANGE IN GRAIN SIZE & SUBSTANTIAL AMOUNTS OF ALL INTERMEDIATE PARTICLE SIZE		GW	WELL GRADED GRAVELS, GRAVEL-SAND MIXTURES; LITTLE OR NO FINES
			PREDOMINANTLY ONE SIZE OF A RANGE OF SIZES WITH SOME INTERMEDIATE SIZES MISSING		GP	POORLY GRADED GRAVELS, GRAVEL-SAND MIXTURES, LITTLE OR NO FINES
		GRAVEL WITH FINES (APPRECIABLE AMOUNT OF FINES)	NON-PLASTIC FINES (FOR IDENTIFICATION PROCEDURES SEE ML BELOW)		GM	SILTY GRAVELS, POORLY GRADED GRAVEL-SAND-SILT MIXTURES
			PLASTIC FINES (FOR IDENTIFICATION PROCEDURES SEE CL BELOW)		GC	CLAYEY GRAVELS, POORLY GRADED GRAVEL-SAND-CLAY MIXTURES
	SANDS — MORE THAN HALF OF COARSE FRACTION IS SMALLER THAN 4.75 mm	CLEAN SANDS (LITTLE OR NO FINES)	WIDE RANGE IN GRAIN SIZES & SUBSTANTIAL AMOUNTS OF ALL INTERMEDIATE PARTICLE SIZES		SW	WELL GRADED SANDS, GRAVELLY SANDS; LITTLE OR NO FINES
			PREDOMINANTLY ONE SIZE OR A RANGE OF SIZES WITH SOME INTERMEDIATE SIZES MISSING		SP	POORLY GRADED SANDS, GRAVELLY SANDS; LITTLE OR NO FINES
		SANDS WITH FINES (APPRECIABLE AMOUNT OF FINES)	NON-PLASTIC FINES (FOR IDENTIFICATION PROCEDURES SEE ML BELOW)		SM	SILTY SANDS, POORLY GRADED SAND-SILT MIXTURES
			PLASTIC FINES (FOR IDENTIFICATION PROCEDURES SEE CL BELOW)		SC	CLAYEY SANDS, POORLY GRADED SAND-CLAY MIXTURES
FINE GRAINED SOILS — MORE THAN HALF OF MATERIAL IS SMALLER THAN 75 μm (I.E. 75 μm IS ABOUT THE SMALLEST PARTICLE VISIBLE TO THE NAKED EYE)	IDENTIFICATION PROCEDURES ON FRACTION SMALLER THAN 425 μm		DRY STRENGTH (CRUSHING CHARACTERISTICS)	DILATANCY (REACTION TO SHAKING)	TOUGHNESS (CONSISTENCY NEAR PLASTIC LIMIT)		
	SILTS AND CLAYS	LIQUID LIMIT LESS THAN 35%	NONE	QUICK	NONE	ML	INORGANIC SILTS & SANDY SILTS OF SLIGHT PLASTICITY, ROCK FLOUR
			MEDIUM TO HIGH	NONE TO VERY SLOW	MEDIUM	CL	CLAYEY SILTS (INORGANIC), GRAVELLY CLAYS, SANDY CLAYS, LEAN CLAYS
			SLIGHT TO MEDIUM	SLOW	SLIGHT	OL	ORGANIC SILT OF LOW PLASTICITY, ORGANIC SANDY SILTS
		LIQUID LIMIT BETWEEN 35% AND 50%	NONE TO SLIGHT	SLOW TO QUICK	SLIGHT	MI	INORGANIC COMPRESSIBLE FINE SANDY SILT WITH CLAY OF MEDIUM PLASTICITY, CLAYEY SILTS
			HIGH	NONE	MEDIUM TO HIGH	CI	SILTY CLAYS (INORGANIC) OF MEDIUM PLASTICITY
			SLIGHT TO MEDIUM	VERY SLOW	SLIGHT	OI	ORGANIC SILTY CLAYS OF MEDIUM PLASTICITY
		LIQUID LIMIT GREATER THAN 50%	SLIGHT TO MEDIUM	SLOW TO NONE	MEDIUM	MH	INORGANIC SILTS, HIGHLY COMPRESSIBLE MICACEOUS OR DIATOMACEOUS FINE SANDY SILTS, ELASTIC SILTS
			HIGH TO VERY HIGH	NONE	HIGH	CH	CLAYS (INORGANIC) OF HIGH PLASTICITY, FAT CLAYS
			MEDIUM TO HIGH	NONE TO VERY SLOW	SLIGHT TO MEDIUM	OH	ORGANIC CLAYS OF HIGH PLASTICITY
HIGHLY ORGANIC SOILS			READILY IDENTIFIED BY COLOUR, ODOUR, SPONGY FEEL & FREQUENTLY BY FIBROUS TEXTURE			PT	PEAT & OTHER HIGHLY ORGANIC SOILS

INFORMATION REQUIRED FOR DESCRIBING SOILS

GIVE TYPE, NAME, IF NECESSARY; INDICATE APPROX. % OF SAND & GRAVEL; MAX. SIZE; ANGULARITY, SURFACE CONDITION, & HARDNESS OF THE COARSE GRAINS; LOCAL OR GEOLOGIC NAME & OTHER PERTINENT DESCRIPTIVE INFORMATION, & SYMBOL IN PARENTHESIS.

FOR UNDISTURBED SOILS ADD INFORMATION ON STRATIFICATION, DEGREE OF COMPACTNESS, CEMENTATION, MOISTURE CONDITIONS & DRAINAGE CHARACTERISTICS.

GIVE TYPE; NAME, IF NECESSARY, INDICATE DEGREE & CHARACTER OF PLASTICITY, AMOUNT & MAXIMUM SIZE OF COARSE GRAINS, COLOUR IN WET CONDITION, ODOUR, IF ANY, LOCAL OR GEOLOGIC NAME & OTHER PERTINENT DESCRIPTIVE INFORMATION & SYMBOL IN PARENTHESIS

FOR UNDISTURBED SOILS ADD INFORMATION ON STRUCTURE, STRATIFICATION, CONSISTENCY IN UNDISTURBED & REMOULDED STATES, MOISTURE & DRAINAGE CONDITIONS.

USE GRAIN SIZE CURVE IN IDENTIFYING THE FRACTIONS AS GIVEN UNDER FIELD IDENTIFICATION

LABORATORY CLASSIFICATION CRITERIA

DETERMINE PERCENTAGES OF GRAVEL & SAND FROM GRAIN SIZE CURVE. DEPENDING ON PERCENTAGE OF FINES (FRACTION SMALLER THAN 75 μm) COARSE GRAINED SOILS ARE CLASSIFIED AS FOLLOWS.

LESS THAN 5%	GW, GP, SW, SP
MORE THAN 12%	GM, GC, SM, SC
5% TO 12%	BORDERLINE CASES REQ USE OF DUAL SYMBOLS

$C_U = \frac{D_{60}}{D_{10}}$ GREATER THAN 4

$C_C = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ BETWEEN ONE AND 3

NOT MEETING ALL GRADATION REQUIREMENTS FOR GW

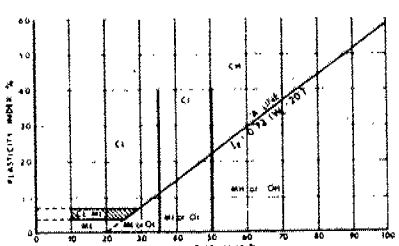
ATTERBERG LIMITS BELOW A-LINE, OR I_p LESS THAN 4	ABOVE A-LINE WITH I_p BETWEEN 4 AND 7 ARE BORDERLINE CASES REQUIRING USE OF DUAL SYMBOLS
ATTERBERG LIMITS ABOVE A-LINE WITH I_p GREATER THAN 7	

$C_U = \frac{D_{60}}{D_{10}}$ GREATER THAN 6

$C_C = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ BETWEEN ONE AND 3

NOT MEETING ALL GRADATION REQUIREMENTS FOR SW

ATTERBERG LIMITS BELOW A-LINE OR I_p LESS THAN 4	ABOVE A-LINE WITH I_p BETWEEN 4 AND 7 ARE BORDERLINE CASES REQUIRING USE OF DUAL SYMBOLS
ATTERBERG LIMITS ABOVE A-LINE WITH I_p GREATER THAN 7	



PLASTICITY CHART
FOR LABORATORY CLASSIFICATION OF FINE GRAINED SOILS

BOUNDARY CLASSIFICATIONS. SOILS POSSESSING CHARACTERISTICS OF TWO GROUPS ARE DESIGNATED BY COMBINATIONS OF GROUP SYMBOLS. FOR EXAMPLE GW-GC, WELL GRADED GRAVEL-SAND MIXTURE WITH CLAY BINDER

FOUNDATION INVESTIGATION REPORT

For

C.N.R. Overhead
3.7 Miles North of Regional Road 14
W.P. 160-74-33, Site 37-700
Hwy. 404, District 6, Toronto

INTRODUCTION

This report contains the results of a foundation investigation carried out at the site of the above-mentioned project. The fieldwork was carried out during the periods of March 7 to March 15, 1978 and May 23 to June 23, 1978 and consisted of a total of 29 boreholes, 9 accompanied by dynamic cone penetration tests. The borings were advanced by means of 3¼ inch hollow stem augers and washboring techniques to depths of up to 107 ft. below the existing ground surface.

SITE DESCRIPTION AND GEOLOGY

The site is located at the proposed crossing of Hwy. 404 and the C.N.R. tracks, approximately 3.7 miles north of Regional Road 14 bordering the Towns of Aurora and Whitchurch, Stouffville in the Regional Municipality of York.

Topography in the vicinity of the site is variable. To the north of the tracks the ground is rolling containing some extensive swamps in the low lying areas, whereas south of the tracks the topography is very hilly. Within the proposed right of way the terrain is bush and tree covered. Northwest of the site adjacent to the highway right of way, is the Westview Golf Club.

The site is located within the physiographic region known as the Oak Ridge Interlobate Moraine. This region has the character of a typical interlobate moraine that has been built between two opposing lobes of the glacier. The subsoil is till with the crest being extensively covered by sand and gravel in hills and terraces. Beds of stratified fine sand, silt and clay are also quite common.

SUBSOIL CONDITIONS

General

Subsoil conditions across the site are quite variable. The surficial deposits adjacent to the C.N.R. tracks and roughly bounded by contour 998 and 996 to the south and north of the tracks respectively consist of very soft to soft organic silt and/or organic clay with a total thickness of up to 16 feet. Elsewhere, beneath a thin veneer of organic silt up to 2 feet thick or extending from the ground surface are surficial deposits up to 15 feet thick composed of loose to compact sand or silt with some sand. Underlying these surficial deposits is an extensive deposit of silty clay to silt of slight plasticity up to 76 feet thick. This cohesive deposit is not continuous but is interrupted in an apparently random fashion by seams or pockets in the order of 10 feet thick composed of loose to dense sand or silts with some sand. One large continuous pocket of silt approximately 50 feet thick was encountered about 250 feet south of the C.N.R. tracks. Underlying the silty clay to silt of slight plasticity deposit or the extensive pocket of silt is a stratum of hard glacial till composed of a heterogeneous mixture of silty clay, sand and gravel which was encountered at depths ranging from 47 to 85 feet below the ground surface. This glacial till was not explored to its full depth but proven to a thickness of up to 20 feet.

The boundaries between the various subsoil types prior to organic subexcavation operations are shown on the Record of Borehole Sheets. The locations and elevations of the boreholes and a stratigraphical profile based on the borehole data is shown on Drawing No. 2. In addition, 5 stratigraphical sections based on borehole data are shown on Drawing No. 2A.

Following is a brief description of the subsoil types and groundwater conditions encountered prior to any organic subexcavation and backfilling operations at the site.

Organic Silt

This surficial deposit was encountered across most of the site being generally only a thin veneer up to 2 feet thick. However, in the vicinity of the tracks the deposit is up to 10 feet thick.

The deposit is composed of black organic silt with some decomposed vegetation and in certain locations contains some sand. Laboratory testing performed on representative samples from this stratum gave the following results.

		Range	Average
Organic Content (% of weight)		1 - 76	18
Natural Moisture Content	(W) %	26 -355	113
Liquid Limit	(W_L)%	18 - 40	32
Plastic Limit	(W_p)%	13 - 29	22
Plasticity Index	(I_p)%	5 - 20	10

The results of the Atterberg Limit Testing are shown on the Plasticity Chart, Figure 1 and indicate that the material is organic and of intermediate plasticity (OI zone).

The shear strength as determined by in-situ vane testing ranges from 80 to 325 P.S.F. Based on the field vane test results and Standard Penetration Test 'N' values ranging from 1 to 6 blows per foot, this deposit is estimated to have a very soft to soft consistency.

Organic Clay

This stratum was encountered immediately below the organic silt deposit in the area roughly bounded by contour 998 and 996 to the south and north of the tracks respectively. The thickness of this cohesive organic deposit ranges from 3 to 11 feet and is composed of a grey to white organic clay or marl. Laboratory testing carried out on samples from this stratum gave the following results.

Physical Properties		Range	Average
Organic Content (% by weight)		2, 13	(two tests)
Natural Moisture Content	(W) %	47-147	108
Liquid Limit (two tests)	(W_L)%	56, 58	
Plastic Limit (two tests)	(W_p)%	46, 46	
Plasticity Index (two tests)	(I_p)%	10, 12	
Bulk Density	( ) PCF	85-108	97
Shear Strength	(Su) PSP	Range	Sensitivity
Field Vane Test		80-240	2-12
Unconfined Compression Test		63-127	

Shown on the Plasticity Chart, Figure 1, are the results of Atterberg Limit Testing. The limits indicate that the deposit is organic of high plasticity (OH zone).

The shear strength as determined by in-situ vane testing ranges from 80 to 240 P.S.F. which indicates that the consistency of the deposit is very soft.

Silty Clay to Silt of Slight Plasticity

This cohesive stratum is the dominant deposit across the site and was encountered immediately below the surficial organic strata or the surficial sand and/or silt deposits. The thickness of this stratum varies from 42 to 75 feet. The deposit is composed of silty clay to silt of slight plasticity and in certain locations contains some sand. In addition, in the southeast area of the site the upper 10 to 23 feet of the stratum contains random seams or pockets of silt and fine sand about ½ inch thick every 3 inches. Furthermore, this deposit is not continuous but is interrupted in a random fashion by seams or pockets of silt, some sand or sand up to 19 feet thick. The results of Atterberg Limit Testing on samples from the silty clay to silt of slight plasticity and samples from the silty clay to silt of slight plasticity with some sand are shown on the Plasticity Chart, Figure 2 and are summarized below.

Silty Clay to Silt of Slight Plasticity

		Range	Average
Natural Moisture Content	(W) %	11-36	19
Liquid Limit	(W_L) %	16-25	21
Plastic Limit	(W_p) %	9-18	14
Plasticity Index	(I_p) %	4-13	6

Silty Clay to Silt of Slight Plasticity With Some Sand

		Range	Average
Natural Moisture Content	(W) %	9-20	14
Liquid Limit	(W_L) %	11-22	16
Plastic Limit	(W_p) %	10-18	12
Plasticity Index	(I_p) %	1- 8	3

The limits indicate that the deposit is inorganic and of low plasticity (CL-ML to CL zone for silty clay to silt of slight plasticity and ML to CL-ML zone for silty clay to silt of slight plasticity with some sand). In addition, the results of grain size distribution testing on representative samples from this deposit are shown on Figure No. 3, one envelope for the silty clay to silt of slight plasticity and one for the silty clay to silt of slight plasticity with some sand.

Generally, the 'N' values as determined by the Standard Penetration Test range from 8 to 71 blows per foot generally increasing with depth except for an 8 to 23 foot thick zone immediately below the deep organic deposit (i.e. adjacent to the C.N.R. tracks and bounded by contour 998 and 996 to the north and south respectively) where 'N' values as low as 1 blow for 18 inches were observed. The shear strength as measured by in-situ vane testing in the zone immediately below the deep organic stratum increases with depth from 1200 to 1600 P.S.F. and

elsewhere was found to be greater than 2000 P.S.F. Based on the S.P.T. and field vane tests the consistency of the deposit is estimated to be very stiff to hard except in the upper portion of the deposit immediately below the deep organic stratum where the consistency is very soft to stiff.

Sand

This deposit was encountered in some borings put down adjacent to the tracks as distinct pockets within the stratum of silty clay to silt of slight plasticity at a depth ranging from 8 to 38 feet below the ground surface. In addition, outside the limits of the deep organic deposit, this granular stratum was encountered in some locations either beneath a thin veneer of organic silt or extending from the ground surface. The thickness of this deposit is estimated to range from 2 to 15 feet thick, being generally in the order of 10 feet thick. Grain size distribution testing performed on representative samples from this stratum are shown in envelope form on Figure 4. The composition of this deposit ranges from a sand with some silt to a sand with some gravel.

The results of Standard Penetration Test 'N' values range generally from 6 to 37 blows per foot except for some tests performed in the surficial deposit where 'N' values as low as 2 and 3 were observed. Based on these values the relative density of the deposit ranges from very loose to dense, being generally in the loose to compact range.

Silt Some Sand

This deposit was encountered in some borings put down adjacent to the tracks within the stratum of silty clay to silt of slight plasticity at depths ranging from 12 to 48 feet below the ground surface. Furthermore, this stratum was encountered in some locations immediately below a thin veneer of organic silt or extending from the ground surface. The thickness of this deposit is estimated to range from 6 to 19 feet. Grain size distribution testing performed on representative samples from this deposit are shown in envelope form on Figure 4. The composition is silt with some sand.

Based on Standard Penetration Test 'N' values ranging generally from 4 to 19 blows per foot, the relative density of the deposit is described as loose to compact.

Silt

This deposit was encountered approximately 250 feet south of the tracks immediately below the stratum of silty clay to silt of slight plasticity at a depth of 11 to 38 feet below the existing ground surface. This cohesionless stratum appears to form a continuous pocket or trench up to 52 feet thick and about 150 feet wide and is approximately parallel to the C.N.R. tracks at this location. The deposit is composed almost entirely of silt with negligible amounts of clay and sand. The results of grain size distribution testing are shown in envelope form, Figure 5.

The relative density of the deposit is described as compact to dense increasing with depth as inferred from the 'N' value range of 19 to 46 blows per foot.

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

This cohesive deposit was encountered in 15 of the boreholes at a depth ranging from 45 to 85 feet below the existing ground surface. The upper boundary of the deposit is gently rising to the north and south from a low basin located some 100 to 300 feet south of the railway tracks. This deposit was not fully penetrated but proven to extend to a thickness of up to 38 feet.

Grain size distribution testing performed on representative samples from this deposit are shown on envelope form on Figure 5. The deposit is a glacial till composed of a heterogeneous mixture of silty clay, sand and gravel. In some locations a 1 to 2 foot zone of cobbles was encountered about 10 feet below the upper surface of this stratum.

Based on Standard Penetration Test 'N' values being generally over 100 blows per foot, the consistency of this stratum is estimated to be hard.

Groundwater Conditions

The groundwater level was observed during the progress of the fieldwork by measuring in the open boreholes approximately 24 hours after completion of the boring. In the low lying swampy areas adjacent to the C.N.R. tracks groundwater was at the surface and elsewhere the groundwater was found to vary from 1 to 7 feet below the existing ground surface which corresponds to elevation 991.3 to 1009.4. These observations indicate that the groundwater level reflects the topography.

In addition, temporary sub-artesian conditions were observed in Borehole 22 and 24 immediately above the glacial till deposit. Piezometers were subsequently installed in B.H. 24 at a depth of 28 and 65 feet to monitor the sub-artesian pressure. The piezometer readings indicate that the sub-artesian pressure is approximately at the groundwater level.

Tom Kazmierowski, P. Eng.
Foundations Engineer

M. Devata, P. Eng.
Senior Foundations Engineer

APPENDIX

Ministry of Transportation and Communications
Ontario

HIGHWAY ENGINEERING DIVISION - ENGINEERING MATERIALS OFFICE - SOIL MECHANICS SECTION

RECORD OF BOREHOLE No 1

13

W P 160-74-33 LOCATION Coords. N 15,958,028, E 1,027,374 ORIGINATED BY M.M.

DIST 6 HWY 404 BOREHOLE TYPE Hollow Stem Augers and Cone Test COMPILED BY M.M.

DATUM Geodetic DATE March 9, 1978 CHECKED BY

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	'N' VALUES	GROUND WATER CONDITIONS	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
996.2	Ground Surface						
0.0 / 990.2	Organic Silt, Some Sand Loose		1	TW	PM		
6.0	Sand		2	SS	4		9 27 48 16
			3	SS	5		
			4	SS	8		2 36 44 18
	Firm to Stiff		5	SS	8		3 24 57 16
	Clayey Silt to Silt of Slight Plasticity; Some Sand; Very Stiff to Hard		6	SS	20		
			7	SS	27		
			8	SS	26		0 1 79 20
			9	SS	45		
			10	SS	37		
			11	SS	55		0 10 74 16
			12	SS	47		
			13	SS	50		11 10 73 6
919.2			14	SS	56		
77.0	Heterogeneous Mixture, Clayey Silt, Sand and Gravel (Glacial Till); Hard		15	SS	60/4"		
			16	SS	138		4 37 43 16
894.7			17	SS	150/2"		
101.5	End of Borehole						

ELEVATION SCALE: 990, 980, 970, 960, 950, 940, 930, 920, 910, 900

DYNAMIC CONE PENETRATION RESISTANCE PLOT: 20 40 60 80 100

SHEAR STRENGTH: ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE; 400 800 1200 1600 2000

+3

+4

Cannot Push Vane

PLASTIC LIMIT Wp — NATURAL MOISTURE CONTENT W — LIQUID LIMIT W_L

WATER CONTENT (%): 20 40 60

UNIT WEIGHT γ

+3, ×5 : Numbers refer to Sensitivity

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

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RECORD OF BOREHOLE No 2

W P 160-74-33 LOCATION Coords. N 15,985,085; E 1,027,412 ORIGINATED BY M.M.

DIST 6 HWY 404 BOREHOLE TYPE Hollow Stem Augers and Cone Test COMPILED BY M.M.

DATUM Geodetic DATE March 9, 1978 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, + FIELD VANE, ● QUICK TRIAXIAL, × LAB VANE; 400 800 1200 1600 2000)	PLASTIC LIMIT Wp / NATURAL MOISTURE CONTENT W / LIQUID LIMIT WL — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ PCF	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
996.6	Ground Surface										
0.0 / 991.6	Organic Silt Very Soft										
5.0	Clayey Silt to Silt of Slight Plasticity With Random Seams or Pockets of Silt and Fine Sand Stiff		1	TW	PM		990	>2500		135	
			2	SS	4			2000			2 20 64 14
			3	SS	3		980	2000			2 26 67 5
	Some Sand Stiff		4	SS	9			2000			11 28 40 21
			5	SS	13		970				
	Clayey Silt to Silt of Slight Plasticity Very Stiff to Hard		6	SS	29						
			7	SS	27		960				0 1 74 25
			8	SS	21						
			9	SS	35		950				
945.1			10	SS	41						
51.5	End of Borehole										

+3, ×5 : Numbers refer to Sensitivity

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

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RECORD OF BOREHOLE No 3

W P 160-74-33 LOCATION Coords. N 15,985,146 E 1,027,455 ORIGINATED BY M.M.

DIST 6 HWY 404 BOREHOLE TYPE Hollow Stem Augers and Cone Test COMPILED BY M.M.

DATUM Geodetic DATE March 7 & 8, 1978 CHECKED BY

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES 'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE
998.6	Ground Surface						
0.0	Silt, Some Sand Loose to Compact		1	SS	11	No Water Level Established	
992.6							990
6.0	Clayey Silt to Silt of Slight Plasticity Soft		2	SS	1		
			3	TW	PM		980
974.6			4	TW	PH		
24.0	Sand, Some Silt Some Gravel Loose to Compact		5	SS	8		970
			6	SS	6		
959.6			7	SS	30		960
39.0	Clayey Silt to Silt of Slight Plasticity		8	SS	18		
			9	SS	41		950
	Silt		10	SS	18		
	Very Stiff to Hard		11	SS	22		940
			12	SS	67		
			13	SS	41		930
925.6			14	SS	60/5"		
73.0	Heterogeneous Mixture Clayey Silt, Sand and Gravel Hard Glacial Till		15	SS	145		920
907.1			16	SS	100/3"		910
91.5	End of Borehole Note: Water Level Not Established						

DYNAMIC CONE PENETRATION RESISTANCE PLOT — 20 40 60 80 100

SHEAR STRENGTH — ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE — 400 800 1200 1600 2000

PLASTIC LIMIT Wp | NATURAL MOISTURE CONTENT W | LIQUID LIMIT Wl

WATER CONTENT (%) — 20 40 60

UNIT WEIGHT γ

REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
0 26 68 6
0 2 69 29
27 44 24 5
7 69 (24)
20 75 (5)
0 7 81 12

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

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

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RECORD OF BOREHOLE No 4

16

W P 160-74-33 LOCATION Coords. N 15,985,250; E 1,027,475 ORIGINATED BY B.L.

DIST 6 HWY 404 BOREHOLE TYPE Hollow Stem Augers and Cone Test COMPILED BY M.M.

DATUM Geodetic DATE March 8, 1978 CHECKED BY W.J.

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES 'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH (○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB VANE; 400 800 1200 1600 2000)	PLASTIC LIMIT Wp / NATURAL MOISTURE CONTENT W / LIQUID LIMIT W_L — WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ PCF	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
995.3	Ground Surface										
0.0	Clayey Silt to Silt of Slight Plasticity With Random Seams of Silt and Fine Sand		1	TW	PM		990	+2	H ○		
			2	TW	PH			+3			
	Very Soft		3	TW	PM		980	+2			
	Soft to Stiff		4	TW	PH			× ○ +5	H	130	
972.3											
23.0	Silt, Some Sand Trace Clay Loose to Compact		5	SS	9		970		○		0 29 61 10
			6	SS	11						
			7	SS	16		960				
957.3											
38.0	Sand, Some Silt Some Gravel Compact		8	SS	17				○		7 51 38 4
949.8											
45.5	Clayey Silt to Silt of Slight Plasticity Some Sand Hard		9	SS	18		950				
			10	SS	50			200/8"			
			11	SS	38		940		○		7 33 55 15
933.8			12	SS	70						
61.5	End of Borehole										

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

20
15 ◇ 5 (%) STRAIN AT FAILURE
10

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RECORD OF BOREHOLE No 5

17

W P 160-74-33 LOCATION Coords. N 15,985,150; E 1,027,355 ORIGINATED BY O.J.

DIST 6 HWY 404 BOREHOLE TYPE Hollow Stem Augers and Cone Test COMPILED BY

DATUM Geodetic DATE March 8, 1978 CHECKED BY

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES 'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH (o UNCONFINED, + FIELD VANE, ● QUICK TRIAXIAL, x LAB VANE)	PLASTIC LIMIT Wp / NATURAL MOISTURE CONTENT W / LIQUID LIMIT W_L — WATER CONTENT (%)	UNIT WEIGHT γ PCF	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
995.2	Ground Surface										
0.0	Organic Silt, V. Soft Organic Clay Very Soft		1	PS	PM	▼	990	+ 5 + 6		109	
988.2											
7.0	Clayey Silt to Silt of Slight Plasticity With Random Seams of Silt and Fine Sand Very Soft to Firm		2	SS	Own Weight			+ 5 + 4			2 26 54 18
			3	SS	2		980				2 28 54 16
			4	TW	PH			Cannot Push Vane ×10		139	
972.2											
23.0	Silt, Some Sand Compact		5	SS	11		970				2 30 62 6
966.2											
29.0	Clayey Silt to Silt of Slight Plasticity Hard		6	SS	0/18"						
			7	SS	21		960				
			8	SS	28						0 1 79 20
			9	SS	72		950				
			10	SS	31						1 8 81 10
942.2											
53.0	Sand, Some Silt and Gravel Dense		11	SS	37		940				20 49 28 3
			12	SS	33						
933.7											
61.5	End of Borehole										

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+3, x5 : Numbers refer to Sensitivity

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

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RECORD OF BOREHOLE No 6

W P 160-74-33 LOCATION Coords. N 15,985,216; E 1,027,395 ORIGINATED BY B.L.

DIST 6 HWY 404 BOREHOLE TYPE Hollow Stem Augers COMPILED BY M.M.

DATUM Geodetic DATE March 15, 1978 CHECKED BY R.J.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE; 400 800 1200 1600 2000)	PLASTIC LIMIT W_P / NATURAL MOISTURE CONTENT W / LIQUID LIMIT W_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ PCF	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES						
994.8	Ground Surface										
0.0	Organic Silt										
989.8	Very Soft						990				
5.0	Clayey Silt to Silt of Slight Plasticity With Random Seams of Sand and Silt		1	SS	PM			+5 +3		127	E_o=0.71 P_c=0.47 tsf C_c=0.21
			2	TW	PM					133	E_o=0.47 C_c=0.06
	Soft / Stiff		3	SS	3		980				
			4	TW	PM			×5 +3			
973.3			5	TW	PM						
21.5	End of Borehole										

Note: Groundwater Level Not Established

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

20
15 ◇ 5 (%) STRAIN AT FAILURE
10

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RECORD OF BOREHOLE No 7

19

W P 160-74-33 LOCATION Coords. N 15,985,276; E 1,027,435 ORIGINATED BY O.J.

DIST 6 HWY 404 BOREHOLE TYPE Hollow Stem Augers and Cone Test COMPILED BY O.J.

DATUM Geodetic DATE March 9, 1978 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 (o UNCONFINED, + FIELD VANE, ● QUICK TRIAXIAL, × LAB VANE) (400 800 1200 1600 2000)	PLASTIC LIMIT Wp / NATURAL MOISTURE CONTENT W / LIQUID LIMIT W_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ PCF	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
994.6 / 0.0	Ground Surface										
992.6	Organic Silt, V. Soft		1	TW	PM	▽	990	×5 Cannot Push Vane		130	E_o=.58 P_c^o=0.2 tsf
2.0	Soft to Firm		2	SS	7			+4 +5			
	Some Sand Stiff		3	SS	8		980				1 17 67 15
			4	SS	10						
	Sandy Silt Loose		5	SS	9		970				14 33 43 10
	Clayey Silt to Silt of Slight Plasticity Very Stiff to Hard		6	SS	26						
			7	SS	67		960				
			8	SS	26						
	Silt Compact		9	SS	19		950				0 3 92 5
	Hard		10	SS	34						
940.6							940				
54.0	Sand, Some Silt and Gravel Compact to Very Dense		11	SS	67						
			12	SS	83						17 46 27 10
928.1			13	SS	26		930				
66.5	End of Borehole										

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

15 20 10 5 (%) STRAIN AT FAILURE

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RECORD OF BOREHOLE No 8

W P 160-74-33 LOCATION Coords. N 15,985,148; E 1,027,313 ORIGINATED BY O.J.

DIST 6 HWY 404 BOREHOLE TYPE Hollow Stem Augers and Cone Test COMPILED BY

DATUM Geodetic DATE March 7, 1978 CHECKED BY W.J.

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 PSF (400 800 1200 1600 2000)	PLASTIC LIMIT Wp / NATURAL MOISTURE CONTENT W / LIQUID LIMIT WL / WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
994.7	Ground Surface										
0.0	Organic Silt Very Soft to Soft		1	SS	PM		990	+ 4			Om 17% W 148%
984.0	Organic Clay Very Soft										
10.0	Clayey Silt to Silt of Slight Plasticity Very Soft		2	SS	0/18"		980	+ 3 +5			
	Stiff to Hard		3	SS	1/18"			Cannot Push Vane			
			4	SS	10			+4			14 23 50 13
	Some Sand		5	SS	9		970				
			6	SS	9						
			7	SS	18		960				
			8	SS	25						2 23 61 14
			9	SS	55		950				0 1 80 19
	Sand, Some Silt, Compact		10	SS	28						10 42 34 14
936.7			11	SS	55		940				
58.0	Heterogeneous Mixture, Clayey Silt Cobbles Sand and Gravel Hard (Glacial Till)		12	SS	145						
			13	SS	100/ 2"		930				9 50 31 10
			14	SS	100/3"		920				
			15	SS	100/ 4"		910				14 44 32 10
898.2			16	SS	100/3"		900				
96.5	End of Borehole										

+3, ×5 : Numbers refer to Sensitivity

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

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RECORD OF BOREHOLE No 9

21

W P 160-74-33 LOCATION Coords. N 15,985,385; E 1,027,464 ORIGINATED BY O.J.

DIST 6 HWY 404 BOREHOLE TYPE Hollow Stem Augers COMPILED BY O.J.

DATUM Geodetic DATE March 10 & 13, 1978 CHECKED BY W.J.

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES 'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE 400 800 1200 1600 2000)	PLASTIC LIMIT Wp / NATURAL MOISTURE CONTENT W / LIQUID LIMIT Wl — WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
995.4	Ground Surface										
0.0	Organic Silt Very Soft		1	TW	PM		990	+ 5 + 2 +6 +12			W 116% Om 13%
	Organic Clay Very Soft		2	SS	1						W 147% Om 10%
979.4			3	SS	2		980				
16.0	Sand, Some Silt Some Gravel Compact		4	SS	14						17 74 (9)
968.4			5	SS	20		970				1 54 35 10
27.0	Clayey Silt to Silt of Slight Plasticity Very Stiff		6	SS	19						
961.4											
34.0	Sandy Gravel		7	SS	20		960				50 31 17 2
956.4	Compact										
39.0	Clayey Silt to Silt of Slight Plasticity Some Sand Hard		8	SS	43						
			9	SS	43		950				8 17 50 25
			10	SS	17						
			11	SS	55		940				11 18 61 10
935.4											
60.0	Heterogeneous Mixture Clayey Silt Sand and Gravel (Glacial Till) Hard		12	SS	150						18 40 28 14
			13	SS	72		930				
			14	SS	100/4"		920				13 46 30 11
							910				
903.9			15	SS	100/2"						
91.5	End of Borehole										

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

20
15 ◇ 5 (%) STRAIN AT FAILURE
10

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RECORD OF BOREHOLE No 10

22

W P 160-74-33 LOCATION Coords. N 15,984,984; E 1,027,348 ORIGINATED BY B.L.

DIST 6 HWY 404 BOREHOLE TYPE Hollow Stem Augers and Cone Test COMPILED BY M.M.

DATUM Geodetic DATE March 13, 1978 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 (o UNCONFINED, • QUICK TRIAXIAL, + FIELD VANE, × LAB VANE; 400 800 1200 1600 2000)	PLASTIC LIMIT Wp / NATURAL MOISTURE CONTENT W / LIQUID LIMIT W_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ PCF	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
996.4	Ground Surface										
0.0	Organic Silt Very Soft to Soft		1	SS	1						
			2	PS	PH		990	+2			
986.4			3	SS	1						0m 4%
10.0	Clayey Silt to Silt of Slight Plasticity With Random Seams or Pockets of Silt and Fine Sand Very Soft to Soft		4	TW	PH			+4			
			5	SS	3						
			6	TW	PH		980				127
			7	SS	1			+2			
			8	TW	PH			+3 ×			
	Clayey Silt to Silt of Slight Plasticity Some Sand						970	+2			
			9	TW	PH						
			10	TW	PH						
	Stiff										
	Very Stiff to Hard		11	SS	17		960				4 28 57 11
			12	SS	18						
			13	SS	33		950				17 16 52 15
			14	SS	29			100/10"			3 14 69 14
911.4							940				
							930				
							920				
85.0	Heterogeneous Mixture, Clayey Silt Sand and Gravel Glacial Till Hard						910				
899.9			15	SS	100/5"		900				
96.5	End of Borehole										

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.3 .5 . Numbers refer to 20

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RECORD OF BOREHOLE No 11

23

W P 160-74-33 LOCATION Coords. N 15,984,932; E 1,027,512 ORIGINATED BY D.C.

DIST 6 HWY 404 BOREHOLE TYPE Hollow Stem Augers COMPILED BY M.M.

DATUM Geodetic DATE May 23, 1978 CHECKED BY

SOIL PROFILE ELEV/DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH (o UNCONFINED, + FIELD VANE, • QUICK TRIAXIAL, × LAB VANE; 400 800 1200 1600 2000)	PLASTIC LIMIT Wp / NATURAL MOISTURE CONTENT W / LIQUID LIMIT WL — WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
1001.9 Ground Surface											
0.0	Organics Sand, Some Silt, Loose		1	SS	2	▼	1000				
2.0	Clayey Silt to Silt of Slight Plasticity Some Sand Very Stiff		2	SS	8			+ 2000			
			3	SS	10						
990.9			4	SS	16				•		0 13 75 12
11.0	Silt Compact to Dense		5	SS	19		990				
			6	SS	27				o		1 1 92 6
			7	SS	25		980				
			8	SS	31				×		0 3 90 7
970.4			9	SS	29						
31.5	End of Borehole										

+3, ×5 : Numbers refer to Sensitivity

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

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RECORD OF BOREHOLE No 12

W P 160-74-33 LOCATION Coords. N 15,984,855; E 1,027,403 ORIGINATED BY D.C.

DIST 6 HWY 404 BOREHOLE TYPE Hollow Stem Augers COMPILED BY M.M.

DATUM Geodetic DATE May 23, 1978 CHECKED BY a.l.

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 (%) 20 40 60	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
1001.6	Ground Surface										
0.0	Organic Silt		1	SS	2		1000				
997.6	Very Soft		2	SS	16						
4.0	Sand, Some Gravel		3	SS	28				6		
990.6	Compact		4	SS	26		990				
11.0	Clayey Silt to Silt of Slight Plasticity Some Sand		5	SS	21						
			6	SS	14						
	Silt Compact		7	SS	19		980				
	Very Stiff		8	SS	29				○		24 16 40 20
			9	SS	23		970				
963.6			10	SS	22						
38.0	Silt		11	SS	15		960				
	Compact		12	SS	22				○		
950.1			13	SS	20						
51.5	End of Borehole										

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

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

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RECORD OF BOREHOLE No 13

25

W P 160-74-33 LOCATION Coords. N 15,984,745; E 1,027,280 ORIGINATED BY D.C.

DIST 6 HWY 404 BOREHOLE TYPE Hollow Stem Augers COMPILED BY M.M.

DATUM Geodetic DATE May 23-24, 1978 CHECKED BY W.J.

SOIL PROFILE ELEV/DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH (o UNCONFINED, + FIELD VANE, • QUICK TRIAXIAL, x LAB VANE; 400 800 1200 1600 2000)	PLASTIC LIMIT Wp / NATURAL MOISTURE CONTENT W / LIQUID LIMIT WL; WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
999.4	Ground Surface										
0.0	Clayey Silt to Silt of Slight Plasticity Some Sand Very Stiff		1	SS	6	▼					
			2	SS	12						
			3	SS	15				OH		1 38 43 18
			4	SS	13		990				
			5	SS	7						
			6	SS	16			→ 2000			
			7	SS	15		980		OH		9 32 41 18
			8	SS	24						
966.4			9	SS	31		970				
33.0	With Gravel										
	Silt Compact to Very Dense		10	SS	19						
			11	SS	66		960				
			12	SS	44				p		0 0 96 4
947.9			13	SS	46		950				
51.5	End of Borehole										

+3, x5 : Numbers refer to Sensitivity

15 20 10 5 (%) STRAIN AT FAILURE

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HIGHWAY ENGINEERING DIVISION - ENGINEERING MATERIALS OFFICE - SOIL MECHANICS SECTION

RECORD OF BOREHOLE No 14

26

W P 160-74-33 LOCATION Coords. N 15,984,940; E 1,027,378 ORIGINATED BY D.C.

DIST 6 HWY 404 BOREHOLE TYPE Hollow Stem Augers COMPILED BY M.M.

DATUM Geodetic DATE May 24, 1978 CHECKED BY W.J.

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 + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 400 800 1200 1600 2000	PLASTIC LIMIT Wp / NATURAL MOISTURE CONTENT W / LIQUID LIMIT WL — WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
996.4	Ground Surface										
0.0	Sand With Silt		1	SS	2						
	Loose		2	SS	11		990		○		2 50 40 8
			3	SS	4						
	Soft Clayey Silt		4	SS	5			+2			
			5	SS	4				○		1 59 39 1
			6	SS	5		980	+2			
977.4											
19.0	Clayey Silt to Silt of Slight Plasticity Some Sand Very Stiff		7	SS	7			+2000	⊖		10 17 50 23
968.4			8	SS	8		970				
28.0	Silt Compact to Dense		9	TW	PH			+2000			
			10	SS	14		960				
			11	SS	25		950				
			12	SS	18				○		
			13	SS	36		940				
			14	SS	38		930				
919.4							920				
77.0	Heterogeneous Mixture Clayey Silt, Sand and Gravel Hard Glacial Till		15	SS	150/5"						
			16	SS	150/4"		910		○		18 45 26 11
904.9			17	SS	117/6"						
91.5	End of Borehole										

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

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

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RECORD OF BOREHOLE No 15

27

W P 160-74-33 LOCATION Coords. N 15,984,836; E 1,027,350 ORIGINATED BY D.C.

DIST 6 HWY 404 BOREHOLE TYPE Hollow Stem Augers COMPILED BY D.C.

DATUM Geodetic DATE May 29-31, 1978 CHECKED BY W.J.

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES 'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH (○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB VANE)	PLASTIC LIMIT Wp / NATURAL MOISTURE CONTENT W / LIQUID LIMIT WL — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
996.1	Ground Surface										
0.0	Sand, Some Silt		1	SS	12						2 55 36 7
	Loose to Compact		2	SS	11						
			3	SS	7		990				2 74 18 6
			4	SS	10			+2			
983.1											
13.0	Clayey Silt to Silt of Slight Plasticity Some Sand		5	SS	29						
			6	SS	23		980				
	Uniform Fine Sand		7	SS	15						
	Very Stiff		8	SS	19		970				2 10 48 40
968.1											
28.0			9	SS	17						
	Silt										
	Compact to Dense						960				
			10	SS	11						
							950				
			11	SS	46				o		0 1 87 12
							940				
							930				
							920				
916.1											
80.0	Heterogeneous Mixture Clayey Silt, Sand and Gravel (Glacial Till)		12	SS	110/5"						
			13	SS	110/4"		910				
	Hard		14	SS	100/4"						
899.6			15	SS	120/1"		900				
96.5	End of Borehole										

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+3, ×5 : Numbers refer to Sensitivity

20
15 ⊹ 5 (%) STRAIN AT FAILURE
10

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RECORD OF BOREHOLE No 16

28

W P 160-74-33 LOCATION Coords. N 15,985,063; E 1,027,455 ORIGINATED BY D.C.

DIST 6 HWY 404 BOREHOLE TYPE Hollow Stem Augers COMPILED BY M.M.

DATUM Geodetic DATE May 31 & June 1, 1978 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 (o UNCONFINED, + FIELD VANE, ● QUICK TRIAXIAL, x LAB VANE; 400 800 1200 1600 2000)	PLASTIC LIMIT Wp / NATURAL MOISTURE CONTENT W / LIQUID LIMIT Wl; WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
998.0	Ground Surface										
0.0	Organic Silt With Sand		1	SS	3	▼					Om 4%
993.0	Soft		2	SS	10			+> 2000	o		2 26 57 15
5.0	Clayey Silt to Silt of Slight Plasticity With Random Seams of Silt and Fine Sand		3	SS	9		990				
			4	SS	5			+4 +5	⊙		0 18 66 16
983.0	Firm to Stiff		5	SS	9						
15.0	Silt, Some Sand Compact		6	SS	10		980				
			7	SS	11						
			8	SS	11		970		o		2 29 63 6
963.0			9	SS	11			+> 2000			
35.0	Clayey Silt to Silt of Slight Plasticity Very Stiff		10	SS	23		960		o		2 10 54 34
			11	TW	PH		950				
							940				
							930				
921.0			12	SS	92						
77.0	Heterogeneous Mixture Clayey Silt Sand and Gravel Cobbles Hard Glacial Till		13	SS	140		920		o		8 49 32 11
			14	SS	100/6"		910				
			15	SS	110/5"						
901.5			16	SS	120/5"						
96.5	End of Borehole										

+3, x5 : Numbers refer to Sensitivity

20
15 ⊹ 5 (%) STRAIN AT FAILURE
10

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RECORD OF BOREHOLE No 17

29

W P 160-74-33 LOCATION Coords. N 15,985,024; E 1,027,490 ORIGINATED BY DC.

DIST 6 HWY 404 BOREHOLE TYPE Hollow Stem Augers 0-55, Washboring With Casing 55-80, Wash Ahead 80-95 COMPILED BY J.J.

DATUM Geodetic DATE June 1, 1978 and June 2, 1978 CHECKED BY A.J.

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
1000.3	Ground Surface							
0.0 / 998.3	Organic Silt With Sand Very Soft		1	SS	5	▼	1000	
2.6	Sand, Some Silt		2	SS	13			
	Compact		3	SS	17			
990.3			4	SS	26			
10.0	Clayey Silt to Silt of Slight Plasticity Some Sand With Pockets of Sand and Gravel up to 1 Ft. Thick Every 4 Feet		5	SS	43		990	
			6	SS	21			
			7	SS	17			
			8	SS	23		980	22 15 38 25
	Very Stiff		9	SS	34			
971.9								
29.0	Silt		10	SS	14		970	
	Compact to Dense						960	
			11	SS	18		950	
							940	
							930	
923.3								
77.0	Heterogeneous Mixture, Clayey Silt Sand and Gravel (Glacial Till)		12	SS	100/ 1"		920	
	Hard		13	SS	93/ 6"			29 37 24 10
			14	SS	110/ 2"		910	
903.8			15	SS	110/ 4"			
96.5	End of Borehole							

DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100

SHEAR STRENGTH
○ UNCONFINED + FIELD VANE
● QUICK TRIAXIAL × LAB VANE

PLASTIC LIMIT Wp — NATURAL MOISTURE CONTENT W — LIQUID LIMIT Wl

WATER CONTENT (%) 20 40 60

UNIT WEIGHT γ

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

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

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30

RECORD OF BOREHOLE No 19

W P 160-74-33 LOCATION Coords. N 15,984,750; E 1,027,362 ORIGINATED BY D.C.

DIST 6 HWY 404 BOREHOLE TYPE Hollow Stem Augers 0-60, Washboring With Casing 60-107 COMPILED BY J.J.

DATUM Geodetic DATE June 6, 1978 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 (%) (20 40 60)	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
1009.4	Ground Surface										
0.0	Sand, Some Gravel		1	SS	4						
	Dense		2	SS	39				○		30 56 (14)
998.4			3	SS	37		1000				
11.0	Clayey Silt to Silt of Slight Plasticity Some Sand		4	SS	34				○		1 32 51 16
	Hard		5	SS	34		990				
22.0	Silt, Some Sand		6	TW	PH						
	Compact		7	SS	10				○		
981.4							980				
28.0	Clayey Silt to Silt of Slight Plasticity Some Sand Hard		8	SS	40						0 37 59 4
			9	TW	PH		970				
							960				
							950				
932.4							940				
77.0	Heterogeneous Mixture, Clayey Silt, Sand and Gravel		10	SS	149		930				
	Silt		12	SS	182						
	Hard						920				
	Glacial Till		13	SS	94/6"						8 47 34 11
			14	SS	100/5"		910				
902.9			15	SS	100/4"						
106.5	End of Borehole										

+3, ×5 : Numbers refer to Sensitivity

20
15 ◇ 5 (%) STRAIN AT FAILURE
10

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RECORD OF BOREHOLE No 20

31

W P 160-74-33 LOCATION Coords. N 15,984,878; E 1,027,458 ORIGINATED BY D.C.

DIST 6 HWY 404 BOREHOLE TYPE Hollow Stem Augers 0-50, Washboring With Casing 50-80, Wash Ahead 80-91.5 COMPILED BY J.J.

DATUM Geodetic DATE June 8, 1978 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 (%) 20 40 60	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
1003.3	Ground Surface										
0.0 1001.3	Organic Silt		1	SS	6		1000				
2.0 995.3	Clayey Silt to Silt of Slight Plasticity Some Sand, Very Stiff		2	SS	22				CH		5 40 41 14
8.0 990.3	Sand, Some Silt Compact		3	SS	20		990				
13.0	Some Sand and Gravel		4	SS	39						
	Silt Dense		5	SS	45				○		0 1 95 4
	Clayey Silt to Silt of Slight Plasticity Hard Some Sand and Gravel		6	SS	51		980				
			7	SS	47		970				
							960				
							950				
							940				
							930				
925.3											
78.0	Heterogeneous Mixture, Clayey Silt Sand and Gravel Hard Glacial Till		8	SS	147/10"		920				
			9	SS	114/6"				CH		
911.8			10	SS	112/6"						
91.5	End of Borehole										

+3, ×5 : Numbers refer to Sensitivity

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

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RECORD OF BOREHOLE No 21

32

W P 160-74-33 LOCATION Coords. N 15,985,514; E 1,027,440 ORIGINATED BY D.C.

DIST 6 HWY 404 BOREHOLE TYPE Hollow Stem Augers COMPILED BY J.J.

DATUM Geodetic DATE June 9, 1978 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 (%) 20 40 60	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
1003.3	Ground Surface										
0.0	Trace Organics		1	SS	5						Om 4%
	Sand, Some Silt Loose		2	SS	5		1000				2 67 25 6
996.3			3	SS	27	▼					
7.0			4	SS	18				⊕		0 19 66 15
			5	TW	PH		990				
			6	SS	24						
			7	SS	24				●		
	Some Sand						980				
	Clayey Silt to Silt of Slight Plasticity		8	SS	38						
			9	SS	36						
	Very Stiff to Hard						970				
			10	SS	24						
							960				
			11	SS	30				⊕		0 2 80 18
928.3							950				
							940				
							930				
75.0	Heterogeneous Mixture, Clayey Silt Sand and Gravel Hard		12	SS	126/ 6"				○		7 43 38 12
			13	SS	100/ 5"		920				
916.8			14	SS	100/ 4"						
86.5	End of Borehole										

+3, ×5 : Numbers refer to Sensitivity

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

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RECORD OF BOREHOLE No 22

33

W P 160-74-33 LOCATION Coords. N 15,985,386; E 1,027,415 ORIGINATED BY D.C.

DIST 6 HWY 404 BOREHOLE TYPE Hollow Stem Augers (0-65 ft.) and Washboring (65 ft.) COMPILED BY M.M.

DATUM Geodetic DATE June 12-14, 1978 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 (o UNCONFINED, + FIELD VANE, ● QUICK TRIAXIAL, x LAB VANE; 400 800 1200 1600 2000)	PLASTIC LIMIT Wp / NATURAL MOISTURE CONTENT W / LIQUID LIMIT W_L — WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
996.0	Ground Surface										
0.0 / 994.0	Organic Silt Soft		1	SS	5						
2.0	Sand, Some Silt Some Gravel Loose to Compact		2	SS	15		990				
			3	SS	6						
			4	SS	17						8 78 (14)
			5	SS	17						
979.0			6	SS	9		980				
17.0	Clayey Silt to Silt of Slight Plasticity Very Stiff		7	SS	11			+			
			8	SS	10		970				
			9	SS	15				⊢o		
			10	SS	24		960				
943.0							950				
			11	SS	113				⊢o		2 12 72 14
53.0	Heterogeneous Mixture, Clayey Silt Sand and Gravel Glacial Till Hard Cobbles		12	SS	88		940				
			13	SS	120/ 5"				o		
			14	SS	100/ 3½"		930				
			15	SS	100/ 6"						
919.5			16	SS	114/ 6"		920				
76.5	End of Borehole										

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+3, x5 : Numbers refer to Sensitivity

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

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RECORD OF BOREHOLE No 23

W P 160-74-33 LOCATION Coords. N 15,985,302; E 1,027,300 ORIGINATED BY D.C.

DIST 6 HWY 404 BOREHOLE TYPE Hollow Stem Augers COMPILED BY M.M.

DATUM Geodetic DATE June 14-15, 1978 CHECKED BY

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES 'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE
996.2	Ground Surface						
0.0 / 994.2	Organic Silt		1	SS	6	▼	
2.0 / 990.2	Sand, Some Silt Compact		2	SS	16		990
6.0	Clayey Silt to Silt of Slight Plasticity Very Stiff to Hard		3	SS	20		
			4	SS	24		
			5	SS	27		980
			6	SS	31		
			7	SS	28		
			8	SS	37		970
			9	SS	22		
			10	SS	71		960
948.2			11	SS	104		
48.0 / 941.2	Silt Very Dense		12	SS	100/ 5"		950
55.0	Heterogeneous Mixture of Clayey Silt, Sand and Gravel Cobbles Hard Glacial Till		13	SS	106/ 6"		940
924.7			14	SS	100/ 5"		930
71.5	End of Borehole						

DYNAMIC CONE PENETRATION RESISTANCE PLOT — 20 40 60 80 100

SHEAR STRENGTH
○ UNCONFINED + FIELD VANE
● QUICK TRIAXIAL × LAB VANE

PLASTIC LIMIT W_p | NATURAL MOISTURE CONTENT W | LIQUID LIMIT W_L

WATER CONTENT (%) 20 40 60

UNIT WEIGHT γ

REMARKS & GRAIN SIZE DISTRIBUTION (%)	GR	SA	SI	CL
	Om	2%		
	2	21	41	36
	0	2	77	21
	10	43	32	15

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

20
15 ◇ 5 (%) STRAIN AT FAILURE
10

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RECORD OF BOREHOLE No 24

35

W P 160-74-33 LOCATION Coords. N 15,985,255; E 1,027,336 ORIGINATED BY D.C.

DIST 6 HWY 404 BOREHOLE TYPE Hollow Stem Auger COMPILED BY D.C.

DATUM Geodetic DATE June 15-19, 1978 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: o UNCONFINED, + FIELD VANE, ● QUICK TRIAXIAL, × LAB VANE (400 800 1200 1600 2000)	PLASTIC LIMIT Wp / NATURAL MOISTURE CONTENT W / LIQUID LIMIT W_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
995.2	Ground Elevation										
0.0	Sand, Some Gravel Trace Organics		1	SS	3	▽					
990.2	Loose to Compact		2	SS	16		990		o		
5.0	Clayey Silt to Silt of Slight Plasticity		3	SS	13						
			4	SS	16				⊡		0 4 90 6
			5	TW	PH			+ 3			
	Stiff to Hard		6	SS	30		980				
			7	SS	20						
			8	SS	39		970		⊡		0 1 80 19
			9	SS	39						Piezometer placed 78 06 19
							960				
			10	SS	25				⊡o		0 1 73 26
							950				
			11	SS	145				o		2 10 74 14
941.2							940				
54.0	Heterogeneous Mixture Clayey Silt, Sand and Gravel		12	SS	100/ 4"						
			13	SS	100/ 5"		930		o		Piezometer placed 78 06 19
923.7			14	SS	150/ 6"						
71.5	End of Borehole										

+3, ×5 : Numbers refer to Sensitivity

15 20 10 5 (%) STRAIN AT FAILURE

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RECORD OF BOREHOLE No 25

36

W P 160-74-33 LOCATION Coords. N 15.985,208; E 1,027,256 ORIGINATED BY D.C.

DIST 6 HWY 404 @ CNR BOREHOLE TYPE Hollow Stem Augers COMPILED BY D.C.

DATUM Geodetic DATE June 20, 1978 CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH (o UNCONFINED, • QUICK TRIAXIAL, + FIELD VANE, x LAB VANE; 400 800 1200 1600 2000)	PLASTIC LIMIT Wp / NATURAL MOISTURE CONTENT W / LIQUID LIMIT WL; WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES						GR SA SI CL
994.7	Ground Surface										
0.0	Organic Silt		1	SS	1½						Om 77% W=355%
	Very Soft		2	SS	1½		990				
986.7	Organic Clay, White to Grey, Very Soft		3	SS	1/18"			+ 4	o		Om 2%
8.0	Clayey Silt to Silt of Slight Plasticity		4	SS	0 WN WT			+ 2	o		
	Very Soft		5	SS	2			+ 2			
975.7			6	SS	3		980				
19.0	Silt, Some Sand		7	SS	7						
	Loose to Compact		8	SS	12		970				
965.7											
29.0	Clayey Silt to Silt of Slight Plasticity		9	SS	40						
	Hard										
958.2			10	SS	63		960		OH		0 2 78 20
36.5	End of Borehole										

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+3, x5 : Numbers refer to Sensitivity

20
15 ◇ 5 (%) STRAIN AT FAILURE
10

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RECORD OF BOREHOLE No 26

37

W P 160-74-33 LOCATION Coords. N 15,985,178; E 1,027,280 ORIGINATED BY D.C.

DIST 6 HWY 404 @ CNR BOREHOLE TYPE Hollow Stem Augers COMPILED BY D.C.

DATUM Geodetic DATE June 21, 1978 CHECKED BY A.J.

SOIL PROFILE ELEV/DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH (o UNCONFINED, • QUICK TRIAXIAL, + FIELD VANE, x 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
994.5	Ground Surface										
0.0	Organic Silt Black Organic Clay Very Soft White to Grey, Very Soft		1	SS	2	18"	990	+8			
986.5			2	SS	27			+4			
			3	TW	PH			+3	HD		
8.0	Clayey Silt to Silt of Slight Plasticity Some Sand Very Soft to Firm		4	SS	0		980	+3			
			5	SS	0						
			6	SS	3			+3			
970.5			7	SS	3						
24.0	Silt, Some Sand Loose		8	SS	6		970		o		1 30 63 6
963.5			9	SS	67						
31.0	Clayey Silt to Silt of Slight Plasticity Hard						960				
958.0			10	SS	50						
36.5	End of Borehole										

OFFICE REPORT ON SOIL EXPLORATION

+3, x5 : Numbers refer to Sensitivity

15 20 10 5 (%) STRAIN AT FAILURE

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Ontario

HIGHWAY ENGINEERING DIVISION - ENGINEERING MATERIALS OFFICE - SOIL MECHANICS SECTION

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RECORD OF BOREHOLE No 27

W P 160-74-33 LOCATION Coords. N 15,985,485; E 1,027,495 ORIGINATED BY D.C.

DIST 6 HWY 404 BOREHOLE TYPE Hollow Stem Augers COMPILED BY D.C.

DATUM Geodetic DATE June 21, 1978 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 (%) (20 40 60)	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
995.3	Ground Elevation										
0.0	Organic Silt Some Sand		1	SS	4						
993.3											
2.0	Silt, Some Sand		2	SS	15		990				0 23 75 2
	Compact		3	SS	21						
987.3											
8.0	Clayey Silt to Silt of Slight Plasticity		4	SS	22						
			5	SS	23						
	Some Sand Silt, Compact		6	SS	25		980				
			7	SS	33						
	Very Stiff to Hard										
			8	SS	30		970				0 2 87 11
964.8			9	SS	21						
31.5	End of Borehole										

+3, ×5 : Numbers refer to Sensitivity

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

OFFICE REPORT ON SOIL EXPLORATION

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

RECORD OF BOREHOLE No 28

39

W P 160-74-33 LOCATION Coords. N 15,985,298; E 1,027,392 ORIGINATED BY D.C.

DIST 6 HWY 404 @ CNR BOREHOLE TYPE Hollow Stem Augers COMPILED BY D.C.

DATUM Geodetic DATE June 22, 1978 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 (%) (20 40 60)	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
995.3	Ground Surface										
0.0	Sand, Some Silt		1	SS	13						
	Loose to Compact		2	SS	15		990				
			3	SS	9				○		18 43 32 7
985.3			4	SS	9						
10.0	Clayey Silt to Silt of Slight Plasticity		5	SS	12						
			6	SS	17		980				
	Some Sand										
	Very Stiff to Hard		7	SS	21						
							970				
963.8			8	SS	32						
			9	SS	28						
31.5	End of Borehole										

OFFICE REPORT ON SOIL EXPLORATION

+3, ×5 : Numbers refer to Sensitivity

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

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HIGHWAY ENGINEERING DIVISION - ENGINEERING MATERIALS OFFICE - SOIL MECHANICS SECTION

RECORD OF BOREHOLE No 29

40

W P 160-74-33 LOCATION Coords. N 15,985,268; E 1,027,273 ORIGINATED BY D.C.

DIST 6 HWY 404 @ CNR BOREHOLE TYPE Hollow Stem Augers COMPILED BY D.C.

DATUM Geodetic DATE June 22, 1978 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 (%)	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES						
994.3											
0.0	Organic Silt Very Soft Organic Clay		1	SS	1						
			2	SS	1/18"		990	+4			
	Very Soft		3	TW	PH			+4			
985.3											
9.0	Clayey Silt to Silt of Slight Plasticity		4	TW	PH			+2			
982.0	Very Soft										
			5	SS	13						
12.0							980				
	Clayey Silt to Silt of Slight Plasticity		6	SS	15				○		0 28 62 10
			7	SS	19						
	Very Stiff to Hard						970				
966.3			8	SS	17						
28.0	Clayey Silt to Silt of Slight Plasticity										
962.8	Hard		9	SS	48				⊢○⊣		
31.5	End of Borehole										

OFFICE REPORT ON SOIL EXPLORATION

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

20
15 ◇ 5 (%) STRAIN AT FAILURE
10

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HIGHWAY ENGINEERING DIVISION - ENGINEERING MATERIALS OFFICE - SOIL MECHANICS SECTION

RECORD OF BOREHOLE No 30

41

W P 160-74-33 LOCATION Coords. N 15,985,320; E 1,027,212 ORIGINATED BY D.C.

DIST 6 HWY 404 BOREHOLE TYPE Hollow Stem Augers COMPILED BY M.M.

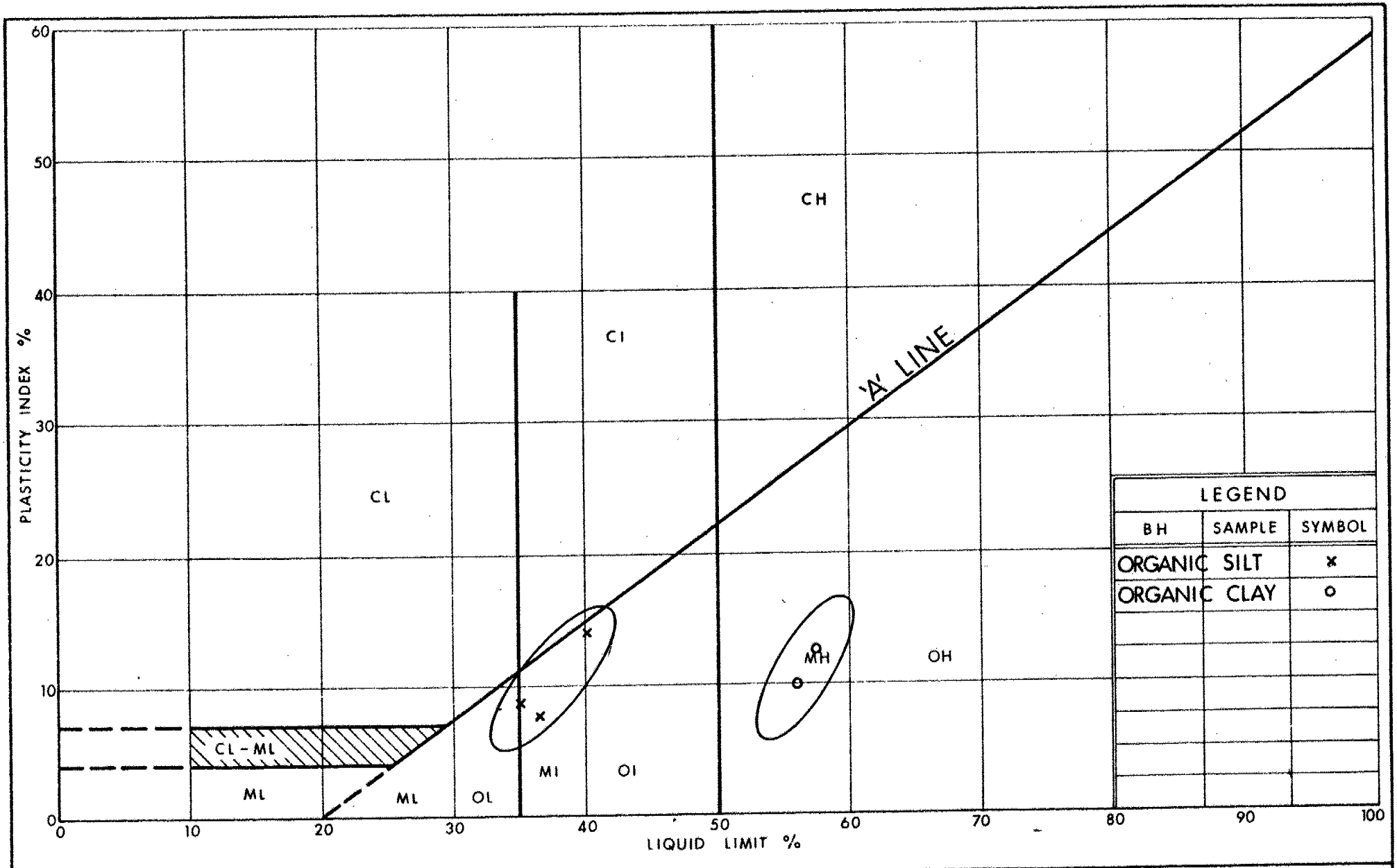
DATUM Geodetic DATE June 23, 1978 CHECKED BY

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 W_L — WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES						GR SA SI CL
996.3	Ground Surface										
0.0	Organic Silt		1	SS	15						
991.3			2	SS	14		990				
5.0	Silt, Some Sand Loose to Compact		3	SS	13						
985.3			4	SS	4						
11.0	Clayey Silt to Silt of Slight Plasticity Very Stiff to Hard		5	SS	13						
			6	SS	24		980				
			7	SS	20						0 3 44 53
			8	SS	24		970				
964.8			9	SS	39						
31.5	End of Borehole										

OFFICE REPORT ON SOIL EXPLORATION

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

20
15 ◇ 5 (%) STRAIN AT FAILURE
10



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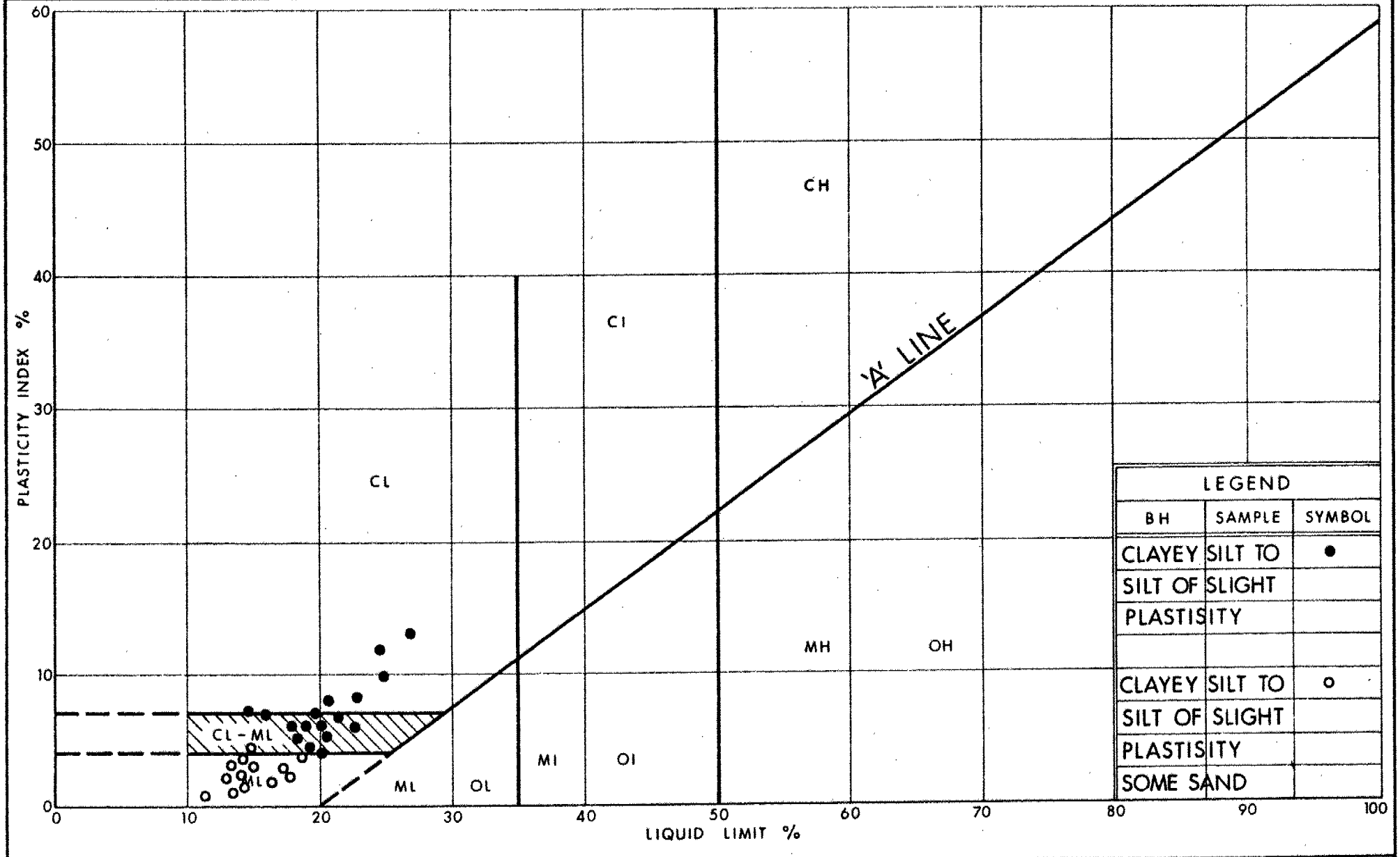
PLASTICITY CHART
ORGANIC SILT & ORGANIC CLAY

FIG No 1
W P 160-74-33



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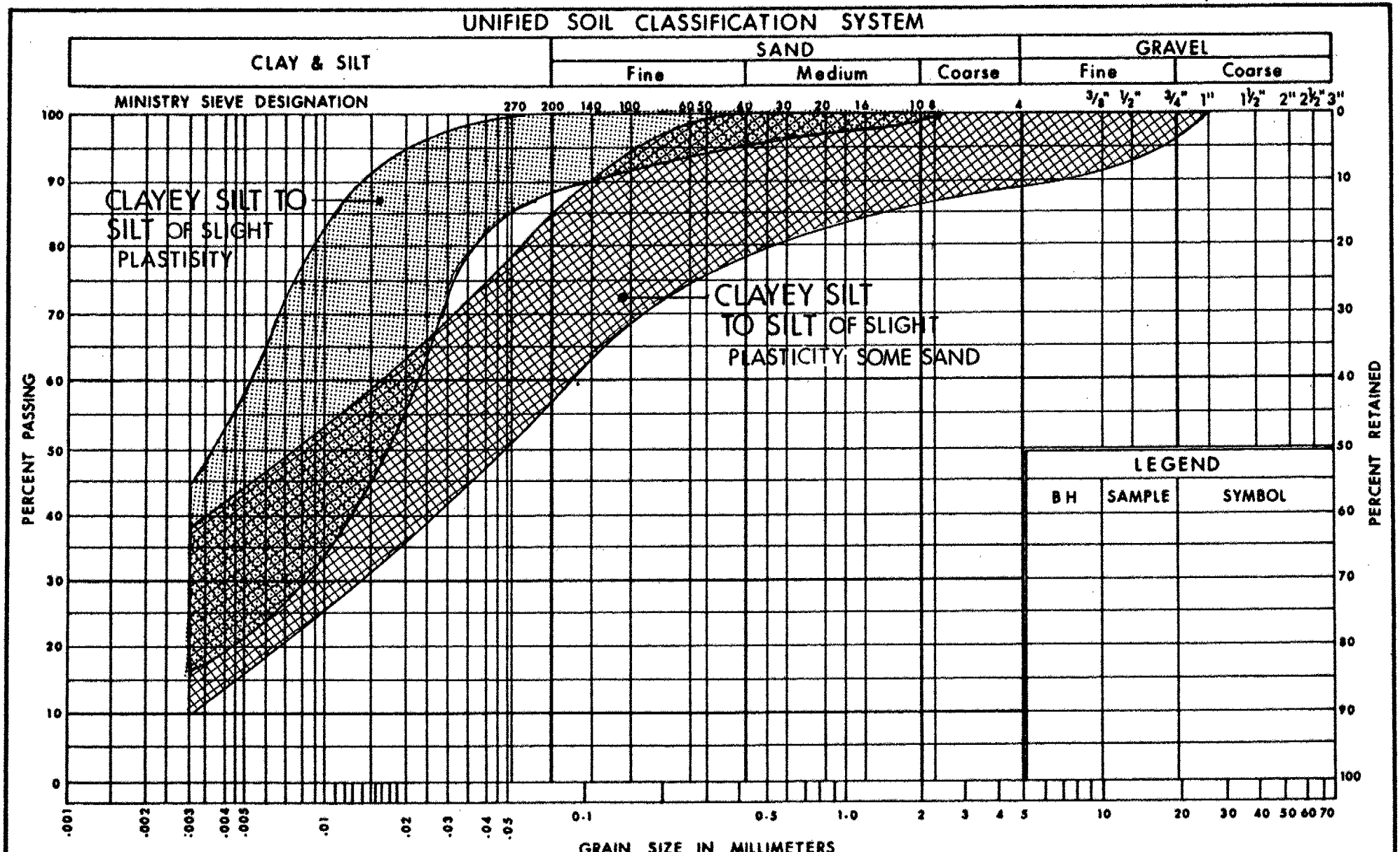
PLASTICITY CHART
CLAYEY SILT TO SILT OF SLIGHT PLASTICITY

FIG No 2
W.P 160-74-33



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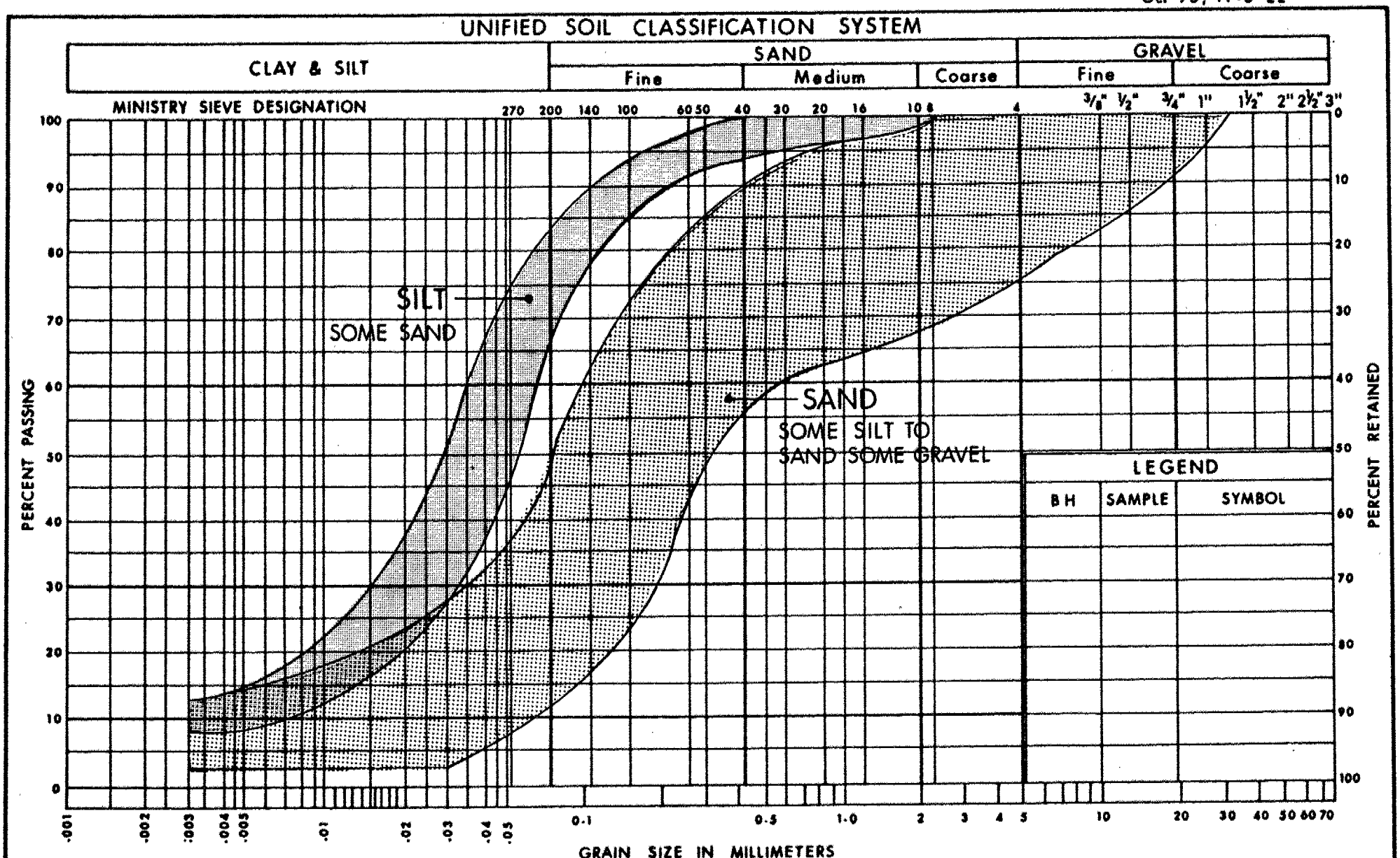
GRAIN SIZE DISTRIBUTION
CLAYEY SILT TO SILT
OF SLIGHT PLASTICITY

FIG No 3
WP 160-74-33



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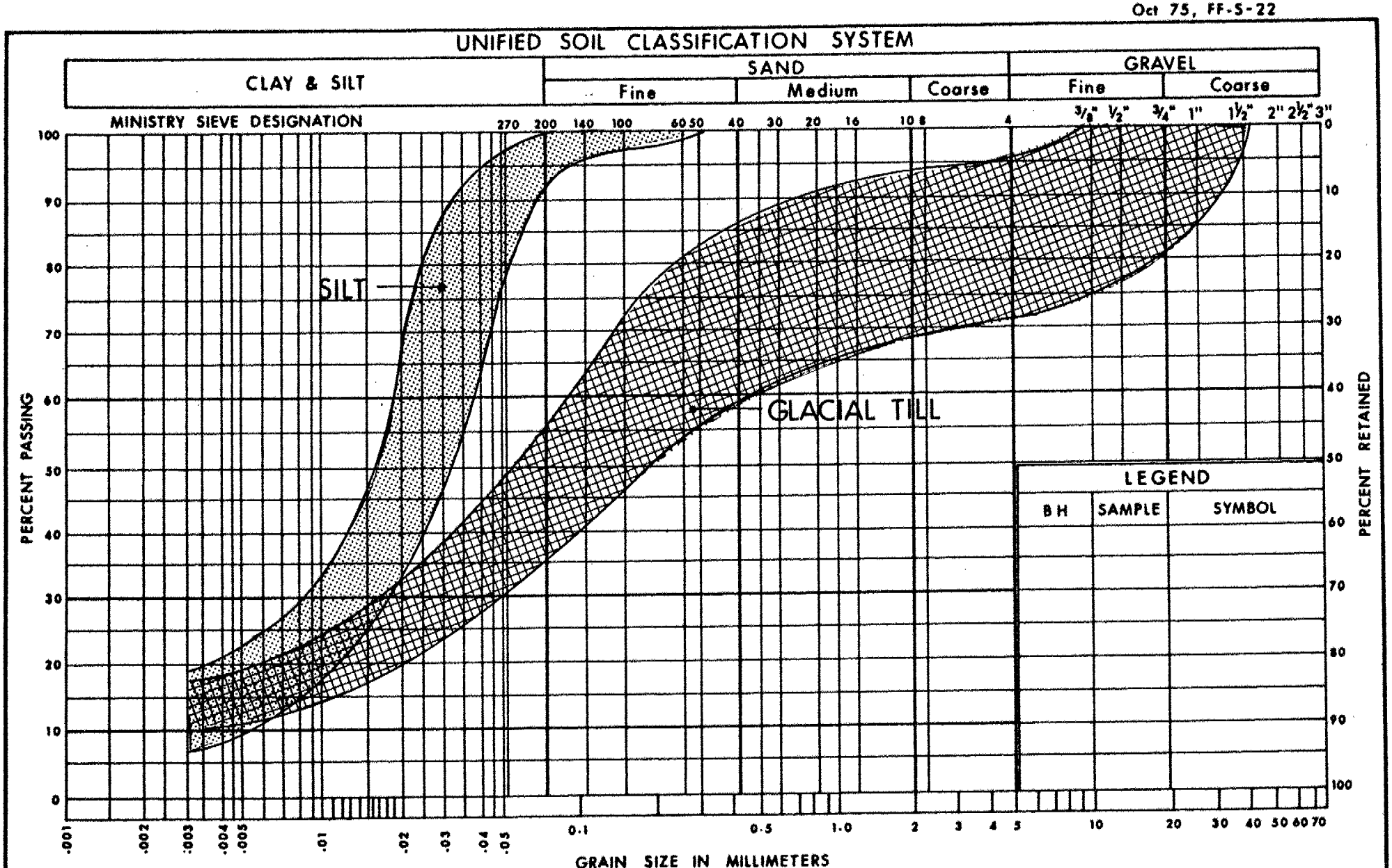
GRAIN SIZE DISTRIBUTION

FIG No 4
W P 160-74-33

45



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GRAIN SIZE DISTRIBUTION

FIG No 5
W P 160-74-33

FOUNDATION INVESTIGATION REPORT

For

Vandorf Side Road Underpass
4.0 Miles North of Regional Road 14
Hwy. 404, District 6, Toronto
W.P. 160-74-34, Site 37-699

INTRODUCTION

This report contains the results of a foundation investigation carried out at the site of the above-mentioned project. The fieldwork was carried out during the period of February 6 to February 17, 1978 and consisted of a total of seven sampled boreholes, six of which were accompanied by a dynamic cone penetration test. The borings were advanced by means of continuous flight hollow stem augers 3 1/4 inch I. D. as well as washboring techniques, to depths ranging from 21 to 123 feet below the existing ground surface.

SITE DESCRIPTION AND GEOLOGY

The site is located on Vandorf Side Road some 1600 ft. west of Woodbine Avenue (Regional Road 8) bordering the Towns of Aurora and Whitchurch-Stouffville, Regional Municipality of York. The topography of the surrounding area is gently undulating. Presently, land use is rural residential. Physiographically, the area is located in the region known as "Oak Ridges Moraine". The surface feature of the general area is hilly, with knobs and basin reliefs typical of end-moraines. Most of the hills are composed of sandy or gravelly material.

SUBSOIL CONDITIONS

General

Subsoil conditions across the site were found to be somewhat variable. Sandy fill material up to 6 feet thick was encountered under the existing roadway bed of Vandorf Side Road.

Below this fill material or immediately beneath a thin layer of topsoil, up to 1 foot thick, is a granular deposit composed of sand and or sandy gravel with the exception of one particular location where this granular statum was not encountered. Beneath this granular deposit or the roadway fill is a cohesive stratum of silty clay and silt of slight plasticity. This stratum in most locations overlies a cohesive deposit of glacial till composed of a heterogeneous mixture of silty clay, sand and traces of gravel. The lower boundary of the deposit was not proven at any of the boring locations beyond a maximum depth of 123.0 feet below the existing ground surface. In certain locations a deposit of silt is sandwiched between the glacial till and the above silty clay and silt deposits. The boundaries between the various subsoil types are shown on the Record of Borehole Sheets. The locations and elevations of the boreholes, together with three stratigraphical sections inferred from the borehole data, are shown on Drawing No. 2. From ground level downwards the subsoil types are described as follows:

Fill Material - Silty Sand and Gravel

On the shoulder of the existing roadway, fill material was encountered extending from the existing grade down to a depth of up to 6.0 feet. The composition of the fill material consists of silty sand and gravel. In places within the fill material traces of organics were also found. It is believed that this fill was obtained from the cut material of surrounding hilly terrain. Based on the Standard Penetration Tests 'N' values which range from 12 to 19 blows per foot, and the nature of augering, it is inferred that the fill material has been subjected to a moderate degree of compaction.

Fine to Medium Sand, Traces of Silt and Gravel

Under a thin layer of topsoil or below the fill material is a deposit 3 to 15 feet thick of fine to medium sand with traces of silt and gravel (BH. 4,5,6 and 7). Typical grain size distribution curves of this material are shown on Fig. 1. The 'N' values obtained from the Standard Penetration Tests ranged from 1 to 28 blows per foot generally increasing with depth which indicates that the relative density of this granular deposit is very loose to compact.

Sandy Gravel, Traces of Silt

A granular deposit of sandy gravel with traces of silt, the thickness of which ranges from 5 to 8 ft., was encountered immediately below the fill material and the topsoil in the eastern portion of the site and below the fine to medium sand stratum in the southwestern portion of the site. A typical grain size distribution curve of the sandy gravel is shown on Figure No. 1. The Standard Penetration Test 'N' values of 15 to 39 blows per foot indicate that the relative density of the sandy gravel is compact to dense.

Irregular Layers of Silty Clay and Silt of Slight Plasticity

Beneath the surficial granular stratum or the topsoil layer where the granular stratum was not encountered is the predominant deposit of this site consisting of irregular layers of silty clay and silt of slight plasticity. Within this deposit, there are also random layers or pockets of noncohesive silt. This deposit was intercepted everywhere at this site and where it was fully penetrated its thickness was found to range from 35 to 76 feet. The grain size distribution curves carried out from typical samples of this deposit are shown in an envelope form on Figure No. 2, and the physical properties of this cohesive material are as follows:

		Range	Average
Liquid Limit	(W_L) %	18-25	22
Plastic Limit	(W^P) %	11-17	15
Moisture Content	(W^P) %	17-28	23
Plasticity Index	(I_p) %	3-15	7

The result of the Atterberg Limit Tests are plotted on the plasticity chart (Fig. 3) which indicates that this cohesive deposit is inorganic and of low plasticity (CL to CL-ML). The Standard Penetration Tests gave 'N' values in a random range of 5 to 67 blows per foot. Based on these 'N' values the consistency of this deposit may be described as firm to very stiff, but being generally stiff.

Silt Traces of Clay and Fine Sand

In certain locations a distinct deposit of silt was sandwiched between the stratum of silty clay and silt of slight plasticity and the glacial till deposit. The overall thickness of this silt stratum varies from 38 to 41 feet. Based on the Standard Penetration Tests 'N' values which range from 17 to 81 blows per foot, the relative density of the silt is assessed as compact to very dense.

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

This glacial till deposit was encountered between elevation 916 and 913, underlying the silt layer or the cohesive stratum of silty clay and silt of low plasticity. The full extent of this glacial till was not explored and the investigation was terminated within this deposit at a maximum depth of 123.0 feet below the existing ground surface. This stratum was proven to a total thickness of 23 feet. In general, the glacial till is cohesive, being composed of a heterogeneous mixture of silty clay, sand and traces of gravel. Typical grain size distribution curves in an envelope form are shown on Figure 2.

The Standard Penetration Tests gave 'N' values in the range of 66 to over 100 blows per foot, generally increasing with depth. Based on these 'N' values the consistency of this cohesive glacial till stratum is estimated to be hard. The physical properties of the cohesive glacial till as determined from laboratory testing are summarized as follows:

Liquid Limit	(W_L) %	12-15	14
Plastic Limit	(W^P) %	9-10	10
Moisture Content	(W^P) %	7-12	9
Plasticity Index	(I_p) %	3- 5	4

The results of the Atterberg Limit Tests are shown on the Plasticity Chart (Figure 3). These results indicate that the matrix is inorganic and of low plasticity.

Groundwater

Groundwater level observations were carried out at the time of the field investigation. The observations indicated that the groundwater level was found to be 1.5 to 24 feet below the existing ground surface which corresponds to a range in elevation of 989.5 to 992.5.

M. Devata, P. Eng.
Senior Foundations Engineer

APPENDIX

Ministry of Transportation and Communications
Ontario

HIGHWAY ENGINEERING DIVISION - ENGINEERING MATERIALS OFFICE - SOIL MECHANICS SECTION

RECORD OF BOREHOLE No 1

53

W P 160-74-34 LOCATION Co-ords N 15,986,637; E 1,027,256 ORIGINATED BY G.P.

DIST 6 HWY 404 BOREHOLE TYPE 3¼" I.D. Hollow Stem Auger & Cone Test COMPILED BY R.S.

DATUM Geodetic DATE February 14 and 17, 1978 CHECKED BY RS

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 PSF (o UNCONFINED, • QUICK TRIAXIAL, + FIELD VANE, × LAB VANE; 400 800 1200 1600 2000)	PLASTIC LIMIT Wp / NATURAL MOISTURE CONTENT W / LIQUID LIMIT WL; WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ PCF	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
995.4	Ground Level										
0.0 / 990.9	Roadway Fill Silty Sand and Gravel						990	3" Frozen Ground 150/6" = 150			
4.5 / 986.0	Topsoil Sandy Gravel Tracesof Silt Brown										
9.4	Irregular Layers of Clayey Silt and Silt of Slight Plasticity Also Random Layers or Pockets of Silt		1	TW	PH		980	S=4.5; S=6	One		0 2 87 11
	Grey		2	TW	PH		970	S=3.4; >2000		126	
	Stiff		3	TW	PH						
958.4			4	TW	PH		960				0 2 76 22
37.0 / 953.9	End of Borehole										
41.5	End of Cone Test							150/6"			

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

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

OFFICE REPORT ON SOIL EXPLORATION

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HIGHWAY ENGINEERING DIVISION - ENGINEERING MATERIALS OFFICE - SOIL MECHANICS SECTION

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RECORD OF BOREHOLE No 2

W P 160-74-34 LOCATION Coords. N 15,986,597; E 1,027,266 ORIGINATED BY G.P.

DIST 6 HWY 404 BOREHOLE TYPE 3¼" I.D. Hollow Stem Augers - Washboring & Cone Test COMPILED BY R.S.

DATUM Geodetic DATE February 8, 9 & 10, 1978 CHECKED BY RS

ELEV / DEPTH	SOIL PROFILE: 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 PSF (o UNCONFINED, • QUICK TRIAXIAL, + FIELD VANE, x LAB VANE; 400 800 1200 1600 2000)	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
994.0	Ground Level										
0.0	Topsoil										
	Sandy Gravel Traces of Silt Compact Brown		1	SS	15		990				
986.6			2	SS	19						0 2 83 15
7.4			3	SS	18						
			4	TW	PH		980				
			5	SS	6			S=4.8			
			6	TW	PH			S=5.3			
	Irregular Layers of Clayey Silt and Silt of Slight Plasticity Also Random Layers or Pockets of Silt		7	SS	5		970	S=3.8			
	Seams of Silty Clay		8	TW	PH						0 1 (99)
	Grey Stiff						960				
			9	SS	13			>2000			
			10	SS	50				120 190		6 3 74 17
952.0											
42.0			11	SS	53		950				0 2 92 6
			12	SS	52						
	Silt, Traces of Clay and Fine Sand		13	SS	41		940				
	Grey										
	Dense to Very Dense		14	SS	81						
			15	SS	36		930				
			16	SS	51						0 3 91 6
	Clayey Silt		17	SS	49		920				
913.5			18	SS	104						2 25 58 15
80.5	Glacial Till Heterogeneous Mixture of Clayey Silt, Sand and Traces of Gravel		19	SS	200/ 4"		910				
	Grey Hard										
898.4			20	SS	212/ 7"		900				
95.6											

+3, x5 : Numbers refer to Sensitivity

15 20 10 5 (%) STRAIN AT FAILURE

OFFICE REPORT ON SOIL EXPLORATION

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HIGHWAY ENGINEERING DIVISION - ENGINEERING MATERIALS OFFICE - SOIL MECHANICS SECTION

RECORD OF BOREHOLE No 3

55

W P 160-74-34 LOCATION Coords. N 15,986,605; E 1,027,154 ORIGINATED BY G.P.

DIST 6 HWY 404 BOREHOLE TYPE 3½" I.D. Hollow Stem Augers & Cone Test COMPILED BY R.S.

DATUM Geodetic DATE February 14, 15 & 16, 1978 CHECKED BY

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE
998.1	Ground Level						
0.0	Roadway fill silty sand traces of gravel compact		1	SS	19		
993.7	Topsoil		2	SS	15		
4.4	Silt Loose to Compact		3	SS	7		990
			4	SS	12		
	Brown Grey		5	SS	23		980
	Irregular layers of clayey silt and silt of slight plasticity also random layers or pockets of silt stiff to very stiff		6	TW	PH		
			7	TW	PH		970
			8	SS	13		
			9	SS	18		
957.1			10	SS	39		960
41.0			11	SS	31		
	Silt, traces of clay & fine sand grey Dense to compact		12	SS	55		950
			13	SS	23		940
			14	SS	21		930
			15	SS	17		
	clayey silt		16	SS	18		920
916.1							
82.0	Glacial till Het. mixture of clayey silt, sand & traces of gravel		17	SS	73		
			18	SS	166/10"		910
903.6	Grey Hard		19	SS	182/6"		
94.5	End of Borehole						

DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100)

SHEAR STRENGTH PSF
○ UNCONFINED + FIELD VANE
● QUICK TRIAXIAL × LAB VANE
400 800 1200 1600 2000

Augered first 3 feet

+s=5.7

+s=4.4

160

PLASTIC LIMIT Wp — NATURAL MOISTURE CONTENT W — LIQUID LIMIT WL

WATER CONTENT (%) 10 20 30

NP

NP

NP

UNIT WEIGHT γ

REMARKS & GRAIN SIZE DISTRIBUTION (%)	GR	SA	SI	CL
	0	0	92	8
	0	5	80	15
	0	4	84	12
	0	2	87	11
	8	44	31	17

+3, ×5 : Numbers refer to Sensitivity

15 20 10 5 (%) STRAIN AT FAILURE

OFFICE REPORT ON SOIL EXPLORATION

Ministry of Transportation and Communications
Ontario

HIGHWAY ENGINEERING DIVISION - ENGINEERING MATERIALS OFFICE - SOIL MECHANICS SECTION

RECORD OF BOREHOLE No 4

56

W P 160-74-34 LOCATION Coords. N 15, 986, 565; E 1,027,161 ORIGINATED BY G.P.

DIST 6 HWY 404 BOREHOLE TYPE 3¼" I.D. Hollow Stem Augers & Cone Test COMPILED BY R. S.

DATUM Geodetic DATE February 10 and 13, 1978 CHECKED BY R.

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
1002.5	Ground Level										
0.0	Topsoil						1000	Frozen Ground			
	Gravelly Sand		1	SS	21						3 93 (4)
	Fine to medium sand Traces of Gravel and silt, Brown Compact		2	SS	12						
991.5			3	SS	18	▼					
11.0			4	SS	10		990				0 4 86 10
			5	SS	10						
	Silt Compact										
			6	TW	PH				NP		0 3 90 7
	Brown Grey						980				
			7	SS	11						7 2 77 14
	Irregular layers of Clayey silt and silt of slight plasticity also random layers or pockets of silt Stiff to Hard		8	TW	PH						
			9	SS	14		970				
			10	TW	PH			125 / 157			0 4 81 15
							960				
			11	SS	39						
			12	SS	67				NP		0 5 85 10
							950				
941.0	Silt V.Dense		13	SS	84						
60.5	End of Borehole										

OFFICE REPORT ON SOIL EXPLORATION

+3, ×5 : Numbers refer to Sensitivity

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

Ministry of Transportation and Communications
Ontario

HIGHWAY ENGINEERING DIVISION - ENGINEERING MATERIALS OFFICE - SOIL MECHANICS SECTION

RECORD OF BOREHOLE No 5

57

W P 160-74-34 LOCATION Coords. N 15,986,572; E 1,027,052 ORIGINATED BY G.P.

DIST 6 HWY 404 BOREHOLE TYPE 3¼" I.D. Hollow Stem Augers & Cone Test COMPILED BY R.S.

DATUM Geodetic DATE February 13 & 14, 1978 CHECKED BY RS

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 PSF (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE; 400 800 1200 1600 2000)	PLASTIC LIMIT Wp / NATURAL MOISTURE CONTENT W / LIQUID LIMIT Wl; WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ PCF	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
1002.2	Ground Level										
0.0	Roadway Fill Silty Sand, Traces of Gravel & Organics Compact		1	SS	12		1000	3 'Frozen Ground			
997.2	Topsoil		2	SS	5					Org.M. 0.49%	4 88 (8)
5.0	Fine to Medium Sand Traces of Silt & Gravel Compact		3	SS	8						
990.2	Brown to Light Brown		4	SS	11	▼	990				
12.0			5	SS	12						
	Brown Grey		6	TW	PH			2000	NP		0 3 90 7
	Silt, Traces of Fine Sand & Seams of Clayey Silt Compact		7	SS	15		980				
			8	SS	14						0 1 90 9
											0 1 84 15
	Irregular Layers of Clayey Silt and Silt of Slight Plasticity, Also Random Layers or Pockets of Silt		9	SS	14		970				
			10	TW	PH			2000		127	
	seams of silty clay									e_o=0.68	
956.7	Stiff to Very Stiff		11	SS	19		960			C_c=0.09	
45.5	End of Borehole										
947.2							950	120			
55.0	End of Cone							130			

+3, ×5 : Numbers refer to Sensitivity

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

OFFICE REPORT ON SOIL EXPLORATION

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HIGHWAY ENGINEERING DIVISION - ENGINEERING MATERIALS OFFICE - SOIL MECHANICS SECTION

58

RECORD OF BOREHOLE No 6

W P 160-74-34 LOCATION Coords. N 15,986,527; E 1,027,069 ORIGINATED BY G.P.

DIST 6 HWY 404 BOREHOLE TYPE 3¼" I.D. Hollow Stem Augers & Cone Test COMPILED BY G.P.

DATUM Geodetic DATE February 6 & 7, 1978 CHECKED BY [illegible]

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 PSF (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE 400 800 1200 1600 2000)	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
1014.0	Ground Level										
0.0	Topsoil										
	Fine to Medium Sand Traces of Silt & Gravel Brown-Light Brown Very Loose to Compact		1	SS	2		1010				
			2	SS	2						
			3	SS	1						4 93 (3)
			4	SS	28		1000				
998.0			5	SS	38			139/6"			
16.0	Sandy Gravel Traces of Silt Greyish Brown to Grey Dense to Compact		6	SS	39						55 41 (4)
989.7			7	SS	20	▼	990				
24.3			8	SS	21						0 0 90 10
			9	TW	PH		980				
			10	SS	16						
	Light Brown Grey		11	SS	33		970				
			12	SS	15						
	Irregular Layers of Clayey Silt and Silt of Slight Plasticity Also Random Layers or Pockets of Silt Stiff to Hard		13	TW	PH		960	>2000			
			14	TW	PH						
			15	SS	10		950				0 1 87 12
			16	SS	14			>2000			
			17	SS	20		940				
			18	SS	15						
			19	SS	23		930	>2000			
			20	SS	41						
			21	SS	48		920				
913.5	Silt Dense		22	SS	42						
100.5	Glacial Till Heterogeneous Mixture of Clayey Silt, Sand & Some Gravel Grey Hard		23	SS	66		910				11 47 28 14
			24	SS	176/6"						
			25	SS	193/9"		900				20 33 29 18
890.7			26	SS	200/4"						
123.3	End of Borehole										

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

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

OFFICE REPORT ON SOIL EXPLORATION

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HIGHWAY ENGINEERING DIVISION - ENGINEERING MATERIALS OFFICE - SOIL MECHANICS SECTION

RECORD OF BOREHOLE No 7

59

W P 160-74-34 LOCATION Coords. N 15,986,632; E 1,027,304 ORIGINATED BY G.P.

DIST 6 HWY 404 BOREHOLE TYPE 3¼" I.D. Hollow Stem Augers COMPILED BY R.S.

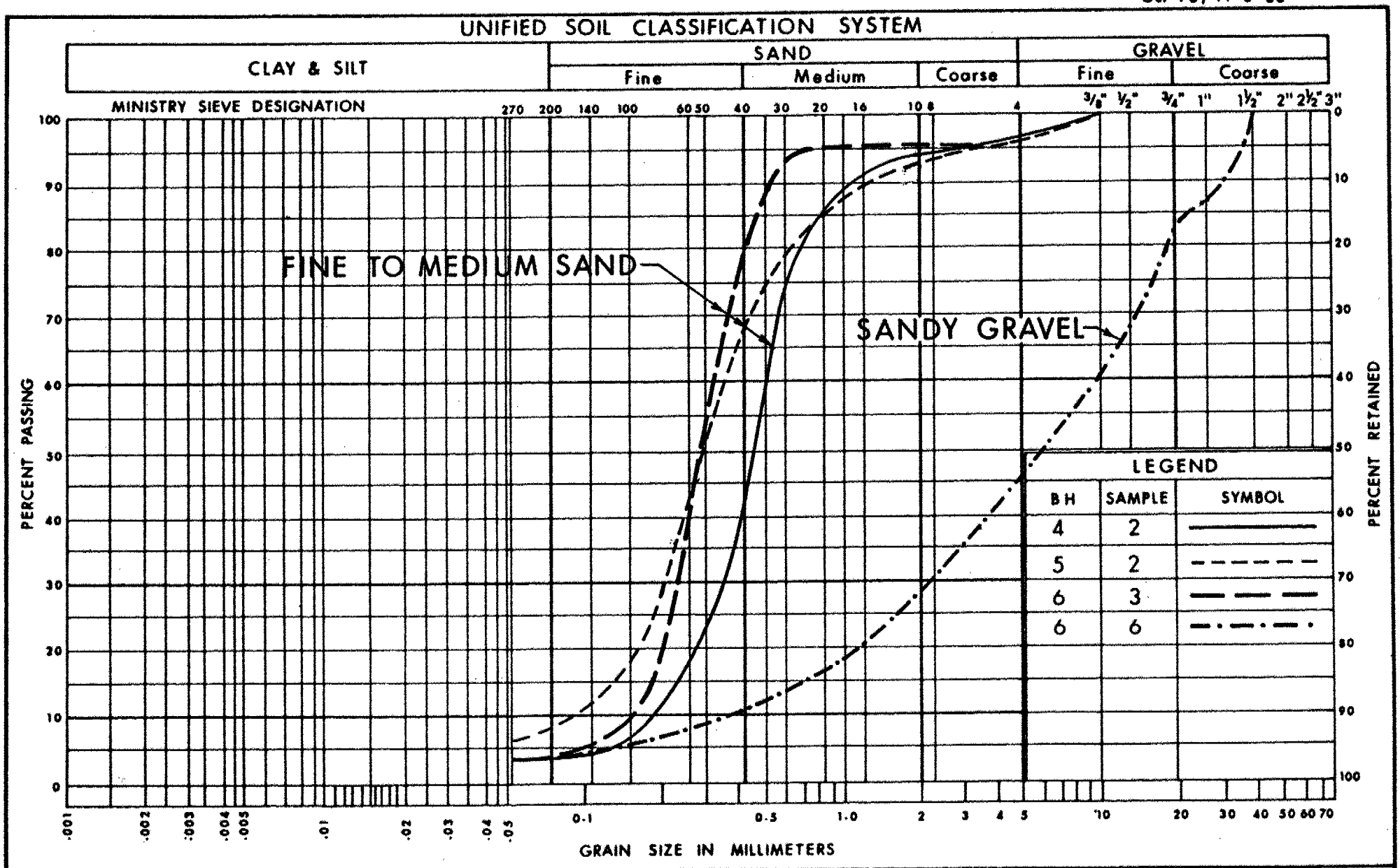
DATUM Geodetic DATE February 17, 1978 CHECKED BY RS

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 PSF (o UNCONFINED, • QUICK TRIAXIAL, + FIELD VANE, × LAB VANE; 400 800 1200 1600 2000)	PLASTIC LIMIT Wp / NATURAL MOISTURE CONTENT W / LIQUID LIMIT WL; WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ PCF	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
995.0	Ground Level										
0.0	Roadway Fill Silty Sand and Gravel						990				
989.0											
6.0	Topsoil										
986.0	Sand										
9.0	Brown Grey Irregular Layers of Cl. Silt & Silt of Slight Plasticity, Also Random Layers or Pockets of Silt, Stiff		1	TW	PH		980		W	134	0 2 85 13
974.3			2	TW	PH			> 2000			
			3	TW	PH			+S=7	NP		0 1 89 10
30.7	End of Borehole										

+3, ×5 : Numbers refer to Sensitivity

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

OFFICE REPORT ON SOIL EXPLORATION



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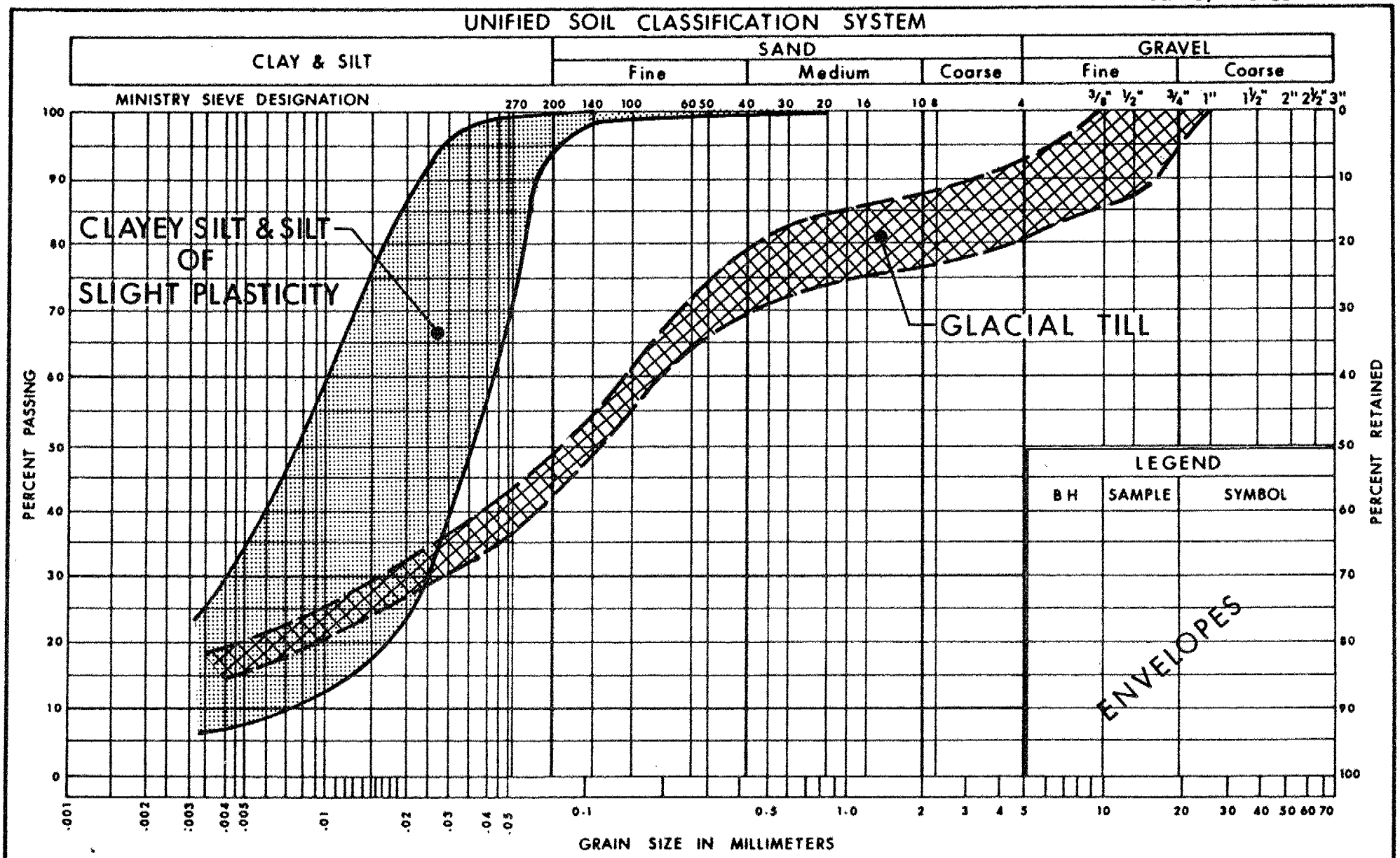
GRAIN SIZE DISTRIBUTION

FIG No 1
W P 160 - 74 - 34
09



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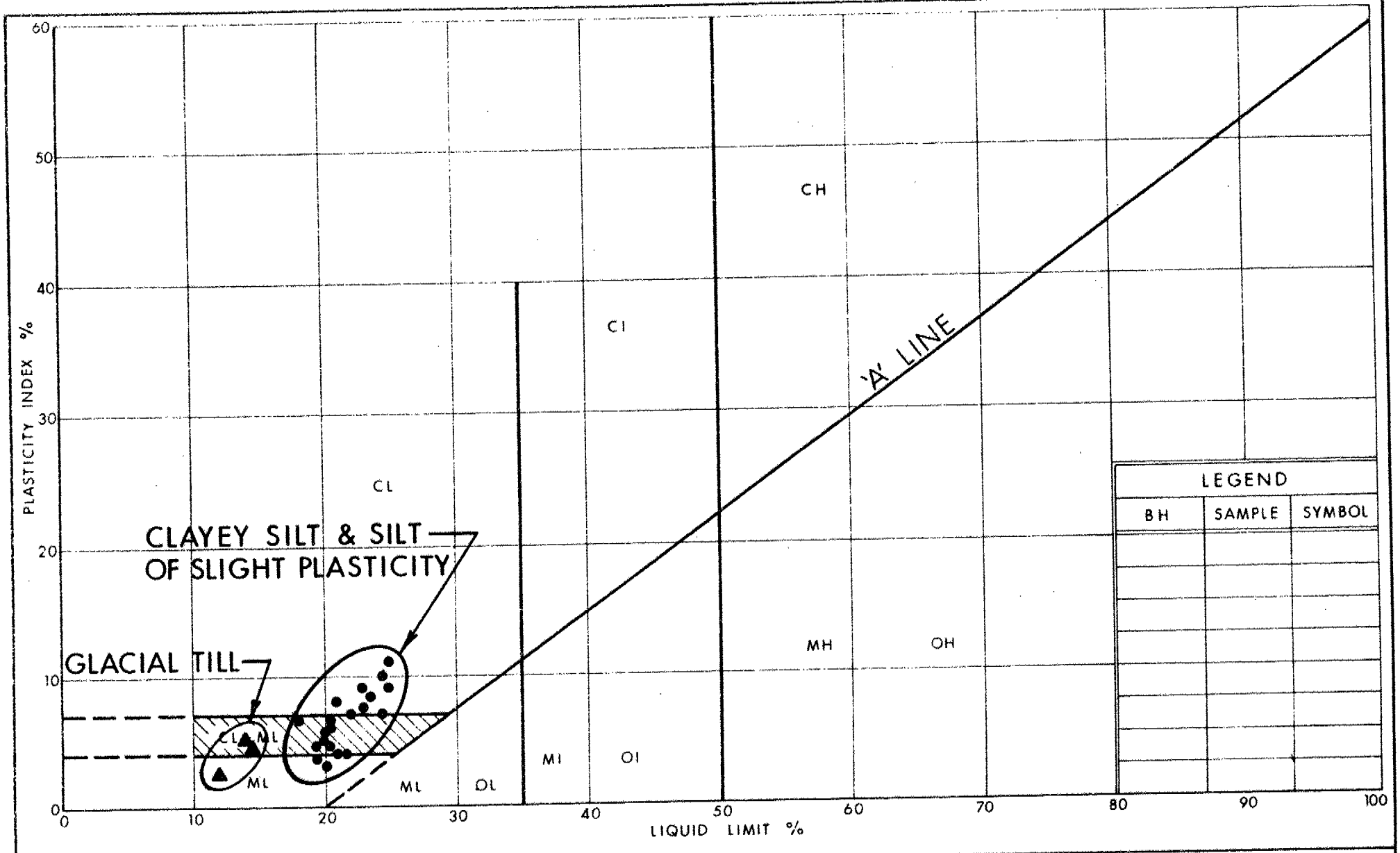
GRAIN SIZE DISTRIBUTION

FIG No 2

W P 160 - 74 - 34

19



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PLASTICITY CHART

FIG No 3
W P 160-74-34

FOUNDATION INVESTIGATION REPORT

For

Holland River Bridge
4.3 Miles North of Regional Road 14
W.P. 160-74-35, Site 37-1060
Hwy. 404, District 6, Toronto

INTRODUCTION

This report contains the results of a foundation investigation carried out at the site of the above-mentioned location. The fieldwork was carried out from February 21 to March 2, 1978 and consisted of a total of seven sampled boreholes and 6 dynamic cone penetration tests. In addition, one sampled borehole and one dynamic cone penetration test was put down for feasibility purposes during December 11 to December 13, 1968 and is incorporated in this report as B.H. 9. The recent boring were advanced by means of hollow stem augers to depths of 32 to 71 feet below ground surface, whereas the earlier boring was advanced by washboring techniques to a depth of 71 feet.

SITE DESCRIPTION AND GEOLOGY

The site is located at the crossing of proposed Hwy. 404 and Holland River approximately due west of Vandorf, bordering the Towns of Aurora and Whitchurch-Stouffville in the Regional Municipality of York.

The topography of the surrounding area is hilly, whereas in the immediate vicinity of the crossing the land slopes down from the north and south on a gradient as steep as 10% to the river. The river itself winds through a tree and bush covered flood plain as wide as 200 feet. At the crossing the river is about 7 to 8 feet wide with a depth of water of 1 to 2 feet at the time of the fieldwork. The

Holland River itself originates some 4 miles northeast of the crossing and flows in a westerly direction across the site, then north to Newmarket and empties finally into Cook Bay.

The area is located in the physiographic region known as the "Oak Ridges Moraine." The region is characterized by a knob-basin relief outlining hills composed of sandy or gravelly materials and some low lying swamp filled valleys.

SUBSOIL CONDITIONS

General

Subsoil conditions across the site are quite variable. The surficial deposit across this site is a 1 to 6 foot thick deposit of very soft to soft organic silt. Below this surficial cohesive stratum are irregular deposits of varying thickness ranging in composition from a silty clay with seams of silt and slight plasticity to a uniform fine sand. Underlying these random deposits at a depth of 52 to 66 feet below the ground surface is a very dense heterogenous mixture of silt, sand and gravel, a glacial till. This deposit was not fully penetrated but explored to a maximum depth of 19 feet.

The boundaries between the various subsoil types are shown on the Record of Borehole Sheets. The locations and elevations of the borings, together with four stratigraphical sections inferred from the borehole data are shown on Drawing No. 2. The various subsoil types are described as follows.

Organic Silt

This surficial deposit was found to extend from the ground surface to a depth of 1 to 6 feet. Laboratory testing performed on representative samples from this deposit gave the following results:

			Range	Average
Organic Content Percent by Weight	(Om)		9- 15	11
Natural Moisture Content	(W)	%	52-121	80

Atterberg Limits			B.H. 8 Sample 1	B.H. 2 Sample 1
Liquid Limit	(W_L)	%	49	36
Plastic Limit	(W_p)	%	36	29
Plasticity Index	(I_p)	%	13	7

The Atterberg Limit testing results are plotted on the Plasticity Chart, Figure 3, and indicate that the deposit is organic of intermediate plasticity (OI zone.) Standard Penetration testing gave an 'N' value range of 1 to 4 blows per foot indicating that the deposit is soft to very soft.

Uniform Fine Sand

This deposit was encountered immediately below the surficial deposit of organic silt in all sampled boreholes except in one borehole located in the southeast quadrant of the site. The thickness of this granular deposit was found to vary between 4 to 23 feet. Grain size distribution testing on samples from this deposit are shown in an envelope form on Figure 1 in the Appendix. The deposit is composed of uniform fine sand with a trace to some silt. Based on Standard Penetration Test 'N' values ranging from 3 to 31 blows/foot, the stratum is estimated to have a very loose to compact relative density. This deposit is highly susceptible to

'boiling' under excess hydrostatic head.

Silty Sand to Sandy Silt

This granular deposit was encountered immediately below the uniform fine sand stratum in all boreholes put down north of the river. In four of the borings this deposit was fully penetrated and its thickness varied from 6 to 49 feet. However, in two boreholes, the boring was terminated at a depth of 32 and 37 feet without completely penetrating the deposit. Here the deposit was found to extend to a minimum thickness of 22 feet.

Grain size distribution testing performed on samples from this stratum are shown on an envelope form in Figure 2 in the Appendix. This deposit is comprised of a sandy silt to silty sand with a trace of clay with some isolated pockets containing some gravel. Standard Penetration testing carried out within this granular deposit gave a wide range of 'N' values of 8 to 42 blows/foot, having one isolated pocket where an 'N' value of 1 blow/foot was observed. These values indicate that the deposit has a relative density of loose to dense except for the isolated pocket mentioned above where the relative density is very loose. This deposit is highly susceptible to 'boiling' under excess hydrostatic head.

Silty Clay With Random Seams of Silt of Slight Plasticity

This slightly cohesive deposit was encountered in random depths in those boreholes put down south of the river and also in one borehole on the east side of the site. The thickness of this stratum was found to vary between 13 to 18 feet. Grain size distribution testing from two representative samples from this deposit is shown on Figure 2 of the Appendix. The deposit is composed of silt with some

clay and a trace of sand. Further laboratory testing on samples from this deposit gave the following results:

			Range	Average
Natural Moisture Content	(W)	%	19-20	19
Liquid Limit	(W_L)	%	14-20	18
Plastic Limit	(W_p)	%	12-15	14
Plasticity Index	(I_p)	%	2- 6	4

The results of the Atterberg Limit testing are plotted on the Plasticity Chart, Figure 3 and indicate that the deposit is inorganic of slight plasticity (ML to CL-ML zone.)

Based on Standard Penetration Test results varying from 1 to 36 blows/foot and a field vane test of 960 PSF, the deposit is estimated to have a very soft to hard consistency generally increasing with depth.

Silt

This noncohesive deposit was encountered in B.H. 3 only extending from a depth of 34 to 66 feet below the ground surface. Grain size distribution testing performed on samples from this deposit are shown in an envelope form on Figure 1 in the Appendix. The deposit is composed of silt with a trace of clay and a trace to some sand. Based on Standard Penetration Test 'N' values ranging from 15 to 67 blows/foot, the relative density of this deposit is estimated to be compact to very dense.

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

This glacial deposit was encountered at various locations at a depth ranging from 23 to 66 feet below the ground surface and was not fully penetrated but found to extend to a minimum thickness of 20 feet. Grain size distribution testing performed on samples from this deposit are shown on envelope

form on Figure 2 of the Appendix. The deposit is composed of a heterogeneous mixture of silt, sand and gravel with a trace of clay. Two distinct zones of this material were encountered; the upper zone at depths ranging from 23 to 32 feet below the ground surface, the lower portion was encountered at a depth of 52 to 66 feet below the ground surface. Standard Penetration Test 'N' values were found to vary between 22 and 62 blows/foot in the upper zone and was generally greater than 100 blows/foot in the lower portion. Based on this testing the upper zone is estimated to have a relative density of compact to very dense while the lower zone is estimated to have a very dense relative density.

Groundwater Conditions

Groundwater level observations were made at the time of the field investigation by measuring the water level in the hollow stem augers. The observations indicate that the groundwater varies from elevation 952 to elevation 953 which corresponds to a depth of 1 to 3 feet below the ground surface. The water level in the river at the time of observation was found to be at elevation 953.2. In addition, artesian conditions were observed in the deposits of silty clay with random seams of silt of slight plasticity at elevation 922 and also within the glacial deposit at elevation 893 in boreholes 7 and 9 respectively. The artesian condition was found to stabilize with a hydrostatic head of 1 to 3 feet above the ground surface which corresponds to elevation 955 to 958.

M. Devata, P. Eng.
Senior Foundations Engineer

APPENDIX

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HIGHWAY ENGINEERING DIVISION - ENGINEERING MATERIALS OFFICE - SOIL MECHANICS SECTION

RECORD OF BOREHOLE No 1

70

W P 160-74-35 LOCATION Co-ords. N 15,987,427; E 1,026,887 ORIGINATED BY MM

DIST 6 HWY 404 BOREHOLE TYPE Hollow Stem Auger & Cone Test COMPILED BY MM

DATUM Geodetic DATE February 21-22, 1978 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 PSF (400 800 1200 1600 2000)	PLASTIC LIMIT Wp / NATURAL MOISTURE CONTENT W / LIQUID LIMIT WL — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
954.9	Ground Level										
0.0	Organic Silt Black		1	SS	1				W=121%	0m 15%	
949.9	V. Soft		2	SS	1		950				
5.0	Sand, Uniform Fine Some silt		3	SS	20						20 75 (5)
	Loose to Compact		4	SS	9						
941.9			5	SS	6						1 68 26 5
13.0	Sandy Silt		6	SS	1		940				0 31 60 9
935.9	V. Loose										
19.0	Clayey Silt with random seams of silt of slight plasticity		7	SS	2/	24"					
	Firm to Stiff		8	SS	6		930	+ 5			
922.9			9	TW	PM						
32.0	Heterogenous Mixture Sand, silt and gravel (Glacial Till)		10	SS	37		920				9 70 (21)
			11	SS	62						
			12	SS	46		910				
	Dense to V. Dense Clayey Silt										
	Hard		13	SS	36						
	V. Dense						900				
			14	SS	100/	10"					18 40 30 12
884.6							890				
70.3	End of Borehole		15	SS	100/	4"					

NOTE: SUBSURFACE CONDITIONS AT TIME OF INVESTIGATION PRIOR TO ORGANIC SUBEXCAVATION.

OFFICE REPORT ON SOIL EXPLORATION

+ UNCONFINED ● QUICK TRIAXIAL × FIELD VANE × LAB VANE

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

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

Ministry of Transportation and Communications
Ontario

HIGHWAY ENGINEERING DIVISION - ENGINEERING MATERIALS OFFICE - SOIL MECHANICS SECTION

RECORD OF BOREHOLE No 2

71

W P 160-74-35 LOCATION Co-ords. N15,987.44; E1,026,829 ORIGINATED BY MM

DIST 6 HWY 404 BOREHOLE TYPE Hollow Stem Auger & Cone Test COMPILED BY MM

DATUM Geodetic DATE February 23, 1978 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 (%) (2.0 4.0 6.0)	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES						GR SA SI CL
955.0	Ground Level										
0.0	Organic silt V. Soft		1	SS	2						
950.0			2	SS	2		950				
5.0	Sand, Uniform Fine Loose to Compact		3	SS	19						5 92 (3)
			4	SS	12						
			5	SS	8						
			6	SS	8		940				
931.0			7	SS	4						
24.0	Sandy silt Loose		8	SS	8		930				0 29 60 11
	Some gravel Compact to Dense		9	SS	25						16 30 49 5
918.0			10	SS	37		920				
36.5	End of Borehole						910				
904.0											
51.0	End of Cone Test										

Om 10%

NOTE: SUBSURFACE CONDITIONS AT TIME OF INVESTIGATION PRIOR TO ORGANIC SUBEXCAVATION.

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

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

OFFICE REPORT ON SOIL EXPLORATION

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HIGHWAY ENGINEERING DIVISION - ENGINEERING MATERIALS OFFICE - SOIL MECHANICS SECTION

RECORD OF BOREHOLE No 3

72

W P 160-74-35 LOCATION Co-ords. N15,987,386; El.026,729 ORIGINATED BY MM
DIST 6 HWY 404 BOREHOLE TYPE Hollow Stem Auger & Cone Test COMPILED BY MM
DATUM Geodetic DATE February 24,27/ 1978 CHECKED BY GP

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 (%) 20 40 60	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
954.7	Ground Level										
0.0	Organic silt		1	SS	10						6 77 (17)
1.0	Sand, Uniform Fine Some silt Loose to Compact		2	SS	12		950				
			3	SS	13						0 82 (18)
			4	SS	5						
			5	SS	7						
			6	SS	4		940				
			7	SS	6						
930.7											
24.0	Silty sand Dense Some Gravel		8	SS	42		930				0 52 43 5
			9	SS	31						22 42 32 4
920.7											
34.0	Silt Compact to V. Dense		10	SS	15		920				0 19 77 4
			11	SS	25						
							910				
			12	SS	4						0 2 82 6
							900				
			13	SS	67						
888.7							890				
66.0	Glacial Till V. Dense		14	SS	100/6"						
884.2											
70.5	End of Borehole										

Note: Water Level Not Established

NOTE: SUBSURFACE CONDITIONS AT TIME OF INVESTIGATION PRIOR TO ORGANIC SUBEXCAVATION.

OFFICE REPORT ON SOIL EXPLORATION

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

20
15 ◇ 5 (%) STRAIN AT FAILURE
10

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HIGHWAY ENGINEERING DIVISION - ENGINEERING MATERIALS OFFICE - SOIL MECHANICS SECTION

RECORD OF BOREHOLE No 4

73

W P 160-74-35 LOCATION Co-ords. N15,987,360; E1,026,764 ORIGINATED BY MM

DIST 6 HWY 404 BOREHOLE TYPE Hollow Stem Auger COMPILED BY MM

DATUM Geodetic DATE February 28, 1978 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 (%) (20 40 60)	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
954.0	Ground Level										
952.0 / 2.0	Org. silt V. Soft		1	SS	10	▼	950		o		0 80 (20)
	Sand, Uniform Fine Some silt		2	SS	31						
	Loose to Compact		3	SS	15						
			4	SS	26				o		0 84 (16)
941.0			5	SS	6						0 55 36 9
13.0	Silty Sand Trace Clay		6	SS	8		940		o		
	Loose to Compact		7	SS	11				o		0 53 39 8
931.0											
23.0	Heterogenous Mixture Sand, silt and gravel (Glacial Till)		8	SS	25		930		o		27 31 31 11
	Compact to Dense								o		
922.5			9	SS	34						
31.5	End of Borehole										

NOTE: SUBSURFACE CONDITIONS AT TIME OF INVESTIGATION PRIOR TO ORGANIC SUBEXCAVATION.

OFFICE REPORT ON SOIL EXPLORATION

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

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

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HIGHWAY ENGINEERING DIVISION - ENGINEERING MATERIALS OFFICE - SOIL MECHANICS SECTION

RECORD OF BOREHOLE No 5

74

W P 160-74-35 LOCATION Co-ords. N15,987,302; E1,026,769 ORIGINATED BY MM

DIST 6 HWY 404 BOREHOLE TYPE Hollow Stem Auger COMPILED BY MM

DATUM Geodetic DATE February 28, 1978 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 (o UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB VANE)	PLASTIC LIMIT Wp / NATURAL MOISTURE CONTENT W / LIQUID LIMIT W_L — WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
954.0	Ground Level										
0.0	Organic silt V. Soft to Soft		1	SS	2/	18"				Om 9%	
948.0			2	SS	4		950				
6.0	Sand, Uniform Fine Compact		3	SS	11				o		2 84 (14)
944.0			4	SS	9						
10.0	Trace Clay		5	SS	6				o		0 35 55 10
			6	SS	7		940		o		6 61 30 3
	Sandy silt to Silty sand										
	Loose to Compact		7	SS	21				o		
							930				
			8	SS	18						
922.5			9	SS	15				o		3 32 61 4
31.5	End of Borehole										

NOTE: SUBSURFACE CONDITIONS AT TIME OF INVESTIGATION PRIOR TO ORGANIC SUBEXCAVATION.

OFFICE REPORT ON SOIL EXPLORATION

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

20
15 ⊹ 5 (%) STRAIN AT FAILURE
10

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HIGHWAY ENGINEERING DIVISION - ENGINEERING MATERIALS OFFICE - SOIL MECHANICS SECTION

75

RECORD OF BOREHOLE No 6

W P 160-74-35 LOCATION Co-ords. N15,987,418; E1,026,788 ORIGINATED BY MM

DIST 6 HWY 404 BOREHOLE TYPE Cone Penetration Test COMPILED BY MM

DATUM Geodetic DATE March 1, 1978 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 (%)	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES						
954.7	Ground Level										
0.0							950				
							940				
							930				
							920				
							910	200/9"			
905.9											
48.8	End of Cone Test										

NOTE: SUBSURFACE CONDITIONS AT TIME OF INVESTIGATION PRIOR TO ORGANIC SUBEXCAVATION.

OFFICE REPORT ON SOIL EXPLORATION

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

20
15 ◇ 5 (%) STRAIN AT FAILURE
10

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HIGHWAY ENGINEERING DIVISION - ENGINEERING MATERIALS OFFICE - SOIL MECHANICS SECTION

RECORD OF BOREHOLE No 7

76

W P 160-74-35 LOCATION Co-ords. N15,987,290; E1,026,826 ORIGINATED BY MM

DIST 6 HWY 404 BOREHOLE TYPE Hollow Stem Auger & Cone Test COMPILED BY MM

DATUM Geodetic DATE March 2, 1978 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 (%) (20 40 60)	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
954.0	Ground Level										
0.0	Organic silt V. Soft		1	SS	1/	18" ▽ Head					0 20 69 11
950.0			2	SS	2/	18"	950				
4.0	Sand, Uniform Fine V. Loose to Loose		3	SS	4						0 97 (3)
			4	SS	3						
			5	SS	7						
940.0			6	SS	8		940				
14.0	Clayey silt with random seams of silt of slight plasticity Stiff to V. Stiff		7	SS	23	Artesian Condition					
			8	SS	14		930				
922.5			9	SS	20	Encountered ▽					
31.5	End of Borehole						920				
							910				
905.0								232			
49.0	End of Cone Test										

NOTE : SUBSURFACE CONDITIONS AT TIME OF INVESTIGATION PRIOR TO ORGANIC SUBEXCAVATION.

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

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

OFFICE REPORT ON SOIL EXPLORATION

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RECORD OF BOREHOLE No 8

W P 160-74-35 LOCATION Co-ords. N15,987,360; E1,026,891 ORIGINATED BY MM
DIST 6 HWY 404 BOREHOLE TYPE Hollow Stem Auger COMPILED BY MM
DATUM Geodetic DATE March 1, 1978 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 (o UNCONFINED, • QUICK TRIAXIAL, + FIELD VANE, × LAB VANE)	PLASTIC LIMIT Wp / NATURAL MOISTURE CONTENT W / LIQUID LIMIT WL — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
954.5	Ground Level										
0.0	Organic silt V. Soft to Soft		1	SS	3		950			Om 9%	
			2	SS	1						
947.5			3	SS	3						0 44 50 6
7.0	Clayey silt with random seams of silt of slight plasticity		4	SS	1				HO		
			5	SS	2						0 7 78 15
	V. Soft to Stiff		6	SS	11		940				
			7	SS	10						0 3 83 14
930.5							930				
24.0	Het. Mixture. Sand, silt, and gravel (Glacial Till) Compact		8	SS	22						
923.5			9	SS	24						30 56 (14)
31.5	End of Borehole										

Note: Water Level Not Established

NOTE: SUBSURFACE CONDITIONS AT TIME OF INVESTIGATION PRIOR TO ORGANIC SUBEXCAVATION.

OFFICE REPORT ON SOIL EXPLORATION

+3, ×5 : Numbers refer to Sensitivity

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

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RECORD OF BOREHOLE No 8A

78

W P 160-74-35 LOCATION Co-ords. N15,987,388; E1,026,918 ORIGINATED BY MM

DIST 6 HWY 404 BOREHOLE TYPE Cone Penetration Test COMPILED BY MM

DATUM Geodetic DATE March 1, 1978 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 (o UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB VANE)	PLASTIC LIMIT Wp / NATURAL MOISTURE CONTENT W / LIQUID LIMIT W_L — WATER CONTENT (%)	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
954.9	Ground Level										
0.0							950				
							940				
							930				
							920				
							910				
903.4								126/6"			
51.5	End of Cone Test										

NOTE: SUBSURFACE CONDITIONS AT TIME OF INVESTIGATION PRIOR TO ORGANIC SUBEXCAVATION.

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

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

OFFICE REPORT ON SOIL EXPLORATION

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RECORD OF BOREHOLE No 9

79

W P 160-74-35 LOCATION Co-ords. N 15,987,355; E 1,026,820 ORIGINATED BY AKB

DIST 6 HWY 404 BOREHOLE TYPE Washboring NX Casing & Cone Test COMPILED BY AKB

DATUM Geodetic DATE December 11-13, 1968 CHECKED BY

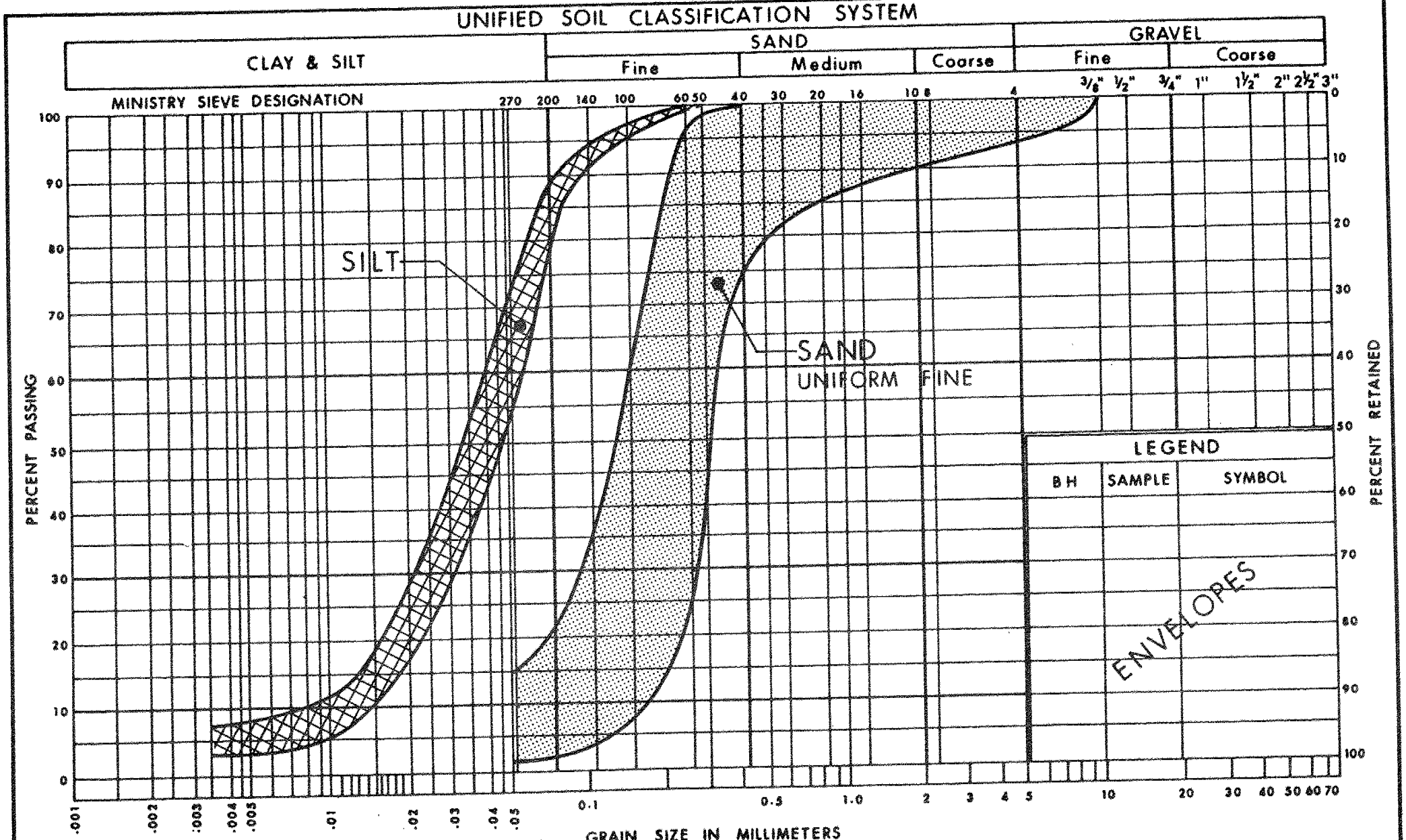
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES 'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH PSF (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE) (400 800 1200 1600 2000)	PLASTIC LIMIT Wp / NATURAL MOISTURE CONTENT W / LIQUID LIMIT WL / WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
954.5	Ground Level										
0.0	Organic silt Soft Dark Brown		1	SS	4		950				2 80 15 3
948.5											
6.0	Sand, Uniform Fine Loose		2	SS	7						
			3	SS	8				NP		
942.0			4	SS	9		940				
12.5			5	TW	PM			× +			0 13 79 8
	Silty sand to sandy silt, traces of clay		6	TW	PM Lost						
			7	SS	15		930	+			2 68 (30)
	Compact to Dense		8	SS	40						0 9 83 8
	Grey		9	SS	27		920		ONP		
			10	TW	PM			+2000			0 13 80 7
			11	TW	PM Lost		910				
			12	SS	27						0 10 86 4
899.5							900				
55.0	Heterogenous Mixture Silt, sand and gravel (Glacial Till) Very Dense Grey		13	SS	77						
			14	SS	100/6"	Artesian Conditions Encountered					15 45 (40)
			15	SS	100/3"		890				
884.0											
70.5	End of Borehole										

NOTE: SUBSURFACE CONDITIONS AT TIME OF INVESTIGATION PRIOR TO ORGANIC SUBEXCAVATION.

OFFICE REPORT ON SOIL EXPLORATION

+3, ×5 : Numbers refer to Sensitivity

15 20/10 5 (%) STRAIN AT FAILURE



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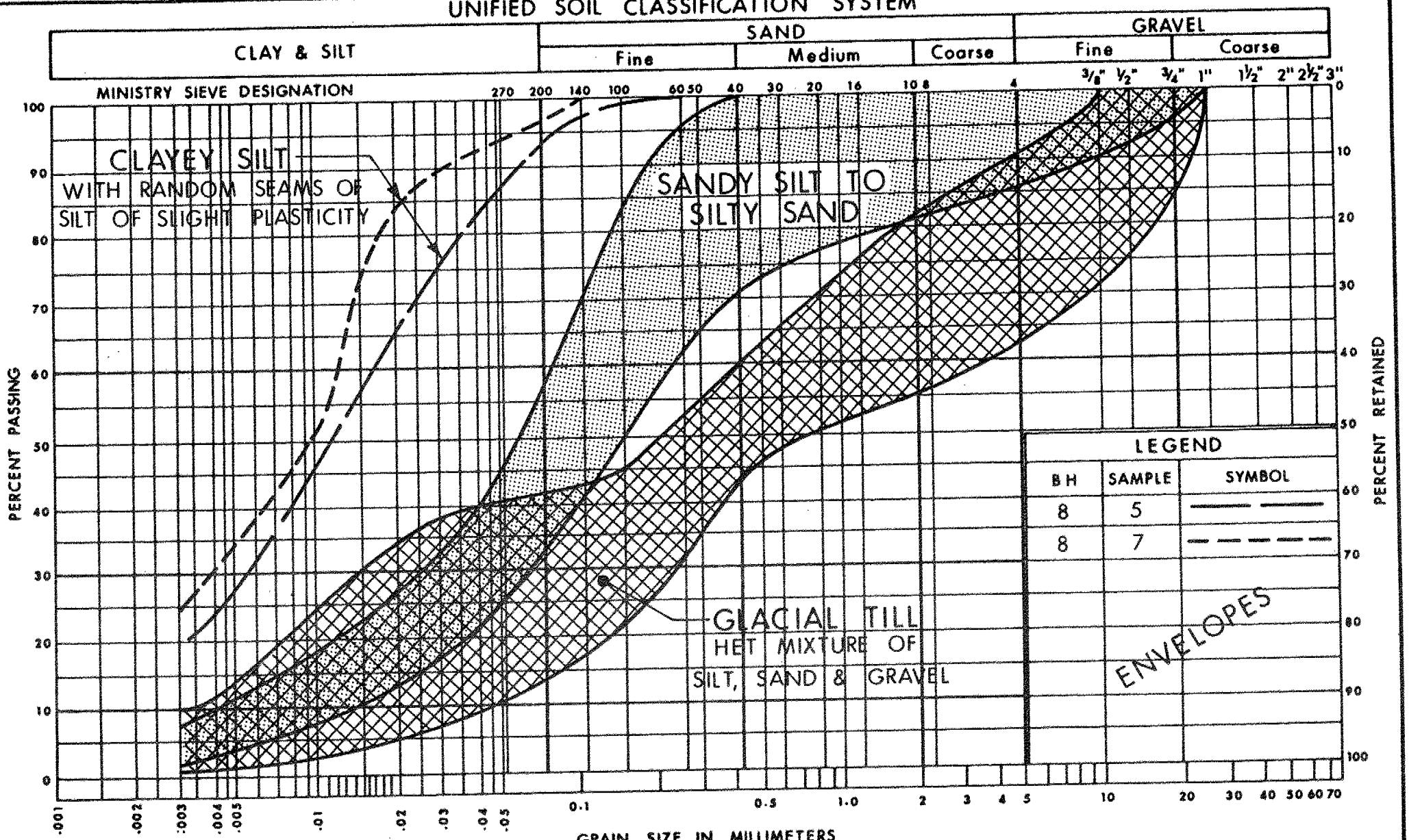
GRAIN SIZE DISTRIBUTION

FIG No 1

W P 160-74-35

08

UNIFIED SOIL CLASSIFICATION SYSTEM



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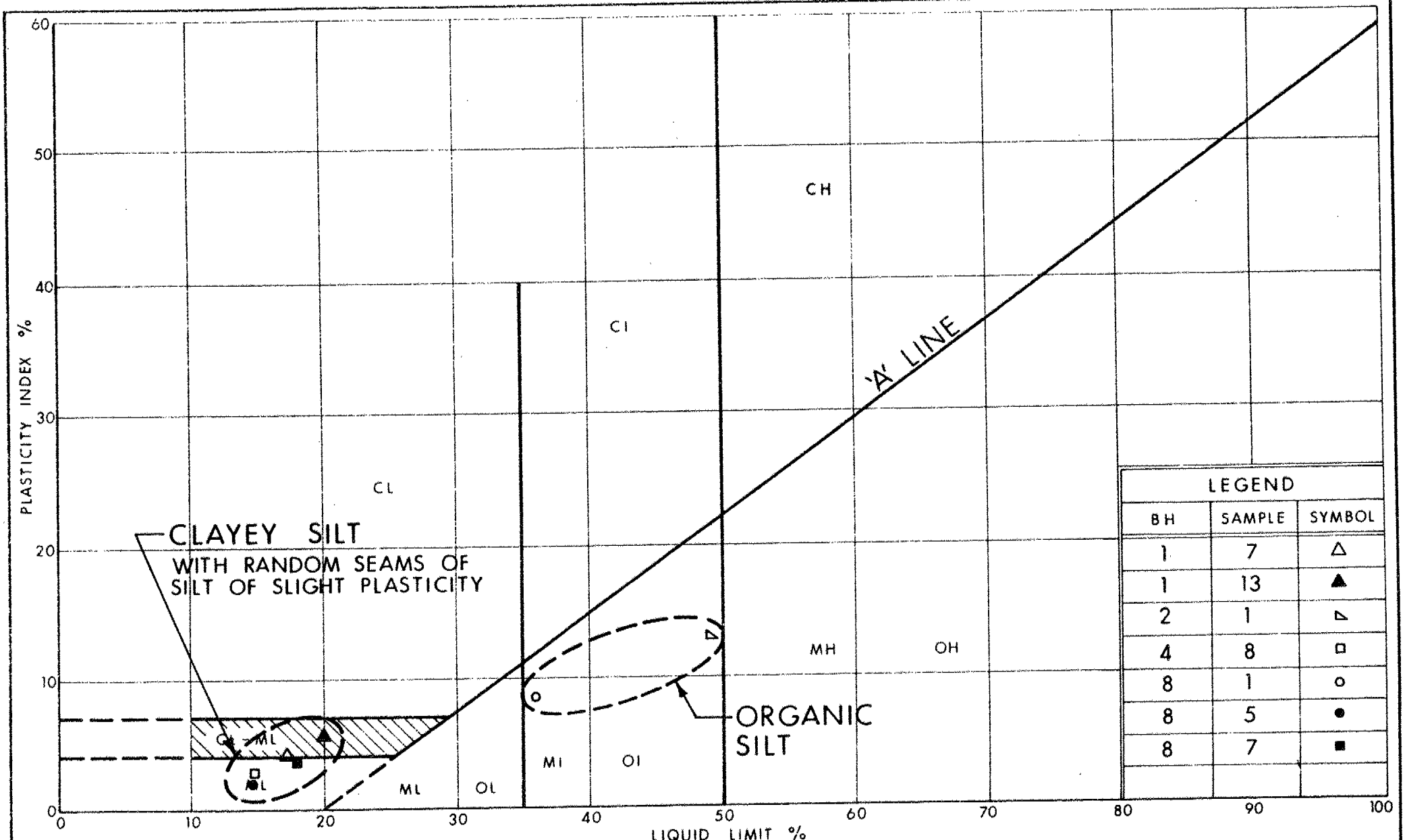
GRAIN SIZE DISTRIBUTION

FIG No 2
W P 160-74-35



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PLASTICITY CHART

FIG No 3
W P 160-74-35

82

FOUNDATION INVESTIGATION REPORT

For

Regional Road 15 Interchange
5.4 Miles North of Regional Road 14
Hwy. 404, District 6, Toronto
W.P. 160-74-36, Site 37-698

INTRODUCTION

This report contains the results of a foundation investigation carried out at the site of the above-mentioned project during the period of December 14 to December 20, 1977.

The fieldwork consisted of six sampled boreholes advanced by means of a continuous flight auger machine equipped with 3¼ inch I.D. hollow stem and solid stem augers.

The boreholes ranged in depth from 35.5 to 51 feet below the ground surface.

SITE DESCRIPTION AND GEOLOGY

The site is located about ½ mile west of Woodbine Avenue (Regional Road 8) and about 5.4 miles north of Regional Road 14 (Gormley Road) in the Towns of Aurora and Whitchurch-Stouffville, Regional Municipality of York. The topography of the general area is flat to undulating. The land is used primarily for farming purposes.

Physiographically the area is located in the region known as "Oak Ridges." This interlobate moraine extends from the Niagara Escarpment to the Trent River, forming the height of land dividing the streams of the Lake Ontario drainage basin from those flowing into Georgian Bay and the Trent River. The surface is hilly with knob and basin relief typical of end-moraines. Most of the hills are composed of sandy or gravelly materials. Other areas are formed of

stratified deposits. The northern border of the morainic area is deeply indented by swamp-floored valleys, along which many outwash terraces are found.

SUBSURFACE CONDITIONS

Subsurface conditions at the site were found to be generally uniform. Beneath a thin layer of topsoil is a cohesive deposit of silty clay with thin lenses or pockets of silt and sand. This cohesive stratum is underlain by a glacial till composed of a heterogeneous mixture of silty clay and sand and occasional gravel. The lower boundary of this deposit was not proven at any of the boring locations beyond a maximum depth of 51.0 feet below the existing ground surface. In certain locations the silty clay stratum is covered by a surficial granular deposit of silty fine sand or organic silt with sand.

A detailed description of the soil encountered in each borehole is given in the Record of Borehole Sheets. The estimated stratigraphical profile and sections shown on Drawing No. 2 are based upon this information. From ground level downwards the subsurface conditions are as follows:

Surficial Deposits - Silty Sand or Organic Silt With Sand

Under a thin layer of topsoil a surficial deposit of 4 to 13 feet thick silty fine sand was encountered (B.H. 5, 6 and 7). The typical grain size distribution curves are shown in an envelope form on Figure 2. The 'N' values obtained from Standard Penetration Tests registered 8 to 24 blows per foot. It is estimated that the relative density of this surficial granular deposit is loose to compact. However, in one borehole (B.H. 2) the surficial deposit is an organic silt with sand and generally has a firm consistency. These

deposits are susceptible to 'boiling' under excess hydrostatic head.

Silty Clay With Thin Lenses or Pockets of Silt and Sand

Immediately beneath a thin cover of topsoil or beneath a surficial cover of silty fine sand or organic silt with sand, is the cohesive stratum of silty clay with thin lenses or pockets of silt and sand. This deposit was observed over the entire site and the overall thickness varied from 21 to 32 feet. The upper 8 to 19 feet is generally brown in colour and below this changes to grey with depth. Within this deposit distinct layers of silt up to 2 feet thick were also observed. The grain size distribution curves carried out from the typical samples of this deposit are shown in an envelope form on Figure 2. The physical properties of this cohesive material are as follows:

			Range
Liquid Limit	(W_L)	%	15-32
Plastic Limit	(W_p)	%	9-18
Moisture Content	(W)	%	11-27

The results of the Atterberg Limits are plotted on the Plasticity Chart on Figure 1 which indicates that this cohesive deposit is inorganic and of low plasticity (CL to CL-ML.)

The Standard Penetration Tests gave 'N' values in the range of 8 to 59 blows/foot with the exception of one value 123 blows/foot. Based on these 'N' values the consistency of the silty clay stratum may be described as stiff to hard. Generally, the strength of the deposit is increasing with depth.

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

This glacial till deposit was observed immediately below the silty clay stratum at all locations over the site. The full depth of this glacial till was not explored and the investigation was terminated within this deposit at a depth of maximum 51.0 feet below the existing ground surface. The upper boundary of this deposit was found to be between elevation 964 and elevation 953. In general, the deposit is cohesive composed of a heterogenous mixture of silty clay and sand with occasional gravel. However, in certain locations within this glacial till stratum random zones of a granular mixture of silt and sand were also observed. Typical grain size distribution curves in an envelope form on Figure 2.

The Standard Penetration Tests gave 'N' values in the range of 67 to over 100 blows/foot, generally increasing with depth. Based on these 'N' values the consistency of this cohesive glacial till stratum is estimated to be hard, and the relative density of the noncohesive portion of the glacial till may be described as very dense.

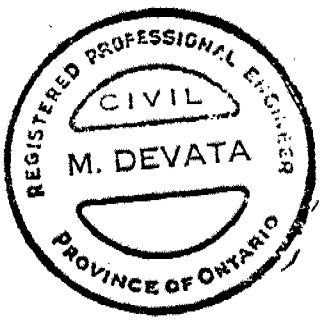
The physical properties of the cohesive glacial till as determined from laboratory testing are summarized as follows:

		Range
Liquid Limit	(W_L) %	13-18
Plastic Limit	(W_p) %	9-11
Moisture Content	(W) %	7-13

The results of the Atterberg Limit Tests are shown on the Plasticity Chart in Figure 1. These results indicate that the matrix is inorganic and of low plasticity.

GROUNDWATER

The groundwater level conditions were observed by measuring in the open boreholes during and after the completion of the foundation investigation. The groundwater level was found to vary between elevation 974 and elevation 984.5 which corresponded to 0.5 to 15 feet below the existing ground surface. The groundwater levels are shown on the Record of Borehole Sheets, as well as on Drawing 2.



M. Devata, P. Eng.
Senior Foundations Engineer

APPENDIX

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HIGHWAY ENGINEERING DIVISION - ENGINEERING MATERIALS OFFICE - SOIL MECHANICS SECTION

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RECORD OF BOREHOLE No 1

W P 160-74-36 LOCATION Coords N 15,992,922; E 1,024,373 ORIGINATED BY VK

DIST 6 HWY 404 BOREHOLE TYPE 3¼ inch I.D.H.S. Auger COMPILED BY VK

DATUM Geodetic DATE December 15, 1977 CHECKED BY

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES 'N' VALUES	GROUND WATER CONDITIONS
983.0	Ground Level					
0.0	Topsoil					
	Clayey Silt With Thin Lenses or Pockets of Silt and Sand		1	SS	14	
			2	SS	14	
			3	SS	9	
	Brown		4	SS	8	
	Grey		5	SS	17	
			6	SS	14	
			7	SS	22	
	Stiff to Very Stiff					
953.0			8	SS	82	
30.0	Glacial Till Heterogeneous Mixture of Clayey Silt and Sand, Occasional Gravel - Random Layers of Silt and Sand		9	SS	100/5"	
			10	SS	100/4"	
	Hard					
932.7			11	SS	100/3"	
50.3	End of Borehole					

ELEVATION SCALE: 980, 970, 960, 950, 940

DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100)

SHEAR STRENGTH
o UNCONFINED + FIELD VANE
● QUICK TRIAXIAL × 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
	0	0	80	20
	0	23	62	15
	0	4	85	11
	0	41	50	9

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

20
15 ◇ 5 (%) STRAIN AT FAILURE
10

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HIGHWAY ENGINEERING DIVISION - ENGINEERING MATERIALS OFFICE - SOIL MECHANICS SECTION

RECORD OF BOREHOLE No 2

90

W P 160-74-36 LOCATION Coords. N 15,992,837; E 1,024,391 ORIGINATED BY VK

DIST 6 HWY 404 BOREHOLE TYPE 3¼ Inch I.D.H.S. Auger COMPILED BY VK

DATUM Geodetic DATE December 16, 1977 CHECKED BY

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES 'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE
986.0	Ground Level						
0.0	Organic Silt With Sand		1	SS	8		
982.0							
4.0	Clayey Silt With Thin Lenses or Pockets of Silt and Sand		2	SS	8		
			3	SS	15		
	Silt, Dense		4	SS	36		
	Brown		5	SS	23		
	Grey		6	SS	15		
	Stiff to Very Stiff		7	SS	22		
958.0							
28.0	Glacial Till Heterogeneous Mixture of Clayey Silt and Sand Occasional Gravel - Random Zones of Silt and Sand		8	SS	151		
			9	SS	100/ 6"		
			10	SS	100/ 3"		
935.5	Hard		11	SS	100/ 6"		
50.5	End of Borehole						

DYNAMIC CONE PENETRATION RESISTANCE PLOT — 20 40 60 80 100

SHEAR STRENGTH
o UNCONFINED + FIELD VANE
● QUICK TRIAXIAL × 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
	0	2	70	28
	0	4	92	4
	0	35	54	11
	2	36	44	18
	0	56	34	10

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

15 20 5 10 (%) STRAIN AT FAILURE

OFFICE REPORT ON SOIL EXPLORATION

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HIGHWAY ENGINEERING DIVISION - ENGINEERING MATERIALS OFFICE - SOIL MECHANICS SECTION

RECORD OF BOREHOLE No 3

91

W P 160-74-36 LOCATION Coords. N 15,992,946; E 1,024,495 ORIGINATED BY VK

DIST 6 HWY 404 BOREHOLE TYPE 3¼ Inch I.D.H.S. Auger COMPILED BY VK

DATUM Geodetic DATE December 14, 1977 CHECKED BY

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES 'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE
989.0	Ground Level						
0.0	Topsoil						
	Clayey Silt With Thin Lenses or Pockets of Silt and Sand		1	SS	15		
			2	SS	18		
			3	SS	26	▼	980
			4	SS	19		
			5	SS	14		
	Brown		6	SS	14		970
	Grey		7	SS	11		
	Stiff to Very Stiff		8	SS	14		960
956.0							
33.0	Glacial Till Heterogeneous Mixture of Clayey Silt and Sand Occasional Gravel - Random Zones of Silt and Sand		9	SS	100/5"		
			10	SS	100/6"		950
	Hard						
938.5			11	SS	185/6"		940
50.5	End of Borehole						

DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100

SHEAR STRENGTH
○ UNCONFINED + FIELD VANE
● QUICK TRIAXIAL × 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
	0	3	82	15
	0	1	74	25
	0	2	89	9
	0	2	78	20
	3	50	39	8

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

20
15 ⊹ 5 (%) STRAIN AT FAILURE
10

OFFICE REPORT ON SOIL EXPLORATION

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HIGHWAY ENGINEERING DIVISION - ENGINEERING MATERIALS OFFICE - SOIL MECHANICS SECTION

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RECORD OF BOREHOLE No 4

W P 160-74-36 LOCATION Coords. N 15,992,879; E 1,024,506 ORIGINATED BY VK

DIST 6 HWY 404 BOREHOLE TYPE 3¼ Inch I.D.H.S. Auger COMPILED BY VK

DATUM Geodetic DATE December 19, 1977 CHECKED BY GP.

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 (%) 10 20 30	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES						
989.0	Ground Level										
0.0	~~Topsoil~~										
	Clayey Silt With Thin Lenses of Silt and Sand		1	SS	15						0 5 87 8
			2	SS	30		980				
			3	SS	22						3 7 80 10
			4	SS	24						
			5	SS	32	▼					
	Brown Grey		6	SS	20		970				
	Very Stiff		7	SS	17						2 34 52 12
961.0											
28.0	Glacial Till Heterogeneous Mixture of Clayey Silt and Sand Occasional Gravel - Random Zones of Silt and Sand		8	SS	100/6"		960				
			9	SS	100/6"						
			10	SS	100/6"		950				1 30 52 17
938.5	Hard		11	SS	100/5"		940				
50.5	End of Borehole										

+3, ×5 : Numbers refer to Sensitivity

20
15 ◇ 5 (%) STRAIN AT FAILURE
10

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RECORD OF BOREHOLE No 5

W P 160-74-36 LOCATION Coords. N 15,992,992; E 1,024,607 ORIGINATED BY VK

DIST 6 HWY 404 BOREHOLE TYPE 3¼ Inch I.D.H.S. Auger COMPILED BY VK

DATUM Geodetic DATE December 14, 1977 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
995.0	Ground Level										
0.0	Topsoil										
	Silty Fine Sand Grey Brown Loose to Compact		1	SS	8		990				0 65 31 4
			2	SS	16						0 66 29 5
			3	SS	24	▼					
981.0			4	SS	17						
14.0	Clayey Silt With Thin Lenses of Silt and Sand Brown Grey		5	SS	18		980				0 1 64 35
			6	SS	59						
			7	SS	50		970				
	Stiff to Hard		8	SS	51						0 1 73 26
960.0											
35.0	Glacial Till Heterogeneous Mixture of Clayey Silt and Sand Occasional Gravel - Random Zones of Silt and Sand		9	SS	67		960				
			10	SS	147		950				
944.0	Hard		11	SS	172/	11"					2 39 45 14
51.0	End of Borehole										

OFFICE REPORT ON SOIL EXPLORATION

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

20
15 ◇ 5 (%) STRAIN AT FAILURE
10

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RECORD OF BOREHOLE No 6

94

W P 160-74-36 LOCATION Coords. N 15,992,908; E 1,024,626 ORIGINATED BY VK

DIST 6 HWY 404 BOREHOLE TYPE 3¼ Inch I.D.H.S. Auger COMPILED BY VK

DATUM Geodetic DATE December 16, 1977 CHECKED BY

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES 'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE
991.0	Ground Level						
0.0	Topsoil						
	Silty Fine Sand - Brown Loose		1	SS	8		
986.0							
5.0	Clayey Silt With Thin Lenses of Silt and Sand		2	SS	15		
			3	SS	25		
			4	SS	29		
			5	SS	33		
	(Brown)						
	(Grey)		6	SS	123		
	Stiff to Hard		7	SS	52		
964.0							
27.0	Glacial Till Heterogeneous Mixture of Clayey Silt and Sand Occasional Gravel - Random Layers of Sand		8	SS	100/ 5"		
			9	SS	150/ 10"		
	Sand		10	SS	167		
	Hard						
940.5			11	SS	100/ 6"		
50.5	End of Borehole						

DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100

SHEAR STRENGTH
○ UNCONFINED + FIELD VANE
● QUICK TRIAXIAL × 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
	0	69	26	5
	0	5	70	25
	0	3	73	24
	0	33	49	18

+3, x5 : Numbers refer to Sensitivity

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

OFFICE REPORT ON SOIL EXPLORATION

Ministry of Transportation and Communications
Ontario

HIGHWAY ENGINEERING DIVISION - ENGINEERING MATERIALS OFFICE - SOIL MECHANICS SECTION

RECORD OF BOREHOLE No 7

95

W P 160-74-36 LOCATION Coords. N 15,992,812; E 1,024,310 ORIGINATED BY VK
DIST 6 HWY 404 BOREHOLE TYPE 3¾ Inch I.D.H.S. Auger COMPILED BY VK
DATUM Geodetic DATE December 20, 1977 CHECKED BY

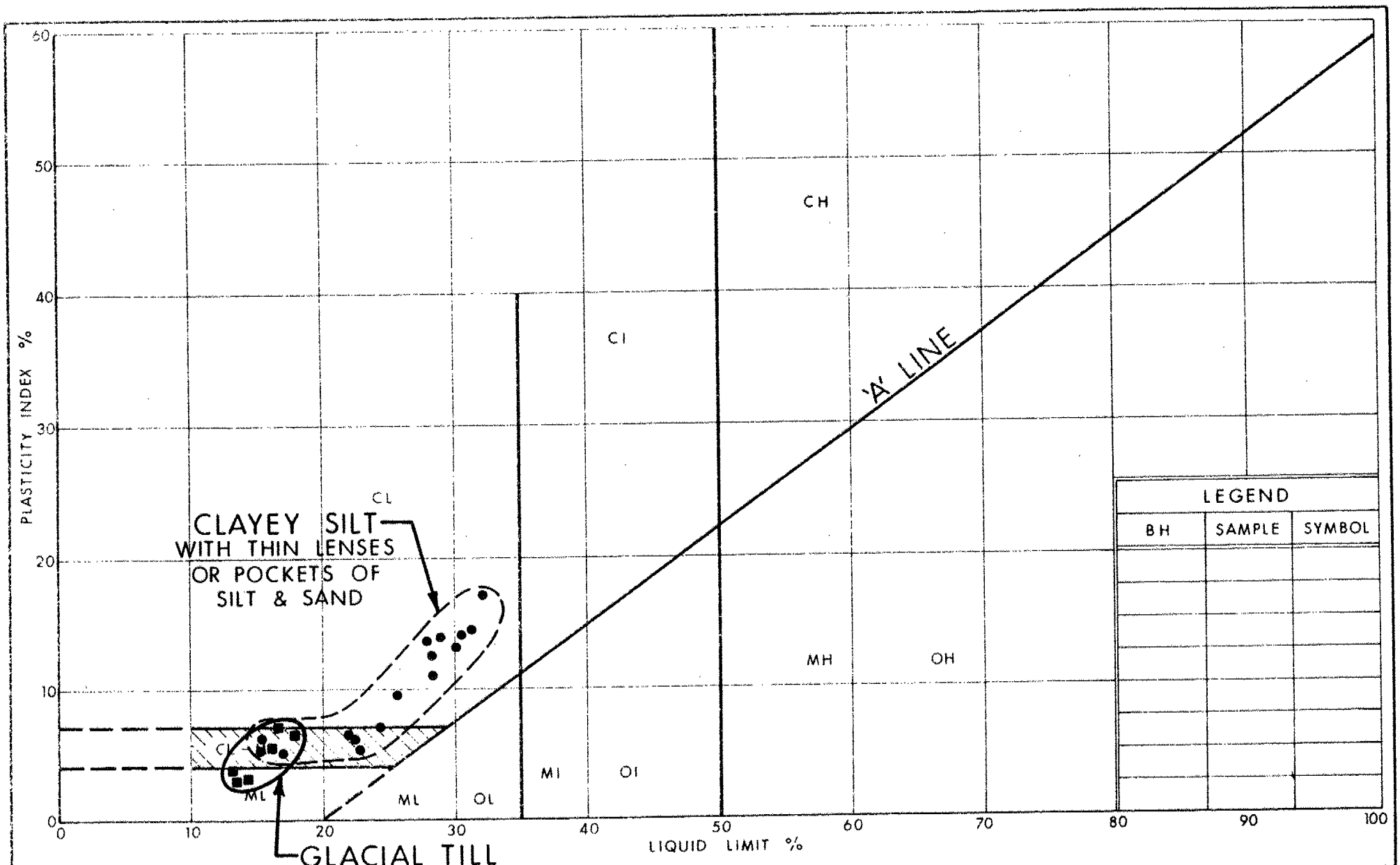
ELEV / DEPTH	SOIL PROFILE DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES 'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE)	PLASTIC LIMIT Wp / NATURAL MOISTURE CONTENT W / LIQUID LIMIT WL / WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
984.0	Ground Level										
0.0	Topsoil										
	Silty Fine Sand - Brown		1	SS	11		980				
978.0	Compact		2	SS	8						0 4 70 26
6.0	Clayey Silt With Thin Lenses of Silt and Sand		3	SS	20						0 6 81 13
	Brown / Grey		4	SS	37		970				
			5	SS	21						
	Stiff to Very Stiff		6	SS	23						0 2 67 31
			7	SS	22		960				
954.0			8	SS	47						
30.0	Glacial Till Heterogeneous Mixture of Clayey Silt & Sand Occ. Gravel Hard		9	SS	100/ 5"		950				4 33 49 14
948.5											
35.5	End of Borehole										

+3, ×5 : Numbers refer to Sensitivity

15 20 10 5 (%) STRAIN AT FAILURE

OFFICE REPORT ON SOIL EXPLORATION

Oct 75, FF-S-21



Ministry of Transportation and Communications
Ontario

PLASTICITY CHART

● - CLAYEY SILT

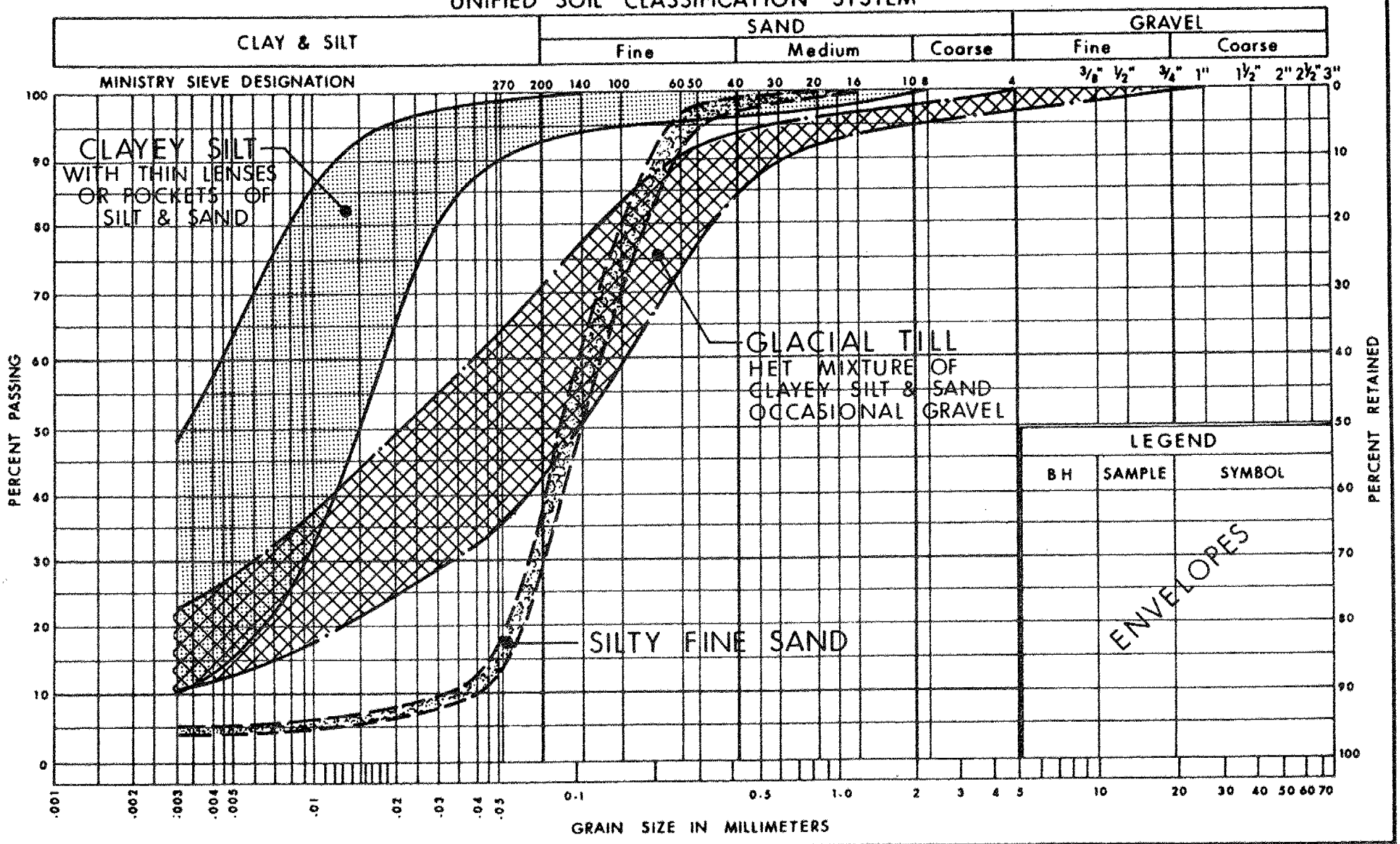
■ - GLACIAL TILL

FIG No 1

W P 160-74-36

96

UNIFIED SOIL CLASSIFICATION SYSTEM



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Ontario

GRAIN SIZE DISTRIBUTION

FIG No 2
W P 160-74-36

97

CONT 82-74

ENGINEERING MATERIALS OFFICE

SOIL MECHANICS SECTION

WP 160-74-33 DIST 6

HWY 404 STR SITE 37-700

C.N.R. Overhead
3.7 Miles North of Regional Road 14

DISTRIBUTION

G.C.E. Burkhardt (3)
R.D. Gunter
M.R. Ernesaks
D.E. Thrasher (2)

C. Grebski
G.A. Wrong
B.J. Giroux
R.S. Pillar

R. Hore

R. Fitzgibbon)
J. Anderson) cover only
G. Sloan)

Files J

SAMPLE DISPOSITION NOTICE

TYPE	DISCARD AFTER	RECOMM. BY
JARS	78 12 15	DMD
TUBES	"	"
ROCK CORES	—	—

GEOCRES 30M14-160

DATE OCT 03 1978

FOUNDATION INVESTIGATION REPORT

For

C.N.R. Overhead
3.7 Miles North of Regional Road 14
W.P. 160-74-33, Site 37-700
Hwy. 404, District 6, Toronto

INTRODUCTION

This report contains the results of a foundation investigation carried out at the site of the above mentioned project. The fieldwork was carried out during the periods of March 7 to March 15, 1978 and May 23 to June 23, 1978 and consisted of a total of 29 boreholes, 9 accompanied by dynamic cone penetration tests. The borings were advanced by means of 3¼ inch hollow stem augers and washboring techniques to depths of up to 107 ft. below the existing ground surface.

SITE DESCRIPTION AND GEOLOGY

The site is located at the proposed crossing of Hwy. 404 and the C.N.R. tracks, approximately 3.7 miles north of Regional Road 14 bordering the Towns of Aurora and Whitchurch, Stouffville in the Regional Municipality of York.

Topography in the vicinity of the site is variable. To the north of the tracks the ground is rolling containing some extensive swamps in the low lying areas, whereas south of the tracks the topography is very hilly. Within the proposed right of way the terrain is bush and tree covered. Northwest of the site adjacent to the highway right of way, is the Westview Golf Club.

The site is located within the physiographic region known as the Oak Ridge Interlobate Moraine. This region has the character of a typical interlobate moraine that has been built between two opposing lobes of the glacier. The subsoil is till with the crest being extensively covered by sand and gravel in hills and terraces. Beds of stratified fine sand, silt and clay are also quite common.

SUBSOIL CONDITIONS

General

Subsoil conditions across the site are quite variable. The surficial deposits adjacent to the C.N.R. tracks and roughly bounded by contour 998 and 996 to the south and north of the tracks respectively consist of very soft to soft organic silt and/or organic clay with a total thickness of up to 16 feet. Elsewhere, beneath a thin veneer of organic silt up to 2 feet thick or extending from the ground surface are surficial deposits up to 15 feet thick composed of loose to compact sand or silt with some sand. Underlying these surficial deposits is an extensive deposit of clayey silt to silt of slight plasticity up to 76 feet thick. This cohesive deposit is not continuous but is interrupted in an apparently random fashion by seams or pockets in the order of 10 feet thick composed of loose to dense sand or silts with some sand. One large continuous pocket of silt approximately 50 feet thick was encountered about 250 feet south of the C.N.R. tracks. Underlying the clayey silt to silt of slight plasticity deposit or the extensive pocket of silt is a stratum of hard glacial till composed of a heterogeneous mixture of clayey silt, sand and gravel which was encountered at depths ranging from 47 to 85 feet below the ground surface. This glacial till was not explored to its full depth but proven to a thickness of up to 20 feet.

The boundaries between the various subsoil types are shown on the Record of Borehole Sheets. The locations and elevations of the boreholes and a stratigraphical profile based on the borehole data is shown on Drawing No. 1607433-A. In addition, 5 stratigraphical sections based on borehole data are shown on Drawing No. 1607433-B.

Following is a brief description of the subsoil types and groundwater conditions encountered.

Organic Silt

This surficial deposit was encountered across most of the site being generally only a thin veneer up to 2 feet thick. However, in the vicinity of the tracks the deposit is up to 10 feet thick.

The deposit is composed of black organic silt with some decomposed vegetation and in certain locations contains some sand. Laboratory testing performed on representative samples from this stratum gave the following results.

		Range	Average
Organic Content (% of weight)		1- 76	18
Natural Moisture Content	(W) %	26-355	113
Liquid Limit	(W_L) %	18- 40	32
Plastic Limit	(W_p) %	13- 29	22
Plasticity Index	(I_p) %	5- 20	10

The results of the Atterberg Limit Testing are shown on the Plasticity Chart, Figure 1 and indicate that the material is organic and of intermediate plasticity (OI zone).

The shear strength as determined by in-situ vane testing ranges from 80 to 325 P.S.F. Based on the field vane test results and Standard Penetration Test 'N' values ranging from 1 to 6 blows per foot, this deposit is estimated to have a very soft to soft consistency.

Organic Clay

This stratum was encountered immediately below the organic silt deposit in the area roughly bounded by contour 998 and 996 to the south and north of the tracks respectively. The thickness of this cohesive organic deposit ranges from 3 to 11 feet and is composed of a grey to white organic clay or marl. Laboratory testing carried out on samples from this stratum gave the following results.

Physical Properties		Range	Average
Organic Content (% by weight)		2, 13	(two tests)
Natural Moisture Content	(W) %	47-147	108
Liquid Limit (two tests)	(W_L) %	56, 58	
Plastic Limit (two tests)	(W_p) %	46, 46	
Plasticity Index (two tests)	(I_p) %	10, 12	
Bulk Density	(γ) PCF	85-109	97
Shear Strength	(Su) PSF	Range	Sensitivity
Field Vane Test		80-240	2-12
Unconfined Compression Test		63-127	

Shown on the Plasticity Chart, Figure 1, are the results of Atterberg Limit Testing. The limits indicate that the deposit is organic of high plasticity (OH zone).

The shear strength as determined by in-situ vane testing ranges from 80 to 240 P.S.F. which indicates that the consistency of the deposit is very soft.

Clayey Silt to Silt of Slight Plasticity

This cohesive stratum is the dominant deposit across the site and was encountered immediately below the surficial organic strata or the surficial sand and/or silt deposits. The thickness of this stratum varies from 42 to 75 feet. The deposit is composed of clayey silt to silt of slight plasticity and in certain locations contains some sand. In addition, in the southeast area of the site the upper 10 to 23 feet of the stratum contains random seams or pockets of silt and fine sand about 1/4 inch thick every 3 inches. Furthermore, this deposit is not continuous but is interrupted in a random fashion by seams or pockets of silt, some sand or sand up to 19 feet thick. The results of Atterberg Limit Testing on samples from the clayey silt to silt of slight plasticity and samples from the clayey silt to silt of slight plasticity with some sand are shown on the Plasticity Chart, Figure 2 and are summarized below.

Clayey Silt to Silt of Slight Plasticity

			Range	Average
Natural Moisture Content	(W)	%	11-36	19
Liquid Limit	(W_L)	%	16-25	21
Plastic Limit	(W_p)	%	9-18	14
Plasticity Index	(I_p)	%	4-13	6

Clayey Silt to Silt of Slight Plasticity With Some Sand

			Range	Average
Natural Moisture Content	(W)	%	9-20	14
Liquid Limit	(W_L)	%	11-22	16
Plastic Limit	(W_p)	%	10-18	12
Plasticity Index	(I_p)	%	1- 8	3

The limits indicate that the deposit is inorganic and of low plasticity (CL-ML to CL zone for clayey silt to silt of slight plasticity and ML to CL-ML zone for clayey silt to silt of slight plasticity with some sand). In addition, the results of grain size distribution testing on representative samples from this deposit are shown on Figure No. 3, one envelope for the clayey silt to silt of slight plasticity and one for the clayey silt to silt of slight plasticity with some sand.

Generally, the 'N' values as determined by the Standard Penetration Test range from 8 to 71 blows per foot generally increasing with depth except for an 8 to 23 foot thick zone immediately below the deep organic deposit (ie. adjacent to the C.N.R. tracks and bounded by contour 998 and 996 to the north and south respectively) where 'N' values as low as 1 blow for 18 inches were observed. The shear strength as measured by in-situ vane testing in the zone immediately below the deep organic stratum increases with depth from 1200 to 1600 P.S.F. and elsewhere was found to be greater than 2000 P.S.F. Based on the S.P.T. and field vane tests the consistency of the deposit is estimated to be very stiff to hard except in the upper portion of the deposit immediately below the deep organic stratum where the consistency is very soft to stiff.

Sand

This deposit was encountered in some borings put down adjacent to the tracks as distinct pockets within the stratum of clayey silt to silt of slight plasticity at a depth ranging from 8 to 38 feet below the ground surface. In addition, outside the limits of the deep organic deposit, this granular stratum was encountered in some locations either beneath a thin veneer of organic silt or extending from the ground surface. The thickness of this deposit is estimated to range from 2 to 15 feet thick, being generally in the order of 10 feet thick. Grain size distribution testing performed on representative samples from this stratum are shown in envelope form on Figure 4. The composition of this deposit ranges from a sand with some silt to a sand with some gravel.

The results of Standard Penetration Test 'N' values range generally from 6 to 37 blows per foot except for some tests performed in the surficial deposit where 'N' values as low as 2 and 3 were observed. Based on these values the relative density of the deposit ranges from very loose to dense, being generally in the loose to compact range.

Silt Some Sand

This deposit was encountered in some borings put down adjacent to the tracks within the stratum of clayey silt to silt of slight plasticity at depths ranging from 12 to 48 feet below the ground surface. Furthermore, this stratum was encountered in some locations immediately below a thin veneer of organic silt or extending from the ground surface. The thickness of this deposit is estimated to range from 6 to 19 feet. Grain size distribution testing performed on representative samples from this deposit are shown on envelope form on Figure 4. The composition is silt with some sand.

Based on Standard Penetration Test 'N' values ranging generally from 4 to 19 blows per foot, the relative density of the deposit is described as loose to compact.

Silt

This deposit was encountered approximately 250 feet south of the tracks immediately below the stratum of clayey silt to silt of slight plasticity at a depth of 11 to 38 feet below the existing ground surface. This cohesionless stratum appears to form a continuous pocket or trench up to 52 feet thick and about 150 feet wide and is approximately parallel to the C.N.R. tracks at this location. The deposit is composed almost entirely of silt with negligible amounts of clay and sand. The results of grain size distribution testing are shown in envelope form, Figure 5.

The relative density of the deposit is described as compact to dense increasing with depth as inferred from the 'N' value range of 19 to 46 blows per foot.

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

This cohesive deposit was encountered in 15 of the boreholes at a depth ranging from 45 to 85 feet below the existing ground surface. The upper boundary of the deposit is gently rising to the north and south from a low basin located some 100 to 300 feet south of the railway tracks. This deposit was not fully penetrated but proven to extend to a thickness of up to 38 feet.

Grain size distribution testing performed on representative samples from this deposit are shown on envelope form on Figure 5. The deposit is a glacial till composed of a heterogeneous mixture of clayey silt, sand and gravel. In some locations a 1 to 2 foot zone of cobbles was encountered about 10 feet below the upper surface of this stratum.

Based on Standard Penetration Test 'N' values being generally over 100 blows per foot, the consistency of this stratum is estimated to be hard.

Groundwater Conditions

The groundwater level was observed during the progress of the fieldwork by measuring in the open boreholes approximately 24 hours after completion of the boring. In the low lying swampy areas adjacent to the C.N.R. tracks groundwater was at the surface and elsewhere the groundwater was found to vary from 1 to 7 feet below the existing ground surface which corresponds to elevation 991.3 to 1009.4. These observations indicate that the groundwater level reflects the topography.

In addition, temporary sub-artesian conditions were observed in Borehole 22 and 24 immediately above the glacial till deposit. Piezometers were subsequently installed in B.H. 24 at a depth of 28 and 65 feet to monitor the sub-artesian pressure. The piezometer readings indicate that the sub-artesian pressure is approximately at the groundwater level.

DISCUSSION AND RECOMMENDATIONS

The proposed crossing of Hwy. 404 and the C.N.R. tracks is located some 1600 feet south of Vandorf Side Road and approximately 1600 feet west of Woodbine Avenue. At this location it is proposed to construct Hwy. 404 as a four lane divided highway with a median width of about 100 feet to accommodate future transportation development within this corridor.

The original proposal included the provision for one additional railway track and required a C.N.R. overhead with twin three span (55'-70'-55') spill-thru type structures and associated fill heights up to 40 feet high. Based on this scheme the foundation investigation fieldwork was carried out in March, 1978. Subsequent C.N.R. requirements included the provision for three additional railway tracks and required a C.N.R. overhead with twin three span (60'-110'-60') spill-thru type structures and associated fill heights up to 44 feet high.

The feasibility of a revised three span scheme was discussed in lieu of the encountered surficial organic material and generally unfavourable subsurface conditions in a memorandum to Mr. G.C.E. Burkhardt from our office dated 78 04 06. This memorandum included comments on the viability of constructing a C.N.R. subway structure rather than an overhead structure.

Based on economic considerations, as well as the anticipated performance of the embankments of a three span overhead or C.N.R. subway, it was decided to construct a multi-span structure at this location.

Two schemes were suggested for consideration. Scheme 'A' was to allow for no subexcavation of organic material and subsequent backfilling and is comprised of the following approximate spans: 70'-90'-90'-110'-110'-90'-90'-70'. Scheme 'B' allows for some subexcavation and backfilling and is composed of the following approximate spans: 90'-90'-110'-110'-90'-90'. Associated embankment fill heights for Scheme 'A' and for Scheme 'B' are in the order of 44 feet high. For Scheme 'A' and 'B' refer to Drawing No. 1607433-C.

Further foundation investigation fieldwork was carried out in May and June of 1978 to determine sufficient subsoil information for the design of the multi-span structure and associated approach fills. Subsoil conditions across the site were found to be quite variable. A surficial deposit of very soft to soft organic silt/clay up to 16 feet deep was encountered adjacent to the C.N.R. tracks roughly bounded by contour 998 and 996 to the north and south respectively. Surficial deposits elsewhere consist of loose to compact sand or silt, some sand in the order of 10 feet thick. Underlying the above surficial deposits is an extensive stratum of clayey silt to silt of slight plasticity which is not continuous but is intercepted by pockets or seams of sand and silt, some sand, generally being in the order of 10 feet thick. This extensive cohesive deposit is intercepted by a large pocket or trench of silt up to 52 feet thick and 150 feet wide located some 250 feet south of the C.N.R. tracks. A hard deposit of glacial till was encountered at depths ranging from 45 to 85 feet below the ground surface. The groundwater level was found at depths ranging from 0 to 7 feet below the existing ground surface.

The presence of the surficial very soft to soft organic deposits and the very soft to firm portion of the clayey silt to silt of slight plasticity deposit in the vicinity of the tracks and extending to a depth of up to 25 feet below the ground surface, is the governing factor from a foundation point of view since it will be necessary to ensure that it is not overstressed by the embankment loading. Furthermore, the location of the abutments and piers will depend to a large extent on the design of the approach fills. Because of the importance of approach fills this aspect will be discussed first.

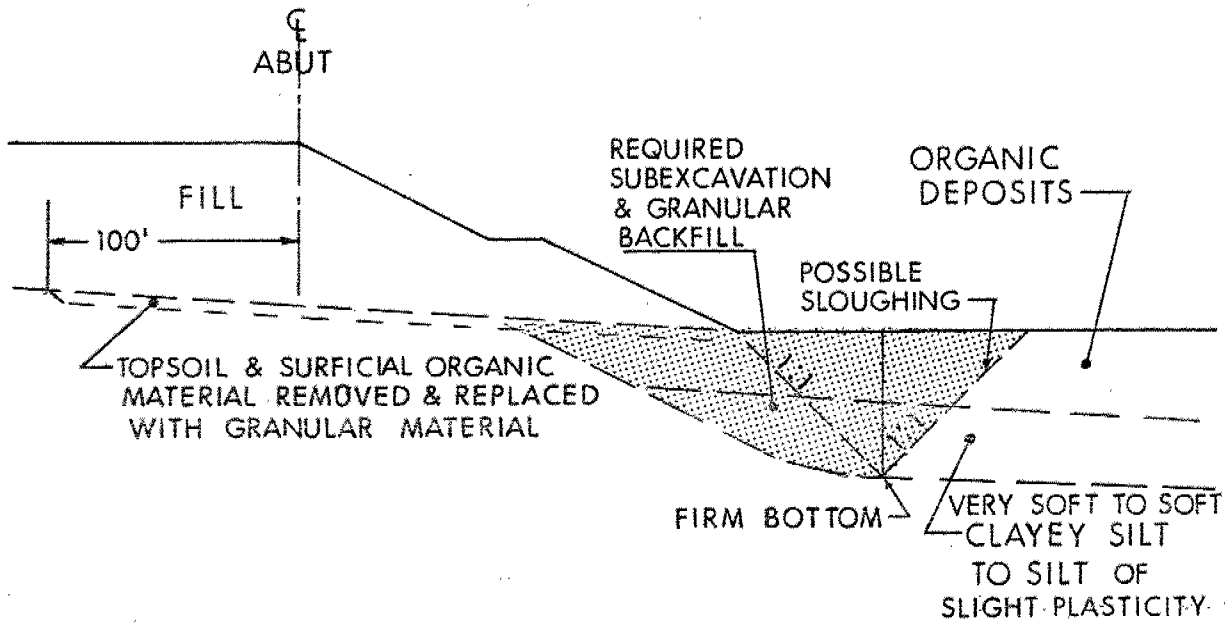
It is to be noted that the recommendations and discussions contained in the following pages are intended to be used as guidelines in locating the abutments and piers. In addition, we have commented on and depicted graphically the requirements for Scheme 'A' and 'B' only. Because of the complex subsoil conditions and the railway and highway geometrics it is beyond the intent of this report to provide sufficient detailed recommendations to cover every combination of structural span ratios and abutment locations. In view of this it is recommended that close liaison between the Structural Office and the Soil Mechanics Section be maintained during the development of the preliminary structural design in order to develop a realistic and rational design of abutments and related approaches.

EARTHWORKS

Based on the profile grade as established to include the provision for a total of four C.N.R. tracks, the height of profile grade above the average ground surface is:

		Height of Profile Grade Above Average Ground Surface
Scheme A		
North Approach	NBL	39
	SBL	42
South Approach	NBL	24
	SBL	31
Scheme B		
North Approach	NBL	43
	SBL	42
South Approach	NBL	27
	SBL	34

Subsoil conditons in the vicinity of the site are generally favourable for embankment foundations except for the area adjacent to the C.N.R. tracks roughly bounded by contour 998 and 996 to the south and north of the tracks respectively. In this area subsoil consists of up to 16 feet of very compressible and very soft to soft organic silt and/or clay overlying clayey silt to silt of slight plasticity which is very soft to firm in the upper 9 feet and below that is very stiff to hard. The subsoil in this area will be detrimental to the stability and performance of high approach embankments. In view of this it is recommended that the very soft to soft organic material and very soft to soft clayey silt to silt of slight plasticity be removed entirely below the embankment to a plan limit as defined by the projection of a 1:1 slope from the toe of the slope to the firm bottom (See Sketch on Following Page). The excavation can be carried out underwater by using vertical side slopes but it is anticipated that sloughing will cause the underwater slope to stabilize at a temporary slope of 1:1. Furthermore, the subexcavation should be completed across the site prior to placing fill the approach fills. The stability of the C.N.R. tracks adjacent to the subexcavation will be discussed later in the report. Backfill placed underwater should be granular type material to prevent segregation underwater. Furthermore, all topsoil within the plan limits of the embankment shall be



completely removed to a minimum distance of 100 feet behind the abutment wall and replaced with acceptable granular material. In addition, fill material to be placed on the steep slopes at the north approach shall be keyed into the existing slope according to the M.T.C. Standard Benching of Earth Slopes (DD-414). Fill material for the remainder of the approaches should be of acceptable earth material placed and compacted according to current M.T.C. standards.

Stability analysis in terms of total stress have been carried out to determine the stability of fills immediately after construction and also the stability of the C.N.R. tracks during subexcavation of the very soft to soft material. In this method of analysis, stability is governed by undrained shear strength properties of foundation and fill materials. The following data and values were used in carrying out the stability analysis.

Fill Material	PCF	ø	Su(PSF)
(Tension Cracks (¼ Fill Height) Granular Type Material	130	30	0

Subsoil Conditions (Adjacent to C.N.R. tracks bounded by contour 998 and 996 to south and north of tracks respectively)
(Water elevation 998 feet)

Elevation (Feet)	(PCF)	(PCF)	ø	Su(PSF)
996-976	110	38	0	150
976-970	110	48	0	400
970-960	110	48	0	1400
960 and below	110	48	0	2000

Subsoil Conditions (Outside limits as described above)
(Water elevation 998 feet)

Elevation (Feet)	(PCF)	(PCF)	ø	Su(PSF)
998-988	130	68	30	0
988 and below	110	48	0	2000

Railway Car Loading Cooper E-70
1000 lbs/sq. ft. Evenly distributed over an area 5 feet (longitudinal) by 14 feet (wide)

Furthermore, it was assumed that the organic material and very soft to soft clayey silt to silt of slight plasticity is removed and backfilled with granular type material according to the aforementioned recommendations.

The following are our recommendations based on the total stress analysis:

A) Stability of C.N.R. Tracks Adjacent to Subexcavations

The existing C.N.R. tracks will be stable if the subexcavation is carried out underwater in strips at right angles to the C.N.R. tracks and not wider than 20 feet provided the bottom of the subexcavation should be kept to a minimum of 90 feet from the centre of the railway track. (Refer Figure 7) However, if subexcavation is required very close to the C.N.R. tracks it may be necessary to incorporate sheet piling

and tie backs for the purposes of track protection. Our office will provide the necessary recommendations for sheet piling and tie backs if it is necessary to proceed with this option.

B) Stability of Approach Embankments, Where Toe of Slope is Outside the Limits of Deep Organic Deposit

1) Embankment fill heights up to 30 feet high will be stable with side and forward slopes of 2 horizontal to 1 vertical provided the toe of the slope is not closer than 15 feet from the deep very soft organic deposits (Refer Section A-A, Drawing 1607433-D).

2) Embankment fill heights up to 44 feet high will be stable with a 10 foot mid-height counterbalancing berm and slopes 2 horizontal to 1 vertical provided the toe of the slope is not closer than 20 feet from the deep very soft organic deposits (Refer Section B-B, Drawing 1607433-D).

C) Stability of Approach Embankments Where Toe of the Slope is Within the Limits of the Deep Organic Deposits and Subexcavation and Backfilling is Carried Out as Mentioned Earlier

1) Embankment fill heights up to 44 feet high will be stable with a 10 foot wide mid-height counterbalancing berm and slopes of 2 horizontal to 1 vertical provided the toe of the slope does not encroach more than 50 feet into the swamp area (Refer Section F-F, Drawing 1607433-D).

These recommendations are shown for Scheme 'A' and Scheme 'B' on the plans on Drawing No. 1707433-C. In addition, the results of total stress analysis of the most critical slopes for Schemes 'A' and 'B' are shown on Drawing No. 1607433-D, Section C-C, Section D-D and Section E-E.

The subexcavation and berm requirements for slope stability are dependent on the embankments underlying foundation subsoil which is in turn affected by the location and position of the abutments. The aspect is shown graphically on Drawing No. 1607433-E where the berm, subexcavation and track protection requirements are qualatively described in relation to the abutment's location.

Structure Foundations

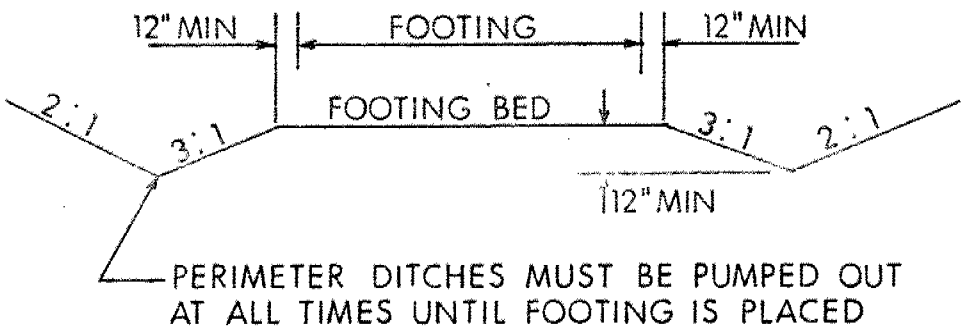
The structure piers and abutments can be supported on end bearing piles driven into the hard glacial deposit. For preliminary design purposes it can be assumed that steel 'H' piles

(12BP74) will attain the required load at approximate tip elevation as follows:

	Approximate Abutment/ Pier Location (Sta.)	Approximate Tip Elevation (Feet)
Southbound Lanes	820+60	925
	819+90	925
	819+00	930
	818+10	925
	817+00	905
	815+90	920
	815+00	915
	814+10	925
Northbound Lanes	822+10	920
	821+50	920
	820+60	925
	819+60	920
	818+60	915
	817+40	910
	816+50	910
	815+60	915
	814+90	915

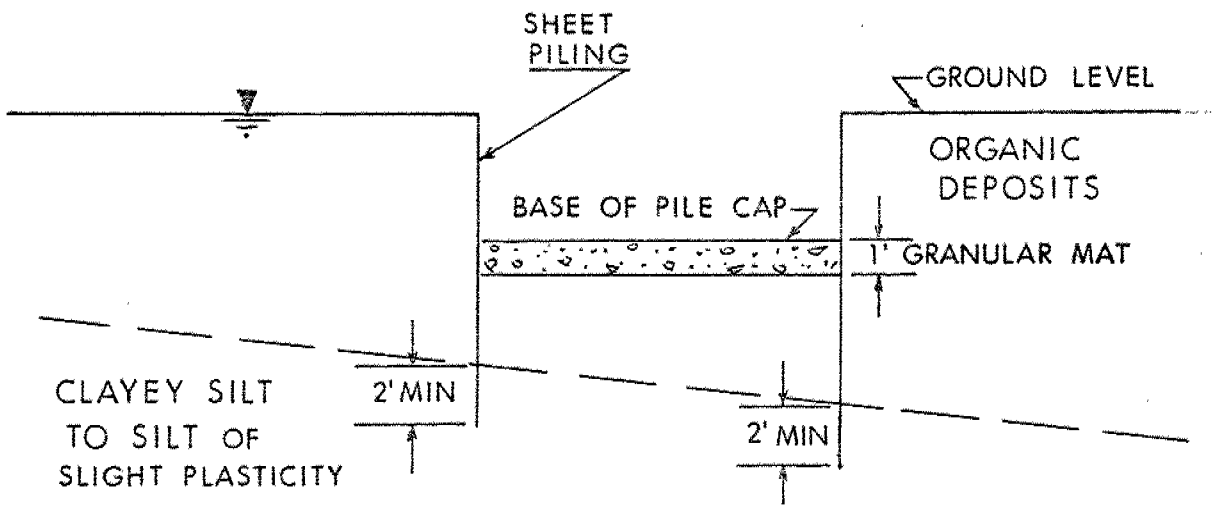
However, driving of the piles during construction should be controlled as per M.T.C. current standards using the Hiley Formula. For design purposes a safe load of 130 tons per pile may be used for 12BP74 steel 'H' piles. These loads are based on our recent experience from a pile load test project on Hwy. 404 at 16th Avenue.

Due to the pervious nature of the surficial sand and silt deposits a temporary dewatering scheme will be required to construct the pile cap in the dry if the base of the pile cap is at or below the prevailing groundwater level. Such a dewatering scheme can be carried out by construction of oversize excavations and pumping from sumps (See Sketch below).



OVERSIZE EXCAVATION WITH PERIMETER DRAINS

For the construction of pier caps located within the boundaries of the deep very soft organic deposits a dewatering scheme will be necessary to construct the pile cap in the dry if the base of the pier cap is located below the prevailing groundwater level. This could be accomplished by driving steel sheet piling to a minimum distance of at least 2 feet into the cohesive subsoil. (see sketch below) Furthermore, to prevent segregation of the concrete and settlement of the pile cap during curing, it will be necessary to provide a 6 inch thick mass concrete pad or a 1 foot thick granular 'A' mat on the organic material prior to placing the pile cap.



Other Considerations

For estimating the earth pressure on the abutments a coefficient of active earth pressure of Ka=0.33 may be used if some movement at the top of the wall is permitted, whereas if no movement at the top of the wall is anticipated, a coefficient of earth pressure at rest Ko=0.5 may be used for design purposes.

Furthermore, to prevent the buildup of hydrostatic pressures behind the abutment wall, free draining granular material should be used for backfill behind the wall as per current M.T.C. standards.

MISCELLANEOUS

The original fieldwork for the investigation was carried out under the supervision of Mr. M. MacLean, Project Engineer, using equipment rented from Master Soil Investigation Limited, Toronto. The fieldwork for the revised schemes was carried out under the supervision of Mr. D. Crawford, Student Technician, using equipment rented from Atcost Soil Drilling Inc., Toronto.

This report was written by Mr. M. MacLean and reviewed by Mr. M. Devata, Supervising Engineer.

M. MacLean, P. Eng.
Project Engineer

M. Devata, P. Eng.
Supervising Engineer

August, 1978

APPENDIX

Ministry of Transportation and Communications
Ontario

HIGHWAY ENGINEERING DIVISION - ENGINEERING MATERIALS OFFICE - SOIL MECHANICS SECTION

RECORD OF BOREHOLE No 1

W P 160-74-33 LOCATION Coords. N 15,958,028, E 1,027,374 ORIGINATED BY M.M.

DIST 6 HWY 404 BOREHOLE TYPE Hollow Stem Augers and Cone Test COMPILED BY M.M.

DATUM Geodetic DATE March 9, 1978 CHECKED BY

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	'N' VALUES	GROUND WATER CONDITIONS	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
996.2	Ground Surface						
0.0 / 990.2	Organic Silt, Some Sand Loose		1	TW	PM		
6.0	Sand		2	SS	4		9 27 48 16
			3	SS	5		
			4	SS	8		2 36 44 18
	Firm to Stiff		5	SS	8		3 24 57 16
	Clayey Silt to Silt of Slight Plasticity Some Sand Very Stiff to Hard		6	SS	20		
			7	SS	27		
			8	SS	26		0 1 79 20
			9	SS	45		
			10	SS	37		
			11	SS	55		0 10 74 16
			12	SS	47		
			13	SS	50		11 10 73 6
919.2			14	SS	56		
77.0	Heterogeneous Mixture, Clayey Silt, Sand and Gravel (Glacial Till) Hard		15	SS	60/ 4"		
			16	SS	138		4 37 43 16
894.7			17	SS	150/ 2"		
101.5	End of Borehole						

ELEVATION SCALE: 990, 980, 970, 960, 950, 940, 930, 920, 910, 900

DYNAMIC CONE PENETRATION RESISTANCE PLOT: 20 40 60 80 100

SHEAR STRENGTH: ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE
400 800 1200 1600 2000

+3

+4

Cannot Push Vane

PLASTIC LIMIT Wp — NATURAL MOISTURE CONTENT W — LIQUID LIMIT W_L

WATER CONTENT (%): 20 40 60

UNIT WEIGHT γ

+3, ×5 : Numbers refer to Sensitivity

20
15 ◇ 5 (%) STRAIN AT FAILURE
10

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HIGHWAY ENGINEERING DIVISION - ENGINEERING MATERIALS OFFICE - SOIL MECHANICS SECTION

RECORD OF BOREHOLE No 2

W P 160-74-33 LOCATION Coords, N 15,985,085; E 1,027,412 ORIGINATED BY M.M.

DIST 6 HWY 404 BOREHOLE TYPE Hollow Stem Augers and Cone Test COMPILED BY M.M.

DATUM Geodetic DATE March 9, 1978 CHECKED BY

SOIL PROFILE ELEV/DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH (o UNCONFINED, • QUICK TRIAXIAL, + FIELD VANE, x LAB VANE; 400 800 1200 1600 2000)	PLASTIC LIMIT Wp / NATURAL MOISTURE CONTENT W / LIQUID LIMIT WL; WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ PCF	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
996.6	Ground Surface										
0.0 / 991.6	Organic Silt Very Soft										
5.0	Clayey Silt to Silt of Slight Plasticity With Random Seams or Pockets of Silt and Fine Sand Stiff		1	TW	PM		990	> 2500	o	135	
			2	SS	4			> 2000	o		2 20 64 14
			3	SS	3		980	> 2000	o		2 26 67 5
	Some Sand Stiff		4	SS	9			> 2000	o H		11 28 40 21
	Clayey Silt to Silt of Slight Plasticity Very Stiff to Hard		5	SS	13		970		o H		
			6	SS	29						
			7	SS	27		960		o		0 1 74 25
			8	SS	21						
			9	SS	35		950		o H		
945.1			10	SS	41						
51.5	End of Borehole										

+3, x5 : Numbers refer to Sensitivity

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

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HIGHWAY ENGINEERING DIVISION - ENGINEERING MATERIALS OFFICE - SOIL MECHANICS SECTION

RECORD OF BOREHOLE No 3

W P 160-74-33 LOCATION Coords. N 15,985,146 E 1,027,455 ORIGINATED BY M.M.

DIST 6 HWY 404 BOREHOLE TYPE Hollow Stem Augers and Cone Test COMPILED BY M.M.

DATUM Geodetic DATE March 7 & 8, 1978 CHECKED BY D.J.

SOIL PROFILE ELEV DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE
998.6	Ground Surface						
0.0	Silt, Some Sand Loose to Compact					No Water Level Established	
992.6			1	SS	11		
6.0	Clayey Silt to Silt of Slight Plasticity Soft		2	SS	1		990
			3	TW	PM		
974.6			4	TW	PH		980
24.0	Sand, Some Silt Some Gravel Loose to Compact		5	SS	8		
			6	SS	6		970
959.6			7	SS	30		
39.0	Clayey Silt to Silt of Slight Plasticity		8	SS	18		960
	Silt		9	SS	41		
	Very Stiff to Hard		10	SS	18		950
			11	SS	22		
			12	SS	67		940
			13	SS	41		
925.6			14	SS	60/5"		930
73.0	Heterogeneous Mixture Clayey Silt, Sand and Gravel Hard Glacial Till		15	SS	145		920
907.1			16	SS	100/3"		910
91.5	End of Borehole						

Note: Water Level Not Established

DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100

SHEAR STRENGTH
○ UNCONFINED + FIELD VANE
● QUICK TRIAXIAL × LAB VANE
400 800 1200 1600 2000

PLASTIC LIMIT Wp | NATURAL MOISTURE CONTENT W | LIQUID LIMIT W_L

WATER CONTENT (%) 20 40 60

UNIT WEIGHT γ

REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
0 26 68 6
0 2 69 29
27 44 24 5
7 69 (24)
20 75 (5)
0 7 81 12

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

20
15 ⊖ 5 (%) STRAIN AT FAILURE
10

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HIGHWAY ENGINEERING DIVISION - ENGINEERING MATERIALS OFFICE - SOIL MECHANICS SECTION

RECORD OF BOREHOLE No 4

W P 160-74-33 LOCATION Coords. N 15,985,250; E 1,027,475 ORIGINATED BY B.L.

DIST 6 HWY 404 BOREHOLE TYPE Hollow Stem Augers and Cone Test COMPILED BY M.M.

DATUM Geodetic DATE March 8, 1978 CHECKED BY W.J.

SOIL PROFILE ELEV/DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH (o UNCONFINED, • QUICK TRIAXIAL, + FIELD VANE, × LAB VANE)	PLASTIC LIMIT Wp / NATURAL MOISTURE CONTENT W / LIQUID LIMIT WL — WATER CONTENT (%)	UNIT WEIGHT γ PCF	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
995.3	Ground Surface							20 40 60 80 100 / 400 800 1200 1600 2000	20 40 60		
0.0	Clayey Silt to Silt of Slight Plasticity With Random Seams of Silt and Fine Sand		1	TW	PM		990	+2			
	Very Soft		2	TW	PH			+3			
	Soft to Stiff		3	TW	PM		980	+2			
972.3			4	TW	PH			×, •, +5		130	
23.0	Silt, Some Sand Trace Clay Loose to Compact		5	SS	9		970				0 29 61 10
			6	SS	11						
957.3			7	SS	16		960				
38.0	Sand, Some Silt Some Gravel Compact		8	SS	17						7 51 38 4
949.8			9	SS	18		950				
45.5	Clayey Silt to Silt of Slight Plasticity Some Sand Hard		10	SS	50			200/8"			
			11	SS	38		940				7 33 55 15
933.8			12	SS	70						
61.5	End of Borehole										

+3, ×5 : Numbers refer to Sensitivity

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

Ministry of Transportation and Communications Ontario

HIGHWAY ENGINEERING DIVISION - ENGINEERING MATERIALS OFFICE - SOIL MECHANICS SECTION

RECORD OF BOREHOLE No 5

W P 160-74-33 LOCATION Coords. N 15,985,150; E 1,027,355 ORIGINATED BY O.J.

DIST 6 HWY 404 BOREHOLE TYPE Hollow Stem Augers and Cone Test COMPILED BY

DATUM Geodetic DATE March 8, 1978 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, x LAB VANE; 400 800 1200 1600 2000)	PLASTIC LIMIT Wp / NATURAL MOISTURE CONTENT W / LIQUID LIMIT WL — WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ PCF	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
995.2	Ground Surface										
0.0	Organic Silt, V. Soft					▼	990				
988.2	Organic Clay Very Soft		1	PS	PM			+ 5 + 6		109	
7.0	Clayey Silt to Silt of Slight Plasticity With Random Seams of Silt and Fine Sand Very Soft to Firm		2	SS	Own Weight			+ 5 + 4	H⊖		2 26 54 18
			3	SS	2		980				2 28 54 16
972.2			4	TW	PH			Cannot Push Vane ○ x 10	H⊖	139	
23.0	Silt, Some Sand Compact		5	SS	11		970		○		2 30 62 6
966.2									H⊖		
29.0	Clayey Silt to Silt of Slight Plasticity Hard		6	SS	0/18"						
			7	SS	21		960				
			8	SS	28				⊖		0 1 79 20
			9	SS	72		950				
942.2			10	SS	31				○		1 8 81 10
53.0	Sand, Some Silt and Gravel Dense		11	SS	37		940				20 49 28 3
933.7			12	SS	33				○		
61.5	End of Borehole										

+3, x5 : Numbers refer to Sensitivity

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

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HIGHWAY ENGINEERING DIVISION - ENGINEERING MATERIALS OFFICE SOIL MECHANICS SECTION

RECORD OF BOREHOLE No 6

W P 160-74-33 LOCATION Coords. N 15,985,216; E 1,027,395 ORIGINATED BY B.L.

DIST 6 HWY 404 BOREHOLE TYPE Hollow Stem Augers COMPILED BY M.M.

DATUM Geodetic DATE March 15, 1978 CHECKED BY [illegible]

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; 400 800 1200 1600 2000)	PLASTIC LIMIT Wp / NATURAL MOISTURE CONTENT W / LIQUID LIMIT WL; WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES						GR SA SI CL
994.8	Ground Surface										
0.0	Organic Silt										
989.8	Very Soft										
5.0	Clayey Silt to Silt of Slight Plasticity With Random Seams of Sand and Silt		1	SS	PM		990	+5 +3		127	E_o=0.71 P_c=0.47 tsf C_c=0.21
	Soft		2	TW	PM						
			3	SS	3					133	E_o=0.47 C_c=0.06
	Stiff		4	TW	PM		980	×5 +3			
973.3			5	TW	PM						
21.5	End of Borehole										

Note: Groundwater Level Not Established

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

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

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HIGHWAY ENGINEERING DIVISION - ENGINEERING MATERIALS OFFICE - SOIL MECHANICS SECTION

RECORD OF BOREHOLE No 7

W P 160-74-33 LOCATION Coords. N 15,985,276; E 1,027,435 ORIGINATED BY O.J.

DIST 6 HWY 404 BOREHOLE TYPE Hollow Stem Augers and Cone Test COMPILED BY O.J.

DATUM Geodetic DATE March 9, 1978 CHECKED BY [illegible]

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 + FIELD VANE ● QUICK TRIAXIAL × LAB VANE) (400 800 1200 1600 2000)	PLASTIC LIMIT Wp / NATURAL MOISTURE CONTENT W / LIQUID LIMIT WL — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ PCF	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
994.6 0.0	Ground Surface										
992.6 2.0	Organic Silt, V. Soft		1	TW	PM	▼	990	×5 Cannot Push Vane		130	E_o=.58 P_c=0.2 tsf
	Soft to Firm		2	SS	7			+4 +5			
	Some Sand Stiff		3	SS	8		980				1 17 67 15
			4	SS	10						
	Sandy Silt Loose		5	SS	9		970				14 33 43 10
	Clayey Silt to Silt of Slight Plasticity Very Stiff to Hard		6	SS	26						
			7	SS	67		960				
			8	SS	26						
	Silt Compact		9	SS	19		950				0 3 92 5
940.6	Hard		10	SS	34						
54.0	Sand, Some Silt and Gravel Compact to Very Dense		11	SS	67		940				
			12	SS	83						17 46 27 10
928.1			13	SS	26		930				
66.5	End of Borehole										

+3, ×5 : Numbers refer to Sensitivity

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

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HIGHWAY ENGINEERING DIVISION - ENGINEERING MATERIALS OFFICE - SOIL MECHANICS SECTION

RECORD OF BOREHOLE No 8

W P 160-74-33 LOCATION Coords. N 15,985,148; E 1,027,313 ORIGINATED BY O.J.

DIST 6 HWY 404 BOREHOLE TYPE Hollow Stem Augers and Cone Test COMPILED BY

DATUM Geodetic DATE March 7, 1978 CHECKED BY [signature]

ELEV / DEPTH	DESCRIPTION	NUMBER	TYPE	'N' VALUES	ELEVATION SCALE	DYNAMIC CONE PENETRATION / SHEAR STRENGTH PSF	WATER CONTENT (%)	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
994.7	Ground Surface							
0.0	Organic Silt Very Soft to Soft				990	+4, +4		
	Organic Clay Very Soft	1	SS	PM				Om 17% W 148%
984.0 / 10.0	Clayey Silt to Silt of Slight Plasticity	2	SS	0/18"		+3		
					980	+5		
	Very Soft	3	SS	1/18"		Cannot Push Vane		
	Stiff to Hard	4	SS	10		+4		14 23 50 13
	Some Sand	5	SS	9	970			
		6	SS	9				
		7	SS	18	960			
		8	SS	25				2 23 61 14
		9	SS	55	950			0 1 80 19
	Sand, Some Silt, Compact	10	SS	28				10 42 34 14
		11	SS	55	940			
936.7 / 58.0	Heterogeneous Mixture, Clayey Silt Cobbles Sand and Gravel Hard (Glacial Till)	12	SS	145				
		13	SS	100/2"	930			9 50 31 10
		14	SS	100/3"	920			
		15	SS	100/4"	910			14 44 32 10
898.2		16	SS	100/3"	900			
96.5	End of Borehole							

+3, x5 : Numbers refer to Sensitivity

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

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HIGHWAY ENGINEERING DIVISION - ENGINEERING MATERIALS OFFICE - SOIL MECHANICS SECTION

RECORD OF BOREHOLE No 9

W P 160-74-33 LOCATION Coords. N 15,985,385; E 1,027,464 ORIGINATED BY O.J.

DIST 6 HWY 404 BOREHOLE TYPE Hollow Stem Augers COMPILED BY O.J.

DATUM Geodetic DATE March 10 & 13, 1978 CHECKED BY A.J.

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES 'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH (o UNCONFINED, • QUICK TRIAXIAL, + FIELD VANE, × LAB VANE; 400 800 1200 1600 2000)	PLASTIC LIMIT Wp / NATURAL MOISTURE CONTENT W / LIQUID LIMIT WL — WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
995.4	Ground Surface										
0.0	Organic Silt Very Soft										
			1	TW	PM		990	+ 5 + 2 +6 +12			W 116% Om 13% W 147% Om 10%
	Organic Clay Very Soft		2	SS	1						
979.4			3	SS	2		980				
16.0	Sand, Some Silt Some Gravel Compact		4	SS	14				o		17 74 (9)
968.4			5	SS	20		970		o		1 54 35 10
27.0	Clayey Silt to Silt of Slight Plasticity Very Stiff		6	SS	19				o		
961.4											
34.0	Sandy Gravel		7	SS	20		960		o		50 31 17 2
956.4	Compact										
39.0	Clayey Silt to Silt of Slight Plasticity Some Sand Hard		8	SS	43						
			9	SS	43		950		o		8 17 50 25
			10	SS	17						
			11	SS	55		940		OH		11 18 61 10
935.4											
60.0	Heterogeneous Mixture Clayey Silt Sand and Gravel (Glacial Till) Hard		12	SS	150				o		18 40 28 14
			13	SS	72		930				
			14	SS	100/4"		920		OH		13 46 30 11
							910				
903.9			15	SS	100/2"						
91.5	End of Borehole										

+3, ×5 : Numbers refer to Sensitivity

15 (20 / 10) S (%) STRAIN AT FAILURE

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RECORD OF BOREHOLE No 10

W P 160-74-33 LOCATION Coords. N 15,984,984; E 1,027,348 ORIGINATED BY B.L.

DIST 6 HWY 404 BOREHOLE TYPE Hollow Stem Augers and Cone Test COMPILED BY M.M.

DATUM Geodetic DATE March 13, 1978 CHECKED BY [illegible]

ELEV / DEPTH	SOIL PROFILE 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, 400 800 1200 1600 2000)	PLASTIC LIMIT Wp / NATURAL MOISTURE CONTENT W / LIQUID LIMIT Wl — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ PCF	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
996.4	Ground Surface										
0.0	Organic Silt Very Soft to Soft		1	SS	1						
			2	PS	PH						
986.4			3	SS	1		990	+2			Om 4%
10.0	Clayey Silt to Silt of Slight Plasticity With Random Seams or Pockets of Silt and Fine Sand Very Soft to Soft		4	TW	PH			+4			
			5	SS	3						
			6	TW	PH						
			7	SS	1		980	+2			127
			8	TW	PH						
	Clayey Silt to Silt of Slight Plasticity Some Sand							+3 ×			
			9	TW	PH		970				
	Stiff Very Stiff to Hard		10	TW	PH			+2			
			11	SS	17		960				4 28 57 11
			12	SS	18						
			13	SS	33		950				17 16 52 15
			14	SS	29			100/10"			3 14 69 14
							940				
							930				
							920				
911.4											
85.0	Heterogeneous Mixture, Clayey Silt Sand and Gravel Glacial Till Hard						910				
899.9			15	SS	100/5"		900				
96.5	End of Borehole										

+3, ×5 : Numbers refer to Sensitivity

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

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HIGHWAY ENGINEERING DIVISION - ENGINEERING MATERIALS OFFICE - SOIL MECHANICS SECTION

RECORD OF BOREHOLE No 11

W P 160-74-33 LOCATION Coords. N 15,984,932; E 1,027,512 ORIGINATED BY D.C.

DIST 6 HWY 404 BOREHOLE TYPE Hollow Stem Augers COMPILED BY M.M.

DATUM Geodetic DATE May 23, 1978 CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH (○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 400 800 1200 1600 2000) / PLASTIC LIMIT Wp — NATURAL MOISTURE CONTENT W — LIQUID LIMIT WL / WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES					GR SA SI CL
1001.9	Ground Surface									
0.0	Organics ~~Sandy Some Silt, Loose~~ Soil		1	SS	2	▼	1000			
2.0	Clayey Silt to Silt of Slight Plasticity Some Sand Very Stiff		2	SS	8					
			3	SS	10			+> 2000		
990.9			4	SS	16					0 13 75 12
11.0	Silt		5	SS	19		990			
	Compact to Dense		6	SS	27					1 1 92 6
			7	SS	25		980			
			8	SS	31					0 3 90 7
970.4			9	SS	29					
31.5	End of Borehole									

+3, ×5 : Numbers refer to Sensitivity

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

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HIGHWAY ENGINEERING DIVISION - ENGINEERING MATERIALS OFFICE - SOIL MECHANICS SECTION

RECORD OF BOREHOLE No 12

W P 160-74-33 LOCATION Coords. N 15,984,855; E 1,027,403 ORIGINATED BY D.C.

DIST 6 HWY 404 BOREHOLE TYPE Hollow Stem Augers COMPILED BY M.M.

DATUM Geodetic DATE May 23, 1978 CHECKED BY A.J.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH (○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB VANE)	PLASTIC LIMIT Wp / NATURAL MOISTURE CONTENT W / LIQUID LIMIT WL — WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES						
1001.6	Ground Surface										
0.0 / 997.6	Organic Silt Very Soft		1	SS	2		1000				
4.0 / 990.6	Sand, Some Gravel Compact		2	SS	16						
			3	SS	28				6		
			4	SS	26		990				
11.0	Clayey Silt to Silt of Slight Plasticity Some Sand		5	SS	21						
			6	SS	14						
	Silt Compact		7	SS	19		980				
	Very Stiff		8	SS	29				○		24 16 40 20
			9	SS	23		970				
963.6			10	SS	22						
38.0	Silt Compact		11	SS	15		960				
			12	SS	22				○		
950.1			13	SS	20						
51.5	End of Borehole										

+3, ×5 : Numbers refer to Sensitivity

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

CHECK RETURN ON SOIL EXPLORATION

Ministry of Transportation and Communications
Ontario

HIGHWAY ENGINEERING DIVISION - ENGINEERING MATERIALS OFFICE - SOIL MECHANICS SECTION

RECORD OF BOREHOLE No 13

W P 160-74-33 LOCATION Coords. N 15,984,745; E 1,027,280 ORIGINATED BY D.C.

DIST 6 HWY 404 BOREHOLE TYPE Hollow Stem Augers COMPILED BY M.M.

DATUM Geodetic DATE May 23-24, 1978 CHECKED BY W.J.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH (o UNCONFINED, + FIELD VANE, • QUICK TRIAXIAL, x LAB VANE; 400 800 1200 1600 2000)	PLASTIC LIMIT Wp / NATURAL MOISTURE CONTENT W / LIQUID LIMIT WL; WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES						GR SA SI CL
999.4	Ground Surface										
0.0	Clayey Silt to Silt of Slight Plasticity Some Sand Very Stiff		1	SS	6	▼	990		OH		1 38 43 18
			2	SS	12						
			3	SS	15						
			4	SS	13						
			5	SS	7						
			6	SS	16		980	+ 2000			
			7	SS	15				OH		9 32 41 18
			8	SS	24						
966.4			9	SS	31		970				
33.0	With Gravel		10	SS	19						
	Silt Compact to Very Dense		11	SS	66		960				
			12	SS	44				o		0 0 96 4
947.9			13	SS	46		950				
51.5	End of Borehole										

+3, x5 : Numbers refer to Sensitivity

20
15 ◇ 5 (%) STRAIN AT FAILURE
10

OFFICE REPORT ON SOIL EXPLORATION

Ministry of Transportation and Communications
Ontario

HIGHWAY ENGINEERING DIVISION - ENGINEERING MATERIALS OFFICE - SOIL MECHANICS SECTION

RECORD OF BOREHOLE No 14

W P 160-74-33 LOCATION Coords. N 15,984,940; E 1,027,378 ORIGINATED BY D.C.

DIST 6 HWY 404 BOREHOLE TYPE Hollow Stem Augers COMPILED BY M.M.

DATUM Geodetic DATE May 24, 1978 CHECKED BY W.J.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH (o UNCONFINED, + FIELD VANE, • QUICK TRIAXIAL, x LAB VANE; 400 800 1200 1600 2000)	PLASTIC LIMIT Wp / NATURAL MOISTURE CONTENT W / LIQUID LIMIT WL; WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES						
996.4	Ground Surface										
0.0	Sand With Silt Loose		1	SS	2						
			2	SS	11				o		2 50 40 8
			3	SS	4		990				
	Soft Clayey Silt		4	SS	5			+2			
			5	SS	4				o		1 59 39 1
977.4			6	SS	5		980	+2			
19.0	Clayey Silt to Silt of Slight Plasticity Some Sand Very Stiff		7	SS	7			+> 2000	10		10 17 50 23
968.4			8	SS	8		970				
28.0			9	TW	PH			+> 2000			
	Silt Compact to Dense		10	SS	14		960				
			11	SS	25						
							950				
			12	SS	18				o		
							940				
			13	SS	36						
							930				
			14	SS	38						
919.4							920				
77.0	Heterogeneous Mixture Clayey Silt, Sand and Gravel Hard Glacial Till		15	SS	150/5"						
			16	SS	150/4"		910		o		18 45 26 11
904.9			17	SS	117/6"						
91.5	End of Borehole										

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

15 20 10 S (%) STRAIN AT FAILURE

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Ontario

HIGHWAY ENGINEERING DIVISION - ENGINEERING MATERIALS OFFICE - SOIL MECHANICS SECTION

RECORD OF BOREHOLE No 15

W P 160-74-33 LOCATION Coords. N 15,984,836; E 1,027,350 ORIGINATED BY D.C.

DIST 6 HWY 404 BOREHOLE TYPE Hollow Stem Augers COMPILED BY D.C.

DATUM Geodetic DATE May 29-31, 1978 CHECKED BY W.J.

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES 'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH (○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB VANE)	PLASTIC LIMIT Wp / NATURAL MOISTURE CONTENT W / LIQUID LIMIT WL — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
996.1	Ground Surface										
0.0	Sand, Some Silt Loose to Compact		1	SS	12						2 55 36 7
			2	SS	11						
			3	SS	7		990				2 74 18 6
			4	SS	10			+ 2			
983.1			5	SS	29						
13.0	Clayey Silt to Silt of Slight Plasticity Some Sand Uniform Fine Sand Very Stiff		6	SS	23		980				
			7	SS	15						
968.1			8	SS	19		970				2 10 48 40
28.0	Silt Compact to Dense		9	SS	17						
			10	SS	11		960				
							950				
			11	SS	46						0 1 87 12
916.1							940				
							930				
							920				
80.0	Heterogeneous Mixture Clayey Silt, Sand and Gravel (Glacial Till) Hard		12	SS	110/5"						
			13	SS	110/4"		910				
			14	SS	100/4"						
899.6			15	SS	120/1"		900				
96.5	End of Borehole										

+3, ×5 : Numbers refer to Sensitivity

20
15 ○ 5 (%) STRAIN AT FAILURE
10

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HIGHWAY ENGINEERING DIVISION - ENGINEERING - MATERIALS OFFICE - SOIL MECHANICS SECTION

RECORD OF BOREHOLE No 16

W P 160-74-33 LOCATION Coords. N 15,985,063; E 1,027,455 ORIGINATED BY D.C.

DIST 6 HWY 404 BOREHOLE TYPE Hollow Stem Augers COMPILED BY M.M.

DATUM Geodetic DATE May 31 & June 1, 1978 CHECKED BY a.j.

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES 'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH (o UNCONFINED, • QUICK TRIAXIAL, + FIELD VANE, x LAB VANE; 400 800 1200 1600 2000)	PLASTIC LIMIT Wp / NATURAL MOISTURE CONTENT W / LIQUID LIMIT W_L — WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
998.0	Ground Surface										
0.0	Organic Silt With Sand		1	SS	3						Om 4%
993.0	Soft		2	SS	10						
5.0	Clayey Silt to Silt of Slight Plasticity With Random Seams of Silt and Fine Sand		3	SS	9			+> 2000			2 26 57 15
			4	SS	5		990	+4, 5			0 18 66 16
983.0	Firm to Stiff		5	SS	9						
15.0	Silt, Some Sand		6	SS	10						
	Compact		7	SS	11		980				
			8	SS	11						
			9	SS	11		970	+> 2000			2 29 63 6
963.0											
35.0	Clayey Silt to Silt of Slight Plasticity		10	SS	23		960				2 10 54 34
	Very Stiff		11	TW	PH		950				
							940				
							930				
921.0			12	SS	92						
77.0	Heterogeneous Mixture Clayey Silt Sand and Gravel Cobbles Hard Glacial Till		13	SS	140		920				8 49 32 11
			14	SS	100/6"		910				
			15	SS	110/5"						
901.5			16	SS	120/5"						
96.5	End of Borehole										

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

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

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HIGHWAY ENGINEERING DIVISION - ENGINEERING MATERIALS OFFICE - SOIL MECHANICS SECTION

RECORD OF BOREHOLE No 17

W P 160-74-33 LOCATION Coords. N 15,985,024; E 1,027,490 ORIGINATED BY DC.

DIST 6 HWY 404 BOREHOLE TYPE Hollow Stem Augers 0-55, Washboring With Casing 55-80, Wash Ahead 80-95 COMPILED BY J.J.

DATUM Geodetic DATE June 1, 1978 and June 2, 1978 CHECKED BY A.J.

ELEV / DEPTH	SOIL PROFILE DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH (o UNCONFINED, • QUICK TRIAXIAL, + FIELD VANE, × LAB VANE)	PLASTIC LIMIT Wp / NATURAL MOISTURE CONTENT W / LIQUID LIMIT Wl — WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
1000.3	Ground Surface										
0.0 / 998.3	Organic Silt With Sand Very Soft		1	SS	5		1000				
2.6	Sand, Some Silt		2	SS	13	▼					
	Compact		3	SS	17						
990.3			4	SS	26						
10.0	Clayey Silt to Silt of Slight Plasticity Some Sand With Pockets of Sand and Gravel up to 1 Ft. Thick Every 4 Feet		5	SS	43		990				
			6	SS	21						
			7	SS	17						
			8	SS	23		980		o H		22 15 38 25
971.9	Very Stiff		9	SS	34						
29.0	Silt		10	SS	14		970				
	Compact to Dense						960				
							950				
			11	SS	18						
							940				
							930				
923.3											
77.0	Heterogeneous Mixture, Clayey Silt Sand and Gravel (Glacial Till)		12	SS	100/ 1"		920				
	Hard		13	SS	93/ 6"				o		29 37 24 10
			14	SS	110/ 2"		910				
903.8			15	SS	110/ 4"						
96.5	End of Borehole										

+3, ×5 : Numbers refer to Sensitivity

15 20 5 10 (%) STRAIN AT FAILURE

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HIGHWAY ENGINEERING DIVISION - ENGINEERING MATERIALS OFFICE - SOIL MECHANICS SECTION

RECORD OF BOREHOLE No 19

W P 160-74-33 LOCATION Coords. N 15,984,750; E 1,027,362 ORIGINATED BY D.C.

DIST 6 HWY 404 BOREHOLE TYPE Hollow Stem Augers 0-60, Washboring With Casing 60-107 COMPILED BY J.J.

DATUM Geodetic DATE June 6, 1978 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 (%) (20 40 60)	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES						
1009.4	Ground Surface										
0.0	Sand, Some Gravel Dense		1	SS	4						
998.4			2	SS	39		1000		○		30 56 (14)
11.0	Clayey Silt to Silt of Slight Plasticity Some Sand Hard		3	SS	37						
987.4			4	SS	34		990		○		1 32 51 16
22.0	Silt, Some Sand Compact		5	SS	34						
981.4			6	TW	PH						
28.0	Clayey Silt to Silt of Slight Plasticity Some Sand Hard		7	SS	10		980		○		
			8	SS	40						0 37 59 4
			9	TW	PH		970				
932.4							960				
77.0	Heterogeneous Mixture, Clayey Silt, Sand and Gravel Silt Hard Glacial Till		10	SS	149		950				
			12	SS	182		940				
			13	SS	94/6"		930				8 47 34 11
			14	SS	100/5"		920				
902.9			15	SS	100/4"		910				
106.5	End of Borehole										

+3, ×5 : Numbers refer to Sensitivity

15 20 5 10 (%) STRAIN AT FAILURE

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HIGHWAY ENGINEERING DIVISION - ENGINEERING MATERIALS OFFICE - SOIL MECHANICS SECTION

RECORD OF BOREHOLE No 20

W P 160-74-33 LOCATION Coords. N 15,984,878; E 1,027,458 ORIGINATED BY D.C.

DIST 6 HWY 404 BOREHOLE TYPE Hollow Stem Augers 0-50, Washboring With Casing 50-80, Wash Ahead 80-91.5 COMPILED BY J.J.

DATUM Geodetic DATE June 8, 1978 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 (%) (20 40 60)	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
1003.3	Ground Surface										
0.0 / 1001.3	Organic Silt		1	SS	6						
2.0 / 995.3	Clayey Silt to Silt of Slight Plasticity Some Sand, Very Stiff		2	SS	22		1000		CH		5 40 41 14
8.0 / 990.3	Sand, Some Silt Compact		3	SS	20						
13.0	Some Sand and Gravel		4	SS	39		990				
	Silt Dense		5	SS	45				⊕		0 1 95 4
	Clayey Silt to Silt of Slight Plasticity Hard Some Sand and Gravel		6	SS	51		980				
			7	SS	47						
925.3							970				
							960				
							950				
							940				
							930				
78.0	Heterogeneous Mixture, Clayey Silt Sand and Gravel Hard Glacial Till		8	SS	147/ 10"						
			9	SS	114/ 6"		920		OH		
911.8			10	SS	112/ 6"						
91.5	End of Borehole										

+3, ×5 : Numbers refer to Sensitivity

15 20 5 (%) STRAIN AT FAILURE 10

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HIGHWAY ENGINEERING DIVISION - ENGINEERING MATERIALS OFFICE - SOIL MECHANICS SECTION

RECORD OF BOREHOLE No 21

W P 160-74-33 LOCATION Coords. N 15,985,514; E 1,027,440 ORIGINATED BY D.C.

DIST 6 HWY 404 BOREHOLE TYPE Hollow Stem Augers COMPILED BY J.J.

DATUM Geodetic DATE June 9, 1978 CHECKED BY W.J.

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES 'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH (○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB VANE)	PLASTIC LIMIT Wp / NATURAL MOISTURE CONTENT W / LIQUID LIMIT WL — WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
1003.3	Ground Surface										
0.0	Trace Organics		1	SS	5						Om 4%
	Sand, Some Silt Loose		2	SS	5		1000				2 67 25 6
996.3											
7.0			3	SS	27	▼					
			4	SS	18				⊕		0 19 66 15
			5	TW	PH		990				
			6	SS	24						
			7	SS	24				⊕		
	Some Sand						980				
	Clayey Silt to Silt of Slight Plasticity		8	SS	38						
			9	SS	36						
	Very Stiff to Hard						970				
			10	SS	24						
							960				
			11	SS	30				⊕		0 2 80 18
							950				
							940				
928.3							930				
75.0	Heterogeneous Mixture, Clayey Silt Sand and Gravel Hard		12	SS	126/ 6"				○		7 43 38 12
			13	SS	100/ 5"						
916.8							920				
			14	SS	100/ 4"						
86.5	End of Borehole										

+3, ×5 : Numbers refer to Sensitivity

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

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HIGHWAY ENGINEERING DIVISION - ENGINEERING MATERIALS OFFICE - SOIL MECHANICS SECTION

RECORD OF BOREHOLE No 22

W P 160-74-33 LOCATION Coords. N 15,985,386; E 1,027,415 ORIGINATED BY D.C.

DIST 6 HWY 404 BOREHOLE TYPE Hollow Stem Augers (0-65 ft.) and Washboring (65 ft.) COMPILED BY M.M.

DATUM Geodetic DATE June 12-14, 1978 CHECKED BY [illegible]

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES 'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH (o UNCONFINED, + FIELD VANE, • QUICK TRIAXIAL, × LAB VANE; 400 800 1200 1600 2000)	PLASTIC LIMIT Wp / NATURAL MOISTURE CONTENT W / LIQUID LIMIT WL — WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
996.0	Ground Surface										
0.0 994.0	Organic Silt Soft		1	SS	5	▽					
2.0	Sand, Some Silt Some Gravel Loose to Compact		2	SS	15		990				
			3	SS	6						
			4	SS	17						8 78 (14)
			5	SS	17						
979.0			6	SS	9		980				
17.0	Clayey Silt to Silt of Slight Plasticity Very Stiff		7	SS	11			+			
			8	SS	10		970				
			9	SS	15				o—H		
			10	SS	24		960				
943.0			11	SS	113		950		o—H		2 12 72 14
53.0	Heterogeneous Mixture, Clayey Silt Sand and Gravel Glacial Till Hard Cobbles		12	SS	88		940				
			13	SS	120/ 5"				o		
			14	SS	100/ 3½"		930				
			15	SS	100/ 6"						
919.5			16	SS	114/ 6"		920				
76.5	End of Borehole										

+3, x5 : Numbers refer to Sensitivity

20
15 ◇ 5 (%) STRAIN AT FAILURE
10

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HIGHWAY ENGINEERING DIVISION - ENGINEERING MATERIALS OFFICE - SOIL MECHANICS SECTION

RECORD OF BOREHOLE No 23

W P 160-74-33 LOCATION Coords. N 15,985,302; E 1,027,300 ORIGINATED BY D.C.

DIST 6 HWY 404 BOREHOLE TYPE Hollow Stem Augers COMPILED BY M.M.

DATUM Geodetic DATE June 14-15, 1978 CHECKED BY W.J.

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES 'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE)	PLASTIC LIMIT Wp / NATURAL MOISTURE CONTENT W / LIQUID LIMIT WL — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
996.2	Ground Surface										
0.0 / 994.2	Organic Silt		1	SS	6	▼					Om 2%
2.0 / 990.2	Sand, Some Silt Compact		2	SS	16		990				
6.0	Clayey Silt to Silt of Slight Plasticity Very Stiff to Hard		3	SS	20						
			4	SS	24				○		2 21 41 36
			5	SS	27						
			6	SS	31		980				
			7	SS	28						
			8	SS	37		970		○		0 2 77 21
			9	SS	22						
			10	SS	71		960				
			11	SS	104						
948.2							950				
48.0 / 941.2	Silt Very Dense		12	SS	100/ 5"						10 43 32 15
55.0	Heterogeneous Mixture of Clayey Silt, Sand and Gravel Cobbles Hard Glacial Till		13	SS	106/ 6"		940		○		
924.7			14	SS	100/ 5"		930				
71.5	End of Borehole										

+3, ×5 : Numbers refer to Sensitivity

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

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HIGHWAY ENGINEERING DIVISION - ENGINEERING MATERIALS OFFICE - SOIL MECHANICS SECTION

RECORD OF BOREHOLE No 24

W P 160-74-33 LOCATION Coords. N 15,985,255; E 1,027,336 ORIGINATED BY D.C.

DIST 6 HWY 404 BOREHOLE TYPE Hollow Stem Auger COMPILED BY D.C.

DATUM Geodetic DATE June 15-19, 1978 CHECKED BY

SOIL PROFILE			SAMPLES			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; 400 800 1200 1600 2000)	PLASTIC LIMIT Wp / NATURAL MOISTURE CONTENT W / LIQUID LIMIT WL; WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES						
995.2	Ground Elevation										
0.0	Sand, Some Gravel Trace Organics Loose to Compact		1	SS	3	▽					
990.2			2	SS	16		990		o		
5.0	Clayey Silt to Silt of Slight Plasticity		3	SS	13						
			4	SS	16				⊡		0 4 90 6
			5	TW	PH			+ 3			
	Stiff to Hard		6	SS	30		980				
			7	SS	20						
			8	SS	39		970		⊡		0 1 80 19 Piezometer placed 78 06 19
			9	SS	39						
			10	SS	25		960		⊡		0 1 73 26
			11	SS	145		950		o		2 10 74 14
941.2											
54.0	Heterogeneous Mixture Clayey Silt, Sand and Gravel		12	SS	100/ 4"		940				
			13	SS	100/ 5"		930		o		Piezometer placed 78 06 19
923.7			14	SS	150/ 6"						
71.5	End of Borehole										

+3, ×5 : Numbers refer to Sensitivity

15 20 5 (%) STRAIN AT FAILURE 10

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HIGHWAY ENGINEERING DIVISION - ENGINEERING MATERIALS OFFICE - SOIL MECHANICS SECTION

RECORD OF BOREHOLE No 25

W P 160-74-33 LOCATION Coords. N 15,985,208; E 1,027,256 ORIGINATED BY D.C.

DIST 6 HWY 404 @ CNR BOREHOLE TYPE Hollow Stem Augers COMPILED BY D.C.

DATUM Geodetic DATE June 20, 1978 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 + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 400 800 1200 1600 2000	PLASTIC LIMIT Wp / NATURAL MOISTURE CONTENT W / LIQUID LIMIT WL — WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
994.7	Ground Surface										
0.0	Organic Silt		1	SS	1½	▼					Om 77% W=355%
	Very Soft		2	SS	1½		990				
986.7	Organic Clay, White to Grey, Very Soft		3	SS	1/18"						Om 2%
8.0	Clayey Silt to Silt of Slight Plasticity		4	SS	0 WN WT			+ 4			
	Very Soft		5	SS	2			+ 2			
975.7			6	SS	3		980	+ 2			
19.0	Silt, Some Sand		7	SS	7						
	Loose to Compact		8	SS	12		970				
965.7											
29.0	Clayey Silt to Silt of Slight Plasticity		9	SS	40						
	Hard										
958.2			10	SS	63		960		OH		0 2 78 20
36.5	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

HIGHWAY ENGINEERING DIVISION - ENGINEERING MATERIALS OFFICE - SOIL MECHANICS SECTION

RECORD OF BOREHOLE No 26

W P 160-74-33 LOCATION Coords. N 15,985,178; E 1,027,280 ORIGINATED BY D.C.

DIST 6 HWY 404 @ CNR BOREHOLE TYPE Hollow Stem Augers COMPILED BY D.C.

DATUM Geodetic DATE June 21, 1978 CHECKED BY W.J.

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 + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 400 800 1200 1600 2000	PLASTIC LIMIT Wp / NATURAL MOISTURE CONTENT W / LIQUID LIMIT WL — WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
994.5	Ground Surface										
0.0	Organic Silt Black Organic Clay Very Soft White to Grey, Very Soft		1	SS	2	▽ 18"	990	+8			
986.5			2	SS	27			+4			
			3	TW	PH			+3			
8.0	Clayey Silt to Silt of Slight Plasticity Some Sand Very Soft to Firm		4	SS	0						
			5	SS	0		980	+3			
			6	SS	3			+3			
			7	SS	3						
970.5							970				
24.0	Silt, Some Sand Loose		8	SS	6						1 30 63 6
963.5											
31.0	Clayey Silt to Silt of Slight Plasticity Hard		9	SS	67						
958.0							960				
			10	SS	50						
36.5	End of Borehole										

+3, ×5 : Numbers refer to Sensitivity

15 20 10 S (%) STRAIN AT FAILURE

OFFICE REPORT ON SOIL EXPLORATION

Ministry of Transportation and Communications
Ontario

HIGHWAY ENGINEERING DIVISION - ENGINEERING MATERIALS OFFICE - SOIL MECHANICS SECTION

RECORD OF BOREHOLE No 27

W P 160-74-33 LOCATION Coords. N 15,985,485; E 1,027,495 ORIGINATED BY D.C.

DIST 6 HWY 404 BOREHOLE TYPE Hollow Stem Augers COMPILED BY D.C.

DATUM Geodetic DATE June 21, 1978 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 (%) (20 40 60)	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES						GR SA SI CL
995.3	Ground Elevation										
0.0 / 993.3	Organic Silt Some Sand		1	SS	4						
2.0	Silt, Some Sand		2	SS	15	▼	990				
987.3	Compact		3	SS	21				○		0 23 75 2
8.0	Clayey Silt to Silt of Slight Plasticity		4	SS	22				⊖		
			5	SS	23						
	Some Sand Silt, Compact		6	SS	25		980				
			7	SS	33						
	Very Stiff to Hard						970				
			8	SS	30				⊖		0 2 87 11
964.8			9	SS	21						
31.5	End of Borehole										

+3, ×5 : Numbers refer to Sensitivity

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

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Ontario

HIGHWAY ENGINEERING DIVISION - ENGINEERING MATERIALS OFFICE - SOIL MECHANICS SECTION

RECORD OF BOREHOLE No 28

W P 160-74-33 LOCATION Coords. N 15,985,298; E 1,027,392 ORIGINATED BY D.C.

DIST 6 HWY 404 & CNR BOREHOLE TYPE Hollow Stem Augers COMPILED BY D.C.

DATUM Geodetic DATE June 22, 1978 CHECKED BY

SOIL PROFILE			SAMPLES			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 (%) (20 40 60)	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES						GR SA SI CL
995.3	Ground Surface										
0.0	Sand, Some Silt		1	SS	13						
			2	SS	15		990				
	Loose to Compact										
			3	SS	9				o		18 43 32 7
985.3			4	SS	9						
10.0	Clayey Silt to Silt of Slight Plasticity		5	SS	12						
			6	SS	17		980				
	Some Sand										
			7	SS	21						
	Very Stiff to Hard										
			8	SS	32		970				
963.8			9	SS	28						
31.5	End of Borehole										

+3, ×5 : Numbers refer to Sensitivity

15 20 10 5 (%) STRAIN AT FAILURE

OFFICE REPORT ON SOIL EXPLORATION

Ministry of Transportation and Communications
Ontario

HIGHWAY ENGINEERING DIVISION - ENGINEERING MATERIALS OFFICE - SOIL MECHANICS SECTION

RECORD OF BOREHOLE No 29

W P 160-74-33 LOCATION Coords. N 15,985,268; E 1,027,273 ORIGINATED BY D.C.

DIST 6 HWY 404 @ CNR BOREHOLE TYPE Hollow Stem Augers COMPILED BY D.C.

DATUM Geodetic DATE June 22, 1978 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)	WATER CONTENT (%) (PLASTIC LIMIT W_P — NATURAL MOISTURE CONTENT W — LIQUID LIMIT W_L)	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES						GR SA SI CL
994.3											
0.0	Organic Silt		1	SS	1						
	Very Soft										
	Organic Clay		2	SS	1/12"		990				
	Very Soft		3	TW	PH			+4			
985.3								+4			
9.0	Clayey Silt to Silt of Slight Plasticity		4	TW	PH			+2			
982.0	Very Soft										
12.0			5	SS	13						
	Clayey Silt to Silt of Slight Plasticity		6	SS	15		980		○		0 28 62 10
	Very Stiff to Hard		7	SS	19						
966.3							970				
28.0	Clayey Silt to Silt of Slight Plasticity		8	SS	17						
962.8	Hard		9	SS	48				○		
31.5	End of Borehole										

OFFICE REPORT ON SOIL EXPLORATION

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

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

Ministry of Transportation and Communications
Ontario

HIGHWAY ENGINEERING DIVISION - ENGINEERING MATERIALS OFFICE - SOIL MECHANICS SECTION

RECORD OF BOREHOLE No 30

W P 160-74-33 LOCATION Coords. N 15,985,320; E 1,027,212 ORIGINATED BY D.C.

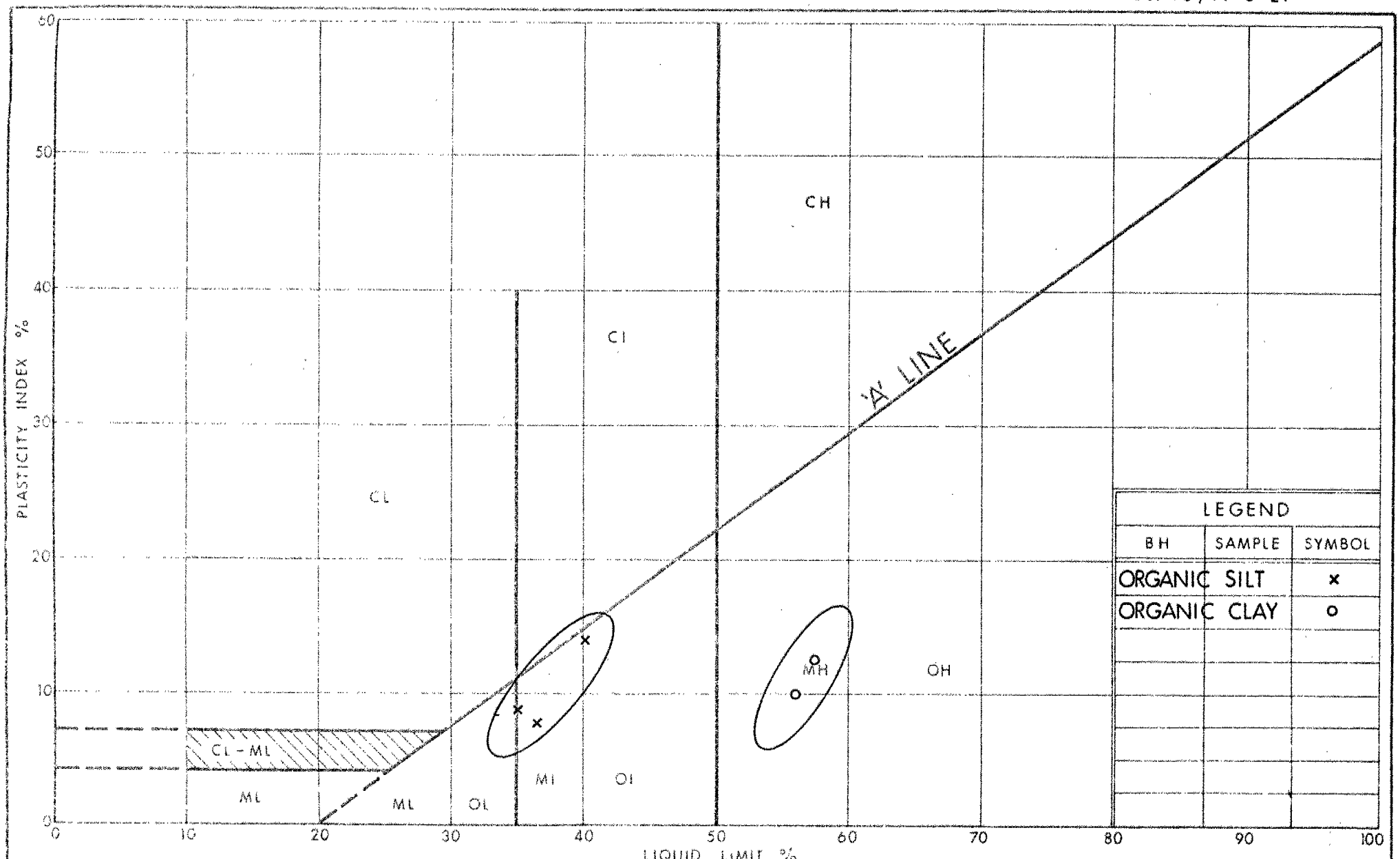
DIST 6 HWY 404 BOREHOLE TYPE Hollow Stem Augers COMPILED BY M.M.

DATUM Geodetic DATE June 23, 1978 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 (%) (20 40 60)	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES						GR SA SI CL
996.3	Ground Surface										
0.0	Organic Silt		1	SS	15						
991.3			2	SS	14		990				
5.0	Silt, Some Sand Loose to Compact		3	SS	13						
985.3			4	SS	4						
11.0	Clayey Silt to Silt of Slight Plasticity		5	SS	13		980				
	Very Stiff to Hard		6	SS	24						
			7	SS	20						0 3 44 53
			8	SS	24		970				
964.8			9	SS	39						
31.5	End of Borehole										

+3, ×5 : Numbers refer to Sensitivity

20
15 ◇ S (%) STRAIN AT FAILURE
10



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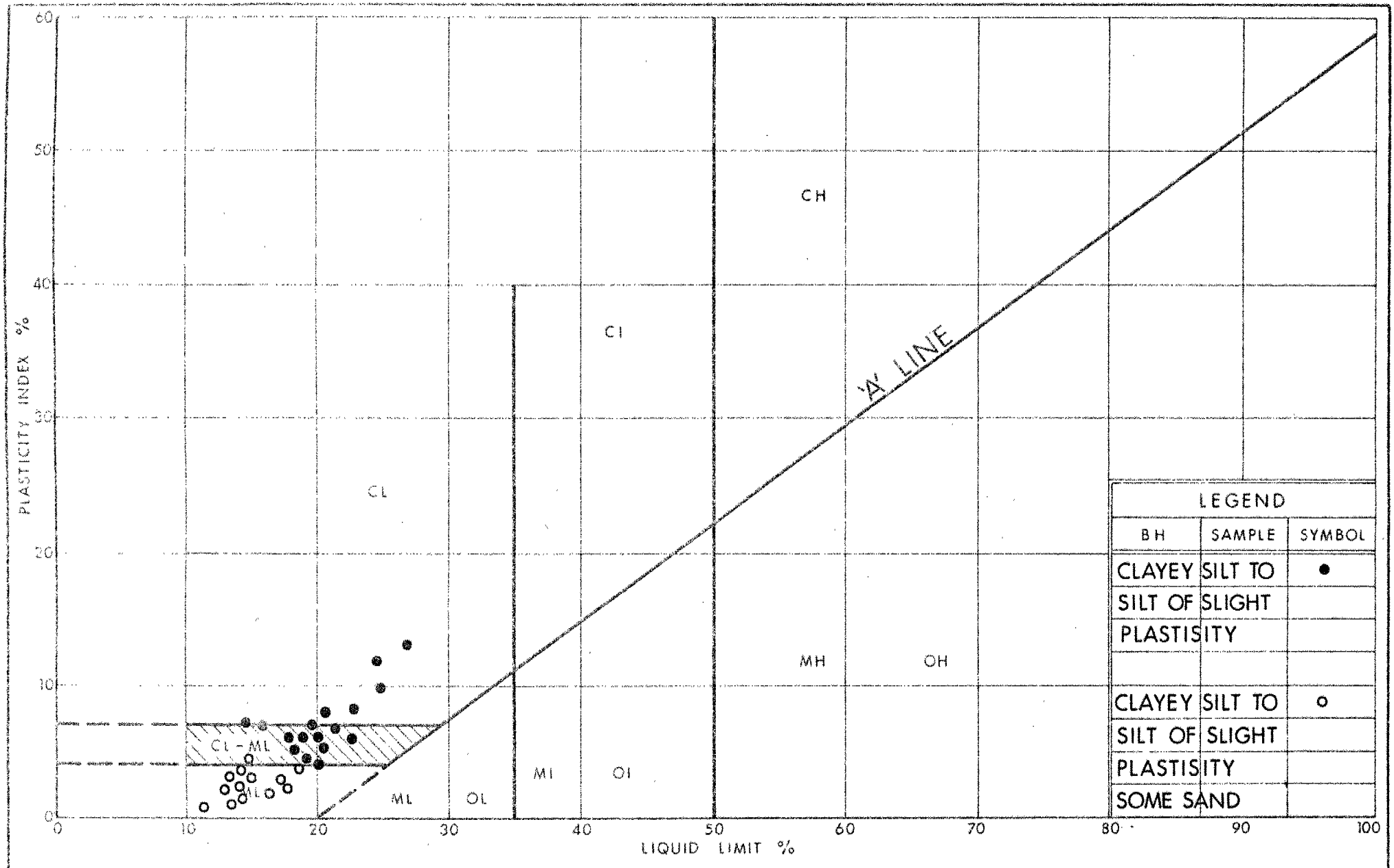
PLASTICITY CHART
ORGANIC SILT & ORGANIC CLAY

FIG No 1
W P 160-74-33



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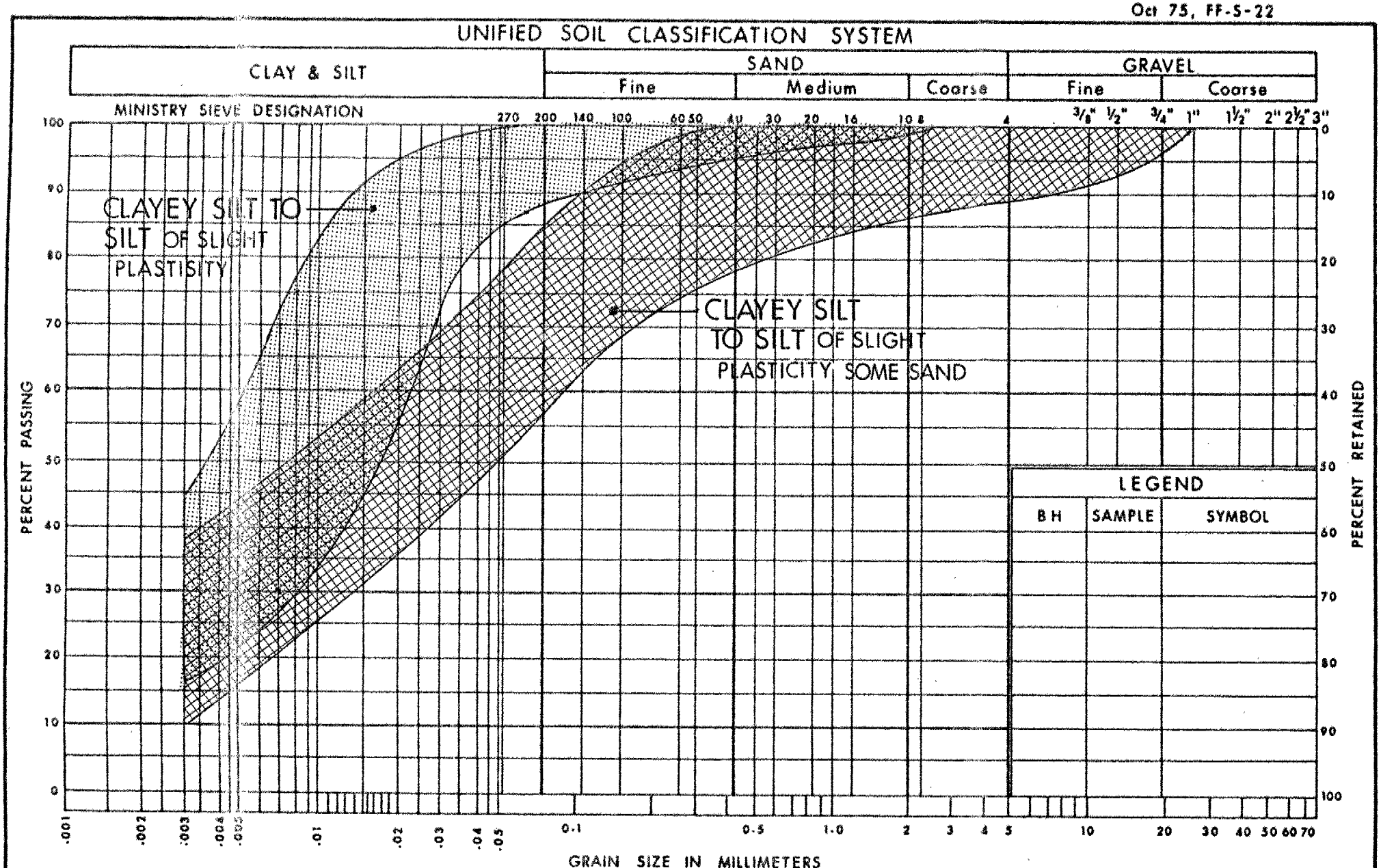
PLASTICITY CHART
CLAYEY SILT TO SILT OF SLIGHT PLASTICITY

FIG No 2
W P 160-74-33



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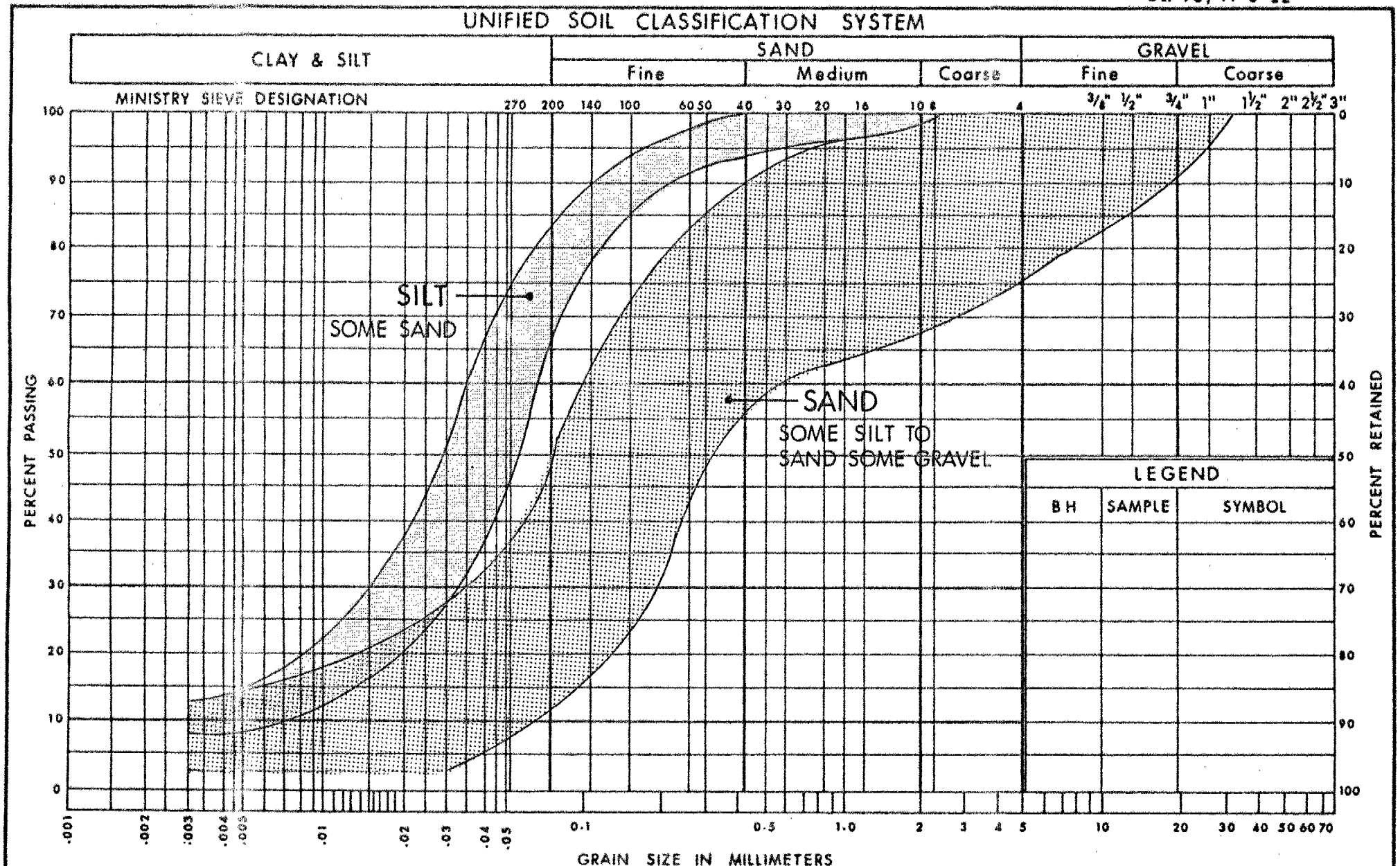
GRAIN SIZE DISTRIBUTION
CLAYEY SILT TO SILT
OF SLIGHT PLASTICITY

FIG No 3
W P 160-74-33



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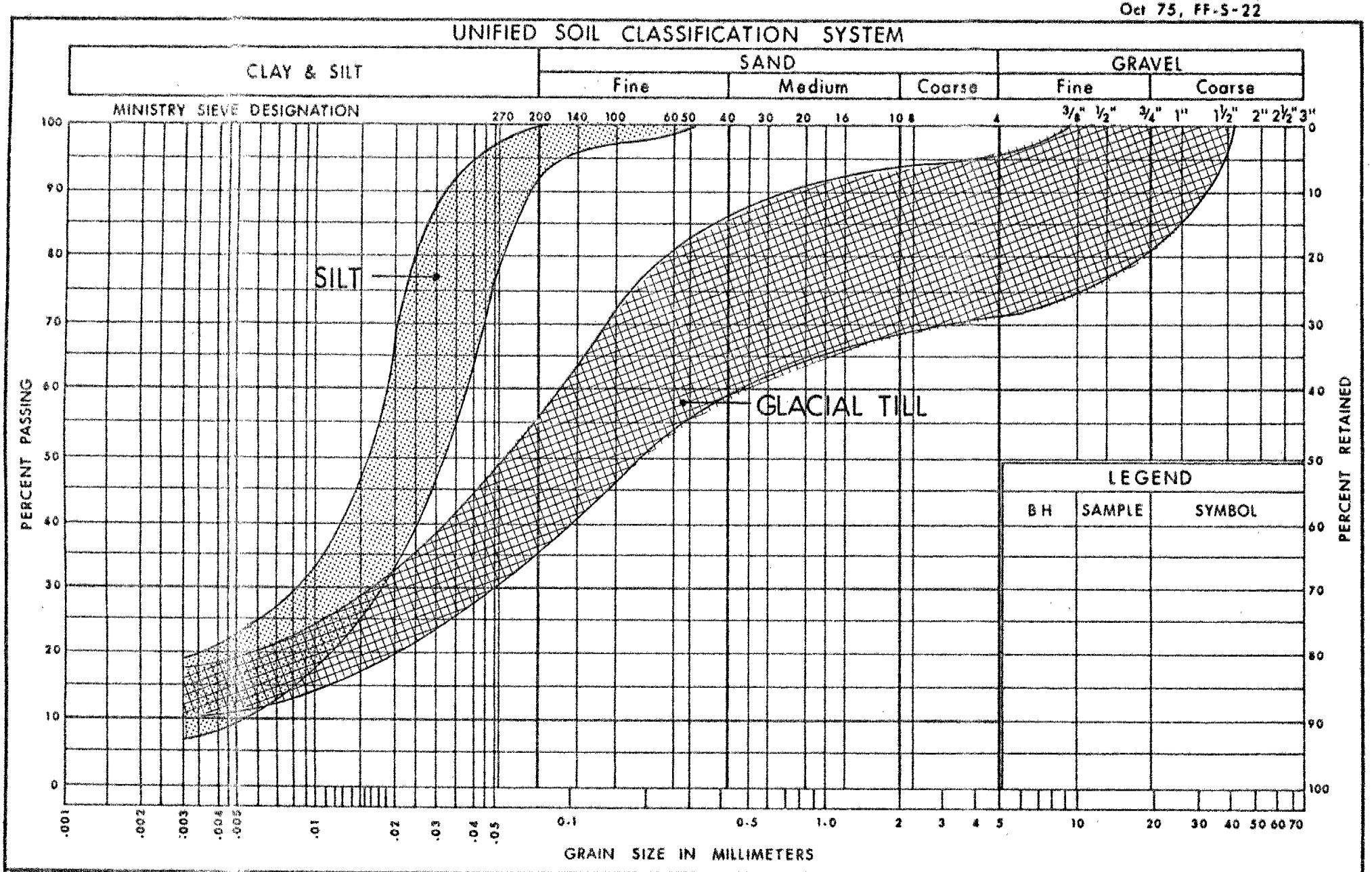
GRAIN SIZE DISTRIBUTION

FIG No 4
W P 160-74-33



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GRAIN SIZE DISTRIBUTION

FIG No 5

W P 160-74-33

UNDRAINED SHEAR STRENGTH VS DEPTH

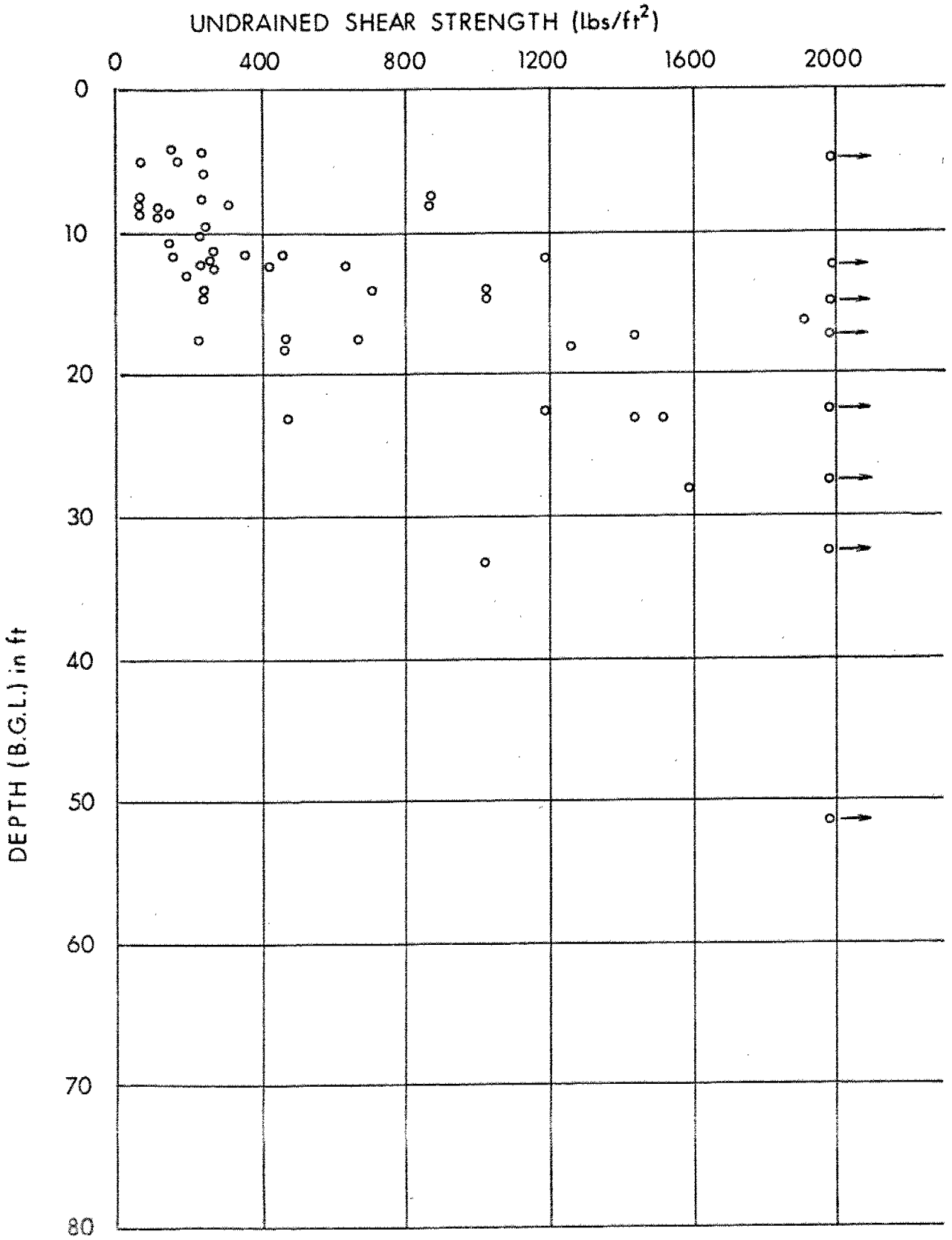
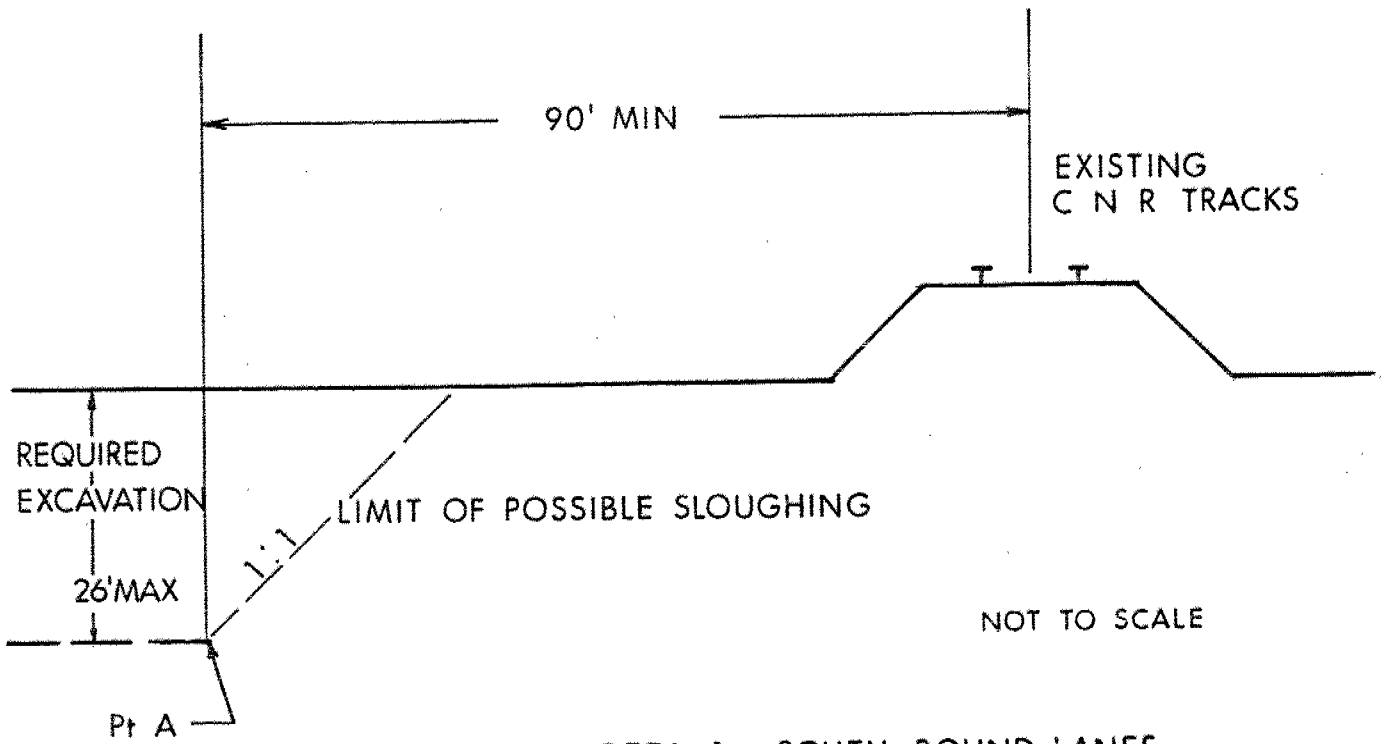


FIG 6

WP 160-74-33

REQUIRMENTS FOR C N R TRACKS
SLOPE STABILITY DURING SUBEXCAVATION



NOT TO SCALE

NOTE: 1 SOUTH BOUND LANES
TRACK PROTECTION IN THE FORM OF SHEET PILING & TIE BACKS MAY BE REQUIRED IF THE BASE OF THE EXCAVATION Pt A, IS CLOSER THAN 90 FEET TO THE C N R TRACKS

2 NORTH BOUND LANES
THE REQUIREMENT FOR TRACK PROTECTION WILL BE EVALUATED BASED ON THE LOCATION OF THE TOE OF THE SLOPE AND THE QUANTITY AND DEPTH OF SUBEXCAVATION

FIG 7

WP 160-74-33

EXPLANATION OF TERMS USED IN REPORT

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

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

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

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

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

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

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

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

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

MODIFIED RECOVERY: SUM OF THOSE NATURALLY FRACTURED CORE PIECES, 4"+ IN LENGTH EXPRESSED AS A PERCENT OF THE LENGTH OF THE CORING RUN. THE ROCK QUALITY DESIGNATION (RQD), FOR MODIFIED RECOVERY, IS:

RQD (%)	0 - 25	25 - 50	50 - 75	75 - 90	90 - 100
	VERY POOR	*POOR*	*FAIR*	*GOOD*	*EXCELLENT*

JOINTING AND BEDDING:

SPACING	2"	2" - 12"	1' - 3'	3' - 10'	> 10'
JOINTING	*VERY CLOSE*	*CLOSE*	*MOD. CLOSE*	*WIDE*	*VERY WIDE*
BEDDING	*VERY THIN*	*THIN*	*MEDIUM*	*THICK*	*VERY THICK*

ABBREVIATIONS & SYMBOLS

LABORATORY TESTING

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

FIELD SAMPLING

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

EARTH PRESSURE TERMS

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

INDEX PROPERTIES

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

STRENGTH PARAMETERS

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

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

HYDRAULIC TERMS

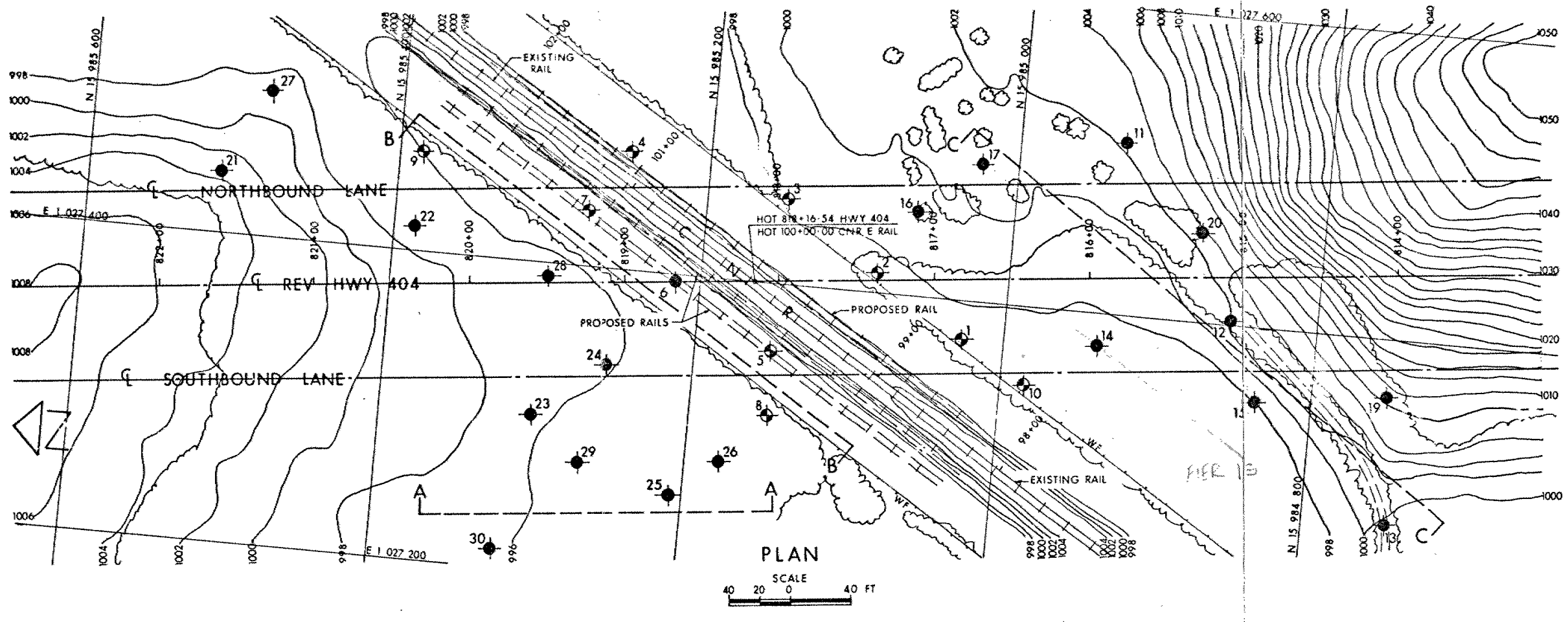
h	HYDRAULIC HEAD OR POTENTIAL
q	RATE OF DISCHARGE
v	VELOCITY OF FLOW
i	HYDRAULIC GRADIENT
j	SEEPAGE FORCE PER UNIT VOLUME
η	COEFFICIENT OF VISCOSITY
k	COEFFICIENT OF HYDRAULIC CONDUCTIVITY
k_h	k IN HORIZONTAL DIRECTION
k_v	k IN VERTICAL DIRECTION
m_v	COEFFICIENT OF VOLUME CHANGE
c_v	COEFFICIENT OF CONSOLIDATION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

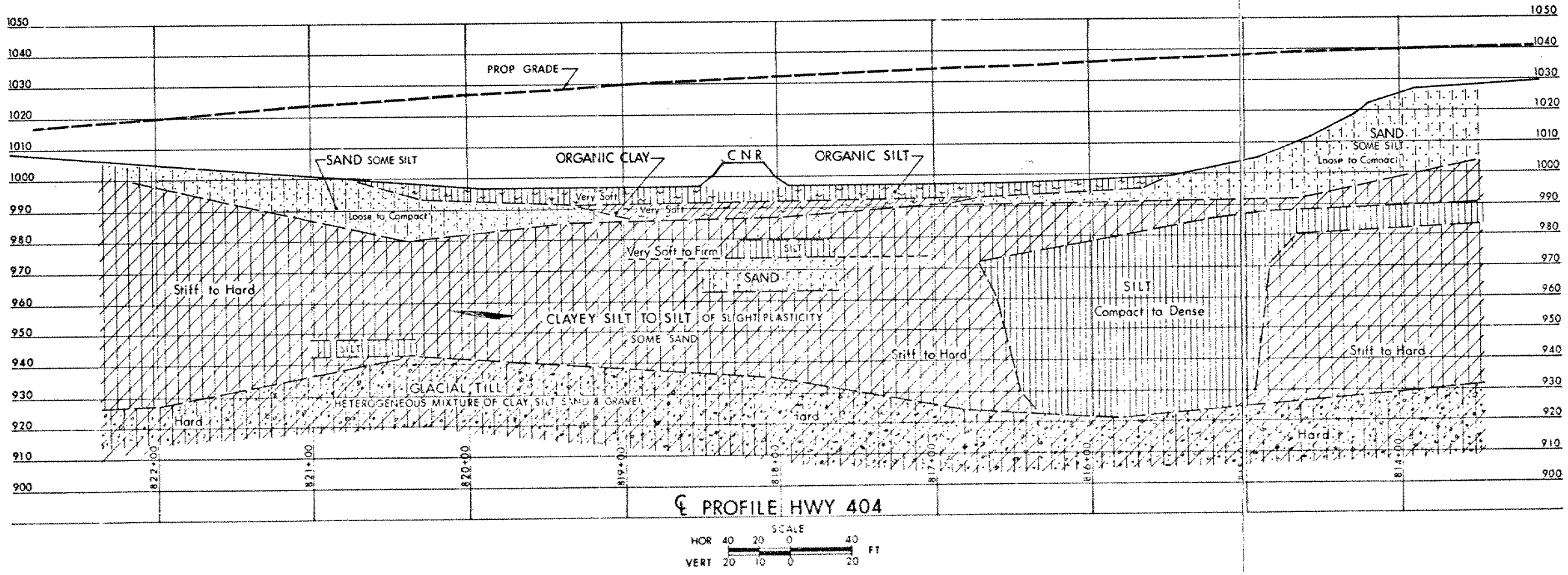
CONT No
WP No 160-74-33

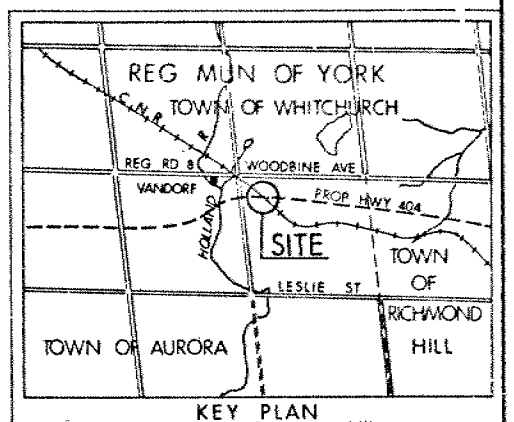
CNR OVERHEAD AT HWY 404

BORE HOLE LOCATIONS & SOIL STRATA

SHEET







LEGEND

- Bore Hole
- Dynamic Cone Penetration Test (Cone)
- Bore Hole & Cone
- 'N' Blows/ft (Std Pen Test 350 ft lbs energy)
- CONE Blows/ft (60° Cone, 350 ft lbs energy)
- W L at time of investigation MAR, MAY & JUNE 1978

NO	ELEVATION	CO-ORDINATES NORTH	EAST
1	996·2	15 985 028	1 027 374
2	996·6	15 985 085	1 027 412
3	998·6	15 985 146	1 027 455
4	995·3	15 985 250	1 027 475
5	995·2	15 985 150	1 027 355
6	994·8	15 985 216	1 027 395
7	994·6	15 985 276	1 027 435
8	994·7	15 985 148	1 027 313
9	995·4	15 985 385	1 027 464
10	996·4	15 984 984	1 027 348
11	1001·9	15 984 932	1 027 512
12	1001·6	15 984 855	1 027 403
13	999·4	15 984 745	1 027 280
14	996·4	15 984 940	1 027 378
15	996·1	15 984 836	1 027 350
16	998·0	15 985 063	1 027 435
17	1000·3	15 985 024	1 027 490
19	1009·4	15 984 750	1 027 362
20	1003·3	15 984 878	1 027 458
21	1003·3	15 985 514	1 027 440
22	996·0	15 985 386	1 027 415
23	996·2	15 985 302	1 027 300
24	995·2	15 985 255	1 027 336
25	994·7	15 985 208	1 027 256
26	994·5	15 985 178	1 027 280
27	995·3	15 985 485	1 027 495
28	995·3	15 985 298	1 027 392
29	994·3	15 985 268	1 027 273
30	996·3	15 985 320	1 027 212

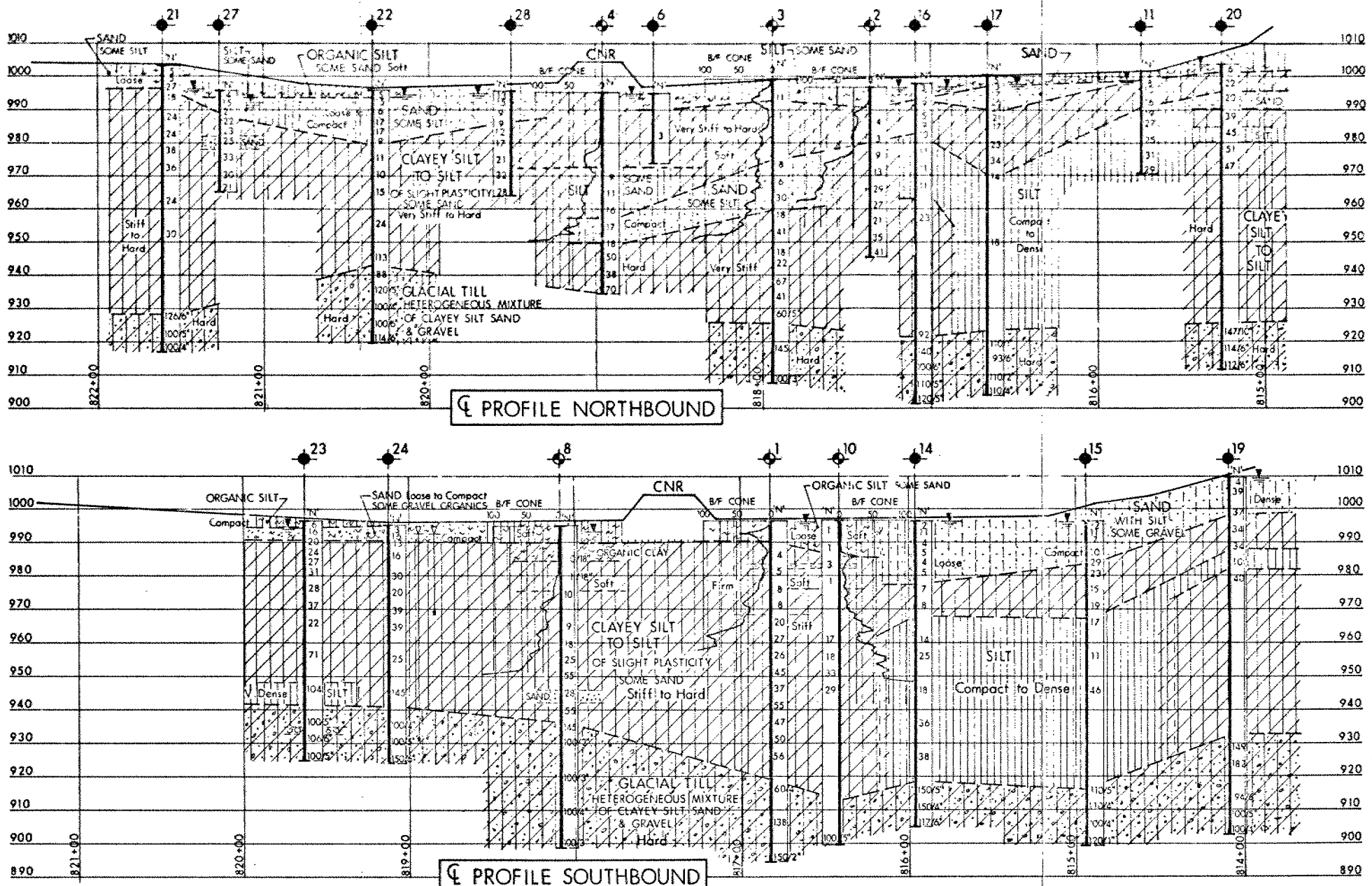
-NOTE-

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

REVISIONS

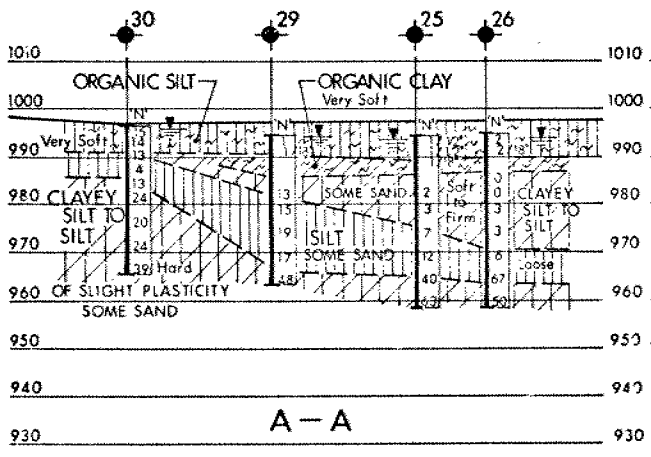
DATE	BY	DESCRIPTION

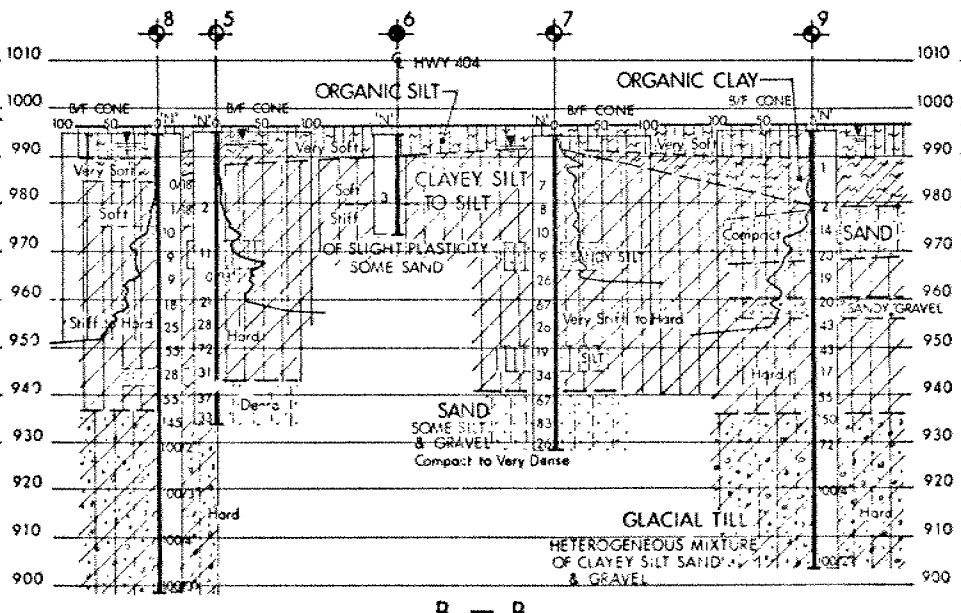
HWY No 404 DIST 6
SUBMITTED M.M. CHECKED DATE 78 09 18 SITE 37-700
DRAWN O.L. CHECKED DWG 160-433-A

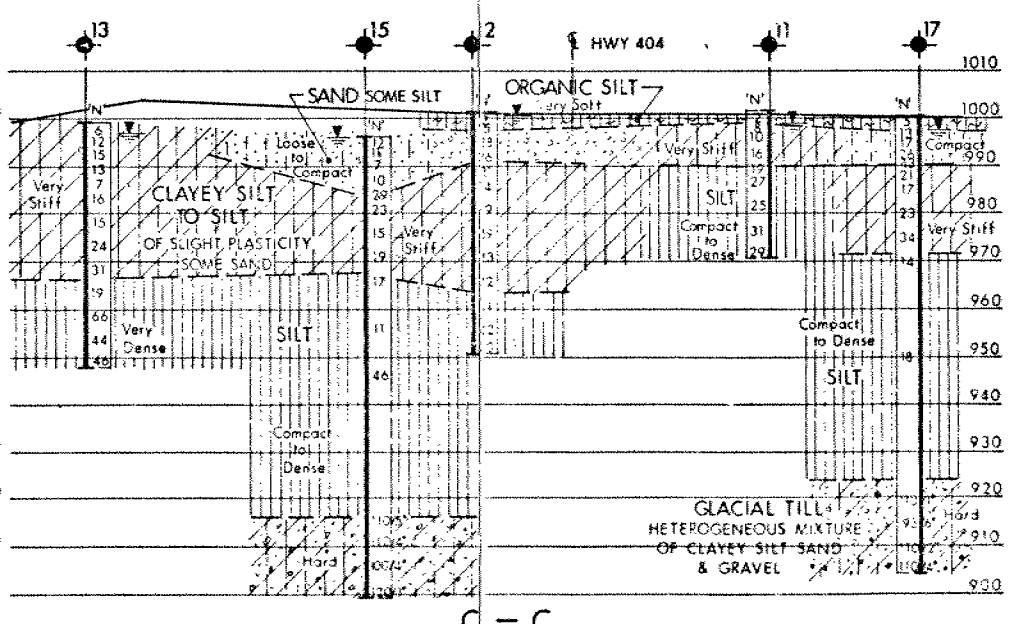


℄ PROFILE NORTHBOUND

℄ PROFILE SOUTHBOUND







SCALE
20 10 0 20 FT

SECTIONS

CONT No
WP No 160-74-33

STRATIGRAPHICAL PROFILES & SECTIONS

SHEET

KEY PLAN

LEGEND

- Bore Hole
- Dynamic Cone Penetration Test (Cone)
- Bore Hole & Cone
- 'N' Blows/ft (Std Pen Test 350 ft lbs energy)
- CONE Blows/ft (60° Cone, 350 ft lbs energy)
- W L at time of investigation
- NO W L established BH No 3 & 6
- PIEZOMETER

No	ELEVATION		

-NOTE-

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

REVISIONS

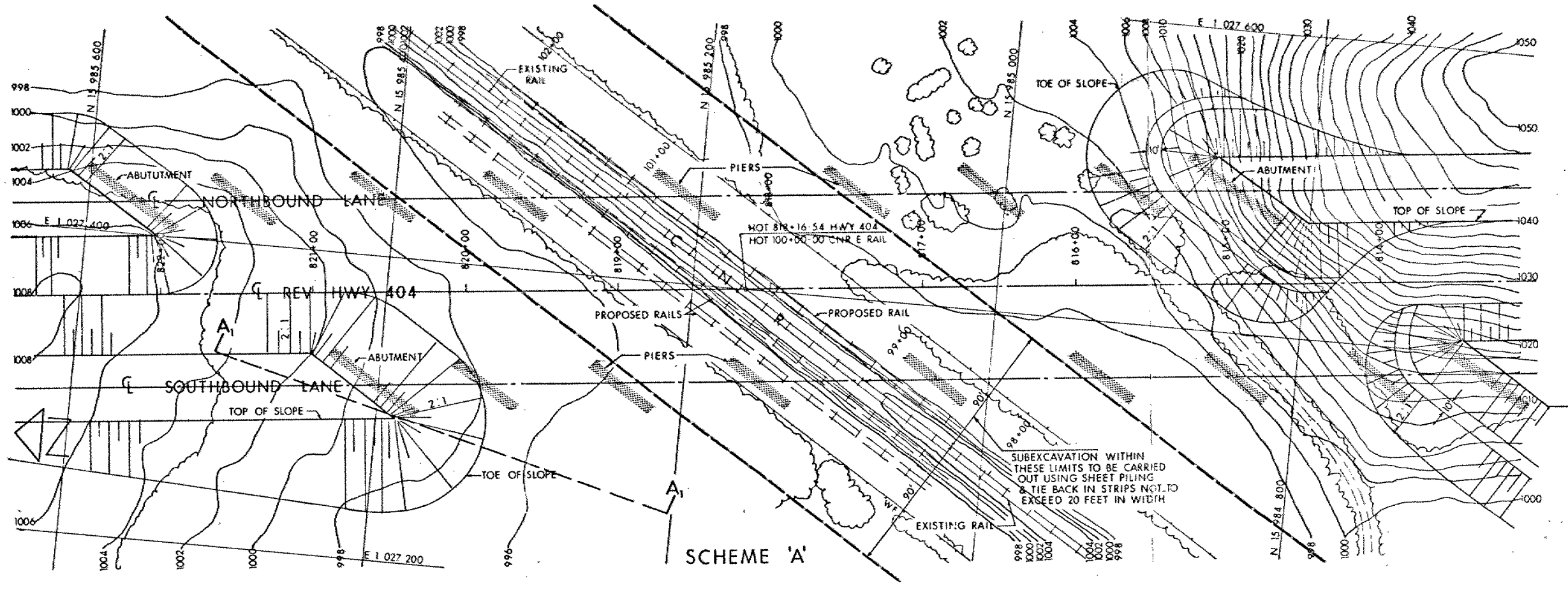
DATE	BY	DESCRIPTION

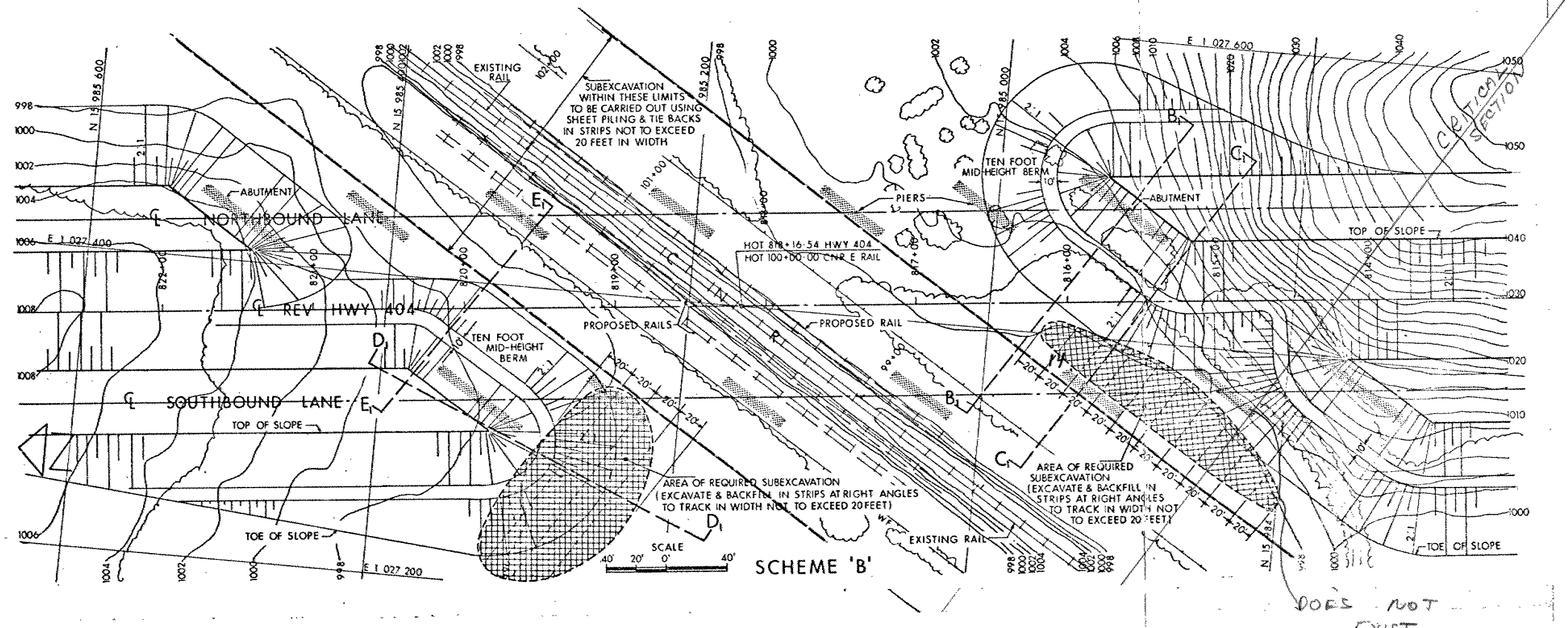
HWY No 404 SHEET 6
SUBM'D M.M. CHECKED DATE 78 09 18 SITE 37-730
DRAWN CHECKED 160743-B

CONT No
WP No 160-74-33

REQUIRMENTS FOR SLOPE STABILITY & SUBEXCAVATION FOR SCHEME 'A' & 'B'

SHEET





NOTE : TOE OF SLOPE BASED ON 20' WING WALL

NO SUBEXCAVATION IS REQUIRED ON SECTIONS A_0-A_1, B_0-B_1 & E_0-E_1

KEY PLAN

LEGEND

- Bore Hole
- Dynamic Cone Penetration Test (Cone)
- Bore Hole & Cone
- 'N' Blows/ft (Std Pen Test 350 ft lbs energy)
- CONE Blows/ft (60° Cone, 350 ft lbs energy)
- WL at time of investigation

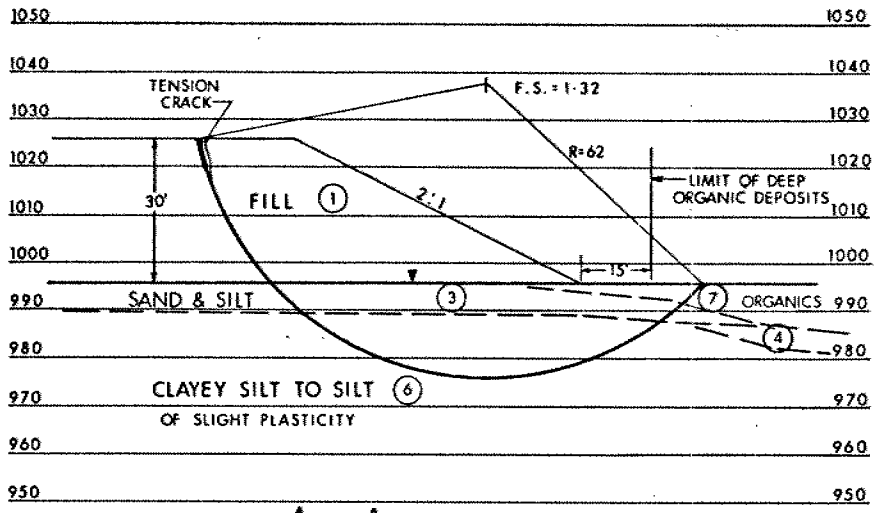
No	ELEVATION		

-NOTE-

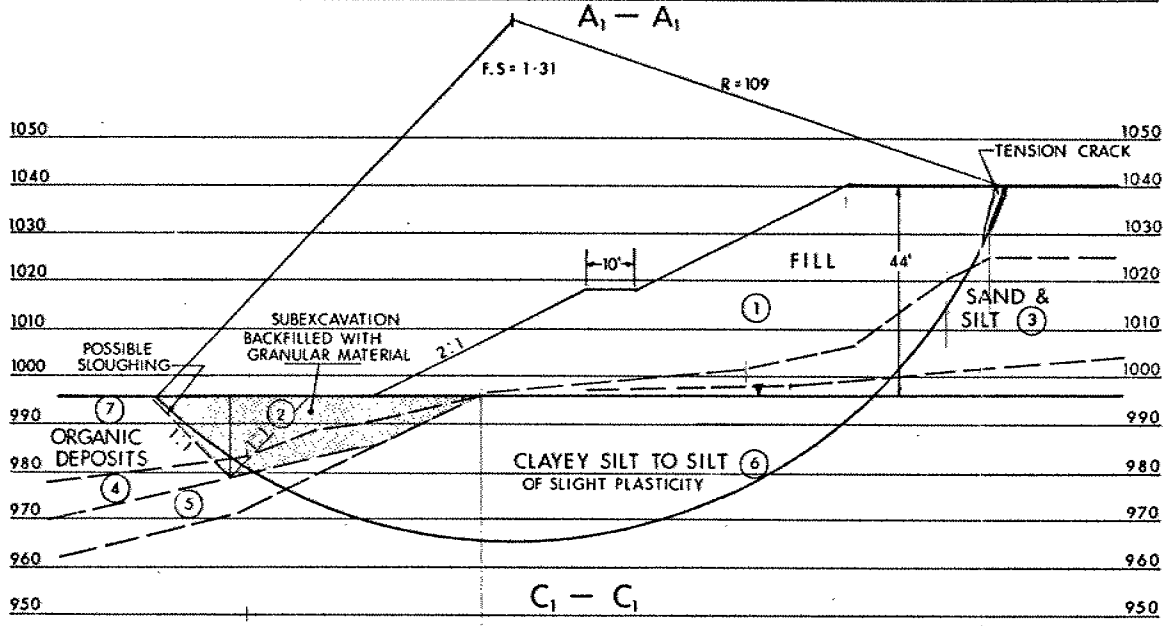
The boundaries between soil strata have been established only at Bore Hole locations. Between Bore Holes the boundaries are assumed from geological evidence.

REVISIONS		
DATE	BY	DESCRIPTION

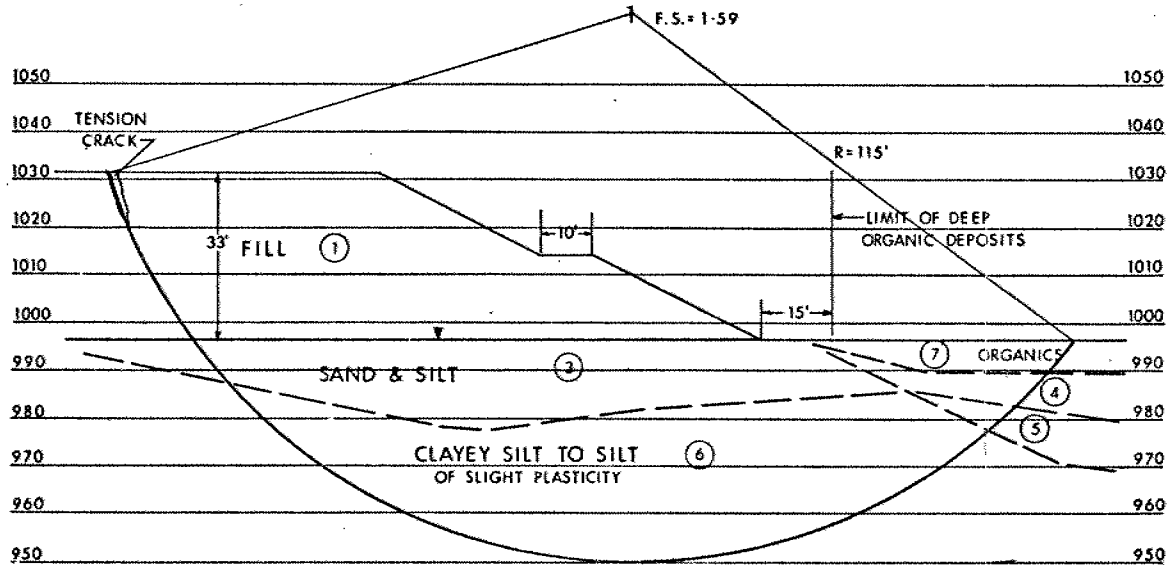
HWY No 404			DIST 6
SUBMITTED M	CHECKED	DATE 78 09 18	SITE 37-700
DRAWN OL J	CHECKED	APPROVED	DWG 1607433-C



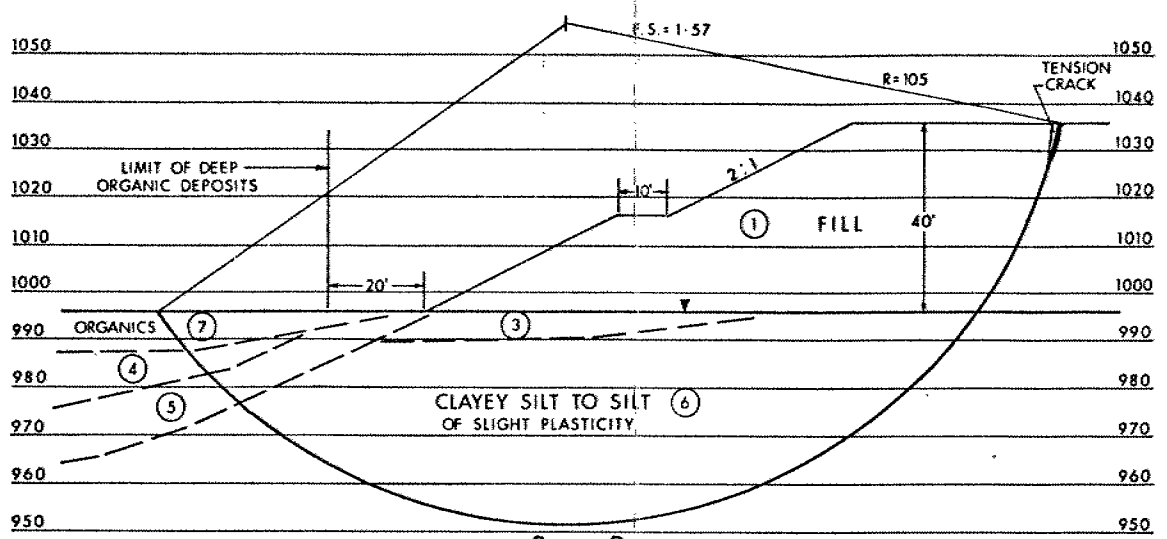
$A_1 - A_1$



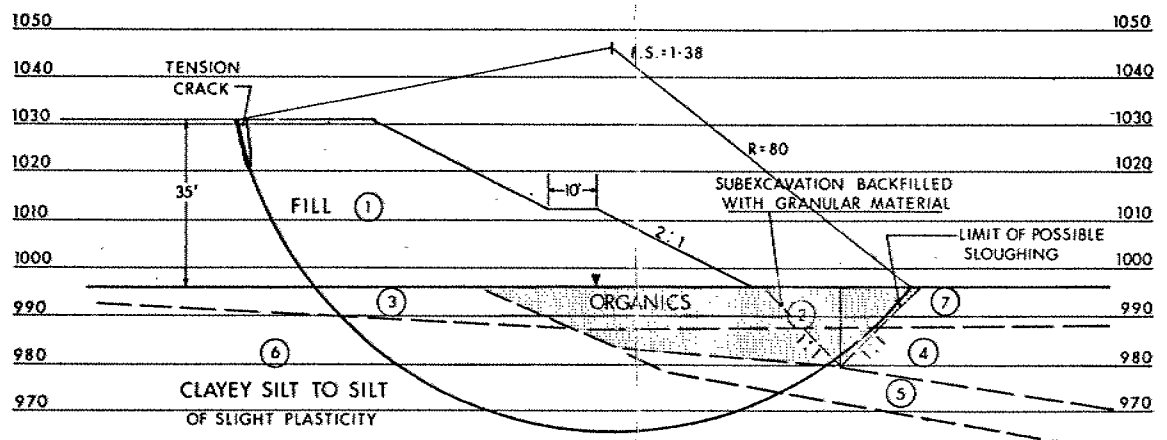
$C_1 - C_1$



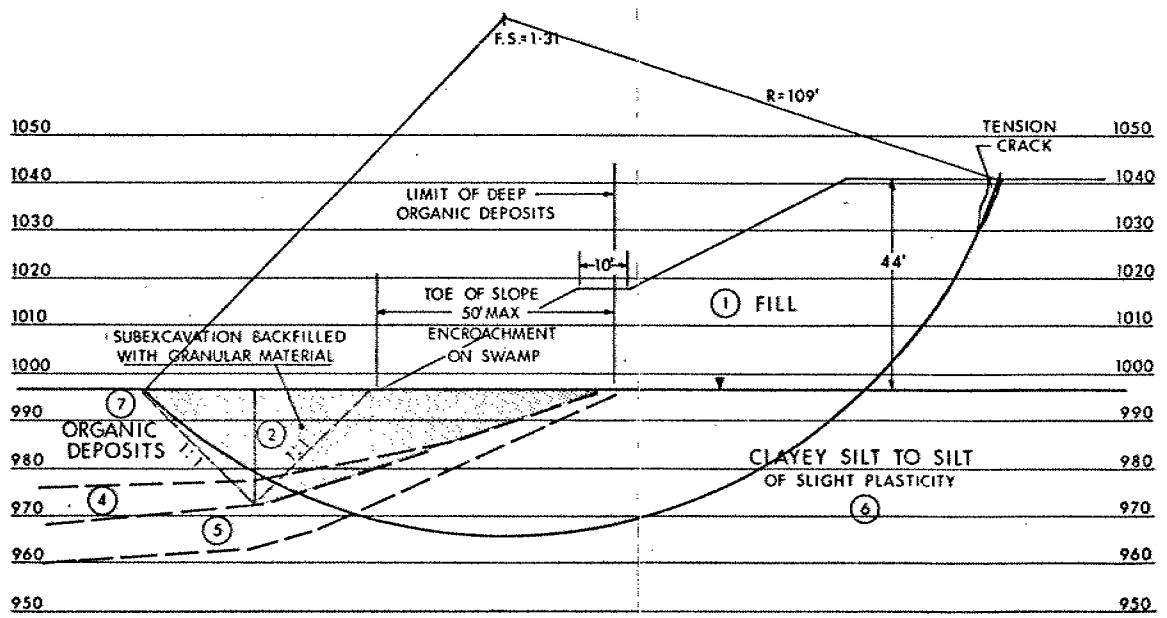
$E_1 - E_1$



$B_1 - B_1$



$D_1 - D_1$



$F_1 - F_1$ THEORETHICAL ONLY

SECTIONS

SCALE
20 10 0 20 FT

WP No 160-74-33
HWY 404 & C N R

TOTAL STRESS ANALYSIS

ASSUMED SUBSOIL STRATIGRAPHY
CRITICAL CIRCLE & FACTOR OF SAFETY

FOR LOCATIONS OF SECTIONS
SEE DRAWING No 1607433-C

NOTE: NO SUBEXCAVATION IS REQUIRED ON SECTIONS A_1-A_1, B_1-B_1, & E_1-E_1

LEGEND

ASSUMED SUBSOIL PROPERTIES

No	DESCRIPTION	S_u psf	Ø dec	γ pcf	γ' pcf
1	FILL MATERIAL	0·0	30	130	68
2	GRANULAR BACK-FILL FOR SUB-EXCAVATION	0·0	30	130	68
3	SAND & SILT	0·0	30	130	68
4	CLAYEY SILT TO SILT OF SLIGHT PLASTICITY	400	0	110	48
5	—"—	1400	0	110	48
6	—"—	2000	0	110	48
7	ORGANIC DEPOSITS	150·0	0	100	38

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

REVISIONS

DATE	BY	DESCRIPTION

HWY No 4		DIST 6
SUBM'D M	CHECKED	DATE 78 09 18
DRAWN O L J	CHECKED	APPROVED
		SITE 37-700
		DWG 1607433-D

OVERSIZE DRAWING

(RETAIN THIS COPY FOR FOLLOW-UP)

7540-1021

SEND TO: Mr. W. Lin.
Structural Design Engineer, Central.
Downsview.

FROM M. MacLean BRANCH Paul & Foundation Design DATE June 23/80

SUBJECT Temporary Sheeting Hwy. 404 & C.N.R. WP. 160-74-33 Site 37-700

At the technical review on 80 06 18 the grading work for the above job was discussed. Additional Details on the temporary sheeting (ie Type, Size, tip ELEV.) were requested. Our comments/revisions are shown on the attached sketch & note. that sheet piling is suggested as MP116 or equivalent. Any comments you have should be passed to the Reg. Struct. Office Attn. Mr. K. Pilgrim.

Due to the advanced stage of contract preparation your earliest attention to this matter is Appreciated.

M. MacLean

c.c. K. Pilgrim

REPLY R Kunkel

REPLY FROM

REPLY DATE

OVERSIZE DRAWING

memorandum

Ontario

To: Mr. M. Devata,
Sr. Engineer Foundations,
Pavement & Foundation
Design Section,
Central Building, Downsview.

Date: 80-06-06

Central Region

Atten: Mr. M. MacLean

RE: C.N.R. Overhead at Highway 404,
W.P. 160-74-33, Site 37-700,
District 6, Toronto

Attached please find sheets 40 and 89 of the contract drawings showing the proposed excavation and fill placement at the above site. The fill placement shown (to match the final structure fills) may present some problems, particularly at the abutment footings when some of the material will be removed for the construction of the footings. The structures will be constructed on a follow-up contract.

Kindly review and let us have your comments at your earliest convenience, before the technical review, now scheduled for 80-06-18.

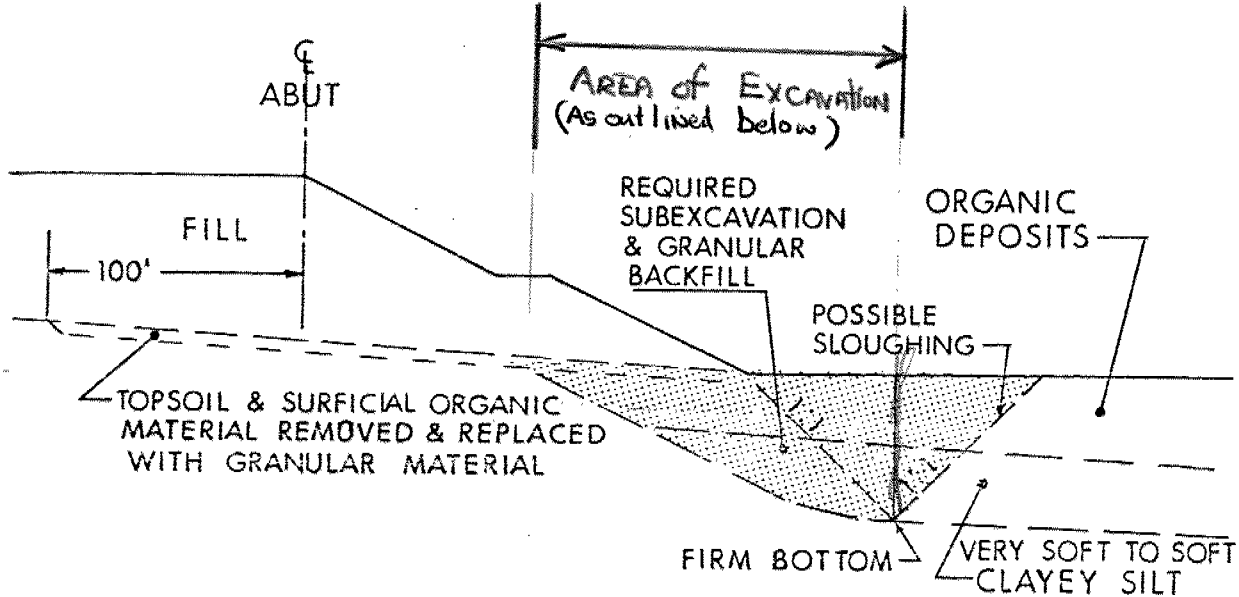
KP:gj
Attach.

K. Pilgrim,
Senior Structural Eng.,
for:
G.C.E. Burkhardt,
Head, Structural Section.

c.c. R. Kunkel

RECEIVED
JUN 9 1980
Pavement and Foundation Design Section

7540-1318 (10/78)



Typical Section

OVERSIZE DRAWING

Ministry of Transportation and Communications
Ontario

Memorandum

To: Mr. C.S. Grebski
Head, Central Section
Structural Office
2nd Floor, West Building

Attention:

From: Soil Mechanics Section
Engineering Materials Office
Room 315, Central Building

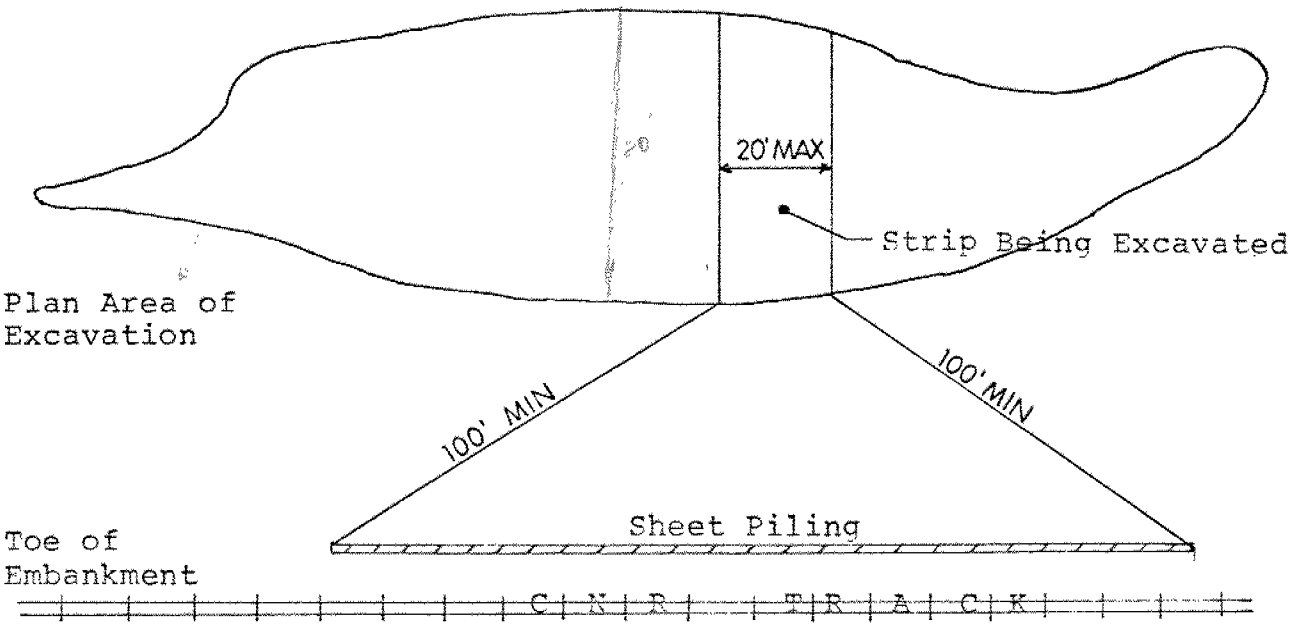
Date: 79 03 22

Our File Ref.

In Reply to

Subject: Re: Hwy. 404 CNR Overhead
W.P. 160-74-33, Site 37-700
District 6, Toronto

As decided in the meeting of 79 02 15 between ourselves and representatives of the concerned Regional Offices, we have reviewed the excavation and sheet piling requirements at the above structure location. In addition, we have further reviewed the preliminary plan dated 1979 02 13 prepared by the structural design consultants and delivered to us at that meeting. This plan includes the revised median slope as outlined in Mr. K. Pilgrim's memorandum to your office dated 79 01 30. On the attached sketch we have shown the probable limits of required excavation at the south approach fill for the ultimate scheme which are to be carried out for the interim construction. The excavation edge will be some 55 feet from the centerline of the existing tracks and up to 26 feet deep, sheet piling will be required in this area for track protection purposes. As discussed, the sheet piling should be located immediately southwest of the C.N.R. embankment. Track protection would be required from C.N.R. Station 95+00 to 99+00; however, since excavation will proceed in strips of less than 20 feet in width, it will not be necessary to maintain the entire length of track protection during excavation. Track protection should be provided to that portion of the C.N.R. embankment within 100 feet of the plan limits of excavation.



The sheet piling should extend to elevation 955.

Attached is also a cross section showing subsoil conditions, excavation requirements and assumed subsoil parameter.

If you have further queries, please do not hesitate to call this office.

M. MacLean
Project Engineer

For: M. Devata
Supervising Engineer

MM/MD/gs

Attach.

cc: G.C.E. Burkhardt, Attn. K. Pilgrim
W. Lin
D.A. MacDonald
R. Van Veen
E. Metzner
Files

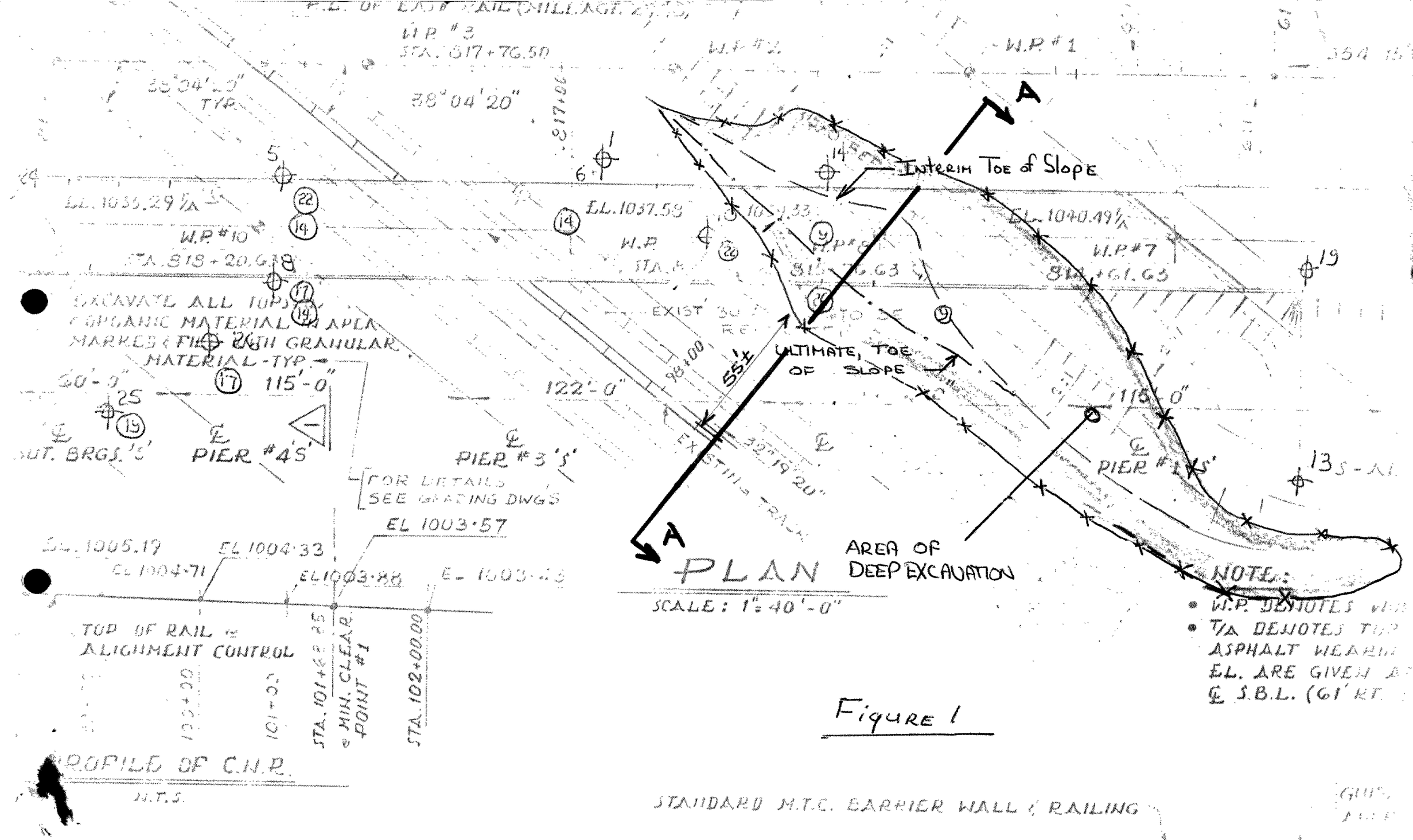
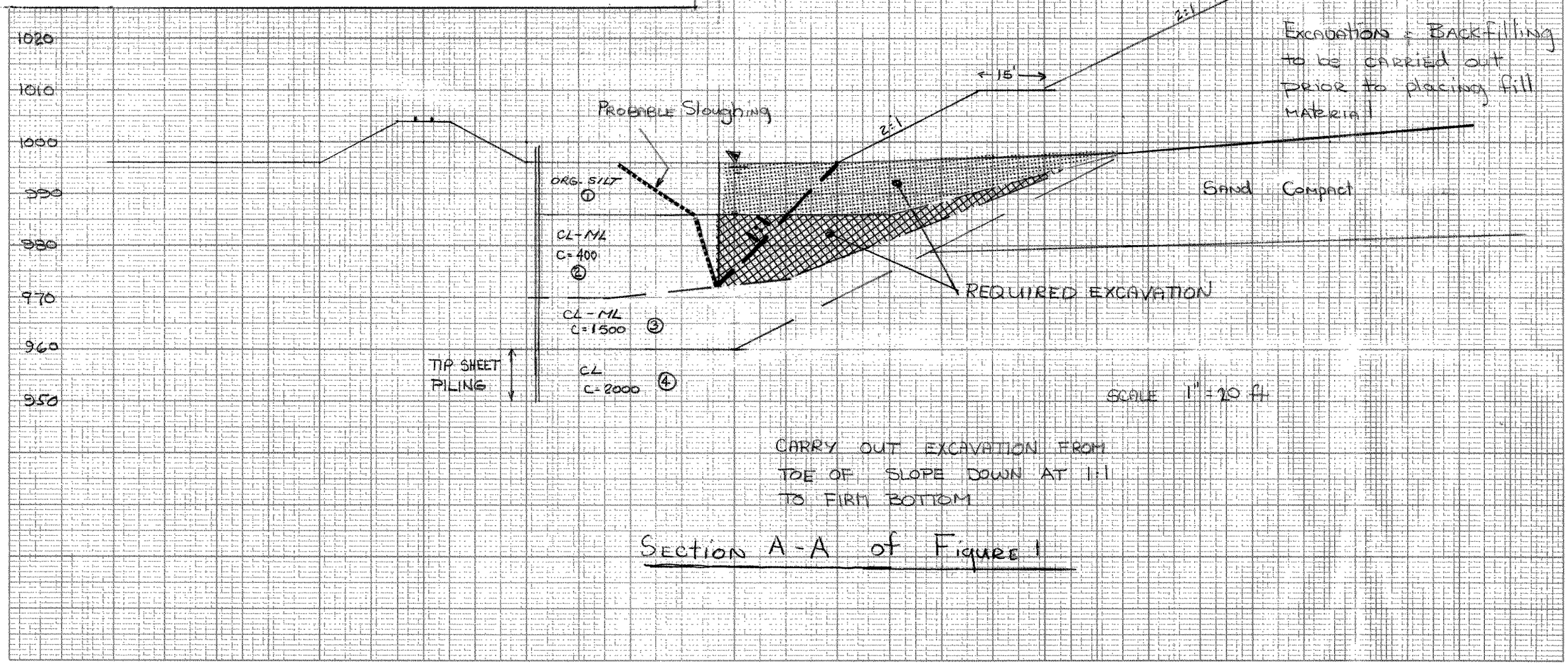


Figure 1

STANDARD M.T.C. BARRIER WALL & RAILING

SUBSOIL PROPERTIES

Type	Bulk Unit Wt. P.C.F.	Submerged Wt. P.C.F.	Cohesion P.S.F.	Internal Friction Ø
1. Organic Silt/Clay	100	38	200	0
2. Clayey Silt to Silt of Slight Plasticity	110	48	400	0
3. Clayey Silt to Silt of Slight Plasticity	110	48	1500	0
4. Clayey Silt to Silt of Slight Plasticity	110	48	2000	0



CARRY OUT EXCAVATION FROM TOE OF SLOPE DOWN AT 1:1 TO FIRM BOTTOM

Section A-A of Figure 1

Ministry of Transportation and Communications
Ontario

fyi fm. Devata

Memorandum

To: Mr. R.G. Burnfield,
Planning and Design,
Central Region.

From: Regional Geotechnical Section,
Central Region.

Attention: Mr. R. Kunkel

Date: 79 02 19

Our File Ref.

In Reply to

Subject: C.N.R. Overhead South of Vandorf Road,
W.P. 160-74-05, Highway 404,
District 6, Toronto.

Following the meeting of 79-02-15 in Boardroom 'B', West Building, we have reviewed the proposed scheme for the temporary haul road across the C.N.R. tracks between the new northbound and southbound structures.

It is proposed to construct a temporary embankment fill with a roadway width of 20 feet for the purpose of transporting heavy equipment across the C.N.R. track. As a result, this scheme would require that from 8 to 9 feet of fill is to be supported by 10 feet of material consisting of very soft and saturated dark brown organics to very soft grey silty clay. This again overlies a deposit of clayey silt to silt with a consistency ranging from very soft to stiff.

In view of the proposed embankment height and subsoil conditions coupled with the fact that heavy loads are to be transported along this road, we would recommend that an alternate crossing location be selected. The proposed fills and anticipated vibrating loads may result in excessive settlements and induce localized failures. In view of the close proximity to the C.N.R. embankment, this would surely be extremely hazardous and costly.

We would recommend that an alternate location be selected, perhaps 200 feet north-east of this location where the embankment height is less and the subsoil conditions are more favorable. To do this, a temporary easement may be required.

In addition, any roadways constructed to provide access to sites within the muskeg area should not be in excess of 3 feet in height above the original ground.

Agree entirely MM

RVV/RDG:saw

R. Van Veen
For: R.D. Gunter
Head, Geotechnical Section

RECEIVED
FEB 20 1979
SOIL MECHANICS
MINISTRY OF TRANSPORTATION & COMMUNICATIONS

c.c. M. Devata
K. Pilgrim
D.A. MacDonald
C.S. Grebski

Structural Section,
Central Region,
3501 Dufferin Street,
Downsview, Ontario.
M3K 1N6
Telephone: 248-3097

January 30, 1979

Mr. F.D. Campbell,
Regional Chief Engineer,
C.N. Rail,
R.R.S. Box 112,
Union Station,
Toronto, Ontario.
M5J 1E7

Dear Sir:

RE: C.N.R. Overhead at Highway 404,
W.P. 160-74-33, Site 37-700,
District 6, Toronto
Mileage 29.98 - Bala Subdivision,
Your File: 1600-BA-30.0

In reply to your letter dated December 29, 1978, attached please find a copy of a memorandum dated November 17, 1978 from our Soil Mechanics Section. This memorandum details their comments on the Preliminary Drawing 37-700-P1, and notes that the soft material should be subexcavated in strips not to exceed 20 feet in width, and should be backfilled immediately with granular material. In one critical area at the southwest approach fill, sheet piling is also suggested. This information is also detailed in the Foundation Report.

The following additional comments have been received from Mr. N. MacLean of our Soil Mechanics Section:

"For the construction of the pier caps located below existing ground and adjacent to the existing C.N.R. tracks, a track protection scheme will be necessary during construction to ensure the stability of the C.N.R. embankment. In our opinion, this can be achieved by constructing a sheeted cofferdam and then carrying out the pier cap excavations within this enclosure.

.....2

mm
files

We would like to point out that the stability of the railway embankment in relation to the proposed sub-excavations was thoroughly analyzed and because of the marginal factors of safety, it was recommended that excavations be carried out in strips not exceeding 20 feet in width or alternatively incorporating sheeting parallel to the critical area. We have recently re-analysed the stability of the railway embankment considering continuous railway loading of 13,000 lbs/lin. foot of track as suggested by C.N.R. The original calculations assumed a Cooper E-70 loading of 1000 lbs/sq. foot evenly distributed over an area 5 feet by fourteen feet wide. The re-assessment agrees closely with our previous analysis.

We do agree that the N.T.C. did not carry out any borings beneath the existing railway embankment because of practical limitations of setting up a drill unit adjacent to the main track. Therefore, in our analysis we have assumed that the material beneath the C.N.R. embankment will be similar to that found beyond the embankment limits in the low lying area. In our opinion, this is a very conservative approach since the railway embankment has been in place for a considerable length of time and some displacement and consolidation of the underlying compressible material has taken place".

Please do not hesitate to contact this office if any further clarification is required. One additional copy of the Foundation Report is also enclosed as requested.

Yours truly,

K.P:gj
Attach.

K. Pilgrim,
Senior Structural Engineer,
for:
G.C.E. Burkhardt,
Head, Structural Section.

c.c. M. MacLean
E. Metzner

Mr. C.S. Grebski,
Head,
Central Section,
Structural Office,
West Building, Downsview.

1979-01-30

RE: C.N.R. Overhead at Highway 404,
W.P. 160-74-33, Site 37-700,
District 6, Toronto

It has just been noted that the 2:1 slope within the median area of 37-700-P1 should be replaced as per the attached cross-section sheet. This would increase the fill height in the median and place the toe of slopes further away from the abutments. When the structure is widened, the fill height will again be increased as shown by the ultimate cross-section. The excavation of topsoil and organic material etc. at the toe of fills should be carried out for the ultimate condition.

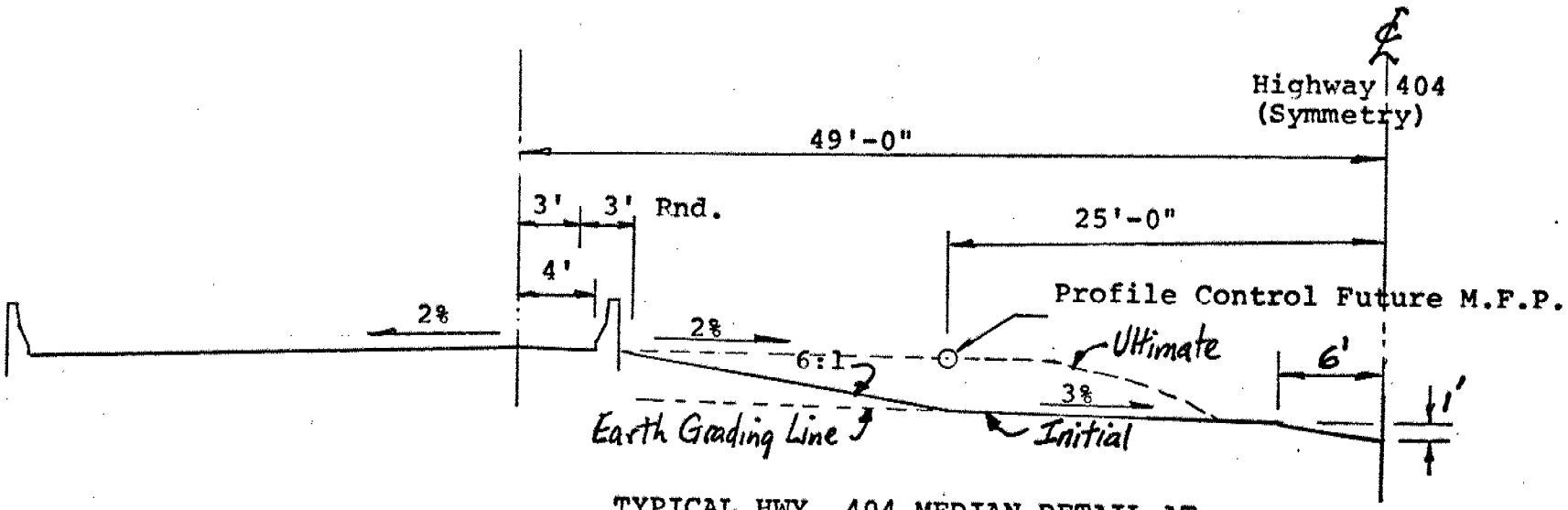
We regret that this information was not provided to you earlier, and wish to apologize for this. Kindly prepare a new preliminary drawing to reflect this, and other comments noted in our memorandum of 1979-01-10.

KP:gj
Attach.

K. Pilgrim,
Senior Structural Engineer,
for:
G.C.E. Burkhardt,
Head, Structural Section.

c.c. E. Metsner
M. Devata (Atten: M. MacLean)

MAC
r. 10s



TYPICAL HWY. 404 MEDIAN DETAIL AT
C.N.R. OVERHEAD
W.P. 160-74-33, SITE 37-700,

Not to Scale
January, 1979

Ministry of Transportation and Communications
Ontario

Memorandum

To: Mr. G.C.E. Burkhardt
Head, Structural Section
Central Region
3501 Dufferin Street, Downsview

Attention: Mr. K. Pilgrim

Our File Ref.

From: Soil Mechanics Section
Engineering Materials Office
Room 315, Central Building

Date: 79 01 24

In Reply to

Subject: Re: Hwy. 404 C.N.R. Overhead
W.P. 160-74-33, Site 37-700

Further to your recent memorandum forwarding the copy of C.N.R.'s letter, we have reviewed the subsurface conditions, together with the recommendations in our report and subsequent comments in our letter of 78 11 17 to Mr. C.S. Grebski. Our additional comments are as follows.

For the construction of the pier caps located below existing ground and adjacent to the existing C.N.R. tracks, a track protection scheme will be necessary during construction to ensure the stability of the C.N.R. embankment. In our opinion, this can be achieved by constructing a sheeted cofferdam and then carrying out the pier cap excavations within this enclosure.

It appears that C.N.R. is not aware of our comments contained in our memorandum of 78 11 17 to Mr. C.S. Grebski. These comments include subexcavation of organic material in strips not exceeding 20 feet in width and backfilling immediately with granular material. In addition, in the one critical area, that of the S/W approach fill, sheet piling was also suggested. It is understood that this aspect will be discussed further between the representatives of this office, the Structural Office and the Area Construction Office from the Region.

We would like to point out that the stability of the railway embankment in relation to the proposed subexcavations was thoroughly analyzed and because of the marginal factors of safety, it was recommended that excavations be carried out in strips not exceeding 20 feet in width or alternatively incorporating sheeting parallel to the critical area. We have recently reanalyzed the stability of the railway embankment considering continuous railway loading of 15,000 lbs/lin. foot of track as suggested by C.N.R. The original calculations assumed a Cooper E-70 loading of 1000 lbs/sq. foot evenly distributed over an area 5 feet by fourteen feet wide. The reassessment agrees closely with our previous analysis.

We do agree that the M.T.C. did not carry out any borings beneath the existing railway embankment because of practical limitations of setting up a drill unit adjacent to the main track. Therefore,

cont'd.....

in our analysis we have assumed that the material beneath the C.N.R. embankment will be similar to that found beyond the embankment limits in the low lying area. In our opinion, this is a very conservative approach since the railway embankment has been in place for a considerable length of time and some displacement and consolidation of the underlying compressible material has taken place.

In view of this, we feel that there is no need for additional borings to investigate the material beneath the railway embankment and furthermore, it is impractical as discussed previously.

M MacLean

M. MacLean
Project Engineer

For: M. Devata
Supervising Engineer

MM/MD/gs

cc: C.S. Grebski
W. Lin
R.D. Gunter
M.R. Ernesaks
D. MacDonald
Files ✓

Mr. C.S. Grebski,
Head, Central Section,
Structural Office,
West Building, Downsview.

C.C.E. Burkhardt,
Structural Section,
Central Region.

1979-01-10

RE: C.N.R. Overhead at Highway 404,
W.P. 160-74-33, Site 37-700,
District 6, Toronto

Preliminary Drawing 37-700-P1 has been reviewed, and the following comments are submitted for your consideration.

1. Indicate top of pier footing elevations for each structure, or "typical" if the same.

2. Add chainage equation and offset to minimum clearance point. Delete minimum clearance point #2.

3. Please show existing 30"Ø C.S.P. (G-Plan 4557) under C.N.R. embankment in the vicinity of Pier #2 "S". The culvert will have to be relocated in order to prevent any conflict with the pier.

4. Show slope of berms perpendicular to centreline abutment bearings.

5. Please add stations and elevations along C.N.R. track as shown in Planning Report.

6. Please show depth of WWF girders and total depth of concrete over exterior girder so that minimum clearance could be checked.

7. The northbound structure will be used by heavy construction equipment to transport fill over the track. Please indicate on drawing.

8. The bridge deck elevations at W.P.'s 9, 10, 11, 12, 14, 15, 16 and 17 appear to be 0.24' greater than as shown. Rail elevation at Station 101+70.20 on C.N.R. profile should read 1003.56.

.....2

The Planning and Design Section has made the following additional comments. "The areas of swamp excavation north and south of the rail embankment require protection on the rail side to prevent damage to the C.N.R. road bed. Sheet piling is recommended. The piers located in the swamp area should be sheet piled also to protect the C.N.R. line during construction of the pier footings". It is however noted that the Soil Mechanics Section has recommended excavating the organic material and soft clayey silt under the proposed fills, and immediately backfilling with granular material in strips not to exceed 20' wide. Sheet piles may also be required in some unspecified areas prior to the excavation and backfilling operations for the embankment protection.

The Soil Mechanics Section will provide recommendations to ensure the stability of the C.N.R. track and approach embankments.

Please make the necessary revisions.

KP:gj

K. Pilgrim,
Senior Structural Engineer,
for:
G.C.E. Burkhardt,
Head, Structural Section.

c.c. M. Devata ✓
E. Metzner

CN Rail

Regional Engineering
R.R.B. Box 112
Union Station
Toronto, Ont.
M5J 1E7

29 December 1978

Our file: 1600-BA-30.0
Your file: WP 160-74-33,
Site 37-700

Mr. G. C. E. Burkhardt
Head, Structural Section
Central Region
Ministry of Transportation & Communications
3501 Dufferin St.
Downsview, Ont.
M3K 1N6

Attn: Mr. K. Pilgrim
Sr. Structural Engineer

Dear Sirs

Re: Proposed Overhead Bridge to Carry Hwy. 404 over our Bala Subdivision at Mi. 29.98 Bala Subdivision

Further to the second paragraph of my letter to you of the 5th instant in connection with subject proposal.

The following advice has been received from Mr. W. W. Wong, our Sr. Geotechnical Engineer, Montreal;

"The subsoil in the immediate area of our track generally consists of up to 18 ft. of compressible organic silt to clay silt, varying with depth from very soft to firm, and undrained shear strength from 100 to 400 lbs./sq. ft. There have been no actual borings taken directly under the track, so assumptions have to be made on analyzing the stability of the railway embankment.

MTC proposes to sub-excavate the soft compressible soil material in the vicinity of our track to a maximum depth of 26 ft. for construction of their approach fills and pier and abutment sub-structure. My preliminary calculations based on assumed

shear strength values indicate that due to sub-excavation the factor of safety of the railway embankment with train load can fall down to very close to 1.0, thereby creating a precarious situation on our track. This is mainline track and we cannot risk any possibility of sudden displacement or rupture of our road bed. The information provided in the MTC soil report is probably adequate for their highway work, but I do not think the stability of our embankment has been thoroughly analyzed.

I therefore recommend that we request the MTC to review the problem, considering continuous trainloads of 15,000 lbs./lin. ft. of track. Depending on the final required layout of the bridge and on how close the sub-excavation would be to the track, it may be necessary to make a few borings on track location to assess the soil condition under our road bed for final design purposes."

Your further submission with respect to the above is hereby requested. It would also be appreciated to be furnished with one additional copy of the soil report.

Yours truly

for: F. D. Campbell
Regional Chief Engineer

JJ-4076

Ministry of Transportation and Communications
Ontario

Memorandum

To: Mr. C.S. Grebski
Head, Central Section
Structural Office
2nd Floor, West Building

Attention:

From: Soil Mechanics Section
Engineering Materials Office
Room 315, Central Building

Date: 78 11 17

Our File Ref.

In Reply to

Subject: Re: Hwy. 404 C.N.R. Overhead
W.P. 160-74-33, Site 37-700
District 6, Toronto

We have reviewed the preliminary structural drawing for the above structure as per your request of 78 10 31, and have the following comments to make.

As mentioned in the foundation investigation and design report all the organic material and soft clayey silt should be removed entirely beneath the embankment to a plan limit as defined by the projection of a 1:1 line from the toe of the slope to firm bottom as shown on the attached typical section. In the area of required subexcavation, i.e. S.B.L. north and south approaches, firm bottom is encountered at depths generally increasing toward the railway tracks to a depth of up to 21 feet, i.e. at about elevation 975. Because of the depth of the required subexcavation and the proximity to the C.N.R. tracks it will be necessary to subexcavate the soft material and backfill immediately with granular material in strips not to exceed 20 feet in width, at right angles to the tracks. Alternatively, if subexcavation and subsequent backfilling is not carried out in strips it may be necessary to use sheet piling in certain areas to ensure stability of the temporary cut slopes and the C.N.R. tracks. In addition, it is important that all subexcavation be completed before the roadway grading starts. These recommendations are shown in graphical form on the attached drawing.

The recommendations for subexcavation are of paramount importance in ensuring the stability of the approach fills. In order to convey the necessary requirements to the construction staff it may be necessary to supply an additional drawing showing the limits and approximate depths of subexcavation, as well as pertinent notes and typical sections. A drawing to this effect is being prepared in our office and will be submitted for the contract package.

In addition, it is suggested that our office be kept informed of the progress of the structural earthworks to make, if necessary, modifications in requirement during construction.

cont'd.....

Also, as discussed in the foundation investigation report it will be necessary to remove all topsoil and surficial organic deposits entirely beneath the plan limits of the embankment to a minimum horizontal distance of 100 feet behind the abutments. In addition, fill material to be placed on the steep slopes at the south approach shall be keyed into the existing slope according to the M.T.C. Standard Benching of Earth Slopes (DD-414).

Furthermore, the berm shown for the N.B.L. north approach is not required. In fact, unless subexcavation is carried out at this location, the presence of the berm is detrimental to the stability of the slope since the toe of the berm will be even closer to the deep organic deposits.

We have no further comments at this time except that our office is more than ready to assist in the preparation of any contract documents relating to the sequence of earthwork construction as discussed above.

M MacLean

M. MacLean
Project Engineer

For: M. Devata
Supervising Engineer

MM/MD/gs

Attach.

cc: D. MacDonald
G.C.E. Burkhardt
R.D. Gunter
M.R. Ernesaks
W. Lin
Files

Ministry of Transportation and Communications
Ontario

Memorandum

To: Mr. G.C.E. Burkhardt,
Head, Structural Section
Central Region
3501 Dufferin St. Downsview
Attention:

From: Soil Mechanics Section
Engineering Materials Office
Room 315, Central Building

Date: 78 07 10

Our File Ref.

In Reply to

Subject: Re: C.N.R. Overhead, 3.7 Miles North of Regional Road 14
W.P. 160-74-33, Site 37-700
Hwy. 404, District 6, Toronto

A meeting was held on 78 07 07 between Mr. G.C.E. Burkhardt, Mr. V. Boehnke of the Central Region Structural Planning Office and Mr. M. Devata and Mr. M. MacLean of the Soil Mechanics Section. The purpose of the meeting was to discuss the implications of the alternate schemes in ~~lieu~~ view of results of the recently completed foundation investigation.

Fieldwork was originally carried out in early March to evaluate twin three span structures at this location. A subsequent memorandum dated 78 04 06 from our office to Mr. G.C.E. Burkhardt of the Structural Section discussed the subsoil conditions encountered at this site and gave preliminary recommendations for construction of high fills at this location. In view of the encountered subsurface conditions and revised requirements of the C.N.R., it was decided to adopt twin multi-span structures at this location and additional fieldwork was subsequently undertaken to outline and further investigate the organic deposits and to obtain sufficient subsurface data for the design of the multispan structures. Because of the duration of the field-work, and the large scope of the foundation investigation, the final report will not be complete until late August. We are hereby submitting preliminary recommendations, sufficient to proceed with the preliminary structural design. In addition, we have included two plans (one for the north-bound lanes one for the southbound lanes) with stratigraphical profiles based on visual classifications of the borehole samples. It is important to note that these plans and profiles are preliminary in nature, and not complete.

The subsurface conditions discussed in our memorandum of 78 04 06 are still valid for the multispan scheme. The recent fieldwork indicates that the organic deposits are roughly located between the existing C.N.R. tracks and con-tour 998 to the south of the track and contour 996 to the north of the tracks.

cont'd...

The depth of organic material is between 10 and 20 feet deep.

As discussed in our memorandum of 78 04 06, construction of the embankments will require the following procedures to be carried out.

1. Excavate all topsoil and organic material within the plan limits of the embankment and backfill with granular type of material. The alternative of leaving the organics in place and providing multiple berms is not desirable.

2. To ensure the stability of the fill material itself, fills up to 25 feet high can be constructed with side slopes of 2:1, however fills in excess of 25 feet will require a mid-height berm. For example a 45 foot high fill will require a berm 10 feet wide.

To avoid any excavation of the organic deposits it will be necessary to construct the abutments not closer to the tracks than locations listed in Table 1 attached. Abutments located closer to the tracks than shown will require subexcavation of the organic material beneath the plan limits of the embankment.

Included in the following table are our preferences for the abutment locations for the alternate schemes received from the Structural Planning Office dated 78 05 11. The final locations of the abutments should be based on economic consideration.

C.N.R. Overhead, Hwy. 404
Table 1

	Approximate Abutment Location for No Organic Subexcavation	Approximate Abutment Location, with some Subexcavation (to comply with Structural Planning Office Scheme)
Northbound Lanes		
North Approach	821+00	821+50
South Approach	815+30	815+60
Southbound Lanes		
North Approach	820+60	820+60
South Approach	813+80	814+10

cont'd...

Finally, as discussed in the earlier memorandum, the structure piers and abutments can be supported on end bearing piles driven into the hard glacial deposit. For preliminary design purposes it can be assumed that steel 'H' piles (12 BP 74) will attain the required load at approximate tip elevation as follows:

	Approximate Abutment/ Pier Location (STA.)	Approximate Tip Elevation (Feet)
Southbound Lanes	820+60	925
	819+90	925
	819+00	930
	818+10	925
	817+00	905
	815+90	920
	815+00	915
	814+10	925
Northbound Lanes	822+10	920
	821+50	920
	820+60	925
	819+60	920
	818+60	915
	817+40	910
	816+50	910
	815+60	915
	814+90	915

However, driving of the piles during construction should be controlled as per M.T.C. current standards using the Hiley Formula. For design purposes a safe load of 130 tons per pile may be used for these steel 'H' piles. These loads are based on our recent experiment of a pile load test project on Hwy. 404 at 16th Avenue .

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

M. Devata

for M. MacLean
Project Engineer

For: M. Devata
Supervising Engineer

MM/sr

cc: C. Grebski, Attn: W. Lin
R.D. Gunter
M.R. Ernesaks

Files

Ministry of Transportation and Communications
Ontario

Memorandum

To: Mr. M. Devata,
Supervising Engineer,
Soils Mechanics Section,
Central Building, Downsview

From: G.C.E. Burkhardt,
Structural Section,
Central Region.

Attention:

Date: 1978-04-26

Our File Ref.

In Reply to

Subject: RE: C.N.R. Overhead at Highway 404,
W.P. 160-74-33, Site 37-700,
District 6, Toronto

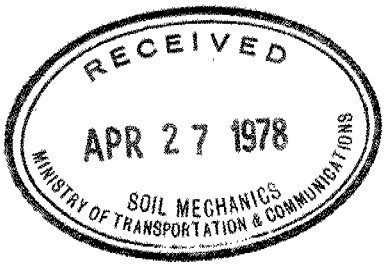
Further to your memorandum of 1978-04-06 and to our recent meetings on the problems associated with the above site, please note that twin multi-span steel structures will be adopted to span the problem area. Ultimately the twin bridges will be widened on the median side.

Attached please find two prints of the site plan, showing span lengths and approximate footing locations for two schemes, A and B.

Scheme A represents twin six span structures each 580' long. Soils information obtained from the Regional Geotechnical Section was used to tentatively locate the abutment footings, which are located so that the toe of fill, assuming 2:1 end slopes does not encroach on soft organic material. Fill would have to be placed at the abutments with this scheme.

Scheme B represents scheme A with two additional 70' long end spans to make twin eight span structures each 720' long. This scheme is proposed as suggested in your memorandum of 1978-04-06 and the realization that the abutment footing locations for scheme A are dependent on your findings during the field investigations.

In any case, we will be relying on your field investigations to give us the best locations for the abutment footings, and this may even be between the locations indicated for the above two schemes. For the scheme that is finally recommended, kindly let us know whether the end slopes at the abutments can be increased above the assumed 2:1 slopes, as this could mean a considerable shortening of the end spans. The final location of the abutment footings, and acceptable end slope, may also mean that some of the intermediate pier footings may be slightly relocated from the positions shown.



.....2

The revised profile grade will be submitted as soon as it is available, and will show the rise in profile as pointed out in our memorandum of 1978-04-03.

Kindly arrange to have a supplementary foundation investigation carried out based on the above. The present scheduling now calls for the final report by 1978-07-12.

KP:gj

K. Pilgrim,
Senior Structural Engineer,
for:
G.C.E. Burkhardt,
Head, Structural Section

c.c. R. Fitzgibbon
J. Anderson
R. Kunkel

Ministry of Transportation and Communications
Ontario

Memorandum

To: Mr. G.C.E. Burkhardt, Head
Structural Office
Central Region
3501 Dufferin St., Downsview

From: Soil Mechanics Section
Engineering Materials Office
3rd Floor, Central Building

Attention: K. Pilgrim

Date: 78 04 06

Our File Ref.

In Reply to

Subject: Re: C.N. R. Overhead,3.7 Miles North of Regional Road 14
W.P. 160-74-33 Site 37-700
Hwy 404, District 6, Toronto

INTRODUCTION

The foundation investigation fieldwork for the above project has been completed. Due to the urgency of this project we are hereby submitting a brief description of the subsurface conditions, together with preliminary recommendations concerning the proposed structure foundations and approaches. This memorandum is intended to provide sufficient information to proceed with the Preliminary Structural Design. The final foundation investigation report with detailed subsoil descriptions and recommendations including the log sheets and drawings, will be issued upon completion of the laboratory testing and drafting.

FIELDWORK AND SUBSURFACE CONDITIONS

The fieldwork consisted of a total of 10 sampled boreholes and 9 dynamic cone penetration tests. The borings were advanced by means of hollow stem continuous flight augers to depths of 22 to 102 feet below the gound surface. Subsoil conditions were found to be quite variable across the site, as is the case throughout much of this physiographic region - The Oak Ridges Interlobate Moraine. Based on visual classifications the subsurface conditions are generally described as follows. The surficial deposit consists of a very soft peat (of the granular amorphous type) and/or organic silt which was found to vary in depth from less than 3 feet to 15 feet. Underlying these organic deposits are very soft to firm deposits of clayey silt to silty clay extending to a depth of up to 23 feet below the existing ground surface. The cohesive deposits overlie pockets or layers of random thickness and occurrence of stiff to hard clayey silt and loose to compact sands, silts, and silty sands; the cohesive deposits being generally dominant. Below these deposits at a depth of 60 to 65 feet is a glacial till composed of a heterogeneous mixture of clayey silt, sand and gravel. The groundwater level was found to be some 2 feet below the existing gound surface.

DISCUSSIONS AND RECOMMENDATIONS

The proposed Hwy. 404 will cross the C.N.R. tracks approximately 3.7 miles north of Regional Road 14. At this location it is proposed to construct Hwy. 404 as a four lane divided highway with a median width of about 100 feet to accommodate future transportation development within this corridor.

cont'd.....

At the time of the field investigation, the initial proposals included the provision for one additional railway track. The C.N.R. Overhead proposal called for twin three span (55'-70'-55) spill-thru type structures which would require fill heights up to 40 feet high. Subsequent C.N.R. requirements include the provision for three additional railway tracks. The revised C.N.R. Overhead proposals are twin three span (60'-110'-60') spill-thru type structures which would require fill heights up to 45 feet high. In addition, there is a further verbal request from the Central Region Structural Planning Section that our office should comment on the viability of constructing a C.N.R. subway structure rather than an overhead crossing.

Embankment Fills

In order to ensure the stability of the 45 foot embankment fills it will be necessary to carry out the following:

1. It is essential that all organic material shall be removed to its full depth within the plan limits of the approach embankments and backfilled with granular A material.

2. The very soft to soft cohesive deposit extending to a depth up to 23 feet below the ground surface will not provide adequate stability for the proposed high embankments. In order to improve the stability the following two alternatives may be considered.

   a) Excavate all the very soft to soft cohesive material down to elevation 977 within the plan limits of the base of the proposed embankments. Requirements for backfilling will be very similar to those described for organic material sub-excavation.

   b) Alternatively, the very soft to soft cohesive material can be left in place but multiple berms will be required both in the transverse and the longitudinal direction for the proposed embankments. In addition, excessive settlements for fills of this magnitude can be anticipated. Furthermore, advance placement of approach embankments will be necessary to minimize the post construction problems of the roadway. For preliminary assessment it can be assumed that fills up to 10 feet will be stable with 2:1 slopes. The configuration of multiple berms will be discussed in the final foundation report if such a scheme can be considered. As indicated previously, the settlements will be excessive and this aspect can only be discussed in detail once the confirmation of the geometry and the final location of the abutments is selected.

3. The approach fills as mentioned previously will be in the order of 45 feet in height. The stability of the fill itself will

cont'd.....

be governed by the selection of embankment material and placement methods. In order to provide adequate stability within the fill material itself irrespective of the base failure, we recommend that fills can only be built with 2:1 slopes up to 30 feet in height. For fills in excess of 30 feet a mid-height berm should be provided. For example, a 22.5 foot wide berm will be required for a fill height of 45 feet. A smooth transition should be incorporated between a 30 foot fill with no berm to a 45 foot fill with a 22.5 foot wide berm.

4. The sub-excavation requirements in the longitudinal direction behind the abutments can only be investigated after the completion of the preliminary design. However, for preliminary design purposes the excavation should extend for a minimum distance of 100 feet behind the abutment bearing seats. Extensive sub-excavation will be necessary and in view of this an elaborate track protection scheme is warranted for the sub-excavation in the proximity of the C.N.R. tracks. One method of achieving this is by driving steel sheet piling parallel to and also on either side of the C.N.R. tracks with tie backs. Such methods were employed successfully on a Hwy. 417 and C.N.R. crossing in Ottawa District.

Structure Foundations

The underlying subsoil conditions are such that the piers and abutments can only be supported on end-bearing piles driven into the hard glacial till deposit. Depending on the final location of the abutments and piers, it may be necessary to carry out further borings upon completion of the preliminary structural design if the location of piers and abutments has shifted significantly. For estimating purposes it can be assumed that steel 'H' piles (12 BP74) will attain the required load at approximate tip elevation as follows:

	Approximate Tip Elevation Ft.
Southbound Lanes	
South Abutment & South Pier	905
North Abutment & North Pier	915
Northbound Lanes	
South Abutment & South Pier	915
North Abutment & North Pier	915

However, driving of piles during construction should be controlled as per M.T.C. current standards using the Hiley Formula. For design purposes a safe load of 130 tons per pile may be used for these steel 'H' piles. These loads are based on our recent experience of a pile load test project on Hwy. 404 at 16th Avenue.

cont'd.....

If excavation for the pier pile cap is carried out below the prevailing groundwater level and if the sub-excavation backfill material is subject to basal upheaval, a dewatering scheme will be necessary to construct the pile cap.

As an alternative, a multi-span structure can be adopted to span the problem area. In so doing, the sub-excavation and berm requirements would be minimized, as well as the adverse affects associated with excessive settlements. In such a case the structure should be spanned from about Sta. 814+50 to Sta. 821+50, having a total length of 700 feet. Whether this alternative is acceptable or not will depend on economic considerations. Again, this alternative will further be elaborated on if it can be considered for design.

C.N.R. Subway Alternative

The Central Region Structural Planning Section also requested our office to comment on the viability of cutting Hwy. 404 at this location and constructing a C.N.R. subway. This would require cuts in excess of 20 feet. Because of the organic material and the underlying very soft cohesive deposits within the cut, and the presence of water, the following procedures are to be adopted.

1. Cuts up to 6 feet deep will be stable with 2:1 side slopes Cuts in excess of 6 feet with 2:1 side slopes will require benches.

   For example, with 2:1 side slopes:

   - Cuts up to 12 feet deep will be stable with one mid-height 15 foot wide bench.
   - Cuts up to 18 feet deep will be stable with 15 foot wide benches at the 1/3 and 2/3 heights.
   - Cuts up to 24 feet deep will be stable with 15 foot wide benches at the 1/4, 1/2 and 3/4 heights.

2. Excessive seepage can be anticipated for the excavation of the approach cuts in the organic material. Pumping at all times during construction will be required to remove the water.

3. The roadway should be provided with permanent subdrains at the toe of both sides of the cut to continually drain the groundwater and also to relieve the rain water from the slopes and the pavement. If adequate relief is not available to drain this water, a permanent pumping system has to be incorporated in the scheme.

4. The presence of numerous silty sand and silt layers at the base elevation of the cut are subjected to boiling under an excessive hydrostatic head. Therefore, a temporary dewatering scheme will be necessary during construction until the permanent subsurface drainage system is in operation.

cont'd.....

5. For construction purposes a detour of the C.N.R. track may be necessary if the subway scheme is adopted.

Because of the complexity of this project and the wide range of alternatives, it would be advantageous to have a meeting to discuss the options with all interested parties to choose the most reasonable solution for this crossing.

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

M MacLean

M. MacLean
Project Engineer

For: M. Devata
Supervising Engineer

MM/MD/ig

cc: R.D. Gunter
M.R. Ernesaks
D.E. Thrasher

C. Grebski
G.A. Wrong
B.J. Giroux
R.S. Pillar

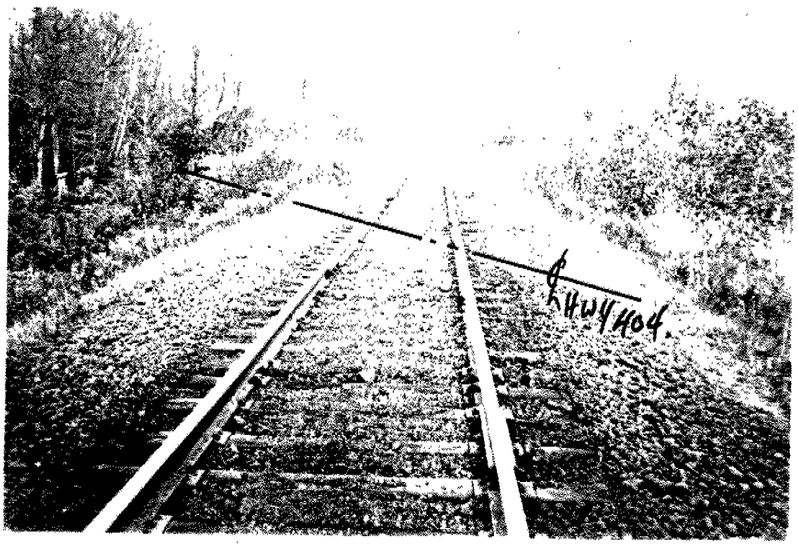
R. Hore

R. Fitzgibbon
J. Anderson
G. Sloan

Files ✓

C.N.R. OVERHEAD — HWY 404
M.P. 160-74-33 SME 37-100

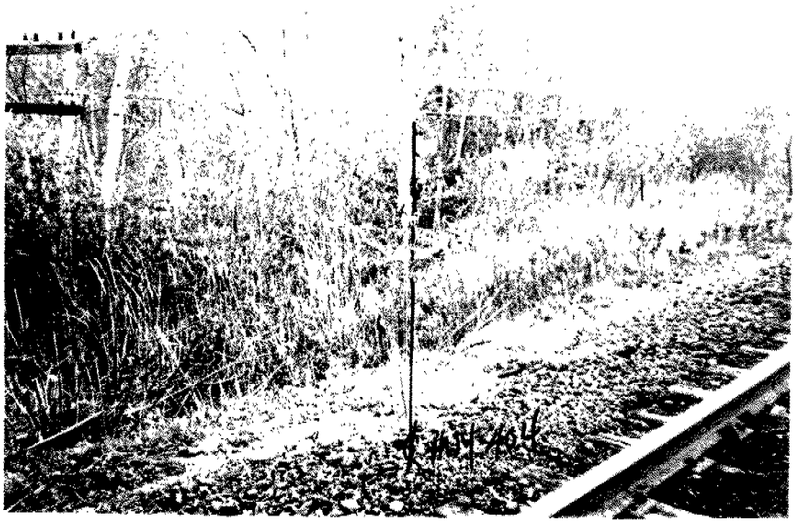
K. Pilgrim
77-10-20



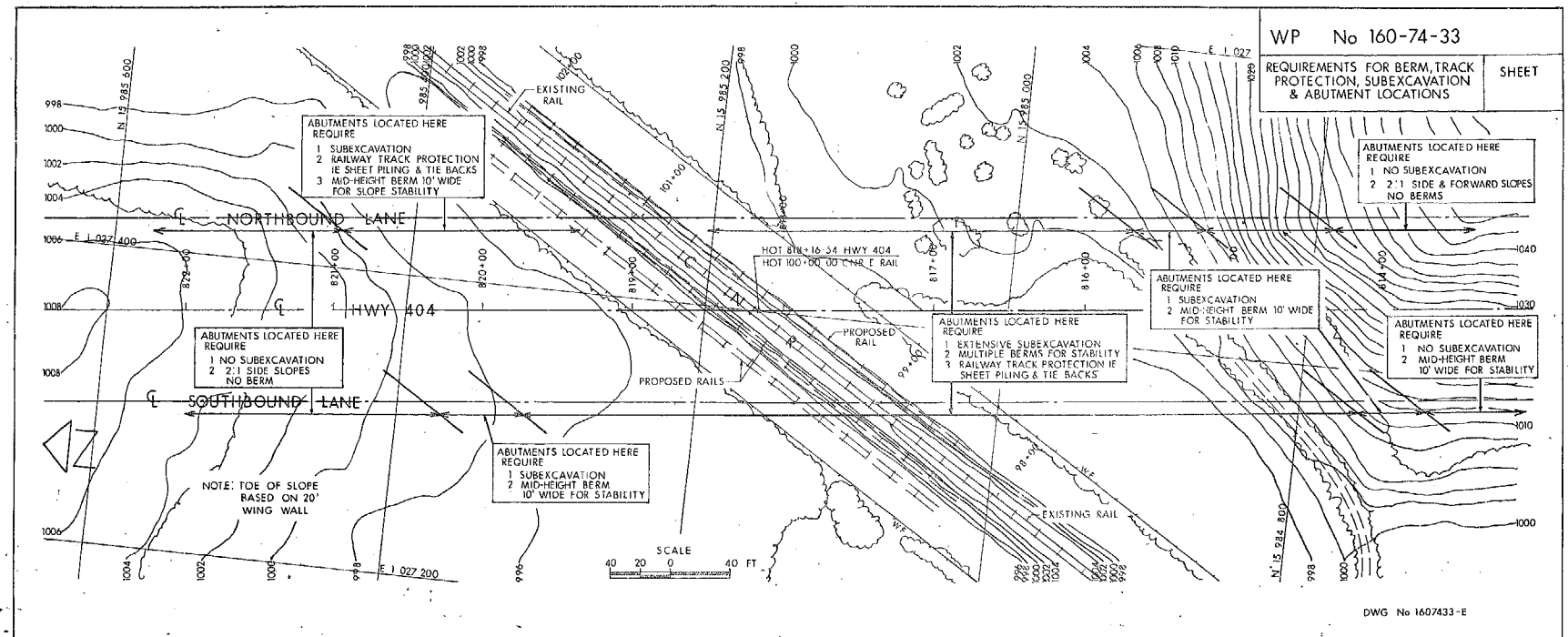
C.N.R. TO BALA

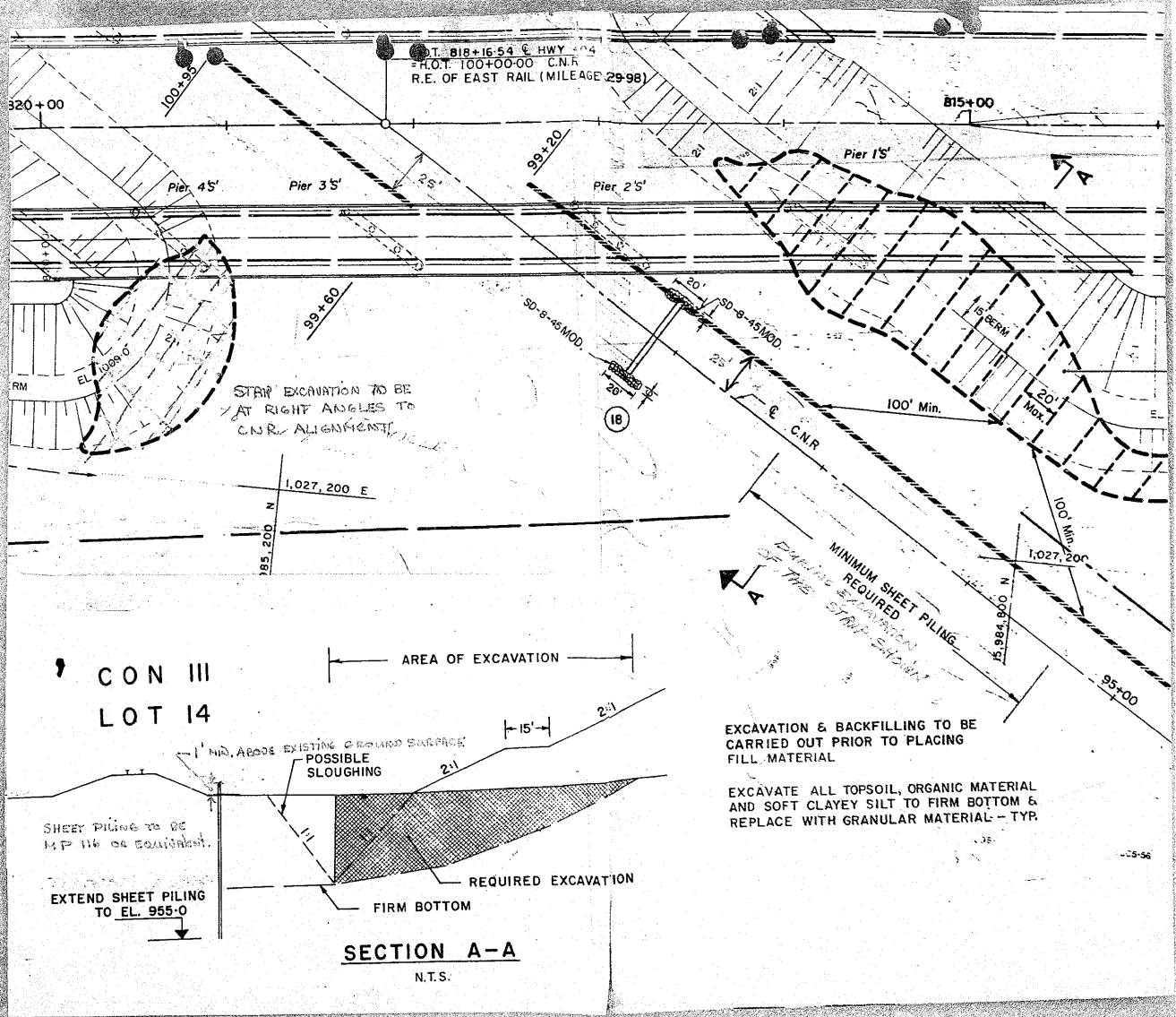
C.N.R. TO TORONTO

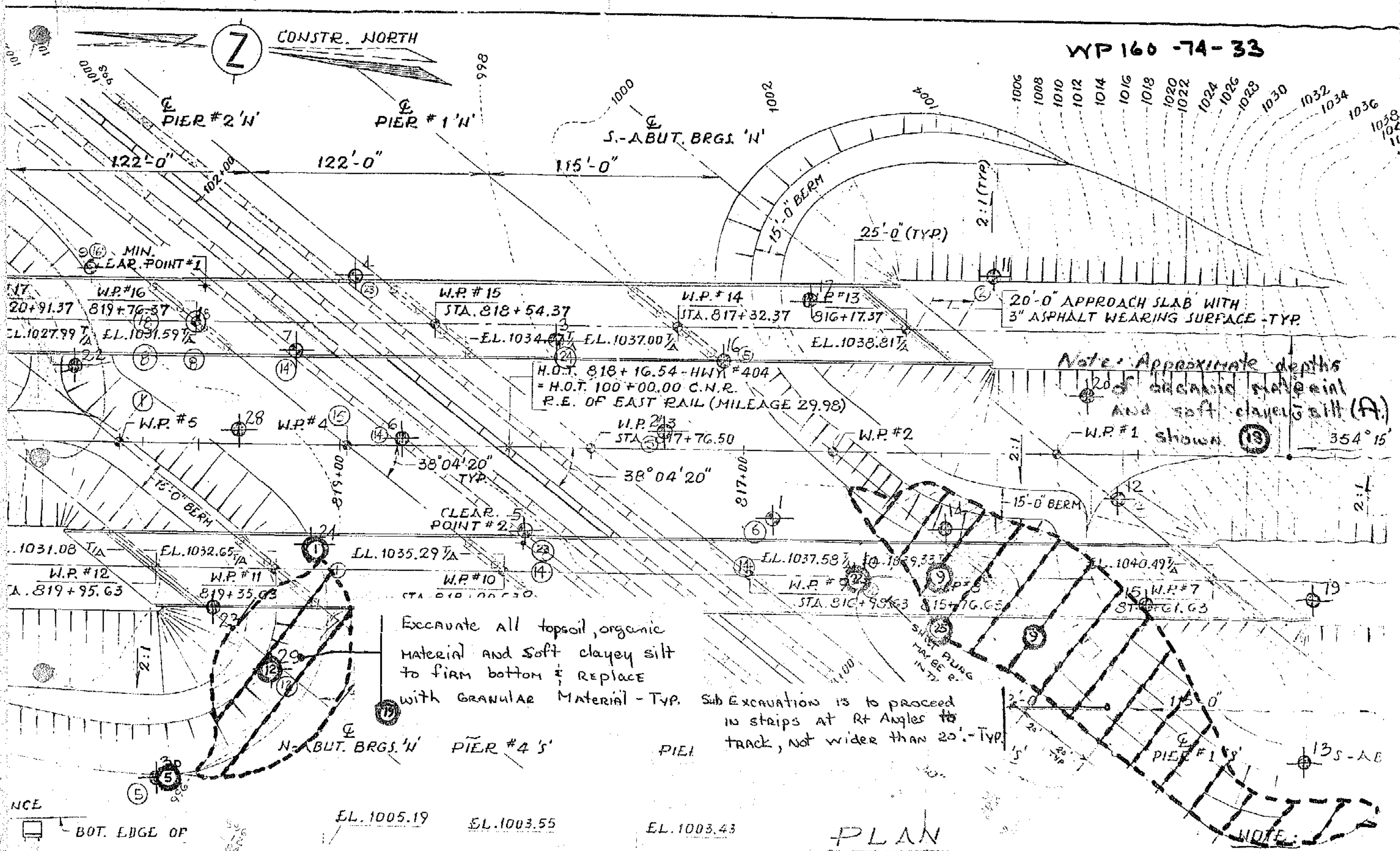
NORTH ALONG
℄ HWY 404



SOUTH ALONG
℄ HWY 404


WP No 160-74-33
REQUIREMENTS FOR BERM, TRACK PROTECTION, SUBEXCAVATION & ABUTMENT LOCATIONS
SHEET
ABUTMENTS LOCATED HERE REQUIRE
1 SUBEXCAVATION
2 RAILWAY TRACK PROTECTION IE SHEET PILING & TIE BACKS
3 MID-HEIGHT BERM 10' WIDE FOR SLOPE STABILITY
EXISTING RAIL
℄ NORTHBOUND LANE
℄ HWY 404
℄ SOUTHBOUND LANE
HOT 818+16.54 HWY 404
HOT 100+00.00 CNR E RAIL
PROPOSED RAILS
PROPOSED RAIL
ABUTMENTS LOCATED HERE REQUIRE
1 NO SUBEXCAVATION
2 2:1 SIDE SLOPES
NO BERM
ABUTMENTS LOCATED HERE REQUIRE
1 SUBEXCAVATION
2 MID-HEIGHT BERM
10' WIDE FOR STABILITY
ABUTMENTS LOCATED HERE REQUIRE
1 EXTENSIVE SUBEXCAVATION
2 MULTIPLE BERMS FOR STABILITY
3 RAILWAY TRACK PROTECTION IE SHEET PILING & TIE BACKS
ABUTMENTS LOCATED HERE REQUIRE
1 SUBEXCAVATION
2 MID-HEIGHT BERM 10' WIDE FOR STABILITY
ABUTMENTS LOCATED HERE REQUIRE
1 NO SUBEXCAVATION
2 2:1 SIDE & FORWARD SLOPES
NO BERMS
ABUTMENTS LOCATED HERE REQUIRE
1 NO SUBEXCAVATION
2 MID-HEIGHT BERM
10' WIDE FOR STABILITY
NOTE: TOE OF SLOPE BASED ON 20' WING WALL
SCALE
40 20 0 40 FT
N 15 985 600
N 15 985 200
N 15 985 000
N 15 984 800
E 1 027 400
E 1 027 200
DWG No 1607433-E


P.T. 818+16·54 ℄ HWY
P.O.T. 100+00·00 C.N.R.
R.E. OF EAST RAIL (MILEAGE 29·98)
820+00
815+00
100+95
99+20
99+60
Pier 4'S'
Pier 3'S'
Pier 2'S'
Pier 1'S'
25'
2:1
20'
SD-8-45 MOD.
15' BERM
20' Max.
100' Min.
℄ C.N.R.
STRIP EXCAVATION TO BE AT RIGHT ANGLES TO C.N.R. ALIGNMENT
1,027,200 E
985,200 N
1,027,200
15,984,800 N
MINIMUM SHEET PILING REQUIRED
DURING EXCAVATION OF THE STRIP SHOWN
95+00
EL. 1009·0
RM
18
CON III
LOT 14
AREA OF EXCAVATION
1' MIN. ABOVE EXISTING GROUND SURFACE
POSSIBLE SLOUGHING
15'
1:1
SHEET PILING TO BE M.P. 116 OR EQUIVALENT.
EXTEND SHEET PILING TO EL. 955·0
REQUIRED EXCAVATION
FIRM BOTTOM
SECTION A-A
N.T.S.
EXCAVATION & BACKFILLING TO BE CARRIED OUT PRIOR TO PLACING FILL MATERIAL
EXCAVATE ALL TOPSOIL, ORGANIC MATERIAL AND SOFT CLAYEY SILT TO FIRM BOTTOM & REPLACE WITH GRANULAR MATERIAL – TYP.



WP 160 -74-33
CONSTR. NORTH
℄ PIER #2 'N'
℄ PIER #1 'N'
℄ S.-ABUT. BRGS. 'N'
122'-0"
122'-0"
115'-0"
15'-0" BERM
2:1 (TYP.)
25'-0" (TYP.)
MIN. CLEAR. POINT #1
W.P. #16
819+76.37
EL. 1031.59 T/A
W.P. #15
STA. 818+54.37
EL. 1034.67 T/A
EL. 1037.00 T/A
W.P. #14
STA. 817+32.37
W.P. #13
816+17.37
EL. 1038.81 T/A
20'-0" APPROACH SLAB WITH 3" ASPHALT WEARING SURFACE - TYP.
H.O.T. 818+16.54 - HWY #404 = H.O.T. 100+00.00 C.N.R. R.E. OF EAST RAIL (MILEAGE 29.98)
Note: Approximate depths of organic material and soft clayey silt (A) shown
W.P. #5
W.P. #4
W.P. #3
STA. 817+76.50
W.P. #2
W.P. #1
354° 15'
38° 04' 20" TYP.
38° 04' 20"
15'-0" BERM
CLEAR. POINT #2
EL. 1031.08 T/A
EL. 1032.65 T/A
EL. 1035.29 T/A
EL. 1037.58 T/A
EL. 1040.49 T/A
W.P. #12
STA. 819+95.63
W.P. #11
819+35.63
W.P. #10
W.P. #9
STA. 816+95.63
W.P. #8
815+76.63
W.P. #7
Excavate all topsoil, organic material and soft clayey silt to firm bottom & replace with granular material - Typ.
Sub Excavation is to proceed in strips at Rt Angles to track, not wider than 20'. - Typ.
Shelby plug may be in
115'-0"
℄ N-ABUT. BRGS. 'N'
PIER #4 'S'
℄ PIER #1 'S'
S-AB
BOT. EDGE OF
EL. 1005.19
EL. 1003.55
EL. 1003.43
NOTE:

PLAN
1" = 40'