

ENGINEERING MATERIALS OFFICE  
SOIL MECHANICS SECTION

WP 157-75-06

DIST 6

HWY 403

STR SITE 24-385

Erin Mills Parkway Underpass

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TYPE	DISCARD AFTER	RECOMM. BY
JARS	78 08 31	MDL
TUBES	—	—
ROCK CORES	After the removal of core	MDL

GEOCRES 30M12-123

DATE JUL 25 1978

# FOUNDATION INVESTIGATION REPORT

For

Erin Mills Parkway Underpass  
W.P. 157-75-06, Site 24-385  
Hwy. 403, District 6, Toronto

## INTRODUCTION

This report contains the results of foundation investigations carried out at the site of the above mentioned project during the periods of May 24 to June 2, 1977 and February 21 to 28, 1978. The fieldwork consisted of ten sampled boreholes advanced by means of a continuous flight auger machine equipped with solid and hollow stem augers. In addition, diamond drilling techniques were employed to obtain a BXL size core of bedrock. The boreholes ranged in depth from 28.4 to 103.5 feet below the ground surface.

## SITE DESCRIPTION AND GEOLOGY

The site is located about one mile southeast of Eglinton Avenue on Erin Mills Parkway in the City of Mississauga, Regional Municipality of Peel.

The land immediately adjacent to the site has a gentle topography sloping down to the south. The land is developed for farming purposes. Physiographically the site is situated in the border region of "Peel Plains" and "South Slope". The characteristic deposit in the vicinity of the area under investigation is composed of cohesive glacial till and granular deposits. The overburden is underlain by shale bedrock of Meaford, Dundas formation, Ordovician Period. This physiographic region is well drained by the Credit, Oakville and Etobicoke Creeks, which have cut deep valleys into the overburden, although in many of the interstream areas drainage is still imperfect.

## SUBSURFACE CONDITIONS

The subsurface conditions were found to be generally uniform over the site. Underlying the roadway fill material on the west side and a shallow surficial organic deposit (swampy area) on the east

side of the centreline, is a stratum of cohesive glacial till. The glacial till is underlain by an extensive granular deposit which consists of silt to sandy silt or clayey silt at the upper portion and gradually changing to silty sand with gravel and boulders. The overburden is underlain by shaley limestone bedrock. Detailed descriptions of the various soil and rock types encountered in each borehole are given in the Record of Borehole Sheets. The estimated stratigraphical profile and sections shown on Drawing #1577506-A are based upon this information. From ground level downwards, the various soil types encountered are as follows.

#### Fill Material

In certain locations where boreholes (B.H. #1, #2, #5 and #9) were put down in the shoulders of the existing Erin Mills Parkway, a surficial layer of 3.5 to 8.0 feet of fill material was encountered.

The fill material is cohesive and is comprised of clayey silt with some sand and traces of organics. The 'N' values ranging from 8 to 21 blows per foot, obtained during sampling, indicate that the fill material is well compacted.

#### Surficial Organic Deposits

At this site on the east side of the Erin Mills Parkway centreline the surficial organic deposits in the swamp area were investigated in the three boreholes (B.H. 6, 7 and 8). The swampy area is covered with 2 to 2.5 feet of water followed by 1.5 to 3.0 foot thick surficial layers of firm organic clay or clayey silt with traces of sand and organics (mostly decayed vegetation).

#### Glacial Till

Underlying the fill material or beneath the surficial organic deposit a stratum of cohesive glacial till was encountered at all locations over the site except at one location (B.H. #5) where the glacial till is covered with a thin layer of silty sand. This glacial deposit varies in thickness from 4.5 to 18.0 feet and is comprised of a heterogeneous mixture of clayey silt, sand and gravel. The Standard Penetration Tests gave 'N' values ranging from 16 blows to over 100 blows per foot generally increasing with depth indicating that the glacial till has a very stiff to hard consistency.

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

		<u>Range</u>
Liquid Limit	(W <sub>L</sub> ) %	26-33
Plastic Limit	(W <sub>P</sub> ) %	15-21
Moisture Content	(W) %	11-16

The results of the Atterberg Limit Tests are shown on the Plasticity Chart (Figure 1) and the typical grain size distribution curves are presented in Figure 3 which are included in the Appendix of this report.

The Atterberg Limits indicate that the cohesive stratum is inorganic and of low plasticity.

Silt to Silty Sand With Layers of Clayey Silt (Upper Granular Deposit)

Underlying the cohesive glacial till is a granular deposit which varies in composition of material and in thickness from 9.5 feet to 32.5 ft. The material is mainly composed of silt with some sand changing to silty sand with random seams of clayey silt up to 2 feet thick. The Standard Penetration Tests gave an 'N' value range of 22 to over 100 blows per foot which indicates that the relative density of the deposit is compact to very dense but generally in the dense to very dense range.

Silty Sand With Gravel and Occasional Boulders (Lower Granular Deposit)

The upper granular stratum is underlain by a deposit of silty sand with gravel and occasional boulders up to 18 inches in size. The lower granular deposit was explored to its full depth in all the boreholes except B.H. 3 and 9 and has a thickness ranging from 17 feet to 53.0 feet. The material in this stratum is generally silty sand with gravel and occasional boulders (up to 18 inches in size), the boulders becoming more frequent with depth. At one location (B.H. #9), the lower granular deposit at approximate elevation 512.0 was subjected to an excess hydrostatic head of 2 feet. Due to this unbalanced hydrostatic head, the silty sand continuously kept pushing into the hollow stem augers and the BX casing and consequently rendered further investigation impossible.



Standard Penetration Tests performed gave 'N' values ranging from 37 to over 100 blows per foot with an exception of 18 blows per foot at one location. Based on these values it is estimated that the relative density of the lower granular deposit varies from dense to very dense with the exception of one location where it may be described as compact.

#### Bedrock - Shaley Limestone

Bedrock was found underlying the lower granular deposit. The bedrock was proven in all boreholes except B.H. #3 and #9 by obtaining BXL size rock core samples.

The dominant type of bedrock encountered across the site is shaley limestone or shale with occasional seams of limestone. The bedrock surface in the area investigated varies from elevation 511.0 to 431.0. The bedrock appears to be dipping in a northeasterly direction. The bedrock in general was found to be moderately fractured in the upper zone but generally in a sound condition. In certain locations, however, the upper one to two feet appeared to be slightly weathered.

At the location of Borehole 5A beneath the upper 6 foot thick layer of glacial till with boulders there is a transition zone and the material is either clayey silt with shale fragments or weathered shale. The precise boundaries between the weathered shale and the overburden are extremely difficult to define. The sound bedrock (shaley limestone) was established about 23 feet below the ground or at elevation 511.0.

#### Groundwater

The groundwater level conditions were observed by measuring in the open boreholes during and after the completion of the foundation investigation. The groundwater levels were found to vary between elevations 519.0 (B.H. #5) and 525.3 (B.H. #3) which corresponds to a depth of 6.5 to 12.5 feet below the existing ground surface.

Boreholes No. 6, 7 and 8 were carried out in the swampy area. During the times of investigation (February, 1978) the thickness of ice cover and the underlying water ranged from 2.0 to 2.5 feet and the groundwater level was found to be at elevation about 531.5.

## DISCUSSIONS AND RECOMMENDATIONS

As part of the new Hwy. 403 construction, an underpass structure has been planned at the crossing of the proposed Hwy. 403 and the widened Erin Mills Parkway.

In the vicinity of the proposed structure the existing ground elevation varies from 532 (north side) to 538 (south side). The revised grade of the Erin Mills Parkway will be at elevation 554.0 and the proposed grade of Hwy. 403 will be at elevation 532.5. This will necessitate fills of up to 22 feet and cuts of about 6 feet.

Separate two span structures (122'-122'), one for northbound lanes and the other for southbound lanes, consisting of closed type abutments with a centre pier, are presently being considered at this crossing.

### Pier Foundation

The centre piers of the two structures can be founded on spread footings located at or below elevation 525.0 or below with an allowable pressure up to 4 t.s.f. A minimum earth cover of 4 feet from the base of the footing should be provided for frost protection requirements. Alternatively, the footings can be founded on piles driven to bedrock. The estimated pile tip elevations based on bedrock surface are as follows:

	<u>East End</u>	<u>West End</u>
Structure (N.B.L.)	438.0	449.0
Structure (S.B.L.)	458.0	478.0

For example, a 12BP74 steel 'H' pile driven to bedrock can be designed for 100 tons per pile allowable load. In view of the presence of occasional boulders the piles should be fitted with reinforced tips.

### Abutment Foundation

Since closed type abutments are contemplated, the recommendations for spread footings will be similar to those for pier foundations. However, due to other reasons, if perched abutments are contemplated,

they should be supported on a core of well compacted granular 'A' material above the natural subsoil as per our current practices. An allowable load of  $2\frac{1}{2}$  t.s.f. may be used for design purposes. All the topsoil and fill material including surficial organic deposits in the swamp area should be removed to the full base width of the granular core. Alternately, these perched abutments can also be supported on end-bearing piles driven to bedrock or into the very dense lower granular deposit. For design purposes it can be assumed that the piles will develop the maximum allowable load of the pile section chosen at the following tip elevations.

<u>Structure</u>	<u>Ref. B.H.</u>	<u>East End</u>	<u>West End</u>
J N.B.L. (South Abutment)	#'s 8 & 9	455.0	470
✓ N.B.L. (North Abutment)	#'s 2 & 6	450.0	457.0
✓ S.B.L. (South Abutment)	#'s 5, 5A & 9	470.0	511.0
S.B.L. (North Abutment)	#'s 2 & 3	<u>457.0</u>	<u>490.0</u>

For piles driven into the lower granular stratum, the pile driving during construction should be controlled by means of the Hiley formula to achieve the required design load. For example, an allowable load of up to 100 tons per pile may be used for a 12BP74 steel 'H' pile driven to bedrock or into the dense granular deposit.

If excavations for the foundation are carried out below the observed groundwater level within the granular subsoil, a dewatering scheme will be required to prevent "boiling" of the foundation base.

#### Approaches

No stability problems are anticipated for the proposed approach fills and cuts if:

1. Fills are placed after the removal of the organic topsoil and surficial organic material
2. Fills and cuts are constructed with standard 2:1 slopes

#### Related Considerations

The abutments should be designed to withstand the lateral earth pressure exerted by the backfill and this pressure is dependent on the deformation characteristics of the retaining structures. If some movement of the top of the wall is permitted, then a coefficient

of active earth pressure ( $k_a$ ) of 0.35 can be used. On the other hand, if the structures are designed as rigid frames, then a coefficient of earth pressure at rest ( $k_o$ ) of 0.5 should be used. To compute the sliding resistance between the rough concrete footing base and granular subsoil or granular 'A' material, a coefficient of friction equal to 0.65 may be assumed. However, if the footing is located on the cohesive subsoil an adhesion value of 2000 p.s.f. should be used.

#### MISCELLANEOUS

The fieldwork was carried out between May 24, 1977 to June 2, 1977 and February 21, 1978 to February 28, 1978 under the supervision of Mr. V. Korlu, Project Engineer, who also prepared this report. The drilling equipment was owned and operated by F.E. Johnston Drilling Company Limited of Toronto, and Atcost Soil Drilling of Concord. This report was reviewed by Mr. M. Devata, Supervising Engineer.

*V. Korlu*  
V. Korlu, P. Eng.  
Project Engineer

*M. Devata*  
M. Devata, P. Eng.  
Supervising Engineer



July, 1978

## APPENDIX

## FIELD AND LABORATORY WORK

At this site due to the presence of swampy conditions on the east side of the Erin Mills Parkway, the first six sampled boreholes were carried out from May 24 to June 2, 1977 and the remaining four boreholes were carried out in the swampy section from February 21 to 28, 1978 when the eight to 12 inch thick surface ice over the area made the movement of the drilling equipment possible. Wherever possible, the boreholes were accompanied by a dynamic cone penetration test. The borings were advanced by continuous flight auger machines (5.1 and 5.3 H.S.M.V.) adapted for soil sampling purposes.

Samples of the overburden were obtained in a 2" O.D. split-spoon sampler at required depths. The samples were hammered into the soil according to the specifications of Standard Penetration Tests. Bedrock was proven in boreholes, where possible, by obtaining BXL size rock core samples.

Groundwater level observations were carried out during the time of investigation in the open boreholes. The soil, bedrock and groundwater conditions encountered at the boring locations are presented in the Record of Borehole Sheets. The locations and elevations of the various boreholes were provided by personnel from Construction Office, Central Region. The elevations in this report are referred to a Geodetic datum. Boring locations and elevations are shown on Drawing No. 1577506-A. All samples were subjected to careful visual examinations in the field and subsequently in the laboratory. Following this examination, laboratory tests were carried out on selected representative samples to determine the physical properties of the various soil types encountered, namely:

Natural Moisture Content

Atterberg Limit

Grain Size Distribution

The results of this testing are plotted on the Record of Borehole Sheets and summarized on Figures 1 to 5, all contained in Appendix 1 of this report.

MINISTRY OF TRANSPORTATION AND COMMUNICATIONS-ONTARIO

HIGHWAY ENGINEERING DIVISION - ENGINEERING MATERIALS OFFICE - SOIL MECHANICS SECTION

RECORD OF BOREHOLE NO 1

WP 157-75-06 LOCATION Co-ords N 15,825,402 ; E 947,811 ORIGINATED BY VK  
 DIST 6 HWY 403 BORING DATE May 31, 1977 COMPILED BY VK  
 DATUM Geodetic BOREHOLE TYPE 3 1/2" Hollow Stem auger; Bx casing; BXL Core CHECKED BY \_\_\_\_\_

SOIL PROFILE			SAMPLES			GROUND WATER ELEV	DYNAMIC CONE PENETRATION RESISTANCE PLOT					LIQUID LIMIT $w_L$ PLASTIC LIMIT $w_p$ WATER CONTENT $w$ $w_p$ — $w$ — $w_L$ WATER CONTENT %	UNIT WEIGHT $\gamma$	REMARKS  % GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	'N' VALUES		20	40	60	80	100			
536.7	Ground Level													
0.0	Fill Material (clayey silt with some sand and traces of organics)		1	SS	12	530						o —		0-19-60-21
528.7			2	SS	20									
8.0	Heterogeneous Mixture of clayey silt, sand and gravel (Glacial till) Hard		3	SS	75							o —		
522.2			4	SS	71	520						o		0- 3-94- 3
14.5	Silt to sandy silt with occasional seams of clayey silt.		5	SS	71									
	Clayey Silt		6	SS	80	510						o —		0-32-58-10
	Very Dense		7	SS	165									
500.7						500								
36.0	Silty sand with gravel and occasional boulders		8	SS	136							o		17-50-31-2
	Very Dense					490								
						480								
						470								
						460								
457.7														
79.0	Shaly limestone Bedrock		9	BXL	100% Rec									
452.7														
84.0	End of Borehole													

20  
15 0-5 % STRAIN AT FAILURE  
10



MINISTRY OF TRANSPORTATION AND COMMUNICATIONS-ONTARIO

HIGHWAY ENGINEERING DIVISION - ENGINEERING MATERIALS OFFICE - SOIL MECHANICS SECTION

RECORD OF BOREHOLE NO 2

WP 157-75-06 LOCATION Co-ords N 15,825,468 :E 947,725 ORIGINATED BY VK  
 DIST 6 HWY 403 BORING DATE June 2 1977 COMPILED BY VK  
 DATUM Geodetic BOREHOLE TYPE 3 1/2" Hollow Stem auger; BX casing; BXL core CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER ELEV	DYNAMIC CONE PENETRATION RESISTANCE PLOT					LIQUID LIMIT $w_L$ PLASTIC LIMIT $w_p$ WATER CONTENT $w$ $w_p \quad w \quad w_L$ WATER CONTENT % 10 20 30	UNIT WEIGHT $\gamma$	REMARKS
ELEV DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	N' VALUES		20	40	60	80	100			
534.0	Ground Level													
0.0	Fill Material													
	Clayey silt with some sand and traces of organics		1	SS	14	530								
526.5	Heterogeneous Mixture of clayey silt, sand and gravel (Glacial Till) Hard		2	SS	62									0-13-58-29
7.5			3	SS	85									
522.0			4	SS	54	520								0-0-88-12
12.0	clayey silt to sandy silt with occasional seams of clayey silt		5	SS	69									
	Very Dense		6	SS	65	510								0-0-95-5
504.0			7	SS	109									
30.0	Silty sand with gravel and occasional boulders random clayey silt layers clayey silt		8	SS	160/11"	500								17-35-36-12
	Very Dense					490								
						480								
						470								18-69- (13)
			9	SS	142/11"									
						460								
457.0														
77.0	Shaly limestone Bedrock		10	BXL	100% Rec									
452.0														
82.0	End of Borehole													

OFFICE REPORT ON SOIL EXPLORATION

MINISTRY OF TRANSPORTATION AND COMMUNICATIONS-ONTARIO

HIGHWAY ENGINEERING DIVISION - ENGINEERING MATERIALS OFFICE - SOIL MECHANICS SECTION

RECORD OF BOREHOLE NO 3

WP 157-75-06 LOCATION Co-ords N 15,825,423 ;E 947,678 ORIGINATED BY VK  
 DIST 6 HWY 403 BORING DATE May 26, 1977 COMPILED BY VK  
 DATUM Geodetic BOREHOLE TYPE 3 1/2" Hollow Stem auger; BX casing; DXL core and CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER	DYNAMIC CONE PENETRATION RESISTANCE PLOT		cone test		UNIT WEIGHT $\gamma$	REMARKS
ELEV DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	'N' VALUES		20 40 60 80 100		LIQUID LIMIT $w_L$ PLASTIC LIMIT $w_p$ WATER CONTENT $w$			
531.8	Ground Level					ELEV						
0.0	Heterogeneous Mixture of clayey silt, sand and few gravel. (Glacial fill) Hard		1	SS	36	530						0-10-60-30
526.3			2	SS	59							0-0- 81-19
5.5	Silt to silty sand with occasional gravel and seams of clayey silt Very Dense		3	SS	74							
			4	SS	84	520						
516.8			5	SS	55							10-61-23-6
15.0	Silty sand with gravel and Boulders		6	SS	170	510						
			7	SS	37							
			8	SS	93	500						
	Dense to Very Dense											
	Boulders		BXL	24"	Rec							
			BXL	6"	Rec							
488.3			9	SS	116	490						
43.5	End of Borehole											

OFFICE REPORT ON SOIL EXPLORATION

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HIGHWAY ENGINEERING DIVISION - ENGINEERING MATERIALS OFFICE - SOIL MECHANICS SECTION

RECORD OF BOREHOLE NO 4

WP 157-75-06 LOCATION Co.ords N 15,825,362 :E 947,771 ORIGINATED BY VK  
 DIST 6 HWY 403 BORING DATE May 24, 1977 COMPILED BY VK  
 DATUM Geodetic BOREHOLE TYPE 3 1/2" Hollow Stem auger; BX casing: BXL core and cone test CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER ELEV	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT $\gamma$	REMARKS
ELEV DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	'N' VALUES		20	40	60	80	100		
532.5	Ground Level												
0.0	Heterogeneous Mixture of clayey silt sand and few gravel (Glacial fill) Hard		1	SS	79	530							0-12-61-27
527.0			2	SS	104								
5.5	Silt to silty sand with occasional gravel and boulders		3	SS	110								0-0- 89-11
			4	SS	85	520							
			5	SS	46								
			6	SS	141	7"							
	20" boulders			BXL	20"	510							
	clayey silt		7	SS	130								0-50- 41-9
	random clayey silt layers		8	SS	100	6"							
	Dense to Very Dense					500							
494.5			9	SS	159								
38.0	Silty sand and gravel and boulders Very Dense		10	SS	100	490							50-35-13-2
477.5						480							
55.0	Shaly limestone Bedrock		11	BXL	Rec								
			12	BXL	Rec								
470.5			13	BXL	Rec								
62.0	End of Borehole												

OFFICE REPORT ON SOIL EXPLORATION



RECORD OF BOREHOLE No 5 (W.O. 76-11005)

W P 157-75-06 LOCATION Co-ords N 15,825,316; E 947,875 ORIGINATED BY VK  
DIST 6 HWY 403 BOREHOLE TYPE H.S. 3 1/2" Ø Auger - CME 55 and Cone Test COMPILED BY VK  
DATUM Geodetic DATE July 2, 1976 CHECKED BY BS

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
538.0	Ground Level																
0.0	Fill Material (mix. of clayey silt with sand, trace of gravel & organics)		1	SS	8											Org. 1.70%	5 19 52 24
531.5			2	SS	60												
6.5	Silty Sand with Occasional Gravel		3	SS	70		530										0 88 (12)
	Very Dense		4	SS	41												
	occasional layers of clayey silt below elev. 520		5	SS	123		520										2 65 (33)
			6	SS	136												4 65 25 6
513.3	Shale Fragments		7	SS	150/4"												
24.7	End of Borehole																

OFFICE REPORT ON SOIL EXPLORATION



# RECORD OF BOREHOLE No 5A

W P 157-75-06 LOCATION Coords. N 15,825,302; E 947,864 ORIGINATED BY V.K.  
DIST 6 HWY 403 BOREHOLE TYPE 3 1/2" H.S. Auger COMPILED BY V.K.  
DATUM Geodetic DATE February 28, 1978 CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100									
								SHEAR STRENGTH									
534.0	Ground Level																
0.0	Clayey Silt With Trace of Sand		1	SS	23												
528.0	(Glacial Till) Boulders Very Stiff		2	SS	103												0 4 80 16
6.0	Reddish Clayey Silt With Fragments of Weathered Shale or Weathered Shale (Transition Zone)		3	SS	165												
			4	SS	147												
			5	SS	100	6"											0 14 56 30
			6	SS	100	5"											
	Hard																
510.7																	
23.3	Bedrock - Sound		7	EXL	100% Rec.												
505.6	Shaley Limestone																
28.4	End of Borehole																



# RECORD OF BOREHOLE No 6

W P 157-75-06 LOCATION Coords. N 15,825,523; E 947,780 ORIGINATED BY V.K.  
DIST 6 HWY 403 BOREHOLE TYPE 3 1/2" H.S. Auger COMPILED BY V.K.  
DATUM Geodetic DATE February 23, 1978 CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100	20 40 60 80 100					
531.6	Ice Surface													
0.0	Water						530							Organic 3.27%
529.3														
526.3	Organic Clay		1	SS	4									0 7 63 30
5.0														
	Heterogeneous Mixture of Clayey Silt With Some Sand and Trace of Gravel (Glacial Till) Brown Grey		2	SS	16									3 18 51 28
			3	SS	38		520							
			4	SS	49									0 1 83 16
			5	SS	104									
	Very Stiff to Hard		6	SS	49		510							
508.6														
25.0	Silt With Trace of Clay		7	SS	22									0 0 96 4
			8	SS	30		500							
			9	SS	30									
493.6	Compact to Dense													
38.0	Silty Sand With Gravel and Occasional Seams of Clayey Silt		10	SS	37		490							15 40 40 5
			11	SS	147		480							49 30 14 7
	Dense to Very Dense						470							
			12	SS	95		460							
450.7														
80.9	Bedrock						450							
447.4	Shale/Limestone		13	BXL	90Z Rec.									
84.2	End of Borehole													

+3, x5: Numbers refer to  
Sensitivity

20  
15 ÷ 5 (%) STRAIN AT FAILURE  
10



# RECORD OF BOREHOLE No 7

W P 157-75-06 LOCATION Coords. N 15,825,463; E 947,873 ORIGINATED BY V.K.  
 DIST 6 HWY 403 BOREHOLE TYPE 3 1/2" H.S. Auger COMPILED BY V.K.  
 DATUM Geodetic DATE February 21, 1978 CHECKED BY R.S.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
531.4	Ice Level																
529.4	Water																
2.0	Clayey Silt and Organics		1	SS	4		530										Organics 0.36%
526.4			2	SS	34												0 6 74 20
5.0	Heterogeneous Mixture of Clayey Silt With Some Sand & Trace of Gravel (Glacial Till)		3	SS	42												1 7 57 35
518.9	Hard Brown Grey		4	SS	35		520										8 16 49 27
12.5			5	SS	50												0 0 87 13
			6	SS	35												
	Silt With Layers of Clayey Silt		7	SS	30		510										0 2 81 17
	Compact to Dense		8	SS	29		500										
			9	SS	28												0 1 68 31
			10	SS	28		490										
487.4																	
44.0	Silty Sand With Trace of Gravel		11	SS	41		480										1 71 23 5
	Occasional Seams of Clayey Silt		12	SS	35		470										0 27 49 24
							460										
							450										
	Boulders		13	BXL	8" Rec.		440										
							430										
434.0	Dense																
97.4	Bedrock Weathered Shaley Sound Limestone		14	BXL	100% Rec.												
427.9																	
103.5	End of Borehole																

OFFICE REPORT ON SOIL EXPLORATION





# RECORD OF BOREHOLE No 8

W P 157-75-06 LOCATION Coords. N 15,825,402; E 947,965 ORIGINATED BY V.K.  
DIST 6 HWY 403 BOREHOLE TYPE 3 1/2" H.S. Auger COMPILED BY V.K.  
DATUM Geodetic DATE February 27, 1978 CHECKED BY AC

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100										WATER CONTENT (%)		
								SHEAR STRENGTH										10 20 30		
531.6	Ice Level																			
0.0	Water						530										Organic 2.74%			
529.1	Organic Clay		1	SS	7												0 7 46 47			
4.0	Heterogeneous Mixture of Clayey Silt With Some Sand & Trace of Gravel (Glacial Till)		2	SS	19												4 23 48 25			
519.6	Very Stiff to Hard		3	SS	59		520										0 1 90 9			
12.0	Brown Grey		4	SS	33												0 0 80 20			
	Silt With Layers of Clayey Silt		5	SS	30															
			6	SS	22		510													
			7	SS	30															
	Compact to Very Dense		8	SS	64		500										14 44 34 8			
			9	SS	47															
			10	SS	55		490													
485.6																				
46.0	Silty Sand With Some Gravel		11	SS	18		480										14 73 ( 13 )			
	Compact to Very Dense						470													
			12	SS	119		460													
455.6																				
76.0	Weathered Sound																			
449.1	Bedrock Shaley Limestone		13	BXL	100% Rec.		450													
82.5	End of Borehole																			

+3, x5: Numbers refer to  
Sensitivity

20  
15-5 (%) STRAIN AT FAILURE  
10

MINISTRY OF TRANSPORTATION AND COMMUNICATIONS-ONTARIO

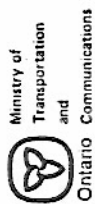
HIGHWAY ENGINEERING DIVISION - ENGINEERING MATERIALS OFFICE - SOIL MECHANICS SECTION

RECORD OF BOREHOLE NO 9

WP 157-65-06 LOCATION Co-ords N 15,825,341 ; E 947,902 ORIGINATED BY VK  
 DIST 6 HWY 403 BORING DATE May 27, 1977 COMPILED BY VK  
 DATUM Geodetic BOREHOLE TYPE 3 1/2" Follow Stem auger; BX casing; BXL core CHECKED BY RS

SOIL PROFILE			SAMPLES			GROUND WATER ELEV	DYNAMIC CONE PENETRATION RESISTANCE PLOT					LIQUID LIMIT — $w_L$ PLASTIC LIMIT — $w_p$ WATER CONTENT — $w$			UNIT WEIGHT $\gamma$	REMARKS
ELEV DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	'N' VALUES		20	40	60	80	100	$w_p$	$w$	$w_L$		
538.0	Ground Level															
0.0	Fill Material clayey silt with some sand and traces of gravel and organics		1	SS	21											
530.0			2	SS	45	530										
8.0	Heterogeneous Mixture of clayey silt, sand and gravel (glacial till)		3	SS	112	8"										0-12-54-34
523.0	Hard		4	SS	135											
15.0	Silty sand with gravel and occasional Boulders random clayey silt layers		5	SS	90	520										
	Very Dense		6	SS	68	510										0-91- (9)
						500										
						490										
	Boulder or Bedrock		7	BVL	4"											
481.5	End of Borehole															
56.5	(The core barrel and the BX Casing jammed, could not continue drilling)															

OFFICE REPORT ON SOIL EXPLORATION



HOLE NO. \_\_\_\_\_ SHEET NO. 1 of 3

PROPERTY	W. P. 157-75-08
LOCATION	403 Hwy. and Erin Mills pkwy.
LATITUDE	
DEPARTURE	
BEARING	

90°

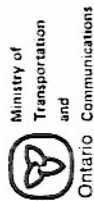
TOTAL FOOTAGE

DATE STARTED  
DATE COMPLETED  
DRILLED BY  
LOGGED BY

FOOTAGE		FORMATION	SAMPLE NUMBER	SHALE %	REMARKS
FROM	TO				
		HOLE #1			
79'10"	79'10"	Limestone, grey colour, med. texture, hard, fossiliferous		2%	
					Core broken, sections weathered
79'10"	80'8"	Shaly limestone, grey colour, fine texture, soft		50%	
80'8"	81'0"	Limestone, grey colour, med. texture, hard, fossiliferous		1%	
81'0"	83'10"	Shaly limestone, grey colour, fine texture, soft & fossiliferous		60%	
83'10"	84'10"	Limestone, grey colour, med. texture, hard, fossiliferous		2%	
		HOLE #2			
77'10"	77'16"	Limestone, grey colour, med. texture, hard		1%	
77'16"	79'10"	Shaly limestone, grey colour, fine texture, soft fossiliferous, partly fissile		60%	

STATE OF EXAMINATION 07 08 77

B.K. Glassford



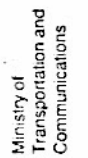
HOLE NO. \_\_\_\_\_ SHEET NO. 2 of 3

PROPERTY LOCATION	W.P. 157-75-06 403 Hwy. and Erin Mills Pkwy.	ELEV. COLLAR	900
LATITUDE		DATUM	
DEPARTURE		DATE STARTED	
BEARING		DATE COMPLETED	
		DRILLED BY	
		LOGGED BY	
		TOTAL FOOTAGE	

FOOTAGE		FORMATION	SAMPLE NUMBER	SHALE %	REMARKS
FROM	TO				
		HOLE # 2 cont'd			
79'0"	79'8"	Limestone, gray colour, med. texture, hard		1%	
79'8"	80'2"	Shaly limestone, grey colour, fine texture, soft fossiliferous, partly fissile		60%	
80'2"	81'6"	Limestone, gray colour, med. texture, hard and fossiliferous		1%	
81'6"	82'0"	Shaly limestone, grey colour, fine texture, soft fossiliferous, partly fissile		60%	
		HOLE #3			
34'0"	37'6"	Limestone, grey colour, fine texture, hard, top 12" weathered		2%	Possible boulders and loose rock
37'6"	38'5"	Shale, red colour, fine texture, soft, broken core		100%	Possible boulders and loose rock
		2 feet missing core			

DATE OF EXAMINATION 07 08 77

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210

HOLE NO. \_\_\_\_\_ SHEET NO. 3 of 3

TOTAL FOOTAGE	
---------------	--

ELEV. COLLAR  
DATUM  
DATE STARTED  
DATE COMPLETED  
DRILLED BY  
LOGGED BY

[illegible]

DATE OF EXAMINATION 07 08 77

B.K. Glassford

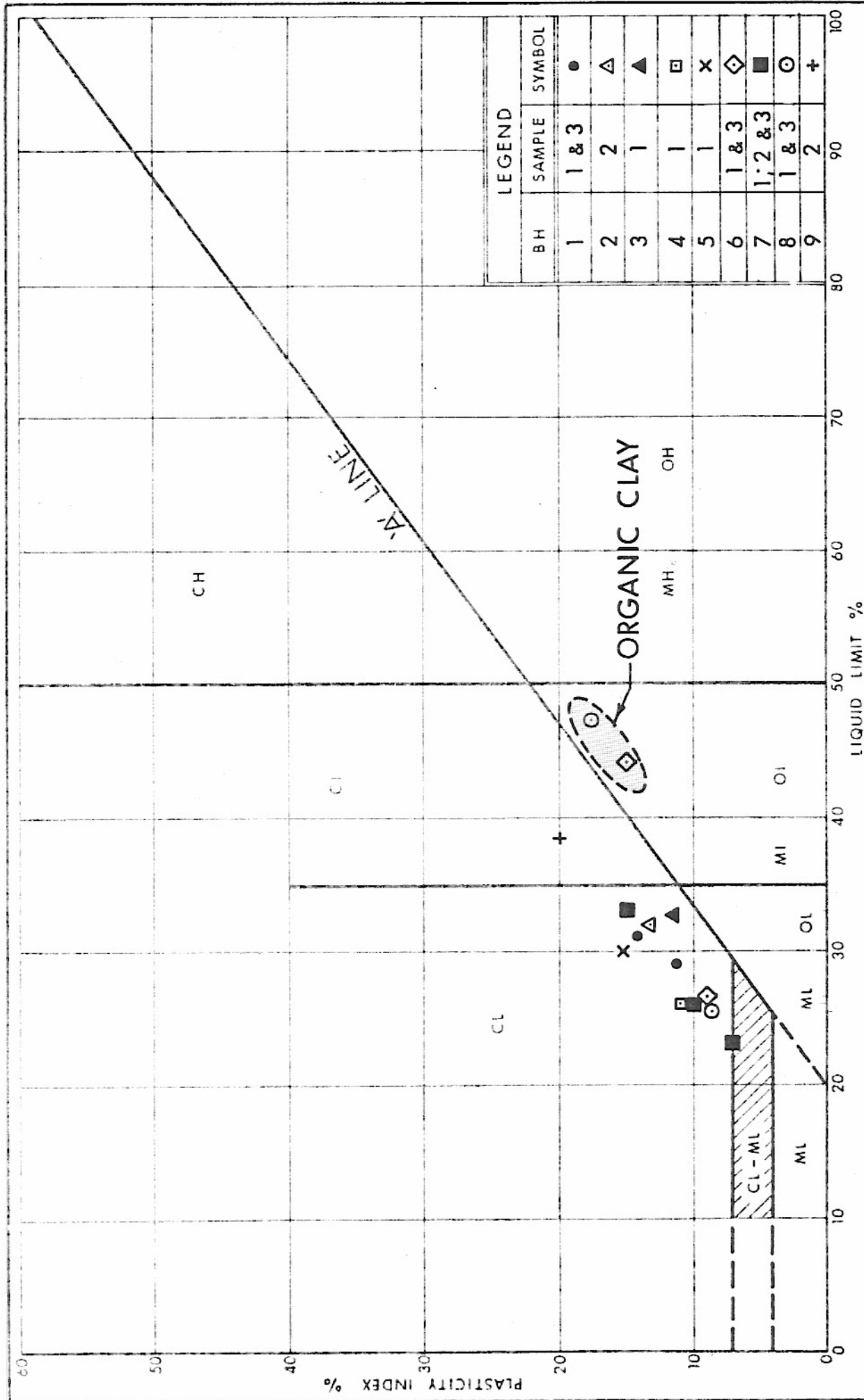


FIG No 1

# PLASTICITY CHART GLACIAL TILL

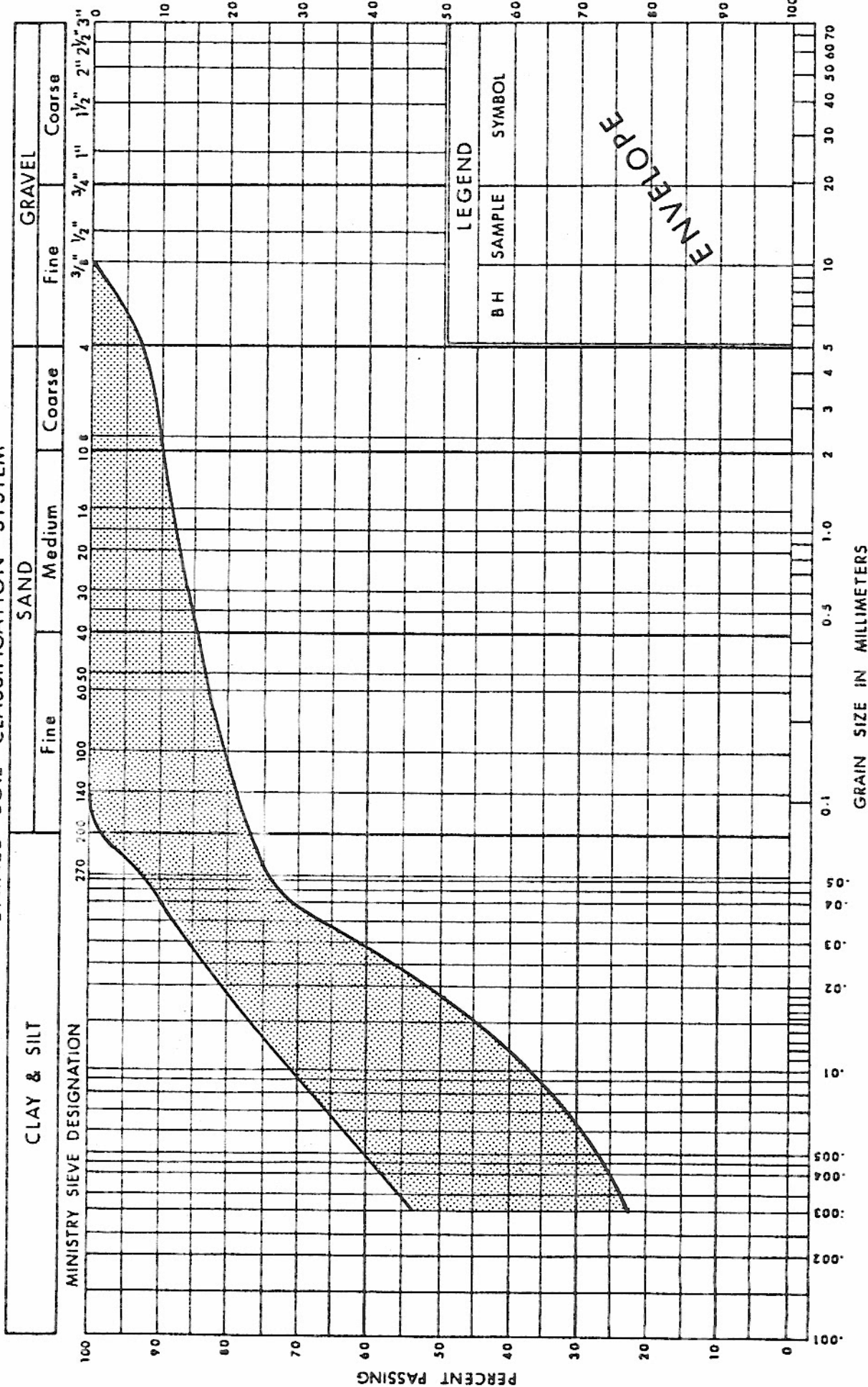
HET MIX OF CLAYEY SILT, SAND & GRAVEL

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W P 157 - 75 - 06



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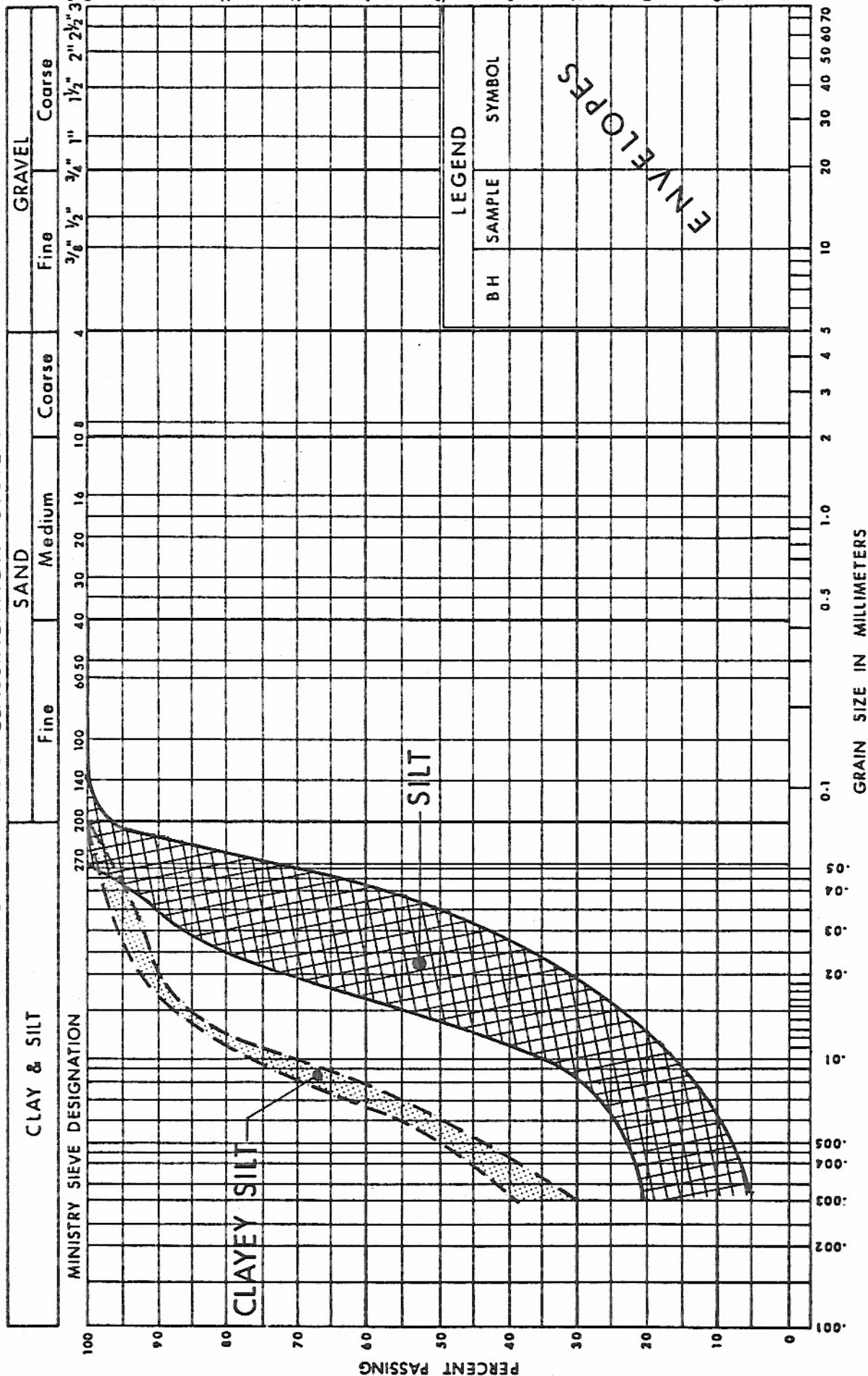
GRAIN SIZE DISTRIBUTION  
GLACIAL TILL  
HET MIX OF CLAYEY SILT WITH SOME SAND & TRACE OF GRAVEL

FIG No 2

WP 157 - 75 - 06



# UNIFIED SOIL CLASSIFICATION SYSTEM



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**GRAIN SIZE DISTRIBUTION**  
**SILT TO SILTY SAND**  
**WITH OCC SEAMS OF CLAYEY SILT**

FIG No 3

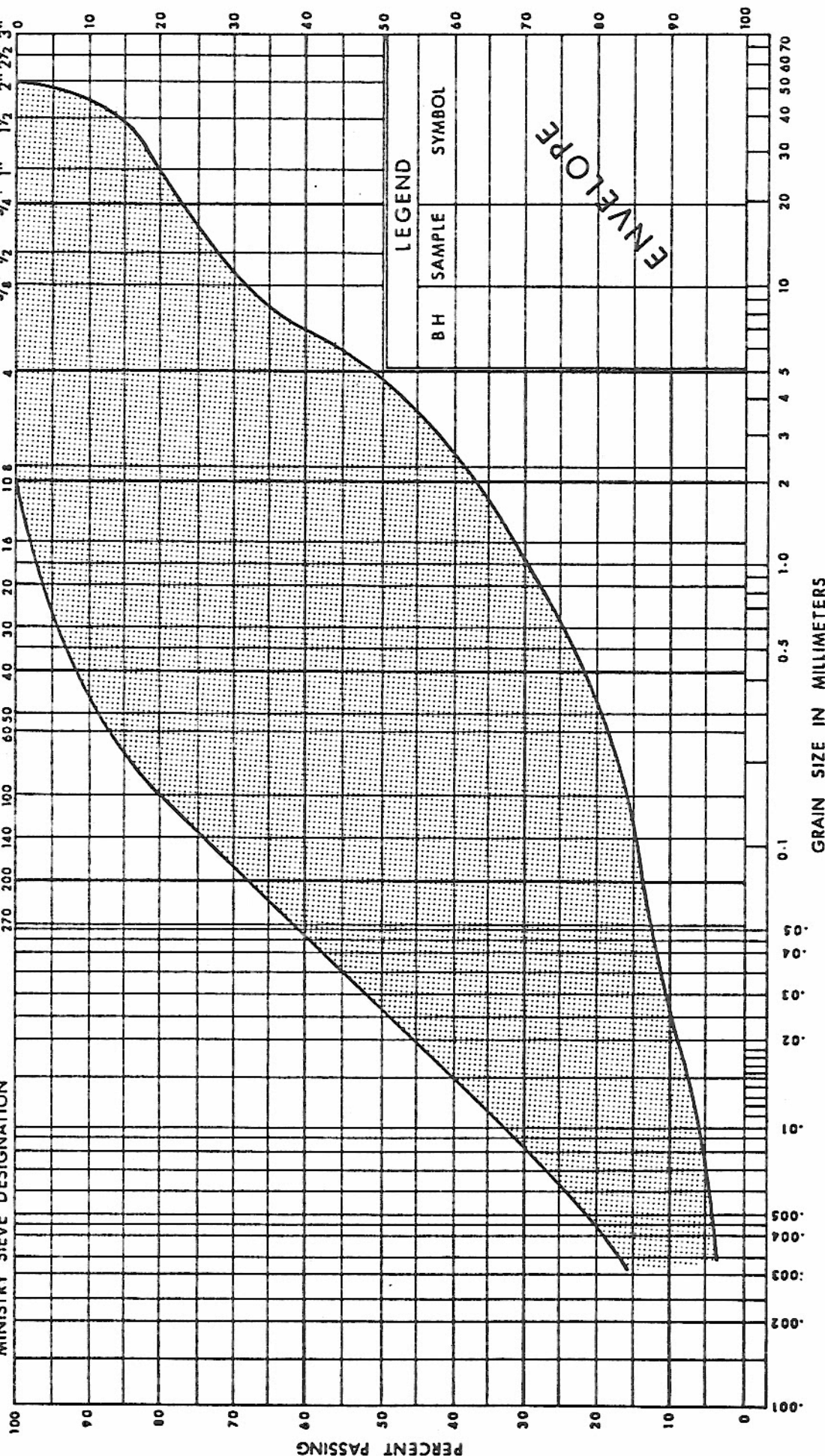
W P 157 - 75 - 06

# UNIFIED SOIL CLASSIFICATION SYSTEM

CLAY & SILT	SAND			GRAVEL		
	Fine	Medium	Coarse	Fine	Coarse	

MINISTRY SIEVE DESIGNATION

270 200 140 100 60 50 40 30 20 16 10.8 4 3/8" 1/2" 3/4" 1" 1 1/2" 2" 2 1/2" 3"



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## GRAIN SIZE DISTRIBUTION

SILTY SAND

WITH OCC GRAVEL & SEAMS OF CLAYEY SILT

FIG No 4

W P 157-75-06

# 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  $N_c$ .

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	MED. 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.  $CUU$  = CONSOLIDATED ISOTROPIC UNDRAINED TRIAXIAL WITH PORE PRESSURE MEASUREMENT UNLESS OTHERWISE SPECIFIED IN REPORT ALL TESTS ARE IN COMPRESSION

### FIELD SAMPLING

SS SPLIT SPOON  
WS WASH SAMPLE  
ST SLOTTED TUBE SAMPLE  
BS BLOCK SAMPLE  
CS CHUNK SAMPLE  
TW THINWALL OPEN  
TP THINWALL PISTON  
OS OSTERBERG SAMPLE  
FS FOIL SAMPLE  
RC ROCK CORE  
PH T.W. ADVANCED HYDRAULICALLY  
PM T.W. ADVANCED MANUALLY

### EARTH PRESSURE TERMS

$\mu$  COEFFICIENT OF FRICTION  
 $\delta$  ANGLE OF WALL FRICTION  
 $k_o$  COEFFICIENT OF EARTH PRESSURE AT REST  
 $k_A$  COEFFICIENT OF ACTIVE EARTH PRESSURE  
 $k_P$  COEFFICIENT OF PASSIVE EARTH PRESSURE  
 $i$  ANGLE OF INCLINATION OF SURCHARGE  
 $w$  SLOPE ANGLE-BACKFACE OF WALL  
 $\beta$  ANGLE OF SLOPE  
 $N_{\gamma}, N_q, N_c$  BEARING CAPACITY FACTORS  
 $D_f$  DEPTH OF FOOTING  
 $B, L$  FOOTING DIMENSIONS

### INDEX PROPERTIES

$\gamma$  UNIT WEIGHT OF SOIL (BULK DENSITY)  
 $\gamma_w$  UNIT WEIGHT OF WATER  
 $\gamma_d$  UNIT DRY WEIGHT OF SOIL (DRY DENSITY)  
 $\gamma'$  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 =  $\frac{I_P \text{ of soil}}{I_P \text{ of } 2\mu m \text{ Soil Fraction}}$   
 $Om$  ORGANIC MATTER CONTENT  
 $S_r$  DEGREE OF SATURATION

### STRENGTH PARAMETERS

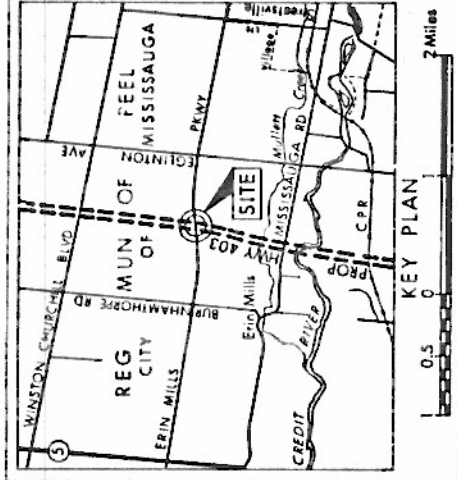
$\phi$  ANGLE OF SHEARING RESISTANCE  
 $\tau_f$  PEAK SHEAR STRENGTH  
 $\tau_R$  RESIDUAL SHEAR STRENGTH  
 $c$  COHESION INTERCEPT  
 $\sigma_1, \sigma_2, \sigma_3$  NORMAL PRINCIPAL STRESSES  
 $u$  PORE WATER PRESSURE  
 $u_e$  EXCESS  $u$   
 $r_u$  PORE PRESSURE RATIO  
 $q_u$  UNCONFINED COMPRESSIVE STRENGTH  
 $s_u$  UNDRAINED SHEAR STRENGTH  
 $\epsilon$  LINEAR STRAIN  
 $\gamma$  SHEAR STRAIN  
 $\nu$  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:  
 $\phi'$  = EFFECTIVE ANGLE OF SHEARING RESISTANCE;  
 $\sigma'$  = 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  
 $\eta$  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  
 $O_c$  OVERCONSOLIDATION RATIO (OCR)





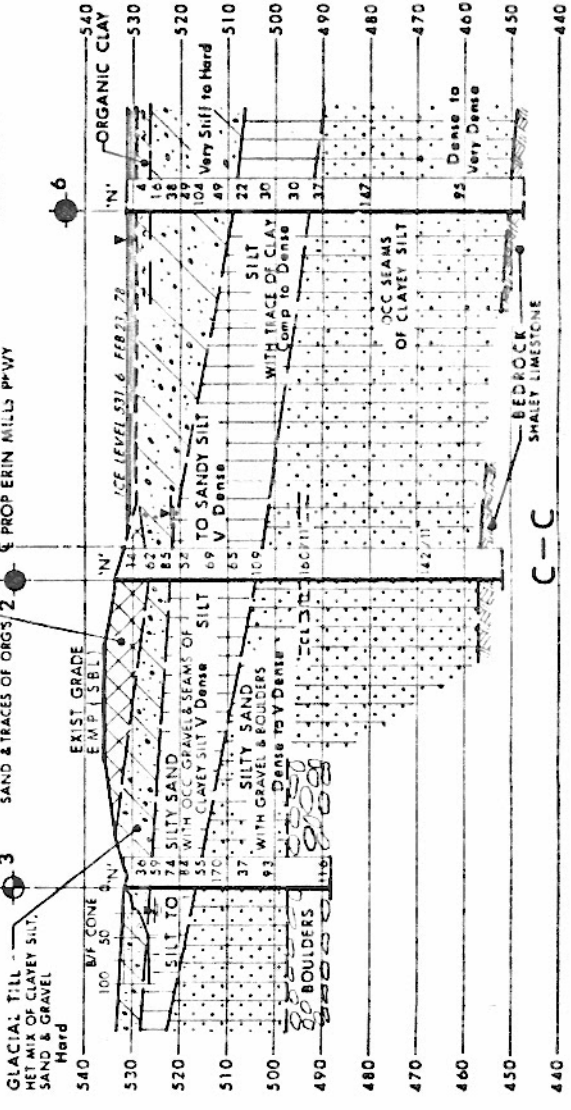
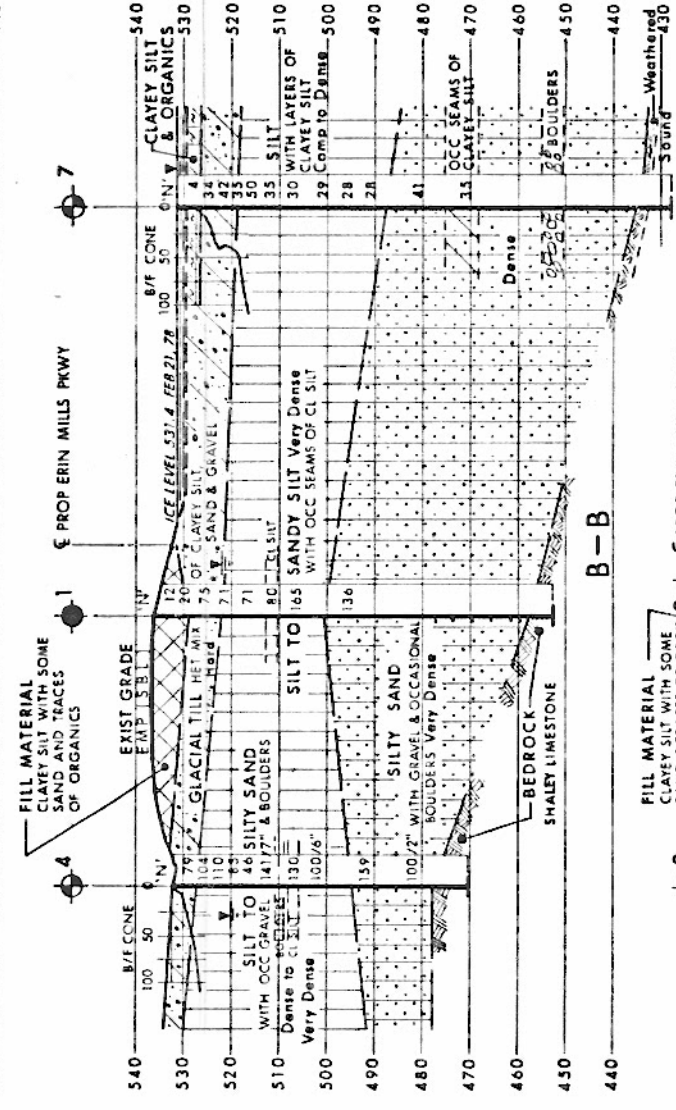
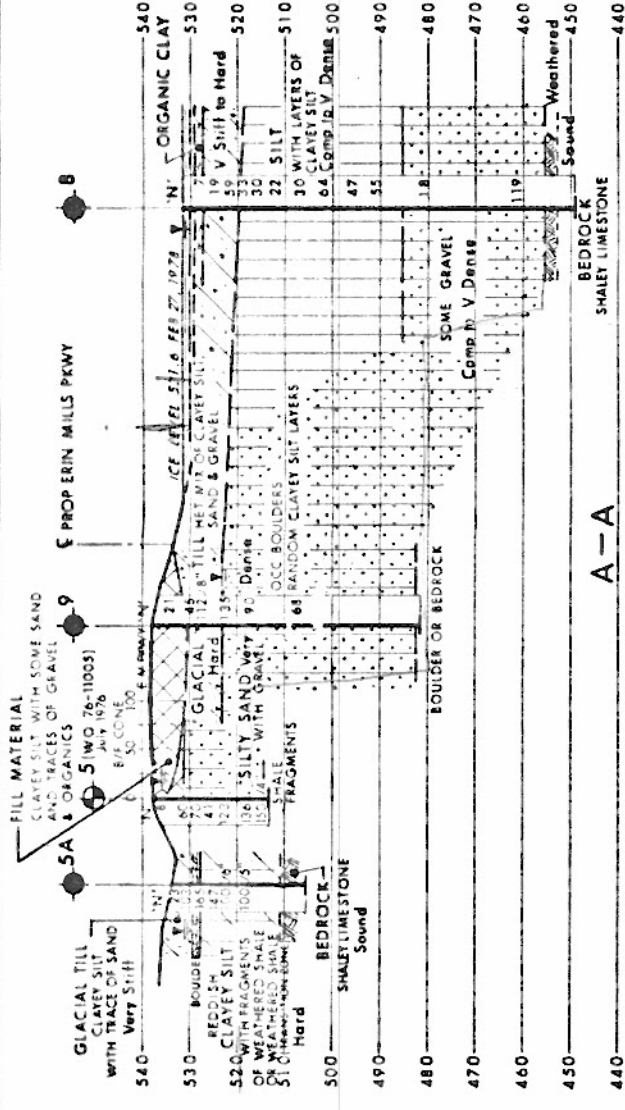
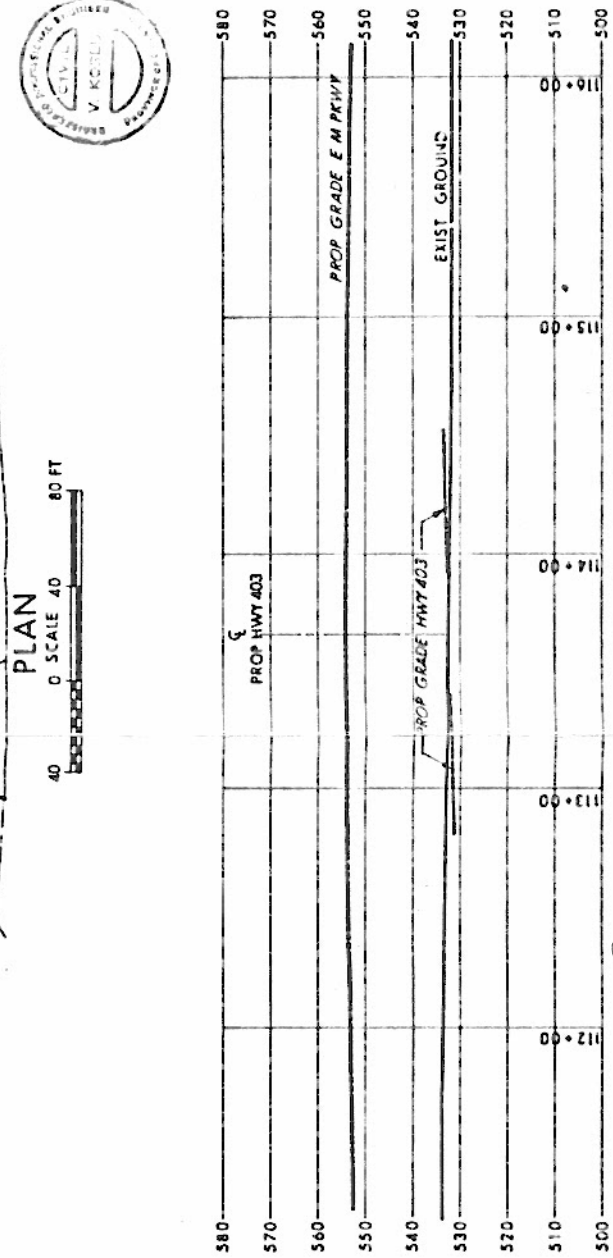
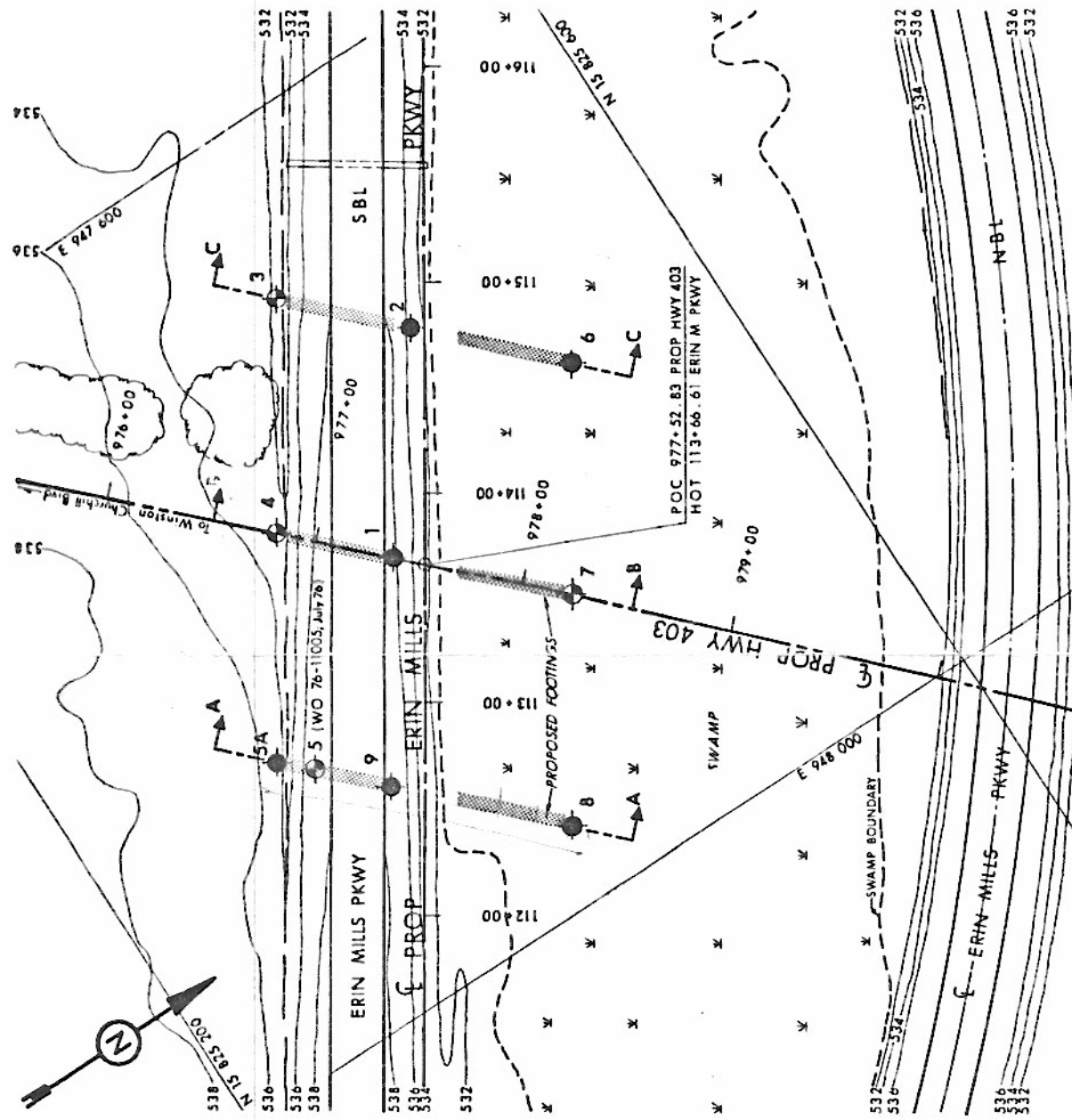
LEGEND			
	Bore Hole		
	Dynamic Cone Penetration Test (Cone)		
	Bore Hole & Cone		
'N'	Blow/ft (Std Pen Test 350 ft lbs energy)		
CONE	Blow/ft (60° Cone, 350 ft lbs energy)		
	WL at time of investigation May & June 1977 ; Bore Hole 5 July 1979 ; Bore Holes 5A, 6, 7 & 8, Feb 1978		
No	ELEVATION	CO-ORDINATES	
		NORTH	EAST
1	536.7	15 825 402	947 811
2	534.0	15 825 468	947 725
3	531.8	15 825 423	947 578
4	532.5	15 825 362	947 771
5	538.0	15 825 316	947 875 (N)
5A	534.0	15 825 302	947 864
6	531.6	15 825 523	947 780
7	531.4	15 825 463	947 873
8	531.6	15 825 402	947 965
9	538.0	15 825 341	947 902

**-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

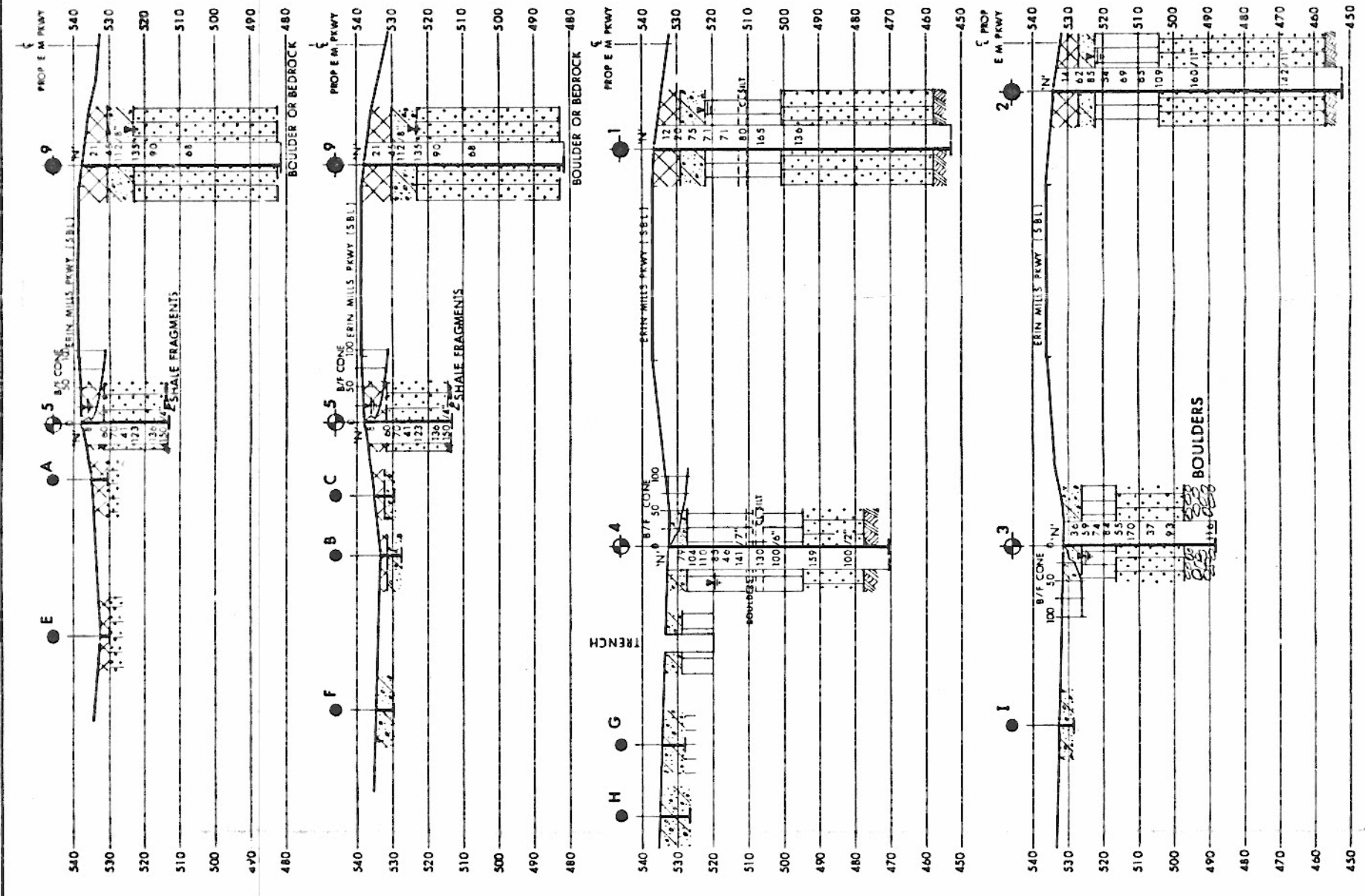
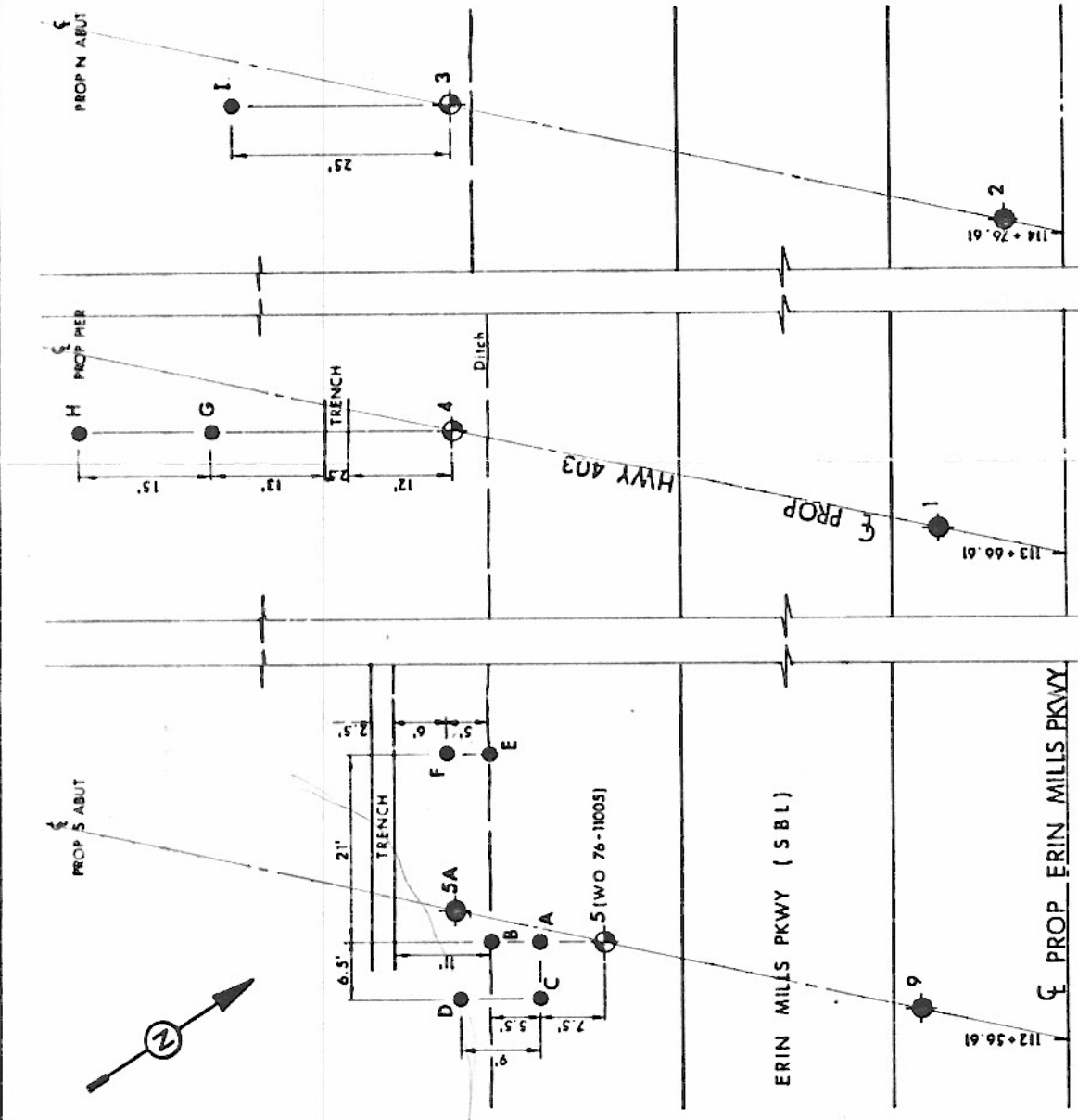
NO.	DATE	BY	SECTION A-A REVISED
1	13 Jan 80	5	Blank Notes SA, 6, 7 & 8 ADDED TO PLAN & SECTION
2	14 Jan 80	5	SECTION A-A

MAY 11, 1977  
 PROPOSED 403  
 GEORES No 30M12-123  
 DIST 6  
 S-BAY V.K. CHECKED 24-JUL-1977 SITE 24-385  
 GRAHAM, R.S. CHICAGO 444-9440 DWG 1577506-A



SECTIONS

**REF. COLE, SHERMAN ASSOCIATES LTD**



SECTIONS THROUGH BOREHOLES & AUGERHOLES



LEGEND

Bore Hole

Dynamic Cone Penetration Test (Cone)

Bore Hole & Cone

Blows/ft (Std Pen Test: 350 ft lbs energy)

CONE Blows/ft (60° Cone, 350 ft lbs energy)

WL at time of investigation May & June 1977, B H 5 July 1976

Auger Hole

No

ELEVATION

BORE HOLES & AUGER HOLES  
LOCATION AS SHOWN

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