

G.I.-30 SEPT. 1976

GEOCRES No. 30M 4-59DIST. 4 REGION W.P. No. 55-75-07CONT. No. W. O. No. STR. SITE No. 9-131HWY. No. 6NLOCATION CNR SUBWAY ON DUNNVILLESUBDIVISION <sup>MILES</sup> 0.5 km NORTH OF GRAND RIVERNo of PAGES -OVERSIZE DRAWINGS TO BE INCLUDED WITH THIS REPORT.REMARKS:

FOUNDATION  
INVESTIGATION & DESIGN  
REPORT

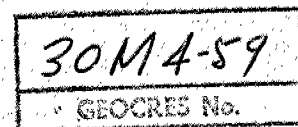
SOIL MECHANICS SECTION

ENGINEERING SERVICES BRANCH  
GEOTECHNICAL OFFICE



Ontario

Ministry of  
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Communications



FOUNDATION INVESTIGATION & DESIGN REPORT

W.P. 55-75-07

DIST. 4

HWY. 6N

STR. SITE 9-131

CNR Subway on Dunnville Subdivision  
0.5 Miles North of Grand River

DISTRIBUTION

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## INTRODUCTION

A Foundation Investigation was carried out at the intersection of the future Highway 6N and realigned C.N.R. tracks to determine the subsurface conditions. This report contains the results of this investigation and the interpreted soil data. The recommendations for the design and construction of the proposed subway foundations and approaches are also included in this report.

The investigation was requested by Mr. G. C. E. Burkhardt, Structural Planning Engineer, for Central Region, in a memorandum dated October 12, 1976.

## SITE DESCRIPTION

The site is located in the vicinity of the town of Caledonia. The terrain adjacent to the proposed structure site is flat to gently rolling. The land is being used for grazing purposes. Underground mining (Gypsum) operations are being carried out by Domtar Limited, just north of the site.

Physiographically, the area lies in the Region referred to as the Haldimand Clay Plain. This region in most part is covered by a somewhat irregular intermixture of stratified clay and till. 'Near Caledonia an odd variation is provided by a scattered group of drumlins partially buried in moderately dissected clay beds.'

## FIELD INVESTIGATION

A total of 5 sampled boreholes and 9 dynamic cone penetration tests was carried out during the course of the field work. The borings were advanced by means of Muskeg vehicle mounted flight auger machines using hollow stem augers. During the field work, disturbed samples were obtained by means of a standard split-spoon sampler; the energy used in driving it, conformed to the requirements of the Standard Penetration Test.

'Undisturbed' samples were recovered using 2-inch I.D. Shelby tubes which were pushed into the soil by hand.

Dynamic cone penetration tests were carried out adjacent to 5 boreholes and also at 4 other locations. Driving energy to advance the cone was 350 ft/lbs per blow.

The bedrock was proved at three borehole locations using BXL rock coring equipment.

The groundwater level was determined by recording the water level in the open boreholes during the course of the field investigation.

In addition, Geonor type Piezometers were also installed and were read periodically after the completion of the field work.

The locations and elevations of the borings were surveyed in the field by personnel from the Central Region, Engineering Plans Office.

### SUBSOIL

#### General

The subsoil at the site was found to vary a great deal in the horizontal and vertical directions.

The boundaries of the different deposits are shown on the record of borehole sheets attached to the appendix. The estimated stratigraphical profile shown on drawing 557507-A is based upon this information.

From groundlevel downwards, the various deposits are as follows:

#### Clayey Silt to Silt

This deposit was encountered only at the most westerly part of the site investigated, to an approximate depth of 7 feet. The material may be classified as clayey silt to silt, trace of sand. The consistency was found to be very stiff.

#### Clayey Silt to Silty Clay

This stratum was intersected at all boring locations immediately at ground surface or below the clayey silt to silt zone. The thickness was found to vary from 7 to 46 feet. The deepest portion being confined to the eastern half of the future structure site. Reference should be made to the record

of borehole sheets for the lower boundary elevations.

The material in the deposit consists mainly of stratified clayey silt and silty clay, traces of sand and occasional gravel. Numerous, irregular silt laminations up to  $\frac{1}{2}$  inch thick were also encountered within the deposit. The consistency or undrained shear strength of the overall deposit was found to vary randomly from stiff to hard.

Physical properties of the deposit as determined from laboratory tests are as follows:

Plastic Limit	(%)	10 - 25
Liquid Limit	(%)	16 - 54
Natural Moisture Content	(%)	10 - 35
Bulk Density	(PCF)	116 - 129
Undrained Shear Strength (PSF)		
Unconfined Compression:		1475 - 2580
Quick Triaxial:		1580 - 3845

Grain-size distribution curves are plotted on figure 1 in the appendix.

#### Heterogeneous Mixture of Gravel, Sand, Silt & Clay (Glacial Till)

Immediately beneath the clayey silt to silty clay is a glacial till stratum composed of a heterogeneous mixture of gravel, sand, silt and clay. The thickness of the deposit ranges from 2 feet (BH#7) to 37 feet (BH#1). The matrix of this till is basically granular in nature. There are random localized zones within this material; where the matrix is cohesive i.e., clayey silt binding coarser sized particles. In addition, there are occasional layers of sand up to 3" throughout. Grain-size distribution tests carried out on samples from the stratum, are plotted on figure 2.

Standard Penetration Tests carried out within the deposit, gave 'N' values ranging from 25 blows per foot to 120 blows per 6 inches. Based on these results, it is estimated that the relative density of the stratum varies from compact to very dense.

#### Dolomite Bedrock

Bedrock was proved at 3 locations by obtaining BXL rock core samples. The bedrock consists of fine textured hard dolomite with frequent gypsum modules.

### Groundwater Conditions

Groundwater level observations, carried out during the field work in the open boreholes, give the following levels:

- BH. #1; Elev: Borehole dry. (no water return during coring operations)
- BH. #4; Elev: Borehole dry.
- BH. #7; Elev: 644
- BH. #10 Elev: 655
- BH. #11 Elev: Borehole dry.

Piezometers were installed during the field work and readings were taken periodically. These readings indicate that near stabilized conditions were reached about 15 days after installation. Only minor fluctuations (approx. 1.5'±) were observed since that time. Based on the latest readings (about 80 days after installation) the piezometric water level is located somewhere between elevation 659 and elevation 661.

### DISCUSSION AND RECOMMENDATIONS

#### Design Proposals

Grade separation by constructing a subway type structure is proposed at the intersection of the future Highway 6N and the planned C.N.R. relocation. The present proposals calls for a four-span (50'-76'-76'-50') structure.

As indicated on plan E-5434-1 the proposed grade of the rail tops will be at elevation 682± while the grades of south and north bound lanes will be at elevation 660±. The side and median ditches are proposed to be approx. 5 feet lower than the Highway 6N profile grade. The original groundlevel within the plan limits of the structure ranges from elevation 680± to elevation 686±.

#### Structure Foundations

Spread footings in original ground: All footings (abutments and piers) can be founded on spread footing type foundations. However, marked differences in subsoil conditions were encountered at the west and east portion of the proposed structure site. At the proposed grades, the west abutment, west and center piers will be located within the very dense glacial till stratum. The eastern portion will however, be located within the stiff to hard clayey silt to silty clay deposit. Due to these facts, the recommendations pertaining to spread footing type foundation design are discussed separately.

Western portion (including centre pier) The footings of the west abutment, west and center piers can be placed within the competent glacial till stratum, (below elevation 670) using an allowable bearing value up to 4.0 TSF. Settlement of the foundation subsoil, due to the surcharge loading of the footings, will be elastic in nature but negligible in magnitude. A value of 0.45 (coefficient of friction) is recommended to compute resistance against sliding of footing bases.

Eastern portion The east abutment and east pier may be founded within the cohesive (clayey silt to silty clay) deposit using the following allowable bearing values:

Abutment: 2.0 TSF  
Pier : 2.5 TSF

It is estimated that settlements of about 1 inch and 2 inches will take place at the pier and abutment location respectively due to the superimposed loads. Further settlement of the abutment is likely, due to groundwater drainage which will occur in the stratified soil below the footing over a long term period once the cut for the roadway is constructed. A lowering of the groundwater of up to about 5 to 6 feet is possible. The magnitude of settlements due to this, is difficult to predict but could be in the order of 2 to 3 inches. Thus a maximum differential settlement between the east pier and east abutment of about 4 inches is possible. A frictional resistance to sliding for the east pier and east abutment footings of 2000 PSF is recommended for design purposes in this case.

#### Piled Foundations

As an alternative, the east pier and east abutment may be founded on end-bearing steel 'H' piles driven to bedrock. It is estimated that the pile tip elevations will vary between elevation 631± and 633±. The maximum allowable load for the particular steel section may be assumed (e.g. 12 BP 74 steel 'H' piles may be designed for 95 tons/pile).

#### Approaches

Up to 30' deep cuts will be required for the future Highway 6N. No stability problems are anticipated for the proposed roadway cut, provided 2:1 slopes are constructed.




Other Considerations

Spread footings and/or pile caps should be protected against frost action by at least 4 feet of earth cover.

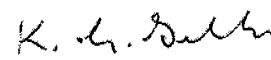
The observed piezometric water level was found to be at elevation 659 - 661. The base of footing excavations for the piers will be at elevation 651±. Therefore, the unbalanced hydrostatic head will be about 8 to 10 feet. However, no major dewatering problems are anticipated since the subsoils (glacial till and clayey silt to silty clay) have sufficient strength, clay content and low permeability to prevent 'boiling' or basal heave. Any seepage into the excavations should be handled by conventional methods, such as pumping from sumps.

MISCELLANEOUS

The field investigation was carried out during the period of November 2 to 5 1976 under the supervision of Mr. H. Szymanski, Technician and Mr. P. Payer.

  
P. Payer, P. Eng.  
Senior Engineer



  
K. G. Selby, P. Eng.  
Supervising Engineer

PP/KGS/km

## APPENDIX

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

## RECORD OF BOREHOLE NO 1

WP 55-75-07

LOCATION Sta. 98+63 o/s 21' Rt. (CNR R.E. of S.R.)

ORIGINATED BY PP

DIST 4 HWY 6N

BORING DATE Nov. 2 &amp; 3, 1976

COMPILED BY PP

DATUM Geodetic

BOREHOLE TYPE Cont.' Flight Auger &amp; Cone Test

CHECKED BY

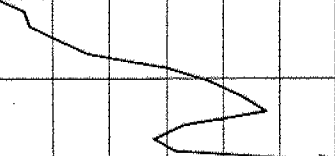
SOIL PROFILE			SAMPLES			GROUND WATER ELEV	DYNAMIC CONE PENETRATION RESISTANCE PLOT					LIQUID LIMIT — $w_L$ PLASTIC LIMIT — $w_p$ WATER CONTENT — $w$			UNIT WEIGHT $\gamma$	REMARKS  % GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	'N' VALUES		20 40 60 80 100					$w_p$ — $w$ — $w_L$				
							SHEAR STRENGTH					WATER CONTENT %				
							○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE									
684.8	Ground Level					ELEV	1000	2000			15	30	45			
0.0	Clayey silt to silt		1	SS	27	680									0 1 79 20	
677.8	Trace of sand		2	SS	28											
7.0	Clayey silt to silty clay		3	SS	22											
	(Stratified)		4	SS	23											
671.3	Very stiff		5	TW	PH											
13.5	Heterogeneous mixture of gravel, sand, silt and clay (Glacial Till)		6	SS	91	670									20 59 15 6	
			7	SS	63											
			8	SS	119	660										
			9	SS	90											
			10	SS	79											
			11	SS	81											
			12	SS	78											
	Occ. layers of sand and clayey silt		13	SS	82										9 32 41 18	
			14	SS	113	650										
	Very Dense		15	SS	46										4 3 62 31	
			16	SS	110	640										
634.3			17	RC BXL	REC 25%										59 27 9 5	
50.5	Dolomite Bedrock Weathered		18	RC BXL	REC 60%	630										
628.3	Gypsum Modules															
56.5	End of Borehole															
	NOTE: Borehole Dry															

 20  
15  $\diamond$  5 % STRAIN AT FAILURE  
10

HIGHWAY ENGINEERING DIVISION - ENGINEERING MATERIALS OFFICE - SOIL MECHANICS SECTION

RECORD OF BOREHOLE NO 2

WP 55-75-07 LOCATION Sta. 98+81 o/s 11' Lt. (CNR R.E. of S.R.) ORIGINATED BY PP  
 DIST 4 HWY 6N BORING DATE Nov. 3, 1976 COMPILED BY PP  
 DATUM Geodetic BOREHOLE TYPE Dynamic Cone Penetration Test CHECKED BY CP

SOIL PROFILE			SAMPLES			GROUND WATER ELEV	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 SHEAR STRENGTH ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE	LIQUID LIMIT $w_L$ PLASTIC LIMIT $w_p$ WATER CONTENT $w$ $w_p$ — $w$ — $w_L$ WATER CONTENT %	UNIT WEIGHT $\gamma$	REMARKS
ELEV DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	'N' VALUES					
685.8	Ground Level									
0.0						680				
674.2										
11.6	End of Cone Test						120/7"			

20  
15  $\phi$  5 % STRAIN AT FAILURE  
10

## RECORD OF BOREHOLE NO 3

WP 55-75-07 LOCATION Sta. 99+13 o/s 21' Rt. (CNR R.E. of S.R.) ORIGINATED BY PP  
 DIST 4 HWY 6N BORING DATE Nov. 4, 1976 COMPILED BY PP  
 DATUM Geodetic BOREHOLE TYPE Dynamic Cone Penetration Test CHECKED BY CP

SOIL PROFILE			SAMPLES			GROUND WATER ELEV	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 SHEAR STRENGTH ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE	LIQUID LIMIT $w_L$ PLASTIC LIMIT $w_p$ WATER CONTENT $w$ $w_p$ — $w$ — $w_L$ WATER CONTENT %	UNIT WEIGHT $\gamma$	REMARKS
ELEV DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	'N' VALUES					
685.5	Ground Level									
0.0						680				
673.8										
11.7	End of Cone Test						120/9"			

20  
 15 0.5 % STRAIN AT FAILURE  
 10

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

## RECORD OF BOREHOLE NO 4

WP 55-75-07 LOCATION Sta. 99+31 o/s 11' Lt. (CNR R.E. of S.R.) ORIGINATED BY PP  
 DIST 4 HWY 6N BORING DATE Nov. 3, 1976 COMPILED BY PP  
 DATUM Geodetic BOREHOLE TYPE Cont'. Flight Auger & Cone Test CHECKED BY PP

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			SHEAR STRENGTH PSF							
															$w_p$ — $w$ — $w_L$		
															WATER CONTENT %		
						1000 2000			15 30 45			GR SA SI CL					
686.0	Ground Level																
0.0	Clayey silt to silty clay (Stratified) Occ. sand layers Very Stiff		1	SS	25	680								0 0 77 23			
671.5																	
14.5	Heterogeneous mixture of gravel, sand, silt & clay (Glacial Till) Occ. sand & clayey silt Layers Very Dense		2	SS	62	670											
			3	SS	105												
			4	SS	100	5"								47 22 21 10			
			5	SS	90	6"											
			6	SS	50	3"	660										
			7	SS	42	3"								13 25 47 15			
			8	SS	99	7"											
			9	SS	71	650											
			10	SS	73									35 35 21 9			
640.9																	
45.1	End of Borehole (Refusal)  NOTE: Borehole Dry																

20  
 15 0.5 % STRAIN AT FAILURE  
 10

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

## RECORD OF BOREHOLE NO 7

WP 55-75-07

LOCATION Sta. 100+65 o/s 21' Rt. (CNR R.E. of S.R.)

ORIGINATED BY PP

DIST 4 HWY 6N

BORING DATE Nov. 4 &amp; 5, 1976

COMPILED BY PP

DATUM Geodetic

BOREHOLE TYPE Cont'. Flight Auger &amp; Cone Test

CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER ELEV	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 SHEAR STRENGTH PSF ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE	LIQUID LIMIT — $w_L$ PLASTIC LIMIT — $w_p$ WATER CONTENT — $w$ $w_p$ — $w$ — $w_L$ WATER CONTENT % 15 30 45	UNIT WEIGHT $\gamma$ PCF	REMARKS % GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	'N' VALUES					
682.0	Ground Level									
0.0	Clayey silt to silty clay (Stratified) Traces of sand & gravel  Occ. silt seams & Layers  Very stiff to Hard		1	SS	17					0 0 84 16
			2	SS	19					
			3	TW	PH				121	
			4	TW	PH					
			5	TW	PH				125	
			6	TW	PH					
			7	TW	PH				122	
			8	TW	PH					
			9	SS	36					3 1 51 45
			10	SS	11					
635.8			11	TW	PH				118	
633.5	Glacial Till		12	SS	30					36 57 (7)
48.5	End of Borehole (refusal)									

20  
15  $\phi$  5 % STRAIN AT FAILURE  
10

HIGHWAY ENGINEERING DIVISION - ENGINEERING MATERIALS OFFICE - SOIL MECHANICS SECTION

RECORD OF BOREHOLE No 8

WP 55-75-07 LOCATION Sta. 100+83 o/s 11' Lt. (CNR R.E. of S.R.) ORIGINATED BY HS  
 DIST 4 HWY 6N BORING DATE Nov. 5, 1976 COMPILED BY GP  
 DATUM Geodetic BOREHOLE TYPE Dynamic Cone Penetration Test CHECKED BY [Signature]

SOIL PROFILE			SAMPLES			GROUND WATER ELEV	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 SHEAR STRENGTH ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE	LIQUID LIMIT $w_L$ PLASTIC LIMIT $w_p$ WATER CONTENT $w$ $w_p \rightarrow w \rightarrow w_L$ WATER CONTENT %	UNIT WEIGHT $\gamma$	REMARKS % GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	'N' VALUES					
682.2	Ground Level					680				
0.0										
672.2										
10.0	End of Cone Test									

20  
15  $\phi$  5 % STRAIN AT FAILURE  
10



HIGHWAY ENGINEERING DIVISION - ENGINEERING MATERIALS OFFICE - SOIL MECHANICS SECTION

RECORD OF BOREHOLE NO 9

WP 55-75-07 LOCATION Sta. 101+15 o/s 21' Rt. (CNR R.E. of S.R.) ORIGINATED BY HS  
 DIST 4 HWY 6N BORING DATE Nov. 5, 1976 COMPILED BY GP  
 DATUM Geodetic BOREHOLE TYPE Dynamic Cone Penetration Test CHECKED BY GP

SOIL PROFILE			SAMPLES			GROUND WATER ELEV	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 SHEAR STRENGTH ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE	LIQUID LIMIT $w_L$ PLASTIC LIMIT $w_p$ WATER CONTENT $w$ $w_p$ — $w$ — $w_L$ WATER CONTENT %	UNIT WEIGHT $\gamma$	REMARKS
ELEV DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	VALUES					
681.4	Ground Level					680				
0.0										
669.4						670	126			
12.0	End of Cone Test									

20  
15  $\phi$  5 % STRAIN AT FAILURE  
10

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

## RECORD OF BOREHOLE NO 10 &amp; 10A

WP 55-75-07 LOCATION Sta. 101+33 o/s 11' Lt. (CNR R.E. of S.R.) ORIGINATED BY HS  
 DIST 4 HWY 6N BORING DATE Nov. 3 & 4, 1976 COMPILED BY PP  
 DATUM Geodetic BOREHOLE TYPE Cont'. Flight Auger & Cone Test CHECKED BY *[Signature]*

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	$w_p$	$w$	$w_L$		
681.1	Ground Level															
0.0	Clayey Silt to silty clay (Stratified)  Trace of sand   Stiff to Very Stiff		1	SS	39	680									118	0 0 52 48
			2	TW	PH											0 0 34 66
			3	SS	26											PIEZOMETER DRY JAN. 21, 1977
			4	TW	PH	670										P-10-2 0 0 86 14
			5	SS	24											
			6	TW	PH											
			7	SS	24											
			8	TW	PH	660										0 0 44 56
			9	SS	21											W.L. IN PIEZOMETER 659.4 JAN. 21, 1977
			10	TW	PH											P-10-1 0 0 59 41
			11	SS	14											
			12	TW	PH	650										
			13	TW	PH											
			14	TW	PH	640										2 4 58 36
637.1																
44.0	Het. Mixture of gravel, sand, silt & clay, compact (Glacial Till)		15	SS	25	630										
631.1																
50.0	Dolomite Bedrock Weathered Sound (impregnated with Gypsum)		16	RC BXL	REC 30%											
621.1			17	RC BXL	REC 100%											
60.0	End of Borehole															

20  
 15  $\phi$  5 % STRAIN AT FAILURE  
 10

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

## RECORD OF BOREHOLE NO 11

WP 55-75-07

LOCATION Sta. 99+94 o/s 3' Rt. (CNR R.E. of S.R.)

ORIGINATED BY HS

DIST 4 HWY 6N

BORING DATE Nov. 2 &amp; 3, 1976

COMPILED BY PP

DATUM Geodetic

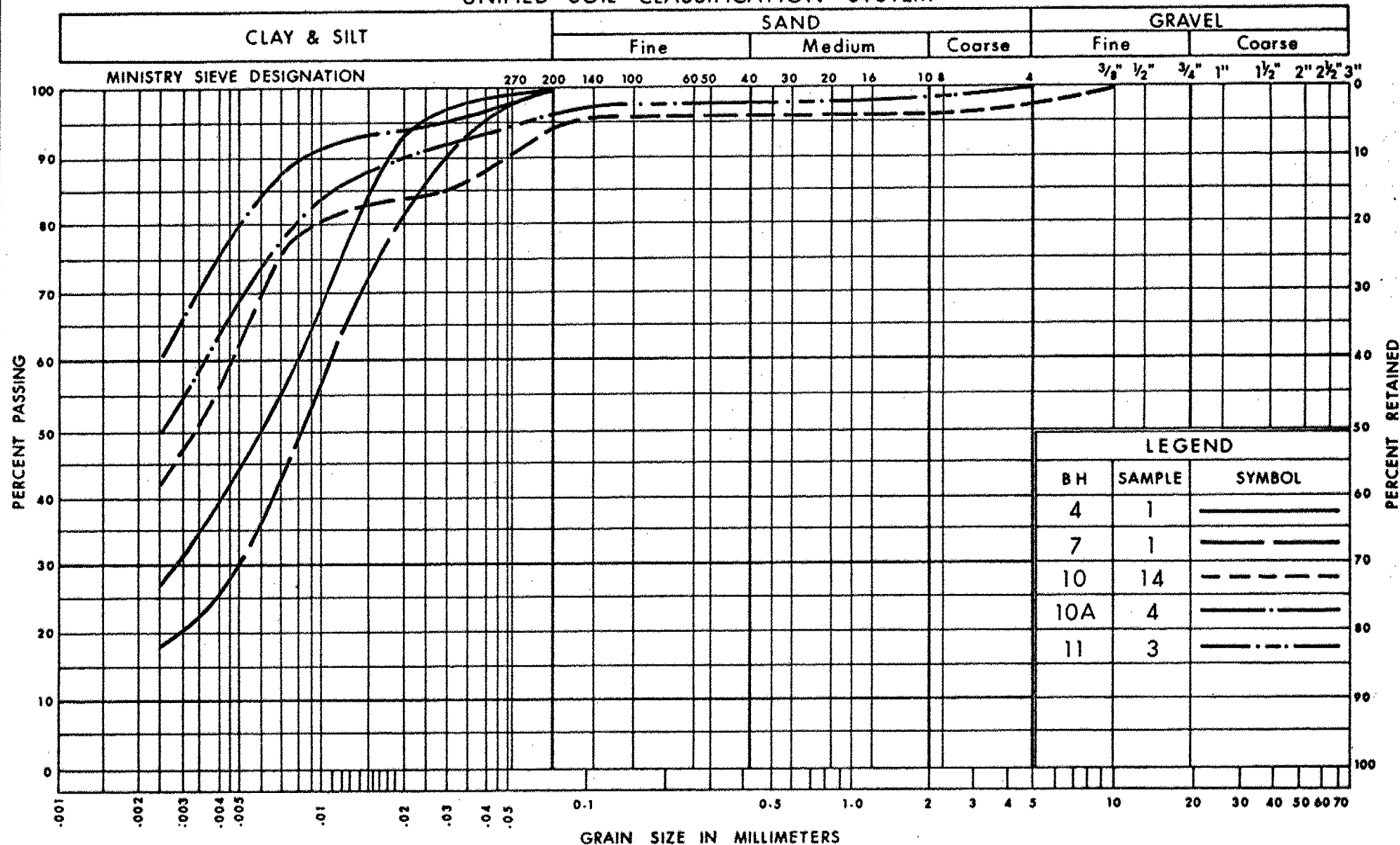
BOREHOLE TYPE Cont. Flight Auger &amp; Cone Test

CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER ELEV	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 SHEAR STRENGTH ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE	LIQUID LIMIT $W_L$ PLASTIC LIMIT $W_P$ WATER CONTENT $W$ $W_p$ $W$ $W_L$ WATER CONTENT % 15 30 45	UNIT WEIGHT $\gamma$	REMARKS
ELEV DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	'N' VALUES					
684.5	Ground Level									
0.0	Clayey silt to silty clay		1	SS	26	680				
	Trace of sand		2	SS	13					
	Stiff to very stiff		3	SS	36	670	142			
668.2	(Stratified)		4	SS	120	6"				
16.3	Heterogeneous		5	SS	168	10"				
	Mixture of gravel, sand, silt & clay		6	SS	59	660				
	Occ. clayey silt layers		7	SS	139					
	Very Dense		8	SS	136	650				
			9	SS	132					
			10	SS	94					
639.7			11	SS		640				
44.8	Dolomite Weathered		12	RC	REC					
634.4	Bedrock Sound			BXL	60%					
50.1	End of Borehole									
	NOTE: Borehole Dry									

 20  
15  $\div$  5 % STRAIN AT FAILURE  
10

## UNIFIED SOIL CLASSIFICATION SYSTEM



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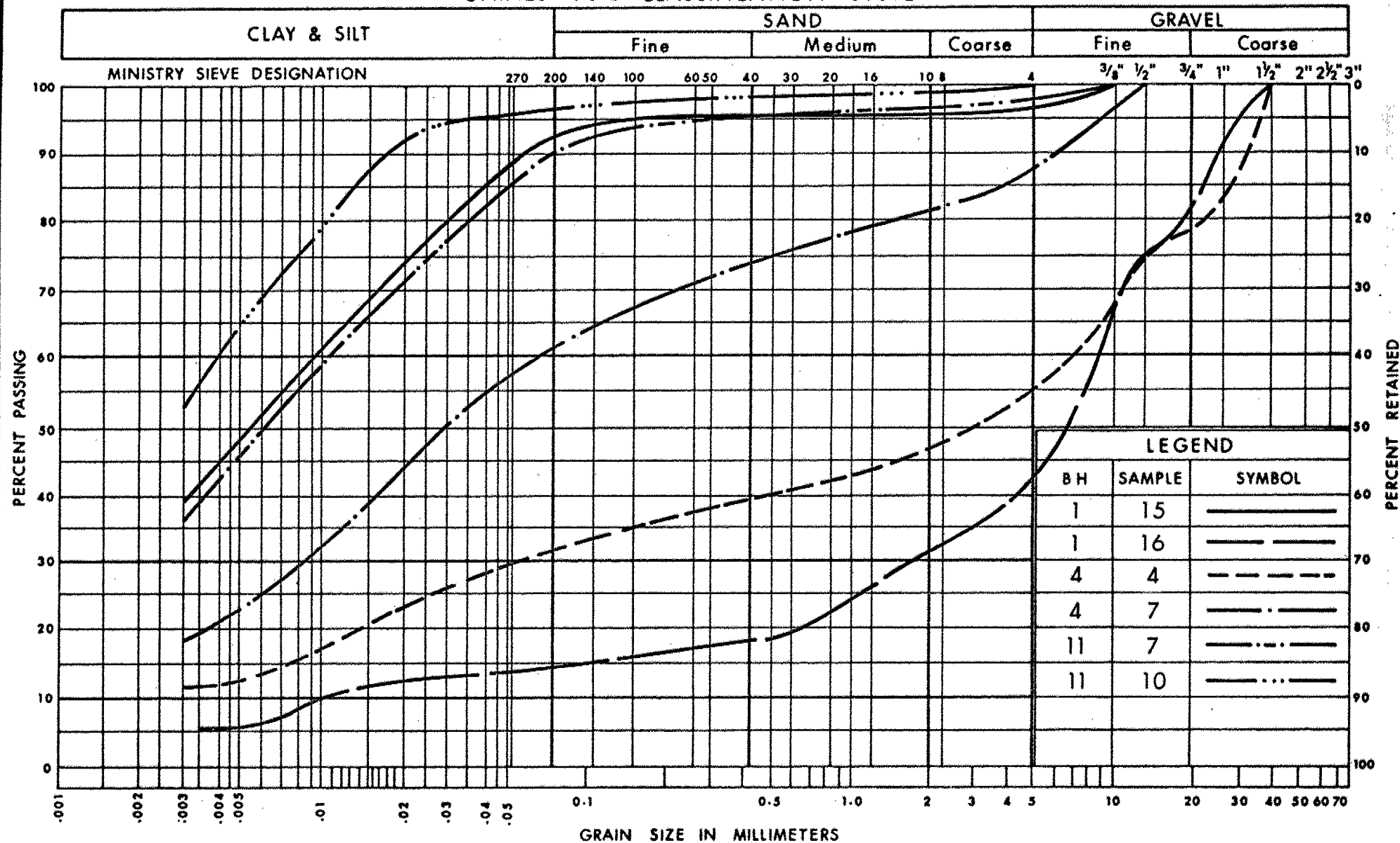
ENGINEERING MATERIALS OFFICE

GRAIN SIZE DISTRIBUTION  
CLAYEY SILT TO SILTY CLAY

FIG No 1

W P 55-75-07

## UNIFIED SOIL CLASSIFICATION SYSTEM



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Communications

**GRAIN SIZE DISTRIBUTION**  
HET. MIXTURE OF GRAVEL, SAND, SILT & CLAY  
(GLACIAL TILL)

FIG No 2

WP 55-75-07

## ABBREVIATIONS & SYMBOLS USED IN THIS REPORT

### PENETRATION RESISTANCE

'N'-STANDARD PENETRATION RESISTANCE - THE NUMBER OF BLOWS REQUIRED TO ADVANCE A STANDARD SPLIT SPOON SAMPLER 12 INCHES INTO THE SUBSOIL, DRIVEN BY MEANS OF A 140 POUND HAMMER FALLING FREELY A DISTANCE OF 30 INCHES

DYNAMIC PENETRATION RESISTANCE - THE NUMBER OF BLOWS REQUIRED TO ADVANCE A 2 INCH, 60 DEGREE CONE, FITTED TO THE END OF DRILL RODS, 12 INCHES INTO THE SUBSOIL, THE DRIVING ENERGY BEING 350 FOOT POUNDS PER BLOW

### DESCRIPTION OF SOIL

THE CONSISTENCY OF COHESIVE SOILS AND THE RELATIVE DENSITY OR DENSENESS OF COHESIONLESS SOILS ARE DESCRIBED IN THE FOLLOWING TERMS:-

<u>CONSISTENCY</u>	<u>c LB/SQ FT</u>	<u>DENSENESS</u>	<u>'N' BLOWS / FT.</u>
VERY SOFT	0 - 250	VERY LOOSE	0 - 4
SOFT	250 - 500	LOOSE	4 - 10
FIRM	500 - 1000	COMPACT	10 - 30
STIFF	1000 - 2000	DENSE	30 - 50
VERY STIFF	2000 - 4000	VERY DENSE	> 50
HARD	> 4000		

TERMS TO BE USED IN DESCRIBING SOILS:-

TRACE < 10% , SOME 10-25% , WITH 25-40% , > 40% SILTY, SANDY, GRAVELLY, CLAYEY ETC

### TYPE OF SAMPLE

S.S	SPLIT SPOON	T.W.	THINWALL OPEN
W.S.	WASHED SAMPLE	T.P.	THINWALL PISTON
S.T	SLOTTED TUBE SAMPLE	O.S	OESTERBERG SAMPLE
A.S.	AUGER SAMPLE	F.S	FOIL SAMPLE
C.S	CHUNK SAMPLE	R.C	ROCK CORE

P.H. SAMPLE ADVANCED HYDRAULICALLY

P.M. SAMPLE ADVANCED MANUALLY

### SOIL TESTS

U	UNCONFINED COMPRESSION	L.V	LABORATORY VANE
UU	UNCONSOLIDATED UNDRAINED TRIAXIAL	F.V.	FIELD VANE
CIU	CONSOLIDATED ISOTROPIC UNDRAINED TRIAXIAL	C	CONSOLIDATION
CID	" " DRAINED "	S	SENSITIVITY
CAU	" ANISOTROPIC UNDRAINED "		
CAD	" " DRAINED "		

# ABBREVIATIONS & SYMBOLS USED IN THIS REPORT

## SOIL PROPERTIES

$\gamma$	UNIT WEIGHT OF SOIL (BULK DENSITY)
$\gamma_s$	UNIT WEIGHT OF SOLID PARTICLES
$\gamma_w$	UNIT WEIGHT OF WATER
$\gamma_d$	UNIT DRY WEIGHT OF SOIL (DRY DENSITY)
$\gamma'$	UNIT WEIGHT OF SUBMERGED SOIL
G	SPECIFIC GRAVITY OF SOLID PARTICLES $G = \frac{\gamma_s}{\gamma_w}$
e	VOID RATIO
n	POROSITY
w	WATER CONTENT
$S_r$	DEGREE OF SATURATION
$w_L$	LIQUID LIMIT
$w_p$	PLASTIC LIMIT
$I_p$	PLASTICITY INDEX
$w_s$	SHRINKAGE LIMIT
$I_L$	LIQUIDITY INDEX = $\frac{w - w_p}{I_p}$
$I_c$	CONSISTENCY INDEX = $\frac{w_L - w}{I_p}$
$e_{max}$	VOID RATIO IN LOOSEST STATE
$e_{min}$	VOID RATIO IN DENSEST STATE
$I_D$	DENSITY INDEX = $\frac{e_{max} - e}{e_{max} - e_{min}}$
	RELATIVE DENSITY $D_r$ IS ALSO USED
h	HYDRAULIC HEAD OR POTENTIAL
q	RATE OF DISCHARGE
v	VELOCITY OF FLOW
i	HYDRAULIC GRADIENT
k	COEFFICIENT OF PERMEABILITY
j	SEEPAGE FORCE PER UNIT VOLUME
$m_v$	COEFFICIENT OF VOLUME CHANGE = $\frac{-\Delta e}{(1+e)\Delta\sigma}$
$c_v$	COEFFICIENT OF CONSOLIDATION
$C_c$	COMPRESSION INDEX = $\frac{\Delta e}{\Delta \log_{10} \sigma}$
$T_v$	TIME FACTOR = $\frac{c_v t}{d^2}$ (d, DRAINAGE PATH)
U	DEGREE OF CONSOLIDATION
$\tau_f$	SHEAR STRENGTH
$c'$	EFFECTIVE COHESION INTERCEPT
$\phi'$	EFFECTIVE ANGLE OF SHEARING RESISTANCE, OR FRICTION
$c_u$	APPARENT COHESION
$\phi_u$	APPARENT ANGLE OF SHEARING RESISTANCE, OR FRICTION
$\mu$	COEFFICIENT OF FRICTION
$S_t$	SENSITIVITY

## GENERAL

$\pi$	= 3.1416
e	BASE OF NATURAL LOGARITHMS 2.7183
$\log_e a$ OR $\ln a$	NATURAL LOGARITHM OF a
$\log_{10} a$ OR $\log a$	LOGARITHM OF a TO BASE 10
t	TIME
g	ACCELERATION DUE TO GRAVITY
V	VOLUME
W	WEIGHT
M	MOMENT
F	FACTOR OF SAFETY

## STRESS AND STRAIN

u	PORE PRESSURE
$\sigma$	NORMAL STRESS
$\sigma'$	NORMAL EFFECTIVE STRESS ( $\bar{\sigma}$ IS ALSO USED)
$\tau$	SHEAR STRESS
$\epsilon$	LINEAR STRAIN
$\gamma$	SHEAR STRAIN
$\nu$	POISSON'S RATIO ( $\mu$ IS ALSO USED)
E	MODULUS OF LINEAR DEFORMATION (YOUNG'S MODULUS)
G	MODULUS OF SHEAR DEFORMATION
K	MODULUS OF COMPRESSIBILITY
$\eta$	COEFFICIENT OF VISCOSITY

## EARTH PRESSURE

d	DISTANCE FROM TOP OF WALL TO POINT OF APPLICATION OF PRESSURE
$\delta$	ANGLE OF WALL FRICTION
K	DIMENSIONLESS COEFFICIENT TO BE USED WITH VARIOUS SUFFIXES IN EXPRESSIONS REFERRING TO NORMAL STRESS ON WALLS
$K_0$	COEFFICIENT OF EARTH PRESSURE AT REST

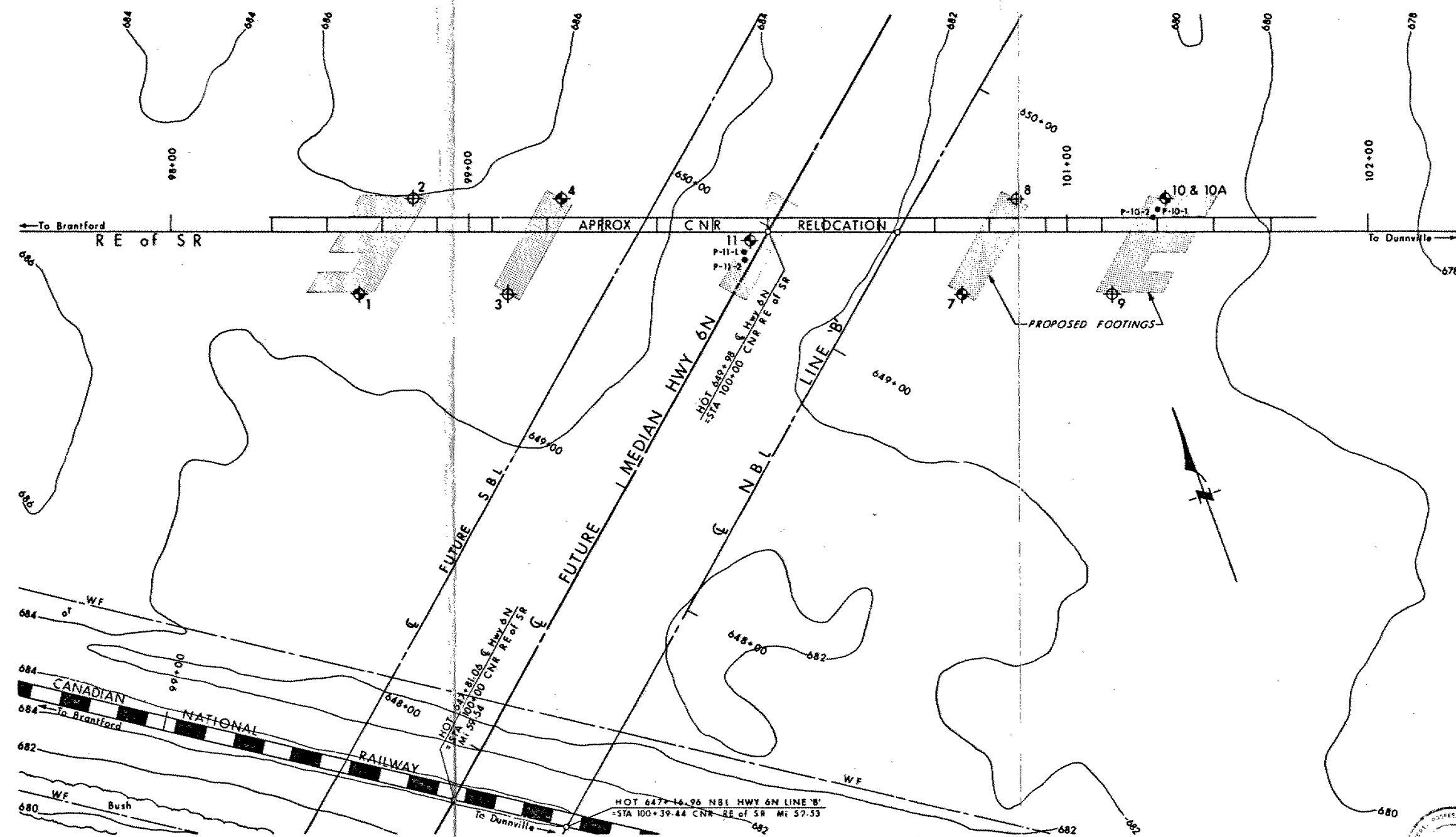
## FOUNDATIONS

B	BREADTH OF FOUNDATION
L	LENGTH OF FOUNDATION
D	DEPTH OF FOUNDATION BENEATH GROUND
N	DIMENSIONLESS COEFFICIENT USED WITH A SUFFIX APPLYING TO SPECIFIC GRAVITY, DEPTH AND COHESION ETC. IN THE FORMULA FOR BEARING CAPACITY
$k_s$	MODULUS OF SUBGRADE REACTION

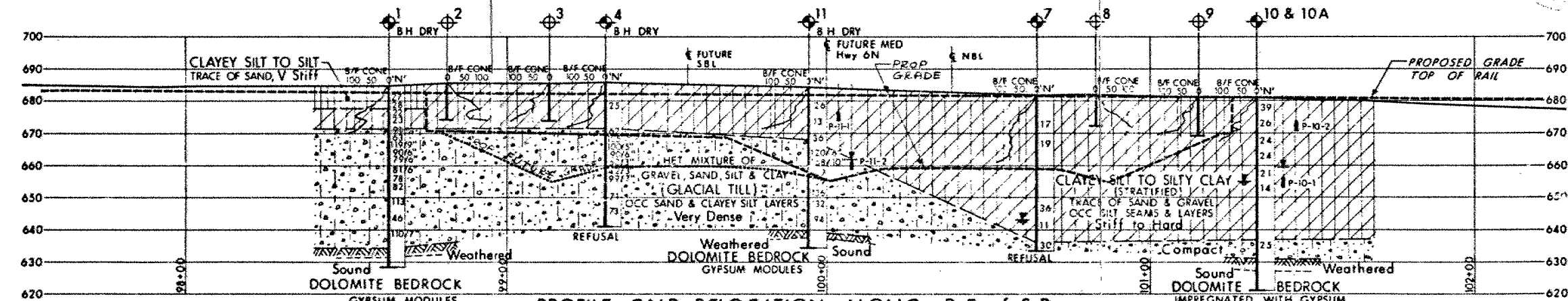
## SLOPES

H	VERTICAL HEIGHT OF SLOPE
D	DEPTH BELOW TOE OF SLOPE TO HARD STRATUM
$\beta$	ANGLE OF SLOPE TO HORIZONTAL

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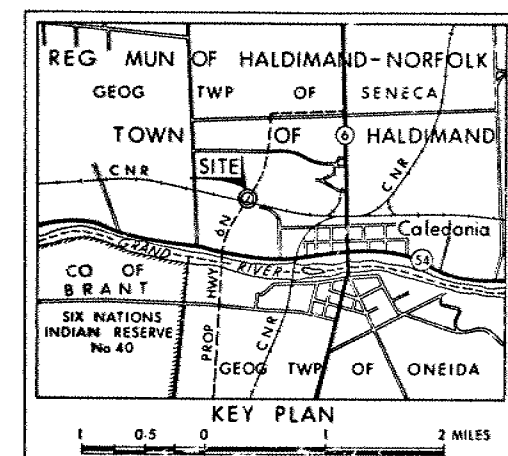
PLAN  
SCALE  
20 10 0 20 40 FT



PROFILE CNR RELOCATION ALONG R E of S R  
SCALE  
20 10 0 20 40 FT

CONT No  
WP No 55-75-07  
CANADIAN NATIONAL RAILWAY  
(0.5 Mi North of Grand River)  
BORE HOLE LOCATIONS & SOIL STRATA

SHEET



- LEGEND
- Bore Hole
  - Dynamic Cone Penetration Test (Cone)
  - Bore Hole & Cone
  - 'N' Blows/ft (Std Pen Test 350 ft lbs energy)
  - CONE Blows/ft (60° Cone, 350 ft lbs energy)
  - WL at time of investigation Nov 1976
  - Piezometric Head
  - Piezometer

No	ELEVATION	STATION	OFFSET
1	684.8	98+63	21' RT
2	685.8	98+81	11' LT
3	685.5	99+13	21' RT
4	686.0	99+31	11' LT
7	682.0	100+65	21' RT
8	682.2	100+83	11' LT
9	681.4	101+15	21' RT
10 & 10A	681.1	101+33	11' LT
11	684.5	99+94	3' RT

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

REVISIONS	DATE	BY	DESCRIPTION

HWY No Prop 6N LINE 'B' NBL DIST 8  
SUBMIT PP. 1 CHECKED DATE Feb 8, 1977 SITE 9-131  
DRAWN 2 CHECKED 2 APPROVED DWS 557507-A

REF No E-5434-1; July 1976



G.C.E. Burkhardt  
Structural Section  
Central Region


Soil Mechanics Section  
Engineering Materials Office  
West Building, Downsview

Mr. F.I. Hewson

77 07 25

CMR Subway at Dunnville Subdivision  
W.P. 55-75-07, Site 9-131  
Hwy. 6, District 4, Hamilton

A review of the preliminary plan for the above noted structure leads to the following soil mechanics related comment. All footings are shown founded on steel H-piles. This is unnecessary for the west abutment, and the west and central piers as these will be founded in very dense glacial till where spread footings would perform as well as piles. It should be noted that pile driving in this subsoil condition will be very difficult.



P. Stuart  
Project Engineer

PS/kr

cc: Files /  
Record Services