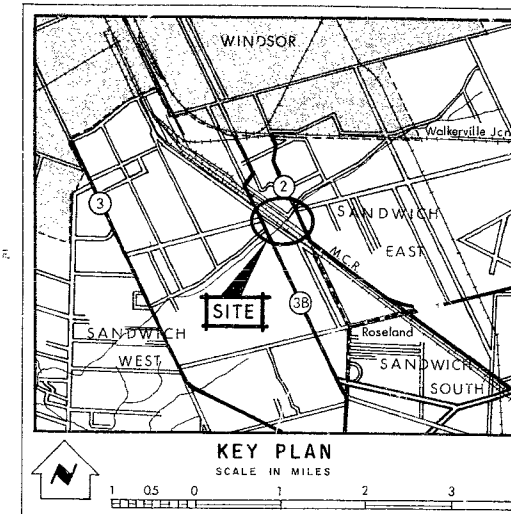
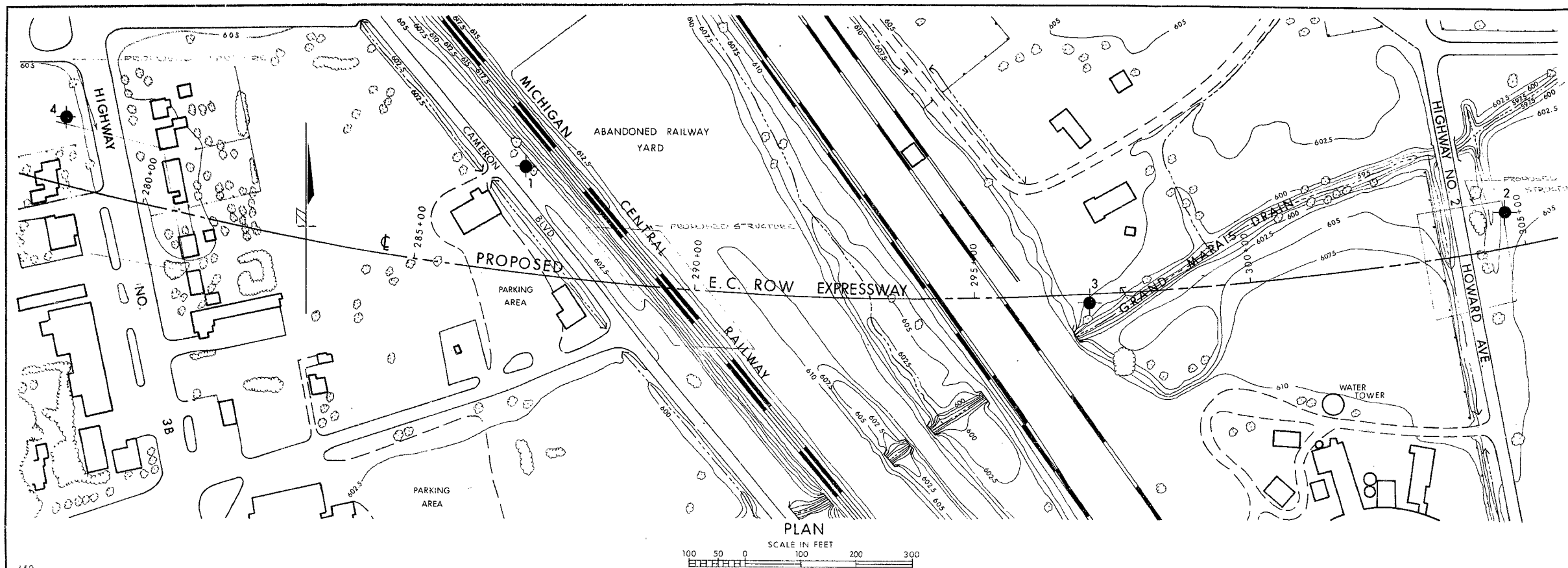


66-F-92
HWY. #3B TO
HOWARD AVE.
E.C. ROW
EXPRESSWAY

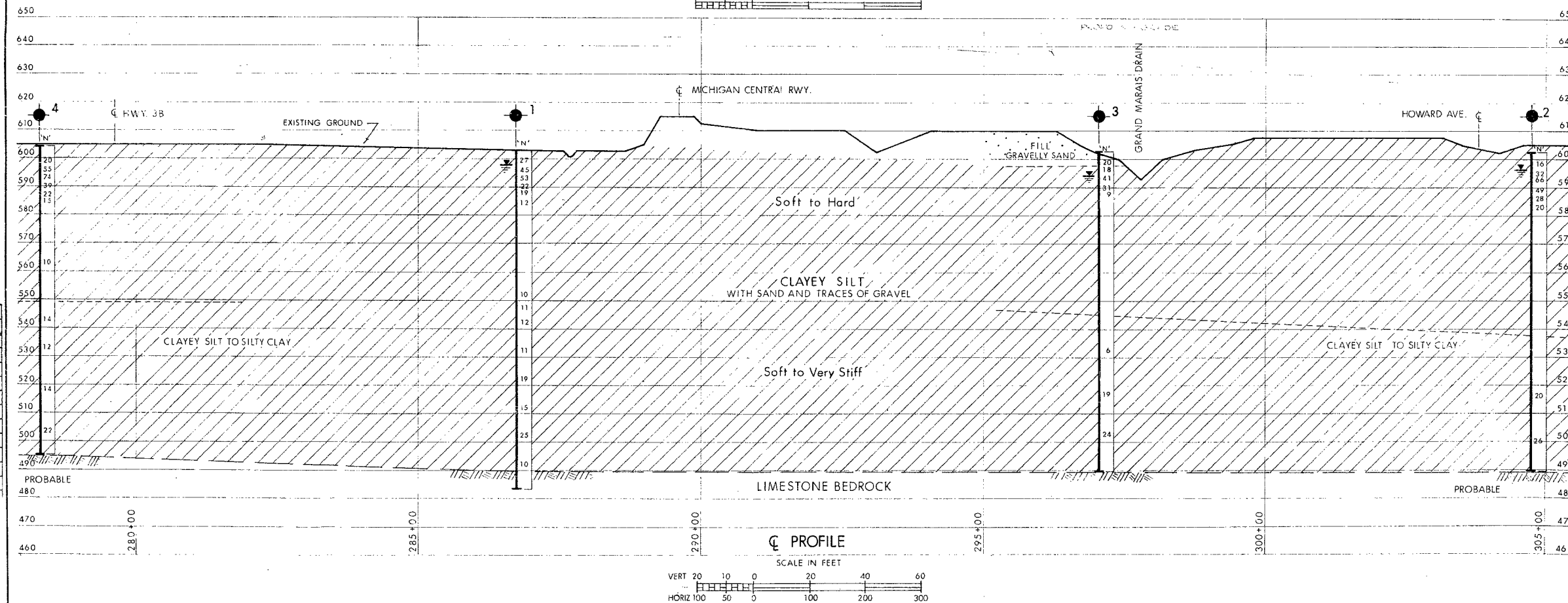


LEGEND			
	Bore Hole		
	Cone Penetration Hole		
	Bore & Cone Penetration Hole		
	Water Levels established at time of field investigation. 8 NOV. 1966		

NO.	ELEVATION	STATION	OFFSET
1	603.0'	286+75	190' LT.
2	602.5'	304+75	65' LT.
3	603.0'	297+05	15' RT.
4	604.0'	278+30	120' LT.

NOTE

The boundaries between soil strata have been established only at Bore Hole locations. Between Bore Holes the boundaries are assumed from geological evidence and may be subject to considerable error.



REVISIONS	DATE	BY	DESCRIPTION

DEPARTMENT OF HIGHWAYS - ONTARIO

MATERIALS & TESTING DIVISION - FOUNDATION SECTION

E.C. ROW EXPRESSWAY
HIGHWAY NO. 38 TO HOWARD AVE.

KING'S HIGHWAY NO. _____ DIST. NO. 1

CO. _____ CITY OF WINDSOR

TWP. _____ LOT _____ CON. _____

BORE HOLE LOCATIONS & SOIL STRATA.

SUBM'D P.P.	CHECKED P.P.	W.P. NO.	M.B.T. DRAWING NO.
DRAWN M.D.	CHECKED M.D.	JOB NO. 66-F-92	66-F-92 A
DATE 12 DEC 1966	SITE NO.		BRIDGE DRAWING NO.
APPROVED <i>[Signature]</i>	SENT NO.		

DEPARTMENT OF HIGHWAYS ONTARIO

MEMORANDUM

BA2485

To: Mr. B. R. Davis,
Bridge Engineer,
Bridge Division.
Attention: Mr. S. McCombie

From: Foundation Section,
Materials & Testing Div.,
Room 107, Lab. Bldg.

Date: January 16, 1967

Our File Ref.

In Reply To: JAN 18 1967

SUBJECT:

PRELIMINARY
FOUNDATION INVESTIGATION REPORT
For
Proposed E.C. Row Expressway,
From Hwy. #3B to Howard Ave.,
City of Windsor, Co. of Essex,
District #1 (Chatham)
W.J. 66-F-92 -- W.P. (Nil)

Attached, we are forwarding to our preliminary foundation investigation report on the subsoil conditions existing at the above structure site.

We believe that the information contained therein, will suffice for your present design requirements.

Should there be any queries in connection with this report, please feel free to contact our Office.

AGS/MdeF
Attach.

cc: Messrs. B. R. Davis (2) ✓
H. A. Tregaskes
D. W. Farren
A. Gater
F. C. Brown
A. P. Watt
J. Roy (2)
B. A. Singh

Foundations Office
Gen. Files

afternoon
A. G. Stermac
PRINCIPAL FOUNDATION ENGINEER

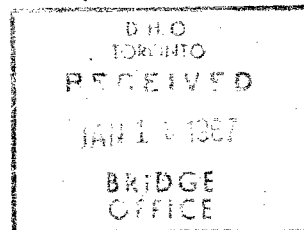


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 3. SOIL TYPES AND SOIL CONDITIONS:
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 - 3.2) Fill Material.
 - 3.3) Clayey Silt with Sand and traces of Gravel.
 - 3.4) Silty Clay to Clayey Silt.
 - 3.5) Limestone Bedrock.
 4. GROUNDWATER LEVEL.
 5. DISCUSSION AND RECOMMENDATIONS.
 6. MISCELLANEOUS.
-

PRELIMINARY
FOUNDATION INVESTIGATION REPORT
For
Proposed E.C. Row Expressway,
From Hwy. #3B to Howard Ave.,
City of Windsor, Co. of Essex,
District #1 (Chatham)
W.J. 66-F-92 -- W.P. (N11)

1. INTRODUCTION:

A preliminary foundation investigation for the proposed E.C. Row Expressway in the City of Windsor, was requested by Mr. J. R. Roy, Regional Materials Engineer, in a memorandum dated October 13, 1966.

Following this request, a field investigation was carried out by the Foundation Section to determine:

- 1) Suitability of the subsoil to support the proposed 40-ft. high earth fill.
- 2) The effect of such a fill on the railway in the immediate vicinity.
- 3) The effect of such a fill on the existing Grand Marais drain culverts in the area.
- 4) Should the Grand Marais Drain be realigned, the minimum distance the drain and the new culverts should be constructed away from this fill.
- 5) What problems could be anticipated with a single high level structure between Hwy. #3B and Howard Avenue - (Hwy. #2 & #98)?

Presented in this report are the results of this investigation, together with our recommendations for the proposals.

cont'd. /2 ...

1. INTRODUCTION: (cont'd.) ...

Four borings were carried out during the field investigation. The locations and elevations are shown on Dwg. No. 66-F-92A, which accompanies this report.

2. FIELD AND LABORATORY WORK:

Boring was achieved by means of conventional diamond drilling equipment adapted for soil sampling purposes. During the field work, disturbed samples were obtained. The driving energy used in driving the standard split-spoon sampler, conformed to the requirements of the Standard Penetration test.

Other samples were obtained by means of 2-in. I.D. Shelby tubes which were pushed into the soil by hand. In-situ shear strength tests were carried out wherever possible, using a standard vane tester, at elevations 12 inches below the various sample depths.

Samples were visually examined and classified at the site as well as in the laboratory. Certain tests were carried out in the laboratory for classification, shear strength determination and settlement analysis purposes. These tests consisted of Atterberg limits, moisture content, grain-size distribution, unconfined and quick triaxial shear strength tests and consolidation tests. The test results are shown on the Borehole Record sheets contained in the Appendix of this report.

3. SOIL TYPES AND SOIL CONDITIONS:

3.1) General:

The subsoil at the site was found to be fairly uniform, despite the relatively great distance from borehole to borehole.

From ground level downward, the following soil types were observed:

cont'd. /3 ...

- 3 -

3. SOIL TYPES AND SOIL CONDITIONS: (cont'd.) ...

3.2) Fill Material:

This stratum was encountered in B.H. #3 only, and found to extend from ground level to a depth of 5.5 ft. It is believed that the material, which consists of gravelly sand, is part of the existing railroad embankment. The relative density may be described as compact.

3.3) Clayey Silt with Sand and traces of Gravel:

This deposit was encountered in Boreholes #1, #2 and #4 immediately below the ground surface, and in B.H. #3 beneath the gravelly sand stratum. The lower boundary was found to vary between El. 537 and El. 545 for Boreholes #2, #3 and #4. At the location of B.H. #1, the stratum extended to an approximate depth of 114 ft.

The material consists of silt and clay with sand and traces of gravel.

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

Natural Moisture Content	:	6% to 24%
Liquid Limit	:	18% to 34%
Plastic Limit	:	11% to 19%
Bulk Density	:	129 to 138 p.c.f.

Typical grain-size distribution curves are included in the Appendix of this report.

The consistency of the overall stratum ranges from soft to hard. Immediately beneath the extreme upper 5 ft., the material appears to be desiccated. Standard Penetration tests carried out in this desiccated zone, gave 'N' values of 32 to 74 blows per foot. The thickness was found to vary between 4 and 10 ft.

cont'd. /4 ...

3. SOIL TYPES AND SOIL CONDITIONS: (cont'd.) ...

3.3) Clayey Silt with Sand and traces of Gravel: (cont'd.) ...

Below this hard zone, the shear strength was found to decrease with increasing depth. Unconfined and triaxial compression tests carried out on 'undisturbed' samples, gave shear strength values, in general, ranging from 350 to 1,425 p.s.f. These values were lower than the field vane tests carried out at the corresponding sample elevations.

3.4) Silty Clay to Clayey Silt:

This deposit was found to underlie the clayey silt deposit, in Borehole #2, #3, and #4, at El. 537.5, El. 545.0, and El. 539.0, respectively. The chief constituents are clay and silt with some sand and traces of gravel. Laboratory tests have revealed that some portion of the material contains a large percentage of clay. In general, the deposit is layered.

The consistency was found to vary from soft to very stiff.

3.5) Limestone Bedrock:

The limestone bedrock was discovered at all borehole locations between El. 494 and El. 489. However, the bedrock was proven by coring only in B.H. #1.

4. GROUNDWATER LEVEL:

The following groundwater levels were observed during the course of the field investigation:

B.H. #1	:	El. 598.0
B.H. #2	:	El. 596.4
B.H. #3	:	El. 594.3

cont'd. /5 ...

5. DISCUSSION AND RECOMMENDATIONS:

It is proposed to construct an expressway between Highway #3B and Howard Ave. in the City of Windsor. This proposal will necessitate grade separations at the existing roadways and the Michigan Central Railway. Due to the grade separation, construction of bridges and approach fills are required. The height of the embankment varies, being the maximum (40 ft.) in the vicinity of the railroad.

As described in the Soil Types and Soil Conditions Section, the shear strength of the subsoil was found to decrease with depth, from 2,000 p.s.f. to 750 p.s.f., immediately below the surface and at El. 530, respectively.

Total stress analyses were carried out assuming the following soil properties:

Embankment; $\gamma = 135$ p.c.f.; $\phi = 35^\circ$

From El. 602 to El. 590; $\gamma = 133$ p.c.f.; $C = 2,000$ p.s.f.

El. 590 to El. 540; $\gamma = 133$ p.c.f.; $C = 750$ p.s.f.

El. 540 to El. 530; $\gamma = 120$ p.c.f.; $C = 750$ p.s.f.

El. 530 to El. 490; $\gamma = 120$ p.c.f.; $C = 1,500$ p.s.f.

Elevation of Water Table : 597.

Side Slopes : 2:1.

The resulting factor of safety indicated that the subsoil has insufficient strength to support the proposed 40-ft. high earth fill with standard 2:1 side slopes.

A second stability analyses was carried out assuming the same soil properties for a 30-ft. high embankment. The resulting safety factor was found to be satisfactory. From the foregoing, it is concluded that fills in excess of 30 ft. will require berms to ensure stability, the length of half height berm required being 100 feet for an embankment fill height of 40 feet.

cont'd. /6 ...

5. DISCUSSION AND RECOMMENDATIONS: (cont'd.) ...

Settlement calculations showed that the maximum settlement (under a 40-ft. fill) will be in the order of 24" and will take place over a long period of time. However, a more detailed investigation is required before the final design scheme is decided.

Based on the preliminary investigation, our recommendations are as follows:

- 1) Fills in excess of 30 ft. require berms. For a 40-ft. high fill, the berm width must be 100 ft. Intermediate heights may be interpolated.
- 2) Total settlement beneath a 40-ft. high fill will be in the order of 24" over a long-term period. It is believed that the effect on the adjacent railway will be negligible.
- 3) The drain culvert at Sta. 297+00 (approx.), would possibly settle up to a maximum of 18" over a long-term period, due to the proposed height of fill being placed over it.
- 4) Provided the open drain is kept outside bermed area, and provided that the total height from bottom of drain to the top of fill is less than 30 ft., no problems should exist. If culverts are built under the fill, provision should be made to accommodate the differential settlements, (i.e., up to about 18 inches). Soft material in the vicinity of existing drain may require special treatment.
- 5) No special problems are anticipated for a high level bridge, supported on piles driven to the bedrock.

The above recommendations are, of course, subject to review when the final scheme is decided upon. It is possible that additional field work will be required.

cont'd. /7 ...

6. MISCELLANEOUS:

The field investigation was carried out from October 26, 1966, to November 8, 1966. The equipment used on the site was owned and operated by Canadian Longyear Limited.

The supervision of the field work, together with the preparation of this report, was carried out by Mr. P. Payer, Project Foundation Engineer, under the general supervision of Mr. K. G. Selby, Supervising Foundation Engineer.

January 1967

APPENDIX I

FOUNDATION SECTION

ORIGINATED BY P.P.

COMPILED BY _____ P.P.

CHECKED BY

[illegible]

DEPARTMENT OF HIGHWAYS - ONTARIO			RECORD OF BOREHOLE NO. 2			FOUNDATION SECTION				
MATERIALS & TESTING DIVISION										
JOB 66-2-92			LOCATION Sta. 304 4750ft-Set 65' Lt.			ORIGINATED BY P.P.				
W.P. Nil			BORING DATE October 31 & November 1, 1966			COMPILED BY P.P.				
DATUM Geodetic			BOREHOLE TYPE Washbore - NX & BX Casing			CHECKED BY				
SOIL PROFILE		SAMPLES			DYNAMIC PENETRATION RESISTANCE		LIQUID LIMIT		BULK DENSITY	REMARKS
ELEV DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	BLOWS / FOOT	ELEV. SCALE	BLOWS / FOOT	WATER CONTENT %		
602.5	GROUND LEVEL									
0.0	Clayey Silt with sand and traces of gravel		1	SS	16	600				
			2	SS	32					
			3	SS	66					
	Brown & Grey		4	SS	49	590				
			5	SS	28					
	Soft to Hard		6	SS	20					
			7	TW	PM	580				
			8	TW	PM					
			9	TW	PM					
			10	TW	PM	570				
			11	TW	PM					
			12	TW	PM	560				
			13	TW	PM					
			14	TW	PM	550				
			15	TW	PM					
			16	TW	PM	540				
537.5	Clayey Silt to silty clay with some sand and traces of gravel		17	TW	PM	530				
65.0	Grey		18	SS	20	520				
			19	SS	26	510				
	Soft to Very Stiff					500				
488.9	End of Borehole (Probable Bedrock)					490				
113.6						480				

MATERIALS & TESTING DIVISION

RECORD OF BOREHOLE NO. 3

FOUNDATION SECTION

JOB 66-F-92

LOCATION Sta. 297+05; 15' Rt.

ORIGINATED BY P.P.

W.D. Nil

BORING DATE November 3 & 4, 1966

COMPILED BY

DATUM Geodetic

BOREHOLE TYPE Washbore-NX & BX Casing

CHECKED BY

[illegible]

DEPARTMENT OF HIGHWAYS - ONTARIO

RECORD OF BOREHOLE NO. 4

FOUNDATION SECTION

MATERIALS & TESTING DIVISION

JOB 65-F-92

LOCATION Sta: 278 430: 120' Lt

ORIGINATED BY P.P.

W.P. Nil

BORING DATE November 7 & 8, 1966

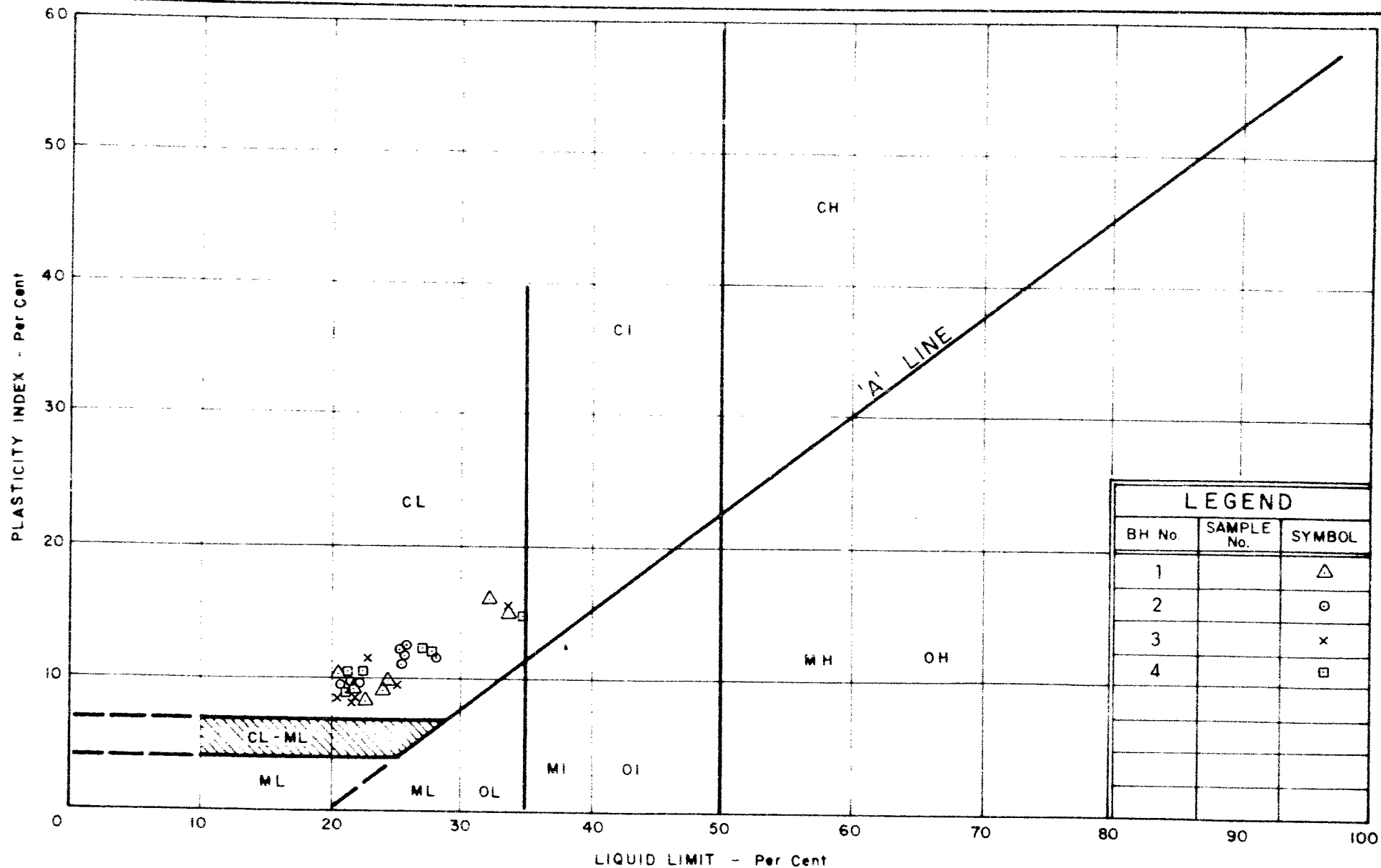
COMPILED BY _____ P.P.

DATUM Geodetic

BOREHOLE TYPE Washbore - NX & Bx Casing

CHECKED BY

SOIL PROFILE			SAMPLES			DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT		LIQUID LIMIT ——— w _L PLASTIC LIMIT ——— w _p WATER CONTENT ——— w		BULK DENSITY γ _p P.C.F.	REMARKS		
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	BLOWS / FOOT	ELEV SCALE	SHEAR STRENGTH P.S.F. ○ Unconfined • Quick Triaxial + Field Vane		WATER CONTENT % w _p ——— w ——— w _L 10 20 30				
604.0	GROUND LEVEL												
0.0	Clayey Silt with sand and traces of gravel. Brown & Grey Firm to Hard		1	SS	20	600						Gr. 5% Sa. 31% Si. 38% Cl. 26% Gr. 1%, Sa. 30% Si. 42% Cl. 27% 138 Gr. 2%, Sa. 31% 136 Si. 40% Clay 27% 135 134 Gr. 2% 134.5 Sa. 26% Si. 44% Cl. 28% 134 Gr. 3% Sa. 30% Si. 39% Cl. 28%	
			2	SS	55								
			3	SS	74								
			4	SS	39								
			5	SS	22								
			6	SS	15								
			7	TW	PM								
			8	TW	PM								
			9	TW	PM								
			10	TW	PM								
			11	TW	PM								
			12	SS	10								
			13	TW	PM								
			14	TW	PM								
			15	SS	14								
539.0	Clayey Silt to Silty Clay with some sand and traces of gravel Grey Firm to very stiff		16	SS	12	530						Gr. 0% Sa. 10% Si. 38% Cl. 52%	
65.0			17	SS	14								
			18	SS	22								
494.5	End of Borehole (Probable Bedrock)					490							



ONTARIO

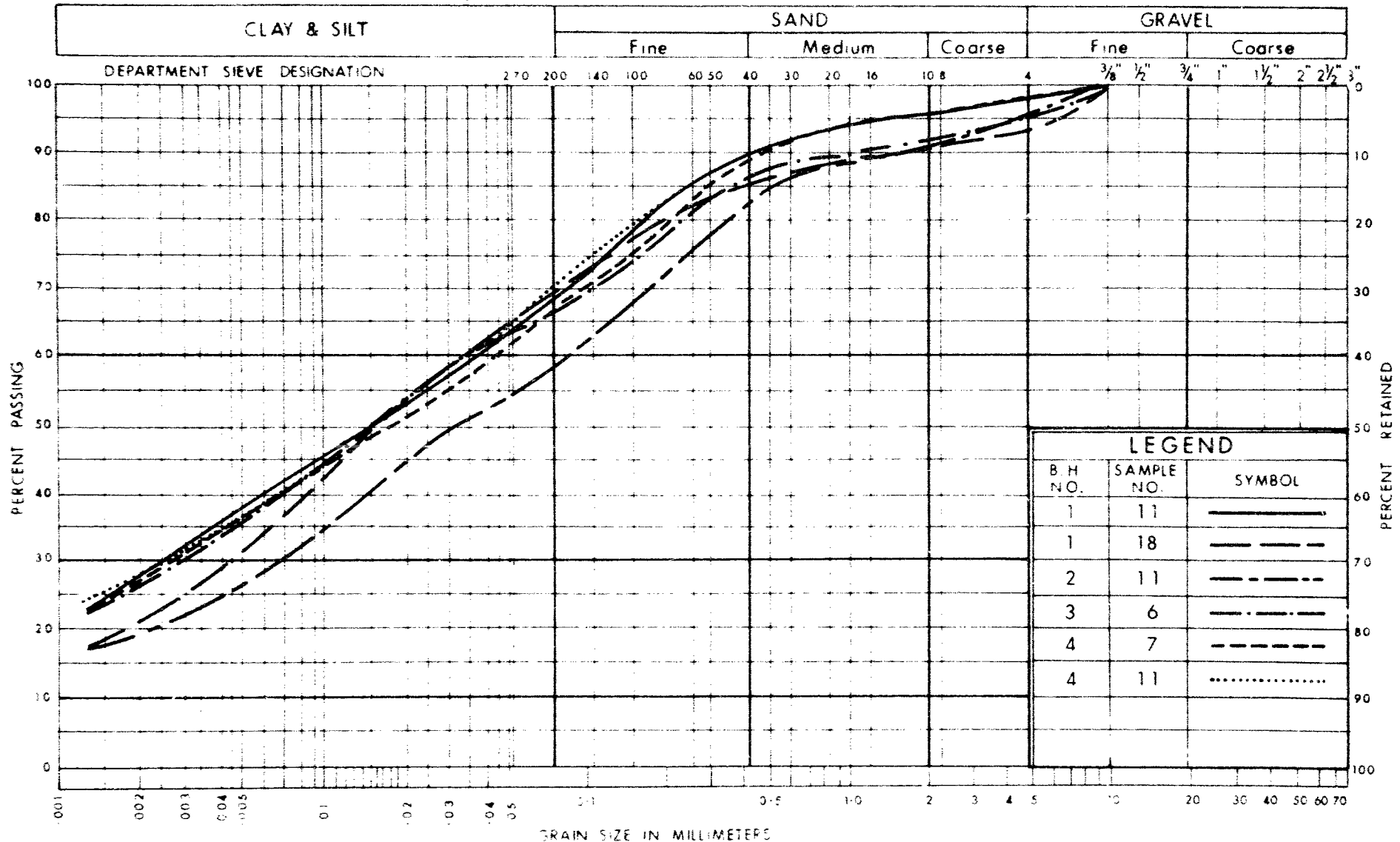
DEPARTMENT OF HIGHWAYS
MATERIALS and
TESTING
DIVISION

PLASTICITY CHART CLAYEY SILT

W.P. No. NIL

JOB No. 66 - F - 92

UNIFIED SOIL CLASSIFICATION SYSTEM



GRAIN SIZE DISTRIBUTION



ONTARIO

DEPARTMENT OF HIGHWAYS
MATERIALS and
TESTING
DIVISION

WP No.

JOB No. 66-F-92

ABBREVIATIONS USED IN THIS REPORT

PENETRATION RESISTANCE

STANDARD PENETRATION RESISTANCE 'N' : - 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>'N' BLOWS / FT.</u>	<u>c LB. / SQ. FT.</u>	<u>DENSENESS</u>	<u>'N' BLOWS / FT.</u>
VERY SOFT	0 - 2	0 - 250	VERY LOOSE	0 - 4
SOFT	2 - 4	250 - 500	LOOSE	4 - 10
FIRM	4 - 8	500 - 1000	COMPACT	10 - 30
STIFF	8 - 15	1000 - 2000	DENSE	30 - 50
VERY STIFF	15 - 30	2000 - 4000	VERY DENSE	> 50
HARD	> 30	> 4000		

TYPE OF SAMPLE

S.S.	SPLIT SPOON	T.W.	THINWALL OPEN
W.S.	WASHED SAMPLE	T.P.	THINWALL PISTON
S.B.	SCRAPER BUCKET SAMPLE	O.S.	OESTERBERG SAMPLE
A.S.	AUGER SAMPLE	F.S.	FOIL SAMPLE
C.S.	CHUNK SAMPLE	R.C.	ROCK CORE
S.T.	SLOTTED TUBE SAMPLE		
	P.H.	SAMPLE ADVANCED HYDRAULICALLY	
	P.M.	SAMPLE ADVANCED MANUALLY	

SOIL TESTS

Q _u	UNCONFINED COMPRESSION	L.V.	LABORATORY VANE
Q	UNDRAINED TRIAXIAL	F.V.	FIELD VANE
Q _{cu}	CONSOLIDATED UNDRAINED TRIAXIAL	C	CONSOLIDATION
Q _d	DRAINED TRIAXIAL	S	SENSITIVITY

ABBREVIATIONS USED IN THIS REPORT

SOIL PROPERTIES

γ	UNIT WEIGHT OF SOIL (BULK DENSITY)
γ_s	UNIT WEIGHT OF SOLID PARTICLES
γ_w	UNIT WEIGHT OF WATER
γ_d	UNIT DRY WEIGHT OF SOIL (DRY DENSITY)
γ'	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
s	SHRINKAGE LIMIT
I_L	LIQUIDITY INDEX = $\frac{w - w_p}{I_p}$
I_C	CONSISTENCY INDEX = $\frac{w_L - w_p}{I_p}$
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
τ_f	SHEAR STRENGTH
c'	EFFECTIVE COHESION INTERCEPT
ϕ'	EFFECTIVE ANGLE OF SHEARING RESISTANCE, OR FRICTION
c_u	APPARENT COHESION
ϕ_u	APPARENT ANGLE OF SHEARING RESISTANCE, OR FRICTION
μ	COEFFICIENT OF FRICTION
S_t	SENSITIVITY

GENERAL

π	= 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
σ	NORMAL STRESS
σ'	NORMAL EFFECTIVE STRESS ($\bar{\sigma}$ IS ALSO USED)
τ	SHEAR STRESS
ϵ	LINEAR STRAIN
γ	SHEAR STRAIN
ν	POISSON'S RATIO (μ IS ALSO USED)
E	MODULUS OF LINEAR DEFORMATION (YOUNG'S MODULUS)
G	MODULUS OF SHEAR DEFORMATION
K	MODULUS OF COMPRESSIBILITY
η	COEFFICIENT OF VISCOSITY

EARTH PRESSURE

d	DISTANCE FROM TOP OF WALL TO POINT OF APPLICATION OF PRESSURE
δ	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
β	ANGLE OF SLOPE TO HORIZONTAL