cc: GEN. FILES.

DEPARTMENT OF HIGHWAYS ONTARIO

MEMORANDUM

✓ 03-69-11

TO: Mr. T. J. Kovich,
Regional Materials Engr.,
Toronto Region,
Rm. 134-A, Lab. Bldg.

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

DATE: March 17, 1965

OUR FILE REF.

IN REPLY TO

SUBJECT:

FOUNDATION INVESTIGATION REPORT
For
The Stability of Cut Sections from
Sta. 25+00 to Sta. 39+00, Hwy. 10,
3 Miles North of Victoria, Ontario,
County of Peel, Dist. #6 (Toronto).
W.J. 65-F-25 -- W.P. 128-61-2

A verbal request was received in February 1965, from Mr. T. J. Kovich, Regional Materials Engineer, to investigate and determine the subsoil conditions at the site of the proposed cut widening on Hwy. 10, some 3 miles north of the Village of Victoria. At this site, it is intended to increase the width of the highway by approximately 30 ft.

Between Sta. 25+00 and Sta. 39+00, there are signs of cut slope instability. The shape and form of the earth movements indicate that the movements are rather shallow and localized.

The main purpose of the investigation was to obtain the necessary information as to whether the road widening through the existing cut is feasible under normal design and construction practices and to recommend measures that would prevent the re-occurrence of the above-mentioned slope surface movements.

cont'd. /2 ...

A foundation investigation was subsequently carried out at the site and the results of this investigation, together with our recommendations pertaining to the stability of the future cut sections, are presented in this report.

The investigation consisted of one sampled borehole located on the top of the cut section at Sta. 37+84, 150 ft. Rt. of centreline. In addition, two Norwegian piezometers were installed, one on the top of the cut and one at the toe. The exact locations, together with their elevations, are shown on Dwg. 65-F-25A.

The investigation revealed that the subsoil immediately below the top of the cut consists mainly of silt to clayey silt. This deposit extends down to 55 ft. where a stratum of dense sandy silt was encountered. The deposit of silt to clayey silt was too hard to obtain undisturbed samples and, therefore, only split-spoon samples were recovered. A wide range of 'N' values from 25 to 135 blows/ft. was recorded in this material. A plot of plasticity index versus liquid limit shows the majority of the points confined to the ML-CL region. Based on the laboratory tests, the physical properties of the material are summarized:

Natural Moisture Content	(W %)	--	17% - 20%
Liquid Limit	(W_L%)	--	23% - 27%
Plastic Limit	(W_P%)	--	18% - 20%

Grain Size Distributions:

Clay	9% - 21%
Silt	74% - 91%
Sand	1% - 5%

cont'd. /3 ...

Water levels observed in the two mentioned piezometers are as follows:

Piezometer	Ground Elev.	Tip Elev.	Water Level Elev.
P_1	969.5	926.6	935.4
P_2	925.2	915.2	no water

These water level observations are a further substantiation of the finding that the unevenness of the cut slopes is due to creep movements and erosion of a relatively shallow surface layer of silty material, rather than the result of a deep-seated movement.

Since surface and shallow seeping ground water is the cause of instability, it is recommended that the future slopes be designed and constructed in such a manner as to provide adequate and effective drainage that would take care of the mentioned water. A suggested section with a 10-ft. bench at the half height of the cut section, including subdrains at the toe and the bench, is shown on Drawing 65-F-25B.

The 6" Ø perforated pipe subdrains back-filled with G.B.C. Class 'B' material, should be located at least 4 ft. below the surface to provide for adequate frost protection. An intercepting ditch at the top of the cut is also recommended to protect the upper portion of the slope from surface run-off. The side slopes should be sodded, staked and wire-meshed as per D.H.O. Standards DD-403.

cont'd. /4 ...

We believe that the foregoing information is sufficient for your present purposes; however, if we can be of further assistance, please do not hesitate to contact this Office.

M. Devata
for A. G. Stermac,
PRINCIPAL FOUNDATION ENGINEER

MD/MdeF
Attach.

cc: Foundations Office
Gen. Files

APPENDIX I.

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 :-

CONSISTENCY	'N' BLOWS/FT.	c LB./SQ.FT.	DENSENESS	'N' BLOWS/FT.
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

Qu	UNCONFINED COMPRESSION	L.V.	LABORATORY VANE
Q	UNDRAINED TRIAXIAL	F.V.	FIELD VANE
Qcu	CONSOLIDATED UNDRAINED TRIAXIAL	C	CONSOLIDATION
Qd	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 $= \frac{w_L - w}{I_P}$
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
	IN TERMS OF EFFECTIVE STRESS $\tau_f = c' + \sigma' \tan \phi'$
c_u	APPARENT COHESION
ϕ_u	APPARENT ANGLE OF SHEARING RESISTANCE, OR FRICTION
	IN TERMS OF TOTAL STRESS $\tau_f = c_u + \sigma \tan \phi$
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 (YOUNGS 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_o	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

FORM OB-ML-126-REVISED
64-3040

OFFICE REPORT ON SOIL EXPLORATION

DEPARTMENT OF HIGHWAYS - ONTARIO
MATERIALS & TESTING DIVISION

RECORD OF BOREHOLE NO. 1

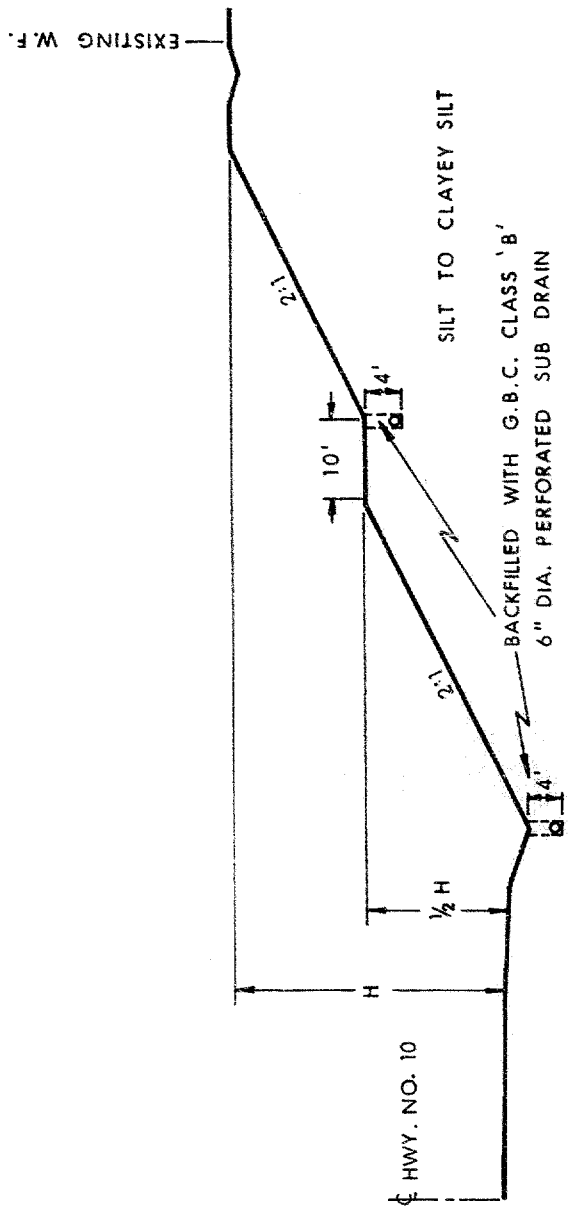
FOUNDATION SECTION

JOB 65-F-25 LOCATION Hwy 10 3mi. N of Victoria ORIGINATED BY C.K.

W.P. 128-61-2 BORING DATE Feb. 19, 22 & 24, 1965 COMPILED BY C.K.

DATUM G.S.C. BOREHOLE TYPE Washboring, using BX Casing. CHECKED BY M.D.

ELEV. / DEPTH	DESCRIPTION	STRAT. PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES BLOWS / FOOT	ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT (20 40 60 80 100) / SHEAR STRENGTH P.S.F.	LIQUID LIMIT w_L / PLASTIC LIMIT w_P / WATER CONTENT w / WATER CONTENT % (10 20 30)	BULK DENSITY γ P.C.F.	REMARKS
969.5										
0.0	Silt to clayey silt with traces of sand. (A layer of silty clay from El 925.5 to El. 921.5) (Brown) Very stiff to hard.		1	SS	48					Gr 0 Sa 0 Si 91 Cl 9
			2	SS						Gr 0 Sa 2 Si 78 Cl 20
			3	SS	135	960				
			4	CS			148 100/4"			
			5	SS	54		End of Cone Test 958.2			
			6	SS	36	950				
946.5										
23.0	(Grey brown to grey)		7	SS	28					Gr 0 Sa 5 Si 74 Cl 21
			8	SS	28	940				WL Elev 935.4 (Mar 5/65)
			9	SS	102					Gr 0 Sa 1 Si 90 Cl 9
			10	SS	37	930				
			11	SS	40					Gr 0 Sa 0 Si 59 Cl 41 Piez Tip El 926.6
			12	SS	25	920				
914.5										
55.0	Sandy silt.		13	SS	122/8"					Gr 0 Sa 41 Si) Cl) 59
55.7	End of borehole at El. 913.8					910				



SCALE: 1" = 20'

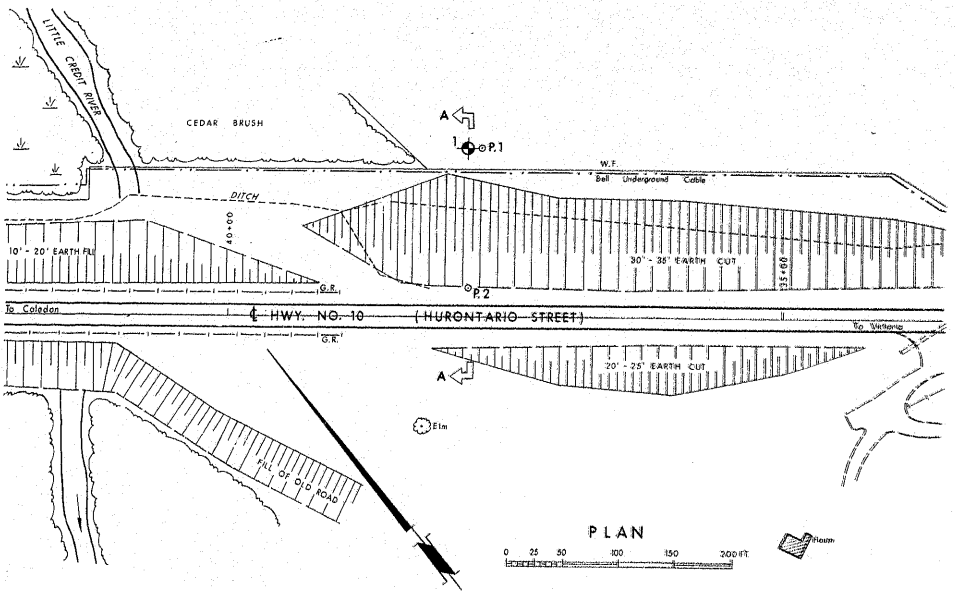
DEPARTMENT OF HIGHWAYS - ONTARIO MATERIALS & TESTING DIVISION FOUNDATION SECTION	**TYPICAL CUT SECTION** STA. 25+00 TO STA. 39+00 W.P. 128-61-2	JOB 65-F-25
DATE MARCH 25, 1965	APPROVED M Dwarte	DRAWING Nº 65 - F - 25B

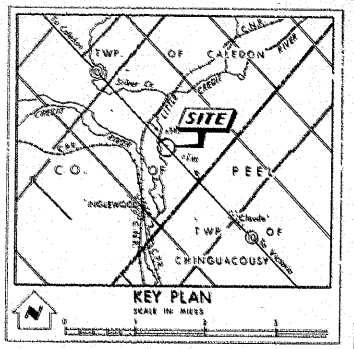
#65-F-25

W.P. #128-61-2

Hwy. #10

Stability of Cut Sections

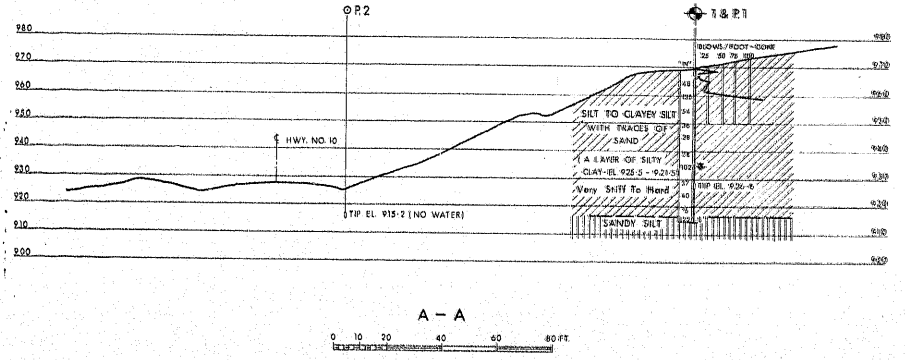




LEGEND

- Bore Hole
- Cone Penetration Hole
- Bore & Cone Penetration Hole
- Water Levels established at time of field investigation, Feb. 1965
- P. - Piezometer

IND.	ELEVATION	STATION	OFFSET
1	929.5	37+84	150' Rt.
P.1	928.3 (TIP)	37+74	150' Rt.
P.2	915.2 (TIP)	37+83	25' Rt.



A – A

0 10 20 40 60 80 FT.

- 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.

DEPARTMENT OF HIGHWAYS - ONTARIO
MATERIALS & RESEARCH SECTION

DEEP CUT
STA. 38+00

SHOWING POSITIONS & ELEVATIONS OF HOLES

HWY. 10 DISTRICT 6 COUNTY PEEL
TOWNSHIP CALEDON LOT 3 CON. 1 W.H.S.
LOCATION 3 MILES NORTH OF VICTORIA
DRAWN BY: F. CLARK CHECKED BY: W.R. 128-61-2
DATE MARCH 24, 1965 APPROVED BY: DRAWING NO. 65-F-25A
SCALE AS SHOWN

BRR NO. 13-8-146