

G.I.-30 SEPT. 1976

GEOCRES No. 3014-56DIST. 4 REGION W.P. No. 113-67-01CONT. No. 75-42W. O. No. STR. SITE No. HWY. No. 20LOCATION SauflervilleNo of PAGES -=====OVERSIZE DRAWINGS TO BE INCLUDED WITH THIS REPORT. REMARKS:



Memorandum

To: G. C. E. Burkhardt (2)
Regional Str. Plan. Eng.
Central Region
3501 Dufferin Street
Attention: Downsview, Ontario

From: Soil Mechanics Section
Geotechnical Office
West Building, Downsview

Date: February 26, 1975

Our File Ref. W.P. 113-67-01

In Reply to

MAR - 6 1975

Subject:

FOUNDATION INVESTIGATION REPORT

for

Road Widening & Culvert Extension
Sta. 560+00 to Sta. 565+00
Hwy. No. 20, Smithsville, District 4
W.P. 113-67-01



Attached we are forwarding to you our detailed foundation investigation report on the subsoil conditions existing at the above mentioned site.

We believe that the factual data and recommendations contained therein will prove adequate for your design requirements. Should additional information be required, please do not hesitate to contact our Office.

K. G. SELBY
Supervising Engineer.

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FOUNDATION INVESTIGATION REPORT

for

Road Widening & Culvert Extension
Sta. 560+00 to Sta. 565+00
Hwy. No. 20, Smithsville, District 4
W.P. 113-67-01

1. INTRODUCTION

Highway No. 20 west of Smithsville is to be widened by some 8 ft. Its profile grade and centre line, as understood, will remain unchanged. In order to accommodate the EBL shoulder as proposed, an additional fill, some 2 ft. wide, spilling over onto the upper portion of the existing slope, will be required. Because foundation problems have been experienced in the EBL between Sta. 560+00 and Sta. 565+00, the Soil Mechanics Section was requested to carry out a foundation investigation at the problem area. The purpose of the investigation is to provide recommendations for slope treatment so that the overall slope under the additional fill will be stable. Also requested from the Soil Mechanics Section are assessments of the foundation condition of a culvert which, in conjunction with the road widening project, is to be installed at Sta. 564+29 to replace the existing concrete box culvert because of its deteriorated condition.

A foundation investigation, therefore, was subsequently carried out by this Section. Our recommendations for slope treatment were summarized in a memo dated February 12, 1975, and those concerning the culvert foundation were presented in a memo dated February 24, 1975. Contained in this Report are results of our fieldwork, subsoil condition, together with our comments and recommendations.

2. DESCRIPTION OF SITE & FIELDWORK

The area concerned is located at the west side of the town of Smithsville, from Sta. 560+00 to Sta. 565+00. The terrain at the site can be described as a plateau overlooking the Twenty Mile Creek. In this locale, Hwy. No. 20 is bounded to the north by flat farm lands and detached houses, and to the south by a natural slope some 25 ft. high,

with the Twenty Mile Creek flowing in an easterly direction along the toe of the slope. It is estimated that the upper portion of the slope, which is composed mainly of granular road bed fill, is at 1.5 horizontal to 1.0 vertical, and the remaining portion, which is the natural ground, is at approximately 2 or 2.5 to 1.0. At present, the lower portion of the slope is well treed.

For a number of years, the EBL has been affected by problems caused by subsoil subsidence. Signs of ground movements are manifested in the development of longitudinal cracks in the pavement, misalignment of guide-rails, as well as tilting of trees. In a letter issued by this Office on July 17, 1967, it was inferred that this ground movement was surfacial and progressive in nature.

The concrete box culvert at Sta. 564+29 is believed to have been constructed in two sections. It appears that the downstream portion has moved as a whole, a small distance over the years, resulting in a slight widening of the construction joint. At present, the downstream portion appears to be in fairly good shape; however, the floor of the upstream portion is badly broken up. It is our opinion that this deteriorated condition may have been caused by frost-heaves, as ice was observed to form underneath the upstream floor during the recent field work and, while the floor is crumble, the ceiling practically shows no sign of distress. These cracks have provided passages for water to seep under the floor. In our view, this seepage not only would create voids under neath the floor, but also would very likely induce some degrees of softening of the underlying material, thus further undermining the culvert foundation.

A total of 13 sampled boreholes were put down at the site. B.H. 1A, 1-4 & 5A were located on the EBL shoulder, which were advanced uncased by means of a solid stem auger, to determine the depth and condition of the granular fill, as well as to reveal any softened material. B.H. 5-11 were located on the slope and were advanced by means of wash-boring techniques, to determine the condition of the natural subsoil. Since a rather precise subsoil stratigraphy is required for slope treatment, samples were recovered at 2 ft. intervals. All samples were obtained by means of a split-spoon sampler, driven into the soil in accordance with the

specification of Standard Penetration Test. Locations and elevations of boreholes were surveyed by personnel of Engineering Survey Services, and are shown in Dwg. No. 1136701-A.

3. SUBSOIL CONDITIONS

The boreholes located on the shoulder revealed a granular fill overlying stiff silty clay. Thickness of the fill was found to be 10 ft. in B.H. 1-4, 5 ft. in B.H. 1A, and 3 ft. in B.H. 5A, respectively. The fill material is generally composed of crushed stone and very silty sand, but that encountered in B.H. 5A also contained a considerable amount of topsoil and traces of clay. The 10 ft. thick fill was placed as a result of the recommendations contained in our letter of July 17, 1967 for slope treatment. This fill, at present, is at a 1.5:1 slope. As indicated by the low 'N' values, this fill apparently was not properly compacted and is in a loose state. In our opinion, the 1.5:1 slope is too steep for fill of such properties. Therefore, in our view, the existing fill probably is not very stable. The silty clay is found to have a very stiff consistency. We believe this silty clay, in its intact state, should not pose any stability problem. This silty clay was found underlain by a very dense sandy till, at a depth of 23 ft.

Encountered in the boreholes on the slope was about 2 ft. of fill, composed of crushed stone and silty sand with organics, asphalt pieces, and then silty clay. This silty clay is soft to firm in consistency. Its upper 5 ft. or so is highly fissured, which may be attributed to weathering, and contains root hair and traces of decayed vegetation. If water is present, it will be readily softened and reduced in shear strength. We believe this material may be responsible for the surfacial instability of the slope which occurs during the spring thaw.

Except in B.H. 5 & 11, where groundwater was observed at 1.5 ft. below ground surface, no groundwater levels were able to develop because of the impermeable nature of the clay and the short duration of the fieldwork.

Results of borings are summarized in the Borelog Sheets.

4. COMMENTS AND RECOMMENDATIONS

As understood, the Soil Mechanics Section was requested to provide recommendations to resolve the stability and settlement problems for the widening of Hwy. 20. Based on our findings, the following recommendations are presented:

(A) If possible, the alignment should be shifted 7 ft. away from the slope and the grade lowered by 2 ft. If this is followed, the problems can be resolved without elaborate slope treatment.

(B) If the original profile grade and the center line have to be retained, the following steps for slope treatments are necessary:

(B-1) To achieve stability only -

- Excavate old fill (about 5 ft.) and replace with well compacted new fill.
- Provide 18" filter blanket of Granular 'A' on slopes.
- Provide drainage outlets, also of Granular 'A', 4 ft. below surface into the river, spaced at 40' - c/c. Details of requirements are shown in Figure 1.

This scheme is intended to resolve the stability problem only and does not rule out the development of differential settlement because the pavement will be supported on different material of different thickness. However, the amount is not expected to be large, and this situation is expected to become stabilized in a year or two.

(B-2) To achieve stability and minimize differential settlement:

- Excavate about 10 ft. of old fill and replace with well compacted new fill.
- Provide filter and drainage as in (B-1).

See Figure 1 for details.

(C) For the culvert foundation:

- Excavate the softened material existing in the downstream

area as well as underneath the present culvert floor. The minimum amounts of excavation are shown in Figure 2 for culvert scheme A, and Figure 3 for culvert scheme B, respectively.

- Backfill the excavation with suitable granular material. Details of bedding, types of fill, and other requirements are contained in Figure 4.
- Provide an 18" filter blanket of Granular 'A' on the south slope of the embankment.
- Rip-rap for energy dissipation is required at both ends of the culvert. At the downstream area within 10 ft. from the outlet the rip-rap should have a thickness of at least 2 ft.
- Although scheme B does not dissipate as much energy of the run-off as scheme A does, we consider scheme B a better scheme for its simplicity, better drainage path in the bedding, and possibly smaller amount of differential settlement of the culvert.

5. MISCELLANEOUS

The fieldwork for this project was carried out during the period of January 28 - January 30, 1975, under the supervision of Mr. B. L. Ly.

Equipment used was owned and operated by Master Soil Investigation Ltd.

This report was prepared by Mr. B. L. Ly, and was reviewed by Mr. K. G. Selby, Supervising Engineer.

B. L. Ly

B. L. LY, P. Eng.

for: K. G. SELBY
Supervising Engineer.



February 28, 1975

ENGINEERING SERVICES BRANCH-GEOTECHNICAL OFFICE-SOIL MECHANICS SECTION

RECORD OF BOREHOLE NO 1

W.P. 113-67-01 LOCATION Sta. 563 +75 13' Rt. 0
 DIST. 4 HWY. 20 BORING DATE January 38, 1975
 DATUM Geodetic BOREHOLE TYPE Solid Stem Auger
 ORIGINATED BY BL
 COMPILED BY OJ
 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 γ	REMARKS % GR. SA. SI. CL.
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	'N' VALUES		20	40	60	80	100	w_p	w	w_L		
625.0	Ground Level															
0.0	Fill: crushed stone & silty sand, numerous asphalt pieces, traces of clay. Compact to Loose. Quite moist below 8 ft.		1	SS	60/5"	620										
			2	SS	21											
			3	SS	2											
615.0			4	SS	8											
10.0	Silty clay. Brown		5	SS	23											
611.5	Stiff & fissured.		6	SS	20											
13.5	End of Borehole					610										

RECORD OF BOREHOLE NO 1A

W.P. 113-67-01 LOCATION Sta. 564 + 00 o/s 15' Rt. 6
 DIST. 4 HWY. 20 BORING DATE December 12, 1974
 DATUM Geodetic BOREHOLE TYPE Solid Stem Auger
 ORIGINATED BY BL
 COMPILED BY OJ
 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 γ	REMARKS % GR SA. SI. CL.
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	"N" VALUES		20	40	60	80	100	w_p	w	w_L		
625.5	Ground Level															
0.0	Fill: (road bed) crushed stone and silty sand.					620										
620.5			1	SS	15											
5.0	Silty clay to clayey silt		2	SS	21											
	Stiff															
	Brown & Fissured		3	SS	28	610										
	Grey		4	SS	20											
602.5																
23.0	Sandy silt (glacial till) some clay & coarse 598.5 Grav. Very Dense, Grey d.k.		5	SS	29	600										
27.0	End of Borehole															
	Notes: 1. Auger refusal at elev. 598.5 2. Split spoon bouncing at el. 598.5 3. No groundwater observed. Hole stayed dry and open.															

ENGINEERING SERVICES BRANCH-GEOTECHNICAL OFFICE-SOIL MECHANICS SECTION

RECORD OF BOREHOLE NO 2

W.P. 113-67-01 LOCATION Sta. 563 + 35 13' Rt. 0 ORIGINATED BY BL
 DIST. 4 HWY. 20 BORING DATE January 28, 1975 COMPILED BY OJ
 DATUM Geodetic BOREHOLE TYPE Solid Stem Auger 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 γ	REMARKS % GR. SA. SI. CL.
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	'N' VALUES		20	40	60	80	100	w_p	w	w_L		
625.0	Ground Level															
0.0	Fill: compact crushed stones & silty sand, with asphalt pieces, dirt & trace of clay.		1	SS	8	620										
			2	SS	4											
			3	SS	8											
615.0			4	SS	16											
10.0	Silty clay. Stiff, Brown & fissured.		5	SS	26	610										
611.5			6	SS	29											
13.5	End of Borehole															

RECORD OF BOREHOLE NO 3

W.P. 113-67-01 LOCATION Sta. 562 + 95 13' Rt. 2 ORIGINATED BY BL
 DIST. 4 HWY. 20 BORING DATE January 28, 1975 COMPILED BY OJ
 DATUM Geodetic BOREHOLE TYPE Solid Stem Auger 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 γ	REMARKS	
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	'N' VALUES		20	40	60	80	100	SHEAR STRENGTH O UNCONFINED + FIELD VANE ● QUICK TRIAXIAL X LAB VANE					WATER CONTENT %
625.8	Ground Level																
0.0	Fill: compact to loose crushed stone & silty sand with asphalt pieces & trace of clay		1	SS	11	620											
			2	SS	7												
			3	SS	2												
615.8			4	SS	11												
10.0	Silty clay.		5	SS	25	610											
612.3	Stiff & Brown		6	SS	26												
13.5	End of Borehole																

RECORD OF BOREHOLE NO 4

W.P. 113-67-01 LOCATION Sta. 562 + 38 13' Rt. 0
 DIST. 4 HWY. 20 BORING DATE January 28, 1975
 DATUM Geodetic BOREHOLE TYPE Solid Stem Auger

ORIGINATED BY BL
 COMPILED BY OJ
 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 γ	REMARKS % GR. SA. SI. CL.
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	'N' VALUES		20 40 60 80 100									
							SHEAR STRENGTH ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE									
627.0	Ground Level															
0.0	Fill: compact crushed stones & silty sand with pieces of asphalt	X	1	SS	55	620										
		X	2	SS	30											
620.0		X	3	SS	10											
617.5	Silty clay, brown, stiff & fissured.	X	4	SS	20	610										
9.5	End of Borehole															
												</				

W.P. 113-67-01 LOCATION Sta. 564 + 20 53' Rt. 0 ORIGINATED BY BL
DIST. 4 HWY. 20 BORING DATE January 28, 1975 COMPILED BY OJ
DATUM Geodetic BOREHOLE TYPE Washboring CHECKED BY _____

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

ENGINEERING SERVICES BRANCH-GEOTECHNICAL OFFICE-SOIL MECHANICS SECTION

RECORD OF BOREHOLE NO 5A

W.P. 113-67-01 LOCATION Sta. 561 + 85 13' Rt. 2
 DIST. 4 HWY. 20 BORING DATE January 28, 1975
 DATUM Geodetic BOREHOLE TYPE Solid Stem Auger
 ORIGINATED BY BL
 COMPILED BY OJ
 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 γ	REMARKS
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	'N' VALUES		20	40	60	80	100	w_p	w	w_L		
627.0	Ground Level															
0.0	Fill: numerous dirt & trace of clay and asphalt.		1	SS	9											
624.0			2	SS	14											
3.0	Silty clay Brown Stiff					620										
616.5			3	SS	29											
11.5	End of Borehole					610										

RECORD OF BOREHOLE NO 6

W.P. 113-67-01 LOCATION Sta. 563 + 72 36' Rt. 6
 DIST. 4 HWY. 20 BORING DATE January 28 1975
 DATUM Geodetic BOREHOLE TYPE Washboring

ORIGINATED BY BL
 COMPILED BY OJ
 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 γ	REMARKS
ELEV. DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	N' VALUES		20	40	60	80	100	w_p	w	w_L		
615.0	Ground Level															
0.0	Fill: silty sand with crushed stones and clay, some asphalt pcs.		1	SS	5	610										
610.0			2	SS	14											
5.0	Silty clay fissured & weathered		3	SS	21											
			4	SS	37											
603.0	Stiff & Brown		5	SS	39											
12.0	End of Borehole					600										

OFFICE REPORT ON SOIL EXPLORATION

RECORD OF BOREHOLE NO 7

W.P. 113-67-01 LOCATION Sta. 563 + 33 28' Rt. 6
 DIST. 4 HWY. 20 BORING DATE January 29, 1975
 DATUM Geodetic BOREHOLE TYPE Solid Stem Auger
 ORIGINATED BY BL
 COMPILED BY OJ
 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 γ	REMARKS
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	'N' VALUES		20	40	60	80	100	W_P	W	W_L		
619.0	Ground Level															
0.0	Fill: crushed stone asphalt & dirty silty sand. quite moist		1	SS	33											
614.0			2	SS	19											
5.0	Silty clay Firm Brittle and fissured		3	SS	20											
			4	SS	62	610										
			5	SS	36											
605.0			6	SS	24											
14.0	End of Borehole					600										

RECORD OF BOREHOLE NO 8

W.P. 113-67-01 LOCATION Sta. 562 + 82 29' Rt. C ORIGINATED BY BL
 DIST. 4 HWY. 20 BORING DATE January 29, 1975 COMPILED BY OJ
 DATUM Geodetic BOREHOLE TYPE Solid Stem Auger 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 γ	REMARKS % GR. SA SI. CL.
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	'N' VALUES		20	40	60	80	100	w_p	w	w_L		
619.0	Ground Level															
0.0	Fill: compact crushed stones & silty sand with asphalt & clay.		1	SS	8											
614.0			2	SS	11											
5.0	Silty clay Brown and fissured Firm to Stiff		3	SS	15											
			4	SS	20											
607.0			5	SS	25	610										
12.0	End of Borehole															
						600										

W.P. 113-67-01 LOCATION Sta. 562 + 25 30' Rt. 6 ORIGINATED BY BL
DIST. 4 HWY. 20 BORING DATE January 29, 1975 COMPILED BY OJ
DATUM Geodetic BOREHOLE TYPE Solid Stem Auger CHECKED BY _____

15 ²⁰ 5 % STRAIN AT FAILURE
10

MINISTRY OF TRANSPORTATION AND COMMUNICATIONS-ONTARIO
ENGINEERING SERVICES BRANCH-GEOTECHNICAL OFFICE-SOIL MECHANICS SECTION

RECORD OF BOREHOLE NO 10

W.P. 113-67-01 LOCATION Sta. 562 + 45 44' Rt. 0
DIST. 4 HWY. 20 BORING DATE January 30, 1975
DATUM Geodetic BOREHOLE TYPE Solid Stem Auger
ORIGINATED BY BL
COMPILED BY OJ
CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER ELEV.	DYNAMIC CONE PENETRATION RESISTANCE PLOT					LIQUID LIMIT —WL PLASTIC LIMIT —WP WATER CONTENT —W			UNIT WEIGHT γ	REMARKS
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	'N' VALUES		20	40	60	80	100	WP	W	WL		
616.0	Ground Level															
0.0	Silt, stones & dirty															
613.0	Silty sand, trace of clay & asphalt.															
3.0	Silty clay. Brown.		1	SS	17											
	Fissured firm		2	SS	14											
	Stiff		3	SS	14											
606.0			4	SS	11	610										
10.0	End of Borehole					600										

MINISTRY OF TRANSPORTATION AND COMMUNICATIONS-ONTARIO
ENGINEERING SERVICES BRANCH-GEOTECHNICAL OFFICE-SOIL MECHANICS SECTION

RECORD OF BOREHOLE NO 11

W.P. 113-67-01 LOCATION Sta. 564 + 30 29' Rt. 6 ORIGINATED BY BL
DIST. 4 HWY. 20 BORING DATE January 30, 1975 COMPILED BY OJ
DATUM Geodetic BOREHOLE TYPE Solid Stem Auger 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 γ	REMARKS
ELEV. DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES		20 40 60 80 100					w_p w w_L				
							SHEAR STRENGTH									
							○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE					WATER CONTENT %				
610.5	Ground Level					610										
0.0	Silty Clay: brown & slightly layered. Quite moist. - Firm - Stiff					600										
			1	SS	25											
			2	SS	13											
599.5			3	SS	12											
11.0	End of Borehole															

OFFICE REPORT ON SOIL EXPLORATION

FIG. (1)

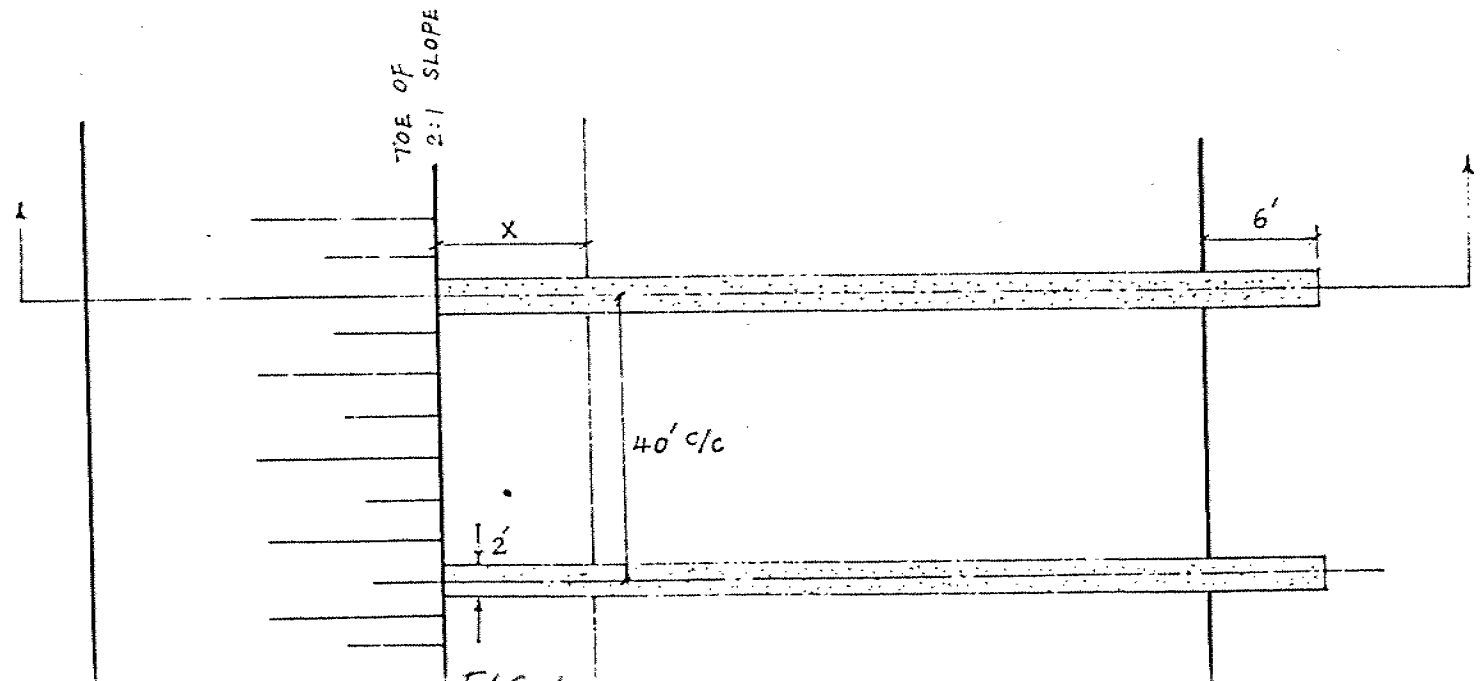
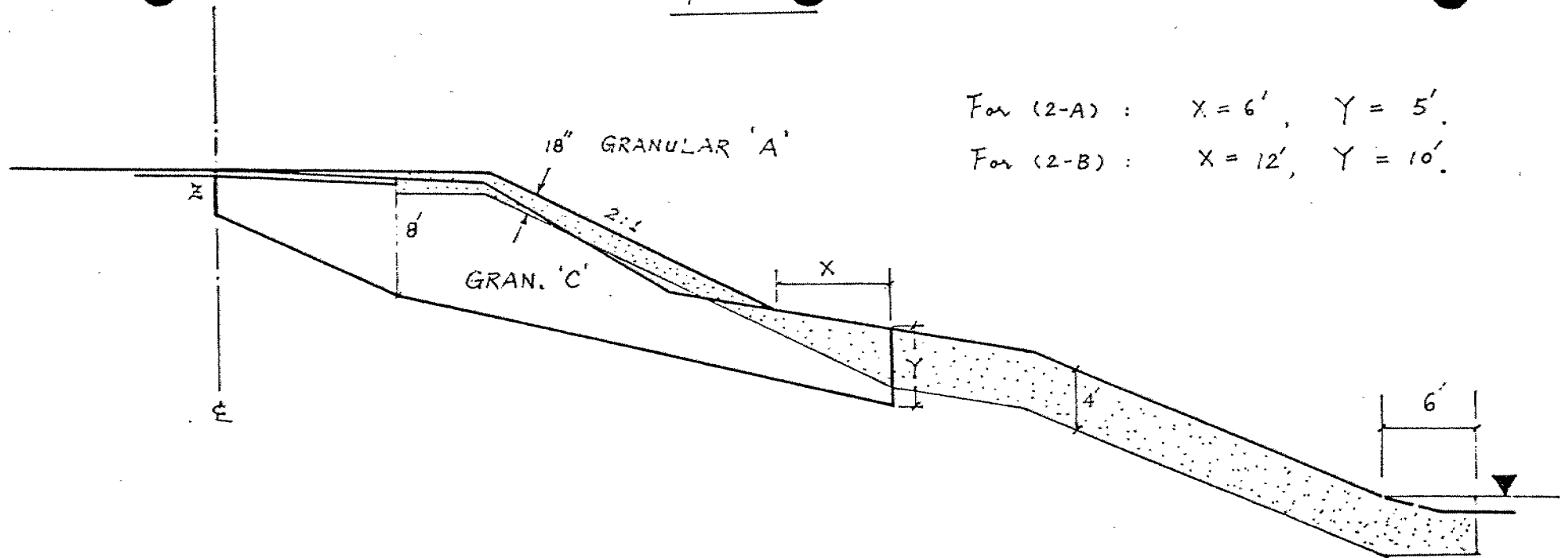
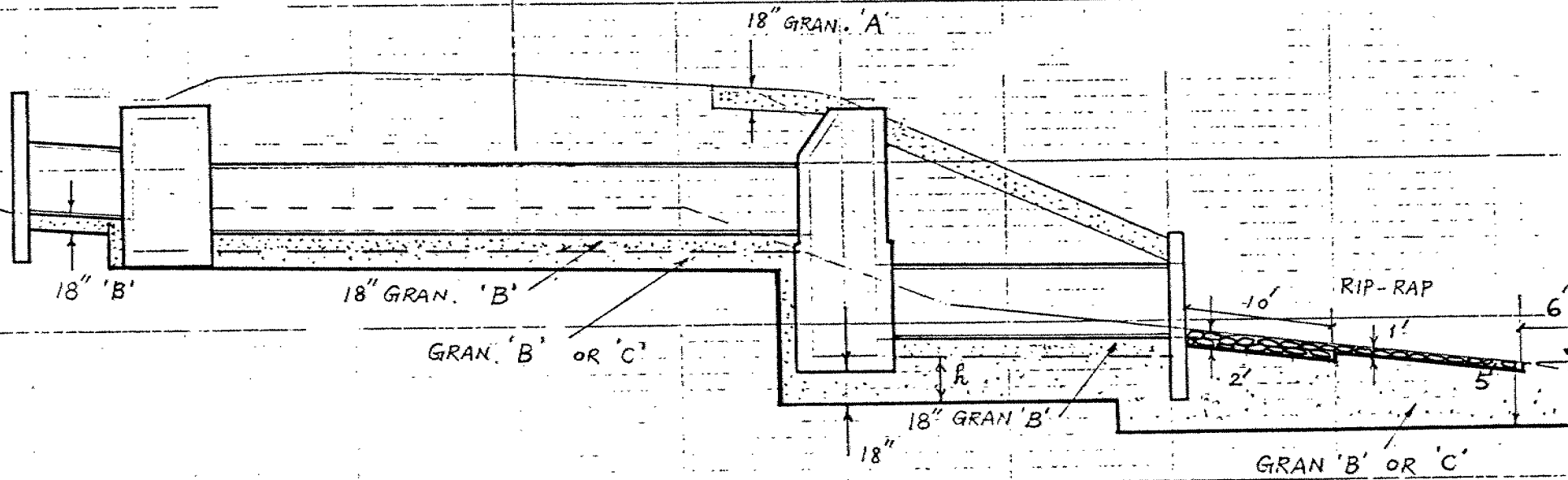


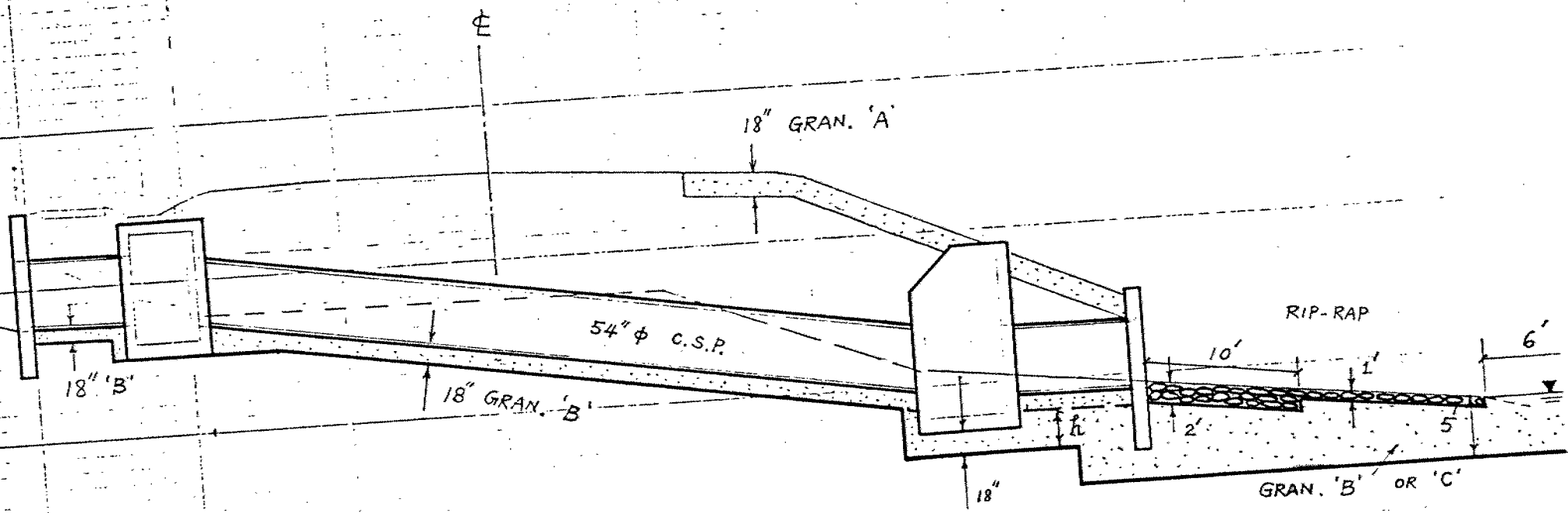
FIG. 1.

£



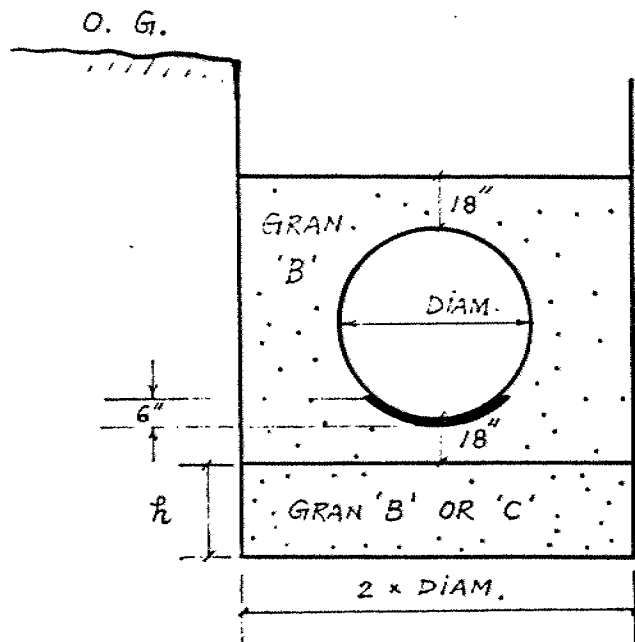
SCHEME A

FIG. 2



SCHEME B

FIG. 3



Note:

1. Bedding to be taken to 18" above the top of the culvert and 18" below the invert.
2. The width of the trench to be 2 times the diameter of the culvert.
3. Pipe bed to be carefully shaped to receive the lowest 6" segment of the pipe.
4. Bedding material to be granular B, free from stone greater than 3" in size.
5. Granular material from 6" above invert to 12" below invert to be left uncompacted.
6. Compaction of bedding material - 95%, except for area referred to in Note 5.
7. h to be determined by appropriate amount of removal of soft material, and to be backfilled with well compacted granular B or C.

FIG (4)

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

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
w_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

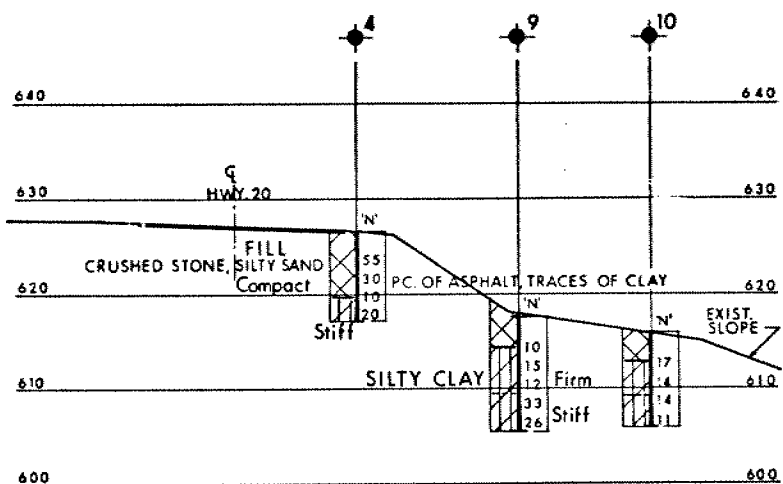
d	DISTANCE FROM TOP OF WALL TO POINT OF APPLICATION OF PRESSURE
δ	ANGLE OF WALL FRICTION
K	DIMENSIONLESS COEFFICIENT TO BE USED WITH VARIOUS SUFFIXES IN EXPRESSIONS REFERRING TO NORMAL STRESS ON WALLS
K_0	COEFFICIENT OF EARTH PRESSURE AT REST

FOUNDATIONS

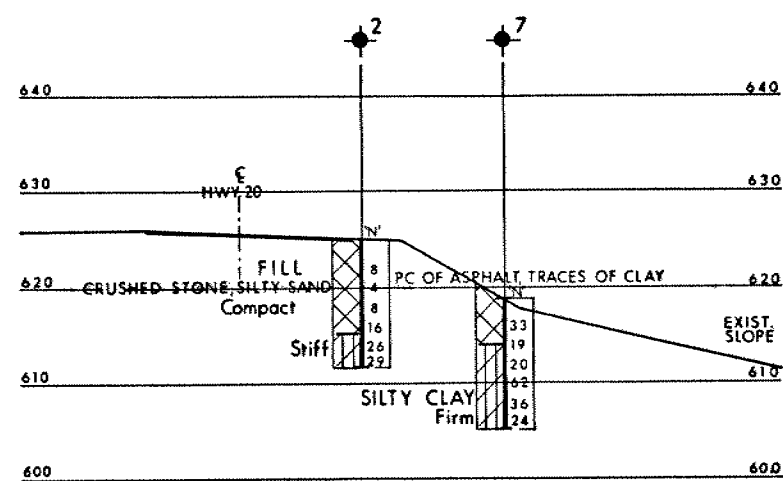
B	BREADTH OF FOUNDATION
L	LENGTH OF FOUNDATION
D	DEPTH OF FOUNDATION BENEATH GROUND
N	DIMENSIONLESS COEFFICIENT USED WITH A SUFFIX APPLYING TO SPECIFIC GRAVITY, DEPTH AND COHESION ETC. IN THE FORMULA FOR BEARING CAPACITY
k_s	MODULUS OF SUBGRADE REACTION

SLOPES

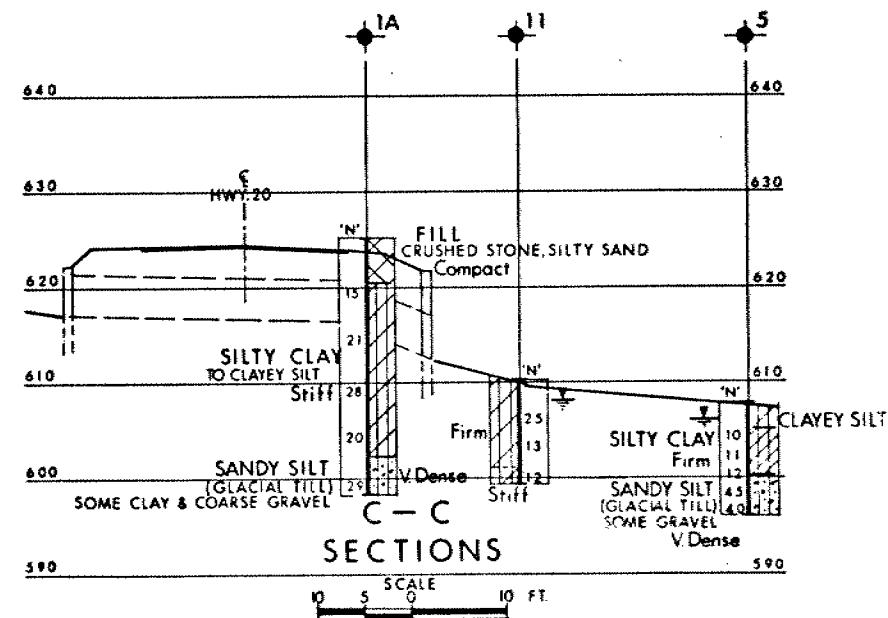
H	VERTICAL HEIGHT OF SLOPE
D	DEPTH BELOW TOE OF SLOPE TO HARD STRATUM
β	ANGLE OF SLOPE TO HORIZONTAL



A-A

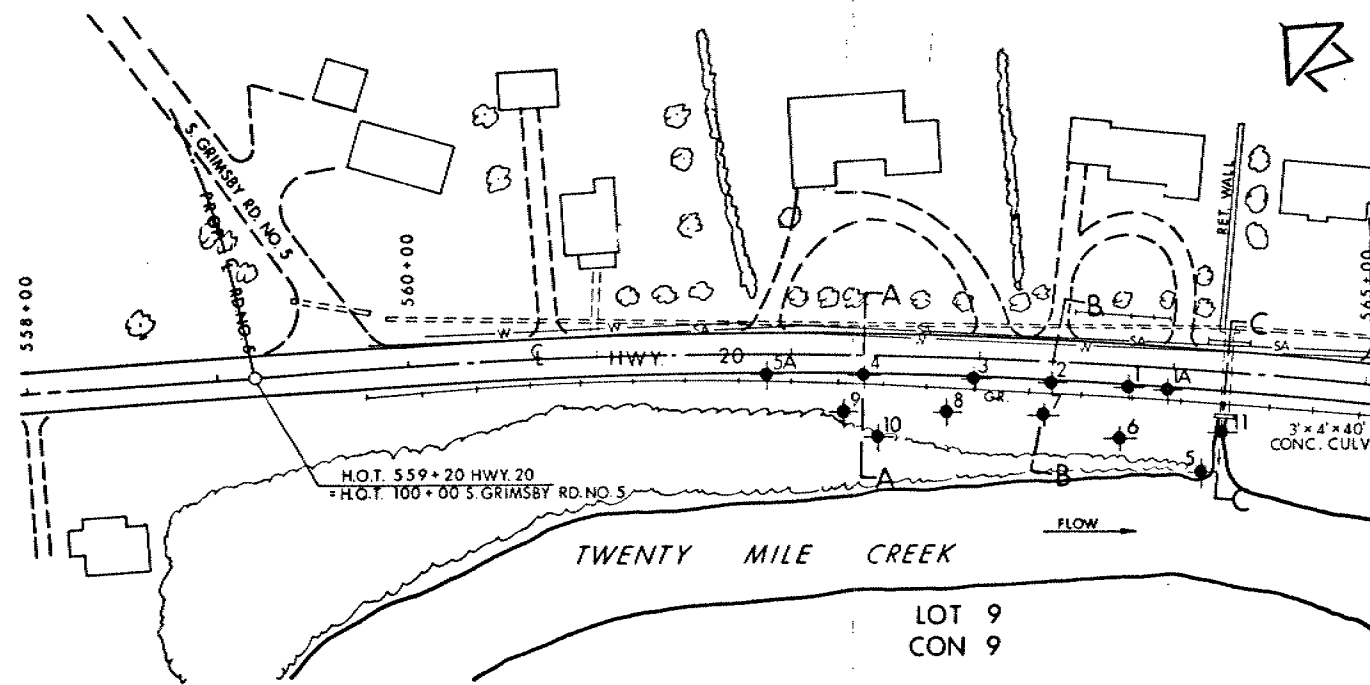


B-B



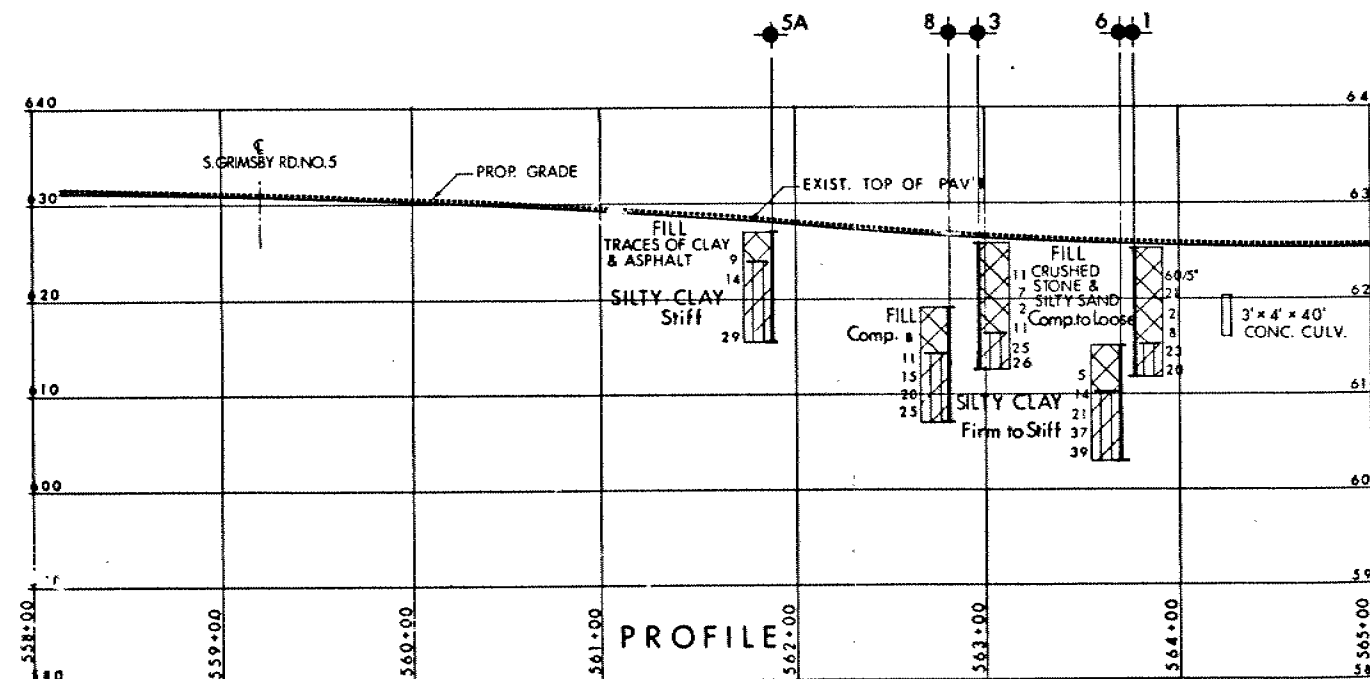
C-C

SCALE 10 5 0 5 10 FT.



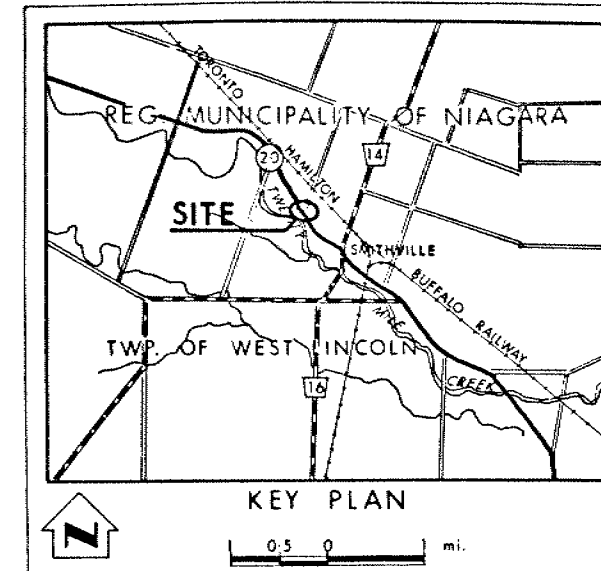
PLAN

SCALE 50 25 0 25 50 FT.



PROFILE

SCALE
HOR 50 25 0 25 50 FT.
VER 10 5 0 5 10 FT.



KEY PLAN

0.5 0 1 mi.

LEGEND

- Bore Hole
- ⊕ Dynamic Cone Penetration Resistance Test
- ⊕ Bore Hole & Cone Test
- W Water Levels established at time of field investigation 28 & 30 JAN. 1975 IN Bore Holes NO. 5 & 11 ONLY.

NO.	ELEVATION	STATION	OFFSET
1	625.0	563+75	13' RT.
1A	625.5	564+00	15' RT.
2	625.0	563+35	13' RT.
3	625.8	562+95	13' RT.
4	627.0	562+38	13' RT.
5	608.0	564+20	53' RT.
5A	627.0	561+85	13' RT.
6	615.0	563+72	36 RT.
7	619.0	563+33	28' RT.
8	619.0	562+82	29' RT.
9	617.5	562+25	30' RT.
10	616.0	562+45	44' RT.
11	610.5	564+30	29' 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.

NOTE: FOR CONTRACT DOCUMENTS
The complete foundation investigation report for this structure may be examined at the Structural Office and Foundations Office, Downsview, and at the HAMILTON District Office.

REVISIONS	DATE	BY	DESCRIPTION

MINISTRY OF TRANSPORTATION AND COMMUNICATIONS—ONTARIO
ENGINEERING SERVICES BRANCH—GEOTECHNICAL OFFICE—SOIL MECHANICS SECTION

ROAD WIDENING & CULVERT EXTENSION

STA. 560+00 — 565+00

HIGHWAY NO. 20 SMITHVILLE DIST. NO. 4

REG. MUNICIPALITY OF NIAGARA

TWP. W. LINCOLN LOT 9 CON. 9

BORE HOLE LOCATIONS & SOIL STRATA

SUBMITTAL	CHECKED	WP NO. 113-67-01	DRAWING NO.
DRAWN BY	CHECKED	WP NO.	1136701-A
DATE 12 FEB. 1975	SITE NO.		BRIDGE DRAWING NO.
APPROVED	CONF. NO.		





totten sims hubicki associates limited

Mr. P. F. Weber
Senior Soils Supervisor
Materials and Testing Office
Central Region
Ministry of Transportation and
Communications
3501 Dufferin Street
Downsview, Ontario

Re: W.P. 113-67-01,04,05
W.P. 632-69-01, Hwy. #20,
Smithville

Dear Sir:

In reply to your letter of January 3rd, 1975, we have reviewed our design proposals in the vicinity of the slope stability problem at Twenty Mile Creek, right of Station 560+00 to Station 566+00, Highway #20.

A reduction of the proposed shoulder width from 6'+2' to 4'+2' would not eliminate fill being placed on the slope.

Property restrictions on the north side of the highway and the curve geometrics ($\Delta=8^{\circ}30'$) prevent the possibility of shifting the highway alignment to the north in order that all the pavement widening may be carried out on the north side of the highway.

Please note that M.T.C. Standard DD-414, Benching of Earth Slopes, has been applied from Station 561+50 to Station 565+25, right and that the Earth Excavation (Grading) quantity for this project results in an excess of 32,000 cubic yards of material which may be used to stabilize the slope.

If you have any further questions regarding this matter, please contact this office at your convenience.

Yours very truly,

D. R. Woods, P. Eng.,

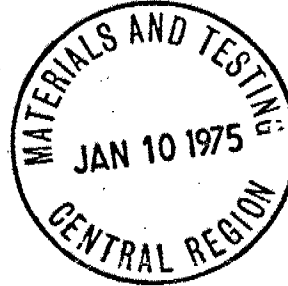
DRW/an

C.C. Mr. A. Sulavella

G.L. TOTTEN B.Sc., P. Eng.
R.E. SIMS B.A.Sc., P. Eng.
J.M. HUBICKI B.A.Sc., P. Eng.
R.L. WINDOVER M.Sc., P. Eng.
P.C. EBERLEE B.A.Sc., P. Eng.

1500 HOPKINS STREET, L1N 2C3
WHITBY, ONTARIO, (416) 668-9363

January 8th, 1975



Mr. W. Killin
Structural Planning Office
Central Region

Soil Mechanics Section,
Geotechnical Office,
West Building, Downsview.

December 19th, 1974

Embankment Widening and Culvert Extension,
W.P. 113-67-01, Sta. 564 + 29,
Highway 20, Smithville, District #4

A borehole was put down on the south shoulder of Highway 20, at Sta. 564 + 00, to obtain subsoil information for the above-mentioned project. Our findings and comments are as follow :

1. Subsoil encountered in the borehole consists of some 5 ft. (Elv. 625.5 - 620.5) of crushed stones and clayey, silty sand fill, 18 ft. (Elv. 620.5 - 602.5) of stiff silty clay to clayey silt, and then 4 ft. (Elv. 602.5 - 598.5) of very dense sandy silt (glacial till), with some clay and coarse gravel. Auger refusal was met at Elv. 598.5, where the split-spoon sampler was bouncing when driven. Due to the impervious nature of the cohesive soil, stable groundwater level was not developed in the short duration of the field work.
2. No stability problem is anticipated provided the new fill is constructed with a 2 (horizontal) : 1 (vertical) slope. The surface of the existing slope should be stepped and roughened according to M.T.C Standard DD-414, before the new fill is placed. The culvert should be supported on firm original ground, and all soft material underneath the culvert should be excavated and back-filled with compacted granular material. Because of the proximity of the Twenty Miles Creek, rip-rap for toe protection may be required. (Details of this requirement may be obtained from the Hydrology Section). Finally, vertical joints should be provided at the junction of the existing culvert and the extended portion, in order to accommodate differential movement.

B. Ly.
Project Engineer
For: K.G. Selby,
Supervising Engineer

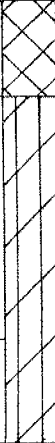

BL:jw

SMS
Jules

ENGINEERING SERVICES BRANCH-GEOTECHNICAL OFFICE-SOIL MECHANICS SECTION

RECORD OF BOREHOLE NO 1

W.P. 113-67-01 LOCATION Sta. 564 + 00 0/s 15' RT. 4 Highway 20 (Smithville) ORIGINATED BY B.L.
 DIST. 4 HWY. 20 BORING DATE December 12th, 1974 COMPILED BY B.L.
 DATUM Geodetic BOREHOLE TYPE Solid Stem Auger CHECKED BY CP

SOIL PROFILE			SAMPLES			GROUND WATER ELEV.	DYNAMIC CONE PENETRATION RESISTANCE PLOT					LIQUID LIMIT ——— w_L PLASTIC LIMIT ——— w_p WATER CONTENT ——— w			UNIT WEIGHT γ	REMARKS
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										
625.5	Ground Level														GR. SAT. CL.	
0.0	Fill: (road bed)					620										
620.5	Crushed Stone & Silty Sand															
5.0	Silty Clay to Clayey Silt		1	SS	15											
	Stiff		2	SS	21											
	Brown & Fissured		3	SS	28		610									
	Grey	4	SS	20												
602.5	Sandy Silt (Glacial Till) some clay & coarse gravel					600										
23.0	Very Dense Grey		5	SS	29											
598.5	End of Borehole															
27.0	Notes :															
	1. Auger refusal at elv. 598.5															
	2. Split spoon bouncing at elv 598.5															
	3. No Groundwater observed. Hole stayed dry and open.															