Mr. A. M. Toye,

Bridge Engineer.

Materials & Research Section.

July 6, 1960.

Re: TECHNICAL REPORT — by

Dr. H. Q. Golder, P.Eng.

Attention: Mr. [illegible] McCombie.

Re: Chedoke Expressway - Highway 403,
Escarpment Section - District 4.

Submitted herewith, is a technical report prepared by Dr. H. Q. Golder, outlining the design requirements along the escarpment section of the Chedoke Expressway.

The main area of instability occurs at Chainages - 576 - 579. The clay soil type in this area will have to be positively removed prior to constructing the embankment fill. As pointed out by Dr. Golder, the depth of excavation has not been positively defined. For estimating purposes, it is suggested that excavation quantities be based upon the bedrock elevation as determined by a geophysical survey in a report submitted by Hunting Technical Exploration Services, dated September, 1959.

We agree with Dr. Golder's suggestion that the bedrock contact should be precisely determined at several cross-sections within this area prior to letting the general contract for excavation. The stability of the embankment to be built in this area is dependent upon complete removal of this clay soil type, and a limited number of borings carried out before letting the contract would make the control work much more definite.

Once you have had an opportunity to review the requirements as set out in this report, we would appreciate having a meeting with you to discuss whether or not you feel that additional exploration in this area is necessary. The supplemental letter to the report prepared by Dr. Golder, has been attached at the back of this report.

[illegible]
Attach.
cc: Messrs. A. M. Toye (2)
H. [illegible] Tregaskes
R. C. Ramsay
I. Campbell
[illegible] Richardson
[illegible] J. Kavich
[illegible] Watt
D.O. Harbor & Surve. (4)
Foundations Office
Gen. Files.

[illegible] Alderman,
PRINCIPAL FOUNDATIONS ENGINEER

Mr. I.C. Campbell, January 4th, 1962.

Sr. Project Design Engineer. Hwy. #403, W.P. 140-57-2,

Materials & Research Division. Grade revision.

The designers, Messrs. I.C. Campbell (D.H.O.) and J. Disher (C.C. Parkers), have enquired what effect on the embankment stability a grade revision from 3.00% to 3.06% would have.

It is understood that the resulting new embankment heights are as follows:-

Station 570+00	47.8'
571+50	47.4'
572+00	46.0'
572+50	36.5'
573+00	30.5'
574+00	39.3'
578+50	34.1'
579+00	30.9'
588+50	31.5'
589+00	33.5'
589+50	34.6'
590+00	31.6'
590+50	34.1'

East of Station 579+00, there is no evidence within the escarpment slope for the presence of a weak clay stratum between bedrock and the dense clay till and/or the talus. The embankment height limit of 30 feet (as per Dr. Golder's Report of November, 1960), does, therefore, not apply in this section and the greater embankment height is not expected to be harmful.

West of Station 579+00 the greatest embankment height is 34.6'. It occurs at Station 589+50, only some 25' from trial shaft "A" where the shear strength of the critical clay layer was found to be over 2700 p.s.f. This is more than twice the strength of 1.000 p.s.f. on which the 30' embankment height limitation is based. It is, therefore, suggested that the proposed increased embankment height (34.6') is well within the supporting capacity of the escarpment slope.

R. Schonfeld,
Project Soils Engineer.
For: T.J. Kovich,
Regional Soils Engineer.

RS/hl
c.c. C.J. Parker,
A. Stermac,
T.J. Kovich (2),
Files.

HUGH Q. GOLDER P.Eng.
D.Eng., M.I.C.E., M.E.I.C.
Consulting Civil Engineer

1706A AVENUE ROAD
TORONTO 12
RUssell 7-5711

23-65-171-

002

CHEDOKE EXPRESSWAY - HIGHWAY 403

ESCARPMENT SECTION

002 CHEDOKE EXPRESSWAY - HIGHWAY 403 - HAMILTON, ONTARIO.

NOTES ON THE ESCARPMENT SECTION

1. These notes deal with the section of the expressway which climbs up the escarpment, chainages 547+00 (bottom of scarp) to 599+00 (top of scarp). These are the new chainages (old chainages 302 to 250 approximately, see Table II).

2. The construction here will be partly in cut and partly on fill on sidelong ground.

3. The geology is explained in the report by Hunting Technical and Exploration Services Ltd. entitled "Report on Seismic Investigations of Proposed Relocation of Highway No. 2 near Ancaster, Ontario" and dated September, 1959. The escarpment is composed mainly of limestones of various formations. Below the limestone is the Queenston Shale. This material breaks down rapidly on exposure to the atmosphere. However it does not enter into the present discussion, because the road level is well above this horizon, except at the bottom of the scarp where there is no problem of stability.

4. The limestone bedrock is covered on the slope by talus material which is a mixture of all the rock of the different formations in the face, plus a certain amount of glacial material from the top of the slope. Some of the rocks in the face are of a shaley nature and the possibility exists that clay

may occur in the talus material. This could constitute a layer of weakness in the construction of the embankments on sidelong ground.

5. To examine the nature of the talus material three test pits (Series I) were put down at points where the proposed embankment was to be high. These points were chainages 594, 150 ft. north of centre line (Pit 1), ch. 589, 100 ft. north of centre line (Pit 2), and ch. 594, 60 - 70 ft. north of centre line (Pit 3).

The bank was to be 46 ft. high at chainage 594 and 72 ft. high at chainage 589. The logs of the pits are given in Table 1. All the pits showed soft clay at a depth of about 3 to 6 ft. Without doing any tests it was evident that a bank 46 ft. high or greater could not be built on this clay.

6. An analysis was then made to determine the shear strength in the clay which would be required for stability. This was of the order of 2, 000 lb/sq.ft. Further, assuming a shear strength of the order of 500 lb/sq.ft. (a reasonable figure from the visual examination made of the samples from the pits) an analysis was made to determine how much of the clay could safely be left in place under the tipped rock forming the embankment.

It soon became evident that the slope of the ground surface below the centre line for a distance of at least 300 ft. had a great effect on the stability, and the Consultants were asked to provide cross sections every 200 ft. giving this information.

The two cases analysed and the results obtained are shown in Appendix I.

7. The cross sections were then examined and at each 100 ft. point a note

was made of the probable treatment necessary, based on the previous analysis and the slopes. The results are given in Table II. This table showed that there was a considerable length from ch. 558 - 566 where it was doubtful whether or not the clay could be left in. Three more test pits (Series II) were therefore dug at chainages 560+23, 563+25 and 565+25 to examine the clay. This proved to be very hard. An analysis had shown that a strength of clay of 700 lb/sq.ft. would be adequate here. This clay can therefore safely be left in position. The logs of these test pits are also given in Table I. The analysis referred to is given in Appendix II.

8. The present position is given below

Chainage	Treatment
547 - 552	Leave clay in
552 - 558	This is a cut section
558 - 576	Leave clay in - buttresses may be required at chainages 567-8, 571 and 575 (see figure 1).
576 - 599	Take clay out. Investigate the possibility of partial removal at ch. 590-592 and 597-598.

> It would be wise to open more test pits in this area as the above judgement is based on only three pits.

9. Above the roadway there will be cut in rock along the whole length. Local experience shows that the rock will stand well at a steep slope (say $1\frac{1}{4}$:1), but there will be some fall of rock and a wide berm must be left to allow this to fall and to collect without danger to the highway. A berm of at

least 10 ft. with a fence to prevent rolling of the rock would seem to be indicated.

At the top of the escarpment the rock is covered by a mantle of till. This should be cut back at 2:1 slope with a small berm at the top of the rock for drainage purposes.

There will probably be places where the rock is not considered good enough to cut at $1\frac{1}{4}$:1. In this case probably the best solution will be to support the bottom portion of the rock face by a crib wall, using steel or reinforced concrete sections and making sure that clean rock is used to fill the crib. The surface above this can be sloped at a suitable angle to the top. It would not be economical to try to determine these areas, nor the slopes to be used, at present. This is much better done as excavation proceeds.

REGISTERED PROFESSIONAL ENGINEER
CIVIL
H. Q. GOLDER
PROVINCE OF ONTARIO

May 1960

H. Q. Golder.

TABLE I.

LOGS OF TEST PITS ON ESCARPMENT SECTION.

SERIES I. Jan. 11th & 12th, 1960.

Pit No.	Chainage & Position		Description
1.	ch. 594 150 ft. N. of C.L. On flat section near bottom of slope	0 - 9" 9" - 4'0"	Brown topsoil and roots Broken limestone and brown soil with roots - very loose - large voids
2.	ch. 589 100 ft. N. of C.L.	0 - 6" 6" - 2'6" 2'6" - 4'6" 4'6" - 7'0"	Dark brown loamy topsoil with roots Angular limestone lumps 2" to 12" (some bigger) - outside stained brown. Voids contain some friable dry brown soil and roots - very loose. Ditto but voids nearly filled with soft brownish red clay - few roots. Brown sandy clay - very soft and wet with angular limestone fragments. A few rounded pebbles - some greenish fragments.
3.	ch. 594 60 to 70 ft. N. of C.L. i.e. higher up slope than Pit 1. on small flat area on slope.	0 - 8" 8" - 20" 20" - 3'6"	Dark brown almost black topsoil with roots Brown clayey soil - friable - with some roots - large numbers of angular limestone rock fragments - all sizes up to (and exceeding) 1 ft. Soft to firm brown clay matrix - large limestone rocks and stones.

SERIES II. March 9th 1960

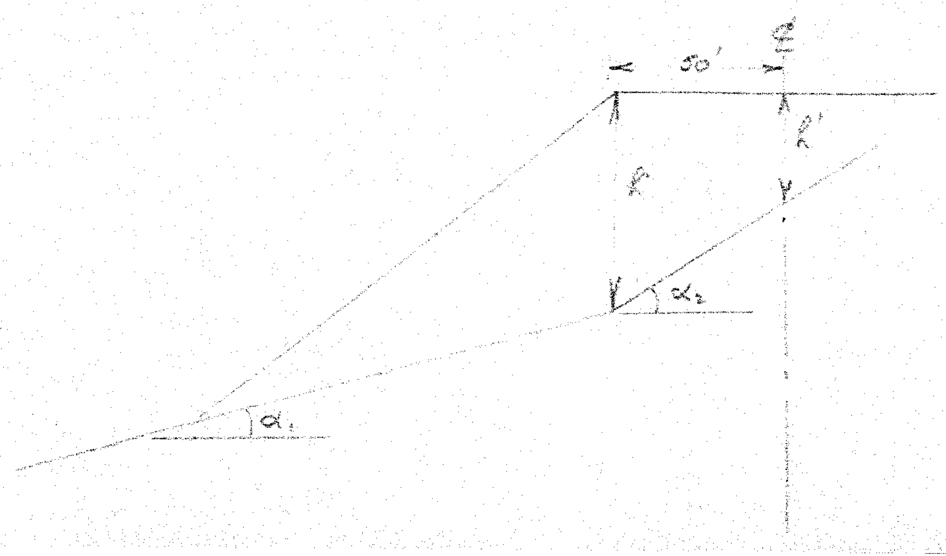
Pit No.	Chainage & Position		Description
1.	ch. 565 + 25	0 - 12"	Brown topsoil and roots
		12" - 7'0"	Angular limestone fragments - voids filled with hard clay
		7'0" +	Brownish grey hard dense clay possibly till.
2.	ch. 563 + 25	0 - 12"	Brown to black topsoil and roots with stones
		12" - 3'0"	Angular limestone fragments with brown soil and few roots
		3'0" - 6'0"	Ditto - lighter in colour - no roots - very dry
		6'0" - 12'0"	Loosely packed limestone fragments voids empty
		12'0" +	large void 2'-3' deep at pit bottom.
3.	ch. 560 + 23	0 - 12"	Brown topsoil with roots
		12" - 3'0"	Hard brown clay
		3'0" - 12'0"	Hard indurated clay mixed with limestone fragments
		at 12'0"	Orange sand at one side of pit. Fragments of red shale & signs of water.

TABLE II.

ESCARPMENT - STABILITY OF ROCK-FILL BANK.

Chainage Old	Chainage New	Ht. of bank-ft. h-edge	Ht. of bank-ft. h'-Cl.	α°	α°	Observations from Cross-Sections	Result	Roll No.
250	599	42	6	28	39	Top of Scarp. Slope about 35° - take out clay.	OUT	6
251	598	46	15	18	31	16° flattening to 11° - probably take out clay		
252	597	47	12	16	35	Flat for 20-30ft. - may be safe with some excavation		
253	596	33	7	27	27	24° - take out clay		
254	595	41	14	31	31	Small flat - then steepens to 32° take out clay in lower portion		
255	594	46	18	30	28	33° slope - must take out clay		
256	593	47	20	29	29	25° slope - " " " "		CaseI
257	592	56	25	32	32	27° flattens to 15° - probably take out clay	IN?	
258	591	66	36	31	31	26°- flattens to 10° - possibly leave in		
259	590	69	39	31	31	28° -flattens to 10° - possibly leave in		Case
260	589	72	39	33	33	25° slope - take out clay	OUT	5
261	588	59	33	28	28	28° " -must take out clay n.e.		
262	587	48	25	28	25	26° " " " " "		
263	586	45	20	25	29	25° " " " " "		
264	585	49	18	25	32	24° " " " " "		
265	584	37	13	27	25	29° " " " " " n.e.		
266	583	45	18	28	32	29° " - take out clay - or large buttress on flat section below		
267	582	48	22	21	27	25° slope - must take out clay		
268	581	44	18	28	28	26° " - take out clay		-
269	580	42	17	30	27	26° slope - must take out clay		
270	579	40	17	23	28	23° " - " " " "		
271	578	33	11	23	23	24° " - " " " " n.e.		4
272	577	25	9	26	23	16° increasing to 21°-must take out clay		
273	576	19	0	21	24	20° slope - must take out clay		
274	575	20	0	20	29	25°slope - then flat section <10° possible buttress- leave in	IN	
275	574	5	0	18	9	15° slope-low bank -leave in		
276	573	1	0			15° " -then flat - " "		
277	572	6	0	28	26	30° " - small bank - dig flat base for bank - leave clay in.		

Chainage Old	Chainage New	Ht. of bank-ft. h-edge	Ht. of bank-ft. h'-Cl.	α_1°	α_2°	Observations from Cross-sections	Result	Roll No.
278	571	20	0	17	32	30° dropping to 17° -probably take clay out - could buttress		4
279	570	27	10?	13	18	11° slope - probably leave clay in		
280	569	~~41~~ 12	~~38~~ 8	4	10	Flat - leave clay in		3
281	568	44	25	13	19	Flat - then 35° scarp - leave clay in and buttress		
282	567	~~35~~ 13	~~10~~	12	26	10° slope - leave clay in + buttress		
283	566	9	0	22	14	> 25° slope - take out unless clay is strong		
284	565	11	0	20	19	20° slope -take out unless clay is strong.		
285	564	12	0	17	20	20° dropping to 12° - possibly leave in		
286	563	11	0	20	20	20° - take out unless clay is strong	Nil if clay strong	
287	562	9	0	20	20	22° - could buttress		
288	561	12	0	20	20	16° - small flat area-could leave in		
289	560	10	0	20	20	25° - take out unless clay is strong		
290	559	10	0	10	24	24° slope - area to be stripped small - take out -unless clay is strong		2
291	558	3	0	18	28	Mainly cut - take out -unless clay is strong		
292	557				CUT			
297	552	10	0	7	7	4° slope - low bank - leave clay in.		
298	551	10	0			leave in + buttress		
299	550	16	0	10	18	21° to flat - leave in + buttress	Nil	
300	549	9	0	18	18	No problem - low bank - leave clay in		1
301	548	21	0	7	21	Flat - low bank - leave clay in		
302	547	16	6			" " " " " "		
						Bottom of scarp		



APPENDIX I.

Analyses of Cases I and II.

Case I.

If x = 165 ft. all clay is taken out, but if x = 100 ft. very little excavation is involved up the slope.

S = O for F = 1 x = 98 ft.
S = 500 lb/sq.ft. for G = 1 x = 93 ft.

Conclusion for Case I - 100 ft. of clay taken out involves little excavation up the slope and gives a satisfactory result i.e. no shear strength required in remaining clay for F = 1.

Case II.

S = 0 for F = 1 x = 114 ft.
S = 500 lb/sq.ft. for F = 1 x = 110 ft.
S = 2,000 lb/sq.ft. " x = 0 ft.

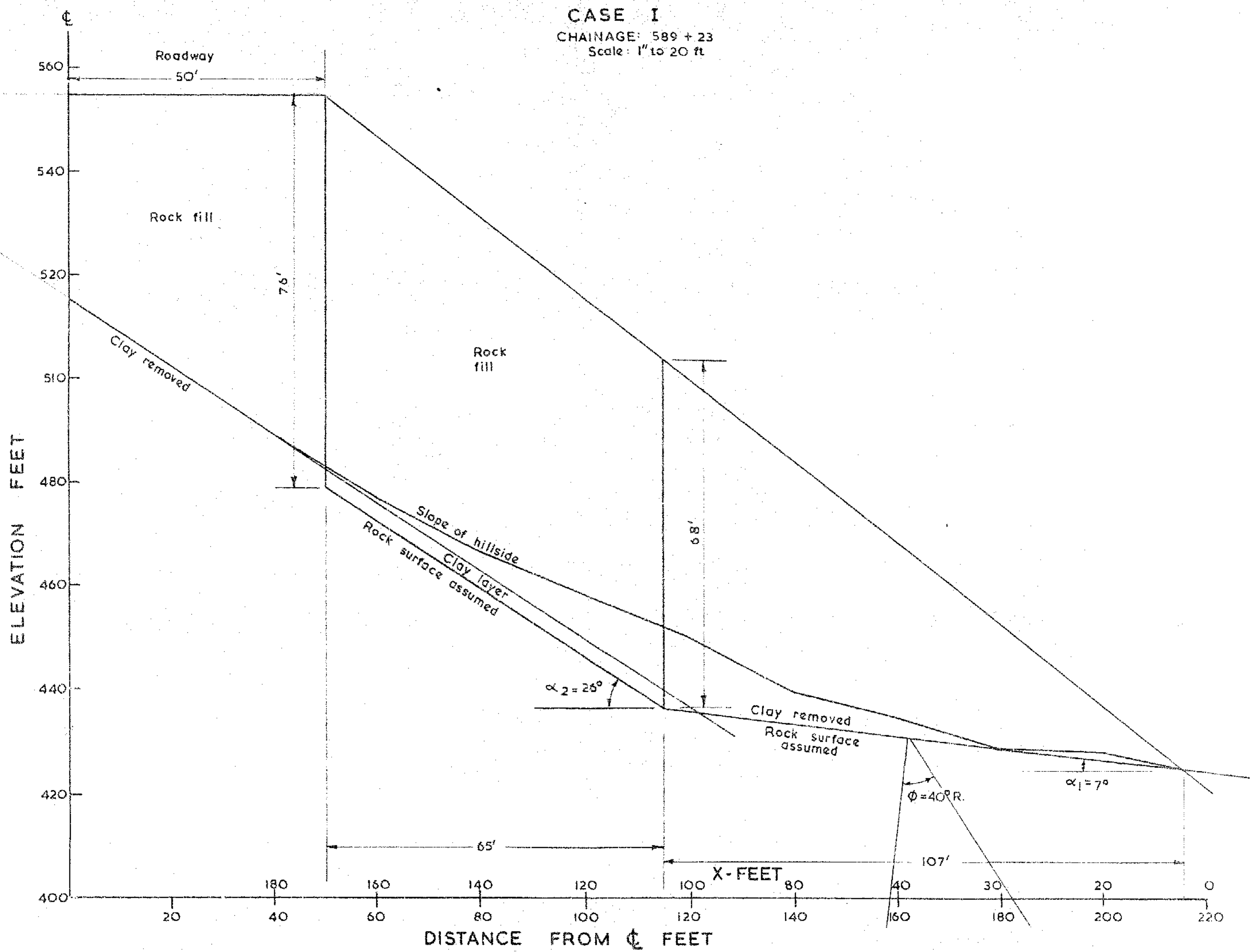
This involves removing nearly all the clay on the slope, unless S approaches 2,000 lb/sq.ft.

Conclusion for Case II.

For all practical purposes, all the clay must come out unless 'S' is much greater than we think i.e. is of the order of 2,000 lb/sq.ft.

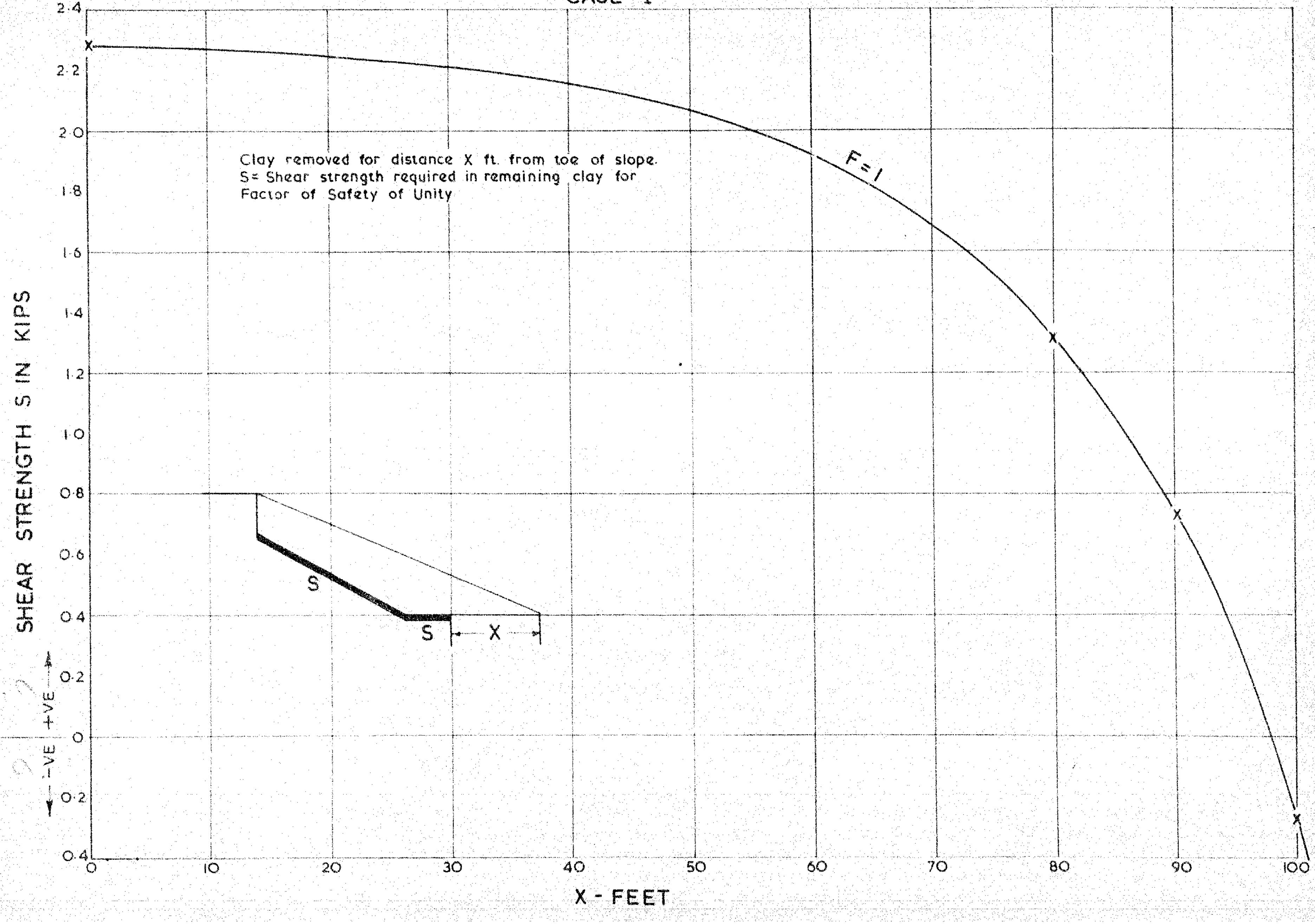
General Conclusion.

The shape of the hillside within 300 ft. of the centre line is of great importance. We must have extended profiles at every 200 ft.



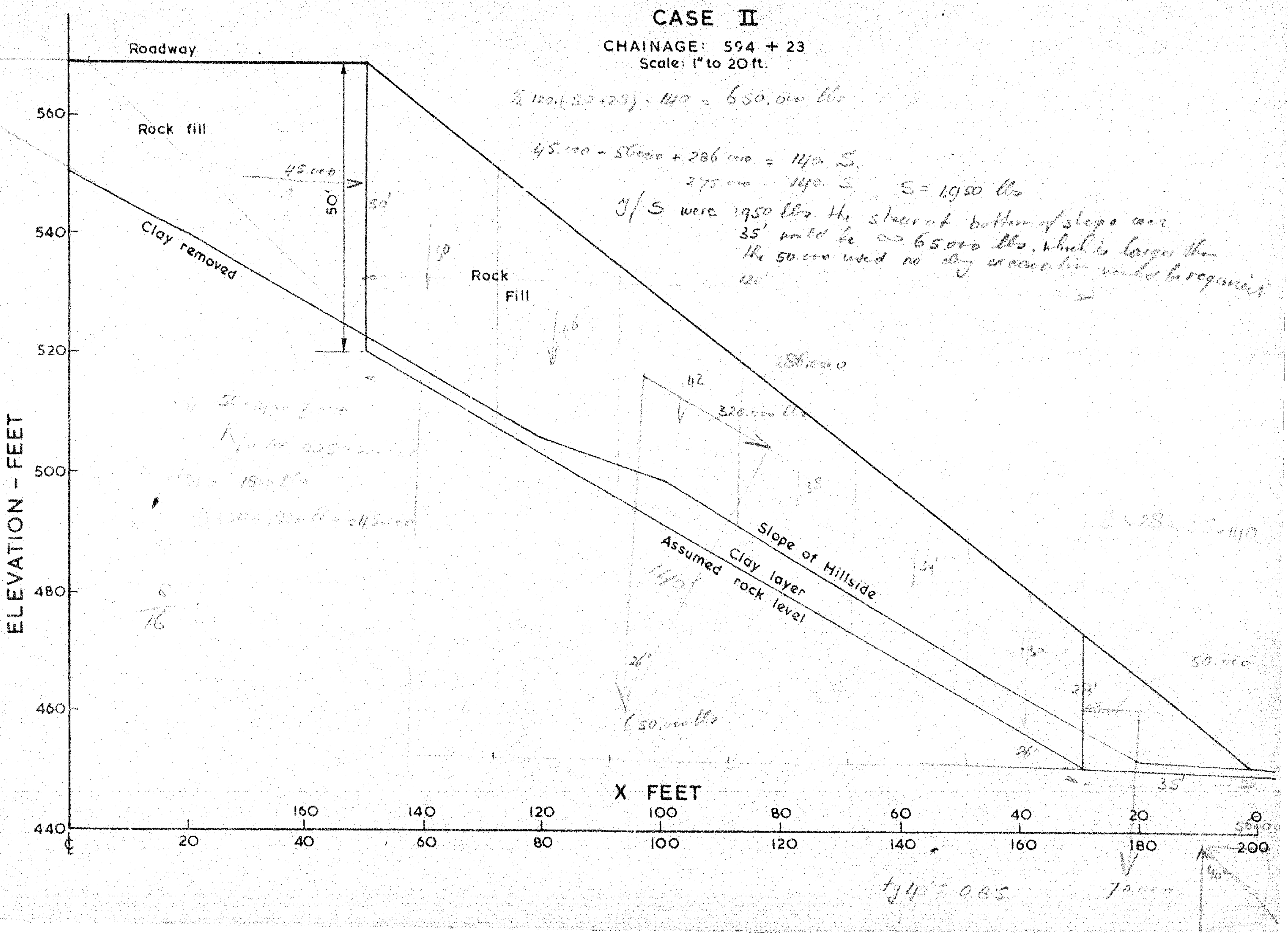
CASE I
CHAINAGE: 589 + 23
Scale: 1" to 20 ft
Roadway
50'
Rock fill
Rock fill
76'
68'
Clay removed
Slope of hillside
Clay layer
Rock surface assumed
$\alpha_2 = 26°$
Clay removed
Rock surface assumed
$\phi = 40°R.$
$\alpha_1 = 7°$
65'
107'
X - FEET
ELEVATION FEET
DISTANCE FROM ℄ FEET

CASE I

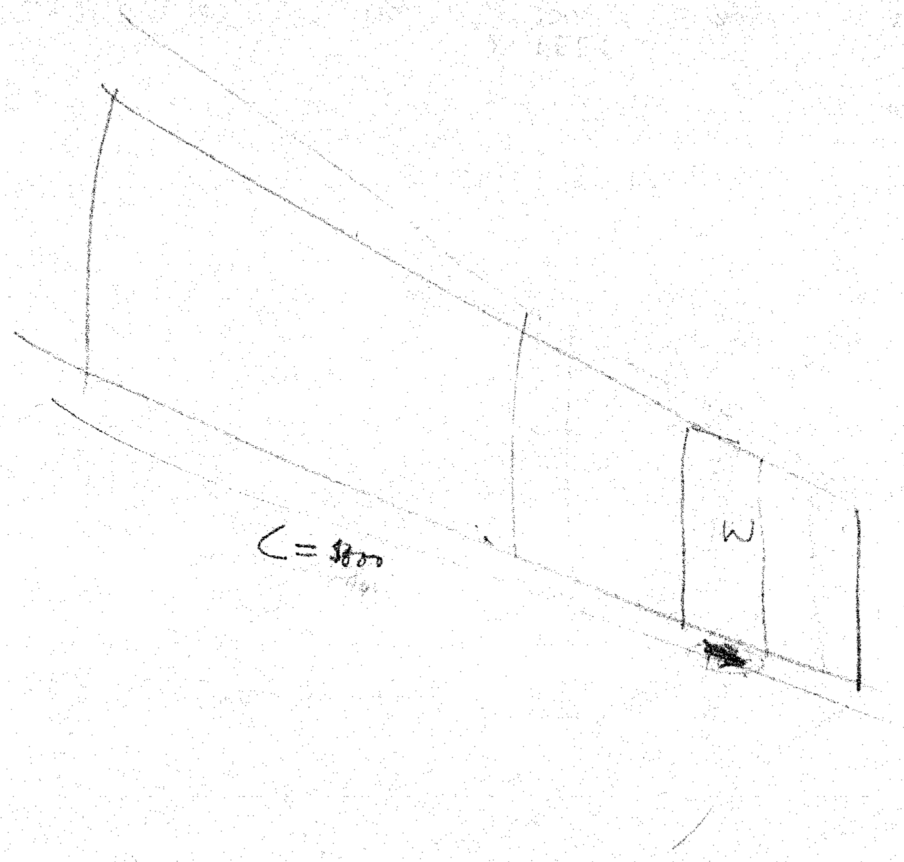


2.4
2.2
2.0
1.8
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0
0.2
0.4
SHEAR STRENGTH S IN KIPS
+VE
-VE
Clay removed for distance X ft. from toe of slope.
S= Shear strength required in remaining clay for
Factor of Safety of Unity
F=1
S
S
X
0
10
20
30
40
50
60
70
80
90
100
X - FEET

OVER

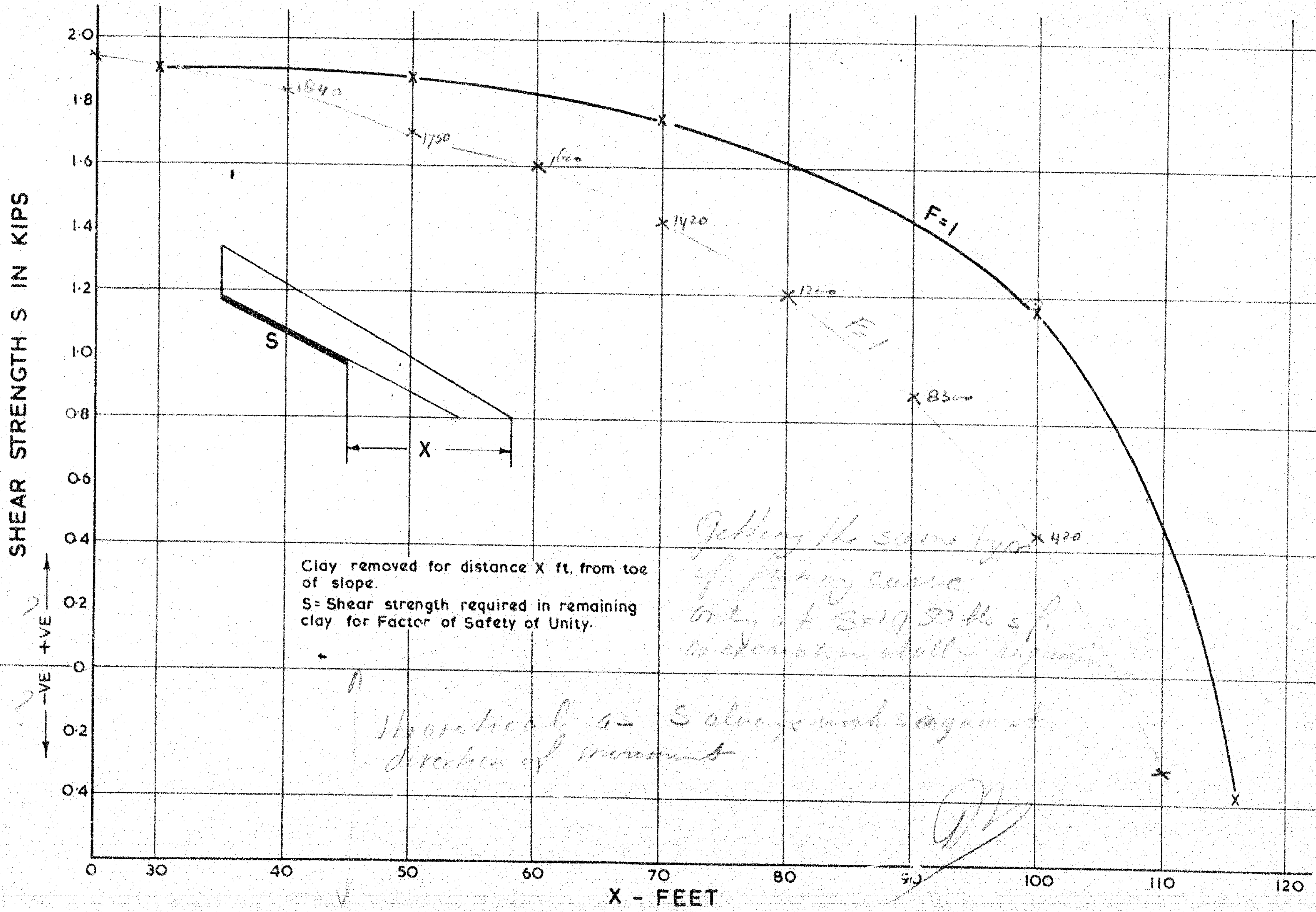


CASE II
CHAINAGE: 594 + 23
Scale: 1" to 20 ft.
Roadway
Rock fill
Rock Fill
50'
Clay removed
Slope of Hillside
Clay layer
Assumed rock level
ELEVATION - FEET
X FEET
560
540
520
500
480
460
440
160
140
120
100
80
60
40
20
0
20
40
60
80
100
120
140
160
180
200
½ 120.(50+29) . 110 = 650,000 lbs
45.000 − 5[illegible] + 286.000 = 110 S.
275.000 = 110 S S = 1,950 lbs
If S were 1950 lbs the shear at bottom of slope over 35' would be ∞ 65.000 lbs, which is larger than the 50.000 used so [illegible] would be required
45.000
286.000
320.000 lbs
650.000 lbs
50.000
35'
tg 41° = 0.85



W from Q / Sand

CASE II


SHEAR STRENGTH S IN KIPS
X - FEET
F=1
S
X
+VE
-VE
Clay removed for distance X ft. from toe of slope.
S= Shear strength required in remaining clay for Factor of Safety of Unity.

CASE A SLOPE 20°

Top of clay

Wt. of rock fill = $1/2 \times 33 \times 17 \times 140$ = 39,200 lb. = W

Disturbing force T = 14,000 lb.

Resisting force = SL L = 50 ft.

For F = 1 S. 50 = 14,000 lb

$$S = \frac{14,000}{50} = \underline{280} \text{ lb. / sq. ft.}$$

OR for F = 1·5 S = 280 x 1·5 = $\underline{420}$ lb. / sq. ft.

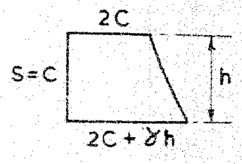
Bottom of Clay

Wt. = 39,200 + 130 x $1/2$ (50 + 64) x 5

= 39,200 + 37,000

= 76,200 lb.

T = 26,000 lb.



Resisting force = $S \cdot L + 1/2\,(4C + \gamma h)\,h$

= $S\,(L + 2) + 1/2\,\gamma h^2$

= S ~~66~~ 74 + $1/2$ x 130 x 25

= ~~66~~ 74 S + 1,610

For F = 1 26,000 = ~~66~~ 74 S + 1,610

S = (26 000 − 1,610) / ~~66~~ 74

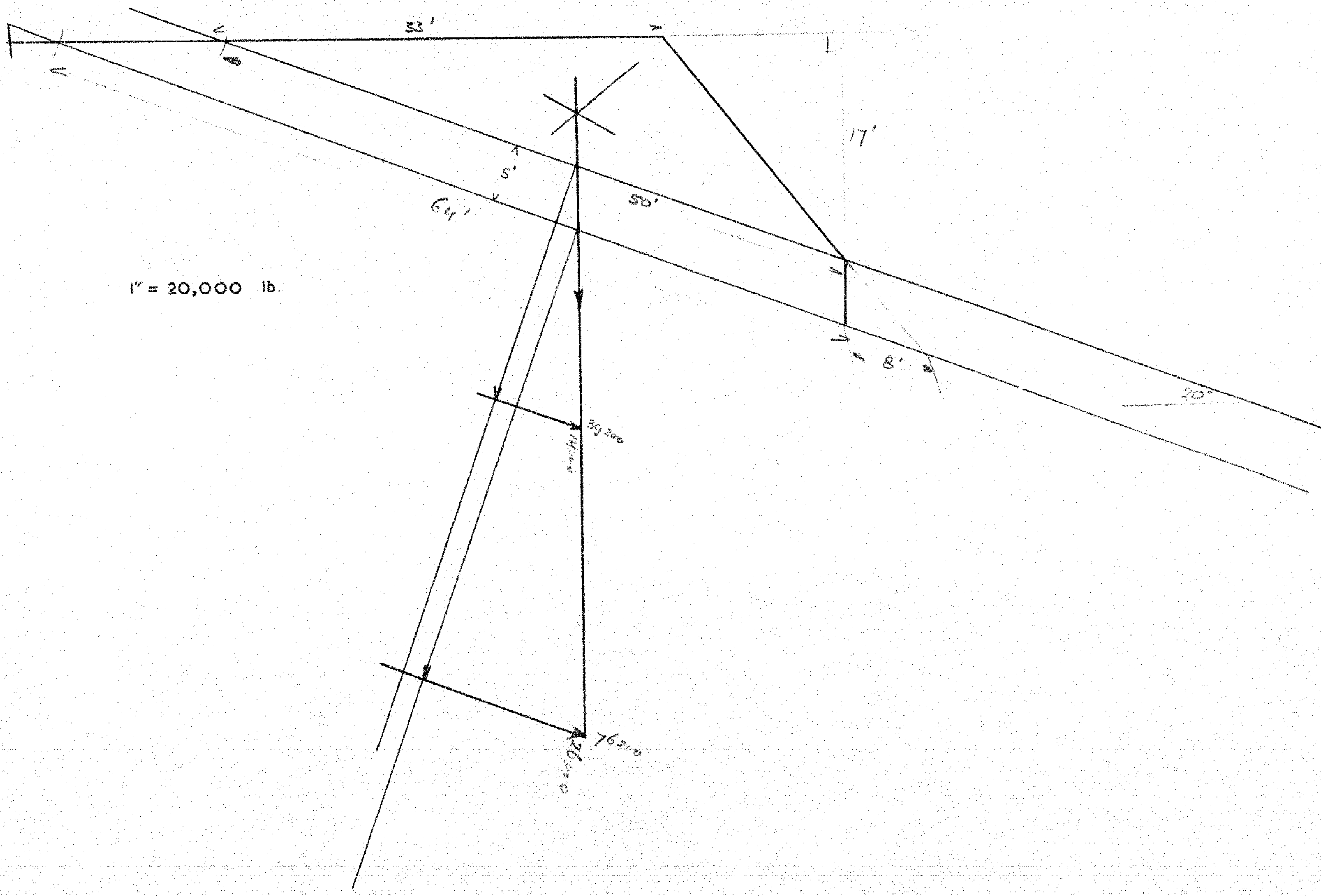
= 24,390 / ~~66~~ 74 = ~~370~~ 330 lb / sq. ft.

More dangerous than top of clay.

For F = 1·5 1·5 = (~~66~~ 74 S + 1,610) / 26,000 S = ~~570~~ 505 lb. / sq. ft.

CASE A - SLOPE 20°

Scale: 1" to 10 ft.



CASE B - SLOPE 25°

Bottom of Clay

Rock Valley

$$\text{Wt.} = 140 \times 1/2 \times 24 \times 19 + 130 \times 5 \times 1/2\ (46 + 58)$$

$$= 32{,}000 + 33{,}700$$

$$= 65{,}700 \text{ lb.}$$

$$T = 28{,}000 \text{ lb.}$$

$$\text{Resisting force} = S\ (58 + \cancel{2}\ 10) + \frac{130}{2} \cdot 25$$

$$= \cancel{60}\ 68 \cdot S + 1{,}610$$

For F = 1

$$\cancel{60}\ 68 \cdot S = 28{,}000 - 1{,}610$$

$$= 26{,}390$$

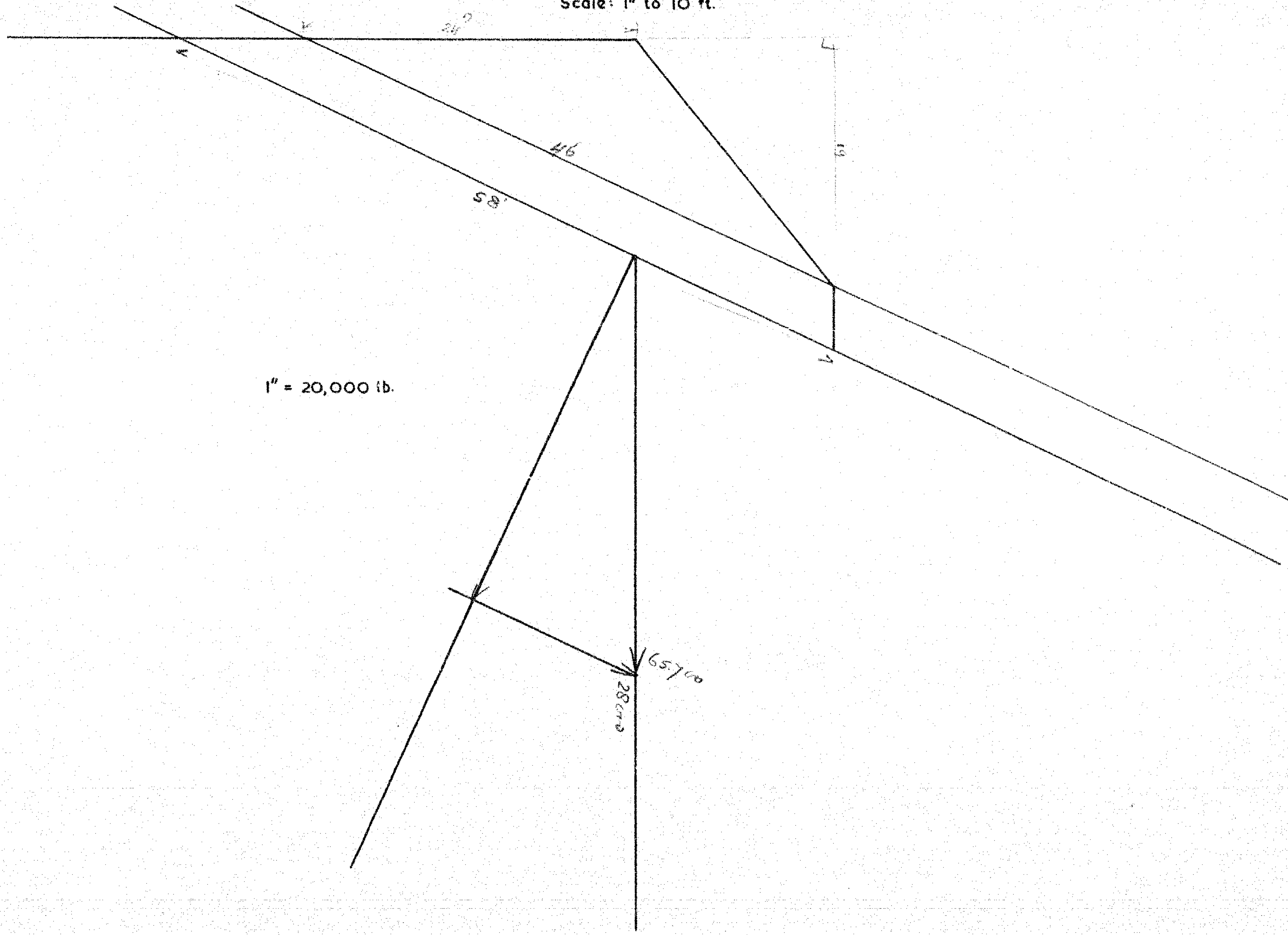
$$S = \frac{26\,390}{\cancel{60}\ 68} \qquad \cancel{440}\ 390 \text{ lb./sq. ft.}$$

For F = 1·5

$$1 \cdot 5 = \frac{\cancel{60}\ 68 \cdot S + 1{,}610}{28{,}000} \qquad S = \cancel{670}\ 590 \text{ lb/sq. ft.}$$

CASE B - SLOPE 25°

Scale: 1" to 10 ft.



Scale: 1" to 20'

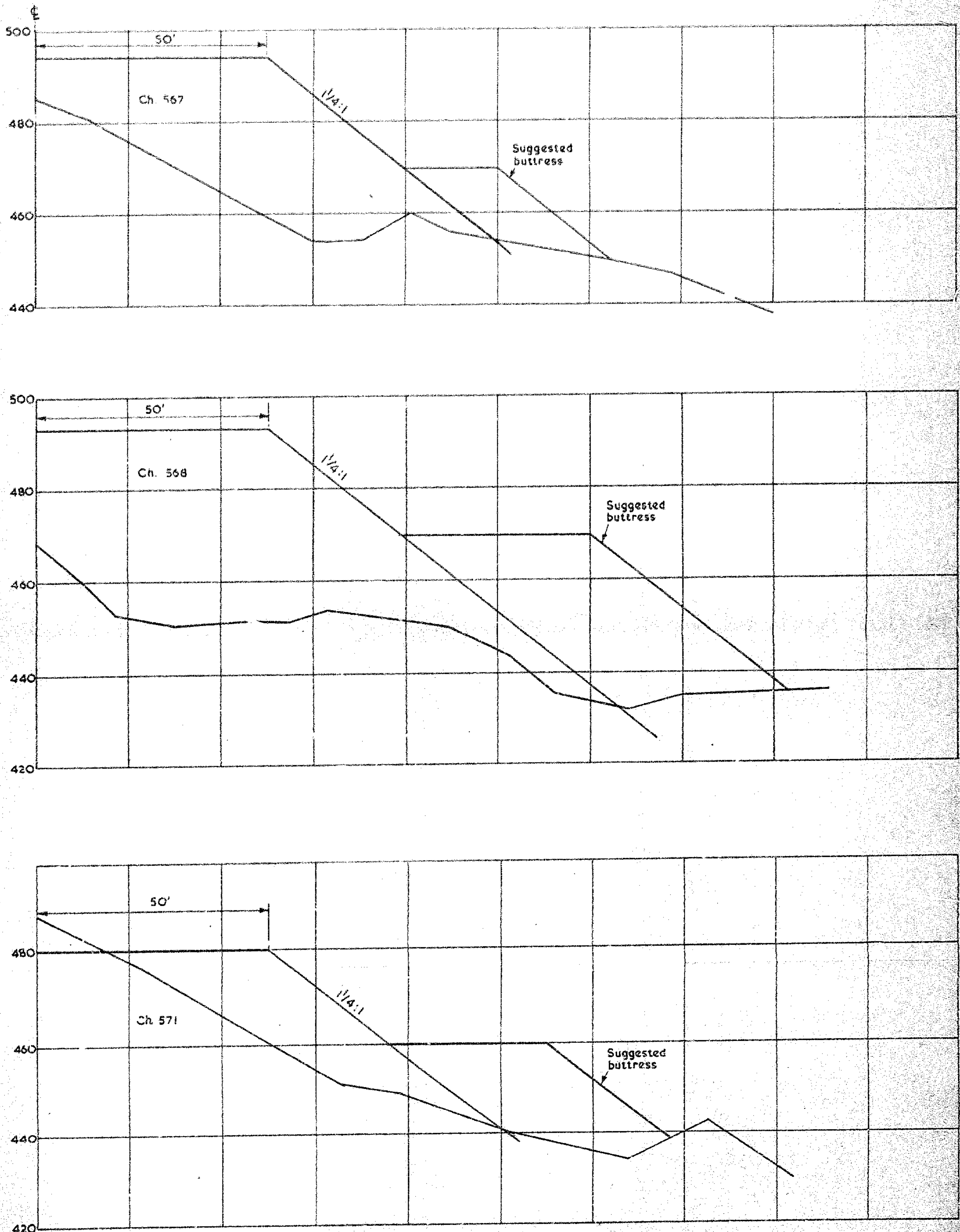


Fig. 1

cc: Gen. Files

23-65-171

file #27

May 5, 1960.

C.C. Parker, Parsons & Brinckerhoff, Ltd.,
Consulting Engineers,
795 Main Street,
Hamilton, Ontario.

Attention: Mr. J. W. Disher.

Re: Chedoke Expressway
Test Pit Excavation
W.J. 60-F-24
W.P. 140-57-2.

Dear Sir:-

During the past winter, we had verbally requested you to provide labour for soils testing purposes along the escarpment. This letter will confirm our earlier requests for which the work has now been completed, and will also serve as an open request to supply labour in future, when same is necessary.

Any labourers procured, will be under the direct supervision of the Engineers of the Materials and Research Section and will be charged to the Department at the prevailing labour rate for the Hamilton area. You will be required to hire these labourers, and make payments to them, making the necessary deductions. The charges for this work will be in accordance with your Agreement with the Director of Planning and Design, under the "Additional Services" heading, except that the charges will be 175% instead of the 200% which you have agreed to in your present invoice.

Yours very truly,

A. Rutka

AR/MdeF

A. Rutka,
A/MATERIALS & RESEARCH ENGINEER

cc: Mr. N. D. Smith
Foundations Office
Gen. Files (2)

23-65-171

Materials and Research Section.

December 14, 1960.

C. C. Parker & Parsons, Brinckerhoff, Ltd.,
Consulting Engineers,
795 Main Street West,
Hamilton, Ontario.

Attention: Mr. J. W. Disher.

Re: CHEDOKE EXPRESSWAY -
Escarpment Section
W.J. 60-F-24 - W.P. 140-57-2.

Dear Sir:-

With respect to our conversation of a few days ago I wish to confirm that the criterion which Dr. Golder established in his report 6002, "Trial Shafts "A" and "B" - Escarpment Section Chedoke Expressway, applies to the section of the expressway from chainage 576 + 00 to chainage 599 + 00. Sections from chainage 576 + 00 back were previously described (See - Golder: Chedoke Expressway, Hwy. 403 Escarpment Section) as being either: "leave clay in" sections or sections to which the phrase, "leave in if clay strong" applied. Our current investigations have not revealed any soft clay in the section from 576 + 00 back. Thus, no stability problems should be encountered.

Enclosed is a table which gives the depth to bedrock at the most recent borings which were carried out from 576 + 00 back, plus a few made to extend higher sections. You will observe that the holes are being drilled every 500 feet. When you have analysed this information, we would appreciate it if you will advise us if there are any sections which you consider to be inadequately covered. We expect to have the rest of the borings finished about January 6, 1961.

Yours very truly,

L. G. Soderman,
PRINCIPAL FOUNDATION ENGR.
Per:

(John Brown,
FOUNDATION PROJECT ENGR.)

JB/MdeF
Encls.

cc: Mr. R. Schonfeld
H. Q. Golder & Associates.
Foundations Office
Gen. Files

SECTION	CHAINAGE	LOCATION	DEPTH TO ROCK	OVERBURDEN	ELEVATION
2C	587+00	147'9"L	7'4"	VERY DENSE SANDY CLAYEY SILT WITH SOME BOULDERS	578'8"
5B	591+00	49'0"L	31'0"	DENSE TO VERY DENSE SANDY CLAYEY SILT VERY BOULDERY	541'4
BETW. 5&6	592+28	152'0"L	9'0"	STIFF REDDISH BROWN SANDY SILTY CLAY NO BOULDERS	574'0"
6C	596+00	151'0"L	7'0"	DENSE SANDY CLAYEY SILT SOME BOULDERS	576'9"
7C	598+00	148'0"L	9'0"	DENSE SANDY CLAYEY SILT SOME BOULDERS	580'2"
8C	583+00	152'0"L	5'4	DENSE SANDY CLAYEY SILT SOME BOULDERS	575'6"
10C	579+00	151'0"L	12'0"	DENSE SANDY CLAYEY SILT WITH SOME BOULDERS	572'0
12B	575+00	48'0"L	8'0"	DENSE SANDY CLAYEY SILT WITH SOME BOULDERS	523'4"
12C	575+00	149'0"L	5'0"	DENSE REDDISH BROWN SILTY SANDY CLAY NOT MANY BOULDERS	570'6"
13B	572+00	52'0"L	9'8	DENSE SANDY CLAYEY SILT VERY BOULDERY	520'9"
13C	572+00	148'0"L	5'3	DENSE SANDY CLAYEY SILT SOME BOULDERS	569'10
14B	569+00	51'0"L	9'9"	VERY DENSE SANDY CLAYEY SILT WITH BOULDERS ABOUT 2' OVER ROCK SILTY GREY CLAY	484'2
14C	568+00	150'0"L	12'0"	DENSE SANDY CLAYEY SILT VERY BOULDERY	568'0"
15B	565+00	52'0"L	33'0"	DENSE SANDY CLAYEY SILT VERY BOULDERY	503'3"
15C	565+00	143'0"L	39'0"	DENSE SANDY CLAYEY SILT SOME BOULDERS ABOUT 3' GREY SILTY CLAY ABOVE ROCK	571'4"
16B	560+00	50'0"L	42'0"	DENSE TO VERY DENSE SANDY CLAYEY SILT VERY BOULDERY	514'8"
16C	560+00	152'0"L	18'[illegible]"	DENSE SANDY CLAYEY SILT SOME BOULDERS	572'6"

SECTION	CHAINAGE	LOCATION	DEPTH TO ROCK	OVERBURDEN	ELEVATION
17B	555+00	52'-0"L	42'-0"	DENSE SANDY, CLAYEY SILT. BETW. 18'-0" BGL AND 23'-0" B.G.E. A LAYER OF FINE GRAVEL AT 38'-0" BGE A LAYER OF SOFT GREY SILTY CLAY	483'-7"
17C	555+00	153'-6"L	5'-0"	DENSE TO DENSE SANDY CLAYEY SILT VERY BOULDERY	568'-3"
18B	550+00	50'-0L Abercrombie, drilling at 43' - no rock	28'-0"	DENSE SANDY, CLAYEY SILT VERY BOULDERY ABOUT 6'-0" BGL DOWN TO 28'-0" BGE DISINTEGRATED RED AND GREEN SHALE	483'-6"
18C	550+00	147'-0"L	5'-0"	DENSE SANDY, CLAYEY SILT SOME BOULDERS	548'-5"
19B	545+00	51'-0"L			449'-9
19C	545+00	149'-0"L			541'-2"
20 B	540+00	50'-0"L			411'-10"
20 C	540+00	152'-0"L	4'-0"		455'-5"
21 B	535+00	51'-0"L			407'-10"
21 C	535+00	150'-0"L			412'-8"
22 B	530+00	48'-0"L			406'-8"
22 C	530+00	152'-0"L			413'-4"
23 B	525+00	49'-0"L			362'-10"
23C	525+00	150'-0"L			379'-0"
24 B	520+00	50'-0"L			334'-4"
24C	520+00	150'-0"L			338'-2"

SECTION	CHAINAGE	LOCATION	DEPTH TO ROCK	OVERBURDEN	ELEVATION
25 B	515+00	50'-0" L			332'-5"
25 C	515+00	150'-0" L			339'-8"

cc: Gen. File

23-65-171

Mr. R. Schonfeld,
Soils Engineer,
Room #134.

December 14, 1960.

Mr. John Brown,
Foundations Engr., Room #110.

Re: CHEDOKE EXPRESSWAY -
Escarpment Section
W.J. 60-F-24 - W.P. 140-57-2.

Attached is a copy of the letter to C.C. Parker which accompanied the table showing the overburden depths at the extra sections being investigated in connection with the above job. As this is a routine soils problem, we will continue to pass the information to you as we receive it. We assume that you will carry out whatever plotting or analysis you consider to be necessary.

JB.

JB/MdeF

John Brown,
PROJECT FOUNDATION ENGINEER.

Materials and Research Section.

December 21, 1960.

C. C. Parker & Parsons, Brinckerhoff, Ltd.,
Consulting Engineers,
795 Main Street West,
Hamilton, Ontario.

Attn: Mr. J. W. Disher.

Re: CHEDOKE EXPRESSWAY -
Escarpment Section
W.J. 60-F-24 - W.P. 140-57-2.

Dear Sir:-

Enclosed are the results of the remainder of the borings on our current exploration program.

All drilling equipment has now been moved out of this area.

Yours very truly,

L. G. Soderman,
PRINCIPAL FOUNDATION ENGR.
Per:

for (John Brown,
PROJECT FOUNDATION ENGR.)

JB/MdeF
Encls.

cc: H. Q. Golder & Associates
R. Schonfeld
Foundations Office
Gen. Files.

STATION	CHAINAGE	LOCATION	DEPTH TO ROCK	OVERBURDEN	ELEVATION
17B	555+00	52'-0" L.	43'-0"	DENSE SANDY, CLAYEY SILT. BETW. 18'-0" BGL AND 23'-0" B.G.E. A LAYER OF FINE GRAVEL. AT 38'-0" BGE A LAYER OF SOFT GREY SILTY CLAY	483'-7"
17C	555+00	153'-6" L	5'-0"	DENSE TO DENSE SANDY CLAYEY SILT VERY BOULDERY	568'-3"
18B	550+00	50'-0" L. Approximately, drilling at 43 - no rock	28'-0"	DENSE SANDY, CLAYEY SILT VERY BOULDERY ABOUT 6'-0" B.G.L DOWN TO 28'-0" B.G.E DISINTEGRATED RED AND GREEN SHALE	483'-6"
18C	550+00	147'-0" L.	5'-0"	DENSE SANDY, CLAYEY SILT SOME BOULDERS	548'-5"
19B	545+00	51'-0" L	6'-0"	DISINTEGRATED RED SHALE	449'-9"
19C	545+00	149'-0" L	42'-0"	SANDY CLAYEY SILT VERY BOULDERY	541'-2"
20B	540+00	50'-0" L	5'-0"	DISINTEGRATED RED SHALE	411'-10"
20C	540+00	152'-0" L	24'-0"	SANDY CLAYEY SILT VERY BOULDERY	456'-5"
21B	535+00	51'-0" L	5'-4"	DISINTEGRATED RED SHALE	407'-10"
21C	535+00	150'-0" L	4'-0"	DISINTEGRATED RED SHALE	412'-8"
22B	530+00	48'-0" L	19'-6"	DISINTEGRATED RED SHALE	406'-8"
22C	530+00	152'-0" L	4'-0"		413'-4"
23B	525+00	49'-0" L	4'-3"	DISINTEGRATED RED SHALE	362'-10"
23C	525+00	150'-0" L	6'-6"		379'-0"
24B	520+00	50'-0" L	NOT DRILLED		334'-4"
24C	520+00	150'-0" L			338'-2"

SECTION	CHAINAGE	LOCATION	DEPTH TO ROCK	OVERBURDEN	ELEVATION
25 B	515+00	50'-0" L	NOT DRILLED		332'-5"
25 C	515+00	150'-0" L	NOT DRILLED		339'-8"

Hwy. #403, T.H. & B. Railway to Mohawk Road.

Phone: 248-3252

Materials & Testing Division - Downsview

September 29th, 1966.

C.C. Parker & Parsons, Brinckerhoff Ltd.,
Consulting Engineers,
688 Queensdale Avenue, East,
Hamilton, Ontario.

W0-57-2 60F-24

Attention: Mr. D. Patterson, P. Eng.

Dear Sir: Re: Contract #65-171, Highway #403,
T.H. & B. Railway to Mohawk Road

This will confirm our earlier verbal statements that it is essential that ditches be constructed on the above detailed project as soon as possible. These are required at the back of each benched area in order to intercept and drain off surface water. Drainage channels would also be required from each end of such ditches down the slope surfaces to the ditches at the final grade of the highway.

The immediate need for such ditches has been stated verbally by several persons, including Mr. A.G. Stermac, Principal Foundation Engineer of the Department of Highways and Dr. H. Golder of H.Q. Golder & Associates, Consulting Engineers. The "Report on a Combined Geological-Geophysical Investigation on the Hamilton Bluffs, Ontario", prepared by Huntec Limited and Lockwood Survey Corp., also stressed the need to keep the talus as dry as possible. Wet conditions of the talus material have undoubtedly been the principal cause of failures in this area.

There is presently a fairly severe seepage zone in the lower backslope opposite Station 551+50 to 552+00 approx., with water flowing from the surface. This is apparently aggravated by the ponding of surface water on one of the upper benches in this area. Good ditches are urgently required here to prevent further slides of the talus material.

There has also been a small failure of talus material overlying shale bedrock in the vicinity of Station 549+00. At least half of the talus material directly affected by this slide should be removed and the drainage above this area must be corrected as soon as possible.

.../2

We would also request that the open cracks in the disposal area opposite Station 552+00 approx., be properly back-filled to prevent the additional retention of water in this manner. An attempt has apparently been made to do this, however, some fairly large cracks have still been left open.

We cannot stress too strongly the urgent need for good drainage above the talus material throughout this Contract, and we would request your co-operation in this matter.

Yours truly,

N.D. Smith,
For: T.J. Kovich,
Regional Materials Engineer.

NDS/hd
c.c. H. Greenland,
A.G. Stermac,
G.A. Wrong.

HUGH Q. GOLDER C.Eng.
D.Eng., M.I.C.E., M.E.I.C.
Consulting Civil Engineer

1766A AVENUE ROAD
TORONTO 12
RUssell 7-5711

002

June 30th. 1960

Mr. L.G. Soderman,
Soils and Foundation Engineer,
Department of Highways,
Parliament Buildings,
Toronto,
ONTARIO.

Dear Sir,

Chedoke Expressway - Escarpment Section

This letter is to amplify my report dated May 1960 dealing with the Escarpment problems of the Chedoke Expressway, and to confirm our conversation of June 28th. at your office.

It appears that three further pits were put down on the site following those described as Series II in my report. Unfortunately I did not see these pits, which were in the area in which I have recommended that the clay should be taken out, viz. chainage 576 - 599, and in which I suggested that further pits should be opened. The records of these pits are not consistent one with another; one shows shale at a depth of 4 feet, one shows soft to firm clay, and the last shows stiff clay. Taken together with the results of the previous pits all this evidence indicates a considerable amount of variation in the strength of the clay in this area.

In general where pits have been opened, they have shown a greater depth to rock than indicated by the geophysical work carried out by Huntings. I suggest therefore that for purposes of calculating quantities of excavation for tender documents only, that the depth to rock given by the Hunting report should be increased by 50% and that the resultant quantity of excavation so calculated should be stated as ± 50%.

The most economical method of treating this section can only be decided on when the depth to rock is known, and this can be determined either as the initial part of the contract, or preferably by further field investigation as outlined below. If time is available it would be better to carry out this work before the contract is let.

The first part of the work is to establish the depth to bedrock below the highest part of the fill, i.e. 50 feet north of the centre-line. This can be done by careful diamond drilling, the holes being spaced 100 to 200 feet apart. The second part is to excavate trenches by machine down to the bedrock to examine the overburden and to decide whether or not it must be removed. If the depth to rock is not great, say 10 to 12 feet, a continuous trench can be dug along the hillside. If the depth is greater then this, short trenches will suffice since the sides may require some support. About five cross-sections perpendicular to the centre-line should also be dug to a distance of 150 feet north of the centre-line.

It is absolutely imperative that this work should be carefully supervised and controlled by a competent soils engineer, and that the same engineer should carry through the whole of the work in order to obtain consistent descriptions throughout. Every pit should be carefully described and should be photographed on colour film. Where clay is met, samples should be taken and moisture content, liquid limit and shear strength should be determined.

A very rough estimate of the cost of this work is $ 10,000 the time required being about two to three months.

Yours faithfully,

H.Q.Golder

cc: Mr. A. M. Toye (2nd copy)

BA 1227

Materials and Research Section.

June 26, 1961.

C. C. Parker & Parsons, Brinckerhoff, Ltd.,
Consulting Engineers,
795 Main Street West,
Hamilton, Ontario.

30M4-1

Attention: Mr. J. W. Fisher.

Re: Foundation Investigation Report
for Chedoke Expressway -
Escarpment Section,
W.J. 60-F-24 -- W.P. 140-57-2.

Dear Sir:-

The report accompanying this letter, contains a detailed description of the subsoil conditions existing at the site of the proposed Chedoke Expressway where it crosses the Niagara Escarpment in the Hamilton area.

For engineering recommendations pertaining to this section of the Expressway, reference should be made to the following report by H. Q. Golder & Associates, Ltd. :- Report #6002, "Trial Shafts 'A' & 'B' - Escarpment Section, Chedoke Expressway, Hamilton, Ontario".

Yours very truly,

L. G. Soderman,
PRINCIPAL FOUNDATION ENGR.
Per:

(A. G. Stermac,
SUPERVISING FOUNDATION ENGR.)

AGS/MdeP
Attach.

cc. Messrs. C.C. Parker & Assoc.(4)
A. M. Toye (2)
H. A. Tregaskes
E. P. McMillan
I. C. Campbell
J. J. Thatcher
P. J. Lovick
J. Roy
J. H. Crumpler
F. L. Saint
C. Korman
A. Watt
Foundations Office
Gen. Files.

TABLE OF CONTENTS

FOUNDATION INVESTIGATION

For

Chedoke Expressway -
Escarpment Section,
W.J. 60-F-24 - W.P. 140-57-2

1. INTRODUCTION:

Presented in this report are the results of a detailed foundation investigation carried out to determine subsoil conditions in certain sections of the Chedoke Expressway where it climbs the scarp slope of the Niagara Escarpment in the Hamilton area. This investigation was instigated as a result of preliminary work carried out by Hunting Technical and Exploration Services, Ltd., and reported in their "Report on Seismic Investigations of Proposed Relocation of Highway #2 near Ancaster, Ontario", and by Dr. H. Q. Golder.

Thirty-five sampled boreholes and a number of shallow test pits were put down between August 1960 and November 1960.

As a result of the information obtained from these boreholes two test shafts were excavated to examine the soil profile in detail. The test shafts are reported by H. Q. Golder & Associates, Ltd. in their report #6002: "Trial Shafts "A" & "B" - Escarpment Section, Chedoke Expressway, Hamilton, Ontario".

This report contains only the information obtained from the investigation and no inferences or conclusions are drawn as to the construction of the embankment. For engineering recommendations concerning this section of the expressway, reference is made to the report by H. Q. Golder & Associates, Ltd., referred to above.

cont'd. /2 ...

2. DESCRIPTION OF SITE AND GEOLOGY:

The site of this investigation lies throughout the scarp slope of the Niagara Escarpment in the west end of the city of Hamilton. The Chedoke Expressway crosses it at an acute angle rising from elevation 330 feet at chainage 515+00 to elevation 642 feet at chainage 619+00 at a uniform grade of 3 per cent. The scarp slope is covered with a very heterogeneous mixture of rock fragments and clay derived partly from weathering of the scarp slope and partly from glacial action. The slope, itself, is of variable steepness and is covered with vegetation.

Various descriptions are available of the geology of the Niagara Escarpment in general, and of its particular aspect in the Hamilton area, and reference is made in particular to the following works:

Bolton, T.E. -- "Silurian Stratigraphy and Palaeontology of the Niagara Escarpment in Ontario" - Geological Survey of Canada Memoir 289.

Hunting Technical & Exploration Services: -- (Geology apparently after Caley 1940).

D.H.O.: -- Soils Design Report W.P. 140-57-2, Hwy. 403, "Chedoke Expressway just West of TH & B Subway to just East of Mohawk Road."

3. DESCRIPTION OF SOIL CONDITIONS:

Drawing 60-F-24B in the folder of this report contains eleven sections showing the boreholes made, the materials that they encountered and their relative elevations. Reference is also made to the appendix where the detailed logs of these boreholes are recorded. Drawing 60-F-24C shows the same sections as Drawing 60-F-24B, but all the information except the depth to bedrock has been omitted.

cont'd. /3 ...

3. DESCRIPTION OF SOIL CONDITIONS: (cont'd.) ...

No correlations could be made about soil conditions from borehole to borehole because the overburden over the whole area investigated was heterogeneous in the extreme. The following general observations are made about soil conditions over the site.

In general, the materials encountered in the borings were:-

Angular or slabby gravels and boulders derived from the limestone bedrocks and mixed with sandy clays and silts in a rather loose, well-graded material.

A material derived from the shale bedrocks at the site and individually described as "sub-shale", or "reworked shale". This material varies from a hard laminated silt or clay with the typical slightly soapy feel of shale; though rather softer layers in which the shale origin was discernible, to material in which particles of still competent shale were embedded in a matrix of shale-derived clay particles. Materials of these types can be considered as earth rather than rock for the purposes of excavation. Cutting slopes established in these materials must be treated as though they were in clay.

Sands, gravels, cobbles and boulders were encountered in many boreholes in pockets with a random distribution. Their locations are indicated on the sections.

Clays and silty or sandy clays were encountered in a number of boreholes usually along the toe of the escarpment. In a number of borings near the then-proposed centre line, clay was encountered (see boreholes 1 and 2), and it was as a result of this, that the trial shafts "A" and "B" were excavated.

cont'd. /3 ...

3. DESCRIPTION OF SOIL CONDITIONS: (cont'd.) ...

The bedrock encountered in the various holes depended on the position on the slope at which they were carried out. In general, the bedrock was encountered at shallower depths and the higher part of the slope than at the lower. The depths to bedrock in the series of holes drilled above the centre line lay between 15 and 30 feet whereas in the holes at the bottom of the escarpment the depth lay between 30 and 40 feet.

4. WATER CONDITIONS:

No water was encountered in any borehole on the slope of the escarpment, although water was encountered in the boreholes carried out at the foot. This water originated in the bedrock and was found to be under enough head to raise it above ground level.

Water will undoubtedly be encountered during the excavations in this section of the expressway, although it is anticipated that the quantity will be small and variable. This water will emerge from bedding planes and fissures in the rocks.

5. REFERENCES:

In addition to the references quoted in the text above, the following works may be consulted for information about this section of the expressway:

For information about the test pits Series I and Series II:-

Dr. H. Q. Golder: "Chedoke Expressway, Highway 403, Escarpment Section" - May 1960.

cont'd. /5 ...

5. REFERENCES: (cont'd.) ...

Dr. H. Q. Golder: Letter to L. G. Soderman, June 30/60 and filed under W.P. 140-57-2.

For general information on the Tertiary Geology of the area:

Karrow, P.F. - "Pleistocene Geology of the Hamilton Map-Area" - Ontario Department of Mines Geological Circular No. 8.

June 1961. REPORT PREPARED BY: ....
for John Brown,
PROJECT FOUNDATION ENGINEER.

REPORT APPROVED BY: ....
A. G. Stermac,
SUPERVISING FOUNDATION ENGINEER.

APPENDIX I.

FORM OB-ML-126 (REV. 1959) - 59-5008

OFFICE REPORT ON SOIL EXPLORATION

DEPARTMENT OF HIGHWAYS - ONTARIO

MATERIALS AND RESEARCH SECTION

W.P. 140-57-2 BORE HOLE NO. 1

JOB 60-F-24 STATION 589+23 (39' Rt.)

DATUM G.S.C. COMPILED BY B.K.

BORING DATE Aug. 5/60. CHECKED BY J.B.

2" DIA. SPLIT TUBE
2" SHELBY TUBE
2" SPLIT TUBE
2" DIA. CONE
2" SHELBY
CASING

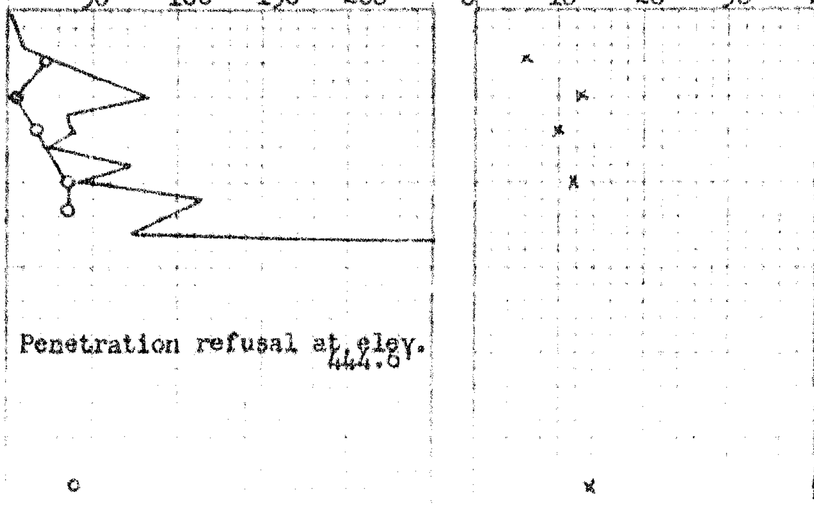
LEGEND

1/2 UNCONFINED COMPRESSION (Qu)
VANE TEST (C) AND SENSITIVITY (S)
NATURAL MOISTURE AND LIQUIDITY INDEX
LIQUID LIMIT
PLASTIC LIMIT

SYMBOL	DESCRIPTION	ELEV. FEET	DEPTH FEET	SAMPLE	NATURAL UNIT WT. P.C.F.
	Groundlevel	488	0		
	Rock fragments.	485		S1	-
	gravel, varying amounts of clayey silt.			S2	-
				S3	-
			10	S4	-
		474		S5	-
	gravel, dense.	468	20		
	boulders.	461			
	silty clay, red with angular gravel.	458	30	S6	-
	sandstone.			RC7	-
		448	40	RC8	-
	shale.	447			
	End of borehole				

STRENGTH AND PENETRATION RESISTANCE P.S.F. / BLOWS/FT.: 50, 100, 150, 200

CONSISTENCY — MOIST. CONTENT % DRY WT.: 0, 10, 20, 30, 40



Penetration refusal at elev. 444.6

Penetration resistance profile shown; obtained by driving a 2" dia. cone from groundlevel to depth noted with an energy of 350 ft. lb. per blow.

ORM OB-ML-126A—60-1015

OFFICE REPORT ON SOIL EXPLORATION

DEPARTMENT OF HIGHWAYS – ONTARIO
MATERIALS AND RESEARCH SECTION

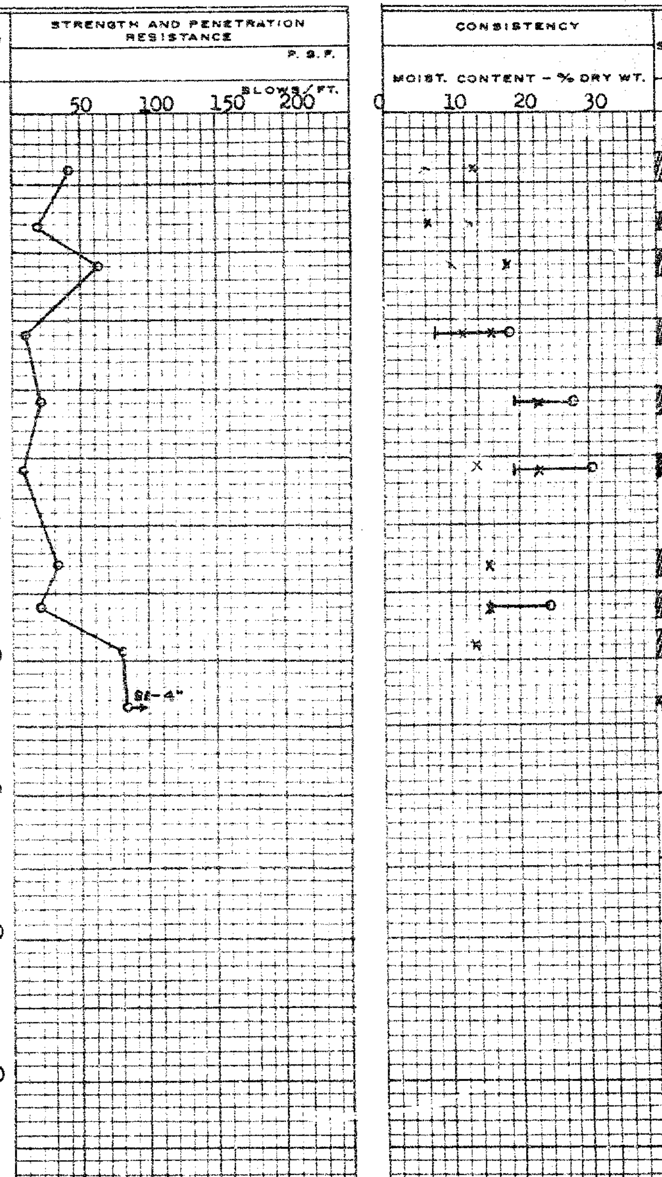
W.P. 140-57-2
BORE HOLE NO. 1A
JOB 60-F-24
STATION 589+40 (243.2' Rt.)
DATUM G.S.C.
COMPILED BY B.K.
BORING DATE Aug. 1960.
CHECKED BY J.B.

2" DIA. SPLIT TUBE
2" SHELBY TUBE
2" SPLIT TUBE
2" DIA. CONE
2" SHELBY
CASING

LEGEND

1/2 UNCONFINED COMPRESSION (Qu) — O
VANE TEST (C) AND SENSITIVITY (S) — +S
NATURAL MOISTURE AND LIQUIDITY INDEX — LI ×
LIQUID LIMIT — O
PLASTIC LIMIT — |

SYMBOL	DESCRIPTION	ELEV. FEET	DEPTH FEET
	Groundlevel	425	0
	sand with clay and roots.	421	
	clayey silt, hard reddish brown with some angular gravel.	416	10
	gravel, bouldery some silt.	410	
	clayey silt, stiff grey with gravel (some shale fragments)	399	20
	Boulders and gravel.	393	30
	Reworked shale (v. stiff grey and red clayey silt)	384	40
	Boulders and gravel.	375	50
	Shale	361	60
	End of borehole		70



SAMPLE	NATURAL UNIT WT. P.C.F.
S1	-
S2	-
S3	-
S4	-
S5	-
T6	122
S7	-
S8	-
S9	-
S10	-
RC11	-
RC12	-
RC13	-
RC14	-

FORM DB-ML-126 (REV. 1959) 59-5008

OFFICE REPORT ON SOIL EXPLORATION

DEPARTMENT OF HIGHWAYS - ONTARIO

MATERIALS AND RESEARCH SECTION

W.P. 140-57-2 BORE HOLE NO. 1B

JOB 60-F-24 STATION 589+00 (70' Lt.)

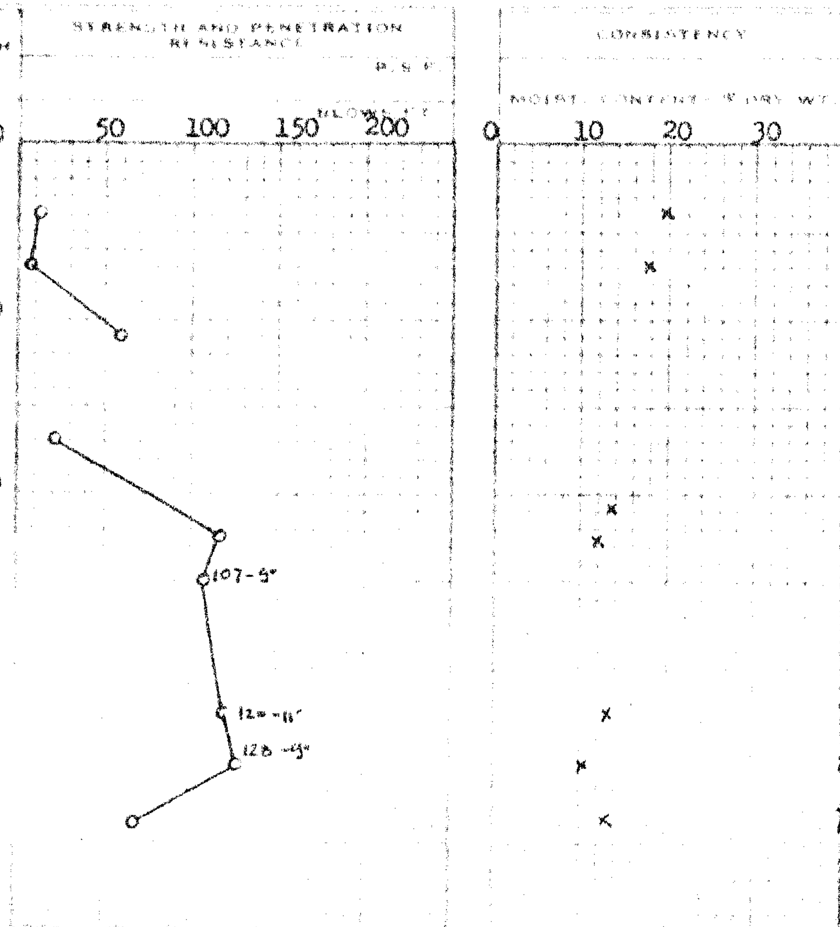
DATUM G.S.C. COMPILED BY B.K.

BORING DATE Sept. 2/60. CHECKED BY J.B.

LEGEND

2" DIA SPLIT TUBE
2" SHELBY TUBE
2" SPLIT TUBE
2" DIA CONE
2" SHELBY
CASING
1/2 UNCONFINED COMPRESSION (Qu)
VANE TEST (C) AND SENSITIVITY (S)
NATURAL MOISTURE AND LIQUIDITY INDEX
LIQUID LIMIT
PLASTIC LIMIT

SYMBOL	DESCRIPTION	ELEV. FEET	DEPTH FEET	SAMPLE	NATURAL UNIT WT. P.C.F.
	Groundlevel	559.0	0		
	Clayey silt with angular gravel.			S1	-
				S2	-
		549.0	10		
	gravel, some silt.			S3	-
				S4	-
				S5	-
		539.0	20		
	silt (subshale), hard green.			S6	-
				S7	-
		534.5		S8	-
	subshale, hard, red laminated.		30		
		527.0			
	Reworked shale, hard, red with angular gravel.			S9	-
				S10	-
		521.5			
	Silt (subshale) hard, green.		40	S11	-
		513.0			
	End of borehole				



FORM OB-ML-126A-60-1015

OFFICE REPORT ON SOIL EXPLORATION

DEPARTMENT OF HIGHWAYS - ONTARIO

MATERIALS AND RESEARCH SECTION

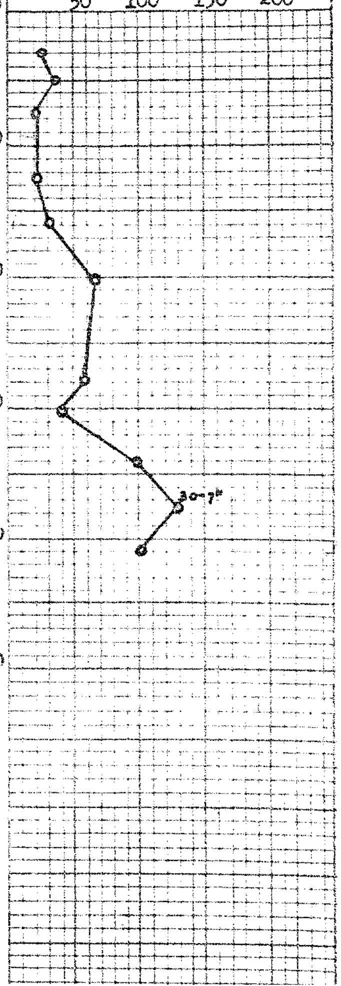
W.P. 140-57-2
BORE HOLE NO. 2
JOB 60-F-24
STATION 587+00 (50' Rt.)
DATUM G.S.C.
COMPILED BY B.K.
BORING DATE Aug. 12/60
CHECKED BY J.B.

LEGEND

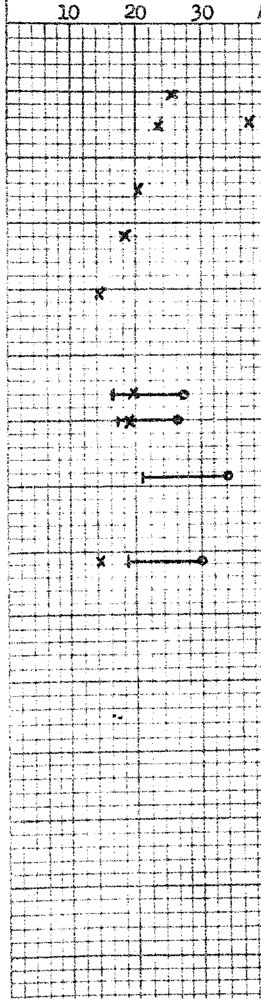
2" DIA. SPLIT TUBE
2" SHELBY TUBE
2" SPLIT TUBE
2" DIA. CONE
2" SHELBY
CASING
1/2 UNCONFINED COMPRESSION (Qu) — O
VANE TEST (C) AND SENSITIVITY (S) — +S
NATURAL MOISTURE AND LIQUIDITY INDEX — X LI
LIQUID LIMIT
PLASTIC LIMIT

SYMBOL	DESCRIPTION	ELEV. FEET	DEPTH FEET
	Groundlevel	507	0
	Topsoil with slabby rock.	505	
	Sand with angular gravel, compacts, some soft clay.	501	
	Clay, sandy reddish brown with much angular gravel and boulders, frequent boulder concentrations.	480	10, 20
	Clay, silty, light grey with much angular gravel and shale fragments	469	30
	Sandstone	468	40
	Shale	452	50
	End of borehole.		

STRENGTH AND PENETRATION RESISTANCE — P.S.F. — BLOWS/FT.: 50, 100, 150, 200



CONSISTENCY — MOIST. CONTENT - % DRY WT.: 10, 20, 30, 40



SAMPLE	NATURAL UNIT WT. P.C.F.
S1	-
S2	-
S3	-
S4	-
S5	-
S6	-
S7	-
S8	-
S9	-
S10	-
S11	-
RC12	-
RC13	-

DEPARTMENT OF HIGHWAYS - ONTARIO
MATERIALS AND RESEARCH SECTION

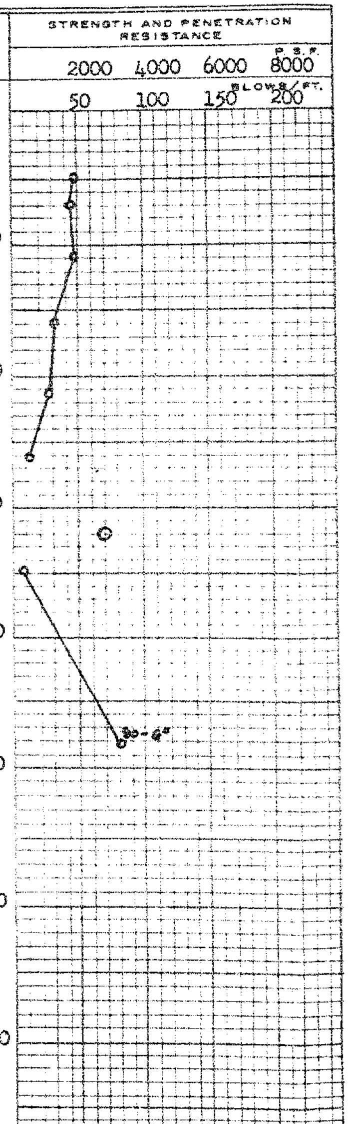
W.P. 140-57-2
BORE HOLE NO. 2A
JOB 60-F-24
STATION 587+16 (225.5' Rt.)
DATUM G.S.C.
COMPILED BY B.K.
BORING DATE Sept. 19/60.
CHECKED BY J.B.

LEGEND

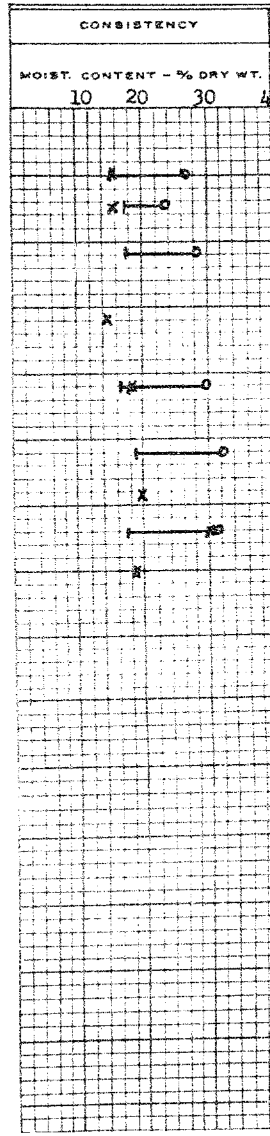
2" DIA. SPLIT TUBE	
2" SHELBY TUBE	
2" SPLIT TUBE	—o—o—
2" DIA. CONE	
2" SHELBY	- - - -
CASING	—x—x—
1/2 UNCONFINED COMPRESSION (Qu)	O
VANE TEST (C) AND SENSITIVITY (S)	+S
NATURAL MOISTURE AND LIQUIDITY INDEX	X LI
LIQUID LIMIT	—o
PLASTIC LIMIT	⊢

SYMBOL	DESCRIPTION	ELEV. FEET	DEPTH FEET
	Groundlevel	434	0
	bouldery topsoil	432	
	Clay-silt with trace of sand and gravel, stiff, brown.	418	10
	Clayey silt, stiff-firm.	395	20, 30
	Subshale	384	40
	Shale	360	50, 60, 70
	End of borehole		

STRENGTH AND PENETRATION RESISTANCE



CONSISTENCY



SAMPLE	NATURAL UNIT WT. P.C.F.
S1	-
S2	-
S3	-
S4	-
S5	-
S6	-
T7	-
T8	-
S9	-
S10	-
RC11	-
RC12	-
RC13	-
RC14	-

DEPARTMENT OF HIGHWAYS - ONTARIO

MATERIALS AND RESEARCH SECTION

W.P. 140-57-2
BORE HOLE NO. 2B
JOB 60-F-2 4
STATION 587+00 (50' Lt.)
DATUM G. S. C.
COMPILED BY B.K.
BORING DATE Sept. 26/60
CHECKED BY J.B.

2" DIA. SPLIT TUBE
2" SHELBY TUBE
2" SPLIT TUBE
2" DIA. CONE
2" SHELBY
CASING

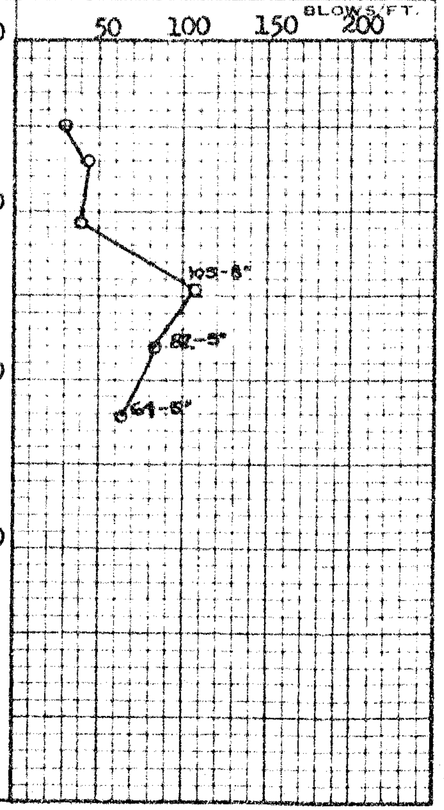
LEGEND

1/2 UNCONFINED COMPRESSION (Qu) — O
VANE TEST (C) AND SENSITIVITY (S) — $+^{S}_{C}$
NATURAL MOISTURE AND LIQUIDITY INDEX — X (LI)
LIQUID LIMIT
PLASTIC LIMIT

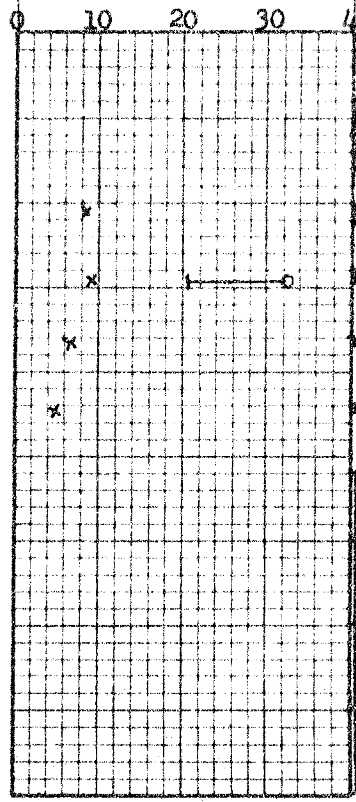
SYMBOL	DESCRIPTION	ELEV. FEET	DEPTH FEET
	Groundlevel	548	0
	BOULDERY TOPSOIL.	545	
	Clay silt with angular coarse gravel and boulders.	539	10
	Silt, red and green (Sub. Shale)	522	20
	Sandstone	520	30
	Shale	503	40

End of borehole.

STRENGTH AND PENETRATION RESISTANCE — P.S.F.



CONSISTENCY — MOIST. CONTENT- % DRY WT.



SAMPLE	NATURAL UNIT WT. P.C.F.
S1	-
S2	-
S3	-
S4	-
S5	-
S6	-
RC7	-
RC8	-
RC9	-
RC10	-

FORM DB-ML-120 (REV. 1959.)—58-3697

OFFICE REPORT ON SOIL EXPLORATION

DEPARTMENT OF HIGHWAYS - ONTARIO

MATERIALS AND RESEARCH SECTION

W.P. 140-57-2

BORE HOLE NO. 3

JOB 60-F-24

STATION 584+98 (36' Rt.)

DATUM G.S.C.

COMPILED BY B.K.

BORING DATE Aug. 17/60.

CHECKED BY J.B.

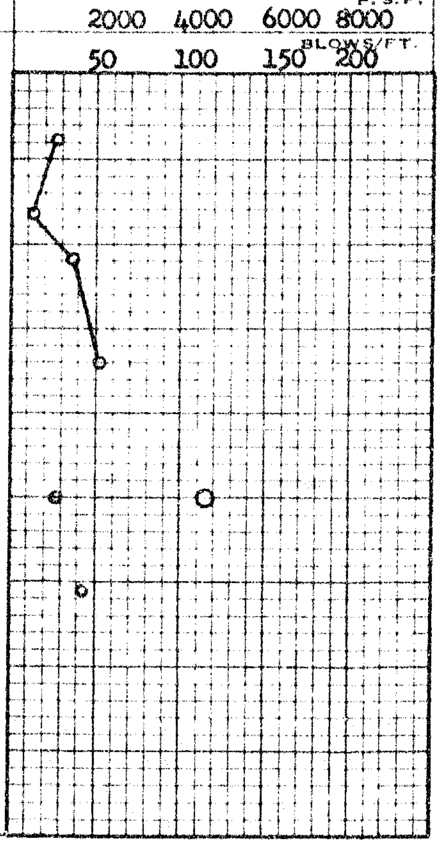
LEGEND

2" DIA. SPLIT TUBE
2" SHELBY TUBE
2" SPLIT TUBE
2" DIA. CONE
2" SHELBY
CASING

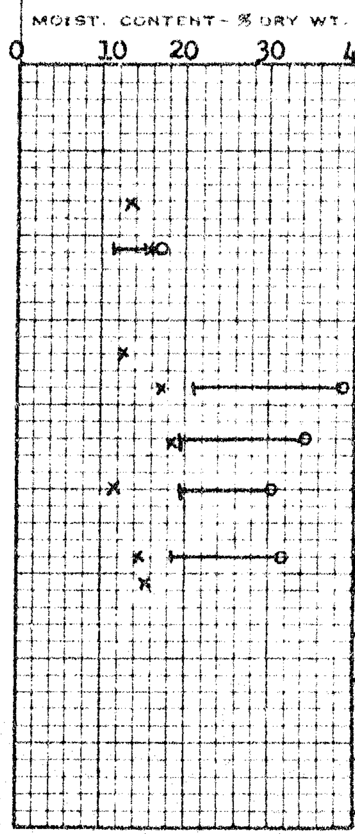
1/2 UNCONFINED COMPRESSION (Qu) ○
VANE TEST (C) AND SENSITIVITY (S) +S
NATURAL MOISTURE AND LIQUIDITY INDEX X
LIQUID LIMIT
PLASTIC LIMIT

SYMBOL	DESCRIPTION	ELEV. FEET	DEPTH FEET
	Groundlevel	505	0
	Gravel angular sandy with little clay some boulders.	498	
	Clay with angular sand and gravel size particles	492	10
	Reworked shale Silt or clay with much angular gravel and some cobbles	475	20
	Sand fine brown with a little clay.	471	30
	Limestone	465	40
	Sandstone	461	
	End of borehole.		

STRENGTH AND PENETRATION RESISTANCE



CONSISTENCY



SAMPLE	NATURAL UNIT WT. P.C.F.
S1	-
S2	-
S3	-
S4	-
C5	-
C6	-
S7	-
S8	-
S9	-
RC10	-
RC11	-
RC12	-

ORM OB-ML-126A—60-1015

OFFICE REPORT ON SOIL EXPLORATION

DEPARTMENT OF HIGHWAYS - ONTARIO
MATERIALS AND RESEARCH SECTION

W.P. 140-57-2
JOB 60-F-24
DATUM G.S.C.
BORING DATE Sept. 19/60

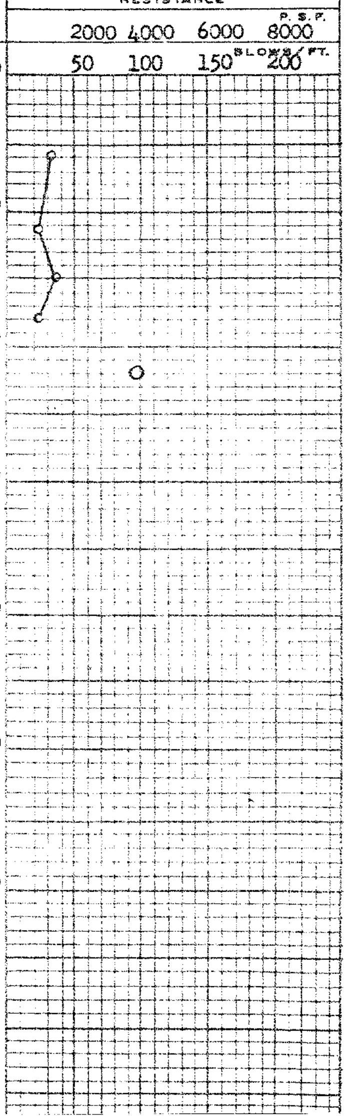
BORE HOLE NO. 3A
STATION 584+95 (186' Rt.)
COMPILED BY B.K.
CHECKED BY J.B.

2" DIA. SPLIT TUBE
2" SHELBY TUBE
2" SPLIT TUBE
2" DIA. CONE
2" SHELBY
CASING

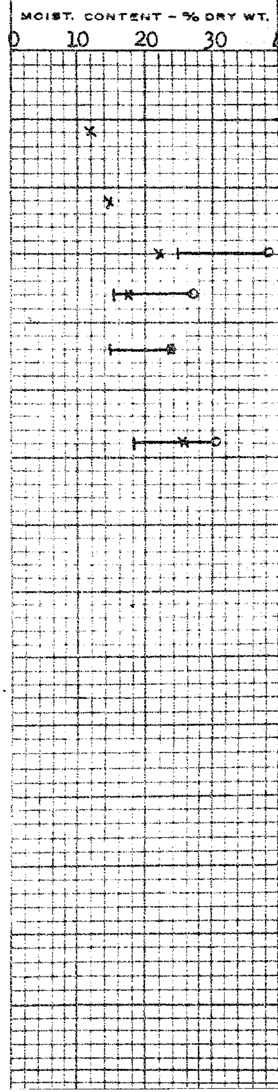
LEGEND
1/2 UNCONFINED COMPRESSION (Qu) — O
VANE TEST (C) AND SENSITIVITY (S) — +S
NATURAL MOISTURE AND LIQUIDITY INDEX — x LI
LIQUID LIMIT — —o
PLASTIC LIMIT — ⊢

SYMBOL	DESCRIPTION	ELEV. FEET	DEPTH FEET	SAMPLE	NATURAL UNIT WT. P.C.F.
	↓ Groundlevel	438	0		
	Gravel, angular, fine and coarse with a matrix of brown sandy cohesive silt; some boulders, silt content increasing with depth.			S1	-
			10	S2	-
	Clayey silt, stiff, grey-brown with sand layers, some gravel.	425		S3	-
				S4	-
	Silty clay, grey, with shale fragments.	418	20	T5	131.5
				T6	-
			30	T7	-
	Shale.	406		RC8	-
			40	RC9	-
				RC10	-
			50	RC11	-
	End of borehole.	385			
			60		

STRENGTH AND PENETRATION RESISTANCE



CONSISTENCY



FORM OB-ML-126A—60-1015

OFFICE REPORT ON SOIL EXPLORATION

DEPARTMENT OF HIGHWAYS - ONTARIO
MATERIALS AND RESEARCH SECTION

W.P. 140-57-2
JOB 60-F-24
DATUM GSC
BORING DATE Aug. 24/60.

BORE HOLE NO. 4
STATION 594+00 (49.7' Rt.)
COMPILED BY B.K.
CHECKED BY J.B.

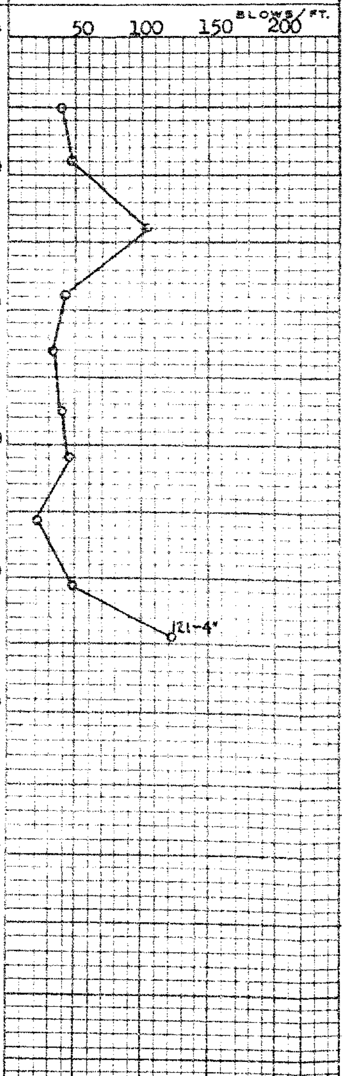
LEGEND

2" DIA. SPLIT TUBE
2" SHELBY TUBE
2" SPLIT TUBE
2" DIA. CONE
2" SHELBY
CASING

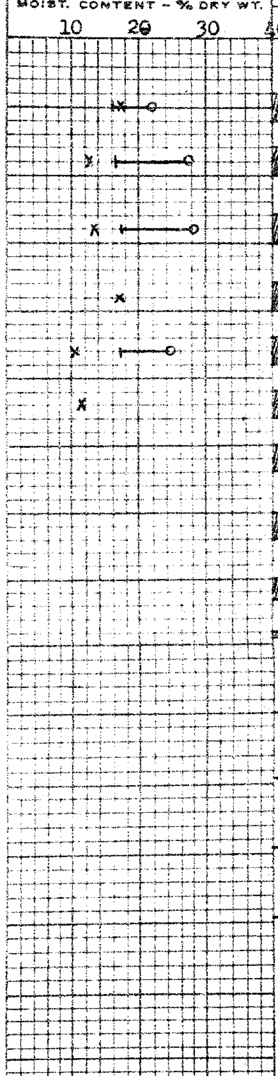
1/2 UNCONFINED COMPRESSION (Qu) O
VANE TEST (C) AND SENSITIVITY (S) +S
NATURAL MOISTURE AND LIQUIDITY INDEX LI x
LIQUID LIMIT
PLASTIC LIMIT

DESCRIPTION	ELEV. FEET	DEPTH FEET	SAMPLE	NATURAL UNIT WT. P.C.F.
↓ Groundlevel	491	0		
Clay, firm, grey brown, with angular fragments of rock.			S1	-
		10	S2	-
	479			
Clay, firm-stiff, with angular gravel and boulders becoming silt, mottled, hard, with increasing amounts of angular gravel.			S3	-
		20	S4	-
			S5	-
			S6	-
	462			
Silt. Mottled, reddish brown and green, with angular gravel particles. Some boulders. (Sub-Shale)		30	S7	-
			S8	-
		40	S9	-
			S10	-
	441	50		
Limestone			RC11	-
	431	60	RC12	-
Sandstone			RC13	-
	426			
End of borehole.		70		

STRENGTH AND PENETRATION RESISTANCE — P.S.F. — BLOWS/FT.



CONSISTENCY — MOIST. CONTENT - % DRY WT.



FORM OB-ML-126A--60-1015

OFFICE REPORT ON SOIL EXPLORATION

DEPARTMENT OF HIGHWAYS - ONTARIO

MATERIALS AND RESEARCH SECTION

W.P. 140-57-2
BORE HOLE NO. 4A
JOB 60-F-24
STATION 594+06 (214' Rt.)
DATUM GSC
COMPILED BY B.K.
BORING DATE Aug. 23/60.
CHECKED BY J.B.

2" DIA. SPLIT TUBE
2" SHELBY TUBE
2" SPLIT TUBE
2" DIA. CONE
2" SHELBY
CASING

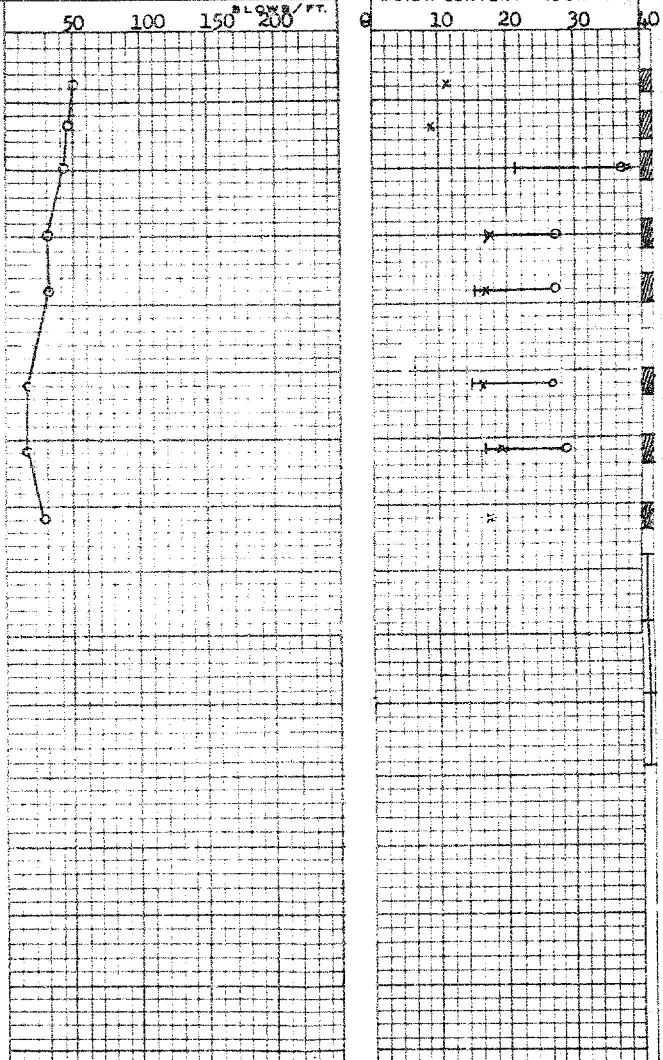
LEGEND

1/2 UNCONFINED COMPRESSION (Qu) — O
VANE TEST (C) AND SENSITIVITY (S) — +S
NATURAL MOISTURE AND LIQUIDITY INDEX — x LI
LIQUID LIMIT — —o
PLASTIC LIMIT — ⊢

SYMBOL	DESCRIPTION	ELEV. FEET	DEPTH FEET	SAMPLE	NATURAL UNIT WT. P.C.F.
	Groundlevel	451	0		
	Sand with silty clay binder.	449			
	Angular gravel with silty clay binder, grey.	442		S1	-
				S2	-
	Clay with sand and broken rock, hard, grey.	428	10	S3	133
				S4	-
			20	S5	-
	Clay with sand, med. hard, dark grey to light grey.			S6	-
			30	S7	-
	Shale particles	412		S8	-
	Shale	397	40	RC9	-
			50	RC10	-
				RC11	-
	End of borehole		60		

STRENGTH AND PENETRATION RESISTANCE — P.S.F. — BLOWS/FT.

CONSISTENCY — MOIST. CONTENT - % DRY WT.



FORM OB-ML-126 (REV. 1959.)—58-5691

OFFICE REPORT ON SOIL EXPLORATION

DEPARTMENT OF HIGHWAYS - ONTARIO

MATERIALS AND RESEARCH SECTION

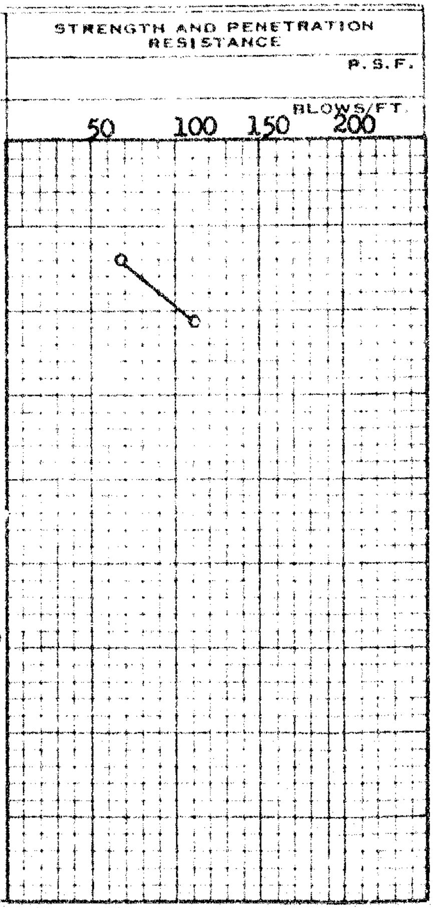
W.P. 140-57-2
JOB 60-F-24
DATUM GSC
BORING DATE Sept. 2/60.

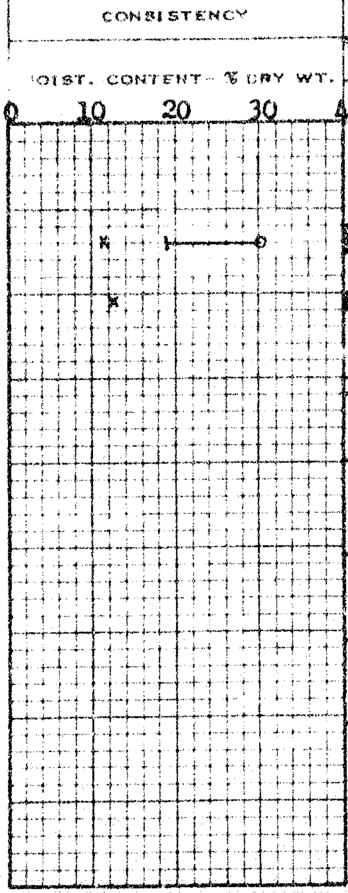
BORE HOLE NO. 4B
STATION 594+00 (35' Lt.)
COMPILED BY B.K.
CHECKED BY J.B.

2" DIA. SPLIT TUBE
2" SHELBY TUBE
2" SPLIT TUBE
2" DIA. CONE
2" SHELBY
CASING

LEGEND
1/2 UNCONFINED COMPRESSION (Qu) ○
VANE TEST (C) AND SENSITIVITY (S) +S
NATURAL MOISTURE AND LIQUIDITY INDEX × LI
LIQUID LIMIT
PLASTIC LIMIT

SYMBOL	DESCRIPTION	ELEV. FEET	DEPTH FEET	SAMPLE	NATURAL UNIT WT. P.C.F.
	↓ Groundlevel	576	0		
	Clay, sandy.	573			
	Sandstone boulders	570		S1	-
	Silt with sand and crushed rock.	567	10	S2	-
	Silt with sand and boulders	563			
	Boulders	561		RC3	-
	Sandstone		20	RC4	-
				RC5	-
			30	RC6	-
		542		RC7	-
	Shale	541			
	End of borehole		40		





FORM DB-ML-126 (REV. 1959.)--58-5691

OFFICE REPORT ON SOIL EXPLORATION

DEPARTMENT OF HIGHWAYS - ONTARIO

MATERIALS AND RESEARCH SECTION

W.P. 140-57-2
JOB 60-F-24
DATUM GSC
BORING DATE Aug. 23/60.

BORE HOLE NO. 5
STATION 591+00 (50' Rt.)
COMPILED BY B.K.
CHECKED BY J.B.

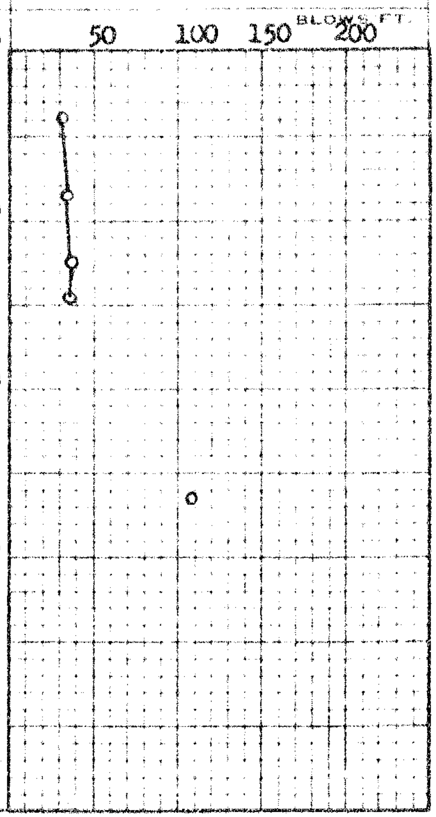
2" DIA. SPLIT TUBE	
2" SHELBY TUBE	
2" SPLIT TUBE	—o—o—
2" DIA. CONE	
2" SHELBY	
CASING	—x—x—

LEGEND

1/2 UNCONFINED COMPRESSION (Qu)	O
VANE TEST (C) AND SENSITIVITY (S)	+S
NATURAL MOISTURE AND LIQUIDITY INDEX	LI X
LIQUID LIMIT	—o
PLASTIC LIMIT	⊢

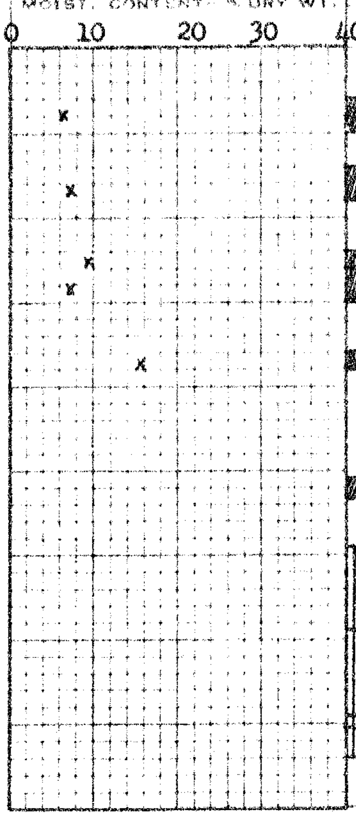
SYMBOL	DESCRIPTION	ELEV. FEET	DEPTH FEET	SAMPLE	NATURAL UNIT WT. P.C.F.
	↓ Groundlevel	492	0		
	Bouldery Topsoil	490			
	Angular gravel, some clay and silt.	485		S1	-
	Silt, brown, wet, with much angular gravel.	475	10	S2, S3, S4	-, -, -
	Silt (Sub-Shale), dry, mottled, red-brown and green.	463	20	S5, S6	-, -
	Sandstone	452	30	RC7, RC8, RC9	-, -, -
	Shale	450	40	RC10	-
	End of borehole				

STRENGTH AND PENETRATION RESISTANCE P.S.F.



CONSISTENCY

MOIST. CONTENT % DRY WT.



FORM OB-ML-126A--60-1015

OFFICE REPORT ON SOIL EXPLORATION

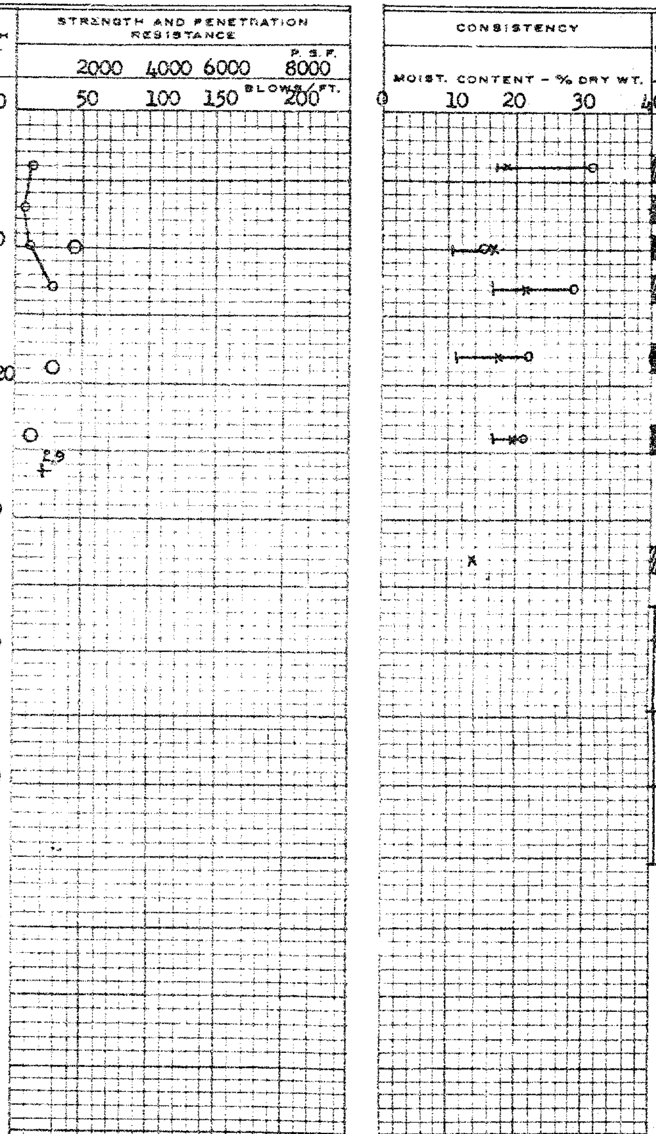
DEPARTMENT OF HIGHWAYS - ONTARIO
MATERIALS AND RESEARCH SECTION

W.P. 140-57-2 BORE HOLE NO. 5A
JOB 60-F-24 STATION 590+97 (221' Rt.)
DATUM GSC COMPILED BY B.K.
BORING DATE Aug. 24/60 CHECKED BY J.B.

2" DIA. SPLIT TUBE
2" SHELBY TUBE
2" SPLIT TUBE
2" DIA. CONE
2" SHELBY
CASING

LEGEND
1/2 UNCONFINED COMPRESSION (Qu) O
VANE TEST (C) AND SENSITIVITY (S) +S
NATURAL MOISTURE AND LIQUIDITY INDEX LI X
LIQUID LIMIT
PLASTIC LIMIT

SYMBOL	DESCRIPTION	ELEV. FEET	DEPTH FEET	SAMPLE	NATURAL UNIT WT. P.C.F.
	Groundlevel	437	0		
	Silt, slightly clayey with a few stones, brown.			S1	-
				S2	-
		427	10		
	Gravel, clayey.	425		T3	141
	Clayey silt, firm to soft with random stones; dark grey pieces of red and green shale.			S4	-
			20	T5	134
				T6	137
			30		
	Some boulders	404			
	Sand, coarse, silty with gravel			S7	-
		400			
	Sub-Shale	397	40	RC8	-
	Shale			RC9	-
			50	RC10	-
		381		RC11	-
	End of borehole		60		



FORM OB-ML-126A--60-1015

OFFICE REPORT ON SOIL EXPLORATION

DEPARTMENT OF HIGHWAYS - ONTARIO
MATERIALS AND RESEARCH SECTION

W.P. 140-57-2
JOB 60-F-24
DATUM GSC
BORING DATE Sept. 9/60.

BORE HOLE NO. 6
STATION 596+00 (51' Rt.)
COMPILED BY B.K.
CHECKED BY J.B.

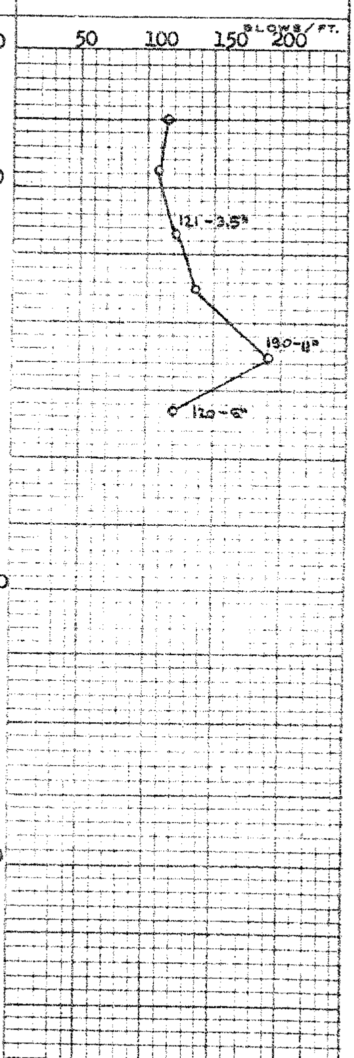
LEGEND

2" DIA. SPLIT TUBE
2" SHELBY TUBE
2" SPLIT TUBE
2" DIA. CONE
2" SHELBY
CASING

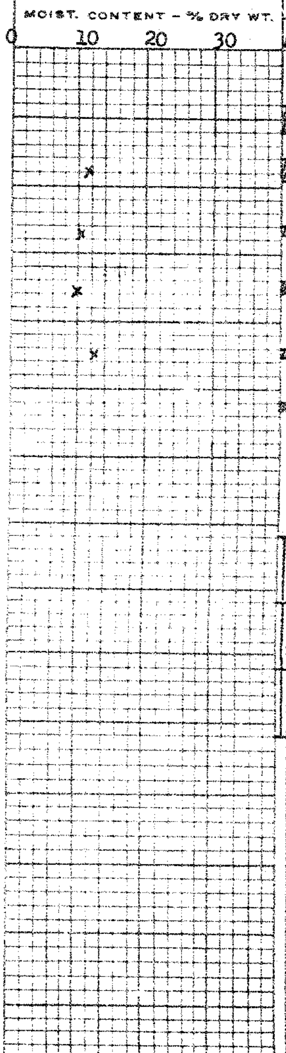
1/2 UNCONFINED COMPRESSION (Qu) — O
VANE TEST (C) AND SENSITIVITY (S) — +S
NATURAL MOISTURE AND LIQUIDITY INDEX — x LI
LIQUID LIMIT
PLASTIC LIMIT

SYMBOL	DESCRIPTION	ELEV. FEET	DEPTH FEET
	↓ Groundlevel	532	0
	Silt, very hard, red (Sub-Shale)	524	10
	Silt, dense, trace of sand.	506	20
	Sub-Shale	496	30
	Shale	481	40
	End of borehole		50, 60

STRENGTH AND PENETRATION RESISTANCE — P.S.F. / BLOWS/FT.



CONSISTENCY — MOIST. CONTENT - % DRY WT.



SAMPLE	NATURAL UNIT WT. P.C.F.
S1	-
S2	-
S3	-
S4	-
S5	-
S6	-
RC7	-
RC8	-
RC9	-

ORM OB-ML-126A--60-1015

OFFICE REPORT ON SOIL EXPLORATION

DEPARTMENT OF HIGHWAYS - ONTARIO
MATERIALS AND RESEARCH SECTION

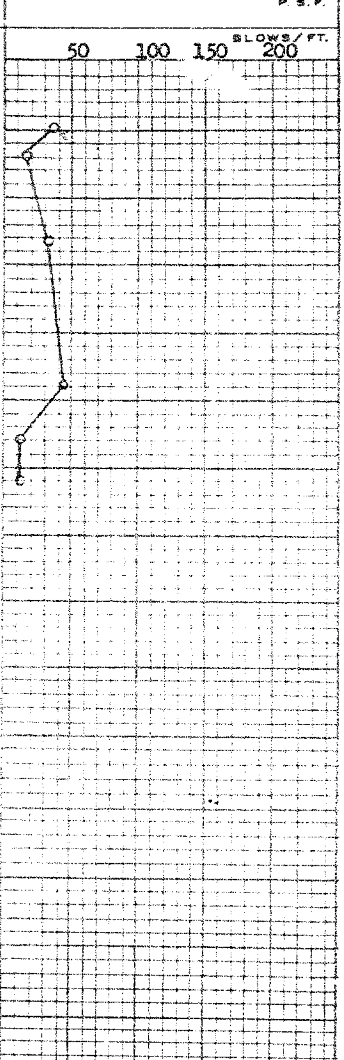
W.P. 140-57-2   BORE HOLE NO. 6A
JOB 60-F-24   STATION 596/00 (215' Rt.)
DATUM G.S.C.   COMPILED BY B.K.
BORING DATE Sept. 14/60.   CHECKED BY J.B.

2" DIA. SPLIT TUBE
2" SHELBY TUBE
2" SPLIT TUBE
2" DIA. CONE
2" SHELBY
CASING

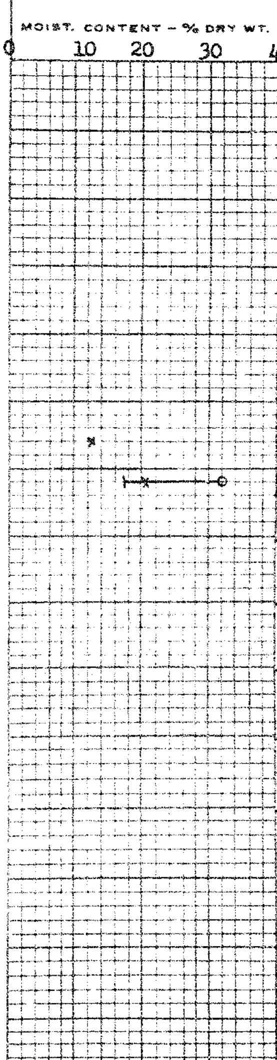
LEGEND
1/2 UNCONFINED COMPRESSION (Qu) O
VANE TEST (C) AND SENSITIVITY (S) +S
NATURAL MOISTURE AND LIQUIDITY INDEX LI x
LIQUID LIMIT —o
PLASTIC LIMIT ⊢

SYMBOL	DESCRIPTION	ELEV. FEET	DEPTH FEET	SAMPLE	NATURAL UNIT WT. P.C.F.
	Groundlevel	450.8	0		
	Topsoil	448.8			
	Silt, sandy, light grey. and boulders, brown.	444.8		S1	-
	Silt, sandy with gravel and boulders, brown.	436.8	10	S2	-
				S3	-
	Boulders	424.5	20	S4	-
	Clay, silty with sand.	415.5	30	S5	-
				S6	-
	Shale		40	RC7	-
				RC8	-
			50	RC9	-
		395.6		RC10	-
	End of borehole		60		

STRENGTH AND PENETRATION RESISTANCE P.S.F.



CONSISTENCY



FORM OB-ML-126A--60-1015

OFFICE REPORT ON SOIL EXPLORATION

DEPARTMENT OF HIGHWAYS - ONTARIO
MATERIALS AND RESEARCH SECTION

W.P. 140-57-2
JOB 60-F-24
DATUM GSC
BORING DATE Sept. 9/60.

BORE HOLE NO. 7
STATION 598+00 (50' Rt.)
COMPILED BY B.K.
CHECKED BY J.B.

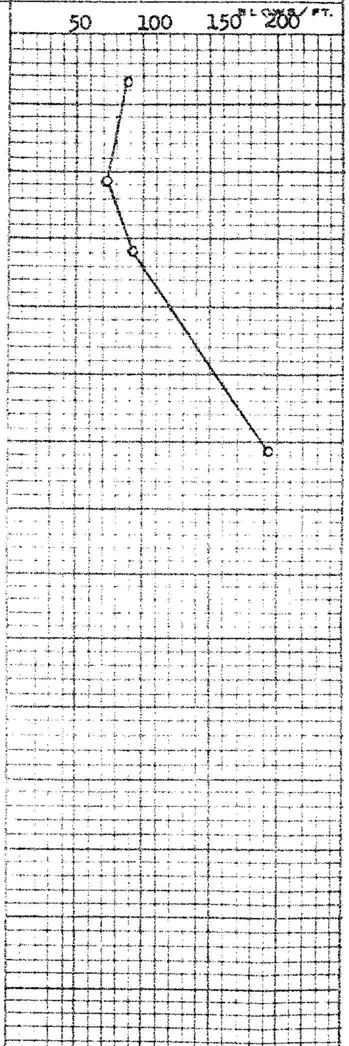
LEGEND

2" DIA. SPLIT TUBE
2" SHELBY TUBE
2" SPLIT TUBE
2" DIA. CONE
2" SHELBY
CASING

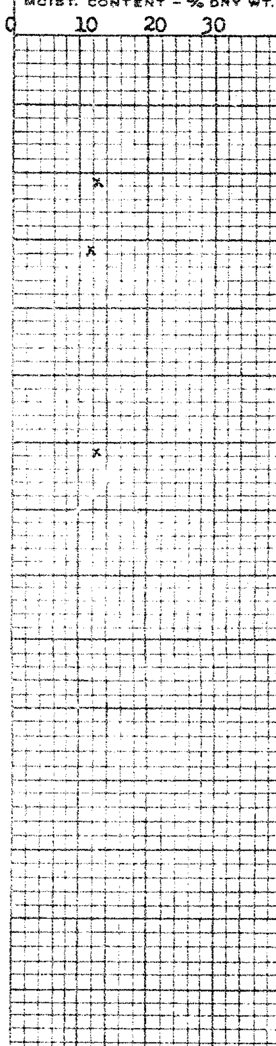
1/2 UNCONFINED COMPRESSION (Qu) — O
VANE TEST (C) AND SENSITIVITY (S) — +S
NATURAL MOISTURE AND LIQUIDITY INDEX — LI x
LIQUID LIMIT
PLASTIC LIMIT

SYMBOL	DESCRIPTION	ELEV. FEET	DEPTH FEET	SAMPLE	NATURAL UNIT WT. P.C.F.
	Groundlevel	533	0		
	Clay with sand and boulders roots, dark brown	531			
	Sub-Shale, red.	525		S1	-
	Silt and boulders with traces of sand hard grey (Reworked Shale)	515	10	S2	-
				S3	-
	Sandstone	514			
	Sub-Shale with sandstone layers.	503	20		
	Silt with sand and shale grey	499	30	S4	-
	Shale, red and green.	480	40	RC5	-
				RC6	-
			50	RC7	-
				RC8	-
	End of borehole		60		

STRENGTH AND PENETRATION RESISTANCE — P.S.F. / BLOWS/FT.



CONSISTENCY — MOIST. CONTENT - % DRY WT.



FORM OB-ML-126A--60-1015

OFFICE REPORT ON SOIL EXPLORATION

DEPARTMENT OF HIGHWAYS - ONTARIO
MATERIALS AND RESEARCH SECTION

W.P. 140-57-2
JOB 60-F-24
DATUM GSC
BORING DATE Sept. 14/60.

BORE HOLE NO. 7A
STATION 598+00 (197.3' Rt.)
COMPILED BY B.K.
CHECKED BY J.B.

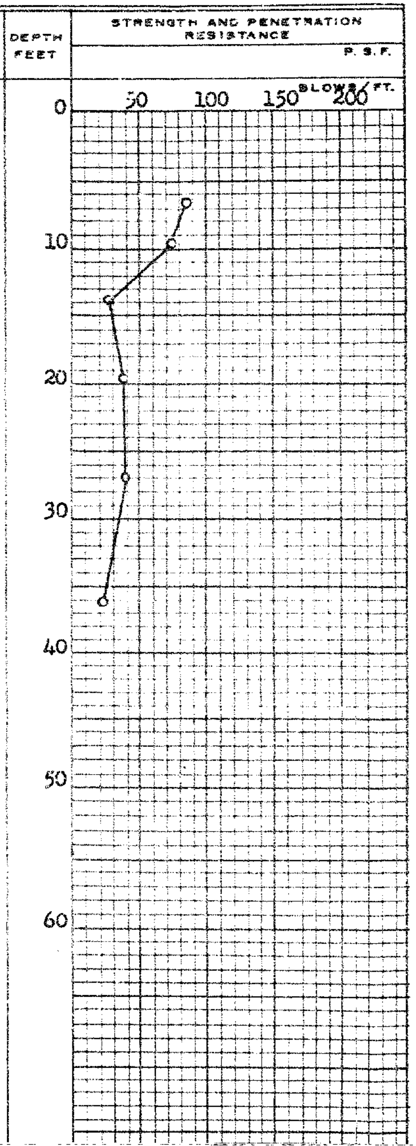
LEGEND

2" DIA. SPLIT TUBE
2" SHELBY TUBE
2" SPLIT TUBE
2" DIA. CONE
2" SHELBY
CASING

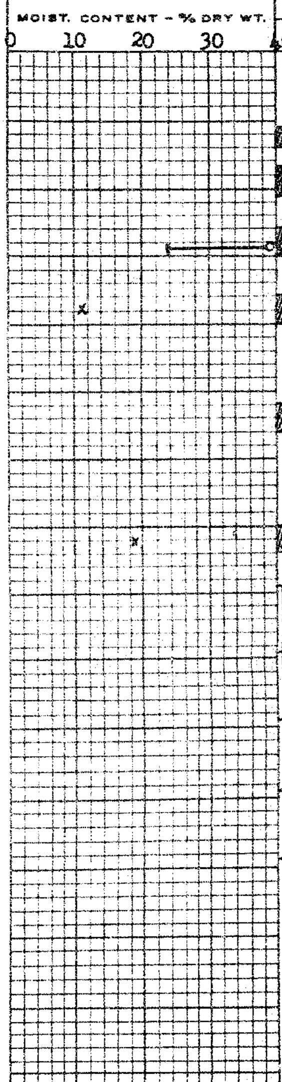
1/2 UNCONFINED COMPRESSION (Qu) — O
VANE TEST (C) AND SENSITIVITY (S) — +S
NATURAL MOISTURE AND LIQUIDITY INDEX — LI X
LIQUID LIMIT
PLASTIC LIMIT

DESCRIPTION	ELEV. FEET	SAMPLE	NATURAL UNIT WT. P.C.F.
Groundlevel	469		
Clay, sandy, org. matter	467		
Silt and boulders, sandy, hard grey with angular coarse gravel.	458	S1, S2	-, -
Silt, cohesive, lt. brown, sandy; angular gravel.	443	S3, S4	-, -
Silt (Reworked shale), with sand, med. stiff, lt. brown.	434	S5	-
Clay silt, cohesive firm grey gravel size fragments	430	S6	-
Shale	410	RC7, RC8, RC9, RC10	-, -, -, -
End of borehole			

STRENGTH AND PENETRATION RESISTANCE P.S.F.



CONSISTENCY



FORM OB-ML-126A 60-1015

OFFICE REPORT ON SOIL EXPLORATION

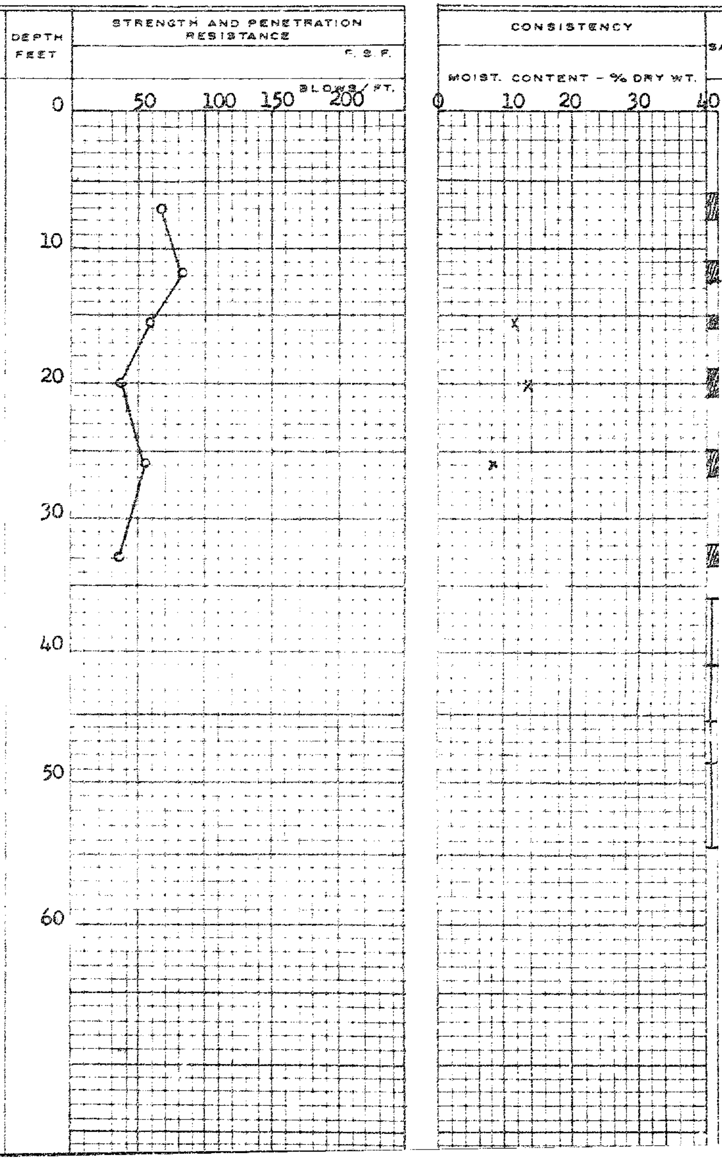
DEPARTMENT OF HIGHWAYS - ONTARIO
MATERIALS AND RESEARCH SECTION

W.P. 140-57-2 BORE HOLE NO. 8
JOB 60-F-24 STATION 583+00 (50' Rt.)
DATUM GSC COMPILED BY B.K.
BORING DATE Sept. 26/60 CHECKED BY J.B.

LEGEND

2" DIA SPLIT TUBE
2" SHELBY TUBE
2" SPLIT TUBE
2" DIA. CONE
2" SHELBY
CASING
1/2 UNCONFINED COMPRESSION (Qu)
VANE TEST (C) AND SENSITIVITY (S)
NATURAL MOISTURE AND LIQUIDITY INDEX
LIQUID LIMIT
PLASTIC LIMIT

SYMBOL	DESCRIPTION	ELEV. FEET	DEPTH FEET
	↓ Groundlevel	494	0
	Clay, dark brown sandy	491	
	Sand, gravel and crushed rock with brown silty clay matrix.	475	
	Silt, hard, mottled, grey-brown with angular sand and gravel through it.	464	
	Boulders	462	
	Angular gravel with wet matrix of slightly cohesive sandy silt.	458	
	Sandstone	449	
	Shale	439	
	End of borehole		



SAMPLE	NATURAL UNIT WT. P.C.F.
S1	-
S2	-
S3	-
S4	-
S5	-
S6	-
RC7	-
RC8	-
RC9	-
RC10	-

FORM OB-ML-126A 60-1015

OFFICE REPORT ON SOIL EXPLORATION

DEPARTMENT OF HIGHWAYS - ONTARIO

MATERIALS AND RESEARCH SECTION

W.P. 140-57-2
JOB 60-F-24
DATUM GSC
BORING DATE Sept. 21/60

BORE HOLE NO. 8A
STATION 583+00 (189' Rt.)
COMPILED BY B.K.
CHECKED BY J.B.

2" DIA SPLIT TUBE
2" SHELBY TUBE
2" SPLIT TUBE
2" DIA. CONE
2" SHELBY
CASING

LEGEND
1/2 UNCONFINED COMPRESSION (Qu)
VANE TEST (C) AND SENSITIVITY (S)
NATURAL MOISTURE AND LIQUIDITY INDEX
LIQUID LIMIT
PLASTIC LIMIT

DESCRIPTION	ELEV. FEET	DEPTH FEET	SAMPLE	NATURAL UNIT WT. P.C.F.
Groundlevel	436.7	0		
Silty clay, stiff-hard, brown.			S1	-
	428.7	10		
Silty-clay, brown, with some sand.			T2	128.1
			T3	132.5
	418.2	20		
Silty clay, firm; grey with sand partings and seams up to ½".			T4	-
			T5	132.9
			S6	-
	410.7			
Silty clay, stiff, grey with a few fragments of shale up to 1/4"	406.7	30		
Shale.			RC7	-
		40	RC8	-
			RC9	-
	386.7	50	RC10	-
End of borehole.		60		

STRENGTH AND PENETRATION RESISTANCE: P.S.F. 2000, 4000, 6000, 8000; BLOWS/FT. 50, 100, 150, 200

CONSISTENCY: MOIST. CONTENT - % DRY WT. 0, 10, 20, 30, 40

FORM OB-ML-126 (REV. 1959.)—58-569)

OFFICE REPORT ON SOIL EXPLORATION

DEPARTMENT OF HIGHWAYS - ONTARIO

MATERIALS AND RESEARCH SECTION

W.P. 140-57-2 BORE HOLE NO. 8B

JOB 60-F-24 STATION 583+00 (51.1' Lt.)

DATUM GSC COMPILED BY B.K.

BORING DATE Sept. 30/60 CHECKED BY J.B.

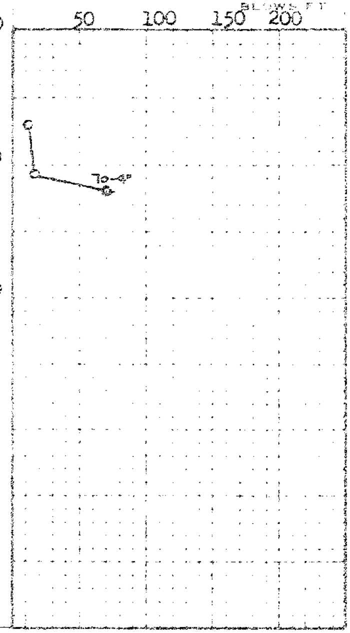
2" DIA. SPLIT TUBE
2" SHELBY TUBE
2" SPLIT TUBE
2" DIA. CONE
2" SHELBY
CASING

LEGEND

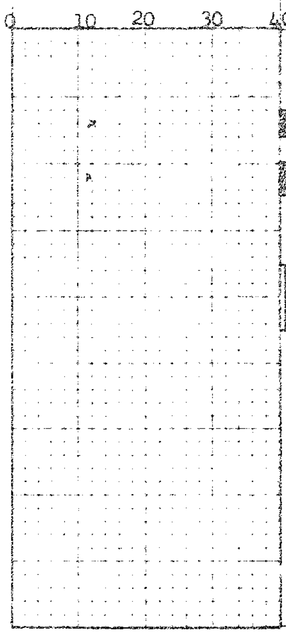
1/2 UNCONFINED COMPRESSION (Qu) ○
VANE TEST (C) AND SENSITIVITY (S) +S
NATURAL MOISTURE AND LIQUIDITY INDEX LI ×
LIQUID LIMIT
PLASTIC LIMIT

SYMBOL	DESCRIPTION	ELEV. FEET	DEPTH FEET	SAMPLE	NATURAL UNIT WT. P.C.F.
	Groundlevel	551	0		
	Silty clay, soft-firm, brown, with much angular gravel.	539		S1	-
				S2, S3	-, -
	Sub-Shale, hard, red, laminated.				
	Sandstone layer 1Ft.		20	RC4	-
	End of borehole.	529			

STRENGTH AND PENETRATION RESISTANCE



CONSISTENCY — MOIST. CONTENT - % DRY WT.



FORM OB-ML-126A - 60-1015

OFFICE REPORT ON SOIL EXPLORATION

DEPARTMENT OF HIGHWAYS - ONTARIO

MATERIALS AND RESEARCH SECTION

W.P. 140-57-2
JOB 60-F-24
DATUM GSC
BORING DATE Oct. 4/60

BORE HOLE NO. 9
STATION 581+00 (50' Rt.)
COMPILED BY B.K.
CHECKED BY J.B.

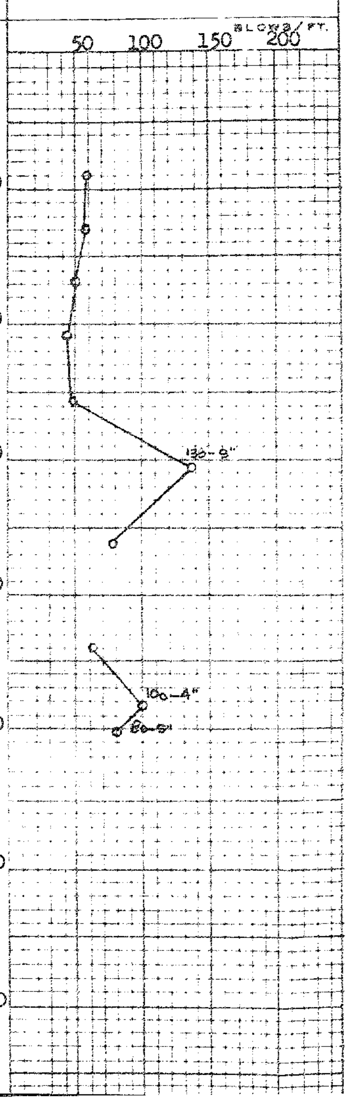
2" DIA SPLIT TUBE
2" SHELBY TUBE
2" SPLIT TUBE
2" DIA CONE
2" SHELBY
CASING

LEGEND

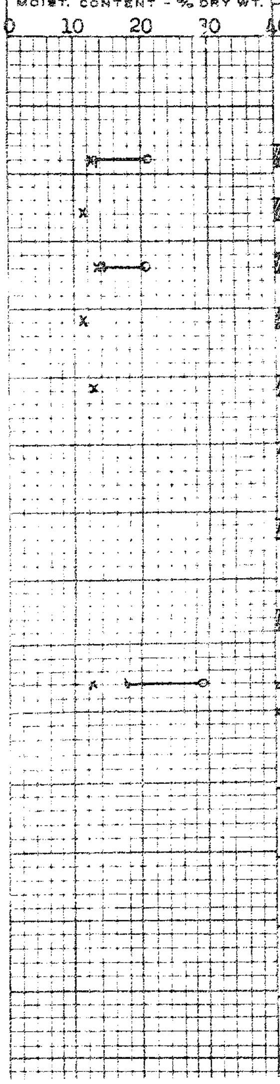
1/2 UNCONFINED COMPRESSION (Qu) — O
VANE TEST (C) AND SENSITIVITY (S) — +S
NATURAL MOISTURE AND LIQUIDITY INDEX — X LI
LIQUID LIMIT — —O
PLASTIC LIMIT — ⊢

SYMBOL	DESCRIPTION	ELEV. FEET	DEPTH FEET
	Groundlevel	486	0
	Silt, firm-stiff, brown with angular gravel, changing to sandy clay, firm to stiff with angular gravel.	460	
	Boulders	456	
	Gravel, fine to coarse, angular, with a clayey silt matrix. Occasional Boulders	444	
	Reworked shale, gravelly.	436	
	Shale	416	
	End of borehole.		

STRENGTH AND PENETRATION RESISTANCE — P.S.F. — BLOWS/FT.



CONSISTENCY — MOIST. CONTENT - % DRY WT.



SAMPLE	NATURAL UNIT WT. P.C.F.
S2	-
S3	-
S4	-
S5	-
S6	-
S8	-
S9	-
RC10	-
S10	-
S11	-
S12	-
RC13	-
RC14	-
RC15	-
RC16	-

OFFICE REPORT ON SOIL EXPLORATION

DEPARTMENT OF HIGHWAYS - ONTARIO

MATERIALS AND RESEARCH SECTION

W.P. 140-57-2 BORE HOLE NO. 9A

JOB 60-F-24 STATION 581+00 (188 Rt.)

DATUM GSC COMPILED BY B.K.

BORING DATE Sept. 29/60 CHECKED BY J.B.

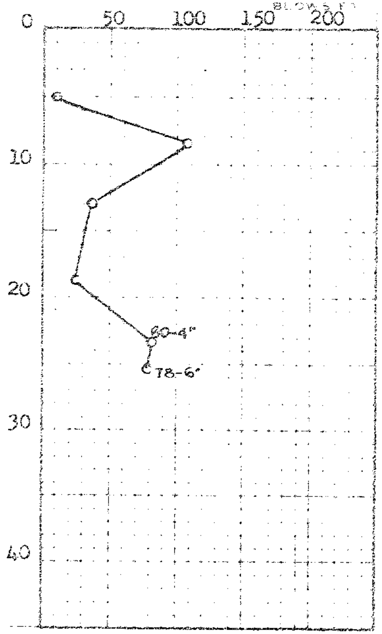
2" DIA. SPLIT TUBE
2" SHELBY TUBE
2" SPLIT TUBE
2" DIA. CONE
2" SHELBY
CASING

LEGEND

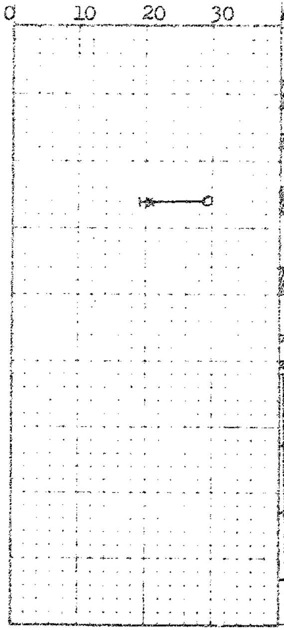
1/2 UNCONFINED COMPRESSION (Qu) ○
VANE TEST (C) AND SENSITIVITY (S) +S
NATURAL MOISTURE AND LIQUIDITY INDEX LI ×
LIQUID LIMIT
PLASTIC LIMIT

SYMBOL	DESCRIPTION	ELEV. FEET	DEPTH FEET
	↓ Groundlevel	431	0
	Sand, Med. dense, brown, uniform, fine.		
		422	
	Boulders, silt in between		
		419	
	Clay, stiff-hard, grey; traces of sand.		
		408	
	Sub-Shale		
		405	
	Shale red and green		
	End of borehole	385	

STRENGTH AND PENETRATION RESISTANCE P.S.F. / BLOWS/FT.



CONSISTENCY — MOIST. CONTENT % DRY WT.



SAMPLE	NATURAL UNIT WT. P.C.F.
S1	-
S2	-
S3	-
S4	-
S5	-
S6	-
RC7	-
RC8	-
RC9	-

FORM OB-ML-126 (REV. 1959.)—58-5691

OFFICE REPORT ON SOIL EXPLORATION

DEPARTMENT OF HIGHWAYS - ONTARIO

MATERIALS AND RESEARCH SECTION

W.P. 140-57-2
BORE HOLE NO. 9B
JOB 60-F-24
STATION 581+00 (52' Lt.)
DATUM GSC
COMPILED BY B.K.
BORING DATE Oct. 11/60
CHECKED BY J.B.

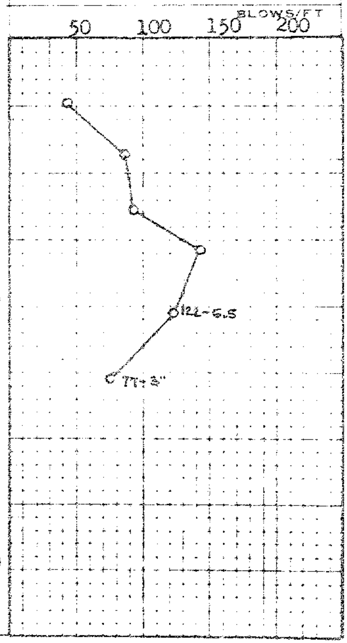
LEGEND

2" DIA. SPLIT TUBE
2" SHELBY TUBE
2" SPLIT TUBE
2" DIA. CONE
2" SHELBY
CASING

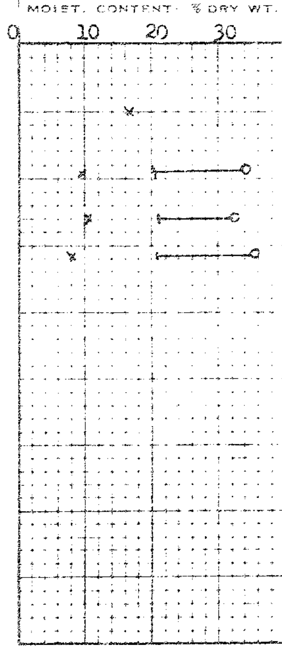
1/2 UNCONFINED COMPRESSION (Qu)
VANE TEST (C) AND SENSITIVITY (S)
NATURAL MOISTURE AND LIQUIDITY INDEX
LIQUID LIMIT
PLASTIC LIMIT

SYMBOL	DESCRIPTION	ELEV. FEET	DEPTH FEET	SAMPLE	NATURAL UNIT WT. P.C.F.
	Groundlevel	544	0		
	Clayey silt, firm, yellow-brown, with fine coarse gravel.	537		S1	-
	Sub-Shale, hard, red laminated.	524	10, 20	S2, S3, S4, S5	-, -, -, -
	Boulders	519			
	~~Silt, cohesive, grey-green with F.-Med., angular gravel.~~	518.7		S6	-
	Boulders	514	30		
	Limestone	513		RC7	-
	Shale		40	RC8, RC9	-, -
	End of borehole	497			

STRENGTH AND PENETRATION RESISTANCE — P.S.F. — BLOWS/FT



CONSISTENCY — MOIST. CONTENT % DRY WT.



FORM OB-ML-126A 60-1015

OFFICE REPORT ON SOIL EXPLORATION

DEPARTMENT OF HIGHWAYS - ONTARIO
MATERIALS AND RESEARCH SECTION

W.P. 140-57-2
JOB 60-F-24
DATUM GSC
BORING DATE Oct. 17/60

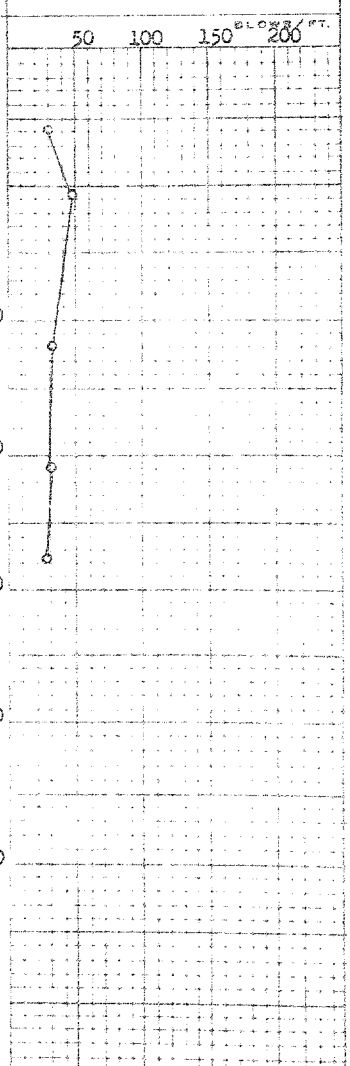
BORE HOLE NO. 10
STATION 579+00 (50' Rt.)
COMPILED BY B.K.
CHECKED BY J.B.

LEGEND

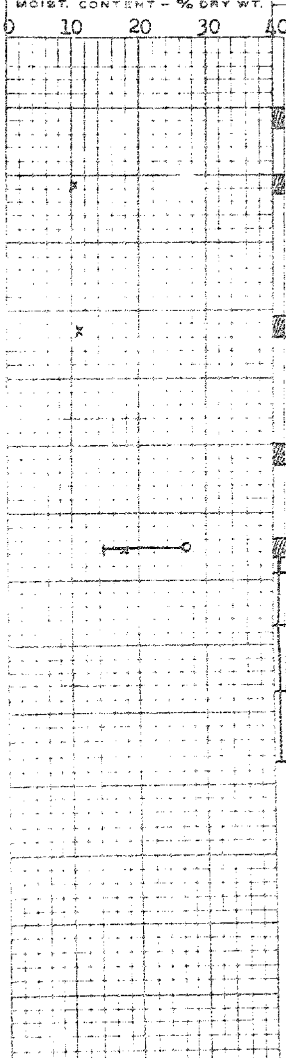
2" DIA SPLIT TUBE
2" SHELBY TUBE
2" SPLIT TUBE
2" DIA CONE
2" SHELBY
CASING
1/2 UNCONFINED COMPRESSION (Qu)
VANE TEST (C) AND SENSITIVITY (S)
NATURAL MOISTURE AND LIQUIDITY INDEX
LIQUID LIMIT
PLASTIC LIMIT

SYMBOL	DESCRIPTION	ELEV. FEET	DEPTH FEET
	↓ Groundlevel	485	0
	Clay, red-brown with fine to coarse sand and fine gravel boulders. Gravel, well graded with a wet brown cohesive sandy silt matrix occ sional boulders and boulder la,ers.	455	30
	Silt, f'rm, dark brown, gravelly; sand, dense, uniform; silty clay, stiff, grey, laminated.	447	
	Shale green and red.	431	
	End of borehole.		

STRENGTH AND PENETRATION RESISTANCE P.S.F. — BLOWS/FT.



CONSISTENCY — MOIST. CONTENT - % DRY WT.



SAMPLE	NATURAL UNIT P.C.F.
S1	-
S2	-
S7	-
S8	-
S9	-
RC10	-
RC11	-
RC12	-
RC13	-

FORM OB-ML-126A 60-1015

OFFICE REPORT ON SOIL EXPLORATION

DEPARTMENT OF HIGHWAYS - ONTARIO

MATERIALS AND RESEARCH SECTION

W.P. 140-57-2
JOB 60-F-24
DATUM GSC
BORING DATE Oct. 1960

BORE HOLE NO. 10A
STATION 579+00 (173' Rt.)
COMPILED BY B.K.
CHECKED BY J.B.

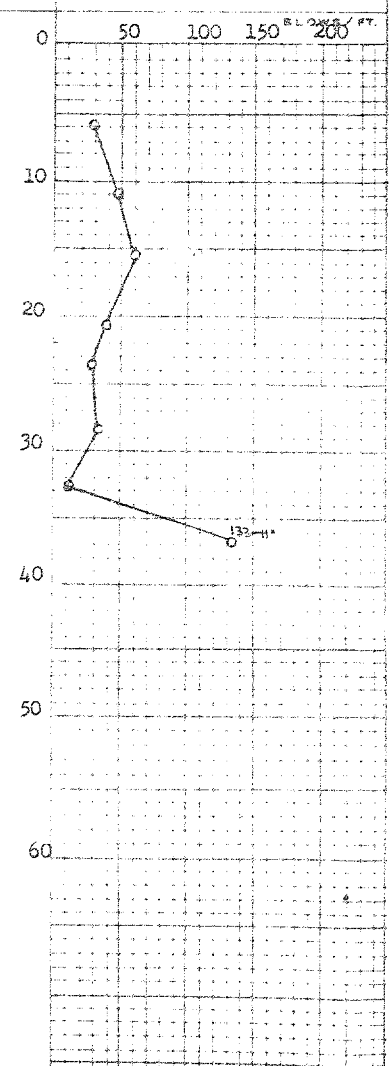
2" DIA SPLIT TUBE
2" SHELBY TUBE
2" SPLIT TUBE
2" DIA CONE
2" SHELBY
CASING

LEGEND

1/2 UNCONFINED COMPRESSION (Qu) O
VANE TEST (C) AND SENSITIVITY (S) +S
NATURAL MOISTURE AND LIQUIDITY INDEX LI X
LIQUID LIMIT
PLASTIC LIMIT

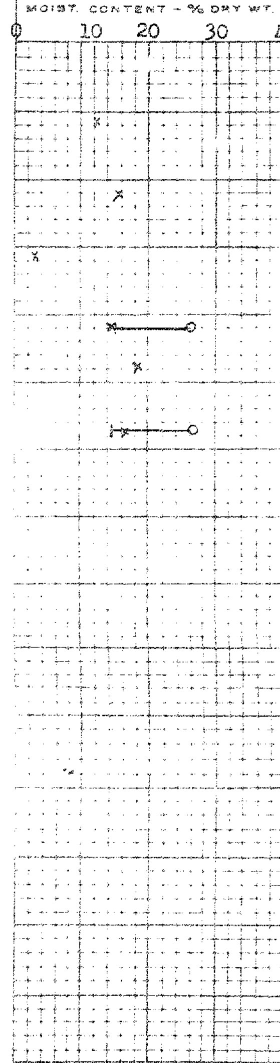
SYMBOL	DESCRIPTION	ELEV. FEET	DEPTH FEET
	↓ Groundlevel	438	0
	Clay, sandy, soft-firm, brown with coarse gravel, becoming gravel, sandy.	418	20
	Clay, stiff to firm, grey with rounded gravel and shale fragments.	403	
	Gravel with firm red silty-clay and boulders.	400	
	Shale, red.	386	
	End of borehole		

STRENGTH AND PENETRATION RESISTANCE P.S.F.



CONSISTENCY

MOIST. CONTENT - % DRY WT.



SAMPLE	NATURAL UNIT WT. P.C.F.
S1	-
S2	-
S3	-
S4	-
S5	-
S6	-
S7	-
S8	-
RC9	-
RC10	-
RC11	-
RC12	-

FORM OB-ML-12EA - 60-1015

OFFICE REPORT ON SOIL EXPLORATION

DEPARTMENT OF HIGHWAYS - ONTARIO
MATERIALS AND RESEARCH SECTION

W.P. 140-57-2 BORE HOLE NO. 10B

JOB 60-F-24 STATION 579+00 (49' Lt.)

DATUM GSC COMPILED BY B.K.

BORING DATE Oct. 6/60 CHECKED BY J.B.

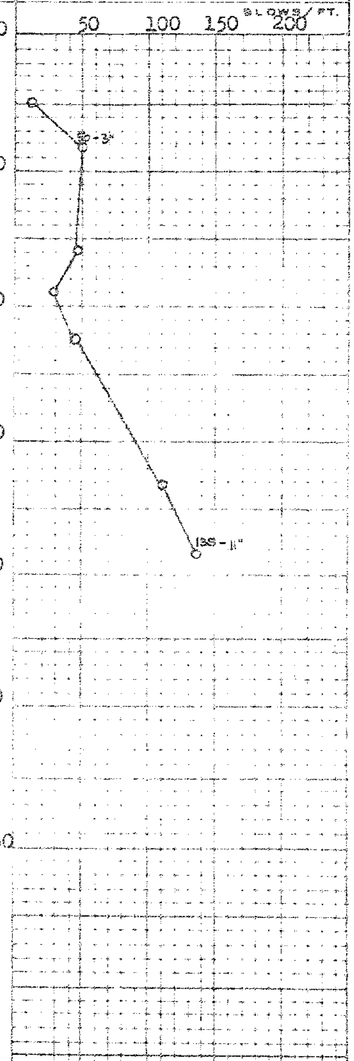
LEGEND

2" DIA SPLIT TUBE
2" SHELBY TUBE
2" SPLIT TUBE
2" DIA CONE
2" SHELBY
CASING

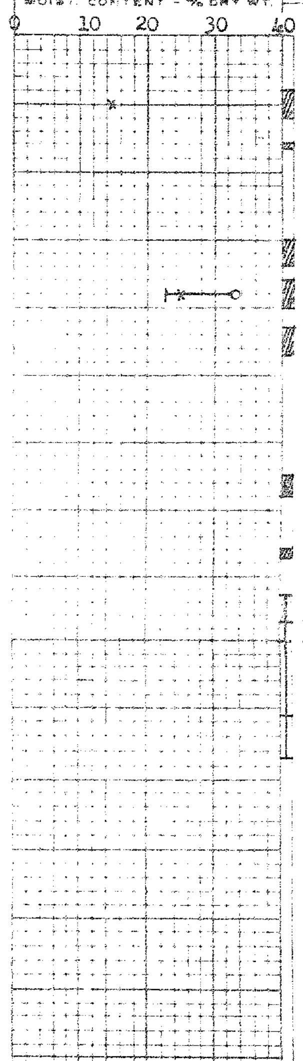
1/2 UNCONFINED COMPRESSION (Qu)
VANE TEST (C) AND SENSITIVITY (S)
NATURAL MOISTURE AND LIQUIDITY INDEX
LIQUID LIMIT
PLASTIC LIMIT

SYMBOL	DESCRIPTION	ELEV. FEET	DEPTH FEET
	Groundlevel	535	0
	Silty-clay, soft, brown with much slabby gravel; boulders.		
	Silty clay, soft to firm, red and green with fine to medium gravel.	516	20
	Clay silt hard, green, becoming grey; occasionally laminated. (Sub-Shale)	491	
	Shale	483	
	End of borehole		

STRENGTH AND PENETRATION RESISTANCE — P.S.F. — BLOWS/FT.



CONSISTENCY — MOIST. CONTENT - % DRY WT.



SAMPLE	NATURAL UNIT WT. P.C.F.
S1	-
S2	-
S3	-
S4	-
S5	-
S6	-
S9	-
RC10	-
RC11	-
RC12	-
RC13	-

M OB-ML-126A 60-1015

OFFICE REPORT ON SOIL EXPLORATION

DEPARTMENT OF HIGHWAYS - ONTARIO
MATERIALS AND RESEARCH SECTION

W.P. 140-57-2
JOB 60-F-24
DATUM GSC
BORING DATE Oct. 19__

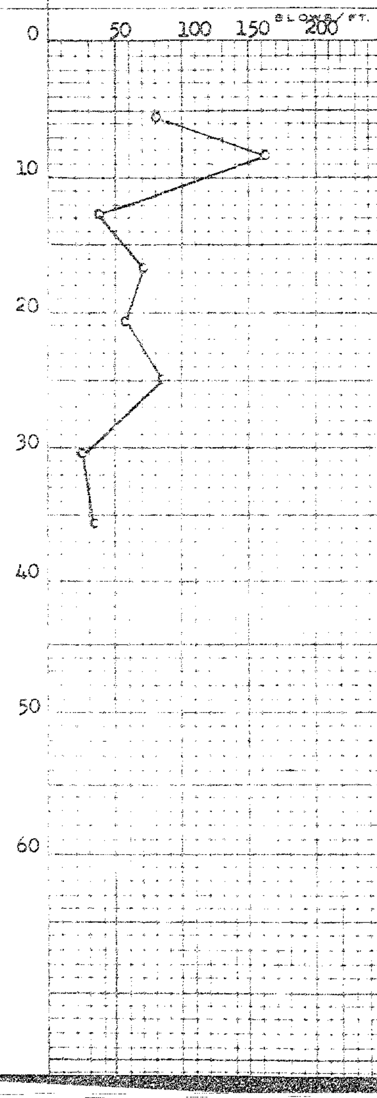
BORE HOLE NO. 11
STATION 577+00 (50' Rt.)
COMPILED BY B.K.
CHECKED BY J.B.

2" DIA. SPLIT TUBE
2" SHELBY TUBE
2" SPLIT TUBE
2" DIA. CONE
2" SHELBY
CASING

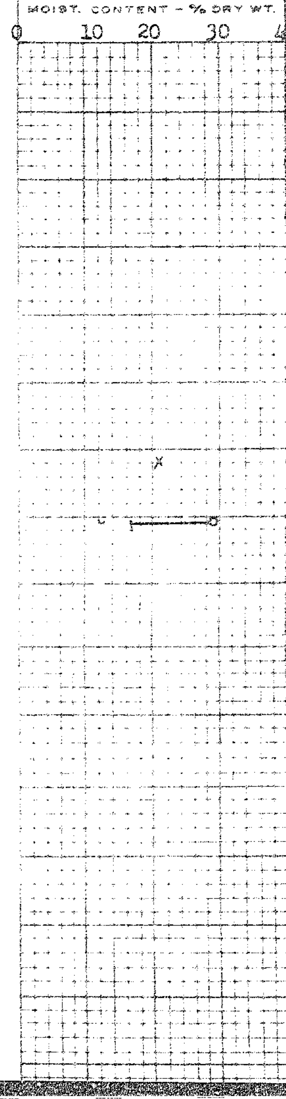
LEGEND
1/2 UNCONFINED COMPRESSION (Qu)
VANE TEST (C) AND SENSITIVITY (S)
NATURAL MOISTURE AND LIQUIDITY INDEX — LI X
LIQUID LIMIT
PLASTIC LIMIT

SYMBOL	DESCRIPTION	ELEV. FEET	DEPTH FEET	SAMPLE	NATURAL UNIT WT. P.C.F.
	Groundlevel	496	0		
	Silt, brown or mottled with friable gravel to very gravelly.	478		S1, S2, S3, S4	-, -, -, -
	Boulders	476			
	Silt (Sub-Shale), cohesive, mottled red and green; some boulders.	472		S5	-
	Gravel, fine to coarse, sandy with some boulders and gravelly clay pockets.	466		S6	-
	Clay, stiff to v. stiff, grey with a few pieces of subangular gravel; pockets of sand.	457		S7, S8	-, -
	Sandstone	441/440		RC9, RC10, RC11, RC12	-, -, -, -
	Shale				
	End of bo[illegible]hole				

STRENGTH AND PENETRATION RESISTANCE — P.S.F. — BLOWS/FT.



CONSISTENCY — MOIST. CONTENT - % DRY WT.



FORM OB-ML-126A 60-1015

OFFICE REPORT ON SOIL EXPLORATION

DEPARTMENT OF HIGHWAYS - ONTARIO

MATERIALS AND RESEARCH SECTION

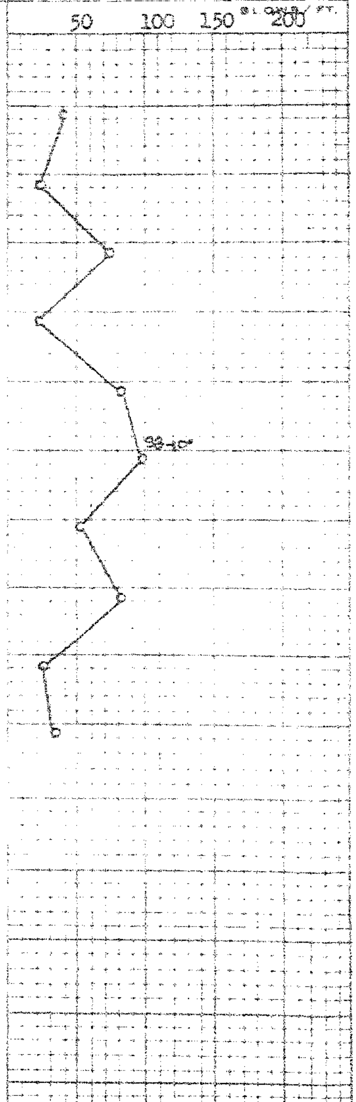
W.P. 140-57-2 BORE HOLE NO. 11A
JOB 60-F-24 STATION 577+00 (123' Rt.)
DATUM GSC COMPILED BY B.K.
BORING DATE Oct. 27/60 CHECKED BY J.B.

2" DIA SPLIT TUBE
2" SHELBY TUBE
2" SPLIT TUBE
2" DIA CONE
2" SHELBY
CASING

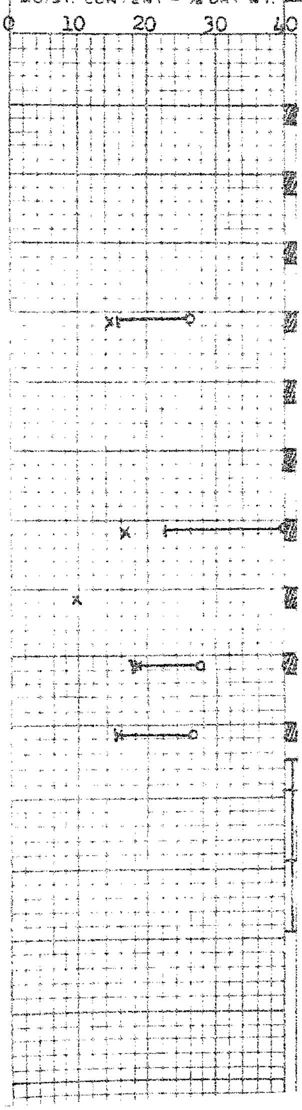
LEGEND
1/2 UNCONFINED COMPRESSION (Qu) O
VANE TEST (C) AND SENSITIVITY (S) +S
NATURAL MOISTURE AND LIQUIDITY INDEX x LI
LIQUID LIMIT —o
PLASTIC LIMIT |—

SYMBOL	DESCRIPTION	ELEV FEET	DEPTH FEET
	Groundlevel	468	0
	Gravel, angular with variable amounts of wet clay-silt, to (Becoming more clayey) silty clay, stiff, mottled brown.	443	
	Gravel, angular, well-graded with some brown sandy clay.	433	
	Silt(sub-shale)v. stiff, green, cohesive, laminated	432	
	Cobbles	428	
	Clay, firm to stiff with many subangular med. gravel size particles.	415	
	Shale	403	
	End of borehole		

STRENGTH AND PENETRATION RESISTANCE — P.S.F. — BLOWS/FT.



CONSISTENCY — MOIST. CONTENT - % DRY WT.



SAMPLE	NATURAL UNIT WT. P.C.F.
S1	-
S2	-
S3	-
S4	-
S5	-
S6	-
S7	-
S8	-
S9	-
S10	-
RC11	-
RC12	-
RC13	-

OFFICE REPORT ON SOIL EXPLORATION

DEPARTMENT OF HIGHWAYS - ONTARIO

MATERIALS AND RESEARCH SECTION

W.P. 140-57-2
JOB 60-F-24
DATUM GSC
BORING DATE Oct. 17/60

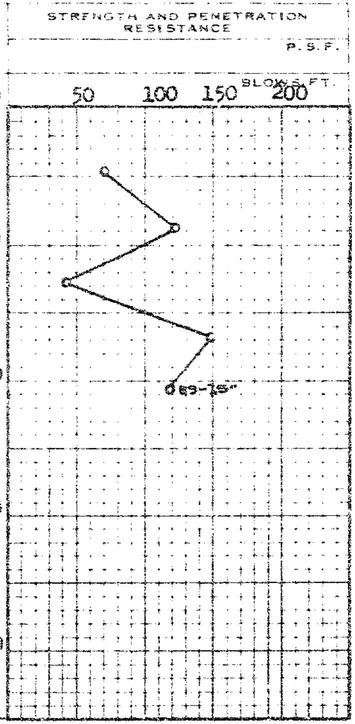
BORE HOLE NO. 11B
STATION 577+00 (50' Lt.)
COMPILED BY B.K.
CHECKED BY J.B.

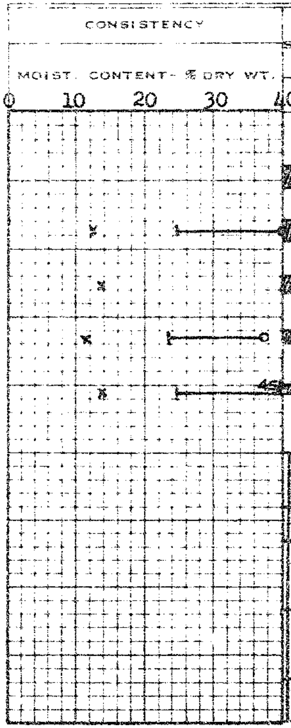
2" DIA. SPLIT TUBE
2" SHELBY TUBE
2" SPLIT TUBE
2" DIA. CONE
2" SHELBY
CASING

LEGEND

1/2 UNCONFINED COMPRESSION (Qu) — O
VANE TEST (C) AND SENSITIVITY (S) — +S
NATURAL MOISTURE AND LIQUIDITY INDEX — X LI
LIQUID LIMIT
PLASTIC LIMIT

SYMBOL	DESCRIPTION	ELEV. FEET	DEPTH FEET
	Groundlevel	533	0
	Silt (Sub-Shale) red and green laminated		
		508	
	Shale (Cabot Head)		
	End of borehole	486	





SAMPLE	NATURAL UNIT WT. P.C.F.
S1	-
S2	-
S3	-
S4	-
S7	-
RC8	-
RC9	-
RC10	-
RC11	-

FORM CB-ML-222
FEB 58
TM 58 5569

SUMMARY OF FIELD & LABORATORY TESTS

JOB 60-F-24
W.P. 140-57-2

HOLE NO	SAMP NO.	SAMPLE DEPTH (FEET)	MATERIAL DESCRIPTION	PENETN. RESIST. BL. W/FT	MOIST. CONT.	PLASTIC LIMIT	LIQUID LIMIT %	SHEAR STRENGTH	UNIT WEIGHT	REMARKS
3	S1	2'-3.5'	Angular gravel with a little silt and some organic matter (roots).	22	6.0	-	-	-	-	
	S2	4'-5.5'	The same with brown cohesive silt.	6	12.7	-	-	-	-	
	S3	6'-7.5'	Coarse angular gravel with a matrix of brown cohesive gravelly silt-wet.	17	10.0	-	-	-	-	
	S4	9'-10.5'	Much the same matrix; drier.	37	11.9	-	-	-	-	
	S5	11'-12.5'	Well graded angular gravel with a small amount of sandy silty clay.	35	-	-	-	-	-	
	S6	27'-28.5'	Silty clay red with angular gravel.	41	13.8	-	-	-	-	
	RC7	30'-35.5'	Sandstone bedrock.	-	-	-	-	-	-	
	RC8	35.5'-40.8'	Sandstone and shale from 39.8'-40.8'	-	-	-	-	-	-	

FORM OB—ML—222
FEB 59
1M-58-5569

SUMMARY OF FIELD & LABORATORY TESTS

JOB 60-F-24
W.P. 140-57-2

HOLE NO.	SAMP NO.	SAMPLE DEPTH (FEET)	MATERIAL DESCRIPTION	PENET'N RESIST. BLOWS FT	MOIST. CONT. %	PLASTIC LIMIT %	LIQUID LIMIT %	SHEAR STRENGTH p.s.f.	UNIT WEIGHT p.c.f.	REMARKS
1A	S1	3'-5'	Silt with sharply angular gravel. Sometimes badly weathered.	40	13.3	-	-	-	-	
	S2	7.3'-8.8'	Reddish brown clayey silt with some angular gravel.	18	6.4	-	-	-	-	
	S3	1[illegible] -12'	Brown silty sand with some fine gravel wet.	61	18.0	-	-	-	-	
	S4	15'-17'	Stiff grey clayey silt with gravel (some shale fragments).	9	15.7	7.4	18.4	-	-	
	S5	20'-22'	Firm-stiff grey clayey silt with gravel (shale fragments).	20	22.8	19.3	27.8	-	-	
	T6	25'-26.5'	(Dried out) grey clayey silt etc.	8	22.8	19.4	30.8	-	122	
	S7	32'-34'	Stiff to v. stiff blue grey and reddish brown cohesive silt and reworked shale.	32	15.3	-	-	-	-	
	S8	35'-37'	V. stiff (dried out?) grey clayey silt with occasional fine gravel particles (some shale fragments)	16	15.2	15.2	24.4	-	-	
	S9	38'-40'	Gravelly silt (red and green mottled) some sand: Reworked shale.	79	13.6	-	-	-	-	
	S10	43'-43.5'	Gravel. Some sandy silt, red, wet.	84-6"	-	-	-	-	-	

FORM OB—ML—222
FEB 59
1M-58-5569

SUMMARY OF FIELD & LABORATORY TESTS

JOB 60-F-24
W.P. 140-57-2

HOLE NO.	SAMP NO.	SAMPLE DEPTH (FEET)	MATERIAL DESCRIPTION	PENET'N RESIST. BLOWS FT.	MOIST. CONT. %	PLASTIC LIMIT %	LIQUID LIMIT %	SHEAR STRENGTH p.s.f.	UNIT WEIGHT p.c.f.	REMARKS
1A	RC11	43.5'-50'	Boulders and gravel.	-	-	-	-	-	-	
	RC12	50'-54.5'	Red shale.	-	-	-	-	-	-	
	RC13	54.5'-59.2'	"	-	-	-	-	-	-	
	RC14	59.2'-64.2'	"	-	-	-	-	-	-	

FORM OB—ML—222
FEB 59
1M-58-5569

JOB 60-F-24
W.P. 140-57-2

SUMMARY OF FIELD & LABORATORY TESTS

HOLE NO.	SAMP NO.	SAMPLE DEPTH (FEET)	MATERIAL DESCRIPTION	PENET'N RESIST. BLOWS FT.	MOIST. CONT. %	PLASTIC LIMIT %	LIQUID LIMIT %	SHEAR STRENGTH p.s.f.	UNIT WEIGHT p.c.f.	REMARKS
1B	S1	3'-5'	Firm-stiff brown clayey silt with some angular ½"gravel.	11	19.7	-	-	-	-	
	S2	6'-8'	Much the same, not much sample.	3	17.9	-	-	-	-	
	S3	10'-12'	Well graded gravel with some silt.	59	-	-	-	-	-	
	S4	13'-15'	Well graded gravel with some silt.	-	-	-	-	-	-	
	S5	16'-18'	Completely dried out; appears to be the same as No. 4.	22	-	-	-	-	-	
	G6	20'-22'	Green silt (Sub-Shale).	-	13.8	-	-	-	-	
	S7	22'-23'	Green silt (Sub-Shale).	156	12.0	-	-	-	-	
	S8	24.5'-25.3'	Laminated red-sub-shale.	107-9"	-	-	-	-	-	
	S9	32'-32.9'	Reddish hard gravelly clay; rather different to sample 8 - no apparent laminae.	120-11"	13.2	-	-	-	-	
	S10	35'-35.7'	Dried out (?) reddish clay-shale some laminations.	128-9"	10.7	-	-	-	-	
	S11	38'-39.2'	Green hard silt (Sub-Shale).	69	13.0	-	-	-	-	
	S12	44'-44'-3"	Green laminated silt (Sub-Shale) less hard than sample 11.	-	-	-	-	-	-	

FORM OB—ML—222
FEB 59
1M-58-5569

SUMMARY OF FIELD & LABORATORY TESTS

JOB 60-F-24
W.P. 140-57-2

HOLE NO.	SAMP NO.	SAMPLE DEPTH (FEET)	MATERIAL DESCRIPTION	PENET'N RESIST. BLOWS FT	MOIST. CONT. %	PLASTIC LIMIT %	LIQUID LIMIT %	SHEAR STRENGTH p.s.f.	UNIT WEIGHT p.c.f.	REMARKS
2	S1	2'-3.5'		27	-	-	-	-	-	No Recovery
	S2	4'-5.5'	Angular pebbles of rock, probably limestone with some v. soft clay plus roots and organic matter (soft wet clay).	37	25.4	-	-	-	-	
	S3	6.5'-8'		22	37.4 23.7	-	-	-	-	
	S4	11.5'-13'	A few angular gravel size pieces of rock (limestone) with soft light brown clay.	22	20.1	-	-	-	-	
	S5	15'-16.5'	Soft brownish clay containing angular fine gravel sizes of broken rock.	31	13.5	-	-	-	-	
	S6	19.5'-21'	Angular fragments of rock up to 1"Ø some decomposed: a little soft brown clay.	66	9.5 14.6	-	-	-	-	
	S7	27'-28.5'	V. soft brown clay containing angular fragments of rock.	59	20.0	16.1	27.1	-	-	
	S8	29'-31'	Soft rather friable brown clay somewhat mottled containing fragments of weathered rock	40	19.1	17.2	26.6	-	-	
	S9	33'-35'	Firm brownish-green mottled friable clay containing fragments of weathered rock	100	43.4	21.0	34.4	-	-	

FORM OB—ML—222
FEB 59
1M-58-5589

JOB 60-F-24
W.P. 140-57-2

SUMMARY OF FIELD & LABORATORY TESTS

HOLE NO.	SAMP NO.	SAMPLE DEPTH (FEET)	MATERIAL DESCRIPTION	PENET'N RESIST. BLOWS FT	MOIST. CONT. %	PLASTIC LIMIT %	LIQUID LIMIT %	SHEAR STRENGTH PSF	UNIT WEIGHT PCF	REMARKS
2	S10	37'-37.6'	Broken rock fragments, many plate-like. With a very little brownish clay.	130-7"	-	-	-	-	-	
	S11	40'-41.5'	Reddish brown soft-firm friable clay with fragments of weathered sandstone.	102	14.1	19.0	30.5	-	-	
	RC12	44.3'-49.8'	Shale.	-	-	-	-	-	-	
	RC13	49.8'-54.8'	Shale.	-	-	-	-	-	-	

FORM OB—ML—222
FEB 59
1M-58-5569

JOB 60-F-24
W.P. 140-57-2

SUMMARY OF FIELD & LABORATORY TESTS

HOLE NO.	SAMP NO.	SAMPLE DEPTH (FEET)	MATERIAL DESCRIPTION	PENETN RESIST. BLOWS/FT	MOIST. CONT. %	PLASTIC LIMIT %	LIQUID LIMIT %	SHEAR STRENGTH psf	UNIT WEIGHT pcf	REMARKS
2A	S1	4'-6'	Dry brown cohesive silt with a few pieces of dolomite 1".	47	15.8	15.9	26.5	-	-	
	S2	6'-8'	Moist brown cohesive silt or clayey silt with a few 1" stones.	44	15.3	17.4	23.1	-	-	
	S3	10'-12'		46	-	17.7	28.1	-	-	
	S4	15'-17'	Brown rather dry clayey silt with nodules of light brown silt.	31	14.9	-	-	-	-	
	S5	20'-22'	Grey moist clayey silt with shale fragments.	26	18.3	16.6	29.7	-	-	
	S6	25'-27'	Firm grey silty clay.	12	-	18.9	32.0	-	-	
	T7	28'-30'	Dark grey firm clay with a 1" piece of limestone.	P	19.5	-	-	-	-	
	T8	31'-33'		P	30.0	17.4	31.0	2390	-	
	S9	34'-36'	Dark grey v. silty clay.	5	18.9	-	-	-	-	
	S10	48'-48.5'	Reddish brown shaley clay silt.	80-6"	-	-	-	-	-	
	RC11	50'-55'	Hard red shale.	-	-	-	-	-	-	Recovery 72%.
	RC12	55'-60'	Hard red shale.	-	-	-	-	-	-	
	RC13	60'-65'	Hard red shale.	-	-	-	-	-	-	
	RC14	65'-70'	Hard red shale.	-	-	-	-	-	-	

FORM OB--ML--222
FEB 59
1M-58-5569

JOB 60-F-24

W.P. 140-57-2

SUMMARY OF FIELD & LABORATORY TESTS

HOLE NO.	SAMP NO.	SAMPLE DEPTH (FEET)	MATERIAL DESCRIPTION	PENETN RESIST. BLOWS FT	MOIST. CONT. %	PLASTIC LIMIT %	LIQUID LIMIT %	SHEAR STRENGTH p.s.f.	UNIT WEIGHT p.c.f.	REMARKS
2B	S1	4'-6'	Angular coarse gravel with a matrix of slightly organic moist brown clayey silt.	30	-	-	-	-	-	
	S2	6'-8'	Moist brown clayey silt with a fairly large amount of angular gravel fragments.	43	-	-	-	-	-	
	S3	10'-11.2'	Silt (Dry reddish-brown shale).	40	8.2	-	-	-	-	
	S4	14'-14.7'	Same as above.	105-8"	9.3	20.4	32.7	-	-	
	S5	18'-18.4'	Rather dry red silt (Shale) with 2" pieces of dolomite.	32-5"	6.6	-	-	-	-	
	S6	22'-22.4'	Rather dry mottled, but predominantly green sub-shale.	64-5"	4.8	-	-	-	-	
	RC7	26'-30'	Soft green shale.	-	-	-	-	-	-	
	RC8	30'-35'	Soft green shale.	-	-	-	-	-	-	
	RC9	35'-40'	Soft green shale.	-	-	-	-	-	-	
	RC10	40'-45'	Soft green shale.	-	-	-	-	-	-	

SUMMARY OF FIELD & LABORATORY TESTS

JOB 60-F-24
W.P. 140-57-2

HOLE NO.	SAMP NO.	SAMPLE DEPTH (FEET)	MATERIAL DESCRIPTION	PENET'N RESIST. BLOWS/FT	MOIST CONT. %	PLASTIC LIMIT %	LIQUID LIMIT %	SHEAR STRENGTH p.s.f.	UNIT WEIGHT p.c.f.	REMARKS
3	S1	3'-4.5'	Broken core of limestone rock - v. broken and angular. A little soft clay.	27	-	-	-	-	-	
	S2	7.2'-9.2'	V. soft wet clay containing fragments of broken rock (limestone)	13	13.1	-	-	-	-	
	S3	10'-12'	Fragments of weathered rock in matrix of soft brown clay.	36	15.7	11.4	16.9	-	-	
	S4	16'-17.5'	Angular fragments of weathered greyish-green, shale-like rock with soft rather friable greyish-green clay. Some brown inclusions. Clay probably residual.	51	12.7	-	-	-	-	
	C5	17.5'-20.2'	Brownish-red soft clay (possibly soft-firm).	-	17.2	21.0	38.9	-	-	
	C6	20.2'-24'	Green and red-brown mottled clay firm. Contains some small angular fragments of rock.	-	18.5	19.5	34.2	-	-	
	S7	24'-26'	Greenish brown firm rather friable clay. Some iron staining; contains particles of weathered rock.	29	11.5	19.9	30.1	4300	-	
	C8	28'-30'	Red-brown soft-firm clay containing fragments of reddish shale, some weathered.	-	14.2	18.7	31.4	-	-	
	S9	30'-31'	Wet brown fine sand with a little clay.	42	15.4	-	-	-	-	
	RC10	33.5'-36.3'	Sandstone.	-	-	-	-	-	-	

FORM OB—ML—222
FEB 59
14-58-5569

SUMMARY OF FIELD & LABORATORY TESTS

JOB 60-F-24
W.P. 140-57-2

HOLE NO	SAMP NO.	SAMPLE DEPTH (FEET)	MATERIAL DESCRIPTION	PENET'N RESIST. BLOWS/FT	MOIST. CONT. %	PLASTIC LIMIT %	LIQUID LIMIT %	SHEAR STRENGTH p.s.f.	UNIT WEIGHT p.c.f.	REMARKS
3	RC11	36.3'-41'	Sandstone.	-	-	-	-	-	-	
	RC12	41'-44'	Sandstone.	-	-	-	-	-	-	

SUMMARY OF FIELD & LABORATORY TESTS

JOB 60-F-24
W.P. 140-57-2

HOLE NO.	SAMP NO.	SAMPLE DEPTH (FEET)	MATERIAL DESCRIPTION	PENET'N RESIST. BLOWS/FT	MOIST. CONT. %	PLASTIC LIMIT	LIQUID LIMIT %	SHEAR STRENGTH	UNIT WEIGHT	REMARKS
3A	S1	5'-7'	Angular fine and coarse gravel with a matrix of brown sandy cohesive silt (Wet).	33	12.0	-	-	-	-	
	S2	10'-12'	Sandy cohesive silt with a considerable amount of angular. Med. and coarse gravel.	24	14.7	-	-	-	-	
	S3	14'-16'	Brown clayey silt, rather dry sample had a ½" layer of medium brown sand.	36	22.0	24.6	38.1	-	-	
	S4	17'-19'	Firm grey very silty clay.	23	17.4	15.3	26.7	-	-	
	T5	21'-23.2'		P	23.5	14.8	23.8	3960	131.5	
	T6	25'-27'		P	-	-	-	-	-	
	T7	28'-30'		P	25.2	18.0	30.5	-	-	
	RC8	33'-38'	Red shale.	-	-	-	-	-	-	
	RC9	38'-43'	"	-	-	-	-	-	-	
	RC10	43'-48'	"	-	-	-	-	-	-	
	RC11	48'-53'	"	-	-	-	-	-	-	

FORM OB—ML—222
FEB 59
1M-58-5569

SUMMARY OF FIELD & LABORATORY TESTS

JOB 60-F-24
W.P. 140-57-2

HOLE NO.	SAMP NO.	SAMPLE DEPTH (FEET)	MATERIAL DESCRIPTION	PENETN RESIST. BLOWS/FT	MOIST CONT. %	PLASTIC LIMIT	LIQUID LIMIT %	SHEAR STRENGTH P.S.F.	UNIT WEIGHT P.C.F.	REMARKS
4	S1	4'-6'	Soft brown clay with angular fragments of rock.	38	17.3	16.0	21.5	-	-	
	S2	8'-10'	Soft-firm brownish clay containing angular fragments of rock.	46	12.7	16.2	27.6	-	-	
	S3	13'-15'	Firm-stiff brown clay containing stones. Suggestion of laminations of brown-green clay in part of sample.	102	13.7	17.3	28.2	-	-	
	S4	18'-20'	Soft green-brown clay mixed with angular fragments of rock: Wet.	40/	17.2	-	-	-	-	
	S5	22'-24'	Mottled light brown dry silt with some 1" stones.	34	10.9	17.2	24.9	-	-	
	S6	26'-28'	Angular gravel mainly fine-medium with some 1½" stones with a matrix of brown sandy cohesive silt rather wet.	37	11.2	-	-	-	-	
	S7	30'-32'	Mottled reddish brown and green silt-rather dry with up to 1½" of pieces of stone.	45	-	-	-	-	-	
	S8	35'-37'	Damp mottled reddish-brown-green silt (Decomposed Shale) with large number angular gravel fragments.	20	-	-	-	-	-	
	S9	40'-41.7'	The same as #8 possibly with more fragments.	47	-	-	-	-	-	
	S10	44'-44.3'		121-4"	-	-	-	-	-	

FORM OB—ML—222
FEB 59
1M-58-5569

SUMMARY OF FIELD & LABORATORY TESTS

JOB 60-F-24
W.P. 140-57-2

HOLE NO.	SAMP NO.	SAMPLE DEPTH (FEET)	MATERIAL DESCRIPTION	PENETR'N RESIST. BLOWS/FT	MOIST. CONT. %	PLASTIC LIMIT %	LIQUID LIMIT %	SHEAR STRENGTH p.s.f.	UNIT WEIGHT p.c.f.	REMARKS
4	RC11	50'-54.7'	Sandstone.	-	-	-	-	-	-	
	RC12	54.7'-59.7'	"	-	-	-	-	-	-	
	RC13	59.7'-64.7'	"	-	-	-	-	-	-	

SUMMARY OF FIELD & LABORATORY TESTS

JOB 60-F-24
W.P. 140-57-2

HOLE NO.	SAMP NO.	SAMPLE DEPTH (FEET)	MATERIAL DESCRIPTION	PENET'N RESIST. BLOWS FT	MOIST. CONT. %	PLASTIC LIMIT %	LIQUID LIMIT %	SHEAR STRENGTH p.s.f.	UNIT WEIGHT p.c.f.	REMARKS
4A	S1	3'-4.5'	Angular gravel with a little brown silt.	50	11.1	-	-	-	-	
	S2	6'-8'	Hard brown gravelly silt (silt with gravel).	46	9.0	-	-	-	-	
	S3	9'-11'	Hard brown silty clay.	42	38.0	21.2	37.0	-	133	
	S4	14'-16'	Stiff grey silty clay.	30	17.8	16.8	27.0	-	-	
	S5	18'-20'	Stiff grey silty clay.	31	16.8	15.4	27.2	-	-	
	S6	25'-27'	Stiff grey silty clay.	17	16.2	14.8	26.2	-	-	
	S7	30'-32'	V. stiff grey silty clay.	15	19.1	16.6	28.7	-	-	
	S8	35'-37'	Firm-stiff grey sandy clay with red shale fragments. (Some gravel).	27	17.4	-	-	-	-	
	RC9	39'-44'	Shale.	-	-	-	-	-	-	
	RC10	44'-49.3'	"	-	-	-	-	-	-	
	RC11	49.3'-54.3'	"	-	-	-	-	-	-	

FORM OB-ML-222
FEB 59
1M-58-5569

SUMMARY OF FIELD & LABORATORY TESTS

JOB 60-F-24
W.P. 140-57-2

HOLE NO.	SAMP NO.	SAMPLE DEPTH (FEET)	MATERIAL DESCRIPTION	PENET'N RESIST. BLOWS FT	MOIST. CONT. %	PLASTIC LIMIT %	LIQUID LIMIT %	SHEAR STRENGTH p.s.f.	UNIT WEIGHT p.c.f.	REMARKS
4B	S1	6'-7.5'	Hard yellow-brown silt. Some gravel	69	11.3	19.0	30.6	-	-	
	S2	10'-11'	Hard yellow-grey mottled silt. Some gravel?	111	12.6	-	-	-	-	
	RC3	15'-16'	Sandstone.	-	-	-	-	-	-	
	RC4	16'-20'	"	-	-	-	-	-	-	
	RC5	20'-25.5'	"	-	-	-	-	-	-	
	RC6	25.5'-30.5'	"	-	-	-	-	-	-	
	RC7	30.5'-35.5'	"	-	-	-	-	-	-	

SUMMARY OF FIELD & LABORATORY TESTS

JOB 60-F-24
W.P. 140-57-2

HOLE NO.	SAMP NO.	SAMPLE DEPTH (FEET)	MATERIAL DESCRIPTION	PENET'N RESIST. BLOWS/FT	MOIST. CONT. %	PLASTIC LIMIT %	LIQUID LIMIT %	SHEAR STRENGTH PSF	UNIT WEIGHT PCF	REMARKS
5	S1	3'-5'	A few pieces of fine to coarse angular gravel.	31	6.3	-	-	-	-	
	S2	7'-9'	Sample dried out.	33	7.1	-	-	-	-	
	S3	12'-13'	Angular gravel with a little brown silt - not much sample left.	38	9.7	-	-	-	-	
	S4	13'-15'	Dry brown friable sandy silt with well graded angular gravel.	36	7.9	-	-	-	-	
	S5	18'-19'	Rather dry mottled red-brown and green sandy silt with fragments of shale.	-	15.8	-	-	-	-	
	S6	25.5'-26.8'		108	-	-	-	-	-	
	RC7	29.5'-34.5'	Sandstone	-	-	-	-	-	-	
	RC8	34.5'-39.5'	"	-	-	-	-	-	-	
	RC9	39.5'-40.1'	"	-	-	-	-	-	-	
	RC10	40.1'-42'	"	-	-	-	-	-	-	

FORM OB—ML—222
FEB 59
1M 58-5569

JOB 60-F-24
W.P. 140-57-2

SUMMARY OF FIELD & LABORATORY TESTS

HOLE NO.	SAMP NO.	SAMPLE DEPTH (FEET)	MATERIAL DESCRIPTION	PENETN RESIST. BLOWS/FT	MOIST. CONT. %	PLASTIC LIMIT %	LIQUID LIMIT %	SHEAR STRENGTH PSF	UNIT WEIGHT PCF	REMARKS
5A	S1	3'-5'	Dry brown(slightly clayey) silt with a few 1/4" stones.	13	18.9	17.2	31.3	-	-	
	S2	6'-8'	Mottled brown stiff (slightly clayey) silt with a few 1/4" stones.	8	-	-	-	-	-	
	T3	9'-10.5'		11	16.7	10.8	15.4	1850	141	
	S4	12'-14'	Firm grey clayey silt with a few 1" stone.	28	21.2	16.6	28.7	-	-	
	T5	17'-19'		P	17.2	11.3	21.8	1050	134	
	T6	23'-25'		P	19.2	10.1	20.7	460	137	
	VANE	26.5'		-	-	-	-	800	-	Sens: 2.9
	S7	32'-34'	Moist to wet brown silty coarse sand with some medium gravel.	-	13.9	-	-	-	-	
	RC8	36.5'-39'	Shale.	-	-	-	-	-	-	
	RC9	39'-44.5'	"	-	-	-	-	-	-	
	RC10	44.5'-50'	"	-	-	-	-	-	-	
	RC11	50'-55.5'	"	-	-	-	-	-	-	

SUMMARY OF FIELD & LABORATORY TESTS

JOB 60-F-24
W.P. 140-57-2

HOLE NO.	SAMP NO.	SAMPLE DEPTH (FEET)	MATERIAL DESCRIPTION	PENETN RESIST. BLOWS FT	MOIST. CONT. %	PLASTIC LIMIT %	LIQUID LIMIT %	SHEAR STRENGTH	UNIT WEIGHT	REMARKS
6	S1	4'-6'	Hard red laminated silt. (Shale).	115	-	-	-	-	-	
	S2	8'-9.5'	Hard green laminated silt (Shale).	107	11.5	-	-	-	-	
	S3	13'-13.8'	"	121-3.5"	10.2	-	-	-	-	
	S4	17'-18'	Hard green laminated silt (Shale). (Piece of Dolomite 1½").	136	10.0	-	-	-	-	
	S5	22'-22.9'	Hard green laminated silt (Shale).	190-11"	12.6	-	-	-	-	
	S6	26'-26.5'	Hard grey to dark brown laminated shale. (very weathered).	120-6"	-	-	-	-	-	
	RC7	36'-41'	Shale.	-	-	-	-	-	-	
	RC8	41'-46'	"	-	-	-	-	-	-	
	RC9	46'-51'	"	-	-	-	-	-	-	

FORM OB-ML-222
FEB 59
1M-59-5569

SUMMARY OF FIELD & LABORATORY TESTS

JOB 60-F-24
W.P. 140-57-2

HOLE NO.	SAMP NO.	SAMPLE DEPTH (FEET)	MATERIAL DESCRIPTION	PENETN RESIST. BLOWS/FT	MOIST. CONT.	PLASTIC LIMIT	LIQUID LIMIT %	SHEAR STRENGTH	UNIT WEIGHT	REMARKS
6A	S1	4'-6'	Rather dry brown sandy angular gravel with a small amount of sandy silt.	36	-	-	-	-	-	
	S2	6'-8'	Brown sandy cohesive silt with many subangular coarse gravel fragments.	17	-	-	-	-	-	
	S3	12'-14'	Angular gravel with rather wet matrix of brown cohesive silt.	33	-	-	-	-	-	
	S4	23'-25'		44	-	-	-	-	-	
	S5	27'-29'	Soft to firm grey clay with 1½" stone.	14	12.1	-	-	-	-	
	S6	30'-32'	Stiff grey silty clay with small (1/4" shale fragments (Till?).	13	20.8	17.4	32.0	-	-	
	RC7	35.2'-40.2'		-	-	-	-	-	-	
	RC8	40.2'-45.2'		-	-	-	-	-	-	
	RC9	45.2'-50.2'		-	-	-	-	-	-	
	RC10	50.2'-55.2'		-	-	-	-	-	-	

SUMMARY OF FIELD & LABORATORY TESTS

JOB 60-F-24

W.P. 140-57-2

HOLE NO	SAMP NO.	SAMPLE DEPTH (FEET)	MATERIAL DESCRIPTION	PENETN RESIST. BLOWS/FT	MOIST. CONT.	PLASTIC LIMIT	LIQUID LIMIT %	SHEAR STRENGTH	UNIT WEIGHT	REMARKS
7	S1	3'-4.5'	Angular fine coarse gravel with a matrix of wet-red sandy clay.	87	-	-	-	-	-	
	S2	10'-11.3'	Hard green laminated silt. (shale).	71	12.4	-	-	-	-	
	S3	15'-16.5'	"	94	11.7	-	-	-	-	
	S4	30'-31.5'	V. stiff-Hard green and red mottled silt (shale).	193	12.2	-	-	-	-	
	RC5	34'-38'	Shale red and green.	-	-	-	-	-	-	
	RC6	38'-43'	"	-	-	-	-	-	-	
	RC7	43'-48'	"	-	-	-	-	-	-	
	RC8	48'-53'	"	-	-	-	-	-	-	

SUMMARY OF FIELD & LABORATORY TESTS

JOB 60-F-24
W.P 140-57-2

HOLE NO	SAMP NO	SAMPLE DEPTH (FEET)	MATERIAL DESCRIPTION	PENETR. RESIST. BLOWS	MOIST. CONT.	PLASTIC LIMIT	LIQUID LIMIT %	SHEAR STRENGTH	UNIT WEIGHT	REMARKS
7A	S1	5.5'-7'	Dry angular coarse gravel with a matrix of sand- no silt in this sample at all.	85	-	-	-	-	-	
	S2	8.5'-10.5'	Dry angular gravel with sand.	75	-	-	-	-	-	
	S3	13'-15'	Moist brown, sandy cohesive silt matrix in fine-medium angular gravel	26	-	23.8	39.2	-	-	
	S4	18'-20'	Angular gravelly sand with a wet matrix of brown sandy silt.	39	11.4	-	-	-	-	
	S5	26'-28'	Red and grey green reworked shale with particles 1"-2" of fairly competent shale in it.	39	-	-	-	-	-	
	S6	35'-37'	Grey moist firm cohesive clay silt.	22	18.9	-	-	-	-	
	RC7	39.5'-44.5'	Shale.	-	-	-	-	-	-	
	RC8	44.5'-49.5'	"	-	-	-	-	-	-	
	RC9	49.5'-54.5'	"	-	-	-	-	-	-	
	RC10	54.5'-59.5'	"	-	-	-	-	-	-	

SUMMARY OF FIELD & LABORATORY TESTS

JOB 60-F-24
W.P. 140-57-2

HOLE NO	SAMP NO	SAMPLE DEPTH (FEET)	MATERIAL DESCRIPTION	[illegible]	MOIST CONT	LIQUID LIMIT	PLASTIC LIMIT %	SHEAR STRENGTH	UNIT WEIGHT	REMARKS
8	S1	6'-8'	Brown gravelly sand with some silt and clay mixed with it-rather wet but this may be drill water.	67	-	-	-	-	-	
	S2	11'-12.5'	Hard dry chocolate brown and grey brown mottled silt with particles up to 1" of sandstone.	82	-	-	-	-	-	
	S3	15'-16'	Angular gravel in a matrix of wet brown sandy clay silt.	58	11.4	-	-	-	-	
	S4	19'-21'	Rather dry mottled brown silt with a large proportion of sand and gravel fragments through it.	35	13.1	-	-	-	-	
	S5	25'-27'	Hard mottled brown silt with stones ($1\frac{1}{2}$") and some fine gravel.	55	8.2	-	-	-	-	
	S6	32'-33.5'	Brown wet angular gravel with a wet matrix of sandy silt slightly cohesive.	35	-	-	-	-	-	
	RC7	36'-41'	Sandstone.	-	-	-	-	-	-	
	RC8	41'-45.5'	"	-	-	-	-	-	-	
	RC9	45.5'-48.5'	Queenston shale.	-	-	-	-	-	-	
	RC10	48.5'-54.5'	"	-	-	-	-	-	-	

SUMMARY OF FIELD & LABORATORY TESTS

JOB 60-F-24
W.P. 140-57-2

HOLE NO.	SAMP. NO.	SAMPLE DEPTH (FEET)	MATERIAL DESCRIPTION	PENETN. RESIST. BLOWS/FT.	MOIST. CONT.	PLASTIC LIMIT	LIQUID LIMIT %	SHEAR STRENGTH	UNIT WEIGHT	REMARKS
8A	S1	5'-7'	Rather dry stiff to hard chocolate brown silty clay with a few 1/10" stones.	11	17.8	21.0	40.4	-	-	
	T2	10'-11.8'		P	24.1	19.8	34.0	4560	128.1	
	T3	15'-16.7'		P	17.2	17.3	26.1	6540	132.5	
	T4	19'-19.8'	Stiff grey silty clay, rather plastic and slightly sensitive with sand partings and sand seams up to ½".	P	-	-	-	-	-	
	T5	21'-22.5'		P	21.0	16.5	25.4	4310	132.9	
	VANE	24'		-	-	-	-	960	-	Sens: 2.3
	S6	25'-27'	Stiff grey silty clay with a few fragments of shale up to 1/4".	18	17.7	-	-	-	-	
	RC7	30'-35'	Queenston shale.	-	-	-	-	-	-	
	RC8	35'-40'	"	-	-	-	-	-	-	
	RC9	40'-45'	"	-	-	-	-	-	-	
	RC10	45'-50'	"	-	-	-	-	-	-	

FORM OB–ML–222
FEB 59
1M 58-5569

SUMMARY OF FIELD & LABORATORY TESTS

JOB 60-F-24
W.P. 140-57-2

HOLE NO.	SAMP NO.	SAMPLE DEPTH (FEET)	MATERIAL DESCRIPTION	PENETR. RESIST. BLOWS/FT	MOIST. CONT.	PLASTIC LIMIT	LIQUID LIMIT %	SHEAR STRENGTH	UNIT WEIGHT	REMARKS
8B	S1	6'-8'	Soft-firm brown silty clay with a large quantity of angular gravel.	13	12.0	-	-	-	-	
	S2	10'-12'	Hard laminated red weathered shale.	18	11.6	-	-	-	-	
	S3	12'-12.3'	Pieces of red shale (gravel size) mixed with soft-firm red silty clay (weathered from shale.	70-4"	-	-	-	-	-	
	RC4	17.5'-22.5'	1' sandstone layer at bottom.	-	-	-	-	-	-	

FORM OB—ML—222
FEB 5
1M-58-5569

SUMMARY OF FIELD & LABORATORY TESTS

JOB 60-F-24
W.P. 140-57-2

HOLE NO.	SAMP NO.	SAMPLE DEPTH (FEET)	MATERIAL DESCRIPTION	PENETN. RESIST. BLOWS/FT	MOIST. CONT. %	PLASTIC LIMIT %	LIQUID LIMIT %	SHEAR STRENGTH	UNIT WEIGHT	REMARKS
9	1	No sample		-	-	-	-	-	-	
	S2	8'-9.5'	Firm-stiff brown silt with angular gravel.	59	12.9	13.1	20.7	-	-	
	S3	12'-13.5'	Firm brown clayey silt with much angular gravel.	58	11.3	-	-	-	-	
	S4	16'-17.5'	Stiff-v. stiff brown clayey silt with angular gravel.	50	13.3	14.1	20.9	-	-	
	S5	20'-21.5'	Firm-stiff brown sandy clay with much angular gravel.	44	11.4	-	-	-	-	
	S6	25'-26.5'	Firm brown clayey sand with much angular gravel.	49	12.8	-	-	-	-	
	7	No sample		-	-	-	-	-	-	
	S8	30'-30.8'	Fine to coarse angular gravel with a matrix of moist clayey silt.	138-9"	-	-	-	-	-	
	S9	35.8'-36.8'	Fine to coarse angular gravel with a matrix of moist clayey silt. (gravel slightly coarse).	78	-	-	-	-	-	
	RC10	37'-41'	See borehole log.	-	-	-	-	-	-	
	S10	42.5'-44'	Weathered shale mixed with some gravel.	61	-	-	-	-	-	
	S11	48'-48.3'		100-4"	12.5	17.3	29.0	-	-	Sample Lost.
	S12	50'-50.4'	Hard red clay (shale) with some gravel.	80-5"	-	-	-	-	-	

SUMMARY OF FIELD & LABORATORY TESTS

JOB 60-F-24
W.P. 140-57-2

HOLE NO	SAMP NO.	SAMPLE DEPTH (FEET)	MATERIAL DESCRIPTION	PENETR. RESIST. BLOWS/FT	MOIST CONT. %	PLASTIC LIMIT	LIQUID LIMIT %	SHEAR STRENGTH	UNIT WEIGHT	REMARKS
9	RC13	50.5'-55.5'		-	-	-	-	-	-	
	RC14	55.5'-60.5'		-	-	-	-	-	-	
	RC15	60.5'-65.5'		-	-	-	-	-	-	
	RC16	65.5'-70.5'		-	-	-	-	-	-	

FORM OB-ML-222
FEB 59
1M-58-5569

SUMMARY OF FIELD & LABORATORY TESTS

JOB 60-F-24
W.P. 140-57-2

HOLE NO.	SAMP. NO.	SAMPLE DEPTH (FEET)	MATERIAL DESCRIPTION	PENETN. RESIST. BLOWS/FT.	MOIST. CONT. %	PLASTIC LIMIT %	LIQUID LIMIT %	SHEAR STRENGTH	UNIT WEIGHT	REMARKS
9A	S1	4'-6'	Brown fine sand (uniform) with angular gravel fragments.	10	-	-	-	-	-	
	S2	8'-9'	Brown fine sand (uniform) with a little fine gravel.	106	-	-	-	-	-	
	S3	12'-14'	Stiff grey clay.	38	20.6	19.2	29.3	-	-	
	S4	18'-20'	Stiff-v. stiff grey clay-trace of sand.	25	-	-	-	-	-	
	S5	23'-23.3'	Stiff grey clay with shale fragments.	80-4"	-	-	-	-	-	
	S6	25'-25.5'	Hard red weathered shale.	78-6"	-	-	-	-	-	
	RC7	26'-31.5'		-	-	-	-	-	-	
	RC8	31.5'-36.5'		-	-	-	-	-	-	
	RC9	36.5'-41.5'		-	-	-	-	-	-	

FORM CB-ML-222
FEB 59
1M-58-5569

SUMMARY OF FIELD & LABORATORY TESTS

JOB 60-F-24

W.P. 140-57-2

HOLE NO.	SAMP. NO.	SAMPLE DEPTH (FEET)	MATERIAL DESCRIPTION	PENETN RESIST. BLOWS/FT	MOIST. Cont. %	PLASTIC LIMIT %	LIQUID LIMIT %	SHEAR STRENGTH PSF	UNIT WEIGHT PCF	REMARKS
9B	S1	4'-5.5'	Firm yellow-brown clayey silt with fine-coarse gravel.	43	16.2	-	-	-	-	
	S2	8'-9.5'	Hard red laminated weathered shale.	85	9.9	20.2	34.0	-	-	
	S3	12'-13.5'	Hard red laminated weathered shale.	93	10.5	21.2	32.2	-	-	
	S4	15'-16.5'	Hard red laminated weathered shale.	142	8.8	20.8	35.8	-	-	
	S5	20'-20.5'	Green laminated shale.	122-6.9"	-	-	-	-	-	
	S6	25'-25.3'	(Wet) Soft grey-green cohesive silt with much fine-medium angular gravel.	77-3"	-	-	-	-	-	
	RC7	31.5'-36'		-	-	-	-	-	-	
	RC8	36'-41.7'		-	-	-	-	-	-	
	RC9	41.7'-47.2'		-	-	-	-	-	-	

SUMMARY OF FIELD & LABORATORY TESTS

JOB 60-F-24
W.P. 140-57-2

HOLE NO	SAMP. NO.	SAMPLE DEPTH (FEET)	MATERIAL DESCRIPTION	PENETN RESIST. BLOWS/FT	MOIST. CONT.	PLASTIC LIMIT	LIQUID LIMIT %	SHEAR STRENGTH	UNIT WEIGHT	REMARKS
10	S1	5'-6.5'		30	-	-	-	-	-	
	S2	10'-11.5'	Well graded gravel with a matrix of wet brown cohesive sandy silt.	48	10.1	-	-	-	-	
	Sa's	3 - 6	Do not exist.	-	-	-	-	-	-	
	S7	20.5'-22'	Well graded gravel with brown wet brown cohesive sandy silt.	33	11.1	-	-	-	-	
	S8	30'-31.5'	Firm dark brown cohesive silt with well graded gravel and some shale fragments.	30	-	-	-	-	-	
	S9	37'-38.5'	Firm-stiff grey laminated silty layers of uniform brown clayey sand.	27	17.5	14.9	26.9	-	-	
	RC10	38.5'-39.5'		-	-	-	-	-	-	
	RC11	39.5'-43.5'		-	-	-	-	-	-	
	RC12	43.5'-48.5'		-	-	-	-	-	-	
	RC13	48.5'-53.8'		-	-	-	-	-	-	

FORM OB-ML-222
FEB 59
1M-58-5569

SUMMARY OF FIELD & LABORATORY TESTS

JOB 60-F-24
W.P. 140-57-2

HOLE NO.	SAMP NO.	SAMPLE DEPTH (FEET)	MATERIAL DESCRIPTION	PENETR'N RESIST. BLOWS/FT	MOIST. CONT.	PLASTIC LIMIT	LIQUID LIMIT %	SHEAR STRENGTH	UNIT WEIGHT	REMARKS
10A	S1	5'-6.5'	Soft-firm brown sandy clay with coarse gravel.	28	12.5	-	-	-	-	
	S2	10.5'-12'	Soft brown clayey sand with fine-coarse gravel.	46	15.8	-	-	-	-	
	S3	15'-16.5'	Well graded sandy gravel.	59	3.0	-	-	-	-	
	S4	20'-21.5'	Stiff-v. stiff grey clay with some rounded gravel.	38	14.5	14.8	26.3	-	-	
	S5	23'-24.5'	Firm grey clay with some rounded gravel and shale fragments.	28	18.4	-	-	-	-	
	S6	28'-29.5'	Firm grey clay.	33	16.6	14.7	26.5	-	-	
	S7	34'-35.5'		13	-	-	-	-	-	
	S8	36'-36.9'	Well graded angular gravel with a matrix of fine red silty clay.	133-11"	-	-	-	-	-	
	RC9	37.3'-38'		-	-	-	-	-	-	
	RC10	38'-43'		-	-	-	-	-	-	
	RC11	43'-48'		-	-	-	-	-	-	
	RC12	48'-52'		-	-	-	-	-	-	

FORM OB—ML—222
FEB 59
1M-58-5869

SUMMARY OF FIELD & LABORATORY TESTS

JOB 60-F-24
W.P. 140-57-2

HOLE NO.	SAMP NO.	SAMPLE DEPTH (FEET)	MATERIAL DESCRIPTION	PENET'N RESIST. BLOWS/FT	MOIST. CONT. %	PLASTIC LIMIT %	LIQUID LIMIT %	SHEAR STRENGTH p.s.f.	UNIT WEIGHT p.c.f.	REMARKS
10B	S1	4'-6'	Soft, brown silty clay with much slabby gravel.	13	14.8	-	-	-	-	
	S2	8'-8.3'		50-3"	-	-	-	-	-	
	S3	15'-17'		46	-	-	-	-	-	
	S4	18'-20'	Soft to firm, red and green silty clay, with fine to medium gravel.	27	24.9	22.2	33.1	-	-	
	S5	21.5'-23.5'	Hard, green clay-silt (shale).	45	-	-	-	-	-	
	S6	32.5'-34'	Hard, grey silt (shale).	110	-	-	-	-	-	
	Samples 7 & 8		Do not exist.	-	-	-	-	-	-	
	S9	38'-38.9'	Hard grey laminated silt (shale)	135-11"	-	-	-	-	-	
	RC10	41.5'-43.5'	Subshale.	-	-	-	-	-	-	
	RC11	43.5'-45'	"	-	-	-	-	-	-	
	RC12	45'-50.5'	Shale.	-	-	-	-	-	-	
	RC13	50.5'-53.2'	"	-	-	-	-	-	-	

SUMMARY OF FIELD & LABORATORY TESTS

JOB 60-F-24
W.P. 140-57-2

HOLE NO.	SAMP NO.	SAMPLE DEPTH (FEET)	MATERIAL DESCRIPTION	PENETN RESIST BLOWS/FT	MOIST CONT	PLASTIC LIMIT	LIQUID LIMIT %	SHEAR STRENGTH	UNIT WEIGHT	REMARKS
11	S1	5'-5.5'	Firm, brown, sandy silt, cohesive with fine to medium gravel.	82	-	-	-	-	-	
	S2	8'-9'	Hard, brown (mottled) silt with friable gravel.	163	-	-	-	-	-	
	S3	12'-13.5'	Firm green and brown silty clay with much medium grained, angular gravel.	38	-	-	-	-	-	
	S4	16'-17.5'	Well graded angular gravel (medium to coarse with a matrix of wet reddish brown silty clay.	70	-	-	-	-	-	
	S5	20'-21.3'	Hard red and green mottled cohesive silt (shale).	59	-	-	-	-	-	
	S6	24'-25.5'	Fine to coarse sandy gravel and separate pockets of brown firm to stiff gravelly clay.	85	-	-	-	-	-	
	S7	30'-31.5'	Stiff, grey clay with few pieces subangular gravel.	26	20.8	-	-	-	-	
	S8	35'-36.5'	Stiff to v. stiff dark grey clay with some gravel.	34	12.2	16.4	29.4	-	-	
	RC9	38.5'-40'		-	-	-	-	-	-	
	RC10	40'-45.3'		-	-	-	-	-	-	
	RC11	45.3'-50.6'		-	-	-	-	-	-	
	RC12	50.6'-55.8'		-	-	-	-	-	-	

FORM OB-ML-222
FEB 59
1M-58-5809

JOB 60-F-24
W.P. 140-57-2

SUMMARY OF FIELD & LABORATORY TESTS

HOLE NO.	SAMP. NO.	SAMPLE DEPTH (FEET)	MATERIAL DESCRIPTION	PENETR. RESIST. BLOWS/FT	MOIST. CONT.	PLASTIC LIMIT	LIQUID LIMIT %	SHEAR STRENGTH	UNIT WEIGHT	REMARKS
11A	S1	5'-6.5'	Well graded angular gravel.	40	-	-	-	-	-	
	S2	10'-11.5'	Well graded angular gravel with a little of wet sandy cohesive silt.	23	-	-	-	-	-	
	S3	15'-16.5'	Brown, gravelly clay-silt.	73	-	-	-	-	-	
	S4	20'-21.5'	Stiff brown mottled silty clay with gravel.	21	14.9	15.4	26.0	-	-	
	S5	25'-26.5'	Well graded angular gravel with matrix of brown sandy clay.	82	-	-	-	-	-	
	S6	30'-31.5'	Well graded, angular gravel with a matrix of wet re dish brown silty clay.	98-10"	-	-	-	-	-	
	S7	35'-36.5'	V. stiff green cohesive silt laminated (shale).	52	16.2	22.4	40.1	-	-	
	S8	40'-41.5'	Firm grey sandy clay with considerable quantity of angular gravel.	82	9.7	-	-	-	-	
	S9	45'-46.5'	Stiff dark grey clay with a few random stones.	23	18.7	17.5	27.8	-	-	
	S10	50'-51.3'	Very stiff, dark grey, silty, clay with many pieces of medium gravel distributed through it.	32	15.1	15.2	26.3	-	-	
	RC11	52.5'-54.5'	Shale.	-	-	-	-	-	-	
	RC12	54.5'-59.2'	"	-	-	-	-	-	-	
	RC13	59.2'-64.5'	"	-	-	-	-	-	-	

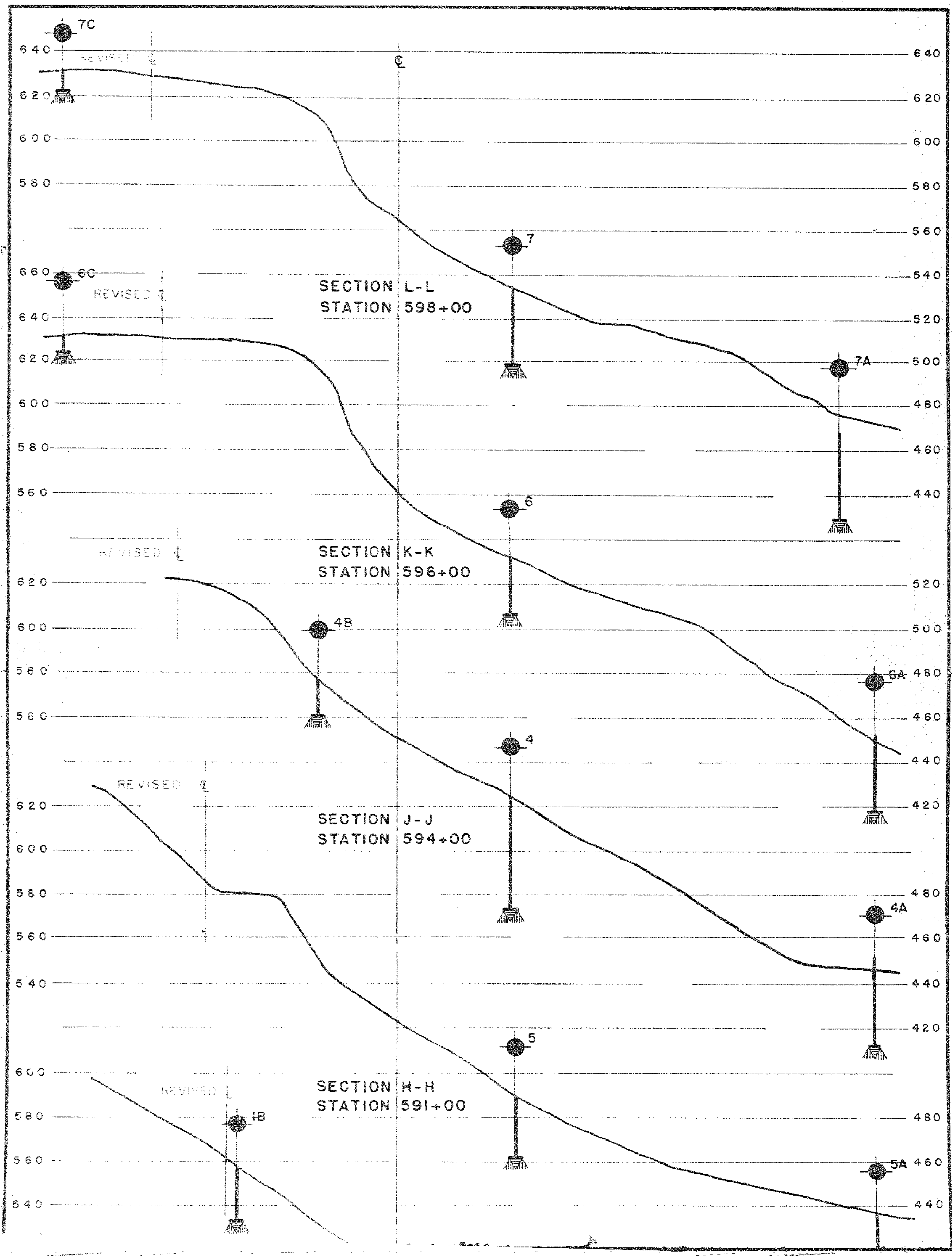
FORM OB-ML-222
FEB 59
IM-58-5569

SUMMARY OF FIELD & LABORATORY TESTS

JOB 60-F-24
W.P. 140-57-2

HOLE NO.	SAMP NO.	SAMPLE DEPTH (FEET)	MATERIAL DESCRIPTION	PENET'N RESIST. BLOWS/FT	MOIST CONT.	PLASTIC LIMIT	LIQUID LIMIT %	SHEAR STRENGTH	UNIT WEIGHT	REMARKS
11B	S1	4'-5.5'	Very stiff, red clay and green silt, laminated (both shale).	70	-	-	-	-	-	
	S2	8'-9.5'	Hard red clay (shale).	122	12.4	24.4	40.8	-	-	
	S3	12'-13.1'	Hard red (clay) shale.	43	13.7	-	-	-	-	
	S4	16'-17'	Hard green laminated silt (shale/ silt stone).	148	11.2	23.6	37.3	-	-	
	Samples 5 & 6		Do not exist.							
	S7	20'-20.6'	Very stiff green laminated silt (shale/silt stone).	119-7.5"	13.9	24.8	45.1	-	-	
	RC8	25'-29'	Shale	-	-	-	-	-	-	
	RC9	29'-31.9'	"	-	-	-	-	-	-	
	RC10	36.8'-41.8'	"	-	-	-	-	-	-	
	RC11	41.8'-46.8'	"	-	-	-	-	-	-	

S denotes split spoon sample
T " shelby tube sample
C " casing sample
G " grab sample
RC " rock core


SECTION L-L
STATION 598+00
SECTION K-K
STATION 596+00
SECTION J-J
STATION 594+00
SECTION H-H
STATION 591+00
REVISED ℄
℄
7C
7
7A
6C
6
6A
4B
4
4A
1B
5
5A
640
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600
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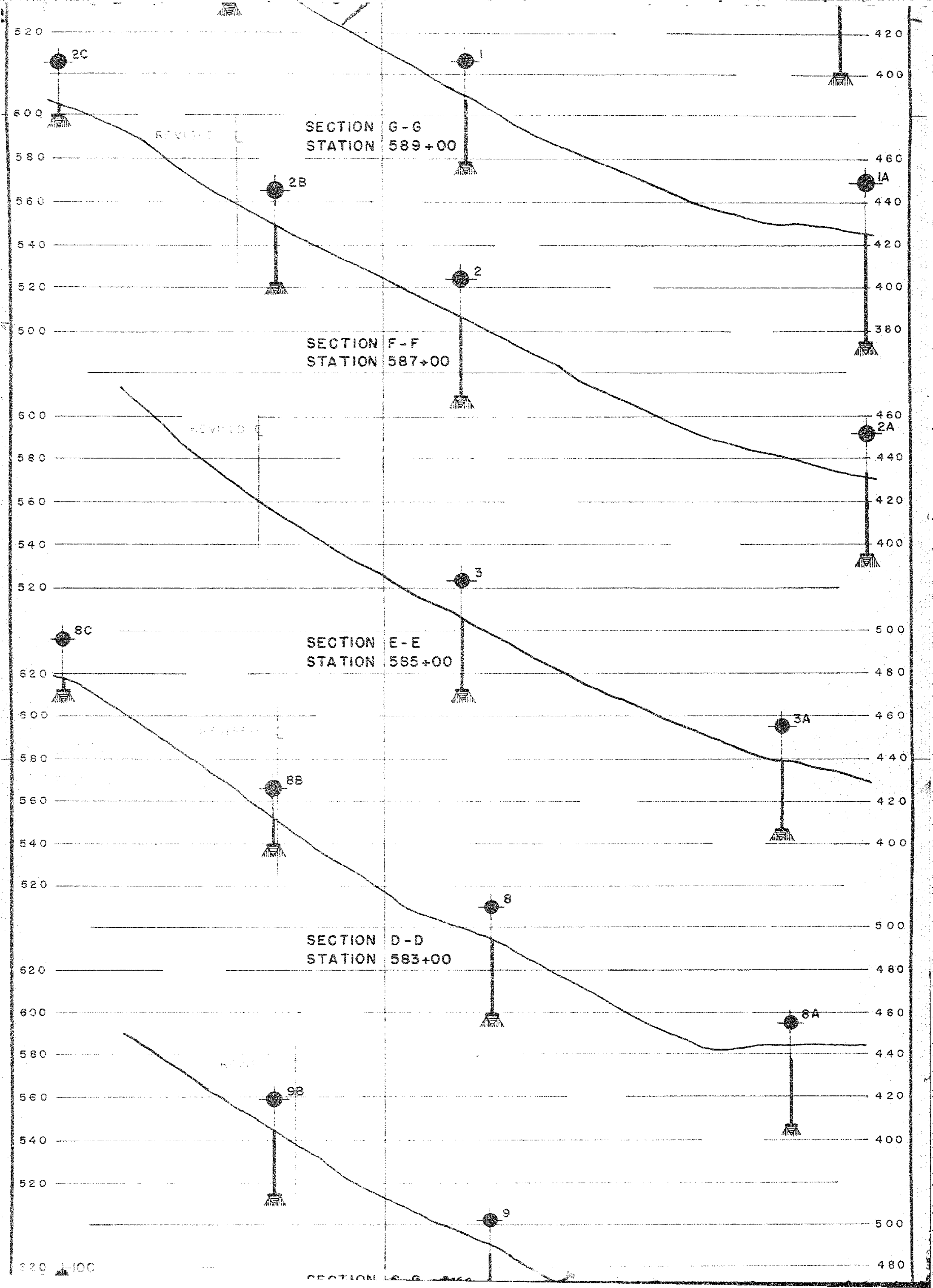
440
420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STATION 589+00
SECTION F-F
STATION 587+00
SECTION E-E
STATION 585+00
SECTION D-D
STATION 583+00
2C
1
1A
2B
2
2A
3
3A
8C
8B
8
8A
9B
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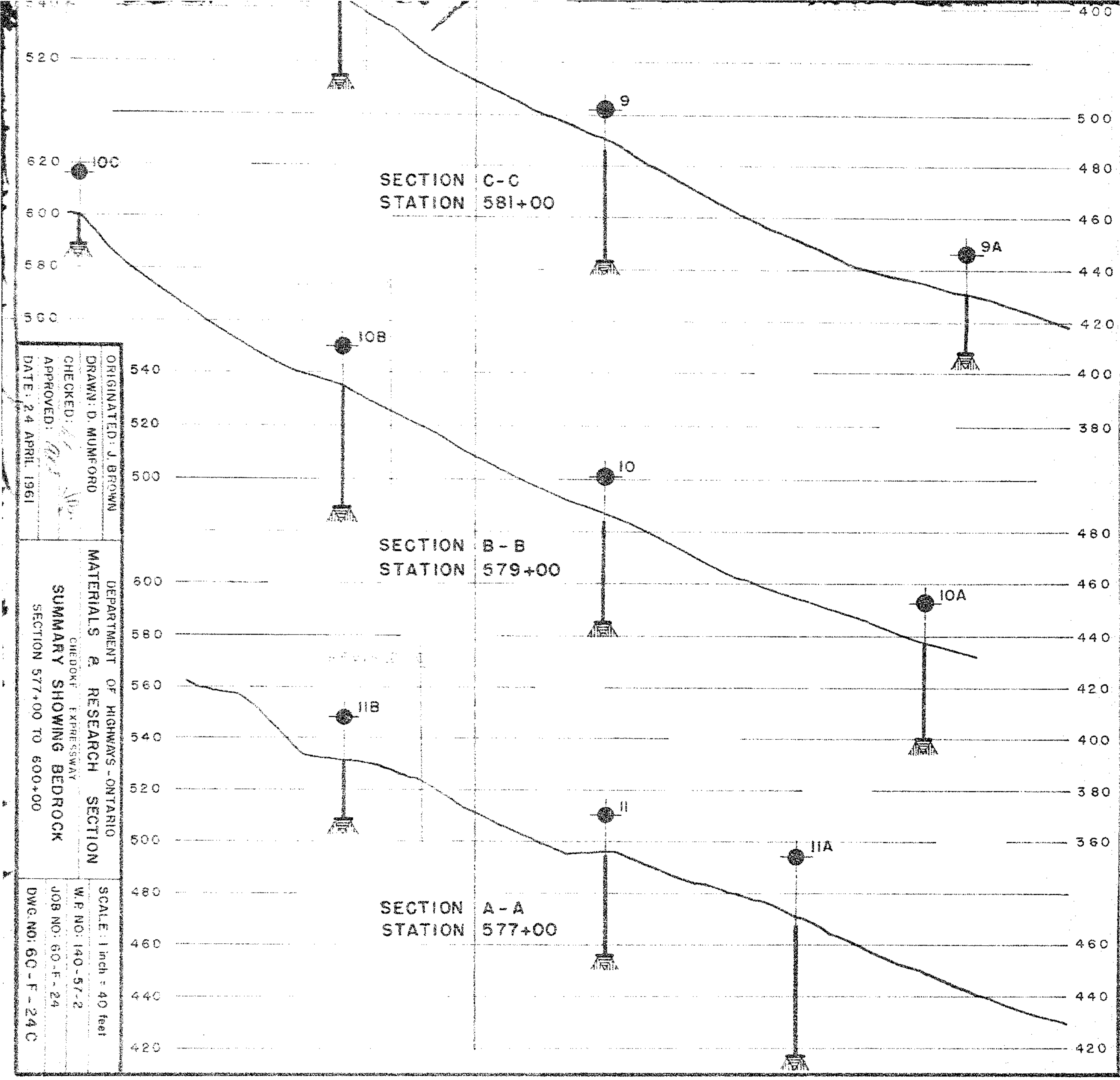
SECTION C-C
STATION 581+00
9
9A
10C
SECTION B-B
STATION 579+00
10
10A
10B
SECTION A-A
STATION 577+00
11
11A
11B
520
500
480
460
440
420
400
380
360
620
600
580
560
540
ORIGINATED: J. BROWN
DRAWN: D. MUMFORD
CHECKED:
APPROVED:
DATE: 24 APRIL 1961
DEPARTMENT OF HIGHWAYS-ONTARIO
MATERIALS & RESEARCH SECTION
CHEDOKE EXPRESSWAY
SUMMARY SHOWING BEDROCK
SECTION 577+00 TO 600+00
SCALE: 1 inch = 40 feet
W.P. NO: 140-57-2
JOB NO: 60-F-24
DWG. NO: 60-F-24C

ONTARIO
DEPARTMENT OF HIGHWAYS

30M4-1
GEOCRES No.

Memo to Mr. H.D. McMillan, Road Design Engineer,

Date October 24th, 1961.

Subject Hwy. #403, W.P.140-57-2 Soils Design Report

From Materials & Research Section.

We are submitting the Soils Design Report and the Soils Design Profile for this project. We are also including a copy of a letter received from Mr. Nixon dated September 15, 1961 which brings to our attention a number of key points that must be considered. Our reply dated October 23, 1961 is also attached.

This is an extremely difficult project. It is not a straight forward job and the design will likely be tailored to fit the job conditions as the pre-engineering progresses. It will therefore be necessary for the Department (Soils and Design Section) to work closely with the Consultants and to make decisions relative to drainage, cross-sections etc. from time to time.

I would suggest that the Consultants review the soils report and if they have any querries which cannot be resolved with Mr. Schonfeld our Soils Engineer, then a meeting should be arranged with them.

The highlights of this project are:

1. The sub-drainage requirements if any.
2. The variable cross-sections in cuts and fills to take into account the variable rock types encountered.
3. The recommendation to crush and stockpile the sound top rock for subsequent granular base course purposes.

G. A. Wrong
for: A. Rutka,
Materials & Research Engineer.

AR/bc
c.c. W.A. Clarke
H.A. Tregaskes
T.C. Muir
J.C. Thatcher
H.A. [illegible]
I.C. Campbell
C.C. Parker's
S. McCombie
W. Wigle
A. Gray
D. MacDonald
G.A. [illegible]

(2)

SOILS DESIGN REPORT

Hwy. #403 1.82 Miles

Chedoke Expressway

(Just west of T.H. & B. Subway
to just east of Mohawk Road.)

WP140-57-2

Soils Profile No. 403A-21.

GENERAL DATA:

The project is located in the Township of Ancaster, County Wentworth. It is the sixth Chedoke Expressway project west of the Q.E.W., the preceding ones (going from east to west) being W.P.'s 93-58-1, 93-58-2, 231-58-1 to 3, and 140-57-1. Adjoining the west limits of this project is WP136-57. Soils design reports for all these preceding projects have been submitted to the Design Office.

Design Criteria have not yet been finalized, but it is the present understanding that 3 ascending and 3 descending lanes will be constructed, and that the median will be 22' wide. Maximum grades will be 3% up, and 5% down. Proposed shoulder widths are 10' outside, and 3' at median.

No structures, other than culverts, occur on this portion of the Chedoke Expressway. There is no interchange with other roads, and the only intersecting existing road (Filman Road) will be closed.

TOPOGRAPHY:

The east end of the project lies at the foot of the Niagara Escarpment, in gently rolling terrain. The projected line climbs up the steep, wooded and bouldery slope of the es-

.../2

carpment. It is intersected by many deeply eroded creeks containing seasonal streams. The west end of the project is situated on the hilly, wooded top of the escarpment.

PHYSIOGRAPHY:

The rocks of the Niagara Escarpment, on the slope of which this project is located, are sedimentary deposits of the Silurian and Ordovician eras. The escarpment follows the line at which hard limestone formations (Guelph, Eramosa, etc.) adjoin a relatively soft shale formation. The escarpment owes its origin to the, mainly preglacial, differential erosion of these rocks.

This region underwent glaciation, with the ice sheet advancing towards the escarpment face, pressing against and overriding it. The clay till of the slopes was deposited during this period. In the course of the following intermittent retreats and advances of the ice front, the low area at the toe of the escarpment was temporarily inundated and caused the deposition in water of one or two clay to sandy clay strata. The presence of these soft layers, confirmed by borings, prevented the adoption of a balanced cut and fill alignment of this project. The glacial till on top of the escarpment edge, having been deposited above inundation level, is consistently denser.

A table of rock formations is contained in the report on the seismic investigation of this project carried out by Hunting Technical and Exploration Services Ltd. The rock formations range from a red argillaceous (Queenston) shale at the base, through sandstones, impure limestones, sandy and calcareous shales, to limestone and dolomite. Some engineering properties of these rocks are described in this report under the heading "Bedrock Data".

SOILS INVESTIGATIONS:

The difficult terrain and the bouldery talus material of 30° to 50° escarpment slopes did not permit the use of power augers over most of the project area. The estimated costs of a full scale coredrill investigation were prohibitive.

Other methods of soils investigation in these conditions had to be explored, and Hunting Technical and Exploration Services Limited were instructed to carry out a seismic investigation on a trial section, between Station 553± and 566±. This work was carried out in May, 1958, and Huntings' "Report on Seismic Depth to Bedrock Determination of a Highway Location in the Hamilton Area" was submitted to the D.H.O. on June 2, 1958. For this investigation, it was proposed to obtain bedrock determinations along cross sections 100' apart, extending 100' to the left and 100' to the right of centreline, with depth determinations at both ends and in the centre. However, because of topographical difficulties, only a centre line bedrock determination at 100' intervals plus 3 full cross sections were obtained. The conclusion drawn from this preliminary investigation was that the thickness of overburden, where limestone is the underlying bedrock, is in the order of a few feet only, and that increasing overburden depths could be expected below elevation approx. 440' where Queenston shale is the underlying bedrock.

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The result of the above-mentioned preliminary investigation, the field work of which had taken only 2 days by a crew of 3 men, was encouraging and, on October 16, 1958, Huntings were instructed to proceed with a full scale seismic survey. The outcome was Huntings' "Report on Seismic Investigations of the Proposed Relocation of Highway No. 2 near Ancaster", dated September, 1959. This survey extended from Stations 487± to 644±. It comprised cross sections 100' apart and 300' wide (150' either side of centre line). Wherever possible, 4 depth determinations were made: one each at both ends of the cross section directed towards the centre, and two at the centre line directed towards left and right. The results of the seismic survey were presented in the form of cross sections on which points where the elevation of bedrock was directly determined or indirectly interpreted are marked with different symbols. Also shown on the cross sections are the various bedrock and overburden velocities which reflect the relative densities of these materials. This investigation appeared to be well-planned and executed, the report well-presented, and it seemed at that time that enough was known about the bedrock elevation of this escarpment section to make a start on the design.

The stability of the talus overburden under the proposed embankments on the escarpment slopes had, of course, still to be investigated. On this subject, Dr. H.Q. Golder, Consultant, reported in May, 1960, dealing with the section between stations 547 and 599 where the line climbs up the steep escarpment slope. In the course of this investigation 6 shallow test pits were dug

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north of the centreline, i.e. below the centreline. The following conclusions were drawn:

(a) No stability problem presented itself between stations 547 and 552.

(b) 20' to 40' high berms were suggested at stations 567 to 568 and 571 to 575.

(c) The soft clay layer to be sub-excavated between station 576 and 599.

(d) Cut slopes in rock to be 1¼ vertical to 1 horizontal at which slope some rock fall could still be expected, and a 10' wide shelf at the toe of the rock cut was called for. In the course of excavation, even a 1¼:1 slope may, in places, be considered not safe enough, in which case a rock filled bin wall, to support the lower portion, was suggested.

(e) Opening of further test pits in order to better substantiate these recommendations, since the results of the 9 shallow test pits were not consistent.

Following up the above report, 3 more test pits were excavated. These showed overburden depths exceeding by a very great margin those indicated by Huntings' report. Dr. Golder, in a letter dated June 30, 1960, suggested that for the compilation of bill quantities, the overburden quantities based on the seismic investigation should be increased by 50% and the resulting quantities should be stated as ± 50%. He also proposed additional boreholes below the high embankments, 100' to 200' apart. Furthermore, the excavation of trenches was recommended in order to closely examine the overburden and to decide whether it had to be removed.

The second report of Dr. Golder's, viz: "Report on Trial Shafts A and B" dated November, 1960, is a follow-up of his above-mentioned letter. This investigation consisted of 2 trial shafts at Stations 589+23 and 594, both 50' downhill from the centreline, and excavated down to bedrock. They were 30' and 50' deep, respectively. Basically, three layers were found to be present in each shaft, viz: talus over glacial clay over bedrock. The talus behaves as a frictional material. The strength of the glacial clay is variable and a lower limit of 1000 p.s.f. was taken for the purpose of stability analysis. The conclusions of the report were: "Height of embankment fill to be limited to 30', and even at this height there is a small chance of local failures; if failures occur, they can be remedied by buttressing."

The discrepancies between the overburden depth arrived at seismically and the depths ascertained by trial pits were further confirmed by a series of coredrill borings carried out after completion of the two trial shafts. Drillings were carried out in 28 new locations. Only the logs of boreholes on the slope above centreline resemble the seismic depths (average 15' drilled against 8' seismic). Below the centreline, the drilled depth averaged 39', against a seismic average of 7', a very serious discrepancy.

The cost of a boring scheme that would provide directly-proven cross sectional rock elevations for the preparation of accurate bill quantities for overburden and rock was prohibitive. The alternative appeared to be an attempt at correcting the interpretation of the seismic field work with the aid of the considerable amount of new boring information obtained in the meantime. All new borehole logs were, therefore, plotted on the seismic cross sections and Huntings went through their field records, correlating proven depths and strata with recorded velocities. They were able, on this basis, to re-interpret and revise their original bedrock line.

Finally, in January, 1961, power auger borings were carried out on top of the escarpment to cover the area affected by the line revision because of the limitation to 30' of the maximum embankment height.

The bedrock elevation cross sections supplied to the Consultants, C.C. Parkers, are considered to be based on the best available compromise between the seismic method under particularly unfavourable conditions, and soils borings on a necessarily limited scale.

BEDROCK DATA:

Only three aspects of the bedrock will be discussed in this report, namely: (1) hardness (in connection with rock excavation), (2) resistance to weathering (in connection with side slope design and the rock's behaviour in embankment fill), and (3) suitability for the production of granular base course.

The following rocks will be encountered - listed in the order as they appear descending from the top of the escarpment:

Eramosa dolomite: Bituminous dolomite. Brownish, weathering almost white. Dense. Beds 1' to 3' thick, some dark grey shale partings. Very hard, must be blasted. Weather resistant, but when deprived of support by gradual weathering of lower layer, liable to massive falls. Quarried commercially in the Stoney Creek area. Generally suitable for granular base course.

"Undivided" Lockport dolomite (Goat Island Member), (Figs. 6,7 & 8): Grey to brownish, weathers dark. Fine grained dolomite with high argillaceous content. Dense. Beds 8" to 2'. Hard chert nodules abound in base. Hard. Must be blasted unless heavily weathered. Weathers at faster rate than Eramosa, above, and Gasport, below. Forms inclined (approx. 1 hor. to 4 vert.) weathered slope. Weathered rock breaks off in pieces 6" to 12" thick and 1' to 2' long. Quarried for G.B.C. commercially in the Dundas, Stoney Creek and St. Catharines areas.

Gasport limestone (Figs. 4, 5 & 6). Blue grey to grey dolomitic limestone with sandy shale lenses. Medium to coarsely crystalline. Beds 1' to 4' thick. Hard. Requires blasting in probably all cases. Weathers uniformly, forming a vertical weathered face. Fallen rock rarely exceeds 2' in greatest dimension. Supplied as G.B.C. by Queenston Quarries.

Decew dolomite (Figs. 4, 6, 8 & 10). Medium to dark grey, weathering to buff, argillaceous to sandy dolomitic limestone. Beds some 7' thick. In places, separated from overlying Gasport by greenish grey shale band 10" thick. Very hard. Needs blasting in all cases. Weather resistant.

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Weathered face is smooth and vertical. Quarried for G.B.C. in Stamford Township.

Rochester shale (Figs. 4,6,7,10 & 11). Dark grey, thinly bedded, sandy to calcareous shale, with frequent 1" to 5" thick beds of grey limestone. The shale layers are friable, but the limestone interbeds are hard. Probably rippable. Was blasted on Hwy. 20 (Stoney Creek) with little difficulty. Must be considered highly susceptible to weathering and is responsible for heavy rock falls of overlying harder formations in some old rock cuts. However, majority of inspected cuts show an almost vertical weathered face in fairly good condition (e.g. Hwy. 2 at Ancaster). The resistance to weathering apparently depends on the thickness locally of the limestone interbeds. The debris from Rochester shale consists of flaky, slate-like fragments. Generally unsuitable for G.B.C.

Clinton limestone (Figs. 9, 10, 11 & 18). Massive, thick to thin bedded, white to light grey crystalline, porous dolomitic limestone, with embedded small pebbles. Hard, requires blasting. Weather resistant, forms vertical face. Quarried for G.B.C. in Nelson Township.

Thorold sandstone (Figs. 9, 11, 13, 22 & 23). Light grey to whitish, fine grained, dense quartzose sandstone. Beds are a few inches to several feet thick. The quartz content is 70%. Hard, requires blasting. Weather resistant, forms vertical face. Rock debris consists of small sizes. Probably suitable for G.B.C., but is not commercially quarried.

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<u>Grimsby sandstone</u> (Figs. 1, 2, 12, 13, 16 & 17). Reddish or grey and red mottled sandstone in beds 4" to 12" thick, separated by red sandy shale partings. Medium hard. Probably rippable. Susceptible to weathering. The weathered slope has an inclination of ½ to 1 hor. to 1 vert. Debris forms a coarse, sandy, clay type material. Unsuitable as G.B.C.

<u>Cabot Head shale</u> (Figs. 13, 14, 17 & 18). Grey shales with some red at base. Frequent interbeds of grey sandy limestone of varying thickness. Hard interbeds and medium soft shale layers. Probably rippable, but, depending on local thickness of interbeds, may need blasting. Weathers to clay type material. The weathered slope also depends on local thickness of limestone interbeds and ranges from ¾ or 1 hor. to 1 vert. Weathered debris is a mixture of clay and limestone fragments.

<u>Manitoulin limestone</u> (Fig. 15). Bluish grey, impure dolomitic limestone, with thin shale partings. Hard, requires blasting. Resistant to weathering.

<u>Whirlpool sandstone</u> (Fig. 15). Light grey quartzose sandstone. Very hard, thick bedded. Has to be blasted. Resistant to weathering.

<u>Queenston shale.</u> (Fig. 15). Red sandy and argillaceous shale. Seams of narrow greenish bands appear to be leached zones of greater permeability. Weathered shale can be ripped easily. The ripping of sound shale becomes increasingly difficult at greater depths, but present experience in-

dicates that it is still economical as compared with blasting. It breaks down rapidly on exposure to the atmosphere and reverts to reddish clay.

SOILS DATA:

The escarpment slopes are steep. The fast water run-off does not favour the development of distinct soils profiles. Furthermore, the irregular covering of pre-glacial talus material by glacial till and, subsequently, by recent rock and soil debris from the top of the escarpment, resulted in a most uneven distribution of materials in the escarpment slope. These materials have been examined from four aspects, viz:

(1) anticipated behaviour during excavation,

(2) suitability for embankment fill,

(3) method of placing which will be adopted when used as fill material,

(4) suitability for use as topsoil.

On this basis, the soils appear distributed as follows:

East of Station 540/

Avg. 6" Topsoil

Upper 4' approx. are a light clay to clay loam, at about optimum moisture. It can be excavated by scraper.

The very-fine-sand-to-silt content of this material is around 40%. The max. Proctor Dry Density is in the region of 108 p.c.f.

At greater depths the density increases and the material is predominantly a silty clay. Ripping of this material as well as of a 5' or more thick transition zone of residual clay and weathered shale may become necessary.

The very-fine-sand-and-silt content is higher, (around 60%). The field moisture will probably be a few percent below optimum.

This material will be placed in fill by the 6" layer compaction method.

Station 540± to 570±

Topsoil on this steep slope is sparse and its excavation will probably be prevented by dense boulder fields.

The following overburden materials will be encountered, but their proportion to each other varies widely from place to place.

Clayey silt mixed with gravel and angular rock fragments occurs in thicknesses from 0' to 10'. It can be scraper excavated. This material should provide good fill although the high silt content will probably make it difficult to handle in wet weather. The texture being variable, no representative max. dry density is suggested and field trials will be needed to arrive at a practical target for compaction.

Boulders and rock fragments in a silt matrix will be encountered in layers 2 to 12 feet thick. The size of individual boulders ranges from a foot to five feet and even more.

Clay Till, stiff to very stiff occurs in thicknesses of 10 to 15 feet. Some of this till may require ripping.

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This material can be placed and compacted in 6" compacted layers.

Hard silt with some gravel, in layers up to 20' may have to be ripped. 6" layer compaction will be called for.

Sand and gravel, dense to loose, with some clay, will be encountered in layers 2' to 20' thick. Boreholes did not reveal cemented material and it is, therefore, probable that scrapers can be used. The 6" layer compaction method will be applicable.

Station 570± to 600±

This section straddles the edge of the escarpment.

The soils conditions below the edge are substantially the same as those described in the preceding section. Above the escarpment edge, the soils are less varied. Topsoil averages a depth of less than 5". Since this area is wooded, perhaps only half of the topsoil will be recovered for use.

Medium Clays to Silty Clays, up to 25' deep, overlie bedrock. The upper 10' layer or so consists of Medium and Light Clay, close to optimum moisture, with a very-fine-sand-and-silt content of between 30% and 60%. The maximum Proctor dry densities are about 105 and 110 p.c.f. respectively. Below it, down to bedrock, is a Silty Clay. Its field moisture is at about the plastic limit, and the very-fine-sand-and-silt content is around 60%.

No excavation problems are anticipated.

Grades in deeper cuts will be in more frost susceptible

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material than those in shallow cuts.

As fill material, only the upper few feet will provide "acceptable borrow" by D.H.O. practice, whilst the deeper material may be "unacceptable" on the grounds of its high frost susceptibility. This does not, of course, preclude its use as embankment fill, but it will be advisable not to use the siltier material within say 5' of finished grade. Fill operations can be expected to be normal and no seepage planes are indicated by borings.

Station 600± to 619+00

This section is located on top of the escarpment. The earth overburden has here a greater depth, up to 40'.

Topsoil averages about 6".

Light and Medium Clays constitute practically the entire overburden. The field moisture is near optimum. The very-fine-sand-and-silt content is 30% to 40%.

Unusual excavation difficulties are not anticipated, with the exception, perhaps, of the knoll at Station 609± where borings indicate seepage at a depth of about 11' and, below it, a wet layer some 2' thick.

The cut material will generally provide suitable earth fill.

Base Stability of Embankments.

The stability problem presented by embankments, based on the escarpment slope containing a low strength clay stratum has been eliminated by the proposed alignment with its maximum

...../15

30' embankment height.

Earth Borrow.

Borrow will not be required. On the contrary, a disposal problem of surplus cut material likely arises. This will be further studied as soon as the details of distribution of the cut quantities are known.

Fill Operations.

According to the type of excavated material used in the embankment fill, three methods will be adopted:

(a) D.H.O. Specification #200 Section 214 (b) Six-inch layer compaction method. for earth overburden on the top and at the bottom of escarpment, also for the talus material of the escarpment slope. Boulders and large size rock debris shall be placed outside the 1:1 slope line.

(b) Amended D.H.O. Spec. #200 (as per "Special Information to Bidders" as outlined in this report under Recommendation #18), for Queenston shale, Cabot Head shale, Grimsby sandstone and Rochester shale. In this case, present experience indicates that, at the request of the Engineer in the field, an increase of the compacted layer thickness to 12" as well as the use of a minimum 15 ton steel rim roller may be called for.

(c) D.H.O. Spec.#200, Section 215, Rock Embankment Construction. This method will be applicable for hard rocks, i.e. limestones and sandstones except Grimsby.

GRANULAR MATERIALS:

Supply sources of granular materials and some granular deposits are listed below:

(1) On this project, between stations approx. 593/00 and 608/00, above elevation 583', i.e. all limestones and dolomites above Rochester shale. The rock cut in this location will make available some 200,000 c.y. of dolomitic limestone. The utilization of this material for the production of Crushed Rock G.B.C. Class "A" should be considered, especially in view of the anticipated surplus of cut material.

(2) Canada Crushed Stone Quarry. supplies G.B.C. "A", possibly rock screenings. Haul approx. 15 miles.

(3) Nelson Crushed Stone. G.B.C. "A" possibly Screenings. Haul approx. 15 miles.

(4) Hannon area. Limestone has been quarried in this area in several localities, e.g. the Miles (McNamara) quarry which supplied, in 1959, G.B.C. Class "A" to the Hwy. #53 Contract (Elfrida to Ryckman Corners). Haul distance 13 Miles approx.

(5) Stoney Creek area. Cope's Quarry and Vinemount Quarry are commercial quarries in this area, supplying G.B.C. Class "A". The haul distance is 14 to 18 miles.

(6) National Slag. Air-Cooled blast furnace slag G.B.C. Class "A" being supplied from the Hamilton Beach Road area. Haul approx. 14 miles.

(7) Aldershot Area. A recently opened pit face shows improved quality as compared with the previously encountered fine silty sand. Strict control at the pit end is necessary Haul distance approx. 12 miles.

...../17

(8) <u>Waterdown Area.</u> Modified Sand Cushion. Known deposits are shallow. Haul approx. 13 miles.

<u>Slide Danger of Embankments.</u> (See Figs. 22, 23, & 24)

Measures to counteract the tendency to slide will consist of:

(a) Subsoil drainage, in order to prevent the forming of a wet, soft layer at the base of the embankment by seepage from the bedrock.

(b) Removal from the existing slope of organic materials which may be conducive to loss of friction and,

(c) In some cases, terracing of existing steep slopes in order to increase friction.

<u>Subsoil Drainage.</u> (See Fig. 20 & 21)

Neither boreholes nor test pits on the escarpment slopes gave evidence of seepage. This may, however, hold true only for late fall and winter conditions when most of the borings were carried out. Drainage provisions for seasonal seepage from the rock into the upper layer of the [illegible]lus material were contemplated in the form of an interceptor drain below the drainage ditch at the upper embankment toe of slope, also of similar drains at vertical intervals under the embankment base. It is, held at present that insufficient evidence is at hand to justify the major expense involved in the construction of a general subsoil drainage system of this type. Seepage encountered during operations will, of course, be dealt with by field recommendations. The sub-soil drainage question will be further considered, including its cost angle, when design cut and fill cross sections are available and the merits of local subsoil drainage systems as against a general scheme can be compared.

SUMMARY AND RECOMMENDATIONS:

1. Type of Contract.

It is recommended that this project be called as a G.B.C. Class "A" and Modified Sand Cushion Contract. It is further suggested that the production and stockpiling of G.B.C. "A" be included in this contract in order to take advantage of a large cut in dolomitic limestone. - This recommendation is based on the present estimate of the rock quantities available for crushing. The specification for "Modified Sand Cushion" to be used on this grading contract is quoted under No.16 of these recommendations and should be included in "Special Information to Bidders".

2. Depth of Granular Base Course for Asphalt Pavement.

(a) Over earth and soft rock, i.e. Stations 514 to 555 approx., 558 to 591 approx., 593 to 599 approx. and 609 to 619 approx.: 24" granular base course consisting 18" G.B.C. Class "A" over 6" Modified Sand Cushion, except in fill sections where the upper 3 feet or more consists of hard rock from the cut sections mentioned in the next paragraph in which case the recommended depth of granular base course is 12" G.B.C. Class "A" only.

(b) Over hard rock, i.e. Stations 555 to 558 approx., 591 to 593 app., and 599 to 609 approx.: 12" GBC Class "A" only.

3. <u>Gradeline.</u>

The present alignment is in keeping with slope stability requirements and there are no objections with regard to the gradeline as far as soils conditions are concerned.

4. <u>Width of Granular Base Course.</u>

The granular base courses are to extend over the full width of the earth grade.

5. <u>Paved Shoulders.</u>

According to present Design Criteria paved shoulders are specified, viz., 8' wide on the outside and 3' wide on the ins[illegible].

6. <u>Supply of Granular Materials.</u>

Sources of supply are discussed in this report on pages 16 and 17.

7. <u>Air Cooled Iron Blast Furnace Slag.</u>

It is suggested that the following item be included in "Special Information to Bidders". "The Contractor may use Air-Cooled Iron Blast Furnace Slag for Granular Base Course Class "A" or Modified Sand Cushion provided that the D.H.O. gradation specifications for these materials are adhered to. In the event that the Contractor does use slag for G.B.C. "A" or Modified Sand Cushion, measurements will be made in tons as stipulated in D.H.O. Specifications. Slag being lighter than natural aggregates, less tonnage will be required and payment will, therefore, be made at the rate of 120% (one hundred and twenty percent) of the tender bid price for G.B.C. Class "A" or Modified Sand Cushion.

8. Earth Borrow:

No earth borrow will be required.

9. Side Slopes:

In Cut:

Overburden above bedrock .... 2 hor. to 1 vert.

Bedrock above elevation app. 548',

i.e. above red Grimsby Sandstone .... 1 hor. to 4 vert.

Bedrock between elevations app. 548' and 461'.

i.e. red Grimsby sandstone and Cabot

Head shales .... 1 hor. to 1 vert.

Bedrock between elevations app. 461' to

441', i.e. Manitoulin limestone and

Whirlpool sandstone .... 1 hor. to 4 vert.

Bedrock below elevation app. 441',

i.e. Queenston shale .... 2 hor. to 1 vert.

10' wide shelves are recommended at the contact elevations between:

Queenston shale and Whirlpool sandstone, elev. app. 441',

Grimsby sandstone and Thorold sandstone, elev. app. 548',

between bedrock and overburden, and at sub-grade elevation outside the ditch where the subgrade is immediately below a 1 hor. to 4 vert. or 1:1 rock cut slope.

In Fill:

Earth fill, including stoney and

bouldery talus material .... 2 hor. to 1 vert.

Shale fill (Queenston shale below elev.

441', Cabot Head shale, between elev. 461'

and 542'. Rochester shale between
562' and 580' .... 2 hor. to 1 vert.
Grimsby sandstone from elev. 542'
to 548' .... 2 hor. to 1 vert.
Rocks other than shales and Grimsby
sandstone .... $1\frac{1}{2}$ hor. to 1 vert.

10. Culverts.

Culvert locations have not yet been plotted on the longitudinal profile. It is expected that culvert foundation problems will not arise and that rigid or flexible culvert types can be used on this project. However, existing steep water courses will probably complicate culvert design. Culvert Foundation recommendations will be made when design data are available.

11. Production of G.B.C. Class "A" from Rock Cut Material.

From material obtained from the dolomitic limestone cut between approx. station 591+50 and 608+00, above elevation 583', G.B.C. Class "A" shall be produced for the succeeding G.B.C. and paving contract. The material is to be stockpiled and a suitable area for stockpiling shall be designated. This should be covered in the "Special Informations to Bidders".

12. Sub-Soil Drainage.

As discussed under the same heading on page 17 of this report, recommendations dealing with subsoil drainage are still under consideration.

13. Stripping of Topsoil and Terracing under Embankments.

The base of embankments, whatever the height of fill, should be stripped of topsoil where the existing slope is 4 hor. to 1 vert., or steeper.

All existing slopes steeper than 3 hor. to 1 vert. shall be terraced as follows:

The height of the vertical step shall be 4' or less, the maximum horizontal bench being 8'.

Benches are to be excavated at one level at a time and the compacted fill broughtup before the next level of benching is excavated. See D.H.O. standard #DD4[illegible].

14. Thickness of Topsoil.

East of Station 540±	:	Avg. 6".
Sta. 540± to 570±	:	Topsoil probably not recoverable on steep and bouldery slope.
Station 570± to 600±	:	On slope, as above. Above escarpment edge, an avg. 5".
Sta. 600± to 619±	:	Avg. 6".

15. Recommendations not covered in this report.

It can be expected that when cut and fill cross-sections will be plotted for detailed design, local stability problems will present themselves. These will be dealt with as they arise and continued close contact will be maintained between the Designer and the Soils Section.

16. Modified Sand Cushion.

The following item should be included in "Special Information to Bidders".

"The Modified Sand Cushion material shall be non-plastic and non-susceptible to frost action as determined by current D.H.O. methods. They shall meet the following gradation requirements:

Passing	4"	Tyler	Sieve	100%
"	1"	"	"	70 - 100%
"	#4	"	"	30 - 100%
"	#14	"	"	20 - 50%
"	#48	"	"	10 - 30%
"	#200	"	"	3 - 20%

17. Identification of Rock Formations.

A number of photographs are attached, showing rock formations which will be encountered. These were taken in old and recent road or railway cuttings, and in natural exposures. They may be helpful also during construction in identifying the transition between rock types, for the proper location of rock shelves and changes of cut slopes.

18. Compaction of Shale Cut Material.

The following item should be included in "Special Information to Bidders".

"Fill material obtained from shale portions of cuts shall be constructed as specified under the "Six-inch layer Compaction Method" of Form #200. In the event that adequate com-

...../24

paction cannot be obtained with the permissible lift thickness, or with the compacting equipment stipulated under the Special Provisions titled "Specification for Compaction by Equipment Rental", then the Engineer shall direct the Contractor to obtain such other compacting equipment as is found suitable by field tests taken by the Engineer at the commencement of the placing of these materials, or to increase the thickness of the lift."

19. Excavation and Fill of Bouldery Talus Material.

The cut in the escarpment slopes will traverse strata fluctuating sharply in thickness between 2' and 12', containing large size rock debris. The size of individual boulders will range from a foot to five feet or even more. The total volume of boulders, of 27 c.f. or more each, encountered in earth excavation is about 1%, and it is suggested that this should b e allowed for in the computation of the bill quantities for rock and earth excavation.

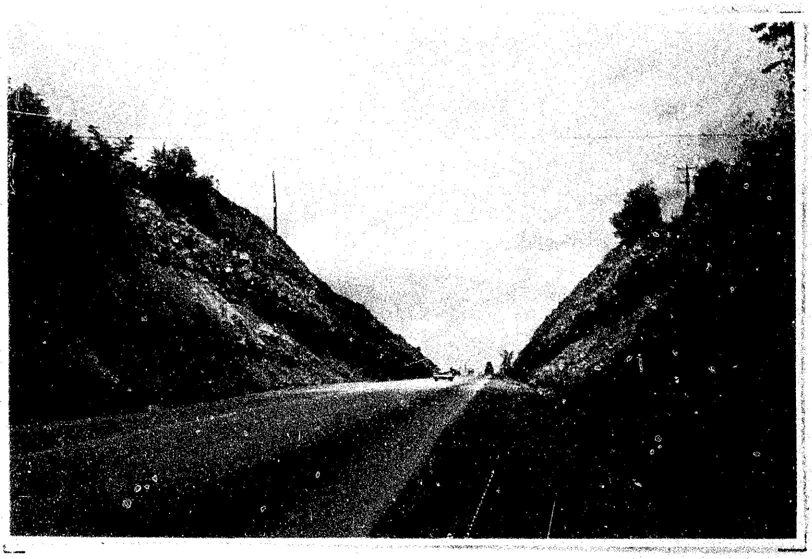


FIG.1: Highway 6 at Clappison Corners

FIG.2: Highway 6 at Clappison Corners

FIG.3: Highway 2 at Ancaster

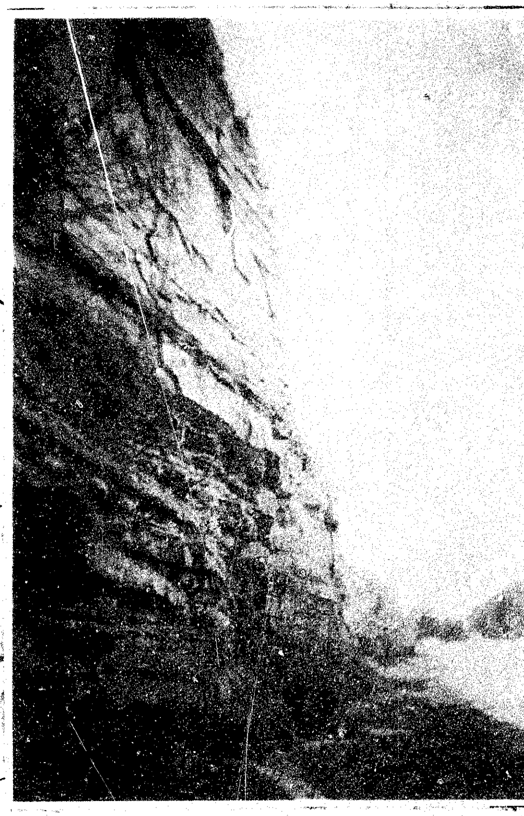
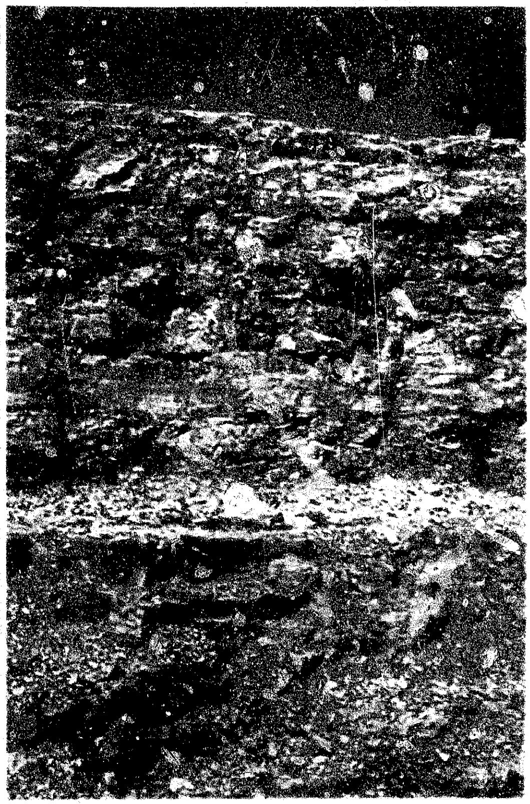


FIG.4: Highway 2 at Ancaster



[illegible]

Gasport (Limestone)

Decew (Dolomite)

Rochester (Shale)

F[illegible] Highway 20 at Stoney Creek.
East Face - Excavated in [illegible]

"[illegible]" [illegible]

Decew ([illegible])

Rochester (Shale)

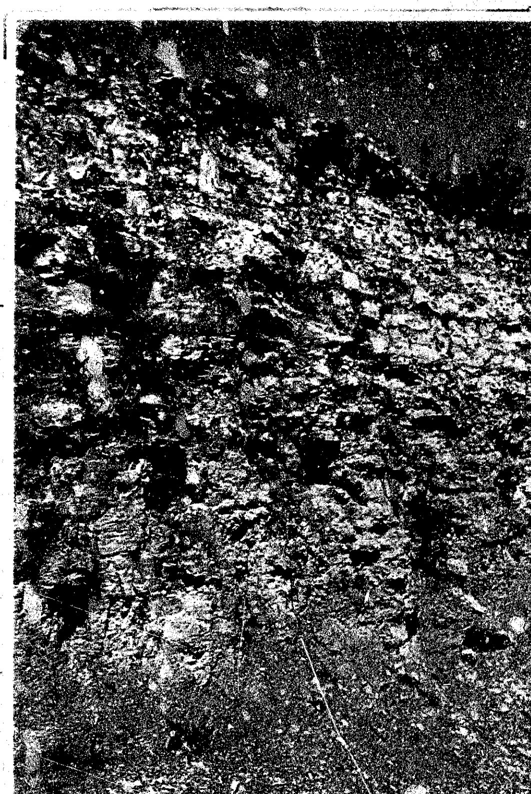


FIG. [illegible] Highway 20 [illegible] Stoney Creek.
[illegible] Face [illegible] Cut.

WEATHERED ROCK CUTS

FIG.7: Highway 20 at Stoney Creek.
East Face Excavated in 1958

FIG.8: Highway 20 at Stoney Creek.
West Face Old Rock Cut.

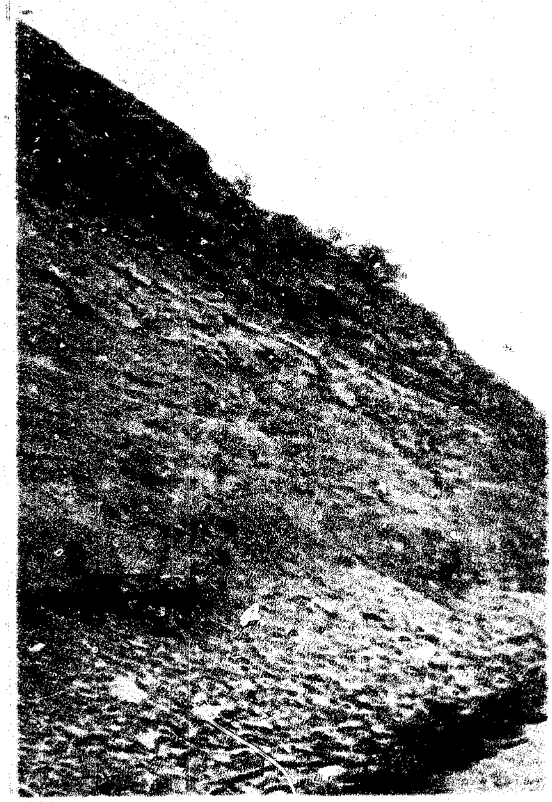


FIG.9: T.H.&B. Railway Cut at Stoney Creek.
Rock Debris Above Grimsby Formation
Consists of Relatively Small Size

FIG.10: [illegible] Railway Cut at Stoney Creek.
[illegible] Rock Fall Caused by Undermin[illegible]
of [illegible] Grimsby Sandstone

FIG. … St. Joseph … E. Flock Road.
… Sandstone

"Undivided," Lockport (Dolomite)

Rochester (Shale)

Clinton (Limestone)

Thorold (Sandstone)

Grimsby (Sandstone and Shale)

[illegible]

[illegible] Shale)

[illegible] Hamilton Mountain Jolley Cut.
Weathering of Cabot Head Shale
Under Grimsby Sandstone.

[illegible] Hamilton [illegible] Mountain [illegible] Road
Cut in [illegible]

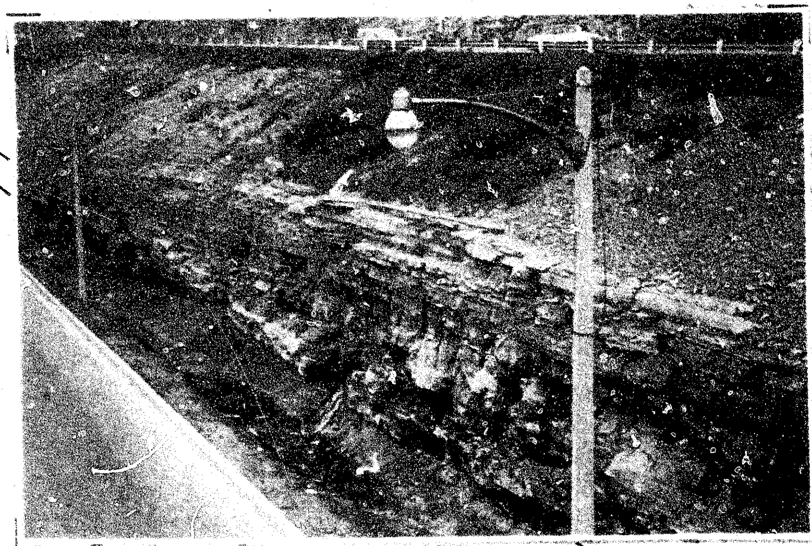


FIG.15: Hamilton, Mountain Blvd. Below Flock Road
Weathering of Queenston Shale Undermines
Hard Whirlpool Sandstone.

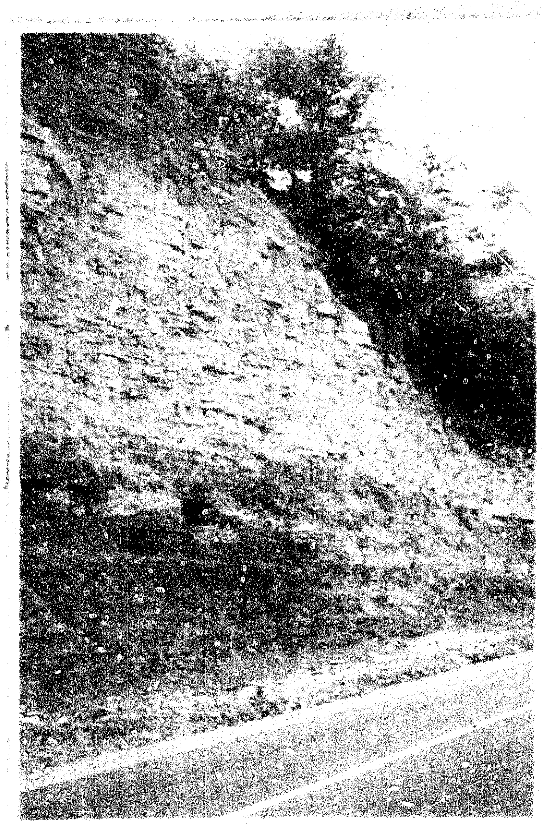


FIG.16: Hamilton. St. Joseph's Drive
Thorold and Grimsby Contact
Note 15" Thick Hard Top Layer
of Red Grimsby.

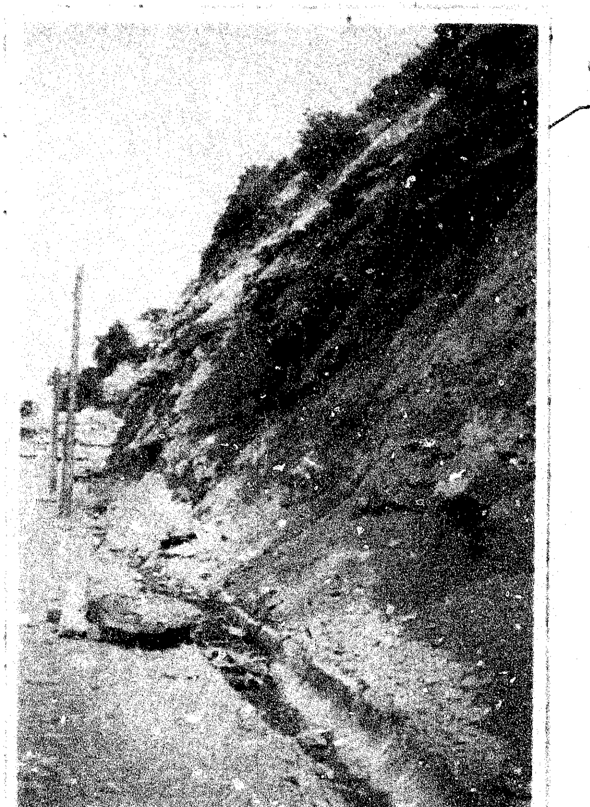


FIG. 17: [illegible] Mountain, [illegible] Road
Rock Fall in Weathered Grimsby

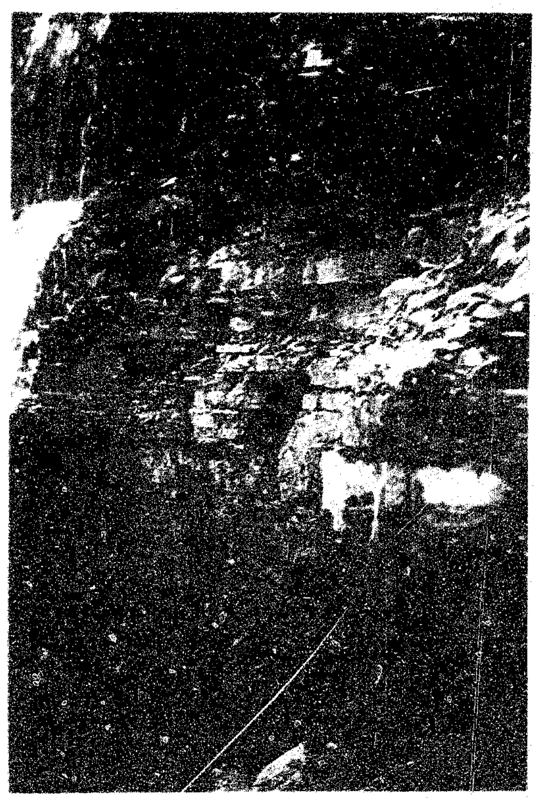
NATURAL ROCK EXPOSURES

Rochester (Shale)

Clinton (Limestone)

Thorold (Sandstone)

FIG.18: Rock Exposure North of Station 561±

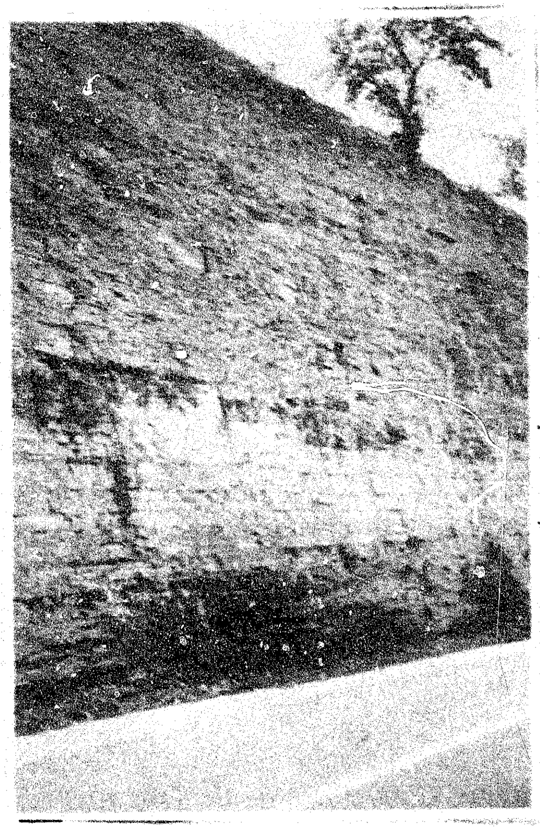


Thorold (Sandstone)

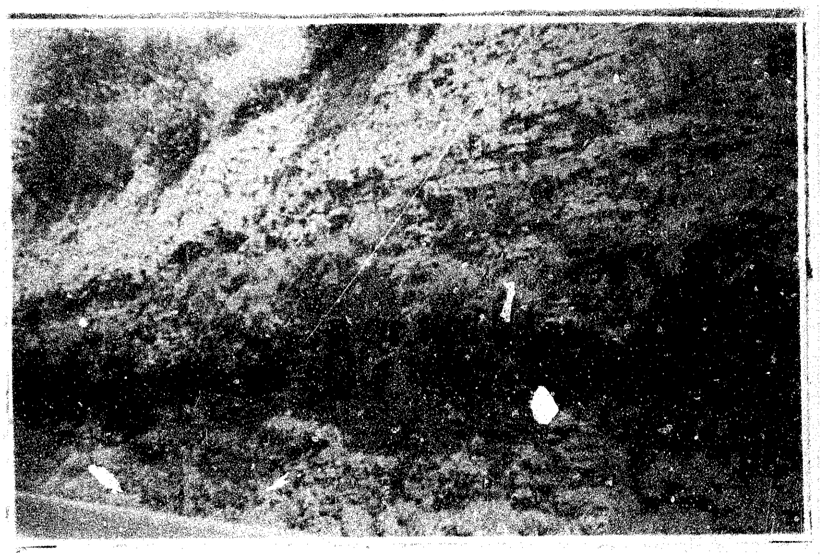
Grimsby (Sandstone & Shale)

Cabot Head (Shale)

FIG.19: Rock Exposure North of Station 561±

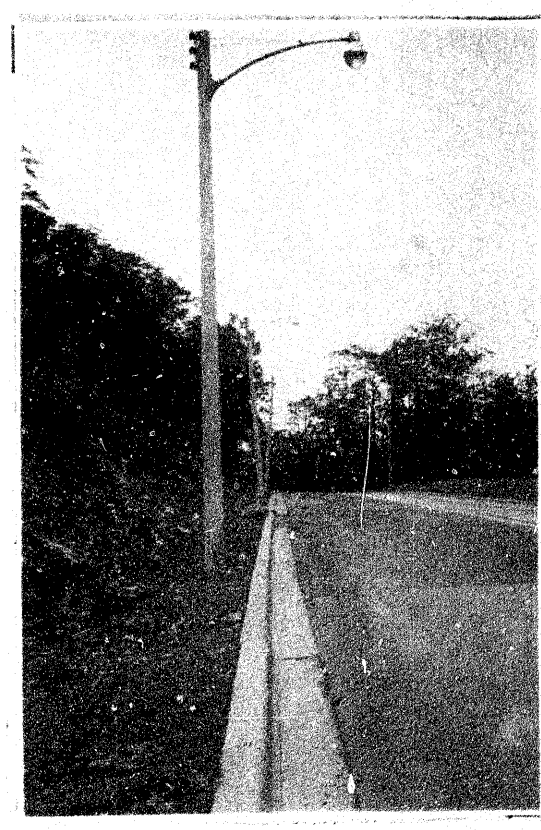


.20 St. Joseph Drive, Hamilton [illegible] in [illegible] Rochester (Shale), Clinton (Limestone) and Thorold (Sandstone)



.21 [illegible] Cut, Hamilton [illegible]

...2: St. Joseph's Drive Near Ferguson ... Hamilton
Attempt at Arresting Creeping ... Toe
With Large Rock.



...3.2: St. ... West of ... Road,

FIG.24: Rock Road [illegible] Road, Hamilton.
[illegible] Failure [illegible] Completion of
[illegible] Provision of [illegible]
Curb and Shoulder.

PHONE: [illegible]

C. C. PARKER & PARSONS, BRINCKERHOFF LTD.
CONSULTING ENGINEERS
755 MAIN STREET WEST
HAMILTON, ONTARIO
CANADA

September 15, 1961.

Mr. A. Rutka,
Materials and Research Engineer,
Department of Highways Ontario,
Parliament Buildings,
Toronto, Ontario.

Attention: Mr. R. Schonfeld.

Re: W. P. 140-57-2 - Highway 403, District 4, Hamilton
Design Problems on Escarpment.

Dear Sir:

You are no doubt aware that roadways leading up the escarpment in the Hamilton area have been a continual source of trouble for many years. Failures have been constantly occuring which have caused trouble and inconvenience, as well as danger, to the travelling public. Maintenance of these road - ways has also been a heavy burden on the taxpayer.

As a result, officials of the City of Hamilton, as well as the populace in general, are waiting with intense interest to see the escarpment section of Highway 403 constructed. Any failures that might occur on this section will reflect discredit on our firm, as Consultants, as well as on your Department.

During the past couple of years we have been constantly studying problems that have occurred on existing roadways up the escarpment, as well as the location of Highway 403 as it makes the ascent. This has been done in the hope that we might, by working in close liaison with you, produce a section of Highway, of which we can all be justly proud.

We have therefore studied the draft copy of your final report on this section with keen interest. In general, we are in complete agreement with your conclusions and recommendations. However, there are some further recommendations that we would like to put forward for your consideration. It is felt

Cont'd. ...

that the cost of implimenting these suggestions is a small item in the overall cost of the project. The additional insurance against failure, appears to justify the cost. These recommendations are itemized below and illustrated on the drawings of typical cross-sections enclosed.

(1) Subsoil Drainage

The report states that neither boreholes nor test pits on the escarpment slopes gave evidence of seepage. We feel that this is due to the particular season in which the boreholes and test pits were put down. It is felt that similar drilling and test-pitting carried out now, in the midst of an extremely wet season would give a different picture. This is borne out by examination of the Ferguson Avenue slide, below the Jolly Cut, further East along the escarpment. This slide has now become a very serious problem to the City.

We therefore feel that a network of deep subsoil drains is most necessary. An inside ditch trench with a perforated pipe at the bottom and backfilled with crushed rock to form a french-drain is recommended, together with connecting laterals, at fifty to one hundred feet on centres. Depth of this drainage network below subgrade to be the greatest practical depth. Ten to twelve feet should be well within the efficient digging range of a backhoe. It is suggested that this subsoil drainage system be used where subgrade is in, or less than five feet above the Queenston shale. Also it should be considered in the Grimsby sandstones and Cabot Head shales, and in the other bedrock areas where the roadbed is partially in cut and partially in fill. The paving of the ditch at the surface should be considered so that the deep drains will be entirely available for seepage water.

(2) Catch-berm below Grimsby sandstones and Cabot Head shales.

Although a 1:1 slope is recommended in this strata; block and slab rubble will still develop due to frost-action and weathering. The 1:1 slope will give rolling rubble a horizontal component tending to throw it out onto the road. It is therefore felt that, where subgrade is in this formation, an extra ten feet of ditch width should be provided. This could be done preferably by moving the slope back, although this would materially increase the excavation quantities. An alternative would be to steepen the cut slope. The extra ditch width in this formation appears necessary, for safety reasons and for efficient maintenance. We note that you recommend a catch-berm at the contact between this formation and the more stable [illegible]. With this we concurr completely.

Mr. A. Rutka. September 15, 1961.

(3) Terraceing or benching of natural slopes under embankment.

Where side hill embankment occurs on steep talus slopes, these natural slopes should be terraced or benched, and the benches thoroughly compacted. This is particularly important, at and near the toe of the embankment slopes.

(4) At the contact between overburden and upper bedrock where any seepage is evident a paved ditch should be provided in the rock.

(5) Any badly fractured vertical zones or chimneys should be pressure sealed with a cement grout.

It would be appreciated if you would give these recommendations your serious consideration. We would be pleased to meet with you to discuss these problems in further detail.

Yours very truly,

C. C. Parker & Parsons, Brinckerhoff Limite

H. C. Nixon, P. Eng.,
Project Manager.

HCN:go

cc: D. R. Suyers
A. Hedefine
R.A. Snowber.

October 24, 1961.

C.[illegible] Parker & Parsons, Brinckerhoff Ltd.,
795 Main Street West,
Hamilton, Ontario.

Attention: Mr. H.G. Nixon

Re: W.P. 140 - 57 - 2 Hwy. 403
Design Problems on Escarpment

Dear Sir:

Thank you for your letter of September 15, 1961. You have brought up a number of very good points which certainly must be considered in the preparation of an adequate design. According to our soils design report and profile for this project you will note that some of your suggestions have been included. Your other suggestions that have not been included are certainly subject to further discussions which we would like to have with you. Our comments on your suggestions are as follows:

1. Subsoil Drainage

The conclusion which may be drawn from the experience of Hamilton City with their escarpment roads is that some of the failures are attributable directly to seepage in the slopes and lack of subsoil drains. Where this is the case, e.g. on St. Joseph's Drive near the Ferguson Steps, slope seepage is, at least at present, evident. -- Other failures appear to have different causes, e.g. undercutting or overloading of natural slopes, or a combination of both.

In the enclosed Soils Report, on Page 17, it is pointed out that, although neither borings nor deep test pits supplied evidence of seepage, the subsoil drainage question will be further considered when design cut and fill cross-sections are available.

Cont'd.../2

[illegible] those areas where [illegible] stability, and to weigh the cost of [illegible] against the cost of a general subsoil drainage scheme.

2. [illegible]

Many rock falls can be caused by undermining of the [illegible] unweathered rock through weathering of underlying softer strata. For this reason, catch-berms are recommended in the Soils Report only at the base of "hard" rock cuts, i.e. limestones and hard sandstones with a 1/4 hor. to 1 vert. slope. The intention is to intercept rock falling in a steep trajectory and also to prevent undermining.

The softer rock (Cabot Head Shale and Grimsby Sandstone) will be shaped to 1:1, at which angle - as a study of existing slopes indicates - weathering penetrates at a fairly uniform rate over the slope, and a slow erosion of small rock particles takes place. This is why a catch-berm at the base of these soft rock formations is thought not to be necessary, especially in view of the large additional quantities of hard rock cut involved.

3. Terracing of Natural Slopes Under Embankments

Your recommendation on this point was inserted in the soils report. An upper limit of 4' for the vertical step was set because of the danger of weakening the natural slope by undercutting.

4. Paved Ditches

We would go along with you regarding paved ditches however this should be discussed further with the Department.

5. Pressure Grouting of Vertical Rock Fractures

This would perhaps best be let to decision in the field.

Mr. Schonfeld is working very closely with you on this project and should you at any time think that a meeting with the Department would be advantageous please do not hesitate to advise and we shall arrange it.

A. Rutka,
Materials & Research Engineer.

[illegible]:bc

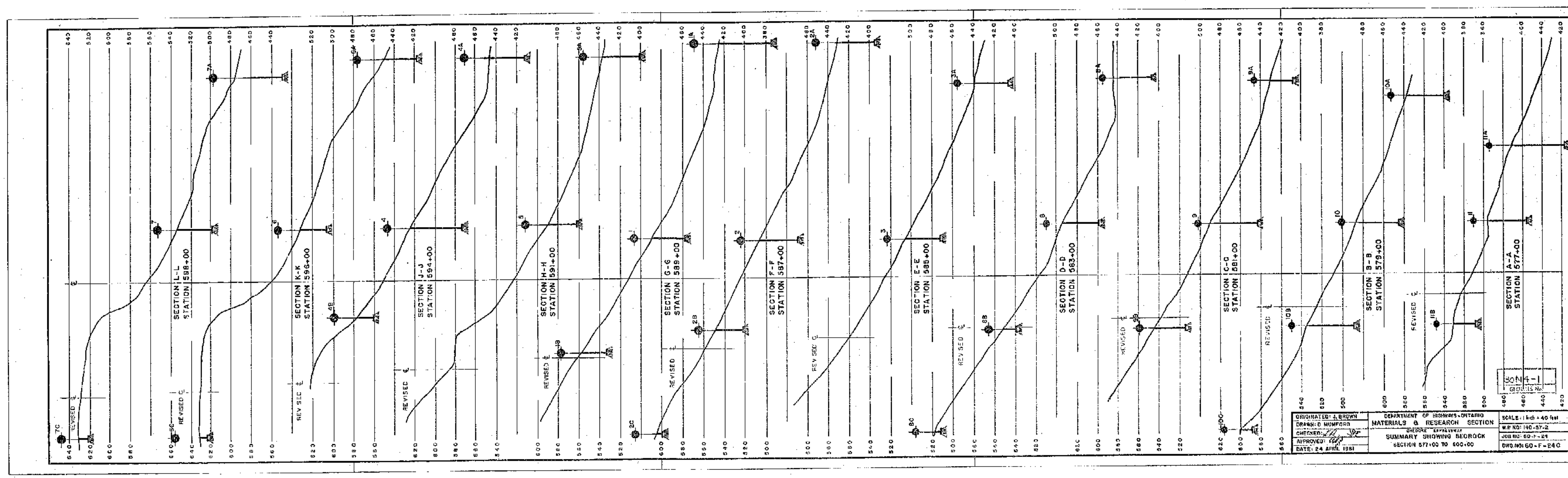
W.P. 140-57-2

HWY. 403

CHEDOKE EXP.

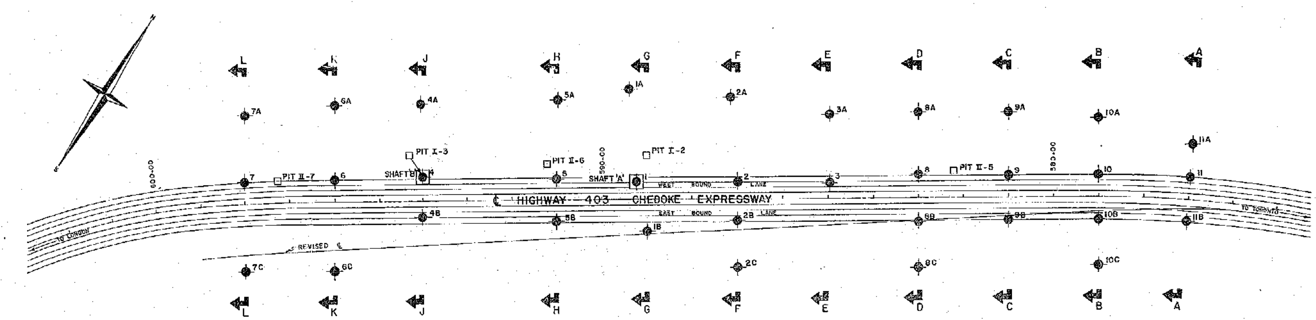
ESCARPMENT

30M4-1

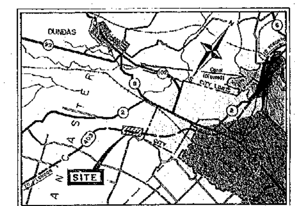


SOME DEFECTS IN NEGATIVE DUE

TO CONDITION OF ORIGINAL DOCUMENTS



PLAN



KEY PLAN
SCALE: 1 inch = 1 Mile

NOTES: FOR SECTIONS INDICATED BUT NOT SHOWN ON THIS SHEET SEE DRAWING 60-F-24B

FOR INFORMATION ON SHAFT 'A' & SHAFT 'B' SEE H.G. GOLDER & ASSOCIATES LTD. "REPORT TO DEPT. OF HIGHWAYS ONT. ON TRIAL SHAFTS 'A' & 'B' ESCARPMENT SECTION CHEDOKE EXPRESSWAY HAMILTON ONTARIO.

30M4-1
GROUP 3 No.

ORIGINATED: J. BROWN	DEPARTMENT OF HIGHWAYS - ONTARIO MATERIALS & RESEARCH SECTION	SCALE: 1 inch = 100 feet
DRAWN: D. MUMFORD		W.R. NO: 140-57-2
CHECKED:	CHEDOKE EXPRESSWAY PLAN SHOWING BORINGS IN THE ESCARPMENT SECTIONS SECTION 577+00 TO 600+00	JOB NO: 60-F-24
APPROVED:		
DATE: 8 FEBRUARY 1961		DWG. NO: 60-F-24A

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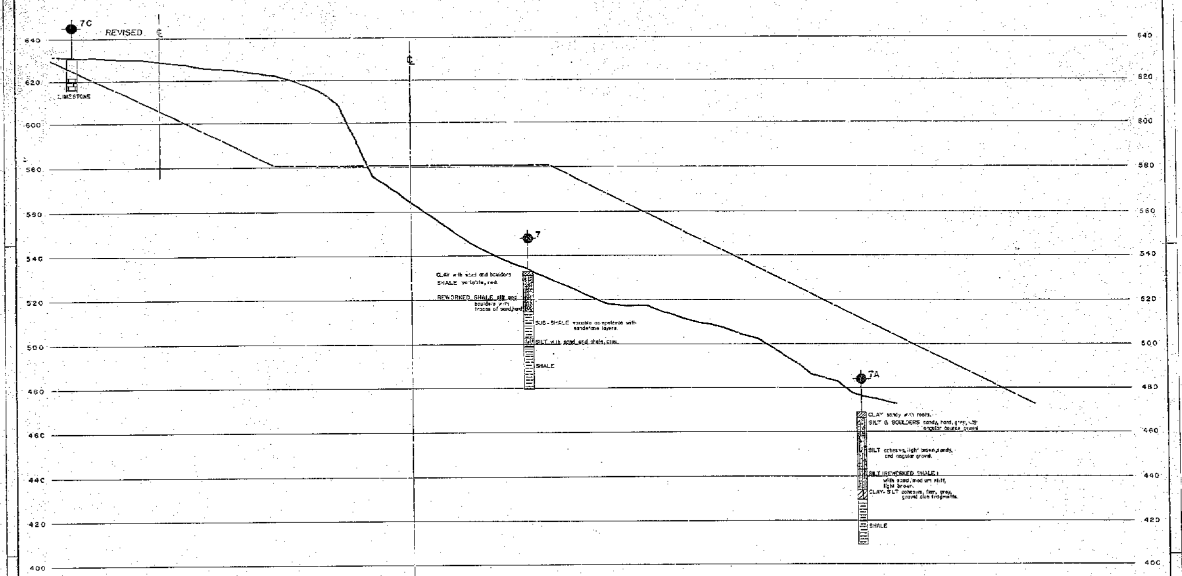
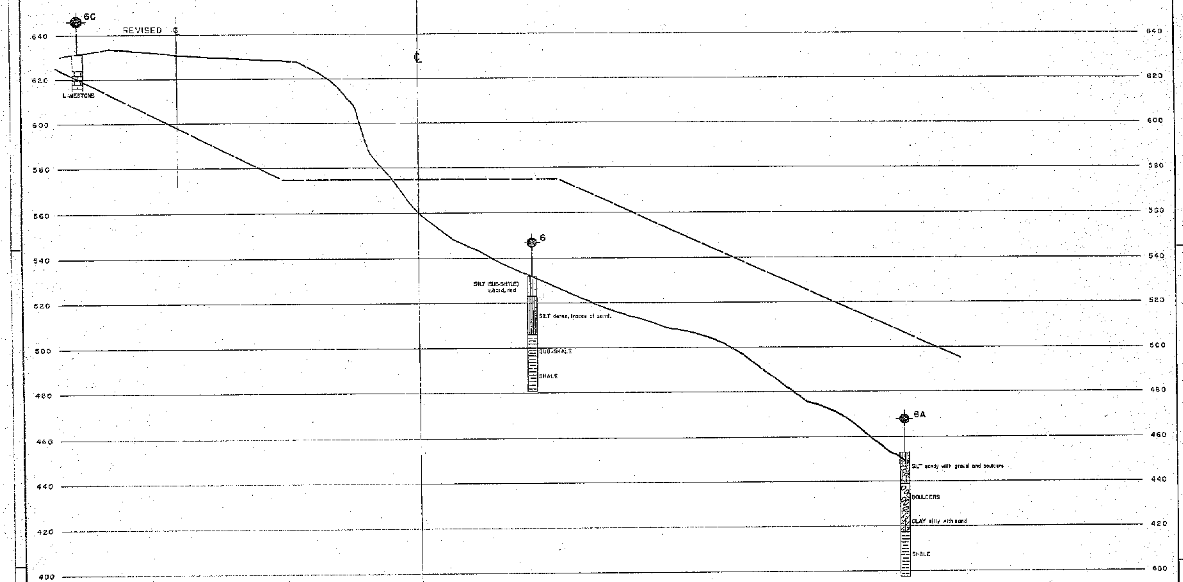
SOME DEFECTS IN NEGATIVE DUE

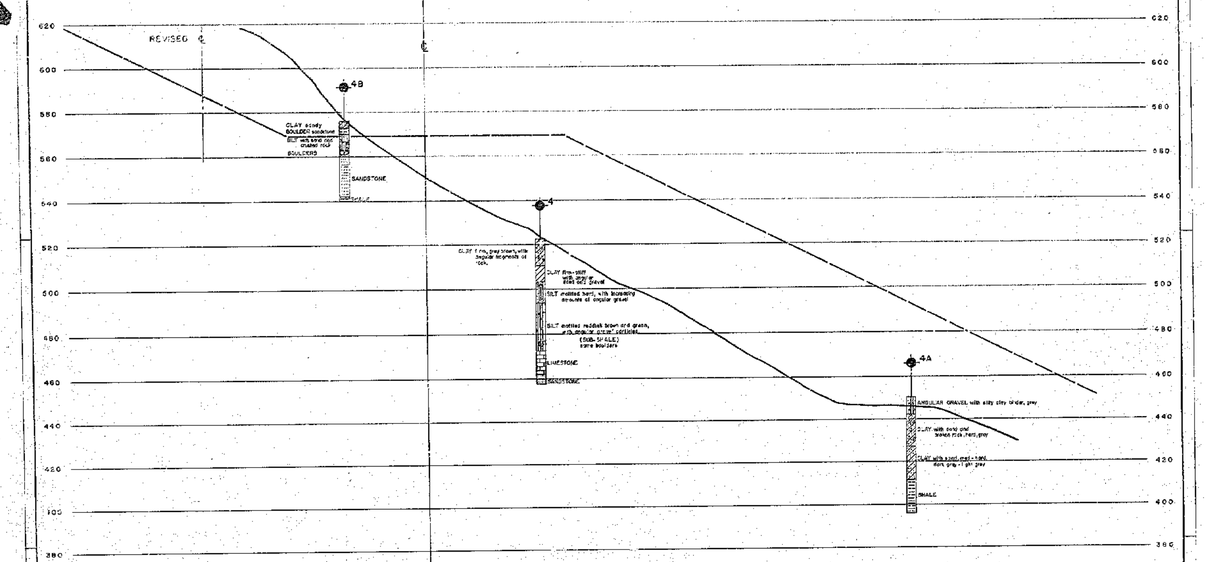
TO CONDITION OF ORIGINAL DOCUMENTS



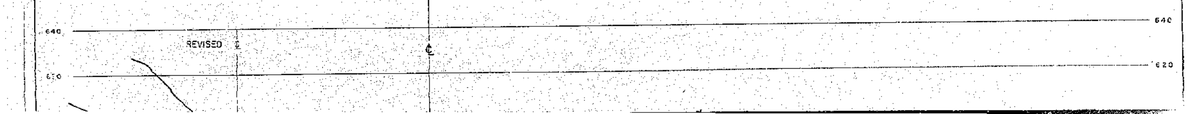
SECTION L-L STA.598+00



SECTION K-K STA.596+00



SECTION J-J STA.594+00



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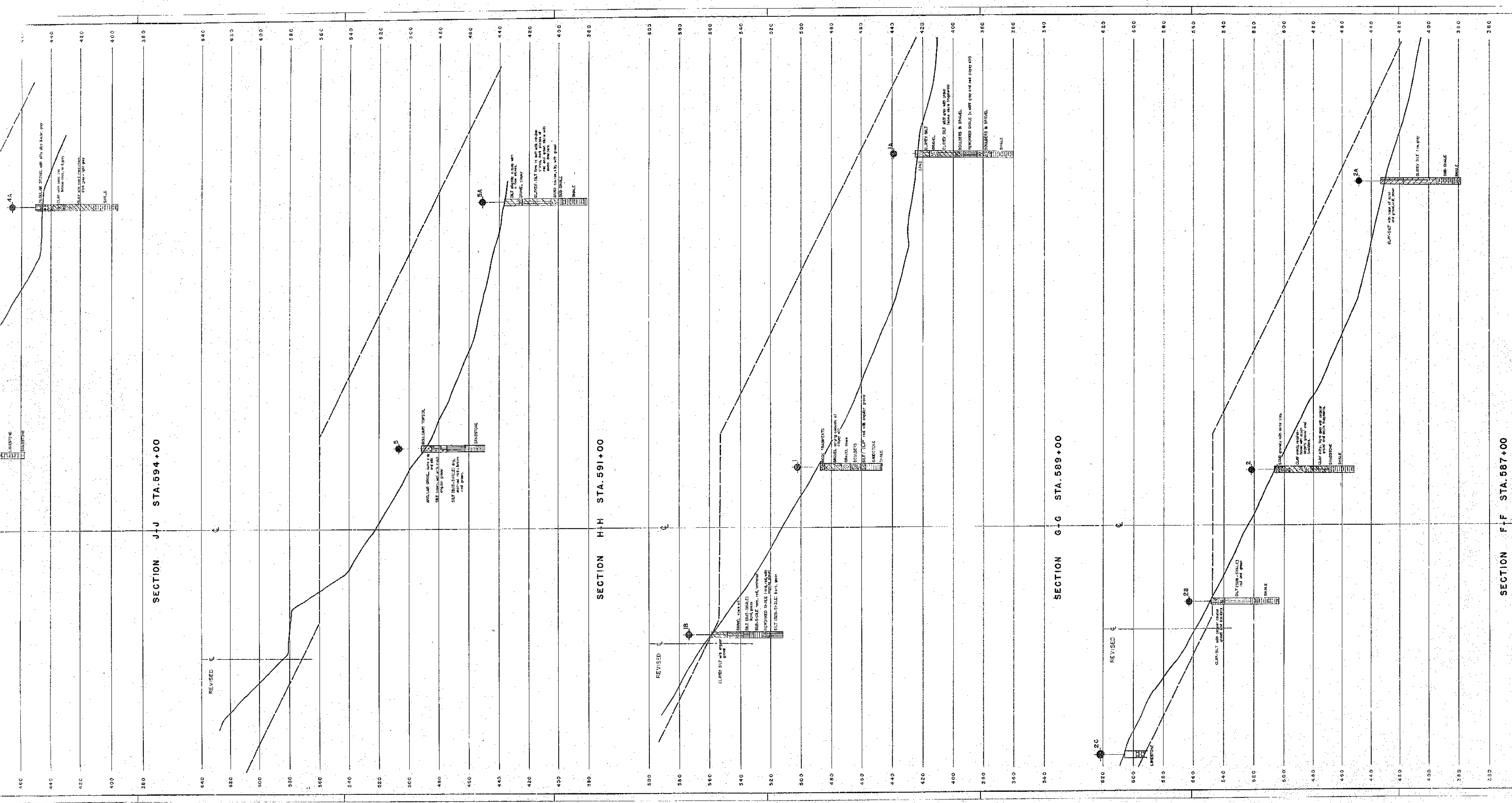

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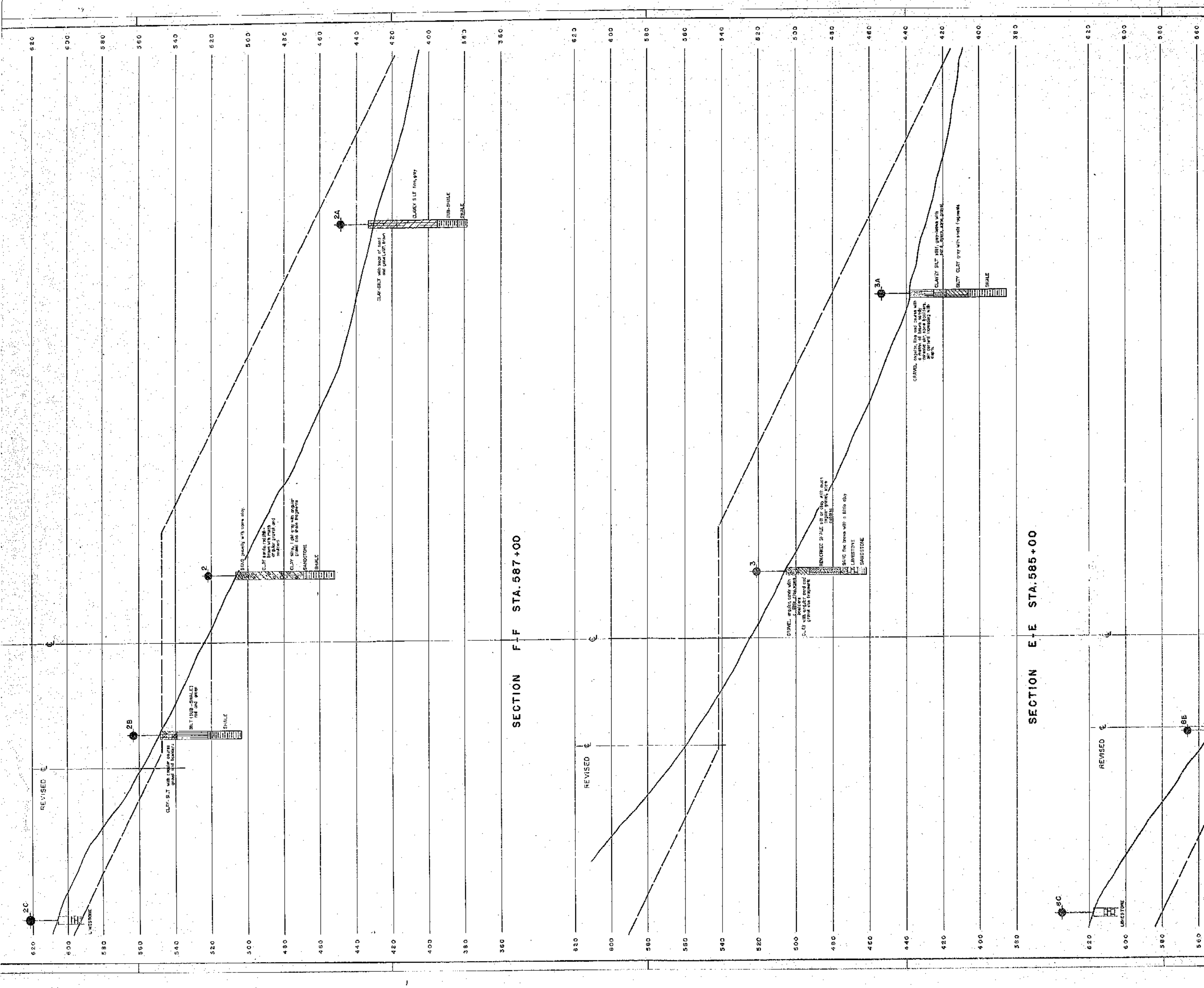
SOME DEFECTS IN NEGATIVE DUE TO CONDITION OF ORIGINAL DOCUMENTS



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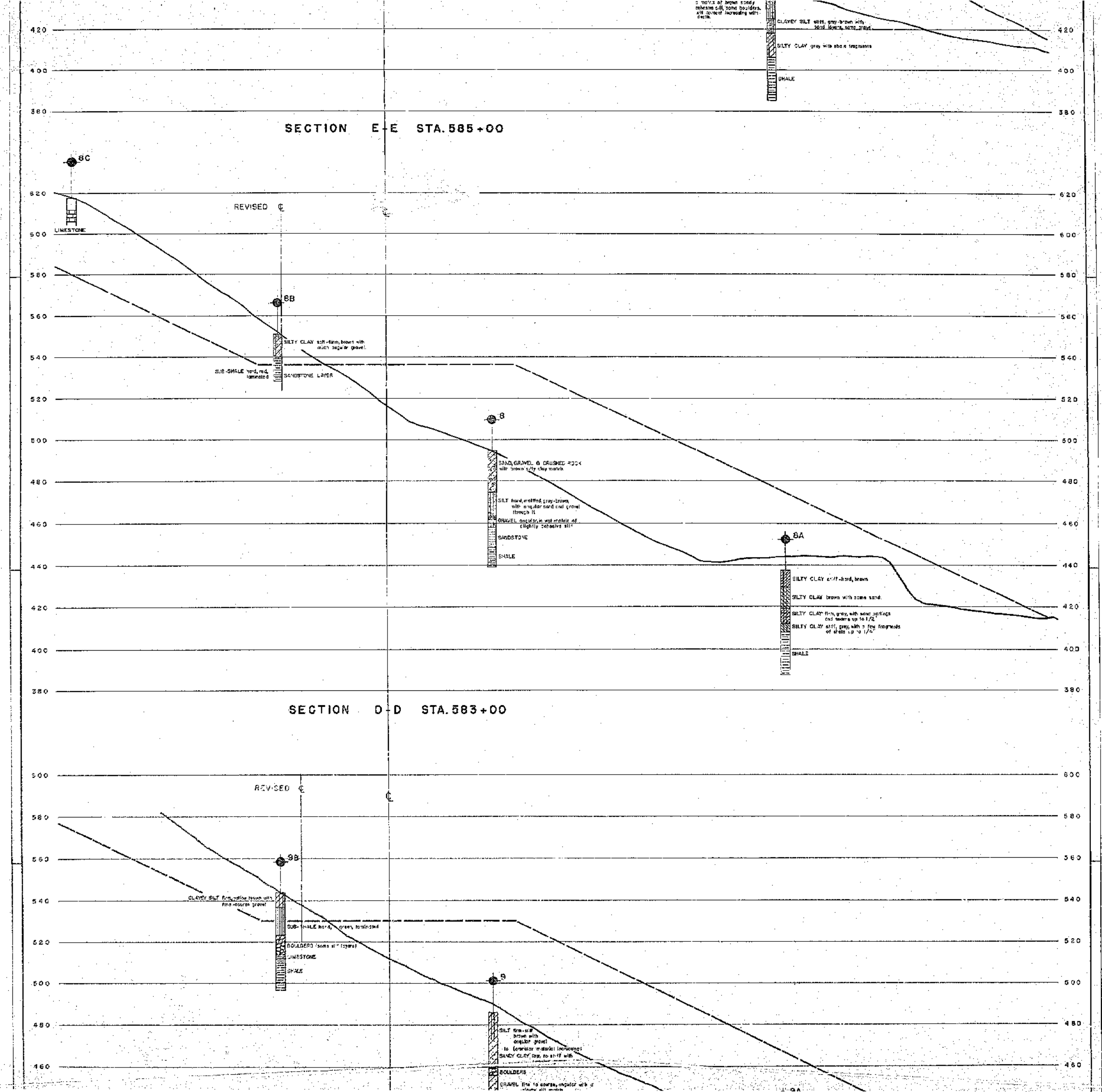
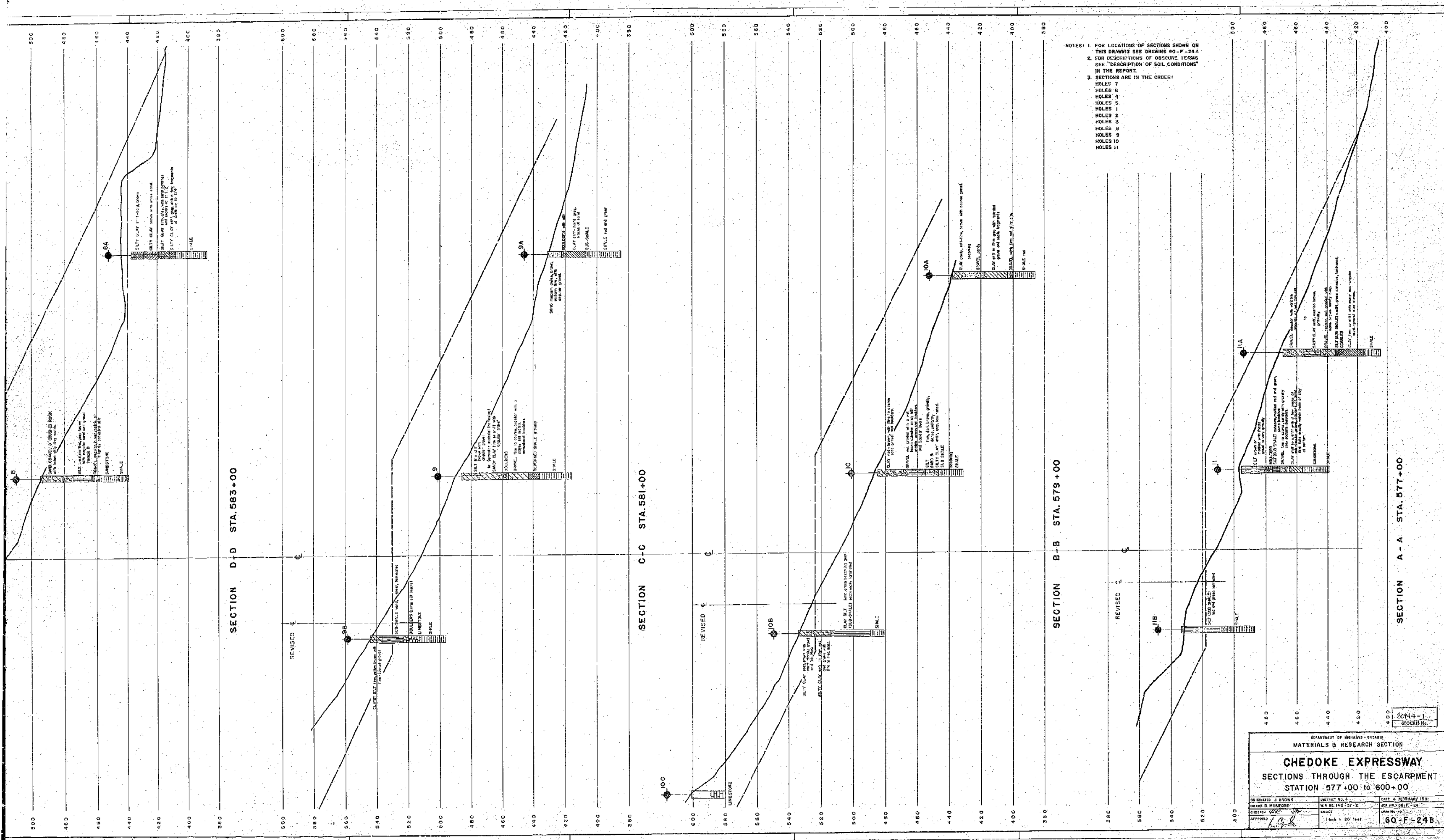
TO CONDITION OF ORIGINAL DOCUMENTS


SECTION E-E STA. 585+00
REVISED ℄
LIMESTONE
SILTY CLAY soft-firm, brown with much angular gravel.
SUB-SHALE hard, red, laminated
SANDSTONE LAYER
SAND, GRAVEL & CRUSHED ROCK with brown silty clay matrix
SANDSTONE
SHALE
SILTY CLAY stiff-hard, brown
SILTY CLAY brown with some sand.
CLAYEY SILT stiff, grey-brown with sand layers, some gravel
SILTY CLAY grey with shale fragments
SECTION D-D STA. 583+00
REVISED ℄
SUB-SHALE hard, green, laminated
BOULDERS (some silt layers)
LIMESTONE
BOULDERS
8C
8B
8
8A
9B
9

3



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