

Mr. A. M. Toye,  
Bridge Engineer.

Materials & Research Section.

August 31, 1960.

FOUNDATION INVESTIGATION REPORT

by: H. G. Acres & Company, Limited.

Attention: Mr. S. McCombie.

Re: Proposed Crossing Hwy. 401 & Summerstown Rd.,  
Twp. of Charlottenberg -- Bridge No. 7,  
W.P. 13-57 -- District 9.

100-57

The foundation report prepared by H. G. Acres & Co., Ltd., for the above site has been reviewed by the Foundation Section. The conclusions presented in this report are for your convenience, summarized as follows:-

- 1) The site is underlain by a layer of medium stiff marine clay, followed by a medium dense stoney till to shale bedrock.
- 2) The layer of medium stiff marine clay is of insufficient strength for economical design of spread footings; thus a piled foundation is recommended.
- 3) The approach embankments for the structure may be constructed according to normal B.H.C. practices. If possible, the approach fills should be placed prior to the construction of the structure by settlement of the fill, will be eliminated.

cont'd. /2 ...

- 4) Settlements of the structure supported by piles driven to bedrock, will be negligible. Some settlement of the approach fills should be expected; however, this is not considered to be a serious problem since the long length of time required for this settlement will make the maintenance of the approaches no different from the average structure.
- 5) Ground water was encountered approximately 3 feet below ground surface. No problems should be encountered due to this water since the impermeable nature of the marine clay will prevent entrance into normal excavations.

If we can be of further assistance in connection with this foundation investigation, please contact the Foundation Section.

L. C. Soderman,  
PRINCIPAL FOUNDATIONS ENGR.  
Per:



(K. Peaker,  
FIELD SUPERVISING FOUNDATION ENGR.)

KP/MdeF.  
Attach.

cc: Messrs. A. M. Teye (2)  
R. A. Tregaskes  
D. C. Ramsay  
J. Ford  
L. E. Walker  
J. E. Gruspler  
A. Watt  
Foundations Office  
Gen. Files ✓

ONTARIO DEPARTMENT OF HIGHWAYS  
Toronto, Ontario

REPORT  
on  
FOUNDATION INVESTIGATION

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PROPOSED CROSSING  
HIGHWAY NO. 401 AND SUMMERSTOWN ROAD  
TOWNSHIP OF CHARLOTTENBURG, DISTRICT NO. 9  
BRIDGE NO. 7, WP 134-57

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*WP 134-57*

H.G. ACRES & COMPANY LIMITED  
Consulting Engineers  
Niagara Falls, Canada

August, 1960

ONTARIO DEPARTMENT OF HIGHWAYS  
Toronto, Ontario

REPORT  
on  
FOUNDATION INVESTIGATION

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PROPOSED CROSSING  
HIGHWAY NO. 401 AND SUMMERSTOWN ROAD  
TOWNSHIP OF CHARLOTTENBURG, DISTRICT NO. 9  
BRIDGE NO. 7, WP 134-57

106-58

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ONTARIO DEPARTMENT OF HIGHWAYS  
Toronto, Ontario

REPORT  
on  
FOUNDATION INVESTIGATION

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PROPOSED CROSSING  
HIGHWAY NO. 401 AND SUMMERSTOWN ROAD  
TOWNSHIP OF CHARLOTTENBURG, DISTRICT NO. 9  
BRIDGE NO. 7, WP 134-57

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Introduction

Present plans of the Ontario Department of Highways include an overpass structure to carry Summerstown Road over Highway No. 401. At the request of the Department, soil explorations were carried out by H.G. Acres & Company Limited to determine the foundation conditions for the overpass structure and for the approach embankments. The F.E. Johnston Drilling Company Limited was retained to perform the soil drilling and field sampling under the supervision of Mr. P.J. Jorgensen and Mr. J.A. MacLeod of H.G. Acres & Company Limited. Field work commenced on June 14, and was completed on June 27, 1960.

### Exploratory Work

The exploratory work consisted of drilling and sampling nine holes, Nos. 888-1 to 888-9 inclusive, the locations of which are shown on Plate I. Two diamond drills were used for the explorations, and the holes were supported by BX casing. Samples of clay were obtained by the use of 2-inch diameter thin-walled tubes and vane tests were performed to measure the in situ shear strengths of the clay. Samples of sandy soil were obtained with a 2-inch diameter split-spoon sampler. Bedrock was proved by diamond drilling in holes Nos. 888-3, 888-4 and 888-6, and AXT size core was recovered.

The program of work is outlined in Appendix A and the drilling reports are given on Plates II to X inclusive.

### Site Conditions and Soil Properties

The site is located in a fertile plain, eight miles northeast of Cornwall, Ontario. This area has been extensively glaciated and subsequently inundated by the Champlain Sea, with the result that most of the surface soils in the area are marine clays. The proposed location of Highway No. 401 at Summerstown

Station follows a strip of land between two moraines, the most southerly of which outcrops along Summerstown Road approximately 250 feet southeast of Highway No. 401. The marine clay has a maximum thickness of 22 feet and was found in all places to overlie till. Bedrock, consisting of a dark calcareous shale, was encountered in three holes at depths of 27 to 30 feet below the ground surface.

The materials which were encountered in the exploratory holes are described in the attached drilling reports, Plates II to X inclusive, and the soil stratigraphy is shown on Plate I.

(a) - Clay - The elevation of the surface of the clay is approximately 168 feet. The clay is quite variable; the liquid limit ranges between 50 and 80 per cent, and the plastic limit ranges between 20 and 30 per cent. The liquidity index of the few samples tested lies between 0.9 and 1.7, the lower values representing samples near the ground surface, and the higher values representing samples near the bottom of the clay deposit.

The natural shear strength of the clay was also found to be quite variable due, possibly, to the heterogeneity of the clay, to sample disturbance, and

to chemical weathering. The natural shear strength varied from 0.28 to 0.99 tons per square foot, the average value being approximately 0.45 tons per square foot. The sensitivity of the clay determined from laboratory tests is generally greater than 10.

The results of the vane tests and the laboratory tests are summarized in Appendixes B and C respectively, and these data are presented graphically on Plate XII.

The result of one consolidation test is shown on Plate XI, and it is compared on Plate XII with three consolidation tests on samples from the nearby site of project WP 138-57. The apparent maximum consolidation pressure to which the sample has been previously subjected has been estimated and, as shown on Plate XIII, it would seem that most of the clay deposit is over-consolidated. This is also implied by a comparison of the high natural shear strengths and the shear strength of a normally consolidated clay having an  $\frac{Su}{p}$  ratio equal 0.30, as shown on Plate XIII. The value of the coefficient of consolidation,  $c_v$ , for the stress range in which the clay will be acting was found to be 1.0 square feet per year.



(b) - Till - A stratum of granular till containing large boulders lies beneath the clay and immediately above bedrock. As shown on Plate I this till increases in thickness from 8 feet, at a distance 150 feet northwest of the centreline of Highway No. 401, to 20 feet, at a distance 150 feet southeast of the centreline of Highway No. 401. The till exists in a medium dense condition as indicated by the fact that the lowest number of blows in a standard penetration test was 15 and the average number was 25 blows; the values varied considerably due to the gravel and boulder content of the till.

(c) - Bedrock - Bedrock was cored in three holes and was found to be a dark calcareous shale of the Rockcliffe formation. Core recovery was good, and the bedrock surface appears to be relatively level, as shown on Plate I.

(d) - Groundwater Conditions - Groundwater levels were measured in holes Nos. 888-1, 888-4 and 888-8 which were all extended into the granular till. The groundwater rose in these holes to within 0.3 and 3.0 feet of the ground surface. It can be seen from Plate I that these water levels are consistent with the elevation of water in the creek which flows under

Summerstown Road near the location of hole No. 888-2. It is assumed that the water pressures in the clay correspond to the groundwater surface determined from pressure measurements in the till.

### Design Considerations

#### (a) - Bearing Capacity

Embankment - The cross section of the embankment which has been considered is shown on Plate XIV. Its stability was checked for the condition where the depth of clay below the embankment is 23 feet, which was the greatest depth of clay found at the site. The assumption was made that the embankment fill acts only as a surface load and has zero shear strength. This is accepted practice when dealing with embankments on very sensitive soils. The average shear stresses developed along circular-arc failure surfaces were determined and the results of these calculations are given on Plate XIV. The maximum average shear stress was found to be approximately 500 pounds per square foot, and this was developed along a deep failure surface which is tangential to the underlying dense till. The average shear strength of the subsoil is 900 pounds per square foot and, therefore, there is

- 7 -

a safety factor of 1.8 against ultimate failure. This value is adequate and represents conditions where the clay deposit is thickest. Therefore, the approach embankments can be built safely without the use of berms.

Bridge Piers - The average natural shear strength of the upper 15 feet of the foundation soil is approximately 0.60 tons per square foot. Using a safety factor of 2.5 against shear failure, the allowable net pressure which could be transferred to the soil at the base of a footing is approximately 1.45 tons per square foot. Assuming a maximum bridge pier load of 50 tons per foot length of pier, the required footing to support this load would have to be 35 feet wide. As this is an impractical width, the use of bearing piles driven into the till below the clay or driven to the bedrock surface is recommended. Piles of small displacement, such as steel H sections would be preferable in order to reduce the amount of disturbance to the clay.

(b) - Settlement - The settlement of the end piers of the bridge and the embankment will be primarily governed by the embankment loading. The loading conditions which have been assumed are shown

on Plate XV. The consolidation characteristics of the clay are given on Plates XI and XII. The average value of apparent modulus of elasticity which has been used to predict immediate settlements is 100 tons per square foot. The predicted settlements are listed on Plate XV and it can be seen that these values are extremely high, considering the relatively shallow thickness of clay involved. These settlements were calculated by using currently accepted analytical and laboratory methods, but we believe that they are somewhat higher than will be experienced. However, as we have no reason to doubt these values on the basis of our own experience, or the experience of others, they have been included in this report. It has been estimated that 50 per cent of the consolidation settlement will take place within 10 years after construction.

#### Conclusions

(a) - On the basis of the drilling work which has been done at the site, the general soil profile consists of sensitive clay which overlies granular till which, in turn, overlies a shale bedrock. The clay achieves a maximum thickness of 23 feet. The groundwater level was found approximately 3 feet below the ground surface.

(b) - The clay is apparently overconsolidated, but extremely compressible because of its sensitive nature. Its average natural undrained shear strength is approximately 900 pounds per square foot, although there exists a somewhat stiffer surface crust.

(c) - The stability of the approach embankments has been considered assuming a height of 24 feet, a crest width of 50 feet, and side slopes of 2 to 1. The safety factor of this section was found to be 1.8. The shear strength of the embankment fill and the added strength of the surface crust were both ignored in these calculations.

(d) - Relatively large settlements below the embankment fills have been estimated, and these range from 0.6 feet below the south end of the bridge to 1.3 feet below the north end of the bridge. Fifty per cent of the ultimate consolidation settlement will take place within approximately 10 years after construction.

(e) - The allowable net bearing pressures which could be used for spread footings is 1.45 tons per square foot.

### Recommendations

(a) - The embankment fills can be built to full height without the use of stabilizing berms.

(b) - The allowable net bearing pressure which can be used for spread footing design on the clay is 1.45 tons per square foot, which for normal bridge pier loads would dictate the use of excessively large footings. The most reasonable alternative design would involve supporting the interior piers on bearing piles which could be driven into the till or to bedrock.

(c) - Foundation shear strains are inevitable when embankment loads of this magnitude are placed on relatively soft soils. We recommend, therefore, that the embankment be built before the bridge structure to prevent the bridge piers from being subjected to these shear strains. We also recommend that piles be used to support the interior bridge piers, and that these piles be of a high capacity, low displacement type such as steel H sections, in order that the foundation soils will be disturbed as little as possible during their driving.

## APPENDIX A

### Program of Work

- June 14, 1960 - Diamond drills arrived at site. Holes Nos. 888-1, 888-2 and 888-3 were commenced. Hole No. 888-2 was completed to a depth of 13 feet.
- June 15, 1960 - Holes Nos. 888-1 and 888-3 were completed to depths of 30 and 39 feet respectively. Hole No. 888-4 was started.
- June 16, 1960 - Holes Nos. 888-5 and 888-6 were started. Hole No. 888-5 was completed to a depth of 23 feet.
- June 17, 1960 - Hole No. 888-7 was started. Holes Nos. 888-4 and 888-7 were completed to depths of 39 and 12 feet respectively.
- June 18, 1960 - Hole No. 888-6 was completed to a depth of 41 feet.
- June 27, 1960 - Holes Nos. 888-8 and 888-9 were started and completed to depths of 24 and 21 feet respectively.

### Summary of Time

Work Type	No. of Holes	Total Length (Feet)	Total Time (Machine-Days)
Soil and rock drilling and sampling	9	240	10

APPENDIX BSummary of Field Vane Test Results

Hole No.	Elevation (Feet)	Undrained Shear Strength		Sensitivity
		Natural	Remoulded	
888-3	159.9	0.93	0.16	5.8
888-4	157.4	0.55	0.12	4.8
	153.7	0.65	0.09	7.0
888-5	159.5	0.99	0.12	8.5
888-6	158.7	0.55	0.08	7.3
888-8	160.0	0.93	0.17	5.6
	155.5	0.42	0.07	5.6
	151.5	0.82	0.11	7.4
	147.7	0.58	0.07	8.9
888-9	159.5	0.76	0.15	5.1
	155.5	0.29	0.11	2.6
	150.5	0.47	0.05	9.2



APPENDIX CSummary of Laboratory Tests

Hole No.	Sample No.	Elevation Feet	Water Content %	Liquid Limit %	Plastic Limit %	Su <sub>n</sub> Tsf	e <sub>f</sub> %	Su <sub>r</sub> Tsf	St
888-4	1	162.7	27.6	59.8	21.0	0.50	20	0.22	2.4
	3	156.3	84.0	80.2	29.7	0.38	2.5	0.03	>10
	4	152.2	73.5	51.6	21.1	0.28	4.0	0.01	>20
888-5	1	162.0	55.7	59.2	21.5	0.65	3.0	0.08	8.2
888-6	1	161.0	71.3	71.7	26.8	0.57	3.5	0.05	>10

Su<sub>n</sub> - Natural undrained shear strength

Su<sub>r</sub> - Remoulded undrained shear strength

e<sub>f</sub> - Failure strain

St - Sensitivity

APPENDIX D

List of Plates

- Plate I - Exploratory Holes, Plan and Section
- Plate II - Drilling Report, Hole No. 888-1
- Plate III - Drilling Report, Hole No. 888-2
- Plate IV - Drilling Report, Hole No. 888-3
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- Plate XIII - Summary of Drilling and Test Results  
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- Plate XIV - Summary of Stability Analyses
- Plate XV - Foundation Settlements due to  
Embankment Loads

# DRILLING REPORT

CLIENT Ontario Department of Highways JOB No. 888  
 PROJECT WP 134-57 HOLE No. 888-1  
 SITE Highway 401, Summerstown Road, Ontario. SHEET No. 1 OF 1

CONTRACTOR: F.E. Johnston Drilling Company Limited STARTED 9.00 A.M. June 14, 1960  
 FINISHED 12.00 A.M. June 15, 1960

METHOD SOIL Modified Wash Boring CASING DIAM. BX  
 OF  
 DRILLING: ROCK CORE DIAM.

LOCATION: LATITUDE OH 270+46 ELEVATIONS: DATUM G.S.C.  
 DEPARTURE 242 Feet right DRILL PLATFORM  
 BEARING GROUND SURFACE 171.0  
 INITIAL DIP 90 degrees ROCK SURFACE  
 OTHER DIPS BOTTOM OF HOLE 141.0  
 WATER TABLE 167.2

DEPTH	SOIL TYPE	DESCRIPTION: COLOUR, CONSISTENCY, STRUCTURE, WATER CONTENT, PLASTICITY, COMPACTNESS, WATER LOSS OR GAIN, ETC.	SAMPLE					PENETRATION TEST
			NO.	TYPE *	SIZE	DEPTH	RET'D	
Feet					Inches	Feet	Inches	Blows
0.0	Till	Light brown, containing many stones and some clay						
4.0	Till	Grey-blue, containing many angular stones and some clay, dense		AZ	2	5.0		
						5.5		14
						6.0		13
						6.5	5	13
			1	AQ	2	9.0		
						9.5		7
						10.0		12
						10.5	7	13
				AZ	2	13.0		
						13.5		12
						14.0		15
						14.5	9	17
16.0	Till	Grey-blue, containing a few angular stones and some clay	2	AQ	2	17.5		
						18.0		18
						18.5		14
						19.0	9	11
21.0	Till	Grey, containing many stones and boulders		AZ	2	21.0		
						21.4	0	50
30.0		End of hole						

SAMPLING METHOD

\* A — SPLIT TUBE  
 B — THIN WALL TUBE  
 C — PISTON SAMPLER  
 D — CORE BARREL

E — AUGER  
 F — WASH

SHIPPING CONTAINER

M — INSERT  
 O — TUBE  
 P — WATER CONTENT TIN  
 Q — GLASS JAR

R — CLOTH BAG  
 S — PLIOFILM BAG  
 Z — DISCARDED

INSPECTOR P. Jorgensen  
 LOGGED BY P. Jorgensen

APPROVED *D. H. MacDonald*  
 DATE July, 1960

# DRILLING REPORT

CLIENT Ontario Department of Highways

JOB No. 888

PROJECT WP 134-57

HOLE No. 888-2

SITE Highway 401, Summerstown Road, Ontario.

SHEET No. 1 OF 1

CONTRACTOR: F.E. Johnston Drilling  
 Company Limited

STARTED 10.45 A.M. June 14, 1960  
 FINISHED 3.30 P.M. June 14, 1960

METHOD OF DRILLING: SOIL Modified Wash Boring  
 ROCK

CASING DIAM. BX  
 CORE DIAM. G.S.C.

LOCATION: LATITUDE CH 270+57  
 DEPARTURE 159 Feet right  
 BEARING  
 INITIAL DIP 90 degrees  
 OTHER DIPS

ELEVATIONS: DATUM  
 DRILL PLATFORM  
 GROUND SURFACE 169.4  
 ROCK SURFACE  
 BOTTOM OF HOLE 156.4  
 WATER TABLE

DEPTH	SOIL TYPE	DESCRIPTION: COLOUR, CONSISTENCY, STRUCTURE, WATER CONTENT, PLASTICITY, COMPACTNESS, WATER LOSS OR GAIN, ETC.	S A M P L E					PENETRATION TEST
			NO.	TYPE*	SIZE	DEPTH	RETD.	
Feet					Inches	Feet	Inches	Blows*
0	Sandy Gravel	Grey-blue, containing some clay, wet						
5.5	Clay	Grey-blue, soft.	1	AQ	2	5.5		
						6.0		4
						6.5		1
						7.0		2
9.5	Till	Grey-blue, containing many angular pebbles and some clay		AZ	2	9.5		
						10.0		10
						10.5		8
						11.0		9
13.0		Hole stopped on suspected boulder.	2	Q	BX	13.0		
		*Penetration test: This is the number of blows of a 140-pound weight falling 30 inches required to advance the sampler to depth indicated						

SAMPLING METHOD

\* A — SPLIT TUBE  
 B — THIN WALL TUBE  
 C — PISTON SAMPLER  
 D — CORE BARREL

E — AUGER  
 F — WASH

SHIPPING CONTAINER

N — INSERT  
 O — TUBE  
 P — WATER CONTENT TIN  
 Q — GLASS JAR

X — TEST BAG  
 S — FROTH W. BAG  
 Z — DISCARDED

INSPECTOR J. Bateson

LOGGED BY P. Jorgensen

APPROVED

DATE

July, 1960

# DRILLING REPORT

CLIENT Ontario Department of Highways  
 PROJECT WP 134-57  
 SITE Highway 401, Summerstown Road, Ontario.

JOB No. 888  
 HOLE No. 888-3  
 SHEET No. 1 OF 1

CONTRACTOR: F.L. Johnston Drilling Company Limited  
 METHOD OF DRILLING: SOIL Modified Wash Boring  
 ROCK Diamond Drill  
 LOCATION: LATITUDE CH 270+54  
 DEPARTURE 143 Feet right  
 BEARING  
 INITIAL DIP 90 degrees  
 OTHER DIPS  
 STARTED 4.15 P.M. June 14, 1960  
 FINISHED 5.00 P.M. June 15, 1960  
 CASING DIAM.  
 CORE DIAM. AXT  
 ELEVATIONS: DATUM G.S.C.  
 DRILL PLATFORM  
 GROUND SURFACE 170.4  
 ROCK SURFACE  
 BOTTOM OF HOLE 131.9  
 WATER TABLE

DEPTH	SOIL TYPE	DESCRIPTION COLOUR CONSISTENCY STRUCTURE, WATER CONTENT, PLASTICITY, COMPACTNESS, WATER LOSS OR GAIN, ETC.	S.A.M. 1 - E					PENETRATION TEST	
			NO.	TYPE	SIZE	DEPTH	TESTED	See Plate II	
Feet					Inches	Feet	Inches	Blows	
0	Sandy Silt	Brown, loose							
5.0	Clay	Brown, weathered							
7.5	Clay	Grey-blue, soft.	1	AQ	2	7.5 9.0		4	
10.5	Till	Grey, very sandy, containing many angular pebbles and stones and some clay, wet medium dense.	2	AQ	2	10.5 11.0 11.5 11.8		3 6 9	
			3	AQ	2	19.5 20.0 20.5 21.0	4	15 16 20	
30.5	Bedrock	Dark, calcareous shale 5.0' of core recovered.							
38.5		End of hole							

SAMPLING METHOD

A - SPIRE TUBE  
 B - THIN WALL TUBE  
 C - PISTON SAMPLER  
 D - CORE BARREL

E - AUGER  
 F - WASH

SHIPPING CONTAINER

M - INSERT  
 O - TUBE  
 P - WATER CONTAINER  
 Q - GLASS JAR

R - CLOTH BAG  
 S - PULPIT BAG  
 T - DISCARDED

INSPECTOR J. Bateson  
 LOGGED BY P. Jorgensen

APPROVED

*D. H. MacDonald*

DATE

July, 1960

# DRILLING REPORT

CLIENT Ontario Department of Highways

JOB No. 888

PROJECT WP 134-57

HOLE No. 888-4

SITE Highway 401, Summerstown Road, Ontario.

SHEET No. 1 OF 2

CONTRACTOR: F.E. Johnston Drilling  
Company Limited

STARTED 1.00 P.M. June 15, 1960

FINISHED 12.00 A.M. June 17, 1960

METHOD OF SOIL Modified Wash Boring

CASING DIAM. BX

DRILLING: ROCK Diamond Drill

CORE DIAM. AXT

LOCATION: LATITUDE CH 270+85  
DEPARTURE 159 Feet left

ELEVATIONS: DATUM G.S.C.

BEARING DRILL PLATFORM

INITIAL DIP 90 degrees GROUND SURFACE 168.2

OTHER DIPS ROCK SURFACE

BOTTOM OF HOLE 129.7

WATER TABLE

DEPTH Feet	SOIL TYPE	DESCRIPTION, COLOUR, CONSISTENCY, STRUCTURE, WATER CONTENT, PLASTICITY, COMPACTNESS, WATER LOSS OR GAIN, ETC.	SAMPLE					PENETRATION TEST See Plate III
			NO.	TYPE	SIZE Inches	DEPTH Feet	RETD Inches	
0.0	Silt	Grey-light brown, containing some clay						Blows
4.0	Clay	Grey, sandy and silty	1	BO	2	5.0 6.0	12	Pushed
7.0	Clay	Grey-blue, containing a few angular pebbles.	2	BO	2	7.0 9.0	24	Pushed
				Vane test		10.8		
			3	BO	2	11.0 12.7	24	Pushed
				Vane test		14.5		
			4	BO	2	15.0 17.0	21	Pushed
18.0	Till	Grey, sandy, containing many angular pebbles and stones	5	AQ	2	19.0 19.5 20.0 20.5		10 13 15

## SAMPLING METHOD

- A - SPLIT TUBE
- B - THIN WALL TUBE
- C - PISTON SAMPLER
- D - CORE BARREL

- E - AUGER
- F - WASH

## SHIPPING CONTAINER

- M - INSERT
- O - TUBE
- P - WATER CONTENT TIN
- Q - GLASS JAR

- R - CLOTH BAG
- S - PLIUM BAG
- T - DISCARDED

INSPECTOR P. Jorgensen

LOGGED BY P. Jorgensen

APPROVED

D. H. MacDonald

DATE

July, 1960

# DRILLING REPORT

JOB No. 888

HOLE No. 8884

SHEET No. 2 OF 2

~~SK-386-16-6B~~

## DRILLING REPORT

CLIENT Ontario Department of Highways

JOB No. 888

PROJECT WP 134-57

HOLE No. 888-5

SITE Highway 401, Summerstown Road, Ontario

SHEET No. 1 OF 1

CONTRACTOR: F.A. Johnston Drilling  
Company Limited

STARTED 9.00 A.M. June 16, 19 60

FINISHED 3.15 P.M. June 16, 19 60

METHOD SOIL Modified Wash Boring

CASING DIAM. BX

OF  
DRILLING: ROCK

CORE DIAM.

LOCATION LATITUDE CH 27C+81 ELEVATIONS. DATUM G.S.C.  
DEPARTURE 76 Feet left  
BEARING  
INITIAL DIP 90 degrees  
OTHER DIPSDRILL PLATFORM  
GROUND SURFACE 168.0  
ROCK SURFACE  
BOTTOM OF HOLE 145.0  
WATER TABLE

DEPTH	SOIL TYPE	PENETRATION, COLOUR, CONSISTENCY, STRUCTURE, WATER CONTENT, PLASTICITY, LIQUIDITY, FACTNESS, WATER LOSS OR GAIN, ETC.	S A M P L E					PENETRATION TEST See Plate III
			NO.	TYPE	SIZE	DEPTH	RET. D.	
Feet					Inches	Feet	Inches	Blows
0.	Clay	Grey-brown, weathered, stiff						
5.0	Clay	Grey-blue, stiff	1	BO	2	5.0		
						7.0	18	Pushed
				Vane test		8.5		
			2	BO	2	10.5		
						12.0	18	Pushed
18.0	Sandy Till							
18.5	Boulder							
22.5	Gravel	Water loss.						
23.0		End of hole						
SAMPLING METHOD			SHIPPING CONTAINER					
A - SPIGOT TUBE			N - INSERT					
B - THIN WALL TUBE			C - TUBE					
C - PISTON SAMPLER			D - WATER CONTENT CAN					
D - CORE BARREL			E - GLASS JAR					
			F - CLOTH BAG					
			G - PLASTIC BAG					
			H - THECARDED					
</								



# DRILLING REPORT

CLIENT Ontario Department of Highways

JOB No. 888

PROJECT WP 134-57

HOLE No. 888-6

SITE Highway 401, Summerstown Road, Ontario.

SHEET No. 1 OF 1

CONTRACTOR: F.E. Johnston Drilling

STARTED 4.30 P.M. June 16, 1960

Company Limited

FINISHED 1.30 P.M. June 18, 1960

METHOD OF SOIL Modified Wash Boring

CASING DIAM. 8X

DRILLING: ROCK Diamond Drill

CORE DIAM. AXT

LOCATION: LATITUDE CE 270+69

ELEVATIONS: DATUM G.S.C.

DEPARTURE 42 feet right

DRILL PLATFORM

BEARING

GROUND SURFACE 171.7

INITIAL DIP 90 degrees

ROCK SURFACE

OTHER DIPS

BOTTOM OF HOLE 131.1

WATER TABLE

DEPTH	SOIL TYPE	DESCRIPTION COLOUR, CONSISTENCY, STRUCTURE, WATER CONTENT, PLASTICITY, COMPACTNESS, WATER LOSS OR GAIN, ETC.	SAMPLE					PENETRATION TEST
			NO.	TYPE	SIZE	DEPTH	RETD.	
Feet					Inches	Feet	Inches	See Plate VII
0	Gravel	Embankment fill						Blows
10.0	Clay	Gray-blue, medium stiff	1	BO	2	10.0		
						11.5	12	Pushed
					Vane Test	13.0		
14.0	Boulder							
15.5	Sandy Till	Grey, fine to medium, containing many angular pebbles and stones, and some clay, wet.	2	AQ	2	16.0		
						16.5		6
						17.0		7
						17.5	18	8
				AZ	2	20.5		
						21.0	0	37
			3	FQ		26.5		
32.0	Bedrock	Dark, calcareous shale						
40.5		End of hole						

SAMPLING METHOD

A - SPIGOT TUBE  
 B - THIN WALL TUBE  
 C - PISTON SAMPLER  
 D - CORE BARREL

E - AUGER  
 F - WASH

SHIPPING CONTAINER

N - INSERT  
 O - TUBE  
 P - WATER CONTENT TIN  
 Q - GLASS JAR

R - CLOTH BAG  
 S - PLENUM BAG  
 T - DISCARDED

INSPECTOR J. Bateson

LOGGED BY P. Jorgensen

APPROVED

*D. H. MacDonald*

DATE

July, 1960

Plate VII

# DRILLING REPORT

CLIENT Ontario Department of Highways

JOB No. 888

PROJECT WP 134-57

HOLE No. 888-7

SITE Highway 401, Summerstown Road, Ontario

SHEET No. 1 OF 1

CONTRACTOR: F.E. Johnston Drilling

STARTED 1.00 P.M. June 17, 19 60

Company Limited

FINISHED 4.00 P.M. June 17, 19 60

METHOD SOIL Modified Wash Boring

CASING DIAM EX

OF

DRILLING:

ROCK

CORE DIAM

LOCATION: LATITUDE CH 269 + 88

ELEVATIONS: DATUM G.S.C.

DEPARTURE 143 Feet right

DRILL PLATFORM

BEARING

GROUND SURFACE 168.7

INITIAL DIP

ROCK SURFACE

OTHER DIPS

BOTTOM OF HOLE 156.7

WATER TABLE

DEPTH	SOIL TYPE	DESCRIPTION, COLOUR, CONSISTENCY, STRUCTURE, WATER CONTENT, PLASTICITY, COMPACTNESS, WATER LOSS OR GAIN, ETC.	SAMPLE					PENETRATION TEST
			NO	TYPE*	SIZE	DEPTH	RETD	
Feet					Inches	Feet	Inches	Blows
0.0	Silt	Light brown, containing some fine sand and clay						
3.0	Clay	Light brown, stiff, weathered and silty						
5.0	Clay	Grey-blue, medium stiff, containing a few angular pebbles	1	AQ	2	5.0 5.5		4
8.3	Sandy Till	Grey, containing clay and many angular pebbles and stones		AZ	2	8.5 9.0 9.5 10.0		19 13 13
				AZ	2	10.5 11.0 11.5 12.0	7	13 26 17 13
12.0		End of hole						

SAMPLING METHOD

A — SPLIT TUBE  
 B — THIN WALL TUBE  
 C — PISTON SAMPLER  
 D — CORE BARREL

E — AUGER  
 F — WASH

SHIPPING CONTAINER

N — INSERT  
 O — TUBE  
 P — WATER CONTENT TIN  
 Q — GLASS JAR

R — CLOTH BAG  
 S — PLASTIC BAG  
 Z — DISCARDED

INSPECTOR P. Jorgensen

APPROVED

*D. H. MacDonald*

LOGGED BY P. Jorgensen

DATE

July, 1960

Plate VIII

# DRILLING REPORT

CLIENT Ontario Department of Highways

JOB No. 888

PROJECT WP 134-57

HOLE No. 888-9

SITE Highway 401, Summerstown Road, Ontario

SHEET No. 1 OF 1

CONTRACTOR: F.E. Johnston Drilling  
 Company Limited

STARTED 1:30 P.M.

June 27, 1960

FINISHED 4:30 P.M.

June 27, 1960

METHOD SOIL Modified Wash Boring

CASING DIAM. EX

OF  
 DRILLING:

ROCK

CORE DIAM.

ATT

LOCATION: LONGITUDE Ch. 270+09  
 DEPARTURE 83 Feet Left  
 BEARING  
 INITIAL DIP 90 degrees  
 OTHER DIPS

ELEVATIONS: DATUM G.S.C.  
 DRILL PLATFORM  
 GROUND SURFACE 168.0  
 ROCK SURFACE  
 BOTTOM OF HOLE 144.5  
 WATER TABLE

DEPTH	SOIL TYPE	DESCRIPTION, COLOUR, CONSISTENCY, STRUCTURE, WATER CONTENT, PLASTICITY, COMPACTNESS, WATER LOSS OR GAIN, ETC.	SAMPLE					PENETRATION TEST
			NO	TYPE*	SIZE	DEPTH	RET'D	
Feet					Inches	Feet	Inches	Plate III
0	Clay	Brown, silty	1	BO	2	5.0		Blows
						6.5	15	Pushed
5	Clay	Brown to grey		Vane Test		8.0		
9	Clay	Blue, homogeneous	2	BO	2	9.0		Pushed
						10.5	15	
				Vane Test		12.5		
22.3	Sandy Gravel	Dense	3	BO	2	13.0		Pushed
						14.5	15	
23.5	Till	End of hole		Vane Test		16.0		
			4	BO	2	17.0		Pushed
						18.5	15	
				Vane Test		20.3		
			5	BO	2	21.0		Pushed
						22.5	18	

## SAMPLING METHOD

- \* A - SPLIT TUBE
- B - THIN WALL TUBE
- C - PISTON SAMPLER
- D - CORE BARREL

- E - AUGER
- F - WASH

## SHIPPING CONTAINER

- N - INSERT
- O - TUBE
- P - WATER CONTENT TIN
- Q - GLASS JAR

- R - CLOTH BAG
- S - PLOFILM BAG
- T - DISCARDED

INSPECTOR J. Bateson

LOGGED BY J. MacLeod

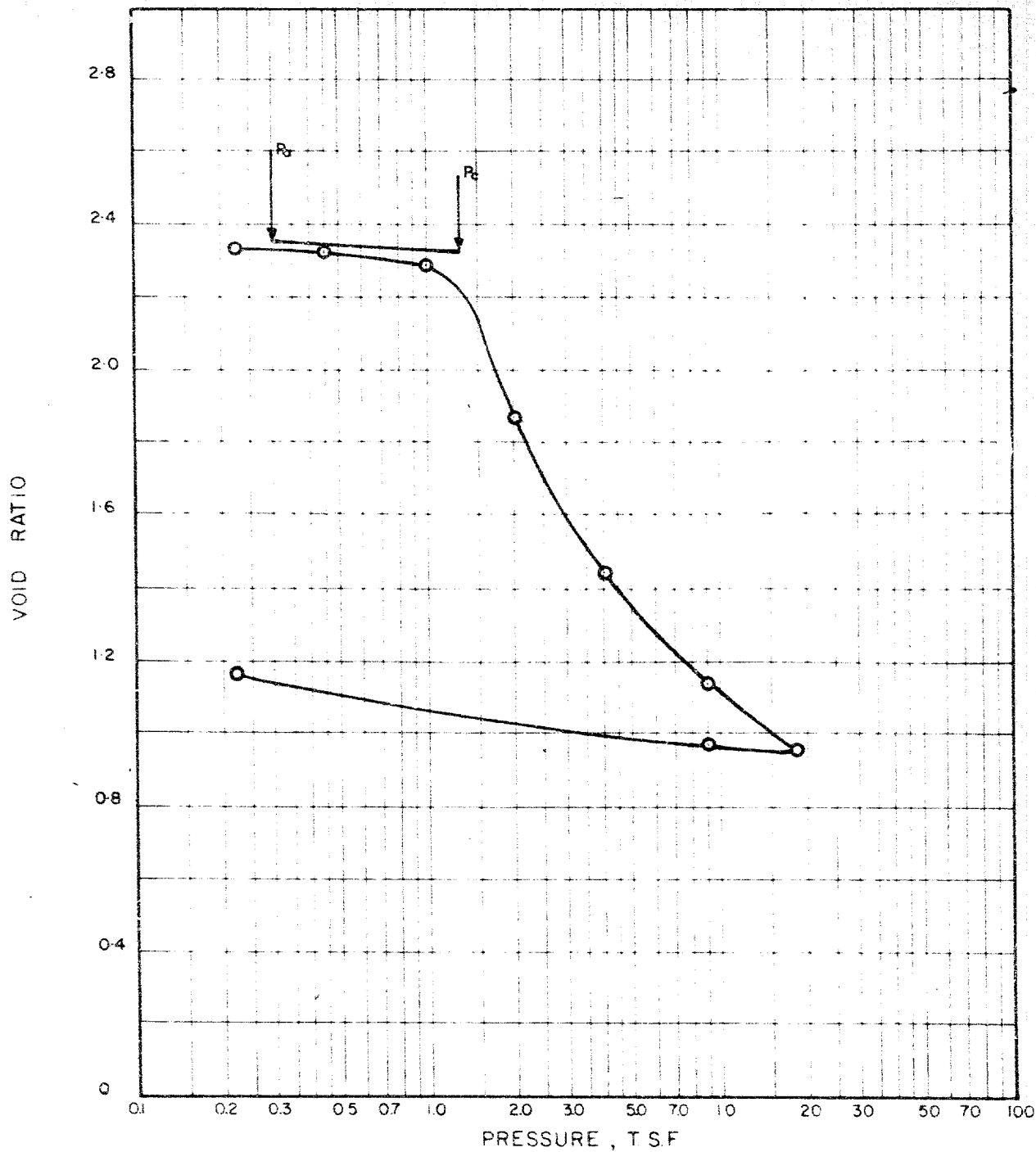
APPROVED

*D. H. MacDonald*

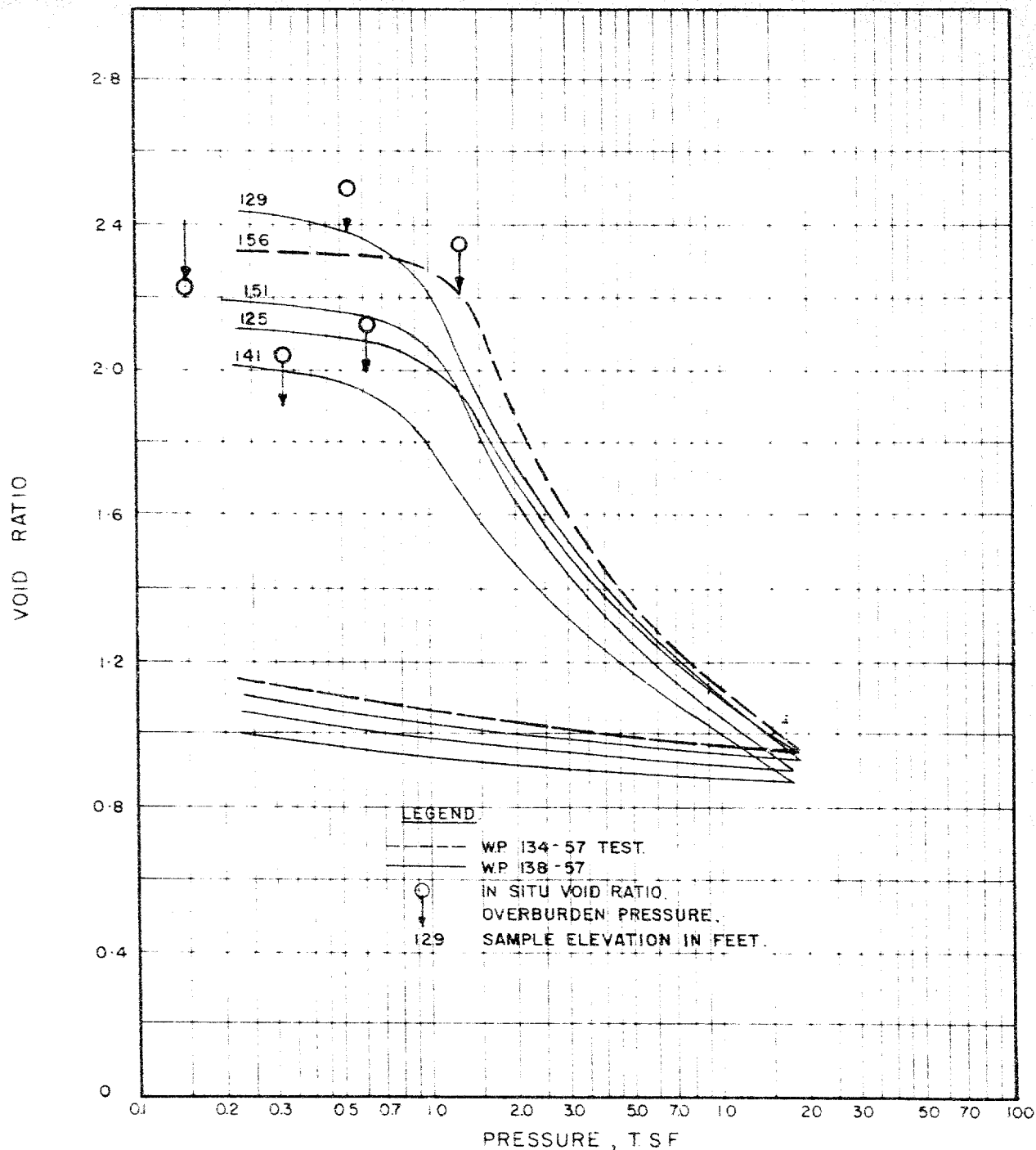
DATE

July, 1960





OVERBURDEN PRESSURE — $P_0 = 0.3$ TSF CONSOLIDATION PRESSURE — $P_c = 1.3$ TSF		NATURAL WATER CONTENT = 87.4% LOADING INTERVAL 24 HRS.			
SAMPLE No 880-80-3 TEST No 880-9-1		TEST DATE JUNE 28, 1960 TESTED BY R.L.			
H. G. ACRES & COMPANY LIMITED CONSULTING ENGINEERS NIAGARA FALLS CANADA		CONSOLIDATION TEST			
ONTARIO DEPARTMENT OF HIGHWAYS		HOLE No. 888-4      SAMPLE ELEV 156'			
WP 134 - 57		<table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 50%; padding: 5px;">           APPROVED  <i>A. H. Macdonald</i>            H.G. ACRES &amp; COMPANY LTD.         </td> <td style="width: 50%; padding: 5px;">           DATE, JULY 1960            JOB No. 888.            PLATE <u>XI</u> </td> </tr> </table>		APPROVED <i>A. H. Macdonald</i> H.G. ACRES & COMPANY LTD.	DATE, JULY 1960 JOB No. 888. PLATE <u>XI</u>
APPROVED <i>A. H. Macdonald</i> H.G. ACRES & COMPANY LTD.	DATE, JULY 1960 JOB No. 888. PLATE <u>XI</u>				



OVERBURDEN PRESSURE —  $P_0$  = \_\_\_\_\_  
 CONSOLIDATION PRESSURE —  $P_c$  = \_\_\_\_\_

NATURAL WATER CONTENT — \_\_\_\_\_  
 LOADING INTERVAL 24 HRS.

SAMPLE No. \_\_\_\_\_  
 TEST No. \_\_\_\_\_

TEST DATE \_\_\_\_\_  
 TESTED BY \_\_\_\_\_

H. G. ACRES & COMPANY LIMITED  
 CONSULTING ENGINEERS  
 NIAGARA FALLS CANADA

ONTARIO DEPARTMENT OF HIGHWAYS

W P 134 - 57

CONSOLIDATION TEST  
 COMPARISON WITH TESTS ON  
 SAMPLES FROM WP 138-57

APPROVED

DATE JULY, 1960

JOB No 888.

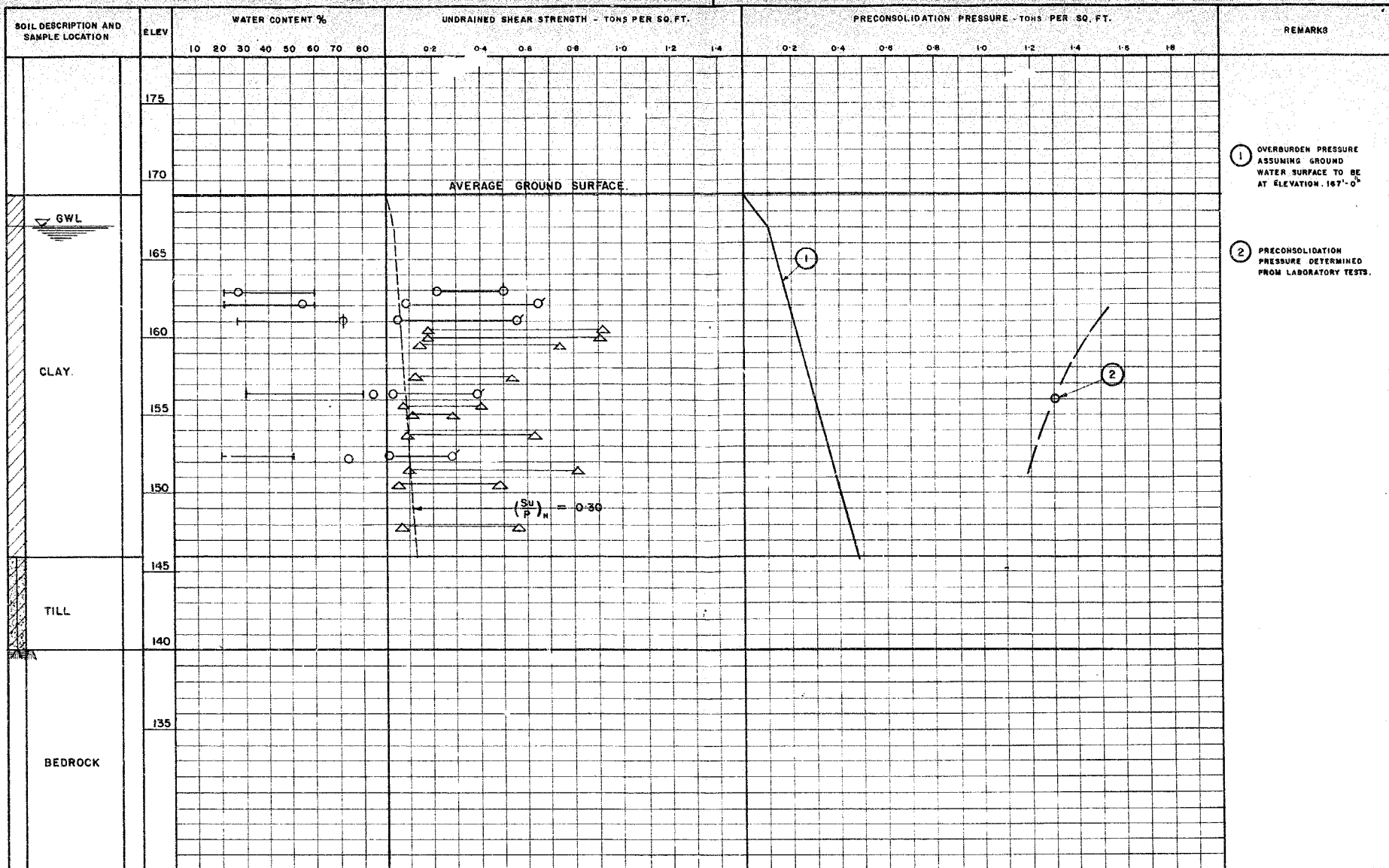
H. G. ACRES & COMPANY LTD.

PLATE XII



NO. 1000  
1000  
1000  
1000  
1000

NO. 1000  
1000  
1000  
1000  
1000



③ SOIL SAMPLE

○ NATURAL WATER CONTENT

— LIQUID LIMIT

— PLASTIC LIMIT

⊙ UNDRAINED COMPRESSION TEST

△ FIELD VANE TEST

— NATURAL STRENGTH

--- REMOULDED STRENGTH

0  
15 — 5  
10  
FAILURE STRAIN

H. G. ACRES & COMPANY LIMITED  
CONSULTING ENGINEERS  
NIAGARA FALLS CANADA

ONTARIO DEPARTMENT OF HIGHWAYS

WP 134-57.

SUMMARY OF DRILLING AND TEST  
RESULTS

COMPARISON OF ALL TESTS.

APPROVED

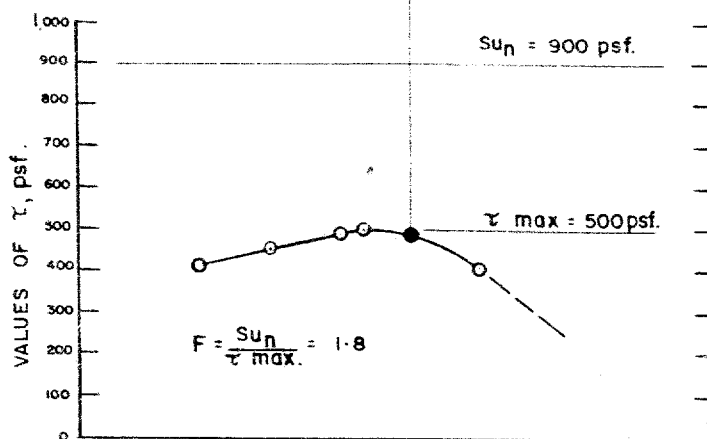
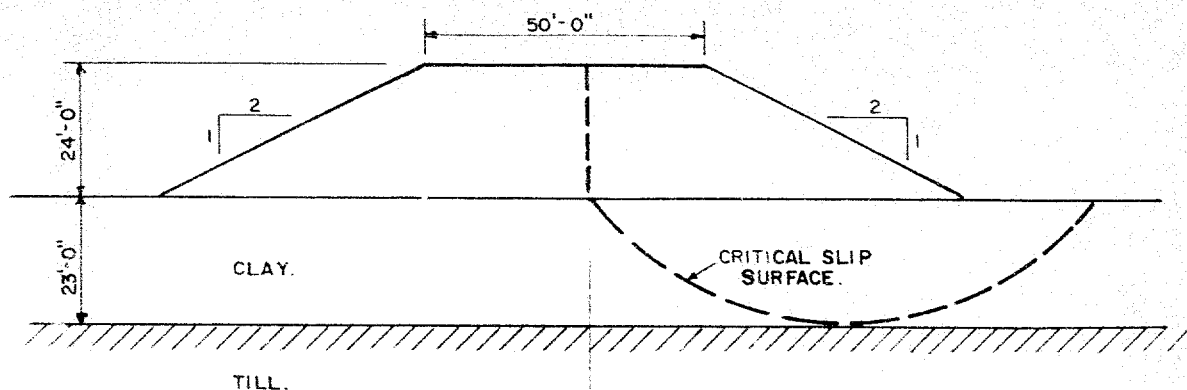
*H. G. Acres*  
H. G. ACRES & COMPANY LIMITED

DATE JULY 1960

JOB No. 883.

PLATE - VIII





$\tau$  DENOTES AVERAGE SHEAR STRESS ALONG SLIP SURFACE.

$Su_n$  DENOTES AVERAGE NATURAL SHEAR STRENGTH OF SUBSOIL.

$F$  DENOTES SAFETY FACTOR

H. G ACRES & COMPANY LIMITED  
CONSULTING ENGINEERS  
NIAGARA FALLS CANADA

ONTARIO DEPARTMENT OF HIGHWAYS

WP 134-57

SUMMARY OF STABILITY ANALYSES.

APPROVED

DATE JULY, 1960

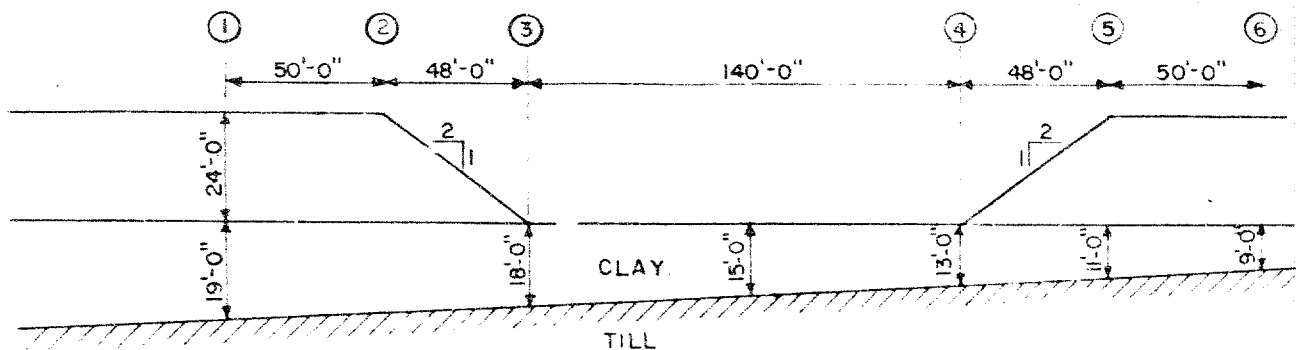
SCALE

JOB No.

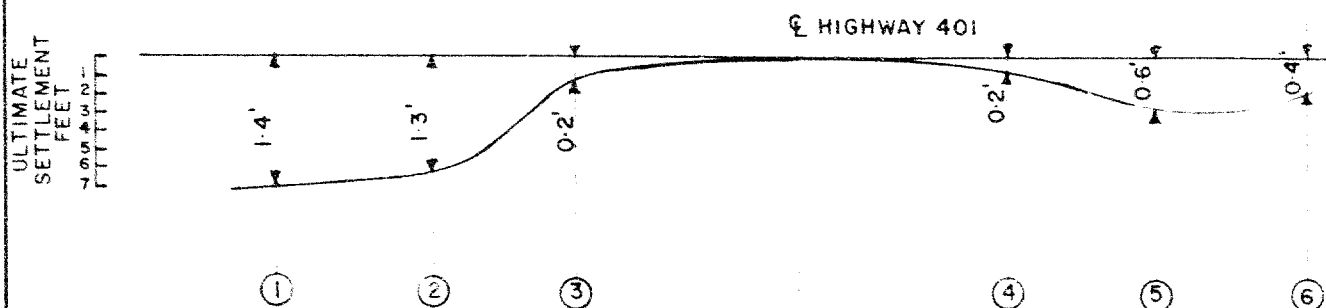
888

H. G. ACRES & COMPANY LIMITED

PLATE - XIV



SECTION ALONG  $\mathcal{C}$  OF SUMMERSTOWN ROAD

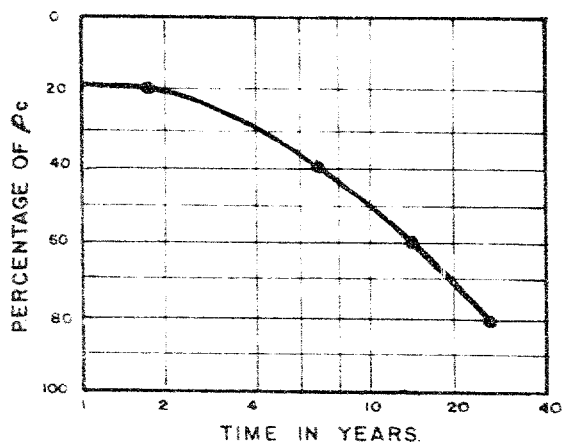


$\rho_i = 0.2$	0.2	0	0	0.1	0.1
$\rho_c = 1.2$	1.1	0.2	0.2	0.5	0.3
$\rho_u = \underline{1.4}$	<u>1.3</u>	<u>0.2</u>	<u>0.2</u>	<u>0.6</u>	<u>0.4</u>

$\rho_i$  = DENOTES ELASTIC SETTLEMENT IN FEET

$\rho_c$  = DENOTES CONSOLIDATION SETTLEMENT IN FEET.

$\rho_u$  = DENOTES ULTIMATE SETTLEMENT IN FEET.



AVERAGE TIME RATE OF SETTLEMENT.

H. G. ACRES & COMPANY LIMITED  
CONSULTING ENGINEERS

NIAGARA FALLS CANADA

ONTARIO DEPARTMENT OF HIGHWAYS

WP 134-57.

FOUNDATION SETTLEMENTS  
DUE TO EMBANKMENT LOAD.

APPROVED

DATE JULY, 1960

*H. G. Acres*  
H. G. ACRES & COMPANY LIMITED

SCALE JOB No.  
888.

PLATE - XV

#60-F-208

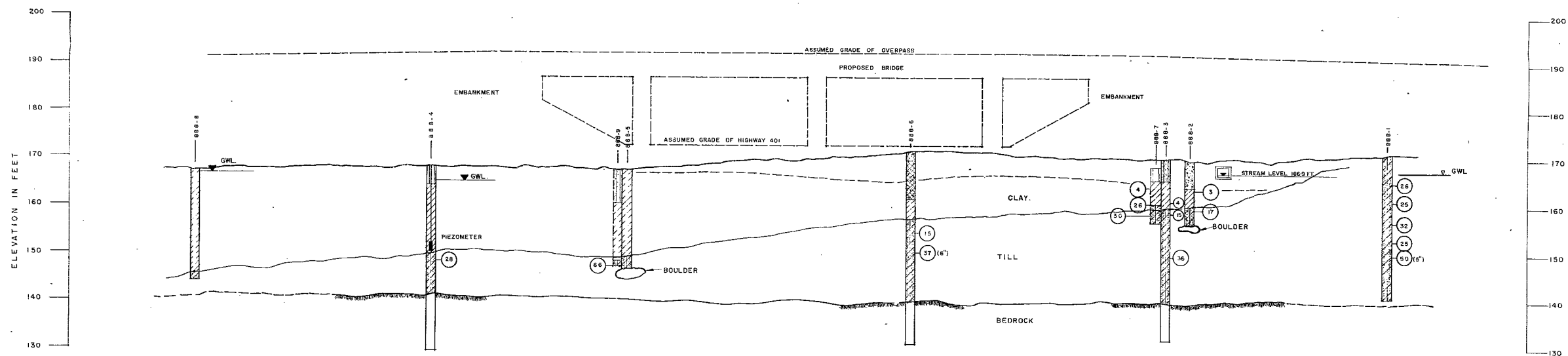
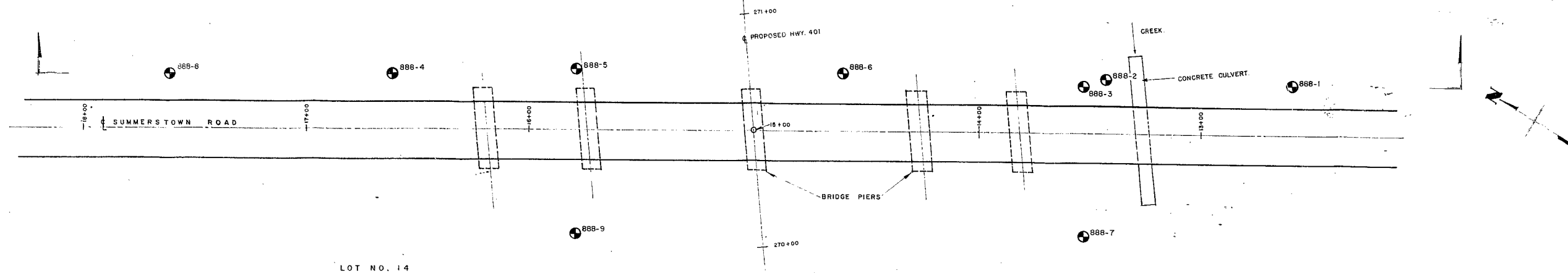
W.P. # 106-59

Hwy. # 401

PROP. CROSSING

SUMMERSTOWN

Rd.- BRIDGE # 7



LEGEND

- ORGANIC SOIL
- CLAY
- SILT
- SAND
- GRAVEL
- FILL
- BEDROCK

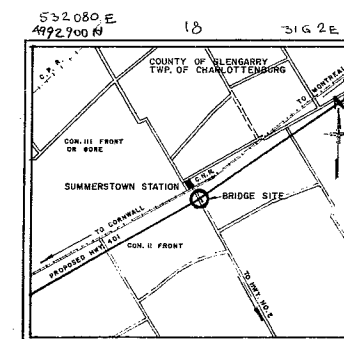
▽ WATER TABLE  
 ⊕ EXPLORATORY DRILL HOLE  
 ⊕ 2 IN. DIA. PENETRATION CONE TEST  
 (15) BLOWS PER FOOT, OR BLOWS FOR NOTED DISTANCE, FOR STANDARD PENETRATION TEST

NOTES:

- STANDARD PENETRATION TESTS WERE PERFORMED USING A 2-IN. OUTSIDE DIAMETER SPLIT-SPOON AND A 140 LB. WEIGHT DROPPING 30 INCHES.
- CONE PENETRATION TESTS WERE PERFORMED USING A 2-IN. DIAMETER D.H.O. CONE AND A 140 LB. WEIGHT DROPPING 30 INCHES.
- WATER LEVELS MEASURED DURING JUNE, 1960.

REFERENCE DRAWINGS

- D.H.O. E-2696-1 BRIDGE NO. 7, PLAN AND SECTION
- D.H.O. F-3158-3 HIGHWAY 401, PROFILES



H. G. ACRES & COMPANY LIMITED CONSULTING ENGINEERS NIAGARA FALLS, CANADA	
ONTARIO DEPARTMENT OF HIGHWAYS	
WP-134-57	
EXPLORATORY HQ PLAN AND SECTIONS	
APPROVED	DATE: JULY, 1960
<i>H. H. Macdonald</i>	SCALE AS NOTED
H. G. ACRES & COMPANY LIMITED	JOB NO. 888
PLATE I	