DEPARTMENT OF HIGHWAYS

Memo to Mr. A. M. Toye,
Bridge Engineer.

Date June 17, 1960.

Subject FINAL FOUNDATION REPORT - by H. G. Acres & Company, Limited.

From Materials & Research Section.

Attention: Mr. S. McCombie.

Re: Proposed Interchange --
Township of Aldborough,
Highway 401 & Highway 76,
Dist. No. 2 -- W.P. 97-59.

Enclosed, please find two copies of the final report submitted by H. G. Acres & Co., Ltd., for the above structure. Two copies of the Preliminary Report were forwarded to your Office on May 31, 1960.

The conclusions and recommendations given in the Preliminary Report will also apply to this final report.

If there are further questions or problems arising in connection with this project, please contact our Office.

L. G. Soderman,
PRINCIPAL FOUNDATIONS ENGR.
Per:
for (A. Stermac,
FOUNDATIONS OFFICE ENGR.)

AS/MdeF
Encl.

cc: Messrs. A. M. Toye (2)
H. A. Tregaskes
D. G. Ramsay
A. Gater
W. L. Fraser
J. Roy
A. Watt

Foundations Office
Gen. Files

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

IN YOUR REPLY REFER TO
FILE 874

June 10, 1960

Ontario Department of Highways,
Parliament Buildings,
Toronto 2, Canada.

Attention: Mr. A. Rutka
A/Materials and
Research Engineer

Gentlemen: Ontario Department of Highways
Proposed Interchange - Township
of Aldborough - District No. 2
Highway 401 and Highway 76
W.P. 97-59

Enclosed with this letter are ten final copies of the above-mentioned report. Three copies of this report were sent to you on May 26, 1960, as a preliminary issue before the final report covers were received.

Yours very truly,

H.G. ACRES & COMPANY LIMITED

T. Cameron Kenney

for D.H. MacDonald
Geotechnical Engineer

TCK:bcb
Encl.

ONTARIO
DEPARTMENT OF HIGHWAYS

Memo to Mr. A. M. Toye,
Bridge Engineer.

From Materials & Research Section.

Date December 27, 1960.

Subject REVIEW OF PRELIMINARY PLAN by Foundations Office.

Attention: Mr. J. L. Keen.

Re: Aldborough Township Bridge No. 4,
Hwy. #401 and Hwy. #76, Dist. #2,
W.P. 97-59.

We have reviewed your preliminary design for the above structure and submit the following comments pertaining to the length and capacity of the 12 BP 53 supporting the abutment footings:-

(1) The soil type at this site is a stiff clayey till with an in-place shear strength greater than 3000 p.s.f. The working capacity of friction piles (BP type) founded in this stratum, will be in the order of 2 tons per foot of embedded pile length. For the pile tip elevation shown on Drawing No. D 4742-1, the allowable design load/pile is estimated to be not more than 30 tons.

(2) We recommend that a design load of 30 tons/pile be used and that all piles be driven to elev. 682.00'. In discussion with your Mr. Keen, the use of a lighter pile section was mentioned. This should not be considered due to the possibility of the lighter section undergoing "whipping" during driving with a consequent decrease in pile to clay contact area and lower resultant pile capacity.

(3) The required driving resistance to obtain a design loading of 30 tons/pile for soil conditions at this site using a driving energy of 12 to 15 ft. kip per blow, is considered to be 3 blows/inch.

We are returning herewith your report, and drawing to follow, under separate cover.

L. G. Soderman

L. G. Soderman,
PRINCIPAL FOUNDATIONS ENGINEER

LGS/MdeF
Encl.
cc: Foundations Office
Gen. Files.

ONTARIO DEPARTMENT OF HIGHWAYS
Toronto, Ontario

REPORT

on

FOUNDATION INVESTIGATION

at

PROPOSED INTERCHANGE
TOWNSHIP OF ALDBOROUGH, DISTRICT NO. 2
HIGHWAY 401 AND HIGHWAY 76
WP 97-59

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

May, 1960

ONTARIO DEPARTMENT OF HIGHWAYS
Toronto, Ontario

REPORT

on

FOUNDATION INVESTIGATION

at

PROPOSED INTERCHANGE
TOWNSHIP OF ALDBOROUGH, DISTRICT NO. 2
HIGHWAY 401 AND HIGHWAY 76
WP 97-59

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ONTARIO DEPARTMENT OF HIGHWAYS
Toronto, Ontario

REPORT

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TOWNSHIP OF ALDBOROUGH, DISTRICT NO. 2
HIGHWAY 401 AND HIGHWAY 76
WP 97-59

Introduction

Soil explorations were carried out by H.G. Acres & Company Limited to determine the foundation conditions for a bridge at the interchange of Highway 401 and Highway 76. The proposed grade of Highway 401 at the site of the interchange is approximately two feet above the present ground surface, whereas the top of the approach embankments to the bridge will be approximately 20 feet above the ground surface. The plan of the site is shown on Plate I.

The F.E. Johnston Drilling Company Limited was retained to perform the soil drilling and field sampling, under the supervision of Mr. J.A. MacLeod of H.G. Acres & Company Limited. Field work commenced on April 12 and was completed on April 14, 1960.

The results of the field laboratory work are contained in the following report.

Exploratory Work

The exploratory work consisted of drilling and sampling four holes and making one cone penetration test. Hole No. 874-1 was drilled to a depth of 80 feet whereas the holes No. 874-2 to No. 874-4, inclusive, were drilled to depths of about 40 feet. The cone penetration test, hole No. 874-5, was made to a depth of 13 feet. The locations of these holes are shown on Plate I.

A Penndrill was used for the drilling. Samples of clay were obtained with 2-inch diameter thin-walled tubes and vane tests were performed to measure in situ the shear strength of the soil where it was found sufficiently soft to test. A 2-inch diameter split-spoon sampler was also used where sandy or extremely stiff soil was encountered.

The program of work is outlined in Appendix A, and the drilling results are shown on Plates II to VI, inclusive.

Site Conditions and Soil Properties

The site is located in flat, featureless country and the general ground surface elevation is approximately 700 feet. It is highly fertile agricultural country, drained by field tiles and drainage ditches. While the drilling work was in progress, there were considerable amounts of surface water everywhere and all field drainage ditches were flowing.

The materials which were encountered in the exploratory holes are described in the attached drilling reports, Plates II to VI inclusive. The soil stratigraphy, as shown on Plate I, consists of clay from the surface to a depth of at least 80 feet.

(a) - Clay - The elevation of the surface of the clay is approximately 703 feet. The clay was found to be extremely uniform to a depth of 80 feet. The average liquid limit is 35 per cent and the average plastic limit is 17 per cent. The natural water content varies between 18 and 24 per cent, and the average value is approximately 20 per cent.

The clay was found to be extremely stiff, as evidenced by the fact that the field vane was unable to fail the soil in shear. The average natural undrained shear strength determined from laboratory compression tests is generally greater than 3,500 psf.

The results of the field vane tests and the laboratory tests are summarized in Appendix B and Appendix C, respectively. These results are shown graphically on Plates X and XI.

The results of three consolidation tests are shown on Plates VII to IX, inclusive, and these results are compared on Plate XII. The clay is preconsolidated and relatively imcompressible. The apparent maximum consolidation pressures to which the samples have been naturally subjected have been estimated. These estimations are subject to considerable doubt as the compressibility curves are quite flat, which makes the graphical prediction of the preconsolidation pressures very difficult. No consolidation tests on samples obtained above elevation 680 feet were performed because the soil was extremely stiff and, therefore, effectively incompressible.

<u>(b) - Ground Water Conditions</u> - No water pressure measurements were made in the foundation soils. For the purposes of this report, the conservative

assumption has been made that the water pressures in the clay correspond to a ground water level two feet below the ground surface.

Design Considerations

(a) - Bearing Capacity

Bridge Footings - The bearing capacity of the bridge footings is dependent upon the shear strength of the clay. Using a safety factor equal to 3 against ultimate failure, and an average value of shear strength equal to 3,500 psf, the allowable net bearing pressures for different sizes and depths of strip footings were determined, and these results are shown on Plate XIII. It can be seen that design pressures of the order of 6.5 kips per square foot can be used for footing design.

Embankment - The maximum bearing pressure transferred to the foundation due to the embankment loading is approximately 2.7 kips per square foot. The average undrained shear strength of the foundation clay is greater than 3,500 psf and, therefore, the safety factor against ultimate foundation failure due to embankment loading is greater than 6.

(b) - Settlement - The settlement of the bridge abutments will be influenced primarily by the approach embankment loads. Although the stresses transferred to the foundation soil at the bases of the bridge footings are much larger than those transferred to the foundation by the embankment, the areas on which the bridge loads are applied are small and, therefore, these stresses quickly dissipate with depth below the footings. To make the prediction of possible settlement of the bridge footings, it has been assumed that these footings will settle the same amount as the foundation below the approach embankment.

The consolidation characteristics of the clay are shown on Plate XII and to estimate the elastic or immediate settlement in the clay, an apparent modulus of elasticity, E, of 800 kips per square foot was chosen.

The embankment loading was assumed to be a uniform strip load of 2.7 kips per square foot. The calculated settlements are as follows:

Elastic settlement .... 0.1 foot.

Consolidation settlement .... 0.4 foot.

Total ultimate settlement . 0.5 foot.

Most of the elastic settlement will occur during the period of construction of the embankment, and the time taken for 50 per cent of the total ultimate settlement to take place is estimated to be 20 years.

Conclusions

(a) - From the drilling work done at the site, it appears that the general soil profile consists of homogeneous clay to a depth of at least 80 feet. The water pressures in the clay were not measured and, for the purposes of this report, the ground water surface has been assumed to be two feet below the ground surface.

(b) - The foundation soils are very stiff and relatively incompressible. Their properties are summarized on Plates XI and XII.

(c) - The 20-foot high embankment approaching the bridge can be safely supported by the foundation soils. The maximum ultimate settlement of the embankment foundation can be expected to be about 0.5 foot.

(d) - Net allowable bearing pressures of the order of 6.5 kips per square foot can be used for the design of bridge footings. The relationship between width and depth of footing and net allowable bearing pressure is given on Plate XIII.

Recommendations

It is recommended that the bridge be supported on spread footings. Net bearing pressures of the order of 6.5 kips per square foot are permissible.

APPENDIX A

Program of Work

April 12, 1960 - Penndrill No. 1 arrived at the site and completed cone penetration test hole No. 874-5. Hole No. 874-1 was commenced.

April 13, 1960 - Hole No. 874-1 was completed to a depth of 80 feet. Hole No. 874-3 was commenced.

Penndrill No. 2 arrived on site and completed hole No. 874-2 to a depth of 40 feet.

April 14, 1960 - Hole No. 874-3 was completed to a depth of 40 feet. Hole No. 874-4 was completed to a depth of 40 feet.

Summary of Time

Work Type	No. of Holes	Total Length Feet	Total Time Hours
Soil Drilling	4	200	40
Cone Penetration Tests	1	13	2-1/2

APPENDIX B

Summary of Field Vane Test Results

Hole No.	Elevation Feet	Undrained Shear Strength Psf		Sensitivity
		Natural	Remoulded	
874-2	684	> 3,560	-	-
	674	> 3,400	-	-
874-3	687	> 3,400	-	-
	677	> 3,400	-	-

APPENDIX C

Summary of Laboratory Test Results

Hole No.	Sample No.	Elevation Feet	Water Content %	Liquid Limit %	Plastic Limit %	Su_n Psf	e_f %	Su_r Psf	St
874-1	1	699	19.7	35.5	17.1	-	-	-	-
	2	694	18.0	34.4	17.7	-	-	-	-
	3	689	17.7	33.8	16.9	6,540	16	-	-
	5	679	18.8	34.1	18.8	3,615	20	2,275	1.6
	8	664	21.4	37.4	19.8	4,865	16	1,793	2.7
	11	634	21.3	37.6	20.4	3,040	20	1,338	2.3
874-2	1	694	19.4	41.2	17.8	-	-	-	-
	2	689	19.2	34.1	16.7	6,310	16	-	-
	4	664	22.5	36.6	18.8	3,585	19	1,405	2.6
874-3	1	692	19.5	33.4	18.2	-	-	-	-
	2	682	19.1	34.8	15.6	4,390	17	2,280	1.9
	5	662	24.1	35.5	17.5	1,193	20	775	1.5
874-4	1	688	20.9	33.8	15.3	4,220	16	1,605	2.6
	3	673	20.5	34.6	15.6	3,990	8	1,480	2.7

e_f - Failure strain

Su_n - Natural undrained shear strength

Su_r - Remoulded undrained shear strength

St - Sensitivity

APPENDIX D

List of Plates

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

DRILLING REPORT

CLIENT: Department of Highways of Ontario — JOB No. 874

PROJECT: Highway 401, Highway 76 Interchange (WP-97-59) — HOLE No. 874-1

SITE: Township of Aldborough Between Lots 18 and 19, Ontario — SHEET No. 1 OF 2

CONTRACTOR: F.E. Johnston Drilling Company Limited
STARTED 9:00 A.M. April 12 1960
FINISHED 9:00 A.M. April 13 1960

METHOD OF DRILLING:
SOIL: Penndrill, 4-Inch Auger — CASING DIAM.
ROCK — CORE DIAM.

LOCATION:
~~LATITUDE~~ Ch. 118+46
DEPARTURE 43 feet right
BEARING
INITIAL DIP 90 Degrees
OTHER DIPS

ELEVATIONS:
DATUM G.S.C.
DRILL PLATFORM
GROUND SURFACE 704.3
ROCK SURFACE
BOTTOM OF HOLE 624.3
WATER TABLE

DEPTH	SOIL TYPE	DESCRIPTION: COLOUR, CONSISTENCY, STRUCTURE, WATER CONTENT, PLASTICITY, COMPACTNESS, WATER LOSS OR GAIN, ETC.	SAMPLE NO.	TYPE*	SIZE	DEPTH	RET'D	PENETRATION TEST *Blows	
					Inches	Feet	Inches		
0.0	Clay till	Dry, medium to stiff,	1	AQ	2	5.0			
		containing pebbles			EL.	5.5		1	
					698	6.0		2	
7.0	Clay till	Moist, grey, very stiff				6.5	18	9	11
		and tenacious with scattered							
		pebbles							
			2	AQ	2	10.0			
						10.5		11	
					693	11.0		16	
						11.5	18	22	38
			3	BO	2	15.0			
						15.5		8	
					688	16.0		12	
						16.5	18	18	30
			4	BO	2	20.0			
						20.5		9	
					683	21.0		13	
						21.5	18	18	31
			5	BO	2	25.0			
						25.5		10	
					678	26.0		15	
						26.5	18	19	34

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 — PLIOFILM BAG
Z — DISCARDED

INSPECTOR J. Bateson

APPROVED D. H. MacDonald

LOGGED BY J. MacLeod

DATE May, 1960

IPER IMPOSED DOCUMENT MAY
PPEAR AS MULTI-FEED ON FILM.

Plate IIA

FORM NO. 91-A

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

DRILLING REPORT

CLIENT Department of Highways of Ontario — JOB No. 874

PROJECT Highway 401, Highway 76 Interchange (WP-97-59) — HOLE No. 874-1

SITE Township of Aldborough Between Lots 18 and 19, Ontario — SHEET No. 2 OF 2

DEPTH	SOIL TYPE	DESCRIPTION COLOUR CONSISTENCY STRUCTURE, WATER CONTENT, PLASTICITY, COMPACTNESS, WATER LOSS OR GAIN, ETC.	SAMPLE NO	TYPE	SIZE Inches	DEPTH Feet	REC'D Inches	PENETRATION TEST *Blows
7.0	Clay till continued		6	BO	2	30.0		
						30.5		16
						31.0		20
						31.5	18	24
			7	BO	2	35.0		
						35.5		16
						36.0		21
						36.5	18	24
			8	BO	2	40.0	18	Machine
						41.5		Pushed
			9	BO	2	50.0	18	Machine
						51.5		Pushed
			10	BO	2	60.0	18	Machine
						61.5		Pushed
			11	BO	2	70.0	18	Machine
						71.5		Pushed
80.0		End of hole.	12	BO	2	80.0	18	Machine
						81.5		Pushed

*Penetration Test

This is the number of blows of a 140-pound weight falling 30 inches required to advance the sampler to depth shown.

FORM NO. 91-B

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

DRILLING REPORT

CLIENT Department of Highways of Ontario JOB No. 874

PROJECT Highway 401, Highway 76 Interchange (WP-97-59) HOLE No. 874-2

SITE Township of Aldborough Between Lots 18 and 19, Ontario SHEET No. 1 OF 1

CONTRACTOR: F.E. Johnston Drilling Company Limited
STARTED 9:00 A.M. April 13 19 60
FINISHED 10:00 A.M. April 14 19 60

METHOD OF DRILLING: SOIL Penndrill, 4-Inch Auger CASING DIAM.
ROCK CORE DIAM.

LOCATION: ~~LATITUDE~~ Ch. 118+ 46
DEPARTURE 55 feet left
BEARING
INITIAL DIP 90 Degrees
OTHER DIPS

ELEVATIONS: DATUM G.S.C.
DRILL PLATFORM -
GROUND SURFACE 703.9 703.9
ROCK SURFACE
BOTTOM OF HOLE 663.9
WATER TABLE

DEPTH	SOIL TYPE	DESCRIPTION: COLOUR, CONSISTENCY, STRUCTURE, WATER CONTENT, PLASTICITY, COMPACTNESS, WATER LOSS OR GAIN, ETC.	SAMPLE NO.	TYPE *	SIZE	DEPTH	RET'D	PENETRATION TEST *Blows
					Inches	Feet	Inches	
0.0	Clay till	Dry, very stiff, pebbles	1	AQ	2	10.0		
		to 1/4-inch.			693.5	10.5		20
						11.0		30
11.0	Clay till	Grey stiff and tenacious	2	BO	2	15.0		
		with scatted pebbles.				15.5		8
					688	16.0		12
						16.5		17
			Vane test			20.0		
			3	BO	2	25.0		Machine
						26.5		Pushed
			Vane test			30.0		
			4	BO	2	40.0		Machine
						41.5		Pushed
40.0		End of hole.						
		*Penetration Test						
		This is the number of blows of a 140-pound weight falling 30 inches required to advance the cone one foot.						

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 — PLIOFILM BAG
Z — DISCARDED

INSPECTOR J. Bateson

LOGGED BY J. MacLeod

APPROVED D. H. MacDonald

DATE May, 1960

Plate III

FORM NO. 91-A

H. G. ACRES & COMPANY LIMITED — CONSULTING ENGINEERS

NIAGARA FALLS, CANADA

DRILLING REPORT

CLIENT: Department of Highways of Ontario — JOB No. 874

PROJECT: Highway 401, Highway 76 Interchange (WP-97-59) — HOLE No. 874-3

SITE: Township of Aldborough Between Lots 18 and 19, Ontario — SHEET No. 1 OF 2

CONTRACTOR: F.E. Johnston Drilling Company Limited — STARTED 3:45 P.M. April 13 1960 — FINISHED 12:00 A.M. April 14 1960

METHOD OF DRILLING: SOIL Penndrill, 4-Inch Auger — CASING DIAM.

ROCK — CORE DIAM.

LOCATION: ~~LATITUDE~~ Ch. 118+ 88
DEPARTURE 50 feet left
BEARING
INITIAL DIP 90 Degrees
OTHER DIPS

ELEVATIONS: DATUM G.S.C.
DRILL PLATFORM
GROUND SURFACE 701.9 702
ROCK SURFACE
BOTTOM OF HOLE 661.9
WATER TABLE

DEPTH	SOIL TYPE	DESCRIPTION: COLOUR, CONSISTENCY, STRUCTURE, WATER CONTENT, PLASTICITY, COMPACTNESS, WATER LOSS OR GAIN, ETC.	SAMPLE NO.	TYPE*	SIZE	DEPTH	RET'D	PENETRATION TEST *Blows	
					Inches	Feet	Inches		
0.0	Clay till	Dry, stiff, pebbles to	1	AQ	2	10.0			
		1/4-inch.				10.5		7	
					691	11.0		12	
						11.5	18	18	30
9.0	Clay till	Grey stiff and tenacious							
		with scattered pebbles.	Vane test			15.0			
			2	BO	2	20.0			
						20.5		8	
					681	21.0		13	
						21.5	18	17	30
			3	BO	2	25.0			
						25.5		8	
					676	26.0		13	
						26.5	18	18	31
			Vane test			30.0			
			4	BO		35.0			
						35.5		10	
					666	36.0		13	
						36.5		18	31

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 — PLIOFILM BAG
Z — DISCARDED

INSPECTOR J. MacLeod

LOGGED BY J. MacLeod

APPROVED D. H. MacDonald

DATE May, 1960

Plate IV

FORM NO.

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

DRILLING REPORT

CLIENT	Department of Highways of Ontario	JOB No.	874
PROJECT	Highway 401, Highway 76 Interchange (WP-97-59)	HOLE No.	874-3
SITE	Township of Aldborough Between Lots 18 and 19, Ontario	SHEET No.	2 OF 2

DEPTH	SOIL TYPE	DESCRIPTION: COLOUR, CONSISTENCY, STRUCTURE, WATER CONTENT, PLASTICITY, COMPACTNESS, WATER LOSS OR GAIN, ETC.	SAMPLE NO.	SAMPLE TYPE	SAMPLE SIZE	SAMPLE DEPTH	SAMPLE REC'D	PENETRATION TEST *Blows
					Inches	Feet	Inches	
			5	BO	2	40.0		Machine
						41.5		Pushed
40.0		End of hole.						
		*Penetration Test						
		This is the number of blows of a 140-pound weight falling 30 inches required to advance the cone one foot.						

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

DRILLING REPORT

CLIENT: Department of Highways of Ontario — JOB No. 874

PROJECT: Highway 401, Highway 76 Interchange (WP-97-59) — HOLE No. 874-~~4~~

SITE: TTownship of Aldborough Between Lots 18 and 19, Ontario — SHEET No. 1 OF 1

CONTRACTOR: F.E. Johnston Drilling Company Limited

STARTED: 11:00 A.M. April 14 1960
FINISHED: 4:30 P.M. April 14 1960

METHOD OF DRILLING:
SOIL: Penndrill, 4-Inch Auger — CASING DIAM.
ROCK — CORE DIAM.

LOCATION:
~~LATITUDE~~ Ch. 118+ 97
DEPARTURE 55 feet right
BEARING
INITIAL DIP 90 Degrees
OTHER DIPS

ELEVATIONS:
DATUM G.S.C.
DRILL PLATFORM
GROUND SURFACE 702.4
ROCK SURFACE
BOTTOM OF HOLE 662.4
WATER TABLE

DEPTH	SOIL TYPE	DESCRIPTION: COLOUR, CONSISTENCY, STRUCTURE, WATER CONTENT, PLASTICITY, COMPACTNESS, WATER LOSS OR GAIN, ETC.	SAMPLE NO.	TYPE *	SIZE	DEPTH	RET'D	PENETRATION TEST *Blows
					Inches	Feet	Inches	
0.0	Clay till	Stiff, contains small		BZ	2	9.0		
		pebbles.				9.5		7
					692	10.0		18
						10.5		20
9.0	Clay till	Dry, stiff, scattered	1	BO	2	14.0		
		pebbles.				14.5		7
					687	15.0		12
						15.5		17
19.0	Clay till	Less dry, stiff, scattered	2	BO	2	19.0		Pushed
		pebbles to 1/2-inch size.				19.5		
						20.0		
						20.5		
			3	BO	2	29.0		Pushed
						29.5		
						30.0		
						31.5		
40.0		End of hole		BZ	2	39.0		Pushed
		*Penetration Test				40.5		
		This is the number of blows						
		of a 140-pound weight fall-						
		ing 30 inches required to						
		advance the cone one foot						

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 — PLIOFILM BAG
Z — DISCARDED

INSPECTOR: J. Bateson
LOGGED BY: J. MacLeod
APPROVED: D. H. MacDonald
DATE: May, 1960

Plate V

FORM NO. 91 A

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

DRILLING REPORT

CLIENT Department of Highways of Ontario JOB No. 874

PROJECT Highway 401, Highway 76 Interchange (WP-97-59) HOLE No. 874-5

SITE Township of Aldborough Between Lots 18 and 19, Ontario SHEET No. 1 OF 1

CONTRACTOR: F.E. Johnston Drilling Company Limited
STARTED 8:00 AM. April 12 1960
FINISHED 9:00 AM. April 12 1960

METHOD OF DRILLING: SOIL D.H.O. Cone Penetration Test CASING DIAM.
ROCK CORE DIAM.

LOCATION: ~~LATITUDE~~ Ch. 118+44
DEPARTURE 48 feet right
BEARING
INITIAL DIP 90 Degrees
OTHER DIPS

ELEVATIONS: DATUM G.S.C.
DRILL PLATFORM —
GROUND SURFACE 704.20
ROCK SURFACE —
BOTTOM OF HOLE
WATER TABLE

DEPTH	SOIL TYPE	DESCRIPTION: COLOUR, CONSISTENCY, STRUCTURE, WATER CONTENT, PLASTICITY, COMPACTNESS, WATER LOSS OR GAIN, ETC.	SAMPLE NO.	TYPE *	SIZE	DEPTH	RET'D	PENETRATION TEST *Blows
						Feet		
0.0	Clay till	Dry, medium to stiff,				1		3
		containing pebbles				2		5
						3		4
						4		4
						5		3
						6		4
7.0	Clay till	Very stiff and tenacious.				7		5
						8		25
						9		37
						10		56
						11		78
						12		105
13.0		End of hole.				13		115
		*D.H.O. Penetration Test						
		This is the number of blows of a 140-pound weight falling 30 inchess required to advance the cone one foot.						

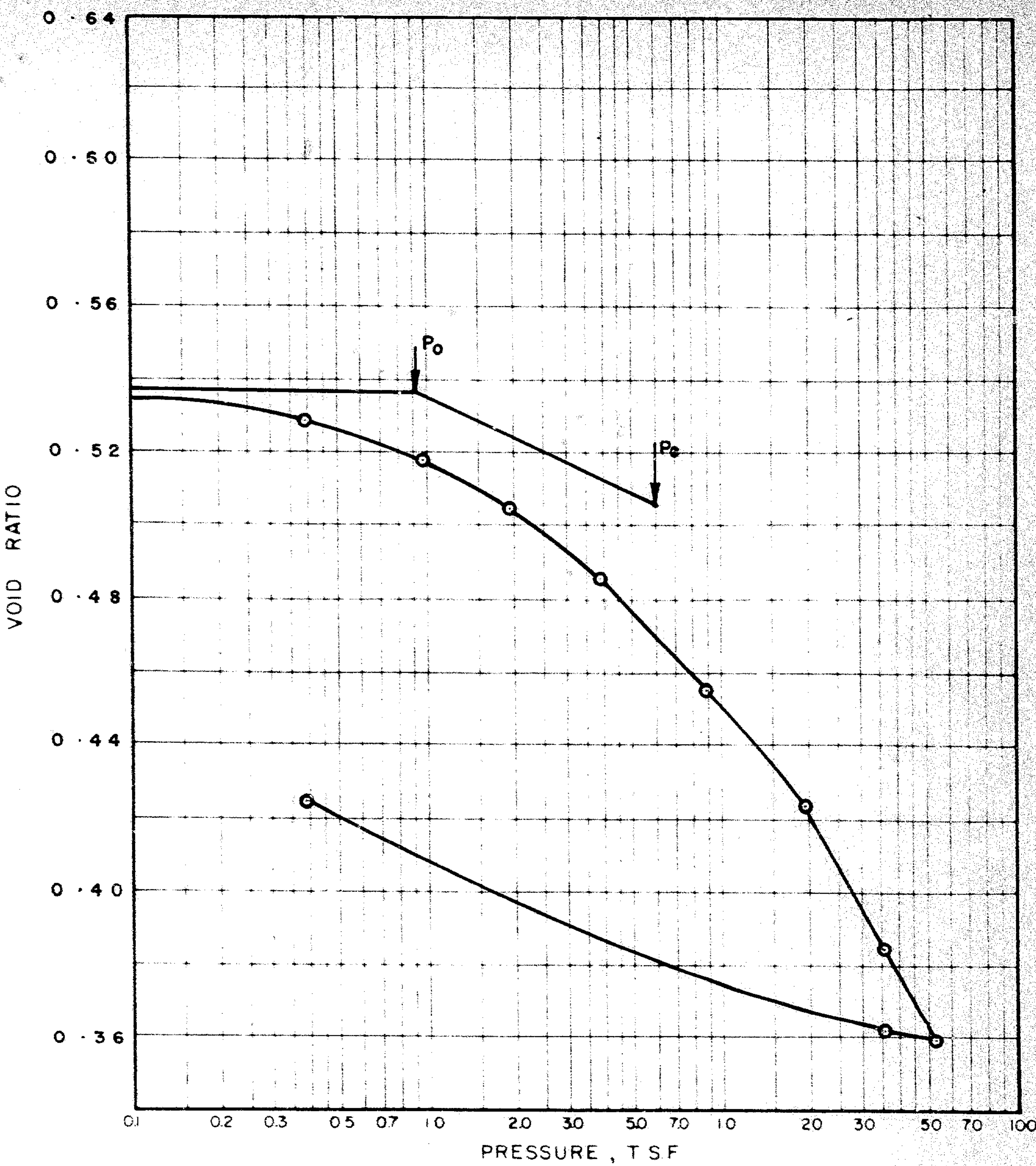
SAMPLING METHOD
*A — SPLIT TUBE
B — THIN WALL TUBE
C — PISTON SAMPLER
D — CORE BARREL
E — AUGER
F — WASH

SHIPPING CONTAINER
N — INSERT
O — TUBE
P — WATER CONTENT TIN
Q — GLASS JAR
R — CLOTH
S — PLIOFILM BAG
Z — DISCARDED

INSPECTOR J. MacLeod
LOGGED BY J. MacLeod
APPROVED D. H. MacDonald
DATE May, 1960

Plate VI

FORM NO. 91 A



OVERBURDEN PRESSURE — P_0 = 0·91 T.S.F. NATURAL WATER CONTENT = 18·52 %

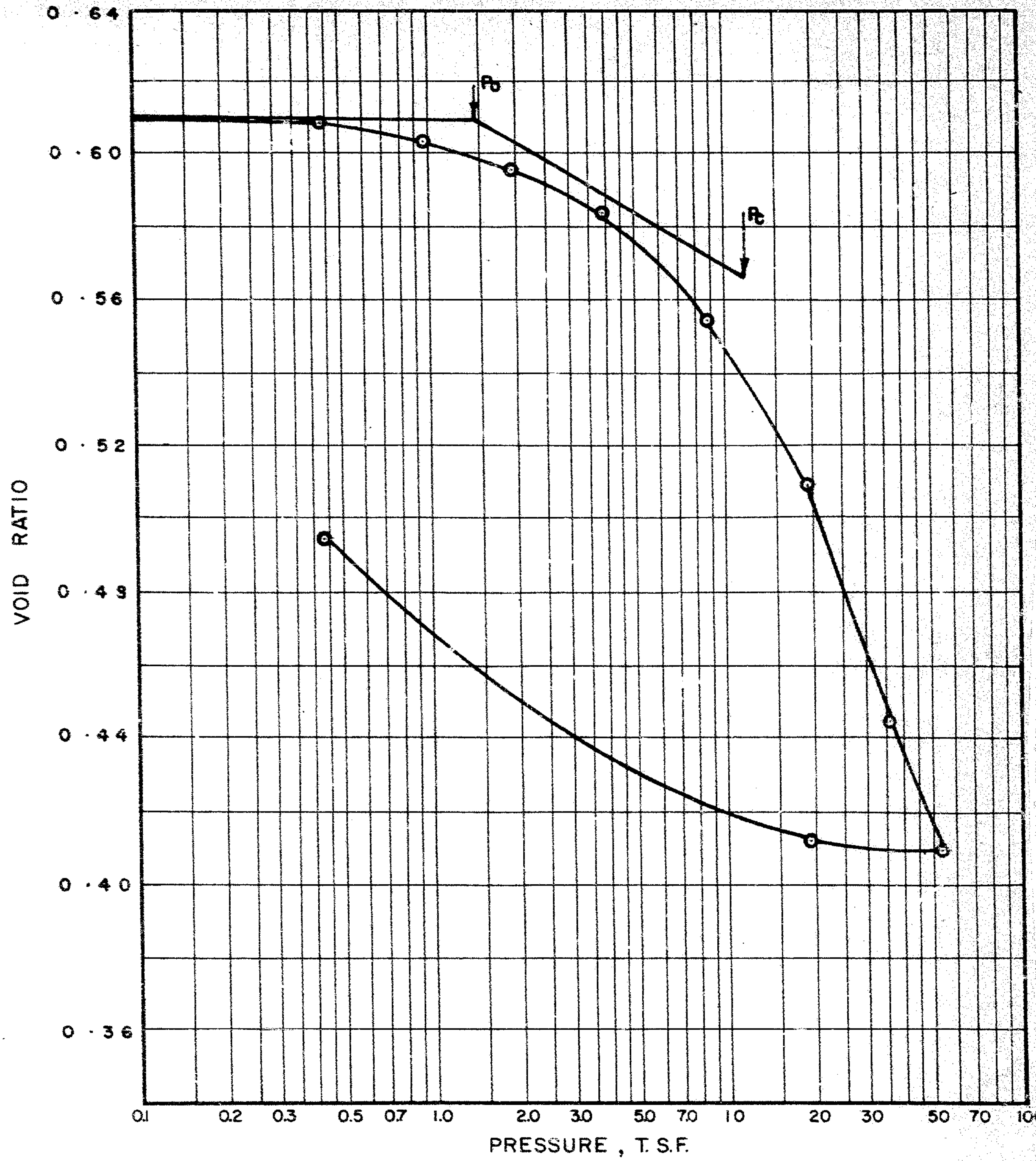
CONSOLIDATION PRESSURE — P_c = 6·0 T.S.F. LOADING INTERVAL - 25 MIN.

SAMPLE No 874 - BO - 3 TEST DATE MAY 3, 1960

TEST No 874 - 9 - 1 TESTED BY R. G.

H G ACRES & COMPANY LIMITED CONSULTING ENGINEERS NIAGARA FALLS CANADA	CONSOLIDATION TEST HOLE No 874 - 1 SAMPLE ELEV 679·0'
DEPARTMENT OF HIGHWAYS OF ONTARIO	APPROVED D. H. MacDonald H G ACRES & COMPANY LTD
HWY. 401, HWY. 76 INTERCHANGE (WP-97-59)	DATE MAY, 1960 JOB No 874 PLATE VII

SK-874-LS-7



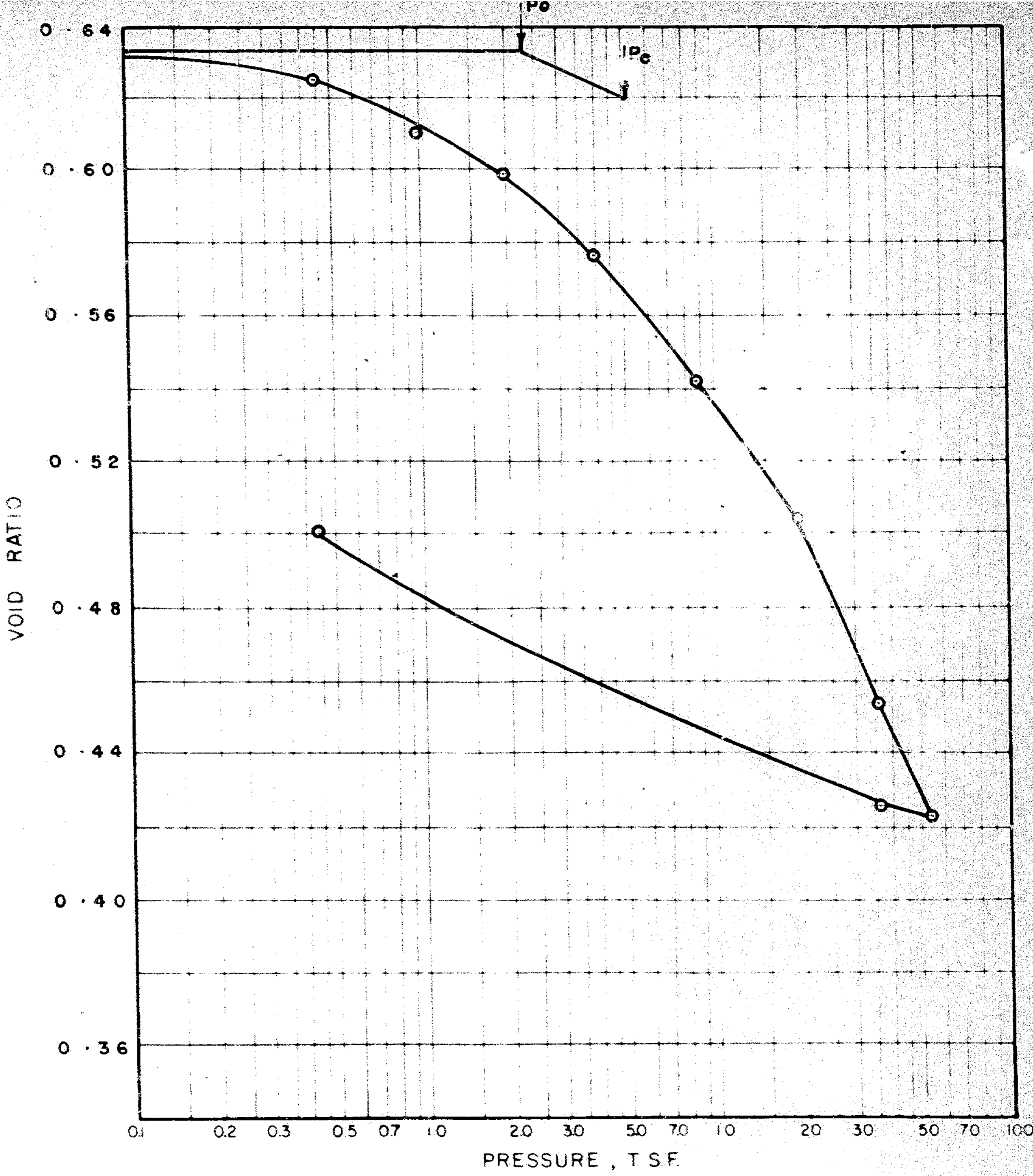
OVERBURDEN PRESSURE — P_0 = 1·43 T. S.F.	NATURAL WATER CONTENT = 21·10 %
CONSOLIDATION PRESSURE — P_c = 12·0 T. S.F.	LOADING INTERVAL - 25 MIN.

SAMPLE No. 874 - BO - 6 TEST DATE MAY 3, 1960

TEST No. 874 - 9 - 2 TESTED BY R. G.

H. G. ACRES & COMPANY LIMITED CONSULTING ENGINEERS NIAGARA FALLS CANADA	CONSOLIDATION TEST HOLE No. 874 - 1 SAMPLE ELEV. 664·0'
DEPARTMENT OF HIGHWAYS OF ONTARIO	APPROVED D. H. MacDonald H.G. ACRES & COMPANY LTD.
HWY. 401, HWY. 76 INTERCHANGE (WP-97-59)	DATE: MAY, 1960 JOB No. 874 PLATE VIII

SK - 874 - LS - 8



OVERBURDEN PRESSURE — P_0 = 2·48 T. S. F.   NATURAL WATER CONTENT = 21·53 %

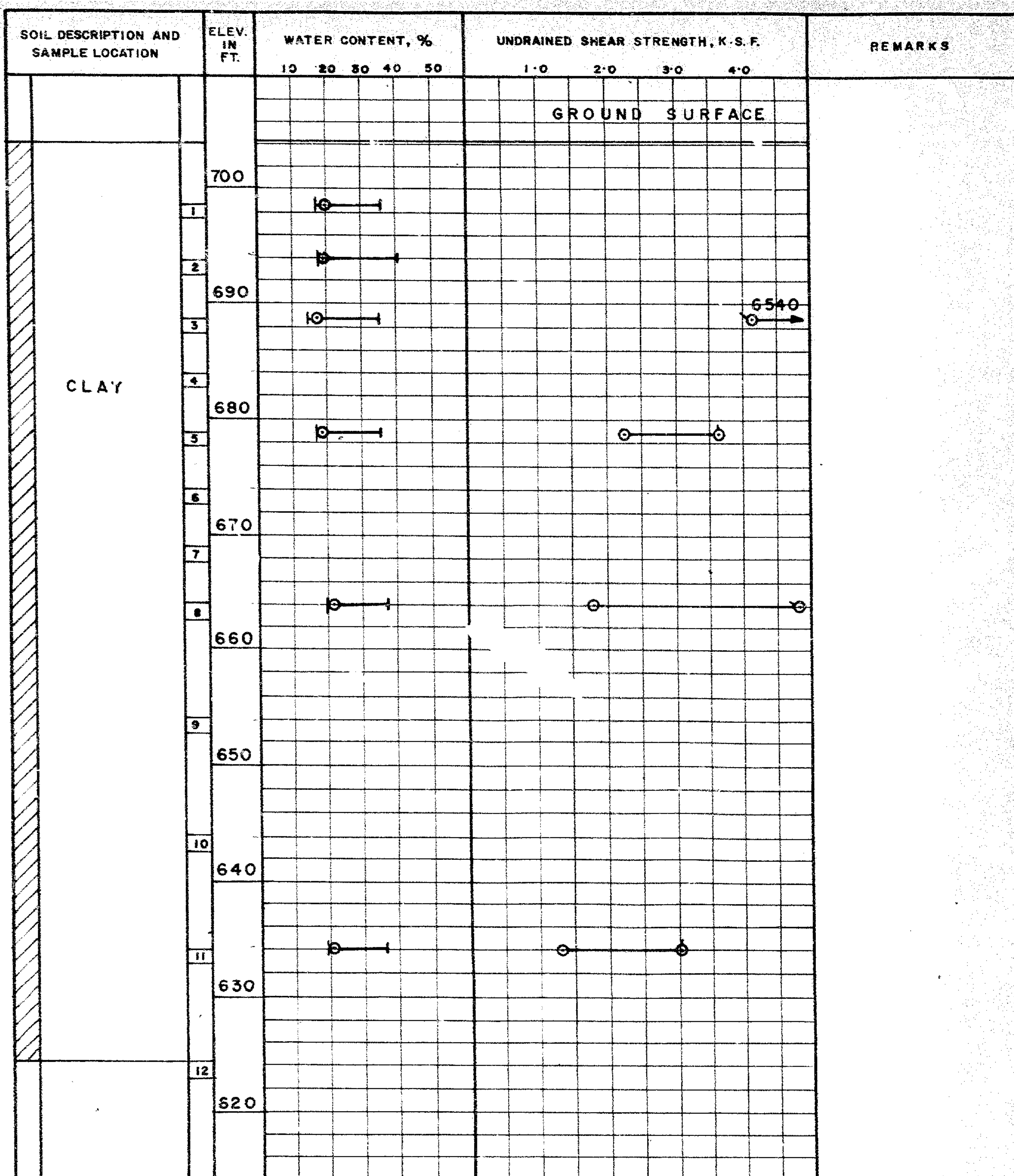
CONSOLIDATION PRESSURE — P_c = 5·2 T. S. F.   LOADING INTERVAL - 25 MIN.

SAMPLE No 874 - BO - 9   TEST DATE MAY 3, 1960

TEST No 874 - 9 - 3   TESTED BY R. G.

H G ACRES & COMPANY LIMITED CONSULTING ENGINEERS NIAGARA FALLS CANADA	CONSOLIDATION TEST HOLE No 874 - 1 SAMPLE ELEV 634·0'
DEPARTMENT OF HIGHWAYS OF ONTARIO	APPROVED D. H. MacDonald H G ACRES & COMPANY LTD
HWY. 401, HWY. 76 INTERCHANGE (WP-97-59)	DATE MAY, 1960 JOB No. 874 PLATE IX

SK-874-LS-9



[3]	SOIL SAMPLE	⊙	UNDRAINED COMPRESSION TEST
⊙	NATURAL WATER CONTENT	△	FIELD VANE TEST
─┤	LIQUID LIMIT	────	NATURAL STRENGTH
├─	PLASTIC LIMIT	— — —	REMOULDED STRENGTH

0 / 15 — 5 / 10
FAILURE STRAIN

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

SUMMARY OF DRILLING AND TEST RESULTS

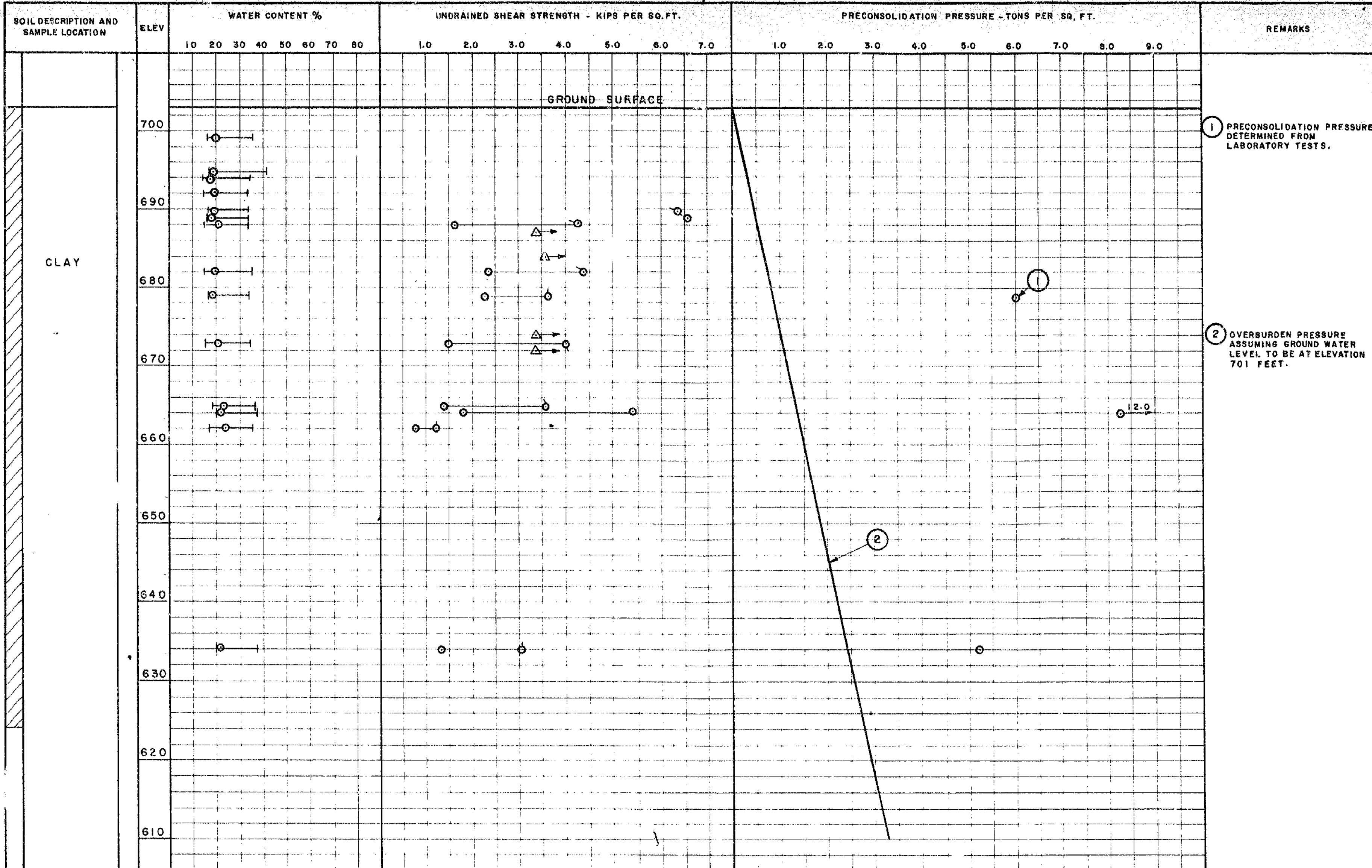
HOLE No. 874-1

DEPARTMENT OF HIGHWAYS OF ONTARIO

HWY. 401, HWY. No. 76 INTERCHANGE (W. P. 97-59)

APPROVED
D. H. MacDonald
H. G. ACRES & COMPANY LTD.

DATE: MAY, 1960
JOB No. 874
PLATE X



[3] SOIL SAMPLE	⊙ UNDRAINED COMPRESSION TEST
⊙ NATURAL WATER CONTENT	△ FIELD VANE TEST
⊣ LIQUID LIMIT	—— NATURAL STRENGTH
⊢ PLASTIC LIMIT	- - - REMOULDED STRENGTH

0
15 ⊙ 5
10
FAILURE STRAIN

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

DEPARTMENT OF HIGHWAYS OF ONTARIO

HWY. 401, HWY. No.76 INTERCHANGE (WP-97-59)

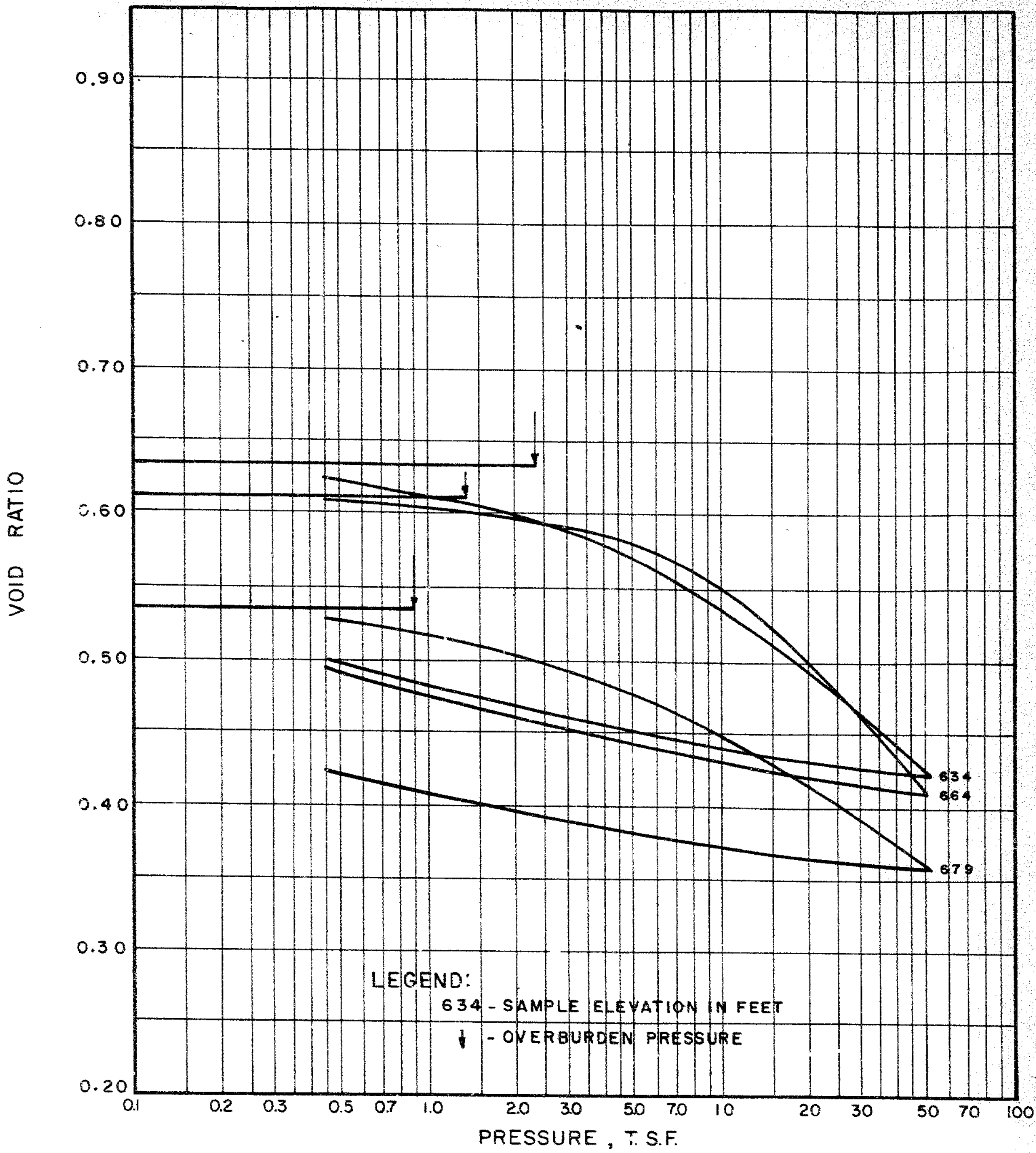
SUMMARY OF DRILLING AND TEST RESULTS

COMPARISON OF ALL TESTS

APPROVED
D. H. MacDonald
H. G. ACRES & COMPANY LIMITED

DATE: MAY, 1960
JOB No. 874
PLATE - XI

SK-874-A-11



OVERBURDEN PRESSURE — P_0 = ——
CONSOLIDATION PRESSURE — P_c = ——
NATURAL WATER CONTENT ——
LOADING INTERVAL - 25 MIN.

SAMPLE No. ——
TEST No. ——
TEST DATE ——
TESTED BY ——

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

DEPARTMENT OF HIGHWAYS OF ONTARIO

HWY. 401, HWY. No. 76 INTERCHANGE (WP-97-59)

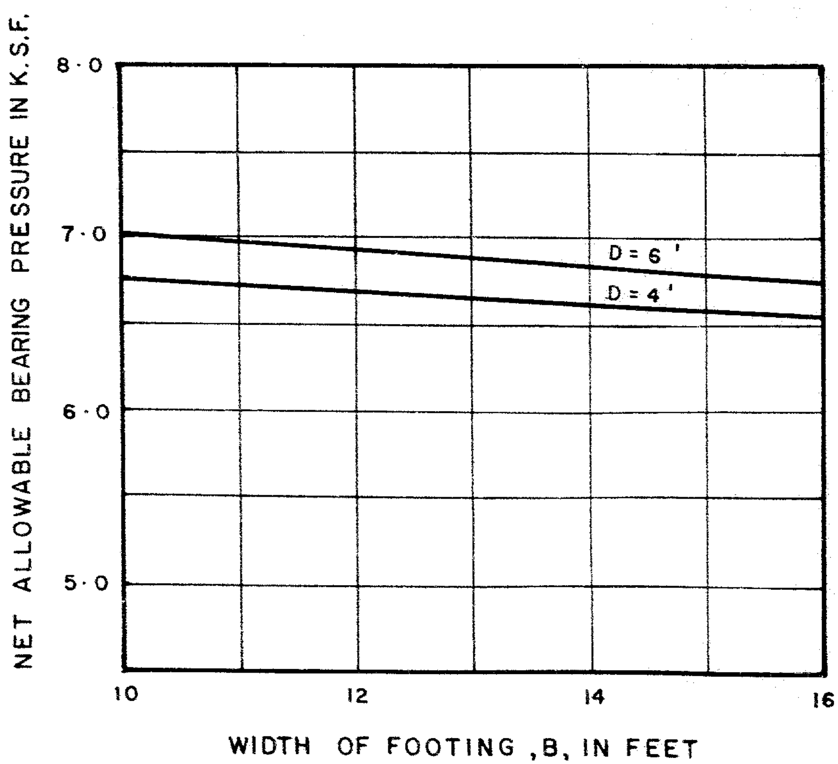
CONSOLIDATION TEST

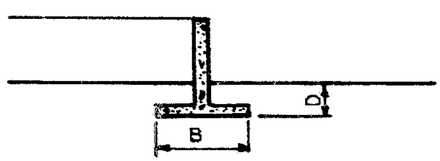
COMPARISON OF ALL TESTS

APPROVED
D. H. MacDonald
H.G. ACRES & COMPANY LTD.

DATE: MAY, 1960
JOB No. 874
PLATE - XII

SK-874-LS-12





CLAY , Su = 3·5 K.S.F.

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

DEPARTMENT OF HIGHWAYS OF ONTARIO

HWY. 401, HWY. 76 INTERCHANGE (W.P. 97-59)

NET ALLOWABLE BEARING PRESSURES FOR BRIDGE FOOTINGS

APPROVED	DATE MAY , 1960	
D. H. MacDonald	SCALE	JOB No. 874
H. G. ACRES & COMPANY LIMITED	PLATE - XIII	

SK-874-LS-13

Determine allowable load per pile for

i) Round Timber pile, TIP DIA. = 8"

ii) Steel tube with closed end 12" DIA.

iii) 12 BP 53

All piles driven to elevation 683.0

<u>Assumptions</u>

1. Adhesion in clay fill = 500 psf.

2. Cohesion of clay = 3500 psf.

∴ Adhesion = 900 psf.

3. Cohesion at tip of pile = 3500 psf.

Pile	Tip Area ft^2	L in fill ft.	L in clay ft.	$N_c A_b C_b$	$\Sigma C L C_a$	Q_f
Timber	0.350	16'	13'	11,000	60,900	71,900
Tube	0.784	16'	13'	24,700	78,800	103,500
12 BP53	0.108	16'	13'	3,400	109400	103,700

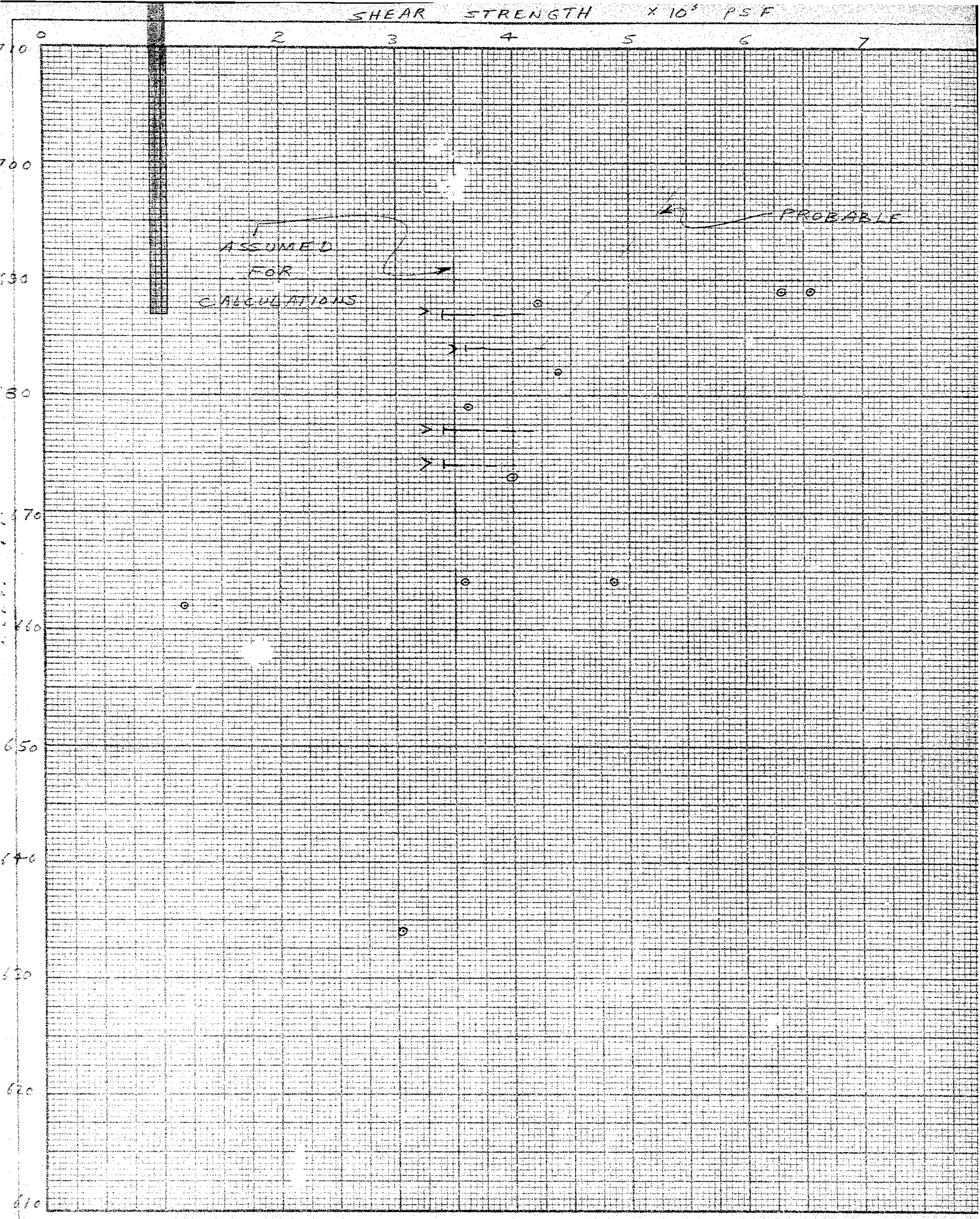
$$Q_f = N_c A_b C_b + C.L\,C_a$$

Allowable load per pile with S.F. = 3

Timber $\dfrac{71,900}{3 \times 2000}$ = 12 tons

Tube $\dfrac{103,500}{3 \times 2000}$ = 17.3 tons <u>52 Tons</u>

12 BP 53 $\dfrac{103,700}{3 \times 2000}$ = 17.3 tons <u>52 Tons</u>


SHEAR STRENGTH × 10³ PSF
0
2
3
4
5
6
7
710
700
690
680
670
660
650
640
630
620
610
PROBABLE
ASSUMED
FOR
CALCULATIONS

Mr. A. M. Toye,

Bridge Engineer.

Materials & Research Section.

December 27, 1960.

REVIEW OF PRELIMINARY PLAN by Foundations Office.

Attention: Mr. J. L. Keen.

Re: Aldborough Township Bridge No. 4,
Hwy. #401 and Hwy. #76, Dist. #2,
W.P. 97-59.

We have reviewed your preliminary design for the above structure and submit the following comments pertaining to the length and capacity of the 12 BP 53 supporting the abutment footings:-

(1) The soil type at this site is a stiff clayey till with an in-place shear strength greater than 3000 p.s.f. The working capacity of friction piles (BP type) founded in this stratum, will be in the order of 2 tons per foot of embedded pile length. For the pile tip elevation shown on Drawing No. D 4742-1, the allowable design load/pile is estimated to be not more than 30 tons.

(2) We recommend that a design load of 30 tons/pile be used and that all piles be driven to elev. 682.00'. In discussion with your Mr. Keen, the use of a lighter pile section was mentioned. This should not be considered due to the possibility of the lighter section undergoing "whipping" during driving with a consequent decrease in pile to clay contact area and lower resultant pile capacity.

(3) The required driving resistance to obtain a design loading of 30 tons/pile for soil conditions at this site using a driving energy of 12 to 15 ft. kip per blow, is considered to be 3 blows/inch.

We are returning herewith your report, and drawing to follow, under separate cover.

L. G. Soderman

L. G. Soderman,
PRINCIPAL FOUNDATIONS ENGINEER

LGS/MdeF
Encl.
cc: Foundations Office
Gen. Files.

cc: Foundations Office

Mr. A. M. Toye,
Bridge Engineer.
Materials & Research Section.

June 17, 1960.

FINAL FOUNDATION REPORT - by
H. G. Acres & Company, Limited.

Attention: Mr. S. McCombie.

Re: Proposed Interchange --
Township of Aldborough,
Highway 401 & Highway 76,
Dist. No. 2 -- W.P. 97-59.

Enclosed, please find two copies of the final report submitted by H. G. Acres & Co., Ltd., for the above structure. Two copies of the Preliminary Report were forwarded to your Office on May 31, 1960.

The conclusions and recommendations given in the Preliminary Report will also apply to this final report.

If there are further questions or problems arising in connection with this project, please contact our Office.

AS/McF
Encl.

L. G. Soderman,
PRINCIPAL FOUNDATIONS ENGR.
Per:
for de Lossl
for (A. Stermac,
FOUNDATIONS OFFICE ENGR.)

cc: Messrs. A. M. Toye (2)
H. A. Tregaskes
D. G. Ramsay
A. Gater
W. L. Fraser
J. Roy
A. Watt

Foundations Office
Gen. Files

Note: The Preliminary Report - was sent to Bridge Office, only.

See attached copy of memo (May 31/60) to Mr. A. M. Toye for recommendations referred to in this memo.

Mr. A. M. Toye,
Bridge Engineer.
Materials & Research Section.

May 31, 1960.

FOUNDATION INVESTIGATION -- by
H. G. Acres & Company, Limited

Attention: Mr. S. McCombie.

Re: Proposed Interchange --
Township of Aldborough,
Highway 401 & Highway 76,
Dist. No. 2 -- W.F. 97-59.

This memo accompanies two copies of the foundation report for the above site, submitted by H. G. Acres & Co., Ltd. We have reviewed the factual data contained in this report and agree with the conclusions that have been reached.

The recommendations pertaining to design, are as follows:-

1. The stiff, relatively incompressible subsoil existing at this site is such that piers and/or abutments can be founded at a minimum depth of 5 ft. below existing ground surface. The net safe footing pressure which can be carried by the subsoil, is 6.5 kips/sq.ft.

2. If the abutments are to be supported on piles driven through the embankment fill material, it is our recommendation that large displacement type piles be used. Tip elevation for such piling should be not less than 10-ft. penetration into the natural subsoil.

3. The permeability of the soil type at this site, is such that seepage into the excavations will be of minor quantities.

If we can be of further assistance with regard to this project, please contact our Office.

LGS/MdeP
Attach.

L. G. Soderman,
PRINCIPAL SOILS & FOUNDATIONS ENGINEER

cc: Messrs. A. M. Toye (2)
H. A. Tregaskes
D. G. Ramsay
A. Gater
W. L. Fraser
J. Roy
A. Watt
Foundations Office -- Gen. Files.

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

IN YOUR REPLY REFER TO
FILE 874

June 10, 1960

Ontario Department of Highways,
Parliament Buildings,
Toronto 2, Canada.

Attention: Mr. A. Rutka
A/Materials and
Research Engineer

Gentlemen: Ontario Department of Highways
Proposed Interchange - Township
of Aldborough - District No. 2
Highway 401 and Highway 76
W.P. 97-59

Enclosed with this letter are ten final copies of the above-mentioned report. Three copies of this report were sent to you on May 26, 1960, as a preliminary issue before the final report covers were received.

Yours very truly,

H.G. ACRES & COMPANY LIMITED

T. Cameron Kenney

for D.H. MacDonald
Geotechnical Engineer

TCK:bcb
Encl.

#60-F-207

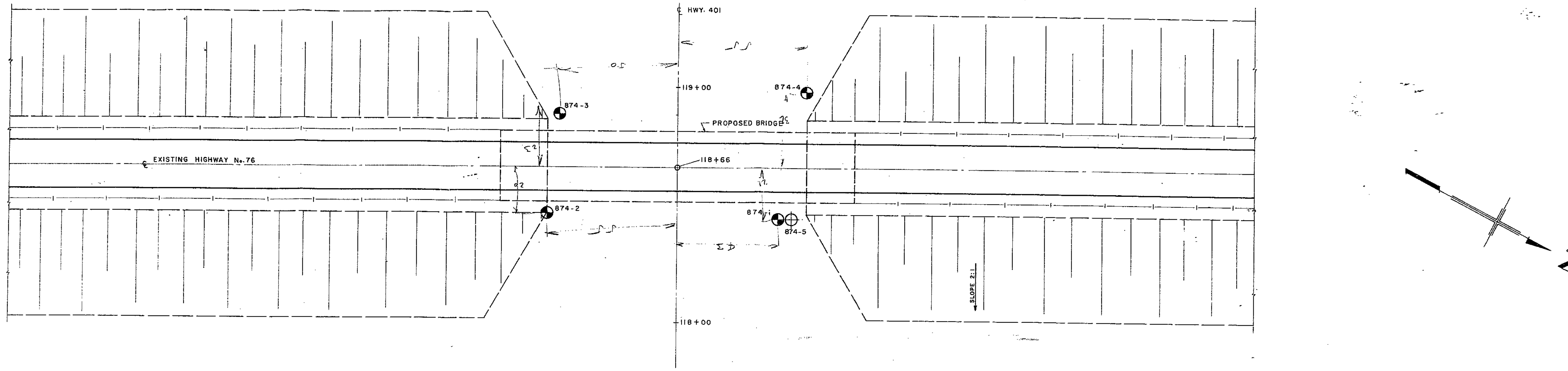
W.P.# 97-59

Hwy. #401 &

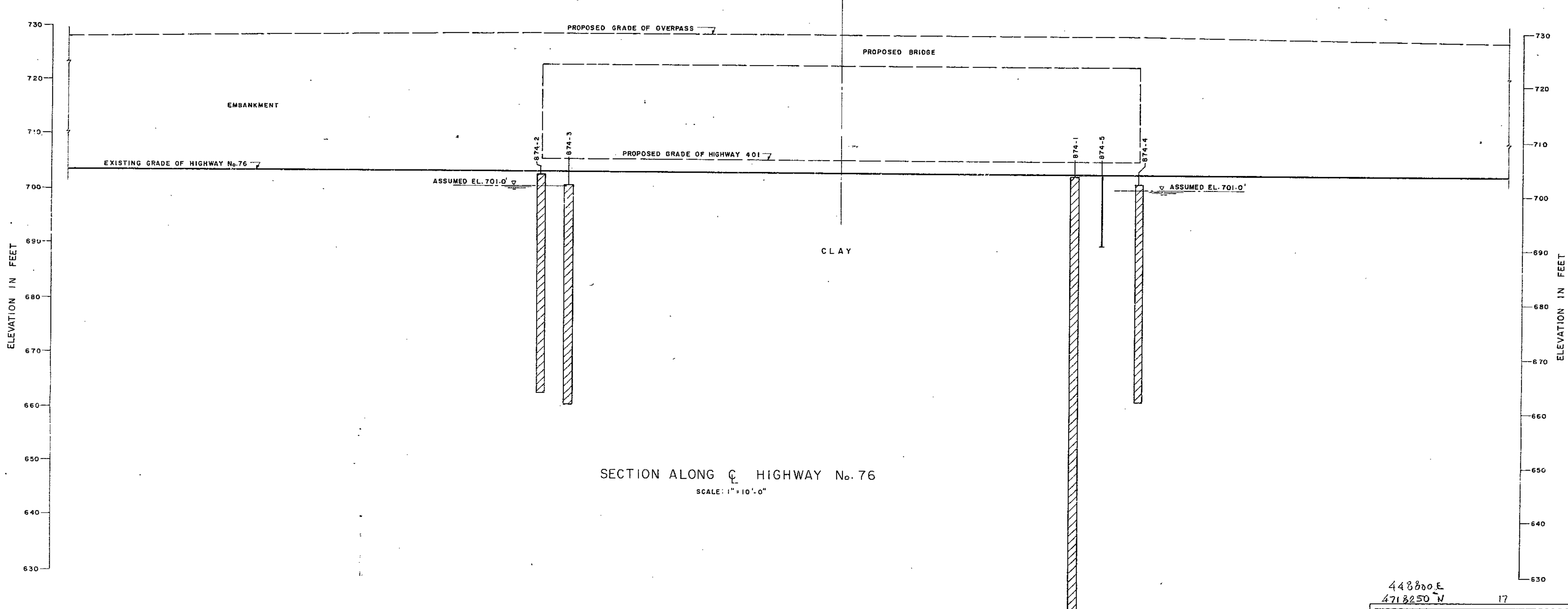
Hwy. # 76

PROPOSED

INTERCHANGE



PLAN
SCALE: 1" = 20'-0"



SECTION ALONG ℄ HIGHWAY No. 76
SCALE: 1" = 10'-0"

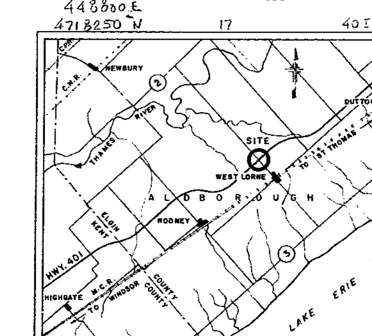
LEGEND

- ORGANIC SOIL
- CLAY
- SILT
- FINE SAND
- COARSE SAND
- GRAVEL
- BEDROCK

- ▽ WATER TABLE
- EXPLORATORY DRILL HOLE
- 2 IN. DIA. PENETRATION CONE TEST

NOTE:
1. CONE PENETRATION TEST WAS PERFORMED USING A 2 IN. DIAMETER D-H-O. CONE AND A 140 LB. WEIGHT DROPPING 30 INCHES.

448800 E
4718250 N
17
40 ZIZE



KEY PLAN
SCALE 1IN. = 4 MI.

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

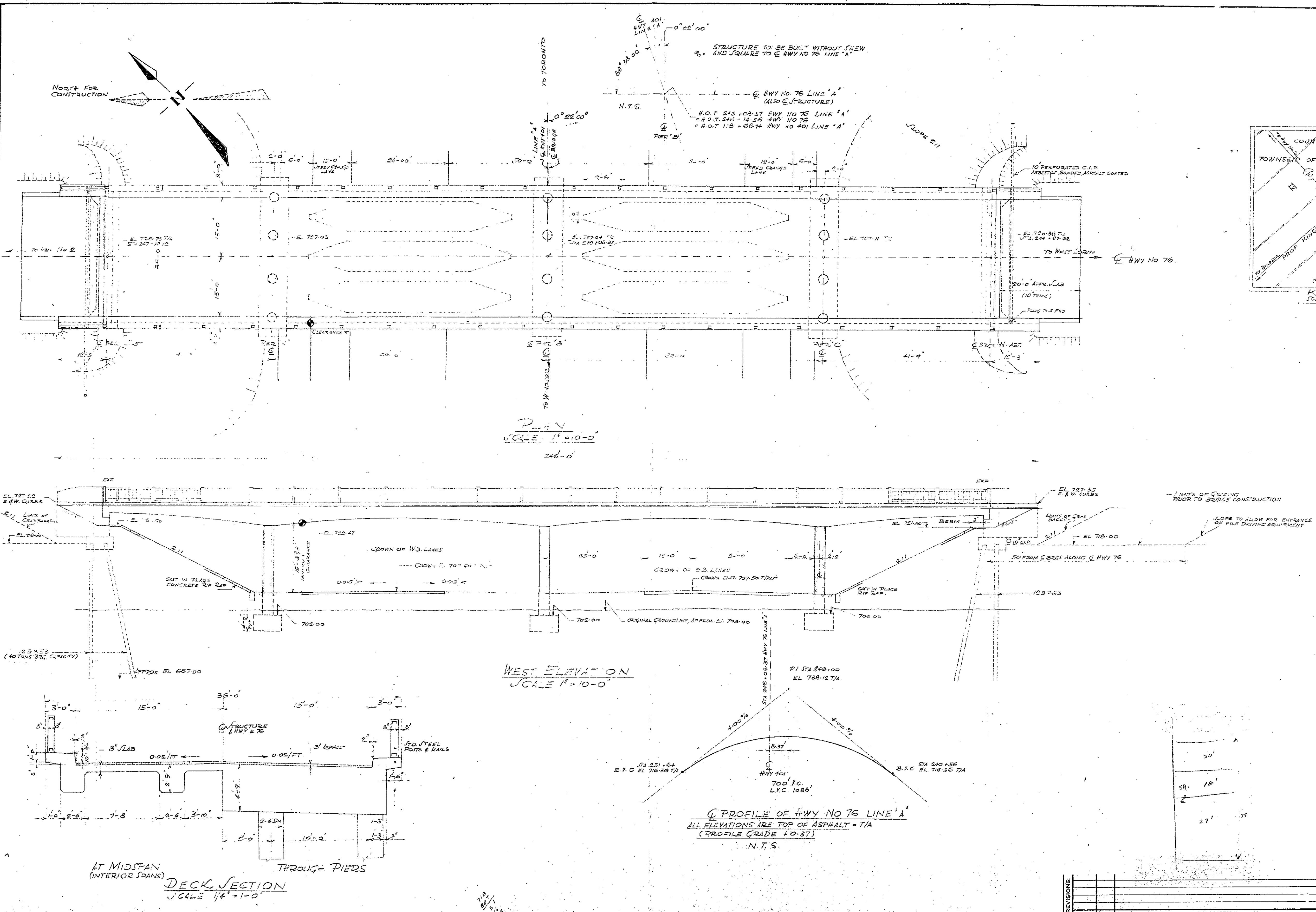
DEPARTMENT OF HIGHWAYS OF ONTARIO

HWY. 401, HWY. No. 76 INTERCHANGE (WP-97-59)

EXPLORATORY HOLES
PLAN AND SECTION

APPROVED	DATE: MAY, 1960	
D. H. MacDonald.	SCALE AS NOTED	JOB No. 874
H. G. ACRES & COMPANY LIMITED	PLATE - I	

SK-874-C-1



Please check use of 12" BP 52 piles for abutments.

see #2

Sauls.

W.P. 97-59

H.A. Haas

DEPARTMENT OF HIGHWAYS:-ONTARIO-
BRIDGE OFFICE:-TORONTO

ALDBOROUGH TWP BRIDGE # 4

THE KING'S HIGHWAY No. 76 INTERCHANGE HWY #401. DIST. No. 2
CO. ELGIN
TWP. ALDBOROUGH LOT 18 & 19 CON. VII

PRELIMINARY.

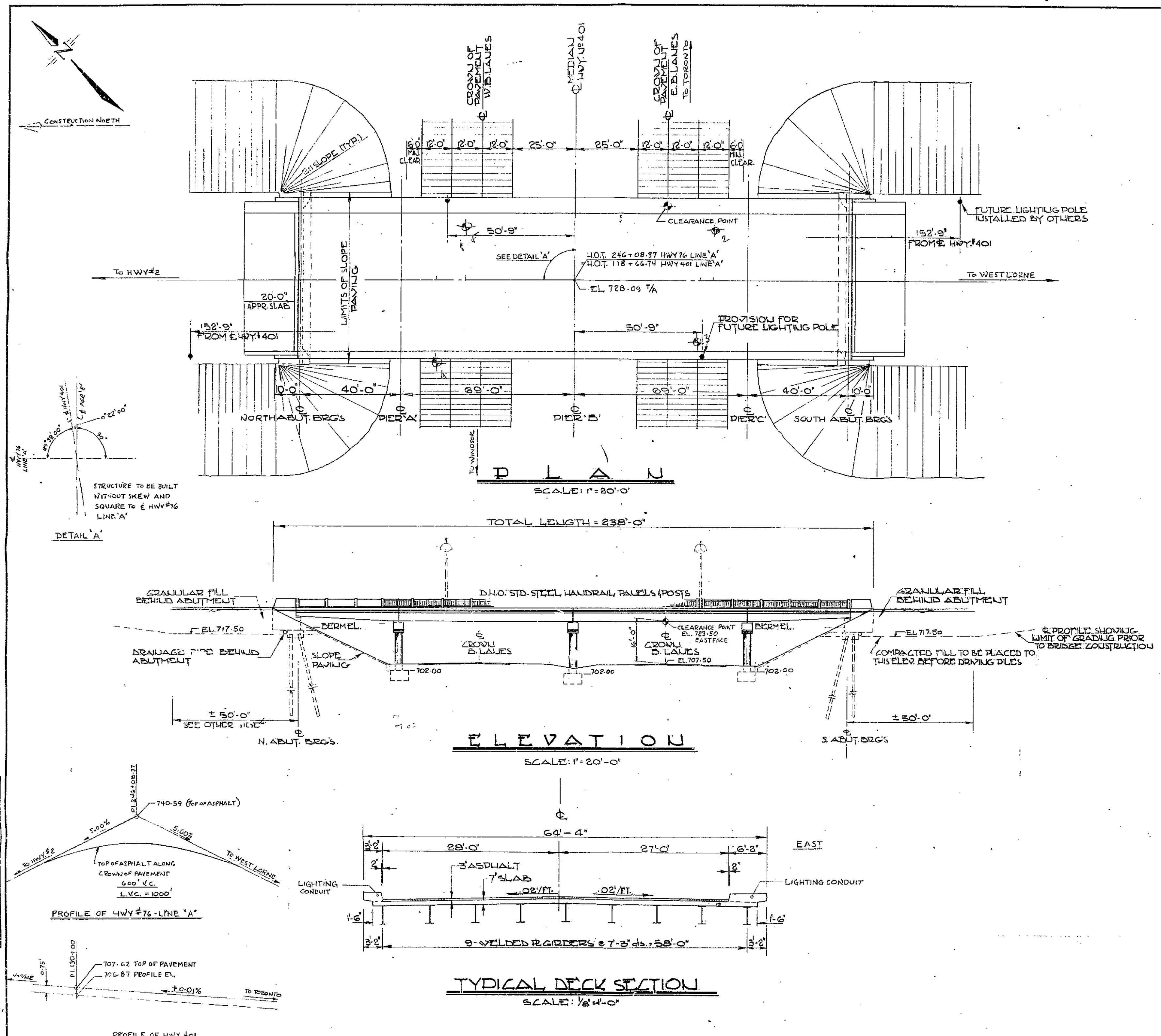
APPROVED

BRIDGE ENGINEER — DESIGN ENGINEER

REFERENCE PLANS						
PLAN F3531-5	DESIGN	B.R.	CHECK		CONTRACT NUMBERS	
PROFILE F3531-1	DRAWING	B.R.	CHECK	J.L.K.		
PROFILE F4019	TRACING		CHECK		LOADING H-20 S-16	DRAWING NUMBER D-4742-P1
SITE PLAN E3639-1	DATE NOVEMBER 1960					
INTER DM 4599						

NOT AVAILABLE AT PRESENT

REVISIONS: DATE BY DESCRIPTION



PRINT RECORD		
No.	FOR	DATE

REVISIONS		
DATE	BY	DESCRIPTION

DEPARTMENT OF HIGHWAYS ONTARIO
BRIDGE DIVISION

HWY. # 76 INTERCHANGE

KING'S HIGHWAY No. 401 & 76 — DIST. No. 2
CO. ELGIN — ALDBOROUGH TWP. BRIDGE # 4
TWP. ALDBOROUGH — LOT 18 & 19 — CON. VII

PRELIMINARY

APPROVED ______ BRIDGE ENGINEER				SITE No. 5-123.	W.P. No. 97-59
DESIGN	J.L.K.	CHECK		CONTRACT Nos.	
DRAWING	E.A.	CHECK	J.L.K		
DATE	Nov/63	LOADING	H20 S16	DRAWING No.	D5403-P1