

#60-F-200

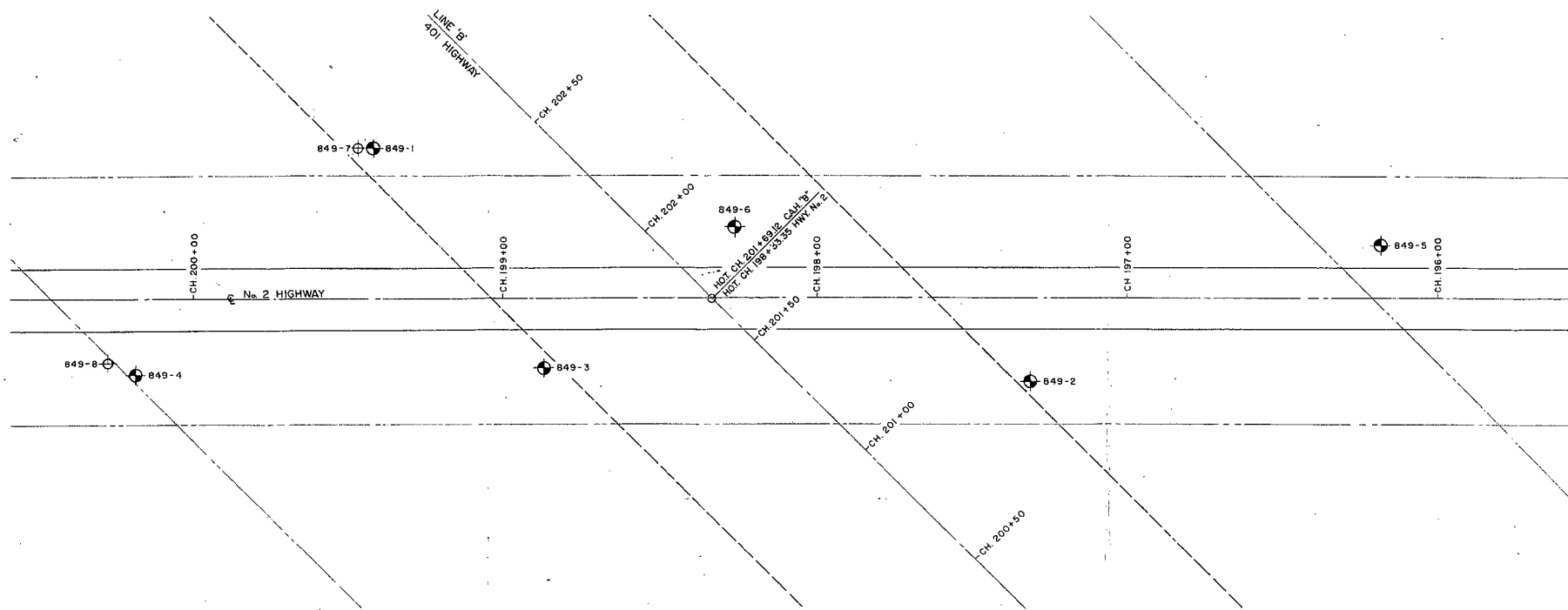
W.P.#165-58

Hwy.#2

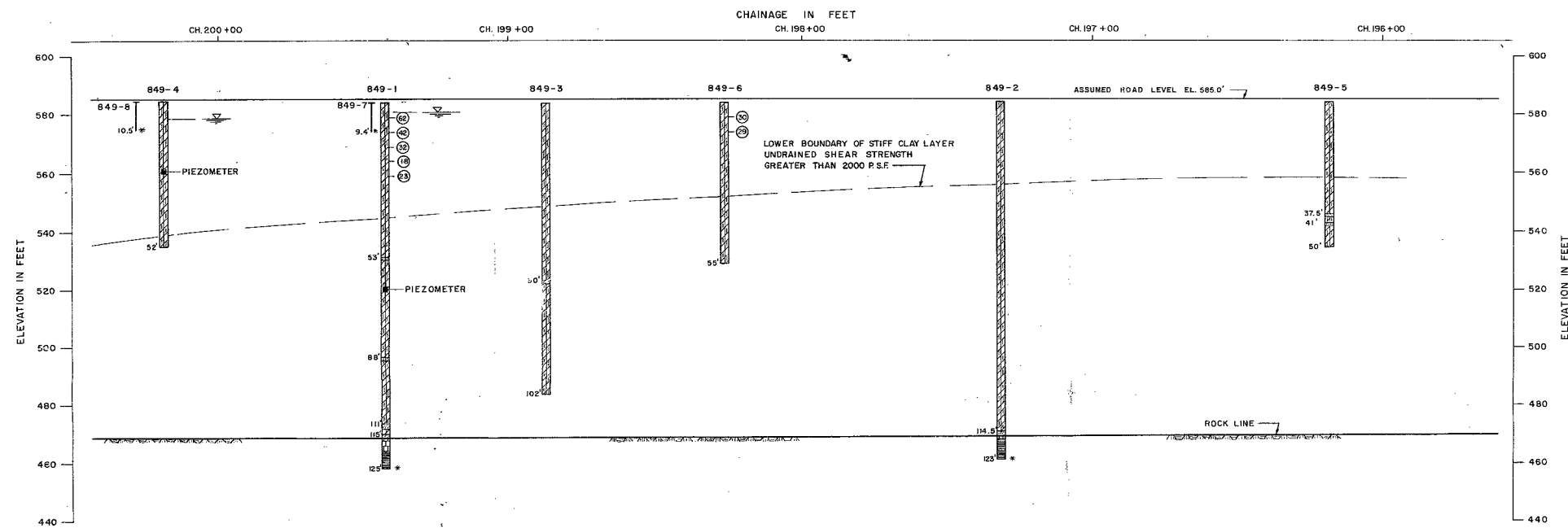
INTERCHANGE

Hwy.#401

E. OF TILBURY



PLAN



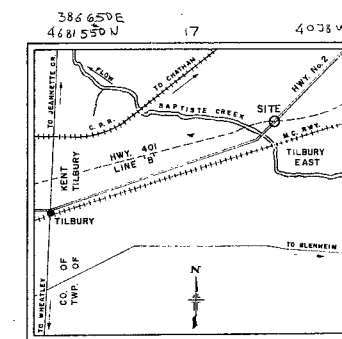
SECTION ALONG C OF No. 2 HIGHWAY

LEGEND

- ▽ WATER TABLE
- ⊕ EXPLORATORY DRILL HOLE
- ⊕ 2 IN. DIA. PENETRATION CONE TEST
- ⊕ 2 IN. DIA. PENETRATION CONE DRIVEN TO REFUSAL
- ⊕ BLOWS PER FOOT FOR 2 IN. SPLIT-SPOON SAMPLER
- CLAY TILL
- SAND
- LIMESTONE
- SHALE

NOTES:

STANDARD PENETRATION TESTS AND CONE PENETRATION TESTS WERE PERFORMED USING A 140 POUND WEIGHT DRIPPING 30 INCHES.



KEY PLAN
SCALE 1 IN. = 1 MI.

H. G. ACRES & COMPANY LIMITED CONSULTING ENGINEERS NIAGARA FALLS, CANADA		
DEPARTMENT OF HIGHWAYS OF ONTARIO		
HIGHWAY 2 CROSSING HIGHWAY 401 (WP 165-58)		
EXPLORATORY HOLES PLAN AND SECTION		
APPROVED	DATE: JAN. 29, 1960	
<i>D. H. MacDonald</i>	SCALE 1 IN. = 20 FT.	JOB No. 849
H. G. ACRES & COMPANY LIMITED	PLATE - I	

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

February 16, 1960.

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

Attention: Mr. S. McCombie.

Re: Hwy. #2 Interchange with Hwy. #401 -
E. of Tilbury - Dist. #1 - Chatham.
W.P. 165-58.

This memo accompanies the detailed report of foundation conditions at the above site, submitted by H.G. Acres & Co., Ltd.. The data presented in this report have been reviewed by this Section, and the soil conditions and engineering properties of these materials, as defined in this report, are in accordance with the known conditions of the soil in this area.

We are in agreement with the Consultants' recommendations that:-

- (1) Spread footing design be adopted rather than footings supported by piling. Footing pressures of the order of 2 1/2 Tons/sq.ft. can be used for design; and
- (2) The approach embankments and ramps can be safely designed using standard slopes of 2:1.

Because of the settlements anticipated due to footing and embankment fill loadings, it is our recommendation that a multi-span, simply-supported structure be designed at this crossing. Provision should be made for jacking of the ends of the approach spans. Settlements of the order of 6 to 8 inches at the abutment locations, can be expected within the 50-year lifetime of this structure.

Should any queries arise with respect to the contents of the attached report, or our foregoing comments, please do not hesitate to call our Office.

LGS/MdeF
Attach.

L. G. Soderman
L. G. Soderman,

PRINCIPAL SOILS & FOUNDATIONS ENGINEER

cc: Messrs. A. M. Toye (2)
H. A. Tregaskes
D. G. Ramsay
A. Gater

G. U. Howell
J. Roy
A. Watt
Foundations Office -- Gen. Files.

DEPARTMENT OF HIGHWAYS OF ONTARIO
Toronto, Ontario

REPORT

on

FOUNDATION CONDITIONS AT THE HIGHWAY 2 CROSSING
OF HIGHWAY 401 AT TILBURY EAST
(WP 165-58)

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

January, 1960

DEPARTMENT OF HIGHWAYS OF ONTARIO
Toronto, Ontario

REPORT

on

FOUNDATION CONDITIONS AT THE HIGHWAY 2 CROSSING
OF HIGHWAY 401 AT TILBURY EAST
(WP 165-58)

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DEPARTMENT OF HIGHWAYS OF ONTARIO
Toronto, Ontario

REPORT

on

FOUNDATION CONDITIONS AT THE HIGHWAY 2 CROSSING
OF HIGHWAY 401 AT TILBURY EAST
(WP 165-58)

Introduction

Soil explorations were carried out by H.G. Acres & Company Limited to determine the foundation conditions for a structure to be built to carry Highway 2 over Highway 401 at Tilbury East. A plan of the site is shown on Plate I in this report.

The F.E. Johnston Drilling Company Limited was retained to perform the soil drilling and field sampling, and Mr. G. Wilson of H.G. Acres & Company Limited supervised the work. Field work commenced on December 14, 1959, and was completed on January 7, 1960. Laboratory testing of the soil samples was done during January, 1960.

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

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Exploratory Work

Previous exploratory work at Tilbury Creek indicated that the use of the diamond drill for soil sampling in this area was likely to result in very slow progress and it was, therefore, intended that a Penndrill be used at Tilbury East. It was also realized that the diamond drill would be necessary to extend to bedrock those auger holes which were deeper than the augering limit of the Penndrill, and also to carry out tests and obtain core to prove the condition of the bedrock.

When exploratory work commenced, however, the Penndrill was not immediately available and the diamond drill was used. Progress was slow and the first hole (No. 849-1) was completed to a depth of 125 feet after 67 hours drilling time. BX casing was used to advance the hole, and it was drilled through the stiff upper crust of the clay, and driven through the softer clay below. The clay proved to be extremely tenacious which made both drilling and sampling difficult. The hole was at all times full of water and fully cased. Only split-spoon samples could be taken in the clay hole down to a depth of 20 feet. Below that depth 2-inch diameter Shelby tube samples were

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taken at 5-foot intervals down to 40 feet and then at 10-foot intervals down to bedrock. Vane tests were performed in the hole immediately after the samples had been recovered. Below a depth of 60 feet, the Shelby tube failed to retain samples and the piston sampler had to be used. The results of the first hole indicated that the stiff surface crust of the clay was thicker than at the Tilbury Creek site, and to simplify the exploratory program, standard 2-inch diameter penetration cone tests were made in an attempt to prove the thickness of the crust without the necessity of drilling. This proved to be impossible as the cones could not be driven beyond a depth of 10 feet.

The Penndrill arrived at the site on December 28, and progress was considerably accelerated. Hole No. 849-2 was augered by the Penndrill to 100 feet and 2-inch diameter Shelby tube samples were obtained at 15-foot intervals from the uncased 4-inch diameter hole. The hole showed no tendency to cave in and the diamond drill extended the hole to bedrock without difficulty.

The elevation of the bedrock surface was found to be essentially the same in holes Nos. 849-1 and 849-2 and it was therefore assumed to be horizontal. The remaining holes were therefore drilled only to prove

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the thickness of the upper crust of the clay till. Unlike the sampling experience in the diamond drill holes, no special difficulty was encountered in retaining 2-inch diameter Shelby tube samples in the augered holes. Despite considerable care, however, it was often found that the length of sample retained was much less than the length sampled and this was assumed to be due to the tensile strength of the clay; that is, the sample could not be twisted off but slipped inside the Shelby tube and was partially pulled out before parting at the base of the Shelby tube.

In all, six holes were drilled, sampled, and vane tested, and piezometers were installed in holes Nos. 849-1 and 849-4 to determine the elevation of the ground water table.

The program of work is given in Appendix A.

Site Conditions and Soil Properties

The site investigated is in very flat and featureless country, which slopes gently towards Lake St. Clair. The general ground surface elevation is approximately 585 feet. It is highly fertile agricultural country, drained by field drainage tiles and shallow drainage ditches flowing into Baptiste Creek.

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While drilling was in progress, there were considerable amounts of surface water lying around and all field drainage tiles were flowing. The site is in a thinly wooded area.

The materials which were encountered in the exploratory holes are described in the attached drilling logs, Plates II to IX, inclusive. The stratigraphy is much the same as at the Tilbury Creek site; that is, a clay-type till extending from the ground surface to bedrock which lies generally at a depth of about 115 feet.

(a) - Clay Till - The clay till is more or less uniform in composition but contains isolated pockets, seams, and layers of sand and sandy till, generally less than one foot in thickness. These sandy zones are generally compact and they can occur at practically any elevation. They are, in all probability, not interconnected except at the bedrock contact. Most of these seams were discovered during vane tests when it was found that, as the vane was pushed into the clay, the resistance sometimes varied considerably with depth and locally high vane shear strengths were found.

The colour of the till is generally grey, becoming lighter towards the bedrock contact. It has been

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highly weathered at the surface and the top 12 feet is generally a dark brown colour with rust coloured streaks where it is fissured.

The results of the field vane tests and the summary of the results of laboratory classification, compression, and consolidation tests performed on the samples are listed in Tables 1 to 7 and shown on Plates X to XV.

Atterberg Limits - The Atterberg limits remain practically constant with depth, showing that the clay till is uniform in composition from near the ground surface to the bedrock. The liquid limit ranges from 31 per cent to 37 per cent and the plastic limit ranges from 16 per cent to 18 per cent. The natural water content generally increases with depth from slightly less than the plastic limit in parts of the surface weathered zone, to values approximately mid-way between the plastic and liquid limits at depths greater than 50 feet. These values agree closely with the test results from the Tilbury Creek site showing that it is essentially the same deposit which covers this entire area.

Shear Strength Properties - The shear strength of the natural and remoulded clay till was determined

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in the field by means of vane tests, and in the laboratory, by unconsolidated undrained compression tests. Reasonably close agreement was found between the two types of tests, although the laboratory tests generally showed lower values than the field tests. The agreement between the remoulded tests was generally close, indicating that these test results were reliable. With regard to the tests on natural samples, it is reasonable to assume that the laboratory tests will err on the low side; small pebbles must be removed from laboratory test specimens and some disturbance can be expected in the sampling of such material. The presence of small stones in the till, however, also tends to give higher apparent shear strengths as determined in situ by the vane. The true value is therefore expected to be slightly lower than the vane but higher than the laboratory values.

The shear strength varies with depth, being high at the surface and decreasing with depth until it reaches a lower limit below which it increases again. It is similar to the Tilbury Creek area except that the stiff layer is thicker and exhibits higher shear strengths. At Tilbury East, however, the thickness of the stiff layer varies, being thickest towards the west

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and decreasing eastwards. This is shown on Plate I where the depth to which the natural shear strength is in excess of 2,000 psf, is shown to vary from 50 feet at hole No. 849-1, to 25 feet at hole No. 849-5.

Consolidation Properties - The results of consolidation tests on three samples from hole No. 849-3 are shown on Plates XVI to XIX. These tests were of the rapid type in which the load changes were made at 25-minute intervals. The preconsolidation pressures were determined by the Casagrande graphical method, and the natural consolidation characteristics were determined by a modification of the Schmartzmann method.

The results of these tests indicate that the clay till is preconsolidated to a depth of about 50 feet, below which it is normally consolidated under the existing overburden pressure (Plate XII).

(b) - Bedrock - At this site the bedrock is represented by the Hamilton formation of the Devonian System. The Hamilton formation is generally recognized as a varied series of soft calcareous shales, locally called "soapstones", with interbedded limestones and black shales, the total thickness generally exceeding 100 feet. The "soapstones" also contain nodules and lenticles of limestone. The dip of this formation in the Tilbury

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East area is very slight and practically horizontal. It was penetrated by diamond drilling in holes Nos. 849-1 and 849-2 at about elevation 470, and the bed-rock surface is believed to be very flat.

In hole No. 849-1 the "soapstone" shales are capped by sound, unweathered limestone about four feet thick while in hole No. 849-2, only six inches of more or less nodular limestone exist above the shales. For this reason it is believed that this limestone is not a continuous band. The "soapstone" shales do not appear to be as soft here as they appeared to be at the Tilbury Creek site. Diamond drill cores were difficult to recover because the shale tends to absorb water during drilling to form a mud slurry and to wash away during drilling. However, it was found to be too hard for sampling by methods other than diamond drill coring and standard 2-inch diameter penetration cones could not be driven into it.

(c) - Ground-Water Conditions - Free ground water in this region is generally encountered during drilling operations at the contact between the clay till and the bedrock. No productive aquifer appears to exist at this particular site, although a small water supply does exist at the bedrock contact. In hole No. 849-1, it was

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impossible to lower the water level in the completed hole below a depth of 70 feet by hand-bailing methods. This indicates a small supply of water which could possibly come from the thin sand seams towards the bottom of the hole. A piezometer was installed in this hole in which the water level quickly rose to within three feet of the ground surface.

A second piezometer was installed in hole No. 849-4. This hole was drilled dry using the Penn-drill, and the piezometer was installed at 25 feet below ground level; that is, within the stiff crust of the clay till.

Readings in both of these piezometers have been made weekly by the Chatham Regional Office of the Department of Highways, and have shown that, in both cases, the water table lies at approximately three feet below the ground surface. These results are shown on Plates IIId and Vc.

Design Considerations

(a) - Bearing Capacity -

General - To consider the stability of the bridge footings and the embankment, the soil profile has been assumed to be a two-layer cohesive system, the

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shear strength of which decreases linearly with depth in the upper layer and remains constant in the lower layer.* The following shear strength values have been chosen to represent the worst foundation conditions in the area:

	Depth Below Ground Surface (feet)	Undrained Shear Strength (ksf)
Upper layer ..	0 to 50	3.0 at surface decreasing linearly to 1.0
Lower layer ..	50 +	1.0 constant with depth

* Reference: Button, S.J., 1953. "The Bearing Capacity on a Two-Layer Cohesive Subsoil". Proc. Third Inter. Conf. Soil Mech., Volume 1, pages 332-335.

Embankment - A simplified analysis was used to consider the foundation stability of the embankment.

The embankment was assumed:

- (i) - to act as a single rigid strip loading
- (ii) - to be composed of two independent strip loadings whose common boundary is a vertical plane passing through the centreline of the embankment, and it was further assumed that no shear stresses could develop along this common boundary.

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By making these assumptions, the stability of the strip loadings would be governed only by the bearing pressures of the strips, the widths of the strips, and the shear strength characteristics of the foundation soil.

The following embankment dimensions and properties were used in the stability analysis:

Embankment height	20 feet
Width, toe to toe	110 feet
Width of equivalent uniformly loaded area	80 feet
Density of material	125 pcf

For an embankment pressure of 2.5 ksf, the factors of safety against ultimate failure for strip widths of 80 feet and 40 feet were found to be 2.9 and 4.0 respectively. The results of these analyses indicate that a 20-foot embankment could be safely built.

Bridge Footings - The type of foundation used for the bridge piers was assumed to be a rigid strip footing. Using a factor of safety of 3.0 against ultimate failure, the allowable net bearing pressures for different sizes and depths of footings were determined and these results are shown on Plate XX. It is seen that design pressures of the order of 5 ksf can be used for footing design.

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(b) - Settlement - The settlement of the embankment foundation was calculated assuming a total clay thickness of 115 feet. For convenience, the clay was divided into three layers at depths 0 to 40 feet, 40 to 80 feet, and 80 to 115 feet, whose consolidation characteristics are shown on Plates XVII, XVIII, and XIX, respectively. For preliminary estimates of the elastic settlements and the time rate of settlement, the following properties of the Tilbury East soil were assumed to be equal to those determined for the Tilbury Creek soil*, and their values are listed below:

- (i) - Average apparent modulus of elasticity equal to 200 ksf.
- (ii) - Average coefficient of consolidation equal to 6×10^{-4} square centimeters per second.

The embankment loading was assumed to be a uniform strip loading of 2.5 ksf, which is an over-estimation of the actual loading; the embankment is to form a ramp leading to the bridge and, therefore, the loading will be triangular rather than uniform. The calculated settlements which are listed below are, therefore, somewhat larger than those which can be expected:

* Reference: Foundation Conditions at the Tilbury Creek Crossing on Highway 401 (W.P. 160-58). December 15, 1959. By H.G. Acres & Company Limited.

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Elastic settlement 0.75 feet
Consolidation settlement 1.35 feet
Total ultimate settlement .. 2.1 feet

The elastic settlement would occur during the period of construction of the embankment, and the time taken for the settlement to become 50 per cent of the total ultimate settlement is estimated to be 10 years, assuming that drainage takes place at the ground and the bedrock surfaces. This assumption is based on the fact that drilling operations proved the existence of an aquifer just above the bedrock and that all other sand seams encountered yielded no water supply, even though they existed below the water table and were of a very permeable nature.

Conclusions

(a) - On the basis of drilling work done at the site, the general soil profile consists of clay till overlying bedrock. In two holes the bedrock was located at a depth of approximately 115 feet. The ground water level was found at about three feet below the ground surface which corresponds to the average depth of drainage ditches in the area.

(b) - The results of field and laboratory tests on the clay till indicate that it exists in a

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preconsolidated state to a depth of approximately 50 feet, and in a normally consolidated state below this depth.

(c) - A stiff surface crust, the undrained shear strength of which exceeds 2.0 ksf, exists to a depth of between 25 and 50 feet; it is 50 feet thick near hole No. 849-1 and decreases in thickness in an easterly direction to 25 feet at hole No. 849-2.

(d) - The bedrock underlying the clay till is the Hamilton formation which consists of soft shales embedded with limestones. The total thickness of this formation in the Tilbury East area is probably about 100 feet. The dip is practically horizontal and the bedrock surface appears to be very flat and at an elevation of approximately 470 feet.

At the site a thin capping, from 6 inches to 4 feet, of sound and intact limestone overlies the softer "soapstone" shales. These shales appear to be much more competent than they were found to be at Tilbury Creek, and they proved to be too hard to be sampled except by diamond drilling methods. However, this is a varied and unpredictable formation and the actual bearing capacities of piles driven into it could only be determined from the results of pile loading tests.

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(e) - The 20-foot high embankment leading to the bridge can be safely supported on the stiff clay crust. However, because the clay underlying the crust is normally consolidated, the application of a pressure of 2.5 ksf will cause relatively high settlements which will be of the order of two feet. This settlement will take place gradually, and it is estimated that 50 per cent of the total ultimate settlement will be complete after ten years.

(f) - Bridge footings loaded to 5.0 ksf can also be safely supported on the clay crust and, since these loaded areas will probably be small in comparison to the thickness of the stiff crust, the settlement due to their loads will be quite small. However, these footings will also settle due to the influence of the embankment by an amount which will be dependent upon the actual embankment loading, the location of the embankment relative to the bridge, and the sequence of construction operations.

Recommendations

In view of the fact that the stiff clay crust is capable of supporting large footing pressures and because bedrock exists at a depth of approximately

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115 feet, it is recommended that the bridge be supported on spread footings rather than piles bearing on bedrock. However, it must be borne in mind that because the bridge is skewed, some amount of differential settlement at the bridge piers is inevitable and therefore the bridge must be designed to accommodate these settlements.

APPENDIX A

Program of Work

- December 14, 1959 - Diamond drill arrived at site; regional office of D.H.O. at Chatham contacted and drilling hole No. 849-1 commenced.
- December 22, 1959 - Hole No. 849-1 completed at depth of 125 feet. Work stopped for Christmas vacation.
- December 28, 1959 - Penndrill arrived on site; hole No. 849-2 commenced.
- December 30, 1959 - Hole No. 849-3 commenced. Diamond drill commenced to prove bedrock in hole No. 849-2.
- December 31, 1959 - Hole No. 849-3 completed at 100 feet. Work stopped for New Year vacation.
- January 4, 1960 - Hole No. 849-4 commenced.
- January 5, 1960 - Hole No. 849-4 completed to 50 feet. Hole No. 849-5 commenced. Diamond drill completed hole No. 849-2 in bedrock at 122 feet.
- January 6, 1960 - Diamond drill returned to Toronto. Hole No. 849-5 completed to 50 feet. Hole No. 849-6 commenced.
- January 7, 1960 - Hole No. 849-6 completed to 55 feet. Penndrill returned to Toronto.

Summary of Drilling Time

- (i) - Diamond drill - Soil drilling
41-1/2 hours for 130 feet
Rock drilling
53-1/2 hours for 21 feet

Appendix A - 2

- (ii) - Penndrill - Soil drilling
49 hours for 355 feet
- (iii) - Overall - 144 hours for 506 feet
equivalent to 28 feet
per 8-hour day

APPENDIX B

Summary of Field and Laboratory Tests

TABLE 1SUMMARY OF FIELD VANE TEST RESULTS - HOLE NO. 849-1

Elevation Feet	Undrained Shear Strength, Psf		Sensitivity
	Natural	Remoulded	
548.9	2,640	1,480	1.8
540.7	2,320	1,390	1.7
530.9	1,480	804	1.8
515.9	1,240	715	1.7
495.4	+3,700 (not typical)	-	-
481.3	1,550	930	1.7
471.2	2,010	680	2.9
470.2	930	495	1.9

TABLE 2SUMMARY OF FIELD VANE TEST RESULTS - HOLE NO. 849-2

Elevation Feet	<u>Undrained Shear Strength, Psf</u>		Sensitivity
	Natural	Remoulded	
521.4	1,390	930	1.5

TABLE 3SUMMARY OF FIELD VANE TEST RESULTS - HOLE NO. 849-3

Elevation Feet	Undrained Shear Strength, Psf		Sensitivity
	Natural	Remoulded	
546.2	1,860	990	1.9
531.2	1,080	650	1.7
522.5	+3,700 (not typical)	-	-
517.5	1,240	770	1.6
506.2	1,700	1,080	1.6
496.2	1,730	920	1.9
481.2	1,700	870	2.0

TABLE 4SUMMARY OF FIELD VANE TEST RESULTS - HOLE NO. 849-4

Elevation Feet	Undrained Shear Strength, Psf		Sensitivity
	Natural	Remoulded	
566.6	3,240	2,010	1.6
561.6	3,100	2,010	1.5
556.6	3,100	2,170	1.4
551.6	2,780	2,010	1.4
546.6	2,620	1,550	1.7
541.6	2,010	1,240	1.6..
531.6	1,240	775	1.6

TABLE 5SUMMARY OF FIELD VANE TEST RESULTS - HOLE NO. 849-5

Elevation Feet	Undrained Shear Strength, Psf		Sensitivity
	Natural	Remoulded	
572.8	+3,700	-	-
566.3	2,320	1,550	1.5
561.3	2,170	1,550	1.4
556.5	1,860	1,240	1.5
551.5	1,700	1,240	1.4
546.5	3,100	1,700	1.8
541.5	1,420	1,080	1.3
531.5	920	465	2.0

TABLE 6SUMMARY OF FIELD VANE TEST RESULTS - HOLE NO. 849-6

Elevation Feet	Undrained Shear Strength, Psf		Sensitivity
	Natural	Remoulded	
566.3	+3,700	-	-
561.3	2,780	2,010	1.4
553.3	2,010	1,390	1.4
547.3	2,010	990	2.0
536.3	1,080	557	1.9
526.3	1,050	557	1.9

TABLE 7Summary of Laboratory Tests

Hole No.	Sample No.	Elevation Feet	Water Content %	Liquid Limit %	Plastic Limit %	S_{u_n} Psf	e_f %	S_{u_r} Psf	St
849-2	1	569	19.0	-	-	2,380	16	1,870	1.3
	2	554	20.6	-	-	1,630	20	1,038	1.6
	3	539	23.8	-	-	994	14	465	2.1
	4	524	23.9	-	-	695	20	455	1.5
	5	509	22.7	-	-	1,128	19	530	2.1
849-3	2	574	20.3	33.7	16.2	8,200	18	-	-
	6	554	20.9	32.6	17.0	1,965	19	1,328	1.5
	9	534	23.4	33.0	17.1	918	15	491	1.9
	10	524	23.6	-	-	814	15	345	2.4
	11	509	22.7	31.8	16.9	1,020	12	441	2.3
	13	484	24.6	37.7	17.5	936	20	685	1.4
849-5	2	574	15.9	32.3	16.2	7,100	18	7,475	-
	6	554	20.8	31.5	17.7	1,592	20	1,088	1.5
	9	534	24.7	32.7	17.1	834	15	343	2.6
849-6	3	569	18.0	30.7	16.7	4,250	20	2,945	1.4
	6	556	20.5	32.5	16.7	1,785	20	1,130	1.6
	10	529	23.5	-	-	806	14	404	2.0

 e_f - Failure strain S_{u_n} = Natural undrained shear strength S_{u_r} = Remoulded undrained shear strength

St = Sensitivity

APPENDIX C

List of Plates

- | | | |
|-------------|---|---|
| Plate I | - | Exploratory Holes, Plan and Section |
| Plate II | - | Drilling Report, Hole No. 849-1 |
| Plate III | - | Drilling Report, Hole No. 849-2 |
| Plate IV | - | Drilling Report, Hole No. 849-3 |
| Plate V | - | Drilling Report, Hole No. 849-4 |
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| Plate VIII | - | Standard Penetration Cone Test 849-7 |
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| Plate X | - | Summary of Drilling and Test Results,
Hole No. 849-1 |
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Hole No. 849-5 |
| Plate XV | - | Summary of Drilling and Test Results,
Hole No. 849-6 |
| Plate XVI | - | Determination of Origin of "P-e" Curves |
| Plate XVII | - | Consolidation Test, Hole No. 849-3,
Sample Elevation 484 Feet. |
| Plate XVIII | - | Consolidation Test, Hole No. 849-3
Sample Elevation 554 Feet. |

Appendix C -- 2

- Plate XIX - Consolidation Test, Hole No. 849-3
 Sample Elevation 534 Feet.
- Plate XX - Allowable Net Bearing Pressures for
 Footings of Different Sizes and
 Depths.

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

DRILLING REPORT

CLIENT Department of Highways of Ontario JOB No. 849
 PROJECT Highway 2 Crossing Highway 401 (WP-165-58) HOLE No. 849-1
 SITE Tilbury East SHEET No. 1 OF 1
 CONTRACTOR: F.E. Johnston Drilling Co. Ltd. STARTED 4:00 P.M. December 14 1959
 FINISHED 5:30 P.M. December 22 1959
 METHOD SOIL Modified Wash Boring CASING DIAM. BX
 OF DRILLING: ROCK Diamond Drill CORE DIAM. BX
 LOCATION: LATITUDE CH 202 + 81 ELEVATIONS: DATUM G.S.C.
 DEPARTURE 42 feet left DRILL PLATFORM --
 BEARING --- GROUND SURFACE 583.9
 INITIAL DIP 90 degrees ROCK SURFACE 468.9
 OTHER DIPS --- BOTTOM OF HOLE 458.4
 --- WATER TABLE 580.0

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	
0.0	Top soil	Black organic soil, dry, hard.	1	A.C.	2	Inches	Feet	Blows
						5.0		
1.0						5.5		13
						6.0		25
	Clay till	Brown and grey, uniform, dry to slightly moist, fissured but intact, very stiff, with scattered pebbles which are partially rounded and composed of black shale and limestone fragments.	2	A.C.	2	10.0	18"	36
						10.5		9
						11.0		22
						11.5	18"	32
			3	A.C.	2	15.0		
						15.5		12
						16.0		15
32.0	Clay till	Brown and grey, stiff and tenacious, with hard band at 53.0 to 54.0	4	B.C.	2	17.5	18"	20
						18.0		pushed to refusal
60.0	Clay till	Grey, uniform, firm and tenacious with scattered pebbles which are mostly angular.	5	B.C.	2	20.0		pushed to refusal
						20.25		refusal
						20.75	9"	27 blows
82.3			6	A.C.	2	25.0		
						25.5		7
						26.0		12
						26.5	Nil	20

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 G. Wilson
 LOGGED BY G. Wilson

APPROVED

A. H. MacDonald

DATE

January 27, 1960

H. G. ACRES & COMPANY LIMITED — CONSULTING ENGINEERS

NIAGARA FALLS, CANADA

DRILLING REPORT

CLIENT Department of Highways of Ontario

JOB No. 849

PROJECT Highway 2 Crossing Highway 401 (WP-165-58)

HOLE No. 849-1

SITE Tilbury East

SHEET No. 2 OF 4

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	RET'D	
					Inches	Feet		
88.3	Clay till	Light grey, stiff and tenacious..	7	B.O.	2	30.0		pushed to
		Contains lenses or layers of both harder and softer material.				31.0	12"	refusal
		The harder materials are probably lenses of sandy till.						
		Contains very few pebbles.						
		Hard bands at:						
		88.3 to 89.0						
		111.25 to 112.0						
		114.5 to 115.0						
					Vane test at	35.0		pushed
			8	B.O.	2	35.0		pushed to
						36.5	18"	refusal
			9	B.O.	2	40.0		pushed to
						41.0		refusal
						41.5	18"	13 blows
					Vane test at	43.2		pushed
115.0	Bedrock	Grey fossiliferous limestone,	10	B.O.	2	50.0		
	(Hamilton	horizontally bedded,				51.5	18"	pushed
	Shale	only moderately hard			Vane test at	53.0		pushed
	Formation)	but intact, becoming	11	B.Z.	2	60.0		(hard for
		softer towards the				61.7	Nil	top 6")
		bottom,						pushed
119.5			12	C.Z.	2	62.0		
						64.0	Nil	pushed
	(Hamilton	Grey shale, ("soapstone")						
	Shale	laminated and horizontally	13	C.C.	2	64.0		
	Formation)	bedded, generally intact				66.0	24"	pushed
		and dry; forms a mud						
		slurry when drilled;			Vane test at	68.0		pushed
		too hard to be sampled						
		except by diamond	14	C.O.	2	85.0		
		drill, highly				86.7	21"	pushed
		fossiliferous.						
					Vane test at	88.5		pushed to
125.5	End of hole							refusal
			15	C.O.	2	99.6		
						101.4	22"	pushed
					Vane test at	102.6		pushed
			16	C.O.	2	110.0		pushed to
						111.2	15"	refusal
					Vane test at	112.7		pushed

DRILLING REPORT

JOB No. 849

HOLE No. 849-1

SHEET No. 3 OF 4

520

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

DRILLING REPORT

CLIENT Department of Highways of Ontario

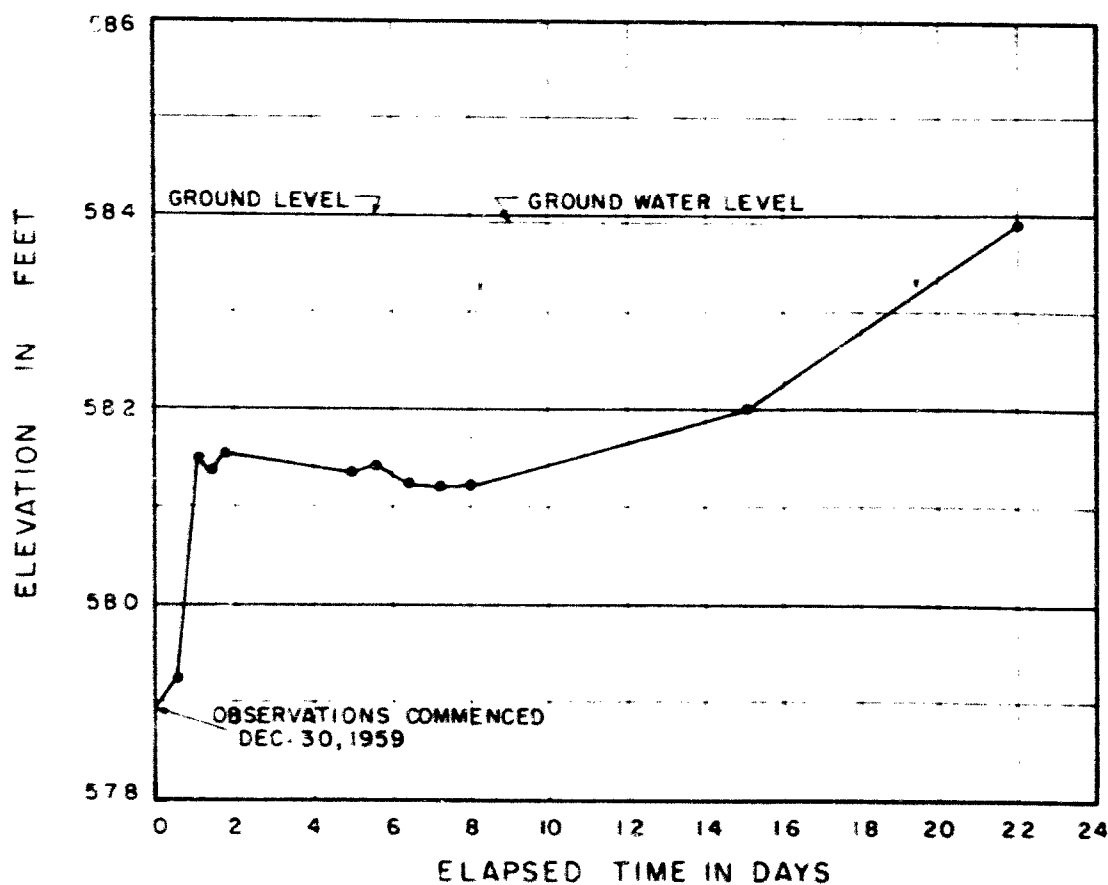
JOB No. 849

PROJECT Highway 2 Crossing Highway 401 (WP-165-58)

HOLE No. 849-1

SITE Tilbury East

SHEET No. 1 OF 4



RECORD OF PIEZOMETER OBSERVATIONS
IN HOLE No. 849-1

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

DRILLING REPORT

CLIENT Department of Highways of Ontario JOB No. 849
 PROJECT Highway 2 Crossing Highway 401 (WP-165-58) HOLE No. 849-2
 SITE Tilbury East SHEET No. 1 OF 2

CONTRACTOR: F.E. Johnston Drilling Co. Ltd. STARTED 8:00 A.M. December 29 1959
 FINISHED 5:00 P.M. December 31 1959
 METHOD SOIL Pendrill to 100 feet (4" Auger) CASING DIAM. BX for Diamond
 OF Drilling
 DRILLING: ROCK Diamond Drill CORE DIAM. 3X

LOCATION: LATITUDE CH 200 + 78 ELEVATIONS: DATUM G.S.C.
 DEPARTURE 53 feet right DRILL PLATFORM --
 BEARING -- GROUND SURFACE 584.4
 INITIAL DIP 90 degrees ROCK SURFACE 469.9
 OTHER DIPS -- BOTTOM OF HOLE 461.4
 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	RET'D	
0"	Road shoulder material	Mixture of black earth and gravel, compact.	1	B.O.	2" diam	15.0		machine
						16.5	18"	pushed
0.75			2	B.O.	2"	30.0		machine
						31.5	18"	pushed
	Clay till	Mottled brown and rust coloured, stiff, weathered, fissured but intact, moist, nonstratified, containing scattered pebbles which are slightly rounded.	3	B.O.	2"	42.0		machine
						44.7	21"	pushed
10.0			4	B.O.	2"	60.0		
						61.5	18"	pushed
	Clay till	Gray and brown stiff and tenacious, slightly weathered with rust coloured streaks, moist.	Vane test at			63.0		pushed
			5	B.O.	2"	75.0		
						76.5	18"	pushed
45.0			6	B.O.	2"	90.0		
	Clay till	Grey, firm and tenacious with only very few small pebbles.				91.5	18"	pushed
			7	B.O.	2"	100.0		
87.0						101.5	18"	pushed
	Clay till	Light grey, stiff, probably stratified with firm bands and sand lenses especially towards the bottom.						
114.5								

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 T.N.
 Q - GLASS JAR

R - CLOTH BAG
 S - PLASTIC BAG
 Z - DISCARDED

INSPECTOR G. Wilson

LOGGED BY G. Wilson

APPROVED

D. H. Macdonald

DATE

January 29, 1960

DRILLING REPORT

JOB No. 849

HOLE No. 849-2

SHEET No. 2 OF 2

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

DRILLING REPORT

CLIENT Department of Highways of Ontario JOB No. 849
 PROJECT Highway 2 Crossing Highway 401 (WP-165-58) HOLE No. 849-3
 SITE Tilbury East SHEET No. 1 OF 2

CONTRACTOR: F.E. Johnston Drilling Co. Ltd. STARTED 11:00 A.M. December 30 1959
 FINISHED 12:00 P.M. January 4 1960

METHOD SOIL Pendrill (4" Auger) CASING DIAM. --
 OF
 DRILLING: ROCK CORE DIAM. --

LOCATION: ~~LATITUDE~~ CH 201 + 91 ELEVATIONS: DATUM G.S.C.
 DEPARTURE 54 feet left DRILL PLATFORM --
 BEARING -- GROUND SURFACE 584.0
 INITIAL DIP 90 degrees ROCK SURFACE --
 OTHER DIPS -- BOTTOM OF HOLE 481.2
 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 ★ 1
			NO.	TYPE *	SIZE	DEPTH	RET'D	
					Inches	Feet		
0.0	Road shoulder material	Compact black earth and gravel mixture, dry.	1	B.4.	2	5.0		
						5.5		pushed
						6.0		12
0.5	Clay till	Yellow and rust coloured, weathered, dry, fissured but intact, very stiff.	2	B.O.	2	10.0	8"	20
						10.5		pushed
						11.0		24
7.0	Clay till	Brown (with rusty streaks) weathered, fissured but intact, moist, very stiff.	3	B.O.	2	15.0	14"	44
						15.5		6
						16.0		14
12.0	Clay till	Grey, very stiff.	4	B.O.	2	20.0	8"	21
						20.5		5
						21.0		11
25.0	Clay till	Grey, stiff.	5	B.O.	2	25.0	12"	15
						25.5		
						26.0		
45.0						26.5	18"	pushed

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
 Z — DISCARDED

INSPECTOR G. Wilson

LOGGED BY G. Wilson

APPROVED

D. H. MacDonald

DATE

January 29, 1960

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

DRILLING REPORT

CLIENT Department of Highways of Ontario

JOB No. 849

PROJECT Highway 2 Crossing Highway 401 (HP-165-58)

HOLE No. 849-3

SITE Tilbury East

SHEET No. 2 OF 2

DEPTH	SOIL TYPE	DESCRIPTION COLOUR, CONSISTENCY, STRUCTURE, WATER CONTENT, PLASTICITY, COMPACTNESS, WATER LOSS OR GAIN, ETC.	SAMPLE					PENETRATION TEST
			NO	TYPE	SIZE	DEPTH	REFD	
					Inches	Feet		
45.0			6	B.O.	2	30.0		
						31.5	18"	pushed
	Clay till	Grey, firm, tenacious (Probably large pebble at 61'-6" preventing vane penetration).	7	B.O.	2	35.0		
						36.5	18"	pushed
70.0					Vane test at	37.7		pushed
	Clay till	Grey, stiff, tenacious partially stratified with firm and stiff bands.	8	B.O.	2	40.0		
						41.5	18"	pushed
102.75	End of hole		9	B.O.	2	50.0		
						51.5	18"	pushed
					Vane test at	52.7		pushed
			10	B.O.	2	60.0		
						61.5	18"	pushed
					Vane test at	61.5		vane will not penetrate
					Vane test at	66.5		pushed
			11	B.O.	2	75.0		
						76.5	18"	pushed
	Notes:				Vane test at	77.7		pushed
	1. Penetration test:		12	B.O.	2	85.0		
		This is the number of blows of a 140-lb weight falling 30 inches required to advance the sampler to distance indicated.			Vane test at	87.7		pushed
			13	B.O.	2	100.0		
						101.5	18"	pushed
	2. No water struck during drilling but during weekend of December 31, 1959 to January 4, 1960, water collected to 37'-0" and hole caved in to 40'-0" below ground level.				Vane test at	102.7		pushed
	3. Hole filled in and plugged January 7, 1960							

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

DRILLING REPORT

CLIENT Department of Highways of Ontario JOB No. 849
PROJECT Highway 2 Crossing Highway 401 (WP-165-58) HOLE No. 849-4
SITE Tilbury East SHEET No. 1 OF 3

CONTRACTOR: F.E. Johnston Drilling Co. Ltd. STARTED 2:30 P.M. January 4 1960
FINISHED 1:30 P.M. January 5 1960

METHOD SOIL Fendrill (4" Auger) CASING DIAM. --
OF DRILLING: ROCK -- CORE DIAM. --

LOCATION: LATITUDE CH 202 + 83 ELEVATIONS: DATUM G.S.C.
DEPARTURE 148 feet left DRILL PLATFORM --
BEARING -- GROUND SURFACE 584.4
INITIAL DIP 90 degrees ROCK SURFACE --
OTHER DIPS -- BOTTOM OF HOLE 531.6
-- 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	
0.0	Road shoulder material	Compact black earth and gravel mixture, dry.	1	B.O.	2	5.0		* 1 Blows
0.5	Clay till	Yellow and rust coloured, weathered, fissured, moist but intact, compact and hard.				5.5		8
						6.0		23
						6.5	16"	37
7.0	Clay till	Brown with rust coloured streaks, moist, partially weathered, fissured but intact, very stiff.	2	B.O.	2	10.0		6
						10.5		16
						11.0	14"	25
			3	B.O.	2	15.0		5
						15.5		8
12.0	Clay till	Grey, uniform, very stiff and tenacious				16.0		14
						16.5	18"	
						Vane test at 17.7		pushed
34.0	Clay till	Grey, uniform, stiff and tenacious	4	B.O.	2	20.0		pushed
						21.5	18"	hard
						Vane test at 22.7		pushed
52.75	End of hole		5	B.O.	2	25.0		pushed
						26.5	18"	hard
						Vane test at 27.7		pushed

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 - PNEUMATIC BAG
Z - DISCARDED

INSPECTOR G. Wilson

LOGGED BY G. Wilson

APPROVED

D. H. MacDonald.

DATE

January 29, 1960

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

CLIENT Department of Highways of Ontario

JOB No. 849

PROJECT Highway 2 Crossing Highway 401 (WP-165-58)

HOLE No. 849-4

SITE Tillary East

SHEET No. 2 OF 3

DEPTH	SOIL TYPE	DESCRIPTION COLOUR, CONSISTENCY, STRUCTURE, WATER CONTENT, PLASTICITY, COMPACTION, WATER LOSS OR GAIN, ETC	SAMPLE					PENETRATION TEST
			NO	TYPE	SIZE	DEPTH	RETD	
					Inches	Feet		
			6	B.O.	2	30.0		
						31.5	18"	pushed
					Vane test at	32.7		pushed
			7	B.O.	2	35.0		
						36.5	18"	pushed
					Vane test at	37.7		pushed
			8	B.O.	2	40.0		
						41.5	12"	pushed
					Vane test at	42.7		pushed
			9	B.O.	2	50.0		
						51.5	18"	pushed
					Vane test at	52.7		pushed
		Notes:						
		1. Penetration Test:						
		This is the number of blows of a 140-lb weight falling 30 inches required to advance the sampler to distance indicated.						
		2. No appreciable water struck during drilling but with the hole at 23.0 feet, about 2 inches of water collected in bottom of hole overnight.						
		When hole at 52.75 feet, water collected in bottom of hole to depth of 3'-0" between January 5, 1960 and January 7, 1960.						
		3. Carborundum piezometer tip installed at 25 feet below ground level.						

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

DRILLING REPORT

CLIENT Department of Highways of Ontario

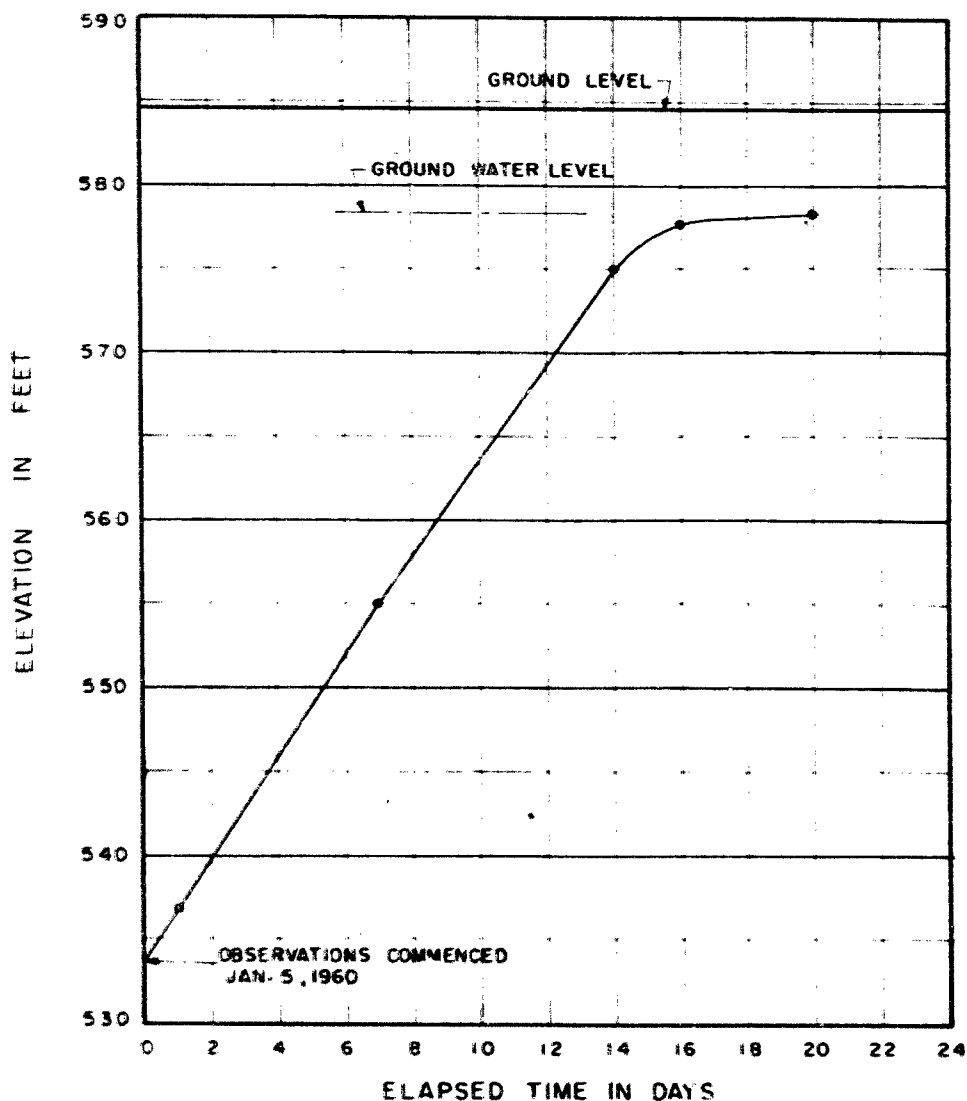
JOB No. 849

PROJECT Highway 2 Crossing Highway 401 (WP-165-58)

HOLE No. 849-4

SITE Tilbury East

SHEET No. 3 OF 3



RECORD OF PIEZOMETER OBSERVATIONS
IN HOLE No. 849-4

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

DRILLING REPORT

CLIENT Department of Highways of Ontario JOB No. 849
PROJECT Highway 2 Crossing Highway 401 (HF-165-58) HOLE No. 849-5
SITE Milbury East SHEET No. 1 OF 2
CONTRACTOR: F.E. Johnston Drilling Co. Ltd. STARTED 2:30 P.M. January 5 1960
FINISHED 12:00 P.M. January 6 1960
METHOD SOIL Fendrill (4" Auger) CASING DIAM. ---
OF DRILLING: ROCK -- CORE DIAM. ---
LOCATION: LATITUDE ON 200 + 30 ELEVATIONS: DATUM C.S.C.
DEPARTURE 164 feet right DRILL PLATFORM --
BEARING -- GROUND SURFACE 584.3
INITIAL DIP 50 degrees ROCK SURFACE --
OTHER DIPS -- BOTTOM OF HOLE 534.3
WATER TABLE --

DEPTH	SOIL TYPE	DESCRIPTION, COLOUR, CONSISTENCY, STRUCTURE, WATER CONTENT, PLASTICITY, COMPACTNESS, WATER LOSS OR GAIN, ETC.	SAMPLE					PENETRATION TEST
			NO	TYPE *	SIZE Inches	DEPTH Feet	RET'D	
0	Road shoulder material	Brown earth and gravel mixture, compact, dry.	1	B.C.	2	5.0		1 Blows
0'-0"						5.5		9
						6.0		30
						6.5	8"	39
7'-0"	Clay till	Yellow and rust coloured, weathered, fissured, dry but intact, compact and hard	2	B.O.	2	10.0		
						10.5		9
						11.0		18
						11.5	12"	24
17'-0"	Clay till	Brown, weathered, slightly moist, very stiff, fissured but intact and uniform.	Vane test at			11.5	(vane did not penetrate soil)	
			3	B.C.	2	15.0		
						15.5		3
						16.0		9
47'-0"	Clay till	Grey, slightly moist, stiff, and tenacious, uniform, except for occasional thin interbedded sand lenses and pockets. 10-inch thick compact, coarse, <u>slate graded</u> and saturated sand lenses at 41.2 to 41.7, and 37.5 to 38.0.	Vane test at			16.0		pushed
			4	B.O.		20.0		
						20.5		
						21.0		pushed
						21.5	18"	hard
50'-0"	Clay till	Grey, firm and tenacious, uniform.	Vane test at			23.0		pushed
50.0	End of hole							

SAMPLING METHOD

A - SPIG TUBE
B - MIN. 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 - CROTH BAG
S - PEXFILM BAG
Z - DISCARDED

INSPECTOR G. Wilson

LOGGED BY G. Wilson

APPROVED

H. H. MacDonald

DATE

January 29, 1960

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

DRILLING REPORT

CLIENT Department of Highways of Ontario

JOB No. 849

PROJECT Highway 2 Crossing Highway 401 (A.P-165-58)

HOLE No. 849-5

SITE Tilbury East

SHEET No. 2 OF 2

DEPTH	SOIL TYPE	DESCRIPTION COLOUR, CONSISTENCY, STRUCTURE, WATER CONTENT, PLASTICITY, COMPACTION, WATER LOSS OR GAIN, ETC.	SAMPLE					PENETRATION TEST
			NO	TYPE	SIZE	DEPTH	RETD	
					Inches	Feet		
			5	B.O.	2	25.0		
						26.5	13"	pushed
					Vane test at	27.7		pushed
			6	B.O.	2	30.0		
						31.5	9"	pushed
					Vane test at	32.7		pushed
			7	B.O.	2	35.0		
						36.5	18"	pushed
					Vane test at	37.7		pushed
			8	B.O.	2	40.0		
						41.5	17"	pushed
					Vane test at	42.7		pushed
			9	B.O.	2	50.0		
						51.5	18"	pushed
					Vane test at	52.7		pushed
		Notes:						
		* 1. Penetration Test:						
		This is the number of blows of a 140-lb weight falling 30 inches required to advance the sampler to distance indicated.						
		2. no water struck during drilling. Hole still dry 24 hours afterwards.						
		3. hole filled in and plugged January 7, 1960.						

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

DRILLING REPORT

CLIENT Department of Highways of Ontario

JOB No. 849

PROJECT Highway 2 Crossing Highway 401 (J.P-165-58)

HOLE No. 849-5

SITE Tilbury East

SHEET No. 2 OF 2

DEPTH	SOIL TYPE	DESCRIPTION COLOUR CONSISTENCY, STRUC TURE, WATER CONTENT, PLASTICITY, COM PACTNESS, WATER LOSS OR GAIN, ETC	SAMPLE					PENETRATION TEST
			NO	TYPE	SIZE Inches	DEPTH Feet	RET D	
			5	B.O.	2	25.0		
						26.5	13"	pushed
					Vane test at	27.7		pushed
			6	B.O.	2	30.0		
						31.5	9"	pushed
					Vane test at	32.7		pushed
			7	B.v.	2	35.0		
						36.5	18"	pushed
					Vane test at	37.7		pushed
			8	E.O.	2	40.0		
						41.5	17"	pushed
					Vane test at	42.7		pushed
	Notes:		9	E.O.	2	50.0		
						51.5	18"	pushed
		* 1. Penetration Test:			Vane test at	52.7		pushed
		This is the number of blows						
		of a 140-lb weight falling						
		30 inches required to						
		advance the sampler to						
		distance indicated.						
		2. No water struck during						
		drilling.						
		Hole still dry 24 hours						
		afterwards.						
		3. hole filled in and plugged						
		January 7, 1960.						

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

DRILLING REPORT

CLIENT	Department of Highways of Ontario	JOB No. 849
PROJECT	Highway 2 Crossing Highway 401 (WP-165-58)	HOLE No. 849-6
SITE	Tilbury East	SHEET No. 1 OF 2
CONTRACTOR: F.E. Johnston Drilling Co. Ltd.		
STARTED 1:30 P.M. January 6 1960		
FINISHED 10:30 A.M. January 7 1960		
METHOD OF DRILLING:	SOIL Pendrill (4" Auger)	CASING DIAM. --
	ROCK --	CORE DIAM. --
LOCATION:	ELEVATIONS: DATUM C.S.C.	
	COORDINATE CH 201 + 81	
	DEPARTURE 21 feet right	DRILL PLATFORM --
	BEARING --	GROUND SURFACE 584.1
	INITIAL DIP 90 degrees	ROCK SURFACE --
	OTHER DIPS --	BOTTOM OF HOLE 526.8
		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	
					Inches	Feet		* 1 Blows
0'	Road shoulder material	Compact black earth and gravel mixture, dry.						
0.5	Clay till	Brown and rust coloured hard, weathered, fissured but intact, dry.	1	A.O.	2	5.0		8
						5.5		16
						6.0		20
7.0	Clay till	Gray, very stiff and tenacious, slightly moist, uniform.	2	A.O.	2	10.0		7
						10.5		13
						11.0		22
22.0	Clay till	Gray, stiff and tenacious	3	B.O.	2	15.0		7
						15.5		13
45.0	Clay till	Gray, firm and tenacious with very few scattered pebbles.	4	B.O.	2	20.0		5
						20.5		10
57.75	End of hole					21.0		16
						21.5	12"	
					Vane test at	22.7		pushed

SAMPLING METHOD

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

1 - AUGER
 2 - WASH

SHIPPING CONTAINER

N - INSERT
 O - TUBE
 P - WATER CONTENT TIN
 Q - GLASS JAR
 R - CLOTH BAG
 S - PHOSPHOR BAG
 Z - DISCARDED

INSPECTOR G. Wilson

LOGGED BY G. Wilson

APPROVED

D. H. MacDonald

DATE

January 29, 1960

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

CLIENT Department of Highways of Ontario

JOB No. 849

PROJECT Highway 2 Crossing Highway 401 (WF-165-58)

HOLE No. 849-6

SITE Tilbury East

SHEET No. 2 OF 2

DEPTH	SOIL TYPE	DESCRIPTION COLOUR, CONSISTENCY, STRUCTURE, WATER CONTENT, PLASTICITY, COMPACTION, WATER LOSS OR GAIN, ETC	SAMPLE					PENETRATION TEST
			NO	TYPE	SIZE	DEPTH	RETD	
					Inches	Feet		
			5	B.Z.	2	25.0		
						26.5	Nil	pushed
			6	B.O.	2	28.0		
						29.5	18"	pushed
					Vane test at	30.7		pushed
			7	B.O.	2	34.0		
						35.5	18"	pushed
					Vane test at	36.7		pushed
			8	B.Z.	2	40.0		
						41.5	Nil	pushed
			9	B.O.	2	45.0		
						46.5	18"	pushed
					Vane test at	47.7		pushed
			10	B.O.	2	55.0		pushed
						56.5	18"	
					Vane test at	57.7		pushed
		Notes:						
		* 1. Penetration Test:						
		This is the number of blows						
		of a 140-lb weight falling						
		30 inches required to advance						
		the sampler the distance						
		indicated.						
		2. No water struck during						
		drilling. Hole remained						
		dry overnight January 6,						
		1960 to January 7, 1960.						
		3. Hole filled in and plugged						
		January 7, 1960.						

DRILLING REPORT

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
		<u>Remarks</u>				<u>Feet</u>	
						0	
		The stiff crust of the clay				1	3
		till cannot be penetrated by				2	5
		driving a standard				3	12
		penetration cone.				4	23
						5	21
						6	45
						7	46
						8	61
						9	140
						9.4	200
							refusal
		* D.H.O. Cone Penetration Test:					
		Number of blows of a 140-lb					
		weight falling 30 inches					
		required to advance the					
		cone one foot.					

<u>SAMPLING METHOD</u>		<u>SHIPPING CONTAINER</u>	
* A - SPLIT TUBE	I - AUGER	N - INSERT	R - CLOTH BAG
B - THIN WALL TUBE	F - WASH	O - TUBE	S - PEXOFILM BAG
C - PISTON SAMPLER		P - WATER CONTENT TIN	Z - DISCARDED
D - CORE BARREL		Q - GLASS JAR	

INSPECTOR	G. Wilson	APPROVED	D. H. MacDonald.
LOGGED BY	G. Wilson	DATE	January 29, 1960

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

DRILLING REPORT

CLIENT	Department of Highways of Ontario	JOB No.	849
PROJECT	Highway 2 Crossing Highway 401 (WP-165-58)	HOLE No.	849-8
SITE	Tilbury East	SHEET No.	1 OF 1
CONTRACTOR:	F.E. Johnston Drilling Co. Ltd	STARTED	9:00 AM. December 30 1959
		FINISHED	10:00 AM. December 30 1959
METHOD OF DRILLING:	SOIL D.H.C. Cone Penetration Test	CASING DIAM.	--
	ROCK	CORE DIAM.	--
LOCATION:	LATITUDE CH 202 + 83 DEPARTURE 158 feet left BEARING -- INITIAL DIP 90 degrees OTHER DIPS --		
	ELEVATIONS: DATUM G.S.C. DRILL PLATFORM -- GROUND SURFACE 584.4 ROCK SURFACE -- BOTTOM OF HOLE 573.9 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	
		<u>Remarks:</u>				<u>Feet</u>		<u>Blows</u>
		The stiff crust of the clay				0		
		till cannot be penetrated by				1		3
		driving a standard penetration				2		6
		cone.				3		10
						4		13
						5		18
						6		23
						7		24
						8		44
						9		49
						10		112
						10.5		200
								refusal
		★ D.H.C. Cone Penetration Test:						
		Number of blows of a 140-lb						
		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 - PAPER BAG
 Z - DISCARDED

INSPECTOR U. Wilson

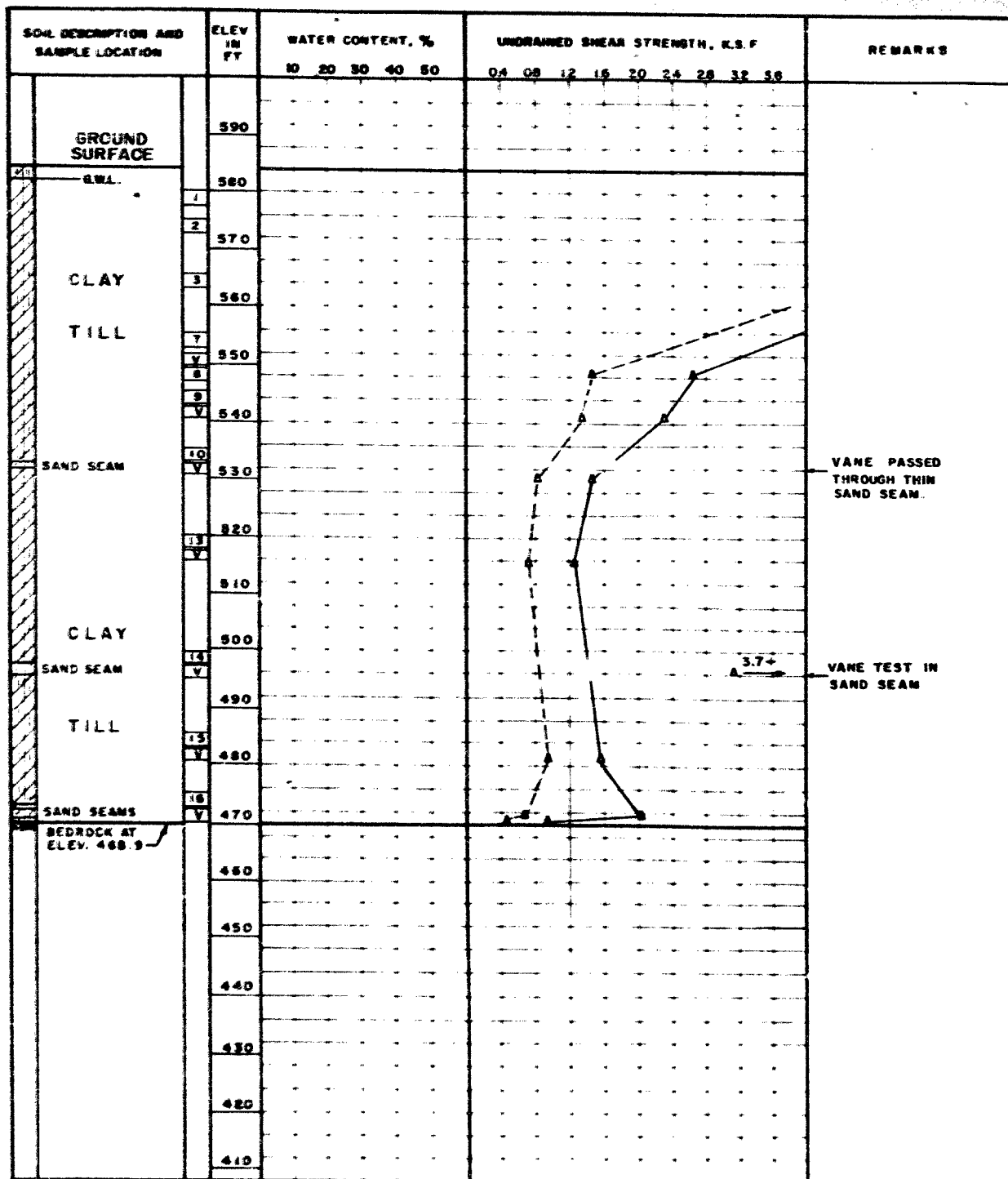
LOGGED BY U. Wilson

APPROVED

D. H. MacDonald.

DATE

January 29, 1960



[S] SOIL SAMPLE OR VANE TEST
 [O] NATURAL WATER CONTENT
 [L] LIQUID LIMIT
 [P] PLASTIC LIMIT

[C] UNDRAINED COMPRESSION TEST
 [A] FIELD VANE TEST
 [—] NATURAL STRENGTH
 [---] 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. 849-1

DEPARTMENT OF HIGHWAYS OF ONTARIO

APPROVED

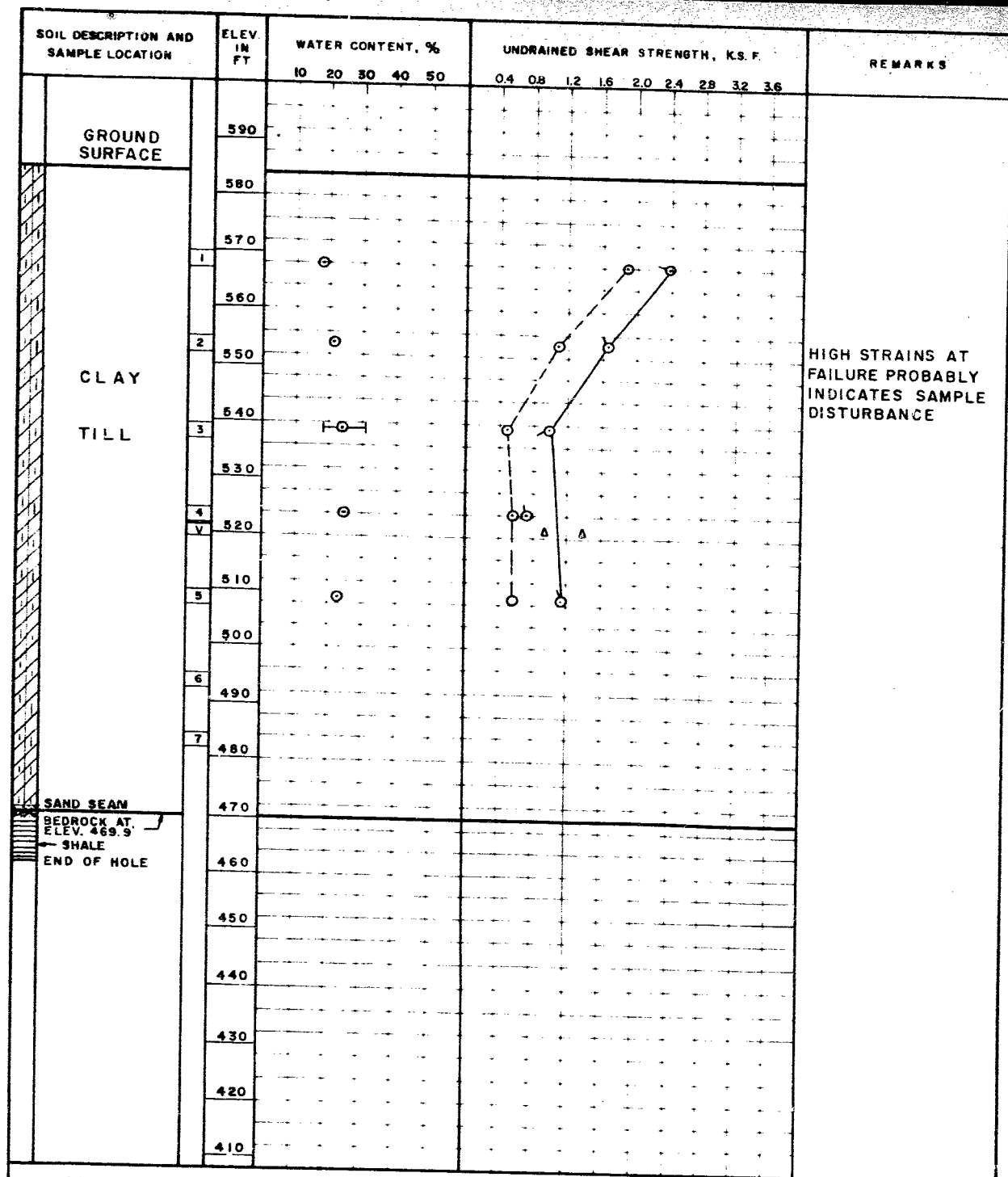
DATE JAN 29, 1960

HWY. 2 CROSSING HWY 401 (WP 165-58)

D. H. Macdonald
 H G ACRES & COMPANY LTD

JOB No 849

PLATE X



3

SOIL SAMPLE OR VANE TEST

○

NATURAL WATER CONTENT

—

LIQUID LIMIT

—

PLASTIC LIMIT

○

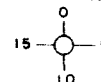
UNDRAINED COMPRESSION TEST

△

FIELD VANE TEST

NATURAL STRENGTH

REMOULDED STRENGTH



FAILURE STRAIN

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

SUMMARY OF DRILLING AND TEST
RESULTS

HOLE No. 849-2

DEPARTMENT OF HIGHWAYS OF ONTARIO

APPROVED

DATE JAN. 29, 1960

HWY. 2 CROSSING HWY 401 (W.P. 165-58)

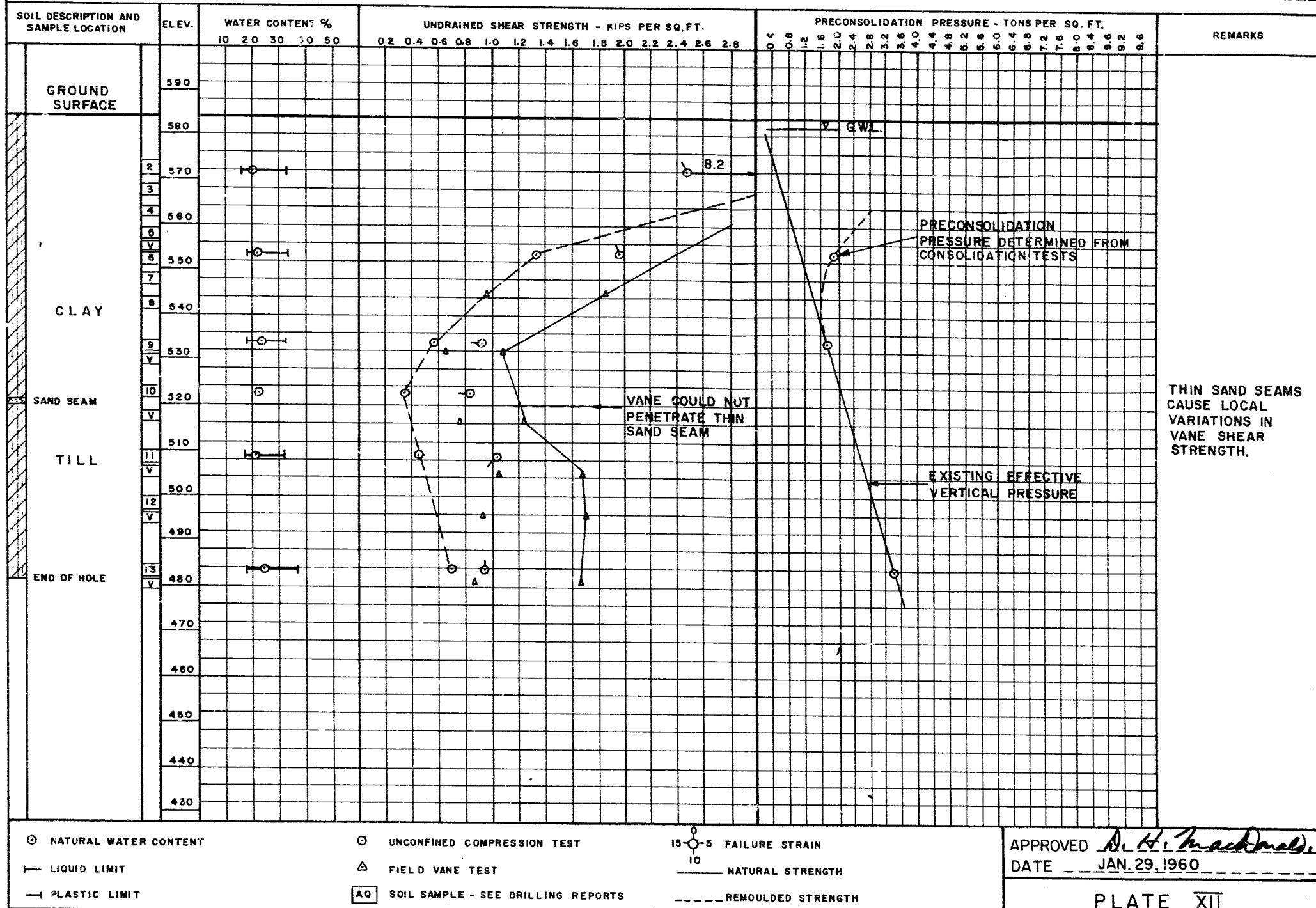
D. H. MacDonald
H. G ACRES & COMPANY LTD.

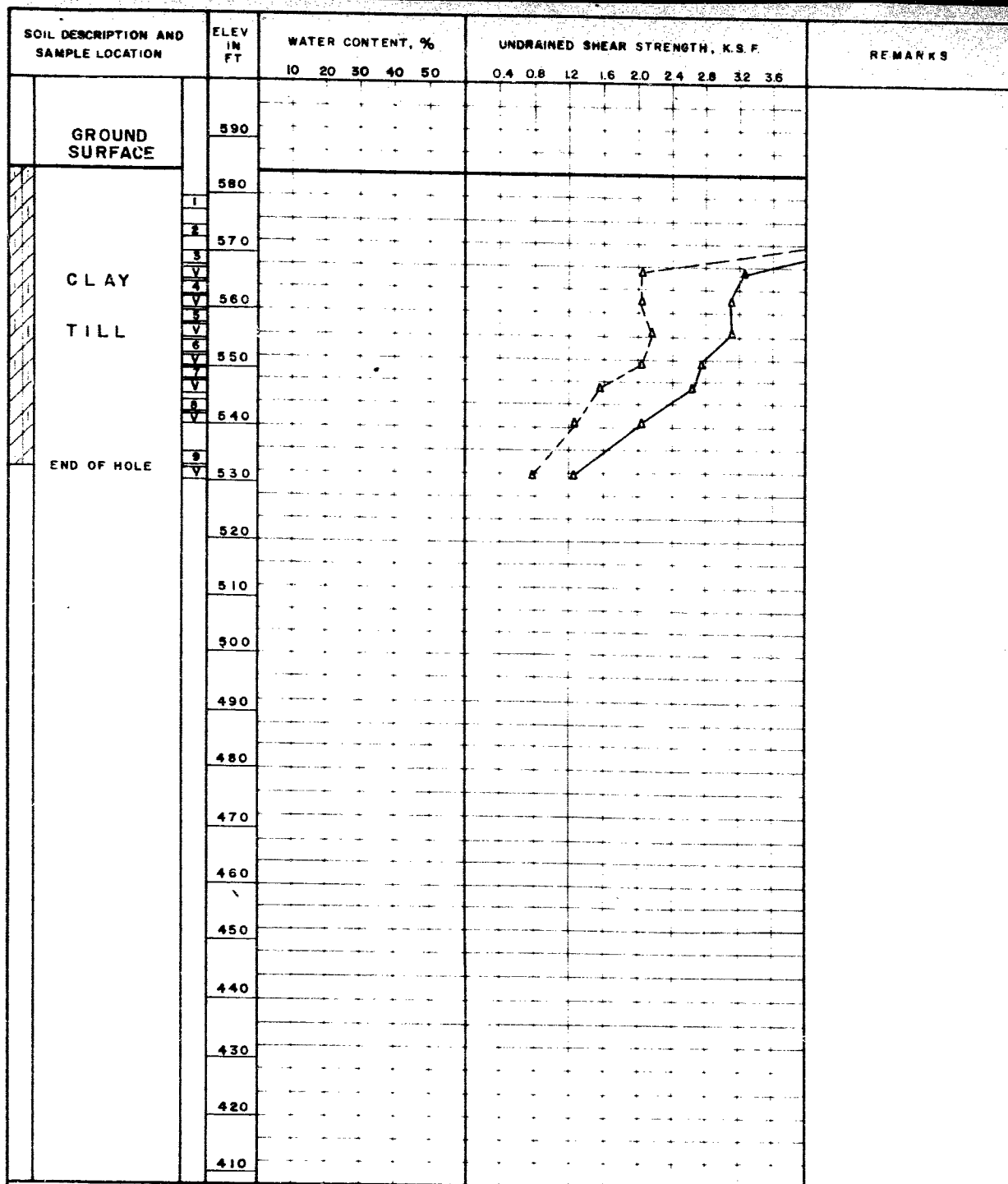
JOB No. 849

PLATE XI

SUMMARY OF DRILLING & TEST RESULTS

JOB NO. 849
HOLE NO. 849-3
SHEET 1 OF 1

ELEVATION DATUM G. S. C.



☒ SOIL SAMPLE OR VANE TEST
☐ NATURAL WATER CONTENT
☐ LIQUID LIMIT
☐ PLASTIC LIMIT

☐ UNDRAINED COMPRESSION TEST
☐ FIELD VANE TEST
☐ NATURAL STRENGTH
☐ REMOULDED STRENGTH

15 — 0 — 5
 10
 FAILURE STRAIN

H G ACRES & COMPANY LIMITED
 CONSULTING ENGINEERS
 NIAGARA FALLS CANADA

SUMMARY OF DRILLING AND TEST RESULTS

HOLE No. 849-4

DEPARTMENT OF HIGHWAYS OF ONTARIO

APPROVED

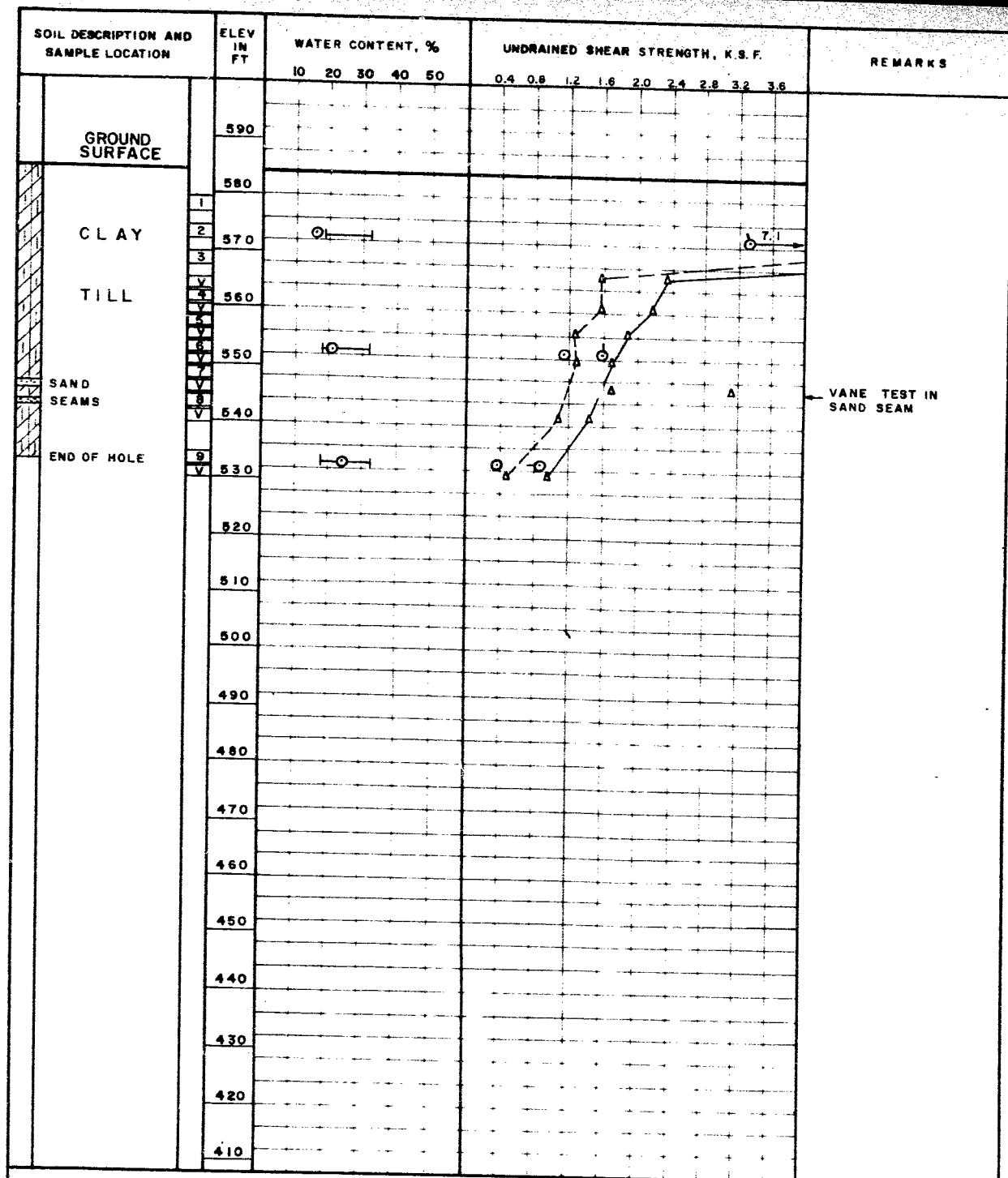
DATE JAN. 29, 1960

HWY. 2 CROSSING HWY. 401 (W.P. 165-58)

D. H. Macdonald
 H G ACRES & COMPANY LTD.

JOB No 849

PLATE XIII



3 SOIL SAMPLE OR VANE TEST
 ○ NATURAL WATER CONTENT
 — LIQUID LIMIT
 — PLASTIC LIMIT

○ UNDRAINED COMPRESSION TEST
 △ FIELD VANE TEST
 — NATURAL STRENGTH
 - - - REMOULDED STRENGTH

15 — 5
 10
 FAILURE STRAIN

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

SUMMARY OF DRILLING AND TEST
 RESULTS

HOLE No. 849-5

DEPARTMENT OF HIGHWAYS OF ONTARIO

APPROVED

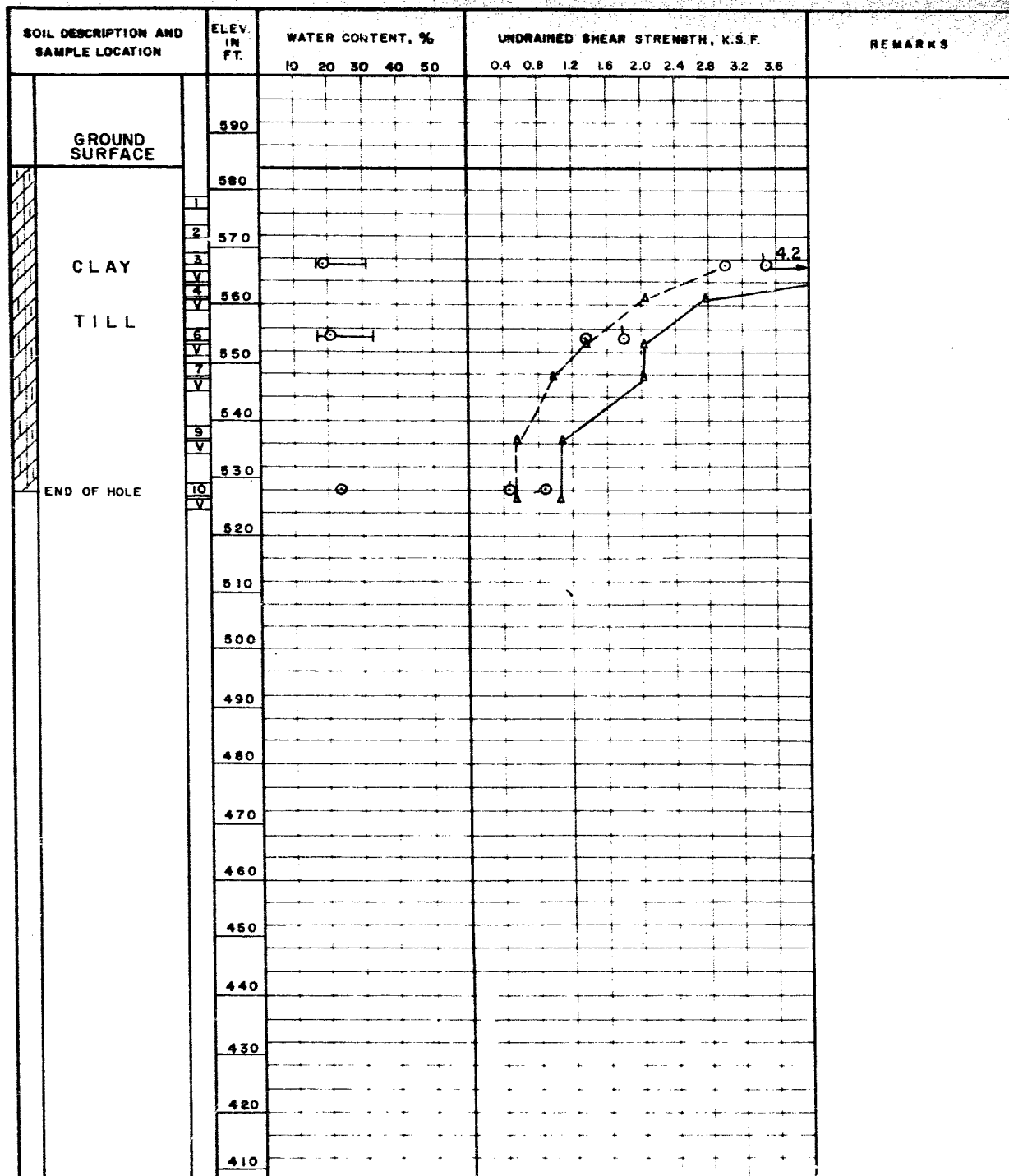
DATE JAN. 29, 1960

HWY. 2 CROSSING HWY. 401 (W.P. 165-58)

D. H. Macdonald
 H.G. ACRES & COMPANY LTD.

JOB No 849

PLATE XIV



3 SOIL SAMPLE OR VANE TEST
 ○ NATURAL WATER CONTENT
 T LIQUID LIMIT
 T PLASTIC LIMIT

○ UNDRAINED COMPRESSION TEST
 △ FIELD VANE TEST
 — NATURAL STRENGTH
 --- REMOULDED STRENGTH

15 0 5
 10
 FAILURE STRAIN

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

SUMMARY OF DRILLING AND TEST RESULTS

HOLE No. 849-6

DEPARTMENT OF HIGHWAYS OF ONTARIO

APPROVED

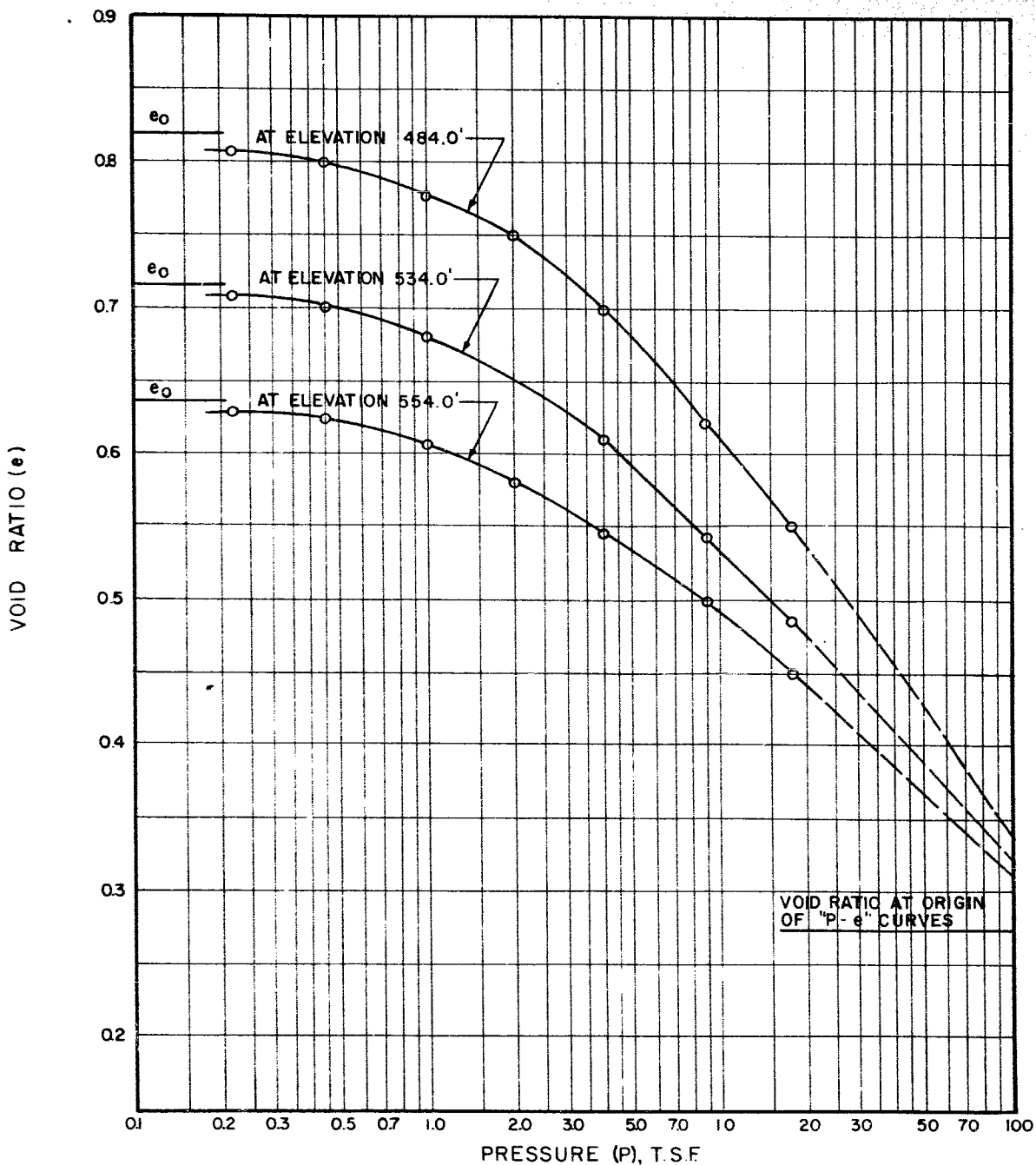
DATE JAN. 29, 1960

HWY. 2 CROSSING HWY 401 (W.P. 165-58)

Dr. H. Macdonald
 H. G. ACRES & COMPANY LTD.

JCB No. 849

PLATE XV



OVERBURDEN PRESSURE - P_0 = _____ NATURAL WATER CONTENT _____
 PRECONSOLIDATION PRESSURE - P_c = _____ LOADING INTERVAL _____

SAMPLE No. _____ TEST DATE _____
 TEST No. _____ TESTED BY _____

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

DETERMINATION OF VOID RATIO
 AT ORIGIN OF "P-e" CURVES"

HOLE No. 849-3 SAMPLE ELEV. AS NOTED

DEPARTMENT OF HIGHWAYS OF ONTARIO

APPROVED

DATE: JAN. 29, 1960

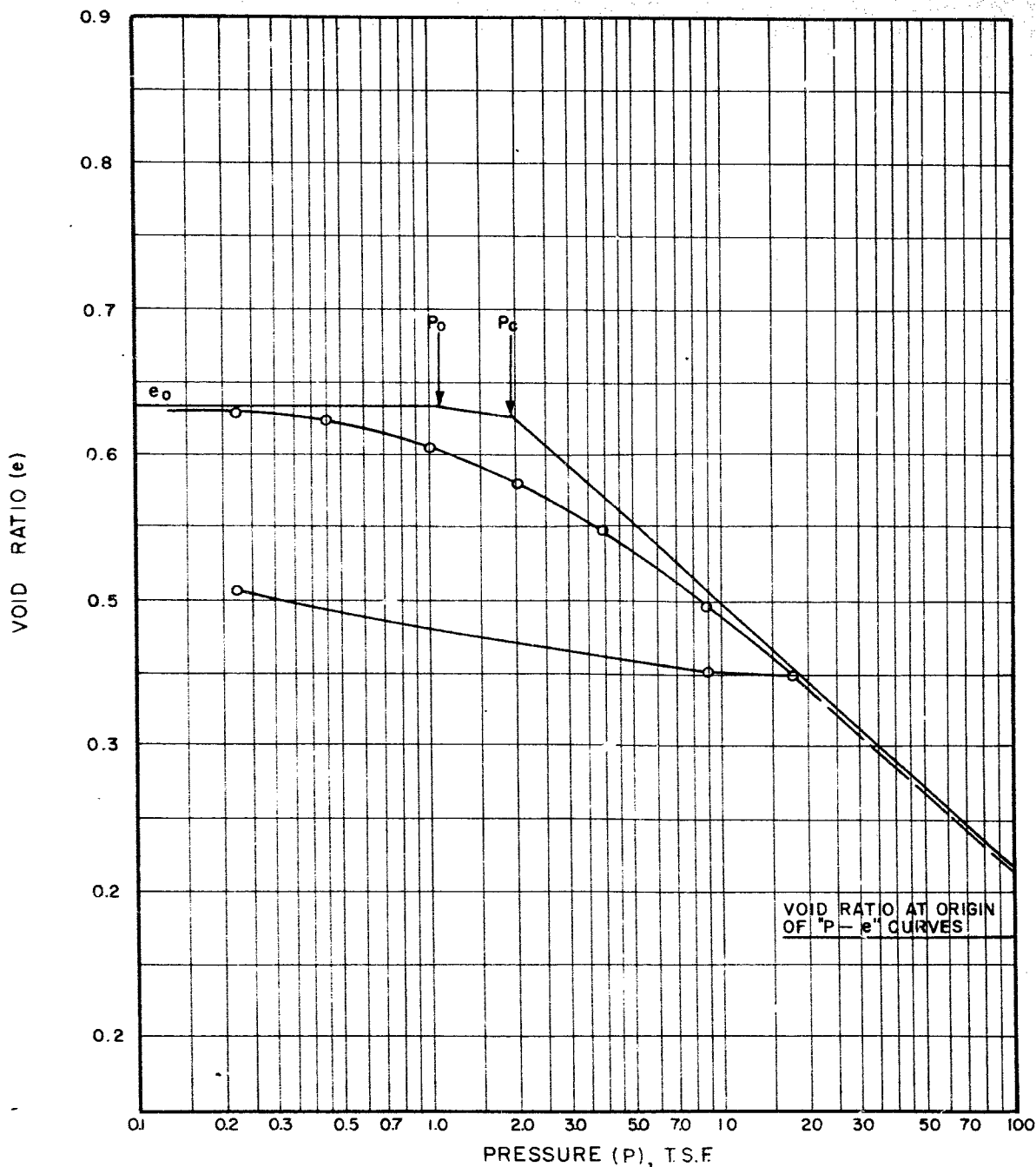
HWY. 2 CROSSING HWY 401 (W.P. 165-58)

A. H. Macdonald

JOB No. 849

H.G. ACRES & COMPANY LTD.

PLATE XVI



OVERBURDEN PRESSURE - $P_o = 1.09$ T.S.F.
 PRECONSOLIDATION PRESSURE - $P_c = 1.90$ T.S.F.

NATURAL WATER CONTENT - $w_o = 21.1\%$
 LOADING INTERVAL - 25 MIN.

SAMPLE No. 849-B0-24
 TEST No. 849-9-1

TEST DATE JAN. 13, 1960
 TESTED BY R. G.

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

CONSOLIDATION TEST

HOLE No. 849-3 SAMPLE ELEV. 554.0'

DEPARTMENT OF HIGHWAYS OF ONTARIO

APPROVED

DATE: JAN. 29, 1960

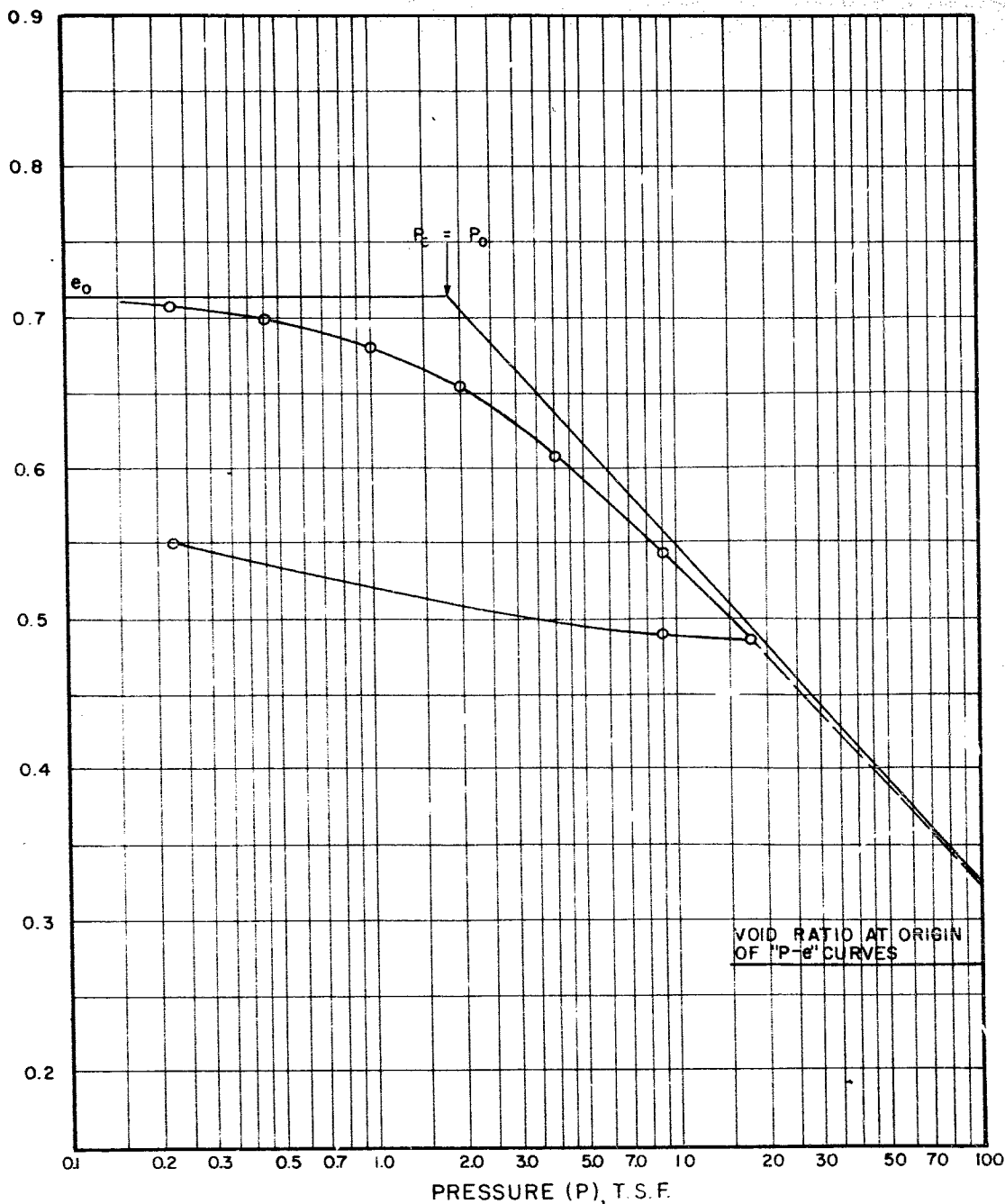
HWY. 2 CROSSING HWY. 401 (W.P. 165-58)

D. H. Macdonald
 H.G. ACRES & COMPANY LTD.

JOB No. 849

PLATE XVII

VOID RATIO (e)



OVERBURDEN PRESSURE — $P_0 = 1.75$ T.S.F. NATURAL WATER CONTENT — $w_o = 24.9\%$
 PRECONSOLIDATION PRESSURE — $P_c = 1.75$ T.S.F. LOADING INTERVAL — 25 MIN.

SAMPLE No. 849-B0-27 TEST DATE JAN. 13, 1960
 TEST No. 849-9-2 TESTED BY R. G.

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

CONSOLIDATION TEST

HOLE No. 849-3 SAMPLE ELEV. 534.0'

DEPARTMENT OF HIGHWAYS OF ONTARIO

APPROVED

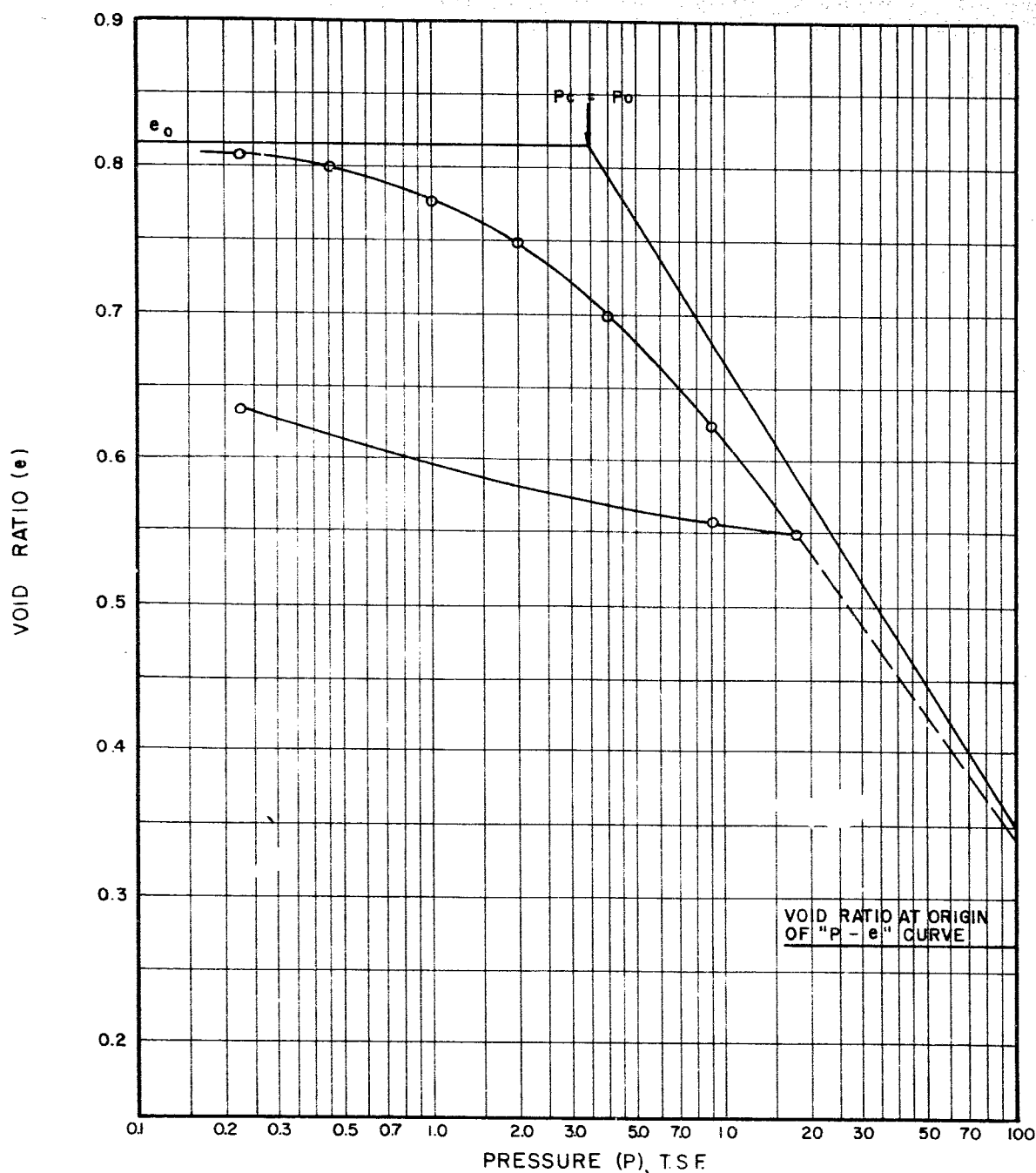
DATE: JAN. 29, 1960

HWY. 2 CROSSING HWY. 401 (W.P. 165-58)

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JOB No. 849

PLATE XVIII



OVERBURDEN PRESSURE - $P_0 = 3.40$ T.S.F.
PRECONSOLIDATION PRESSURE - $P_c = 3.40$ T.S.F.

NATURAL WATER CONTENT - $w_0 = 29.0$ %
LOADING INTERVAL - 25 MIN.

SAMPLE No. 849-80-31

TEST DATE JAN. 14, 1960

TEST No. 849-9-3

TESTED BY R. G.

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

CONSOLIDATION TEST

HOLE No. 849-3 SAMPLE ELEV. 484.0'

DEPARTMENT OF HIGHWAYS OF ONTARIO

APPROVED

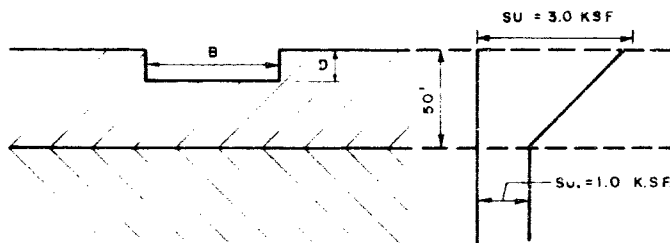
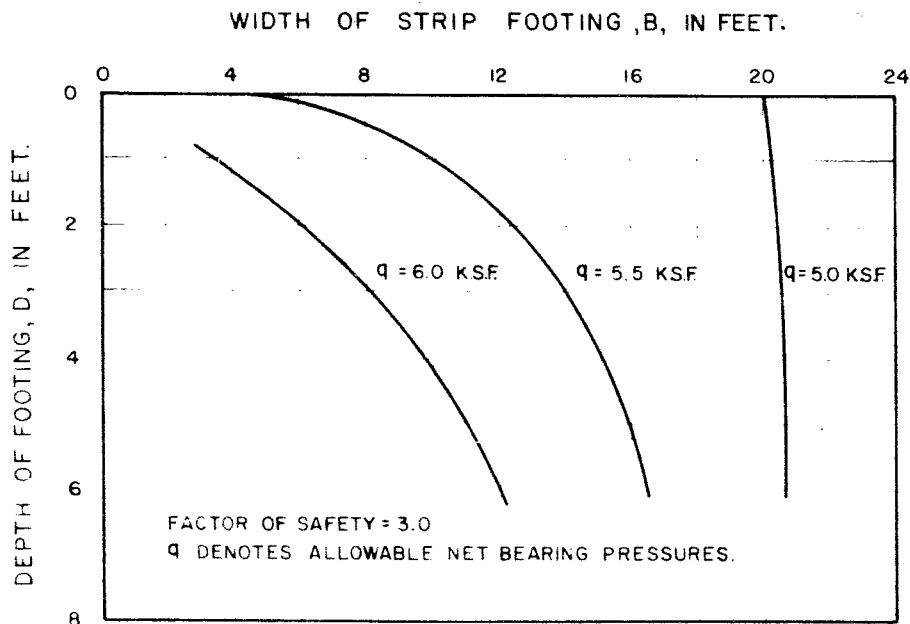
DATE: JAN. 29, 1960

HWY. 2 CROSSING HWY 401 (W.P. 165-58)

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JOB No. 849

PLATE XIX



Su. DENOTES UNDRAINED SHEAR STRENGTH

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

DEPARTMENT OF HIGHWAYS OF ONTARIO

HWY. 2 CROSSING HWY. 401 (W.P. 165-58)

ALLOWABLE NET BEARING PRESSURES
FOR FOOTINGS OF DIFFERENT
SIZES AND DEPTHS

APPROVED

DATE JAN. 29, 1960

D. H. Macdonald
H. G. ACRES & COMPANY LTD.

SCALE JOB No.
849

PLATE - XX