cc: Foundations Office

Mr. A. M. Toye, March 3, 1961.

Bridge Design Engineer.

Materials & Research Section.

Attention: Mr. J. B. Curtis.

Re: W.P. 274-60 Huntley Twp. C.N.R. O'Head
W.P. 275-60 Carp R. Bridge Hwy. 44
District #9.

In our reply of February 15, 1961 to your memo dated February 2, 1961, we did not answer the question with regard to the required length of structure which would bridge both the C.N.R. and the diverted Carp Creek. This resulted because data on the depth, width and slopes of the diverted creek were not available at that time. Now, that this information is available, we have studied the problem and attached you will find a sketch showing all the required distances and dimensions that have to be taken into consideration in the design. The profile is along the centre line of the existing Highway No. 44 and was taken from the Plan No. E 3611-1.

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

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

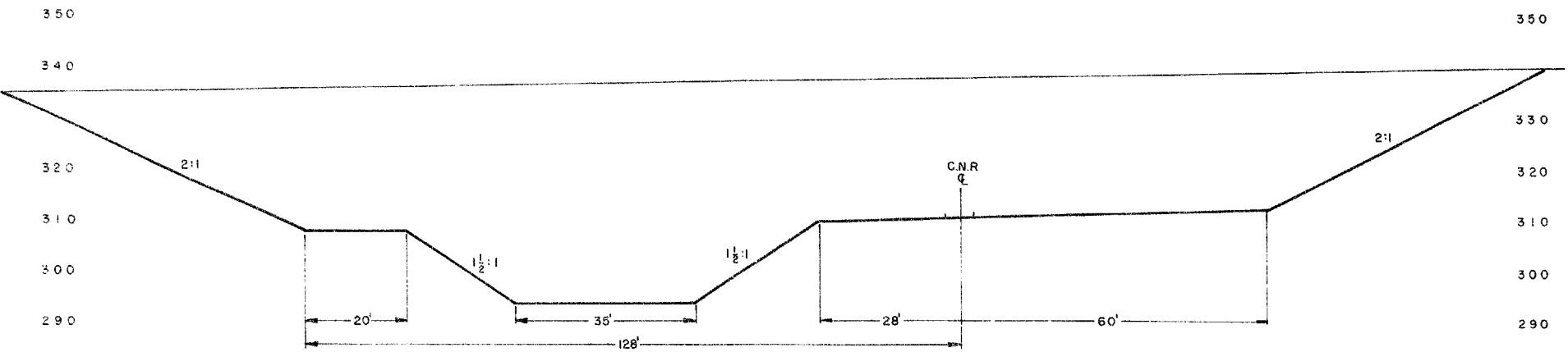
ACS/MdeP
Attach.
cc: Foundations Office
General Office.

PROPOSED NEW CROSSING OF
HWY. 44 AND CARP RIVER AND C.N.R.

W.P. 274 - 60

W.P. 275 - 60

SCALE: 1 in. = 20 ft.



OVER

OFFICE LOCATION—
DOWNSVIEW AVE.,
KEELE ST. — HIGHWAY 401
TORONTO, ONTARIO.

ONTARIO
DEPARTMENT OF HIGHWAYS

POSTAL ADDRESS—
DEPARTMENT OF HIGHWAYS,
PARLIAMENT BUILDINGS,
TORONTO 5, ONTARIO.

Bridge Division,
February 2nd, 1961.

MEMORANDUM TO:

Mr. L.G. Soderman,
Principal Soils & Foundations Engineer,
Room 107,
Downsview, Ontario.

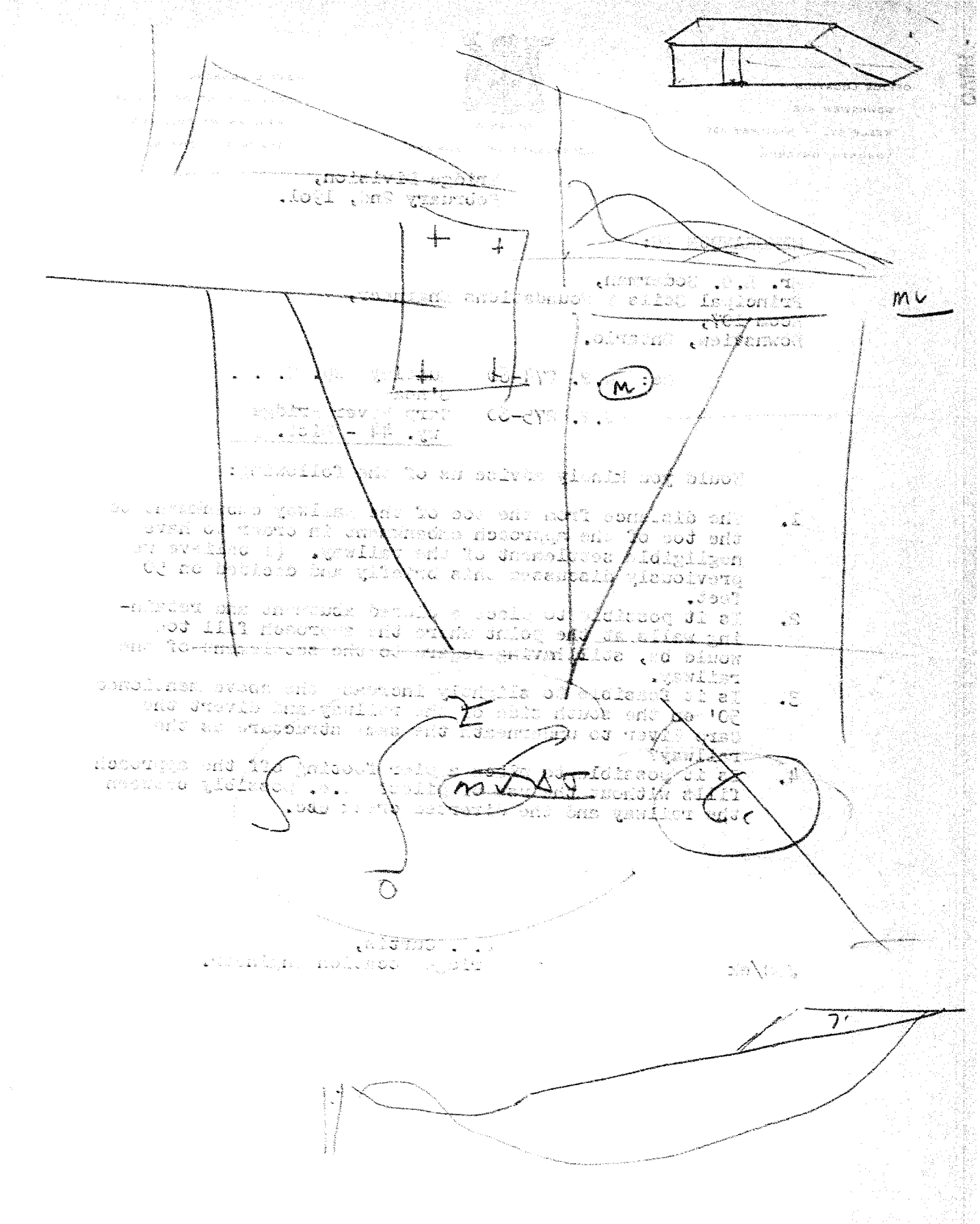
Re: W.P. 274-60 Huntley Twp. C.N.R. O'head
W.P. 275-60 Carp River Bridge Hwy. 44 - Dist. 9

Would you kindly advise us of the following:

1. The distance from the toe of the Railway embankment to the toe of the approach embankment in order to have negligible settlement of the railway. (I believe we previously discussed this briefly and decided on 50 feet.
2. Is it possible to place a closed abutment and retaining walls at the point where the approach fill toe would be, still having regard to the settlement of the railway.
3. Is it feasible to slightly increase the above mentioned 50' on the south side of the railway and divert the Carp River to underneath the same structure as the railway?
4. Is it possible to place a pier footing off the approach fills without the use of piles? i.e. possibly between the railway and the diverted creek etc.

J.B. Curtis,
Bridge Location Engineer.

JBC/ek



Mr. A. M. Toye, February 15, 1961.

Bridge Design Engineer.

Materials & Research.

Attention: Mr. J. B. Curtis.

Re: W.P.274-60 Huntley Twp. C.N.R. O'Head
W.P.275-60 Carp R. Bridge Hwy. 44
District #9.

In reply to your memo dated Feb. 2, 1961, we have the following comments to make: -

1. The distance from the toe of the approach fill to the ℄ of the railway should be not less than 60'. According to our calculations based upon the Westerguard Equations the increase in pressure under the railway due to the influence of the 34' high embankment will be less than the existing preconsolidation pressure values of the subsoil. In consequence settlements under the railway should be negligible if the above-mentioned distance is maintained.

2. We would not recommend that the abutments be supported by spread footings in original ground owing to the low recommended safe bearing pressure of 1600 lbs/sq. ft., and the fact that the footings in such a case would also have to support the full height of the 34.0' fill at completion of construction.

We do recommend that the abutments be supported by spread footings in the fill provided that the following conditions are observed:-

(a) The fill should be placed about 12 months prior to the bridge construction and compacted for the full width of the embankment under conditions of strict control: a granular material should preferably be used as it is easier to control.

Cont'd /2 ...

OVER

(b) The fill should be surcharged by about 5' of material for the end 50' length of embankment. It is assumed that 2:1 final slopes will be used but during the preconsolidation stage they may be built steeper.

(c) Provided that strict control is maintained and good compaction achieved -- a design load of 2 Tons/Sq. Ft. may be used for the bridge abutment footings.

If it is not desired to use spread footings on the fill the other alternative is piles driven to bedrock.

3. With regard to your enquiry about diverting the creek we are unable to comment until you supply us with more information concerning your proposal. We should know the elevation and width of the creek bed as well as the side slopes.

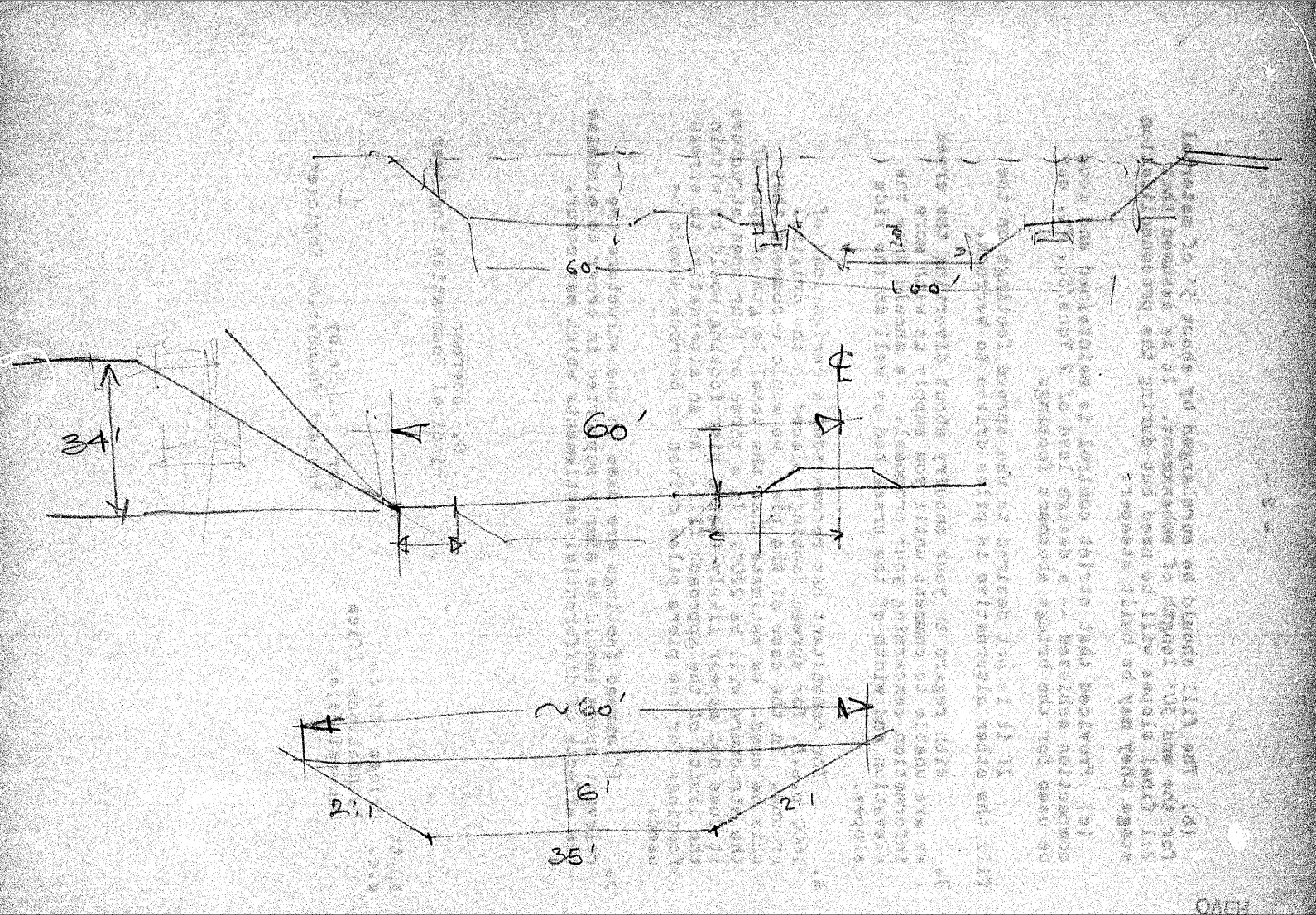
4. The consultant has recommended a design load of 1600 p.s.f. for spread footings placed in the original ground. In the case of the piers we would recommend that this be used. We estimate that the total length of span of the structure will be 220'. In a three or four span structure it does not appear likely that a pier footing would be within the limits of the approach fill. As an alternative to spread footings for the piers piles driven to bedrock should be used.

5. If spread footings are used in the structure the relevant spans should be simply supported in order to minimize the effects of differential settlements which may occur.

L. G. Roderman
Principal Foundation Engineer

K./tt
c.c. Bridge Office
Foundations Office
General Files

Per: E. Selby
Project Foundation Engineer


60
60'
34'
60'
~60'
2:1
6'
2:1
35'

W.P. 274-60
W.P. 275-60

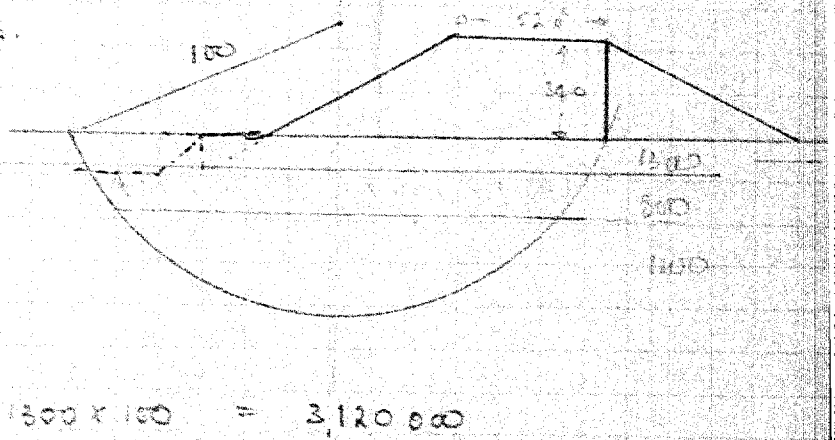
Actuating moment

$$130\left[(520 \times 340 \times 66) + \left(\frac{14+34}{2} \cdot 40 \times 23\right)\right]$$

$$130\left[117{,}000 + 22{,}100\right]$$

$$130\left[139{,}100\right]$$

$$= 18{,}100{,}000 \text{ ft. lbs.}$$



Resisting moment:

$$= \left(\tfrac{1}{2} \times 25 \times 14 \times 130 \times 9\right) + 24 \times 1300 \times 100 = 3{,}120{,}000$$

$$+ 60 \times 500 \times 100 = 3{,}200{,}000.$$

$$+ 170 \times 1100 \times 100. = 18{,}700{,}000.$$

$$+ 34 \times 500 \times 100 = 1{,}700{,}000$$

$$= 230{,}000 + \qquad 25{,}920{,}000$$

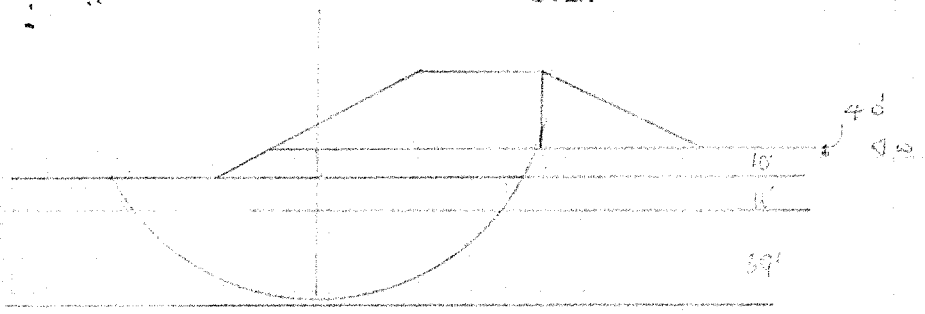
$$= 26{,}250{,}000 \text{ ft lbs}$$

$$FS: \quad \frac{25{,}250{,}000}{18{,}100{,}000}$$

$$\therefore \quad 1.4$$

If embankment base 500 FS = 1.50

OVER



Activating Moments

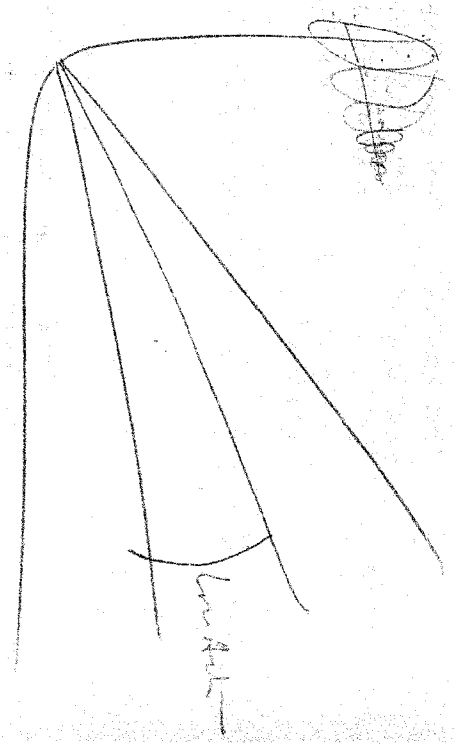
$$18,100,000 + 920 \times 40 \times 120 \times 46 = 2080,000$$
$$+ 920 \times 60 \times 60 \times 46 = 1525,000$$

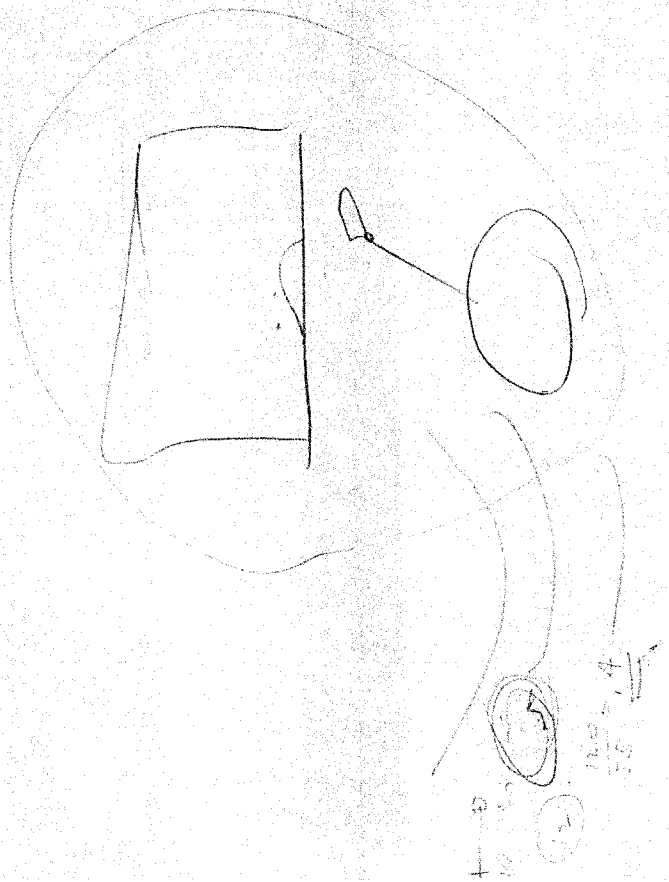
$$= 21,705,000.$$

Resisting Moments

$$= 830,000 +$$
$$+ 38 \times 4 \times 120 \times 14 = 1,848,500$$
$$+ 43 \times 6 \times 60 \times 21 = 305,000$$
$$+ 12 \times 1200 \times 1100 = 1,560,000$$
$$+ 40 \times 800 \times 100 = 3,200,000$$
$$+ 170 \times 1100 \times 100 = 18,700,000$$
$$24,203,500$$

$$FS = \frac{24,203,500}{21,705,000} = 1.12$$





Mr. A. M. Toye, January 10, 1961.

Bridge Engineer. FOUNDATION INVESTIGATION REPORT

Materials and Research Section. by: H. G. Acres & Company, Limited.

Attention: Mr. S. McCombie.

Re: Proposed Crossing Hwy. 44 and C.N.R.,
Twp. of Huntley, District No. 9,
W.P. 274-60.

Attached to this memo, we are forwarding to you, the above mentioned report submitted by the Consultant, H. G. Acres. We have reviewed the report and have found the factual data well presented. We agree with the Consultant's conclusions and recommendations and would like once more to emphasize the importance of scheduling the construction.

In his report, the Consultant reasons about the degree of accuracy of settlement predictions and concludes that the values that are given in the report are most probably too large. Nevertheless, the values are given and are in the order of 4 feet. Due to the stratification of the soil and the presence of sandy layers, it is believed that the settlement will occur during a relatively short period of time. It would therefore be essential that the embankment which will be the main cause of settlement, be built a year ahead of the bridge.

Since the depth at which bedrock is encountered exceeds 100 feet, the use of piles becomes questionable from the economic point of view, and other solutions should be tried and investigated. Consequently, in this particular case, spread footings are recommended. This recommendation pertains to piers as well as to abutments. It is therefore essential that good compaction of fill material at and around abutment footing locations be assured. On well compacted fills, abutments can be placed on spread footings.

cont'd. /2 ...

It cannot be forecast with certainty, to what extent settlements will be completed within a year after construction, and it is therefore recommended that a simply supported structure be designed.

We believe that this information, together with the information and recommendations contained in the report, will be adequate for your future design work. However, should there be any other question in connection with this problem that you would like to discuss, please feel free to call on our Office.

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

A. G. Sterman

(A. G. Sterman,
FOUNDATION OFFICE ENGR.)

AGS/MdeF
Attach.

cc: Messrs. A. M. Toye (2)
R. A. Tregashes
H. D. McMillan
J. Ford
L. E. Walker
J. B. Crumpler
A. Watt
Foundations Office
Gen. Files.

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

IN YOUR REPLY REFER TO
FILE 907

December 23, 1960

Ontario Department of Highways,
Materials and Research Section,
Parliament Buildings,
Toronto 2, Ontario.

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

Gentlemen: Proposed Crossing Highway 44 and Canadian National Railway, Township of Huntley, District No. 9, WP 274-60

Enclosed with this letter are ten final copies of the above-mentioned report. This report deals with the field exploratory work, laboratory testing, design considerations and recommendations concerning the road embankment and bridge foundations.

Should any matters discussed in this report require clarification, we will be happy to give you all possible assistance.

Yours very truly,

H.G. ACRES & COMPANY LIMITED

D.H. MacDonald

D.H. MacDonald
Geotechnical Engineer

DJC:sa
Encls:

ONTARIO

DEPARTMENT OF HIGHWAYS

Memo to Mr. A. M. Toye, *Date* August 24, 1961.

Bridge Engineer. *Subject*

From Materials & Research Section,

(Foundations Office).

Attention: Mr. B. Davis.

Re:- W.P. 275-60 Carp River Bridge
Hwy. #44, 0.25 Miles South of
Hwy. #17. District #9.

In answer to your memo of August 23rd, 1961, regarding the proposed construction of a completely new structure at the above location we would like to confirm that the recommendations given in our memo dated April 11th, 1961, are still applicable.

A. G. Stermac
Principal Foundation Engineer

KGS/tt
cc: Mr. J. B. Curtis
Foundations Office
Gen. Files

K. G. Selby

Per:
(K. G. Selby
Senior Project Foundation Engineer.

Mr. A. M. Toye, August 31, 1961.

Bridge Engineer.

Materials & Research Section,

(Foundations Office).

Attention: Mr. Bruce Davis.

Re: Proposed Crossing - Hwy. 44 and Carp River,
Township of Huntley, District No. 9,
W.P. 275-60.

This is to confirm the telephone conversation of August 29th about the foundations of the above-mentioned bridge.

If steel 'H' end-bearing piles, driven down to bedrock are decided upon, 50 - 60 ton loads per pile can be used. On the other hand, if short friction piles, driven only 20 ft. into the ground are decided upon, a safe load of only 10 tons per pile can be used. This value has been arrived at by calculations using the available soil properties and assuming a factor of safety of 3. The calculated value is applicable to 12 BP 53 'H' piles or displacement piles of 12" diameter.

There is a strong possibility that higher safe load values could be obtained for the short friction piles, but this would have to be established by a pile loading test. It is recommended that such a test be decided upon. Three piles would have to be driven, two of which would be utilized as supports for the testing of the third middle one.

AGS/MdeF

A. G. Stermac,
PRINCIPAL FOUNDATION ENGINEER

cc: Foundations Office
Gen. Files.

OFFICE LOCATION—
DOWNSVIEW AVE.,
KEELE ST. — HIGHWAY 401
TORONTO, ONTARIO.

ONTARIO
DEPARTMENT OF HIGHWAYS

POSTAL ADDRESS—
DEPARTMENT OF HIGHWAYS,
PARLIAMENT BUILDINGS,
TORONTO 5, ONTARIO.

Hydrology Section,
November 4, 1960.

MEMORANDUM TO:

Copy attached for TH&I.

Mr. S. McCombie,
Bridge Planning Engineer,
Bridge Division,
Department of Highways,
Downsview, Ont.

RE: Carp River east of Carp
Hwy. 44, District 9,
W.P. 275-60 B W 434

The area drained above the crossing is 43.6 square miles, a large percentage of which is swamp or woodland. The rate of runoff is consequently relatively low for the size of watershed.

Allowance for future deepening of the channel should be made in deciding the depth of footings.

Summary of recommendations - Plan E 3612-1, G. 2660-1

1. Minimum span 40' measured square to abutments, or equivalent waterway area 400 square feet measured between elevations 292.0 and 302.0.
2. Angle of skew: 30° (Left handed)
3. Minimum soffit elevation 305.0
4. Location of centre - line: station 473 + 50.
5. Depth of footings to be determined after receipt of Soil Report. Allowance should be made for possible future deepening of up to 3'.

JDH/et

J. D. Harris,
for W. Wilkie,
Bridge Hydrology Engineer.

ONTARIO

DEPARTMENT OF HIGHWAYS

Memo to Mr. S. McCombie, *Date* April 11, 1961.

Bridge Planning Engr. *Subject*

From Materials & Research Section -

(Foundations Office)

Attention: Mr. John Curtis.

File under BA 1171

Re: Proposed Crossing Hwy. 44 and Carp River,
Twp. of Huntley, District No. 9,
W.P. 275-60.

We were advised that the above mentioned proposed structure will not be built, and that only a widening of the existing structure is contemplated. In connection with this widening, we have carried out settlement analyses in order to find out how the building of the new structure is going to affect the existing one. In our calculations, we have assumed that the road width is going to be 48 feet.

If the recommended safe bearing pressure of 1,600 lb./sq.ft. is being used, a settlement in the order of 3/4 of an inch can be expected. Some additional settlement will also occur due to the load of the widened embankment. We are of the opinion that the resultant settlement will not exceed about one inch, and the new structure will therefore not affect the old one - i.e., no damage should be expected. However, some maintenance will be necessary during a certain period of time. We would suggest that the new structure - i.e., the addition - be built as a separate unit and not be doweled with the old one.

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

A. G. Stermac

(A. G. Stermac,
SUPERVISING FOUNDATION ENGR.

AGS/MdeF

cc: Foundations Office
Gen. Files.

ONTARIO
DEPARTMENT OF HIGHWAYS

Memo to Mr. A. M. Toye, Bridge Engineer. *Date* January 11, 1961.

Subject FOUNDATION INVESTIGATION REPO

From Materials & Research Section. by: H. G. Acres & Company, Limite

Attention: Mr. S. McCombie.

Re: Proposed Crossing Hwy. 44 and Carp River,
Twp. of Huntley -- District No. 9
W.P. 275-60.

Attached to this memo, we are forwarding to you the above mentioned report submitted by the Consultant, H.G. Acres & Company, Ltd. We have reviewed the report and have found the factual data well presented. It seems to us that the necessity of scheduling the construction is not stressed enough in the report. If the approach fills are not built in advance and enough time allowed for the settlements to take place, it would not be possible to construct - i.e., place the abutment footings on the fill. One year is considered to be the desirable period of time that should be allowed between the construction of the embankments and the bridge structure.

We believe that the recommendations contained in the report and supplemented in this memo, will be adequate for your future work. However, should there be any other question you would like to discuss, please feel free to call on our Office.

AGS/MdeF
Attach.
cc: Messrs. A. M. Toye (2)
H. A. Tregaskes
H. D. McMillan
J. Ford
L. E. Walker
J. E. Gruspier
A. Watt

Foundations Office
Gen. Files.

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

A. G. Stermac

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

DE LEUW, CATHER & COMPANY OF CANADA LIMITED

CONSULTING ENGINEERS

TORONTO OTTAWA ST. JOHN'S

2277 RIVERSIDE DRIVE
OTTAWA 8, ONTARIO
REgent 3-4160

Our Ref. 3040-G-8

July 20th, 1962

Mr. F. I. Hewson,
Consultant Liaison Engineer,
Department of Highways of Ontario,
Parliament Buildings,
Toronto, Ontario.

Dear Mr. Hewson:

Re: Carp River Bridge W.P. 275-60

In filing away our records for the above structure, we note that the Soils Report which you sent to us on September 5th, 1961, appears to be your file copy as it includes the original inter-department correspondence. We feel that this should be kept with your records and we have made a copy of extracts for our file.

When this contract is scheduled for construction, we would be interested in the Tender Price and visiting the site during construction. It is assumed that supervision will be carried out by the District Office but we are always anxious to follow through designs for the experience to be gained for future contracts. This applies also to the CNR structure in Smiths Falls.

Yours very truly,
DE LEUW, CATHER & CO. OF CANADA LIMITED

Leon J. Marshall, P. Eng.,
Chief Bridge Engineer

LJM:rm
Encls.

BA 1171

ONTARIO DEPARTMENT OF HIGHWAYS
Toronto, Ontario

REPORT

on

FOUNDATION INVESTIGATION

PROPOSED CROSSING
HIGHWAY 44 AND CANADIAN NATIONAL RAILWAY
TOWNSHIP OF HUNTLEY, DISTRICT NO. 9
WP 274-60

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

November, 1960

ONTARIO DEPARTMENT OF HIGHWAYS
Toronto, Ontario

REPORT

on

FOUNDATION INVESTIGATION

PROPOSED CROSSING
HIGHWAY 44 AND CANADIAN NATIONAL RAILWAY
TOWNSHIP OF HUNTLEY, DISTRICT NO. 9
WP 274-60

Table of Contents

ONTARIO DEPARTMENT OF HIGHWAYS
Toronto, Ontario

REPORT

on

FOUNDATION INVESTIGATION

PROPOSED CROSSING
HIGHWAY 44 AND CANADIAN NATIONAL RAILWAY
TOWNSHIP OF HUNTLEY, DISTRICT NO. 9
WP 274-60

Introduction

At the request of the Ontario Department of Highways, soil explorations were carried out by H.G. Acres & Company Limited at the above-mentioned site to determine the foundation conditions for the bridge and its approach embankments. A plan of the site is shown on Plate I.

The F.E. Johnston Drilling Company Limited performed the drilling and soil sampling operations, under the supervision of Mr. J.A. MacLeod of H.G. Acres & Company Limited. The field work commenced on October 26, 1960, and was completed on November 16, 1960. Laboratory testing of the soil samples was completed in November 1960.

The results of the field and laboratory work are presented in this report, together with our

interpretations of these data and our recommendations concerning the foundation conditions and designs.

Geology of the Site

The site of the proposed crossing is the flat bottom of a valley which extends away from the Ottawa River. The site is underlain by limestone which outcrops as the land rises gently to the southwest. The limestone is of Ordovician age and believed to be of the Ottawa formation (Trenton or Blackriver). About 650 feet north of this site an outcrop of igneous and metamorphic rock rises abruptly above the surrounding soils.

During the most recent glacial period, the bedrock surface was generally denuded and subsequently the low lying areas were covered with a variable thickness of till, which is composed mainly of sand and gravel. After the glaciers retreated, the area was inundated by the Champlain Sea and in this marine environment, the till was buried beneath deposits of fine sand, silt and clay. At this particular site these deposits are stratified to a high degree and are lacking in horizontal uniformity. Subsequent uplift has raised the soils considerably above sea level with the result that weathering and desiccation

have developed a stiff crust, about ten feet thick, on the stratified silty clay marine deposit.

The Carp River, a meandering stream only about four feet deep, flows along the axis of the valley. Meander scars indicate that the stream has wandered in a wide belt across the valley. It is possible that the stream was previously much larger and may have effected the erosion of a significant depth of the marine deposits.

Exploratory Work

Two diamond drills were used in the exploration work. In the marine deposit, the wash boring method was employed and NX or BX casing was used to advance the hole. Two-inch diameter Shelby tube samples were taken at 6- or 12-foot intervals after the general soil profile had been established by sampling at 4-foot intervals in the initial hole, No. 907-1. In addition, 3-inch fixed-piston samples were taken at 5-foot intervals in holes Nos. 907-6 and 907-9. These piston samples were taken in an attempt to reduce sample disturbance, which experience has shown to be large in sensitive clays when the standard 2-inch Shelby tubes are used. Where possible, in situ vane tests were performed 18 inches below the

lower elevations of all tube samples, immediately after the samples were removed, or 18 inches below the bottom of the casing if a sample was not taken.

When sand or gravel was encountered, standard penetration tests were performed and the split-spoon samples were retained. When rock was encountered, the NX or BX casing could not be advanced; under these circumstances, hole No. 907-1 was advanced by diamond drilling with AX casing 7.5 feet through sound limestone. In holes Nos. 907-4 and 907-8, the casing was advanced until rock or boulders were encountered, but no core was taken. All other holes, with the exception of hole No. 907-9, were stopped at a depth of approximately 70 feet where a deposit of fine sand overlying the bedrock was encountered.

Hole No. 907-9 was added to the original program when the results of vane tests in holes Nos. 907-4 and 907-7 indicated the presence of a layer of relatively low shear strength between elevations 290 and 274 feet. Additional vane tests were performed in hole No. 907-9, and 3-inch piston samples were recovered in order to verify the presence of this layer which had been indicated by very few test results.

A total of nine holes were drilled and sampled, and in each of these vane tests and ground

water observations were made.

The program of work is outlined in Appendix A.

Site Conditions and Soil Properties

The site investigated is in the flat bottom of a valley whose average ground surface elevation is approximately 305 feet. The land is poorly drained and is used mostly for pasture.

The soils which were encountered in the exploratory holes are described in the attached drilling reports, Plates II to X, inclusive.

(a) - Existing Embankment - The existing Highway No. 44 consists of an embankment, about 6 feet high, which contains a heterogeneous mixture of sand and gravel. This embankment rests immediately upon the crust of the underlying silty clay deposit.

(b) - Silty Clay Crust - This is the stiff, weathered and desiccated surface layer of the marine deposit. The crust has a variable thickness as shown on Plate I, and the transition to the underlying deposit is a gradual one rather than an abrupt boundary which the single dotted line on Plate I might suggest.

Within this layer, the soil has the following average properties:

Liquid limit = 56.6 per cent
Plastic limit = 20.4 per cent
Water content = 45.0 per cent

Vane tests generally were not performed because this soil was too stiff to fail by this means. The natural undrained shear strength, determined from a laboratory compression test, was 2,400 psf at an elevation of 303.3 feet.

(c) - Silty Clay - This soil is not a homogeneous deposit, and it has been called silty clay only because this is the predominant grain size. At this particular site the deposit is extremely stratified and contains layers of fine sand, silt and clay. The approximate limits of this deposit are shown on Plate I. The stratification, as observed in the tube samples, varied from horizontal to a slope as great as 20 degrees. Some 3-inch piston samples showed such a distortion of stratification that the only explanation, other than sample disturbance, must be that of slope failures during deposition.

On the basis of the test results, this deposit should not be assigned average properties. However, as shown on Plates XV and XVIII, there is a trend toward decreasing plasticity and water content with increasing depth. The natural undrained shear

strength was measured by means of field vane tests and laboratory compression tests on samples trimmed from 3-inch piston samples. It was found that for samples that failed at strains less than 2 per cent, the results of the compression tests agree very closely with the results of the field vane test. This is shown on Plate XV where all the test results for hole No. 907-6 are summarized. Because of this close correlation the reliability of the vane test results has been established for this particular deposit. Considering only holes Nos. 907-1, 907-2, 907-3, 907-5, 907-6, and 907-8, as shown on Plate XVI, the average natural undrained shear strength for this deposit can be taken as at least 1,100 psf. However, considering holes Nos. 907-4, 907-7, and 907-9, as shown on Plate XVII, the average natural undrained shear strength between elevation 290 feet and elevation 274 feet, can be taken as no more than 800 psf, but below elevation 274 feet it is at least 1,100 psf.

The results of the laboratory tests are summarized in Appendix B and shown graphically on Plates XV to XVIII. The results of the field vane tests are summarized in Appendix C and shown graphically on Plates XV to XVIII.

The maximum sensitivity of this clay, indicated by the field vane tests, is 8.6, but experience has shown that sensitivities measured by this method are generally lower than those measured in the laboratory. Unfortunately, when remoulded in the laboratory, the soil, except in the crust, was too soft to test with the conventional equipment available, and, for this reason, the sensitivity could not be measured. Therefore, no remoulded tests were attempted, but rather the number of shocks in the liquid limit device at natural water content was recorded. These are all less than the liquid limit with a minimum value of one blow being obtained. It has been suggested that the sensitivity of this material exceeds 100(1).

Consolidation tests were made on samples taken from the more uniform silty clay strata and the "p-e" curves are presented on Plates XI to XIV. From these data, it may be deduced that this deposit has experienced overconsolidation even below the crust. The curves for the silty clay below the crust have the shape characteristic of sensitive soils, and if the preconsolidation pressure is exceeded, this soil is very compressible. The apparent preconsolidation

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(1) Eden, W.J. and Crawford, C.B. 1957. "Geotechnical Properties of Leda Clay in the Ottawa Area" Proc. 4th International Conference on Soil Mechanics, Vol. 1, pp. 22-27.

pressures have been estimated and the results are summarized on Plate XVIII. Sample disturbance reduces the apparent preconsolidation pressure, and if failure strain in the compression test can be taken as a measure of sample disturbance, the estimates of preconsolidation pressure are probably low. The best estimate would be given by sample No. 907-CO-10 as shown on Plate XIV, because this sample is taken from the same sample tube as a compression sample which failed at 1.5 per cent strain.

(d) - Fine Sand - This is an extremely stratified deposit and, although the layers are predominantly sand, it also contains many layers of silt and some clay layers. The density as indicated by the number of blows in the standard penetration test, ranges from loose to medium. The approximate limits of this deposit are shown on Plate I.

(e) - Sand and Gravel - This is a heterogeneous deposit of sand and gravel and ranges from medium to dense. It consists of only a thin layer overlying the bedrock surface, as shown on Plate I. This probably is a glacial till.

(f) - Bedrock - The bedrock is a sound, horizontally bedded limestone belonging to the Ottawa formation.

(g) - Ground Water Conditions - The elevation of the free ground water surface in the silty clay and silty clay crust was observed in the bore holes after drilling was completed. The steady state elevations are recorded on the drilling reports. From these observations it can be seen that, as the ground surface rises to the northeast, the ground water surface also rises. The elevation shown on Plate XVIII is the average elevation in the immediate vicinity of the bridge.

Design Considerations

(a) - Bearing Capacity

Road Embankment - The critical condition for stability of an embankment founded on sensitive clays generally occurs during construction or shortly after completion of construction. Even though it is probable that some consolidation of the silty clay would take place during construction due to the presence of the sand layers, the "$\phi = 0$" method of stability analysis is considered to be the most applicable for this case. In this method of analysis, stability is governed by the applied loads and by the stress strain and shear strength properties of the foundation and embankment soils.

The embankment for the approach to the overpass structure will be approximately 34 feet high with respect to the original ground surface and 52 feet wide at the top, and the unit weight of the embankment material will be approximately 130 pcf. Using these loading requirements, the analyses indicate that the factor of safety will be approximately 1.5 for an embankment with 1.5 to 1 side slopes, regardless of the choice of soil properties. The soil properties and the results of the analyses are considered in some detail below.

(i) - Shear Strength of the Silty Clay -

The 3-inch fixed-piston samples were the best undisturbed samples that were obtained for laboratory compression tests. Since the natural undrained shear strength measured in these samples agreed closely with the vane test results in the same hole, No. 907-6, it is thought justifiable to use the vane test results for the analysis of the embankment stability without modification.

From the vane test results a horizontal as well as vertical variation exists in the shear strength of the silty clay deposit. For the purpose of the stability analysis average values must be used.

Therefore, the following are considered the best estimates of the shear strength profile for the analysis of the embankment stability:

Station	Elevation	Shear Strength
477+00 to 478+70	290 to 274	800 psf
	274 and below	1,100 psf
478+70 to 483+00	290 and below	1,100 psf

In a marine deposit of such very high sensitivity a shear failure would be expected at strains of less than one per cent with large strength reductions at larger strains. The minimum value measured in the compression tests was 1.25 per cent, but since even the best samples probably suffer some disturbance, the in situ failure strain has been assumed to be 0.7 per cent.

(ii) - Shear Strength of the Crust - The natural undrained shear strength of the crust on the basis of the laboratory compression test is approximately 2,400 psf. However, experience suggests that this strength can be developed only at strains of

about two per cent. Therefore, by the time this shear strength could be mobilized along the failure surface in the crust, the shear strength of the underlying sensitive clay would be reduced to much less than its maximum value. For a strain of 0.7 per cent along the failure surface the strength that could be developed in the crust would be only about 1,300 psf.

(iii) - Shear Strength of the Fine Sand - The deposit of stratified fine sand at a depth of approximately 65 feet is a relatively free draining soil compared to the overlying soils, but the critical circle in the stability analyses does not cut this deep and, therefore, this complication is not encountered.

(iv) - Shear Strength of the Embankment - At 0.7 per cent strain, the shear strength developed in the compacted fill of the embankment will probably be very small and, therefore, it is assumed to be zero in the calculations.

(v) - Factor of Safety - The minimum depth of the silty clay is 36 feet and the maximum depth is 65 feet. Using the maximum depth in the analyses, the minimum factors of safety are obtained.

The factors of safety have been calculated for embankments with 2 to 1 and 1.5 to 1 side slopes, and for the variations in shear strength which occur along the right-of-way.

Plate XIX gives a summary of the factors of safety, and it should be noted that the factor of safety is affected very little by the variations in shear strength. A minimum value of 1.48 occurs at station 478+60 for 1.5 to 1 slopes. It is considered that this factor of safety, with the method of analysis, shear strengths and slopes involved, is satisfactory.

The abutments do not decrease the overall stability of the embankment. The increase in foundation stresses due to the abutment load is offset by the greater bearing capacity at the end of the fill. However, the abutment loads might cause a critical condition with respect to the stability of the end slope within the embankment itself. This can only be determined, as a design consideration, when the in-place properties of the embankment materials are known.

Bridge Piers - One method of supporting the bridge would be with spread footings. The net bearing pressure for a shallow footing on clay is given by the following expression:

$$q_{net} = 5\left(1 + 0.2 \frac{D}{B}\right)\left(1 + 0.2 \frac{B}{L}\right) Su$$

where: q_{net} denotes the net bearing capacity of the foundation soil.

D denotes the depth of the base of the footing below the surface of the overburden.

B denotes the footing width.

L denotes the footing length.

Su denotes the natural undrained shear strength of the foundation soil.

The base of the footings would be located at a depth of approximately 6 feet below the original ground surface, where the crust is thin or non-existent, and also between stations 478+70 and 483+00, where an average value of shear strength of 1,100 psf would be applicable. However, since the locations of the borings do not completely eliminate the possibility of the existence of the layer of 800-psf soil beneath at least part of a footing, it is considered that the footings should be designed on the basis of a minimum shear strength of 800 psf. Since the depth of influence of a footing load is approximately limited to its width, this shear strength will apply throughout the full depth of influence. Applying a factor of safety of 3, the allowable bearing pressure can be calculated. On the basis of our calculations and using a depth of footing of 6 feet, the allowable bearing capacity is approximately 1,600 psf for all practical footing shapes.

The bridge will be approximately 32 feet wide, and will consist of a centre span 40 feet long and approach spans approximately 50 feet long. The total load on each of the centre piers will be approximately 630 kips. For a centrally loaded footing with a 30-degree skew, the dimensions of the footing would be 36 feet by 11 feet. However, to take into account the effect of eccentric loading, the footing width would have to be increased so that the maximum stress beneath the footing, due to the eccentric load, does not exceed 1,600 psf.

The alternative to spread footings for the support of the bridge piers would be bearing piles driven to rock. Due to the high sensitivity of the silty clay, a non-displacement type pile, such as steel H-piles, would have to be used. However, the excessive depth of overburden makes this type of foundation impracticable.

(b) - Settlement - The settlement of the embankment and of the end abutments of the bridge will be governed primarily by the embankment loading. The loading conditions which have been assumed are shown on Plate XX. The consolidation characteristics of the clay are given on Plates XI to XIV, and the

apparent preconsolidation pressures are summarized on Plate XVIII. The value of the apparent modulus of elasticity which has been used to predict the immediate settlements is 80 tons per square foot. The calculated settlements are shown on Plate XX, and it can be seen that they are very large. The most important factors contributing to these large settlements are the apparent preconsolidation pressures and the steep initial portions of the "p-e" curves beyond the points of preconsolidation. However, the samples were definitely disturbed, and these disturbances, especially in sensitive clays, will cause reductions in the apparent preconsolidation pressures. Therefore, if the true preconsolidation pressures were higher, the calculated settlements would be much lower. For this reason, the calculated settlements are considered to be too large, and the error in estimation may be appreciable.

However, the deposit is extremely stratified and contains many sand layers throughout its depth. Therefore, even if large settlements do occur, most of the settlement will probably be complete within a few weeks. The stratification makes it impossible to estimate this time accurately. However, by observation of the settlement of the embankment after

its completion, the magnitude and time for complete consolidation could be determined.

The footings which support the centre span of the bridge will only be subjected to small elastic and consolidation settlements, because the soil pressures beneath these footings will not exceed the pre-consolidation pressures. These settlements will occur primarily during construction. Thus the worst condition which might result from settlement would be the differential settlement between the abutments and the piers. The most satisfactory method of reducing this differential settlement to an acceptable amount would be to schedule the construction program to allow time for the settlement of the embankment to take place. This time can best be determined by field observations.

Conclusions

(a) - From the drilling work done at the site, the overburden was found to be approximately 100 feet thick. The soils are of marine origin and consist of stratified fine sand, silt and clay with the fine sand becoming more predominant with depth. There is a horizontal surface crust approximately 10 feet thick.

Beneath this crust, the silty clay and other strata are extremely sensitive. Below a depth of 65 feet the deposit consists of stratified fine sand, with occasional layers of silt and clay. The bedrock is a sound, horizontally bedded, limestone.

(b) - The properties of the foundation soils are summarized on Plates XV to XVIII.

(c) - The 34-foot high embankment, with a crest width of 52 feet, and with 1.5 to 1 side and end slopes, can be safely supported on the undisturbed foundation soils. However, the design of the end slopes must also consider the stability within the embankment due to the abutment loads. The calculated settlement of the embankment is very large, but the actual settlements will probably be much smaller.

(d) - The bridge can be supported on spread footings. The footings should be placed at a depth of 6 feet below the original ground surface. The maximum pressure at any point beneath the footings should not exceed 1,600 psf, for these conditions.

Recommendations

The embankment should be constructed with side and end slopes not steeper than 1.5 to 1.

The bridge structure should be supported on spread footings with the base of the footings 6 feet below the original ground surface. The maximum soil pressure should not exceed 1,600 psf.

APPENDIX A

Program of Work

October 26, 1960 - Diamond drill No. 1 arrived at the site. Hole No. 907-1 was commenced.

October 28, 1960 - Diamond drill No. 2 arrived at the site. Hole No. 907-2 was commenced.

October 31, 1960 - Hole No. 907-1 was completed.

November 1, 1960 - Hole No. 907-2 was completed. Holes Nos. 907-3 and 907-6 were commenced.

November 2, 1960 - Hole No. 907-3 was completed.

November 3, 1960 - Hole No. 907-4 was commenced.

November 4, 1960 - Holes Nos. 907-4 and 907-6 were completed. Hole No. 907-8 was commenced.

November 7, 1960 - Hole No. 907-8 was completed. Hole No. 907-7 was commenced.

November 8, 1960 - Hole No. 907-7 was completed.

November 14, 1960 - Holes Nos. 907-5 and 907-9 were commenced. Hole No. 907-5 was completed.

November 15, 1960 - Hole No. 907-9 was completed.

Summary of Time

Work Type	Number of Holes	Total Length Feet	Total Time Hours
Modified wash boring	9	656.2	161.5
Diamond drilling	1	7.5	5

APPENDIX B

Summary of Laboratory Test Results

Hole No.	Sample No.	Elevation (Feet)	Water Content (%)	Liquid Limit (%)	Plastic Limit (%)	Su_n (Psf)	e_f (%)	Remoulded Test*
907-1	3	303.3	37.1	52.3	20.0	2400	6.00	-
907-6	3	298.8	53.1	59.0	20.9	2025	1.50	-
	4	294.8	53.7	44.0	19.6	740	2.00	B8
	5+	289.8	46.1	35.5	20.4	637	3.00	B5
	6	284.8	48.9	35.7	21.1	1205	1.25	B6
	7	279.8	47.8	39.1	19.4	863	3.50	B9
	8	274.8	40.2	30.9	16.6	1485	1.87	B6
	9	269.8	35.2	26.5	14.8	1283	3.00	B9
	10	264.8	37.1	31.4	16.5	1545	1.50	B7
	11	259.8	28.0	-	-	-	-	-
	12	254.8	38.8	35.0	20.4	2075	2.50	-
	13	249.8	28.5	-	-	-	-	-
	14	244.8	39.8	-	-	-	-	-
907-9	2	293.2	51.0	45.8	19.3	954	6.00	B26
	3	288.2	41.3	25.3	15.2	347	3.00	B1
	4	283.2	48.9	32.9	19.0	1090	1.50	B2.5

e_f - Failure strain

Su_n - Natural undrained shear strength

B8 - Number of shocks in liquid limit device

* Because most remoulded samples were too soft for a compression test, the number of shocks in the liquid limit device at natural water content is given.

\+ Specific gravity of sample No. 5 in hole No. 907-6 was 2.76.

Note: All laboratory compression tests were "Undrained Triaxial Compression" tests.

APPENDIX C

Summary of Field Vane Test Results

Hole No.	Elevation (Feet)	Undrained Shear Strength (Psf) Natural	Remoulded	Sensitivity
907-1	297.8	1950	403	4.84
	293.8	975	203	4.80
	289.3	1300	280	4.65
	285.8	1330	220	6.05
	281.8	670	93	7.20
	277.8	1380	360	3.84
	273.8	900	140	6.43
	269.8	1100	279	3.94
	265.8	1380	220	6.27
	261.8	1980	233	8.50
	257.3	2540	750	3.39
907-2	295.0	1670	295	5.66
	289.0	1300	280	4.65
	283.0	1150	230	5.00
	277.0	1640	340	4.82
	271.0	1490	265	5.62
	265.0	1120	248	4.52
	259.0	1610	280	5.75
	253.0	2230	530	4.21
907-3	296.3	1740	340	5.12
	290.3	1270	280	4.54
	284.3	1070	220	4.87
	278.3	1400	340	4.12
	272.3	1180	220	5.37
	267.8	1020	220	4.64
	260.3	1610	310	5.20
	255.8	806	230	3.51
	248.3	2220	465	4.77
	243.8	1730	340	5.09
907-4	290.9	745	123	6.05
	281.9	806	155	5.20
	277.4	2320	434	5.35
	269.9	1180	220	5.37
	257.9	1610	186	8.65
	253.4	2570	620	4.15
	245.9	1550	356	4.35
	241.4	1330	323	4.12

Appendix C - 2

Hole No.	Elevation (Feet)	Undrained Shear Strength (Psf) Natural	Remoulded	Sensitivity
907-5	293.7	1050	200	5.25
	283.2	1270	248	5.16
	278.7	1640	340	4.83
	271.2	2050	450	4.55
	259.2	1550	310	5.00
	254.7	2780	680	4.09
907-6	292.5	1365	280	4.87
	288.0	1270	186	6.83
	283.0	1270	250	5.08
	278.5	1425	430	3.32
	273.0	1290	815	1.58
	268.0	1300	326	3.99
	257.8	961	310	3.10
907-7	286.2	775	124	6.25
	278.7	900	186	4.84
	274.2	697	139	5.01
	266.7	1640	280	5.85
907-8	300.5	1085	217	5.00
	293.0	3000	555	5.40
	288.5	1580	450	3.51
	281.0	2110	652	3.24
	276.5	1220	155	7.87
907-9	291.3	992	403	2.46
	286.3	650	108	6.02
	281.3	1175	280	4.20

APPENDIX D

List of Plates

Appendix D - 2

Plate XVIII - Summary of Drilling and Testing Results Comparison of All Tests.

Plate XIX - Summary of Stability Analyses.

Plate XX - Foundation Settlements Due to Embankment Loads.

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

DRILLING REPORT

CLIENT Ontario Department of Highways — JOB No. 907

PROJECT WP 274-60 — HOLE No. 907-1

SITE Highway 44 and Canadian National Railway — SHEET No. 1 OF 3

CONTRACTOR: F.E. Johnston Drilling Company Limited

STARTED 3:00 P.M. October 26 1960

FINISHED 4:30 P.M. October 31 1960

METHOD OF DRILLING: SOIL Modified wash boring — CASING DIAM. BX

ROCK Diamond Drill — CORE DIAM. AX

LOCATION: ~~LATITUDE~~ Chainage 480 + 03
DEPARTURE 16 feet right
BEARING
INITIAL DIP 90 Degrees
OTHER DIPS

ELEVATIONS:
DATUM GSC
DRILL PLATFORM
GROUND SURFACE 312.8
ROCK SURFACE 220.5
BOTTOM OF HOLE 213.0
WATER TABLE 304.8

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 RET'D	PENETRATION TEST Blows *
Feet					Inches	Feet	Inches	
0.0	Sand and gravel	Embankment of existing highway	1	AZ	2	4.0		
						4.5		2
						5.0		4
5.5	Silty clay	Mottled, grey brown, weathered, stiff, stratified				5.5	Nil	4
			2	BO	2	6.0		Pushed to
						6.5	6	refusal
			3	BO	2	8.5		Bar
						10.0	18	pushed
			4	BO	2	12.0		Bar
						13.5	18	pushed
				Vane Test		15.0		
16.0	Silty clay	Grey, medium to stiff, stratified, containing many thin sand and silt layers	5	BO	2	16.0		
						17.5	18	Pushed
				Vane Test		19.0		
			6	BO	2	20.5		
						22.0	18	Pushed
				Vane Test		23.5		

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 TIN
Q – GLASS JAR
R – CLOTH BAG
S – PLIOFILM BAG
Z – DISCARDED

INSPECTOR J. Bateson

LOGGED BY J. MacLeod

APPROVED D. H. MacDonald

DATE November, 1960

Plate IIA

FORM NO. 61-A

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

DRILLING REPORT

CLIENT: Ontario Department of Highways — JOB No. 907

PROJECT: WP 274-00 — HOLE No. 907-1

SITE: Highway 44 and Canadian National Railway — SHEET No 2 OF 3

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 RET'D	PENETRATION TEST
Feet					Inches	Feet	Inches	Blows *
			7	BO	2	24.0		
						25.5	18	Pushed
				Vane Test		27.0		
			8	BO	2	28.0		
						29.5	18	Pushed
				Vane Test		31.0		
			9	BO	2	32.0		
						33.5	18	Pushed
				Vane Test		35.0		
			10	BO	2	36.0		
						37.4	15	Pushed
				Vane Test		39.5		
			11	BO	2	40.0		
						41.5	18	Pushed
				Vane Test		43.0		
			12	BO	2	44.0		
						45.5	18	Pushed
				Vane Test		47.0		
			13	BO	2	48.0		
						49.5	18	Pushed
				Vane Test		51.0		
52.0	Sandy silty clay	Grey, medium consistency, stratified	14	BO	2	52.5		
						54.0	18	Pushed
				Vane Test		55.5		
			15	BO	2	60.0		
						61.5	18	Pushed
68.0	Sand	Fine, medium density stratified containing thin silt and clay layers						
79.5	Sand	Fine, medium to dense stratified containing thin silt and clay layers	16	AQ	2	79.5		
						80.0		46
						80.5		20
						81.0	9	12

Plate IIB

FORM NO. 9-18

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

DRILLING REPORT

CLIENT Ontario Department of Highways — JOB No. 907

PROJECT WP 274-60 — HOLE No. 907-1

SITE Highway 44 and Canadian National Railway — SHEET No. 3 OF 3

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	Blows *
Feet					Inches	Feet	Inches	
87.5	Sandy gravel	Grey hetrogeneous dense	17	AQ	2	88.0		
						88.5		77
						88.8		53 plus
92.3	Bedrock	Sound limestone	DZ			92.3		
						96.0	100%	
						96.0		
99.8		End of hole				99.8	100%	

* Penetration Test
The value given is the number of blows of a 140-pound weight falling freely 30 inches required to advance the standard split-spoon sampler 6 inches to the depth indicated.

Plate IIC

FORM NO. 91-B

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

DRILLING REPORT

CLIENT Ontario Department of Highways — JOB No. 907

PROJECT WP 274-60 — HOLE No. 907-2

SITE Highway 44 and Canadian National Railway — SHEET No. 1 OF 2

CONTRACTOR: F.E. Johnston Drilling Company Limited — STARTED 8:00 A.M. October 28 1960 — FINISHED 9:00 A.M. November 1 1960

METHOD OF DRILLING: SOIL Modified wash boring — CASING DIAM. BX

ROCK Diamond Drill — CORE DIAM. AX

LOCATION: ~~LATITUDE~~ Chainage 478 + 82 — DEPARTURE 14 feet right — BEARING — INITIAL DIP 90 Degrees — OTHER DIPS

ELEVATIONS: DATUM GSC — DRILL PLATFORM — GROUND SURFACE 310.0 — ROCK SURFACE — BOTTOM OF HOLE 239.0 — WATER TABLE 304.0

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 RET'D	PENETRATION TEST Blows *
Feet					Inches	Feet	Inches	
0.0	Sand and gravel	Embankment of existing highway						
5.0	Silty clay	Mottled, grey brown, weathered, stiff, containing some small angular pebbles	1	BO	2	6.0		Bar
						7.5	18	pushed
			2	BO	2	12.0		
						13.5	18	Pushed
14.0	Silty clay	Grey, medium to stiff, stratified, containing many thin sand and silt layers		Vane Test		15.0		
			3	BO	2	18.0		
						19.5	18	Pushed
				Vane Test		21.0		
			4	BO	2	24.0		
						25.5	18	Pushed
				Vane Test		27.0		
			5	BO	2	30.0		
						31.5	18	Pushed
				Vane Test		33.0		

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 November, 1960

Plate IIIA

FORM NO. 91-A

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

DRILLING REPORT

CLIENT Ontario Department of Highways — JOB No. 907

PROJECT WP 274-60 — HOLE No. 907-2

SITE Highway 44 and Canadian National Railway — 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	RET'D	
Feet					Inches	Feet	Inches	Blows*
			6	BQ	2	36.0		
						37.5	18	Pushed
				Vane Test		39.0		
			7	BQ	2	42.0		
						43.5	9	Pushed
				Vane Test		45.0		
			8	BQ	2	48.0		
						49.5	18	Pushed
				Vane Test		51.0		
			9	BQ	2	54.0		
						55.5	18	Pushed
				Vane Test		57.0		
			10	BQ	2	60.0		
						61.5	18	Pushed
65.0	Sand	Fine, medium density stratified containing thin silt and clay layers	11	BQ	2	71.0		
						71.5		2
						72.0		5
72.5		End of hole				72.5	18	6

*** Penetration Test**

The value given is the number of blows of a 140-pound weight falling freely 30 inches required to advance the standard split-spoon sampler 6 inches to the depth indicated.

Plate IIIB

FORM NO. 9-18

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

DRILLING REPORT

CLIENT: Ontario Department of Highways — JOB No.: 907

PROJECT: WP 274-60 — HOLE No.: 907-3

SITE: Highway 44 and Canadian National Railway — SHEET No.: 1 OF 2

CONTRACTOR: F.E. Johnston Drilling Company Limited
STARTED 11:00 A.M. November 1 1960
FINISHED 5:00 P.M. November 2 1960

METHOD OF DRILLING:
SOIL: Modified wash boring — CASING DIAM.: BX
ROCK: Diamond Drill — CORE DIAM.: AX

LOCATION: ~~LATITUDE~~ Chainage 479 + 22
DEPARTURE 13 feet right
BEARING
INITIAL DIP 90 Degrees
OTHER DIPS

ELEVATIONS:
DATUM: GSC
DRILL PLATFORM
GROUND SURFACE: 311.3
ROCK SURFACE
BOTTOM OF HOLE: 238.8
WATER TABLE: 304.0

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 RET'D	PENETRATION TEST Blows *
Feet					Inches	Feet	Inches	
0.0	Sand and gravel	Embankment of existing highway						
6.0	Silty clay	Mottled, grey brown, stiff weathered	1	AQ	2.	6.0		
						6.5		2
						7.0		6
						7.5	18	5
			2	BO	2.	12.0		
						13.5	18	Pushed
15.0	Silty clay	Grey medium to stiff stratified containing		Vane Test		15.0		
		many thin sand and silt	3	BO	2.	18.0		
		layers				19.5	18	Pushed
				Vane Test		21.0		
			4	BO	2.	24.0		
						25.5	18	Pushed
				Vane Test		27.0		
			5	BO	2.	30.0		
						31.5	18	Pushed
				Vane Test		33.0		

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 November, 1960

Plate IVA

FORM NO. 91-A

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

DRILLING REPORT

CLIENT: Ontario Department of Highways — JOB No. 907

PROJECT: WP 274-60 — HOLE No. 907-3

SITE: Highway 44 and Canadian National Railway — 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 RET'D	PENETRATION TEST
Feet					Inches	Feet	Inches	Blows *
			6	BO	2	36.0		
						37.5	18	Pushed
				Vane Test		39.0		
				Vane Test		43.5		
			7	BO	2	48.0		
						49.5	18	Pushed
				Vane Test		51.0		
				Vane Test		55.5		
			8	BO	2	60.0		
						61.5	18	Pushed
				Vane Test		63.0		
				Vane Test		67.5		
71.0	Sand	Fine, medium density stratified	1	AQ	2	71.0		
						71.5		4
						72.0		3
72.5		End of hole				72.5	3	4

* Penetration Test

The value given is the number of blows of a 140-pound weight falling freely 30 inches required to advance the standard split-spoon sampler 6 inches to the depth indicated.

Plate IVB

FORM NO. 91-B

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

DRILLING REPORT

CLIENT Ontario Department of Highways — JOB No. 907

PROJECT WP 274-60 — HOLE No. 907-4

SITE Highway 44 and Canadian National Railway — SHEET No. 1 OF 2

CONTRACTOR: F.E. Johnston Drilling Company Limited
STARTED 9:00 A.M. November 3 1960
FINISHED 4:30 P.M. November 4 1960

METHOD OF DRILLING: SOIL Modified wash boring — CASING DIAM. BX
ROCK Diamond Drill — CORE DIAM. AX

LOCATION: ~~LATITUDE~~ Chainage 478 + 66
DEPARTURE 20 feet left
BEARING
INITIAL DIP 90 Degrees
OTHER DIPS

ELEVATIONS:
DATUM GSC
DRILL PLATFORM
GROUND SURFACE 308.9
ROCK SURFACE 195.9
BOTTOM OF HOLE 195.9
WATER TABLE 303.4

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 RET'D	PENETRATION TEST Blows *
Feet					Inches	Feet	Inches	
0.0	Sand and gravel	Embankment of existing highway						
6.0	Silty clay	Mottled, grey brown, weathered, stiff stratified	1	BO	2	6.0		Bar
						7.5	18	pushed
12.0	Silty clay	Grey, medium to stiff stratified containing many thin sand and silt layers	2	BO	2	12.0		
						13.5	18	Pushed
				Vane Test		18.0		
			3	BO	2	24.0		
						25.5	18	Pushed
				Vane Test		27.0		
				Vane Test		31.5		
			4	BO	2	36.0		
						37.5	18	Pushed
				Vane Test		39.0		
			5	BO	2	48.0		
						49.5	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 — PLIOFILM BAG
Z — DISCARDED

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

Plate VA

FORM NO. 91-A

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

DRILLING REPORT

CLIENT Ontario Department of Highways — JOB No. 907

PROJECT WP-274-60 — HOLE No. 907-4

SITE Highway 44 and Canadian National Railway — 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	RET'D	
Feet					Inches	Feet	Inches	Blows *
				Vane Test		51.0		
				Vane Test		55.5		
			6	BQ	2	60.0		
						61.5	18	Pushed
				Vane Test		63.0		
				Vane Test		67.5		
68.0	Sand	Grey fine dense to medium stratified	7	AQ	2	72.0		
						72.5		2
						73.0		5
						73.5		3
112.0	Gravel	Angular pebbles						
113.0	Rock	Boulder or bedrock End of hole						

* Penetration Test

The value given is the number of blows of a 140-pound weight falling freely 30 inches required to advance the standard split-spoon sampler 6 inches to the depth indicated.

Plate VB

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

DRILLING REPORT

CLIENT Ontario Department of Highways — JOB No. 907

PROJECT WP 274-60 — HOLE No. 907-5

SITE Highway 44 and Canadian National Railway — SHEET No. 1 OF 2

CONTRACTOR: F.E. Johnston Drilling Company Limited — STARTED 7:30 A.M. November 14 1960 — FINISHED 12:00 A.M. November 14 1960

METHOD OF DRILLING: SOIL Modified wash boring — CASING DIAM. BX

ROCK Diamond Drill — CORE DIAM. AX

LOCATION: ~~LATITUDE~~ Chainage 479 + 46
DEPARTURE 14 feet left
BEARING
INITIAL DIP 90 Degrees
OTHER DIPS

ELEVATIONS:
DATUM GSC
DRILL PLATFORM
GROUND SURFACE 312.2
ROCK SURFACE -
BOTTOM OF HOLE 241.7
WATER TABLE 305.0

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 RET'D	PENETRATION TEST Blows *
Feet					Inches	Feet	Inches	
0.0	Sand and gravel	Embankment of existing highway	1	AQ	2	6.0		
						6.5		2
						7.0		3
7.5	Silty clay	Mottled grey brown weathered stiff stratified				7.5	18	3
			2	BQ	2	12.0		Bar
						13.5	13	pushed
17.0	Silty clay	Grey medium to stiff stratified containing many layers of silt and sand		Vane Test		18.5		
				BZ	2	24.0		
						25.5	4	Pushed
			3	BQ	2	26.0		
						27.5	18	Pushed
				Vane Test		29.0		
				Vane Test		33.5		
			4	BQ	2	38.0		
						39.5	18	Pushed
				Vane Test		41.0		

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 November, 1960

Plate VIA

FORM NO. 91-A

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

DRILLING REPORT

CLIENT Ontario Department of Highways — JOB No. 907

PROJECT WP 274-60 — HOLE No. 907-5

SITE Highway 44 and Canadian National Railway — 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	RET'D	
Feet					Inches	Feet	Inches	Blows *
			5	BO	2	44.0		
						45.5	18	Pushed
			6	BO	2	50.0		
						51.5	18	Pushed
				Vane Test		53.0		
				Vane Test		57.5		
60.0	Sand	Grey silty loose to medium density stratified containing silt and clay layers	7	AQ	2	62.0		
						62.5		1
						63.0		2
						63.5	18	3
			8	AQ	2	69.0		
						69.5		3
						70.0		3
70.5		End of hole				70.5	18	4

* Penetration Test

The value given is the number of blows of a 140-pound weight falling freely 30 inches required to advance the standard split-spoon sampler 6 inches to the depth indicated.

Plate VIB

FORM NO. 91-8

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

DRILLING REPORT

CLIENT Ontario Department of Highways — JOB No. 907

PROJECT WP 274-60 — HOLE No. 907-6

SITE Highway 44 and Canadian National Railway — SHEET No. 1 OF 2

CONTRACTOR: F.E. Johnston Drilling Company Limited — STARTED 9:00 A.M. November 1 19 60 — FINISHED 12:00 A.M. November 4 19 60

METHOD OF DRILLING: SOIL Modified wash boring — CASING DIAM. NX

ROCK Diamond Drill — CORE DIAM. AX

LOCATION: ~~LATITUDE~~ Chainage 479 + 84 — DEPARTURE 17 feet left — BEARING — INITIAL DIP 90 Degrees — OTHER DIPS

ELEVATIONS: DATUM CSC — DRILL PLATFORM — GROUND SURFACE 312.8 — ROCK SURFACE — BOTTOM OF HOLE 243.3 — WATER TABLE 304.7

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 RET'D	PENETRATION TEST Blows *
Feet					Inches	Feet	Inches	
0.0	Sand and gravel	Embankment of existing highway	1	AQ	2	7.0		
						7.5		3
						8.0		4
8.5	Silty clay	Mottled, grey brown, stiff weathered stratified				8.5		5
		containing thin silt	2	BO	2	11.5		
		and sand layers				13.0	6	Pushed
			3	BO	2	13.0		Bar
						14.5	18	pushed
16.5	Silty clay	Grey, medium to stiff stratified, containing	4	CO	3	17.0		
		many thin silt and sand layers				18.4	17	Pushed
				Vane Test		20.0		
			5	CO	3	22.0		
						23.4	17	Pushed
				Vane Test		25.0		
			6	CO	3	27.0		
						28.3	15	Pushed
				Vane Test		30.0		

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 November, 1960

Plate VIIA

FORM NO. 91-A

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

DRILLING REPORT

CLIENT Ontario Department of Highways — JOB No. 907

PROJECT WP 274-60 — HOLE No. 907-6

SITE Highway 44 and Canadian National Railway — 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 RET'D	PENETRATION TEST Blows *
Feet					Inches	Feet	Inches	
			7	CO	3	32.0		
						33.4	17	Pushed
				Vane Test		35.0		
			8	CO	3	37.0		
						38.4	17	Pushed
				Vane Test		40.0		
		*Penetration Test The value given is the number of blows of a 140-pound weight falling freely 30 inches required to advance the standard split-spoon sampler 6 inches to the depth indicated.	9	CO	3	42.0		
						43.4	17	Pushed
				Vane Test		45.0		
			10	CO	3	47.0		
						48.4	17	Pushed
				Vane Test		50.9		
			11	CO	3	52.0		Bar
						53.4	17	pushed
				Vane Test		55.0		
			12	CO	3	57.0		
						58.4	17	Pushed
58.5	Sandy silt	Grey medium to stiff stratified						
62.0	Silty sand	Grey fine, medium density stratified containing thin silt and clay layers	13	CO	3	62.0		
						63.4	17	Pushed
				Vane Test		65.0		
			14	CO	3	67.0		
						68.0	12	Pushed
			15	AQ	3	68.0		
						68.5		2
						69.0		3
69.5		End of hole				69.5	12	5

Plate VIIB

FORM NO 91-B

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

DRILLING REPORT

CLIENT: Ontario Department of Highways — JOB No. 907

PROJECT: WP 274-60 — HOLE No. 907-7

SITE: Highway 44 and Canadian National Railway — SHEET No. 1 OF 2

CONTRACTOR: F.E. Johnston Drilling Company Limited
STARTED 9:00 A.M. November 7 19 60
FINISHED 10:30 A.M. November 8 19 60

METHOD OF DRILLING: SOIL Modified wash boring — CASING DIAM. BX
ROCK Diamond Drill — CORE DIAM. AX

LOCATION: ~~LATITUDE~~ Chainage 477 + 00
DEPARTURE 19 feet right
BEARING
INITIAL DIP 90 Degrees
OTHER DIPS

ELEVATIONS: DATUM GSC
DRILL PLATFORM
GROUND SURFACE 305.7
ROCK SURFACE
BOTTOM OF HOLE 235.7
WATER TABLE 301.1

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 RET'D	PENETRATION TEST Blows *
Feet					Inches	Feet	Inches	
0.0	Sand and gravel	Embankment of existing highway						
6.0	Silty clay	Mottled grey brown, stiff weathered stratified	1	BO	2	6.0		Bar pushed
						7.5	15	
			2	BO	2	12.0		
						13.5	15	Pushed
18.0	Silty clay	Grey medium to stiff, stratified containing many thin layers		Vane Test		19.5		
			3	BO	2	24.0		
						25.5	15	Pushed
				Vane Test		27.0		
				Vane Test		31.5		
			4	BO	2	36.0		
						37.5	15	Pushed
				Vane Test		39.0		
42.0	Silty sand	Grey fine loose stratified		BZ	2	42.0		
						43.5	Nil	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 — PLIOFILM BAG
Z — DISCARDED

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

Plate VIIIA

FORM NO. G1-A

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

DRILLING REPORT

CLIENT Ontario Department of Highways — JOB No. 907

PROJECT WF 274-60 — HOLE No. 907-7

SITE Highway 44 and Canadian National Railway — 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 RET'D	PENETRATION TEST
Feet					Inches	Feet	Inches	Blows *
			5	AQ	2	43.5		
						45.0	18	Pushed
			6	AQ	2	48.0		
						49.5	18	Pushed
			7	AQ	2	54.0		
						55.5	18	Pushed
			8	AQ	2	66.0		
						66.5		2
						67.0		4
						67.5	18	5
70.0		End of hole						

* Penetration Test

The value given is the number of blows of a 140-pound weight falling freely 30 inches required to advance the standard split-spoon sampler 6 inches to the depth indicated.

Plate VIIIB

FORM NO. 91-B

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

DRILLING REPORT

CLIENT Ontario Department of Highways — JOB No. 907

PROJECT WP 274-60 — HOLE No. 907-8

SITE Highway 44 and Canadian National Railway — SHEET No. 1 OF 2

CONTRACTOR: F.E. Johnston Drilling Company Limited
STARTED 2:00 P.M. November 4 1960
FINISHED 5:00 P.M. November 7 1960

METHOD OF DRILLING:
SOIL Modified wash boring — CASING DIAM. BX
ROCK Diamond Drill — CORE DIAM. AX

LOCATION:
~~LATITUDE~~ Chainage 483 + 02
DEPARTURE 27 feet left
BEARING
INITIAL DIP 90 Degrees
OTHER DIPS

ELEVATIONS:
DATUM GSC
DRILL PLATFORM
GROUND SURFACE 320.0
ROCK SURFACE 252.1
BOTTOM OF HOLE 252.1
WATER TABLE 312.0

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 RET'D	PENETRATION TEST Blows *
Feet					Inches	Feet	Inches	
0.0	Sand and gravel	Embankment of the existing highway						
7.0	Silty clay	Mottled, grey brown, stiff weathered, stratified containing thin silt and sand layers						
12.0	Silty clay	Grey, medium to stiff stratified, containing many thin silt and sand layers	1	BO	2	12.0		Bar
						13.5	15	pushed
				Vane Test		19.5		
			2	BO	2	24.0		
						25.5	18	Pushed
				Vane Test		27.0		
				Vane Test		31.5		
36.0		3-Inch layer containing angular pebbles, 1/2 to 1 inch size	3	AQ	2	36.0		
						36.5		3
						37.0		1
						37.5	18	2
				Vane Test		39.0		
				Vane Test		43.5		

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 TIN
Q — GLASS JAR
R — CLOTH BAG
S — PLIOFILM BAG
Z — DISCARDED

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

Plate IXA

FORM NO. 91-A

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

DRILLING REPORT

CLIENT Ontario Department of Highways — JOB No. 907

PROJECT WP 274-60 — HOLE No. 907-8

SITE Highway 44 and Canadian National Railway — 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	RET'D	Blows *
Feet					Inches	Feet	Inches	
			4	BZ	2	48.0		Pushed to
						48.5	6	refusal
			5	AQ	2	48.5		
						49.0		2
						49.5		3
50.0	Sandy silt	Grey, medium consistency stratified, containing clay and sand layers				50.0	12	5
			6	AQ	2	54.0		
						54.5		2
						55.0		1
						55.5	12	2
60.0	Silty sand	Grey, medium density stratified	7	AQ	2	60.0		
						60.5		4
						61.0		6
						61.5	12	11
66.0	Sand and gravel	Hetrogeneous medium density		AZ	2	66.0		
						66.5		40
						67.0		16
						67.5	Nil	6
67.9	Rock	Bedrock or boulder End of hole						

* Penetration Test
The value given is the number of blows of a 140-pound weight falling freely 30 inches required to advance the standard split-spoon sampler 6 inches to the depth indicated.

Plate IXB

FORM NO. 9-15

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

DRILLING REPORT

CLIENT Ontario Department of Highways — JOB No. 907

PROJECT WP 274-60 — HOLE No. 907-9

SITE Highway 44 and Canadian National Railway — SHEET No. 1 OF 1

CONTRACTOR: F.E. Johnston Drilling Company Limited
STARTED 3:00 P.M. November 14 1960
FINISHED 11:30 A.M. November 15 1960

METHOD OF DRILLING: SOIL Modified wash boring — CASING DIAM. NX
ROCK Diamond Drill — CORE DIAM.

LOCATION: ~~LATITUDE~~ Chainage 478 + 60
DEPARTURE 20 feet left
BEARING
INITIAL DIP 90 Degrees
OTHER DIPS

ELEVATIONS: DATUM GSC
DRILL PLATFORM
GROUND SURFACE 309.2
ROCK SURFACE -
BOTTOM OF HOLE 281.2
WATER TABLE 303.2

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 RET'D	PENETRATION TEST Blows *
Feet					Inches	Feet	Inches	
0.0	Sand and gravel	Embankment of existing highway						
6.0	Silty clay	Mottled, grey brown, weathered, stiff, stratified	1	BO	2	10.0		Pushed to refusal
						11.0	12	
15.0	Silty clay	Grey, medium to stiff stratified containing sand and silt layers	2	CO	3	15.0		
						16.4	15	Pushed
				Vane Test		17.9		
			3	CO	3	20.0		
						21.4	16	Pushed
				Vane Test		22.9		
			4	CO	3	25.0		
						26.4	16	Pushed
				Vane Test		27.9		
28.0		End of hole						

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

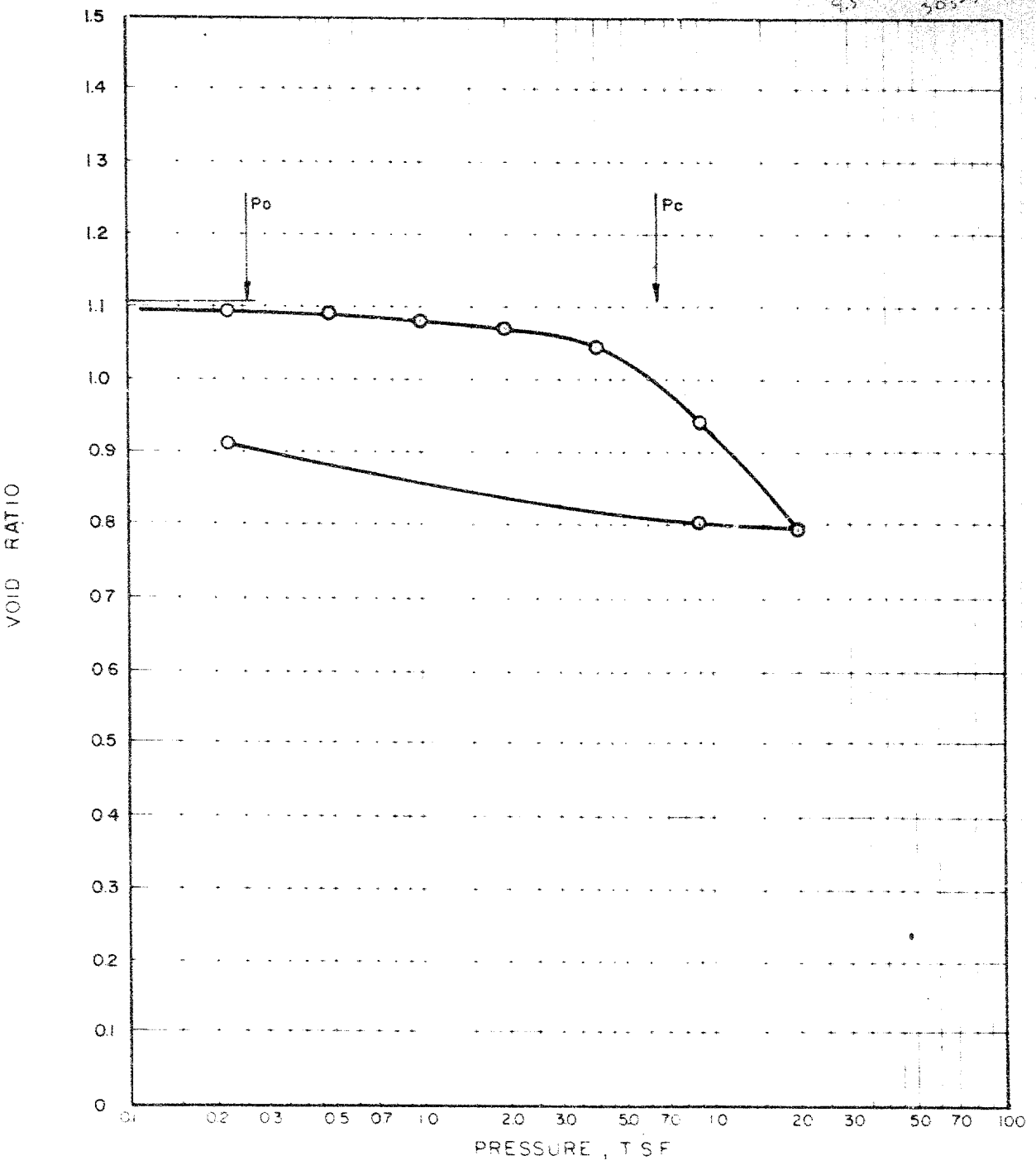
SHIPPING CONTAINER
N – INSERT
O – TUBE
P – WATER CONTENT TIN
Q – GLASS JAR
R – CLOTH BAG
S – PLIOFILM BAG
Z – DISCARDED

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

Plate KA

FORM NO. 91-A

9.5' 303-3



OVERBURDEN PRESSURE — P_o = 0.26 TSF

CONSOLIDATION PRESSURE — P_c = 6.50 TSF

NATURAL WATER CONTENT 37.1 %

LOADING INTERVAL 100% PRIMARY CONSOLIDATION

SAMPLE No 907-BO-2

TEST No 907-9-4

TEST DATE NOVEMBER 10, 1960

TESTED BY R.L.

H G ACRES & COMPANY LIMITED
CONSULTING ENGINEERS
NIAGARA FALLS CANADA

ONTARIO DEPARTMENT OF HIGHWAYS

WP - 274 - 60

CONSOLIDATION TEST

HOLE No 907-1

SAMPLE ELEV 303.3

APPROVED

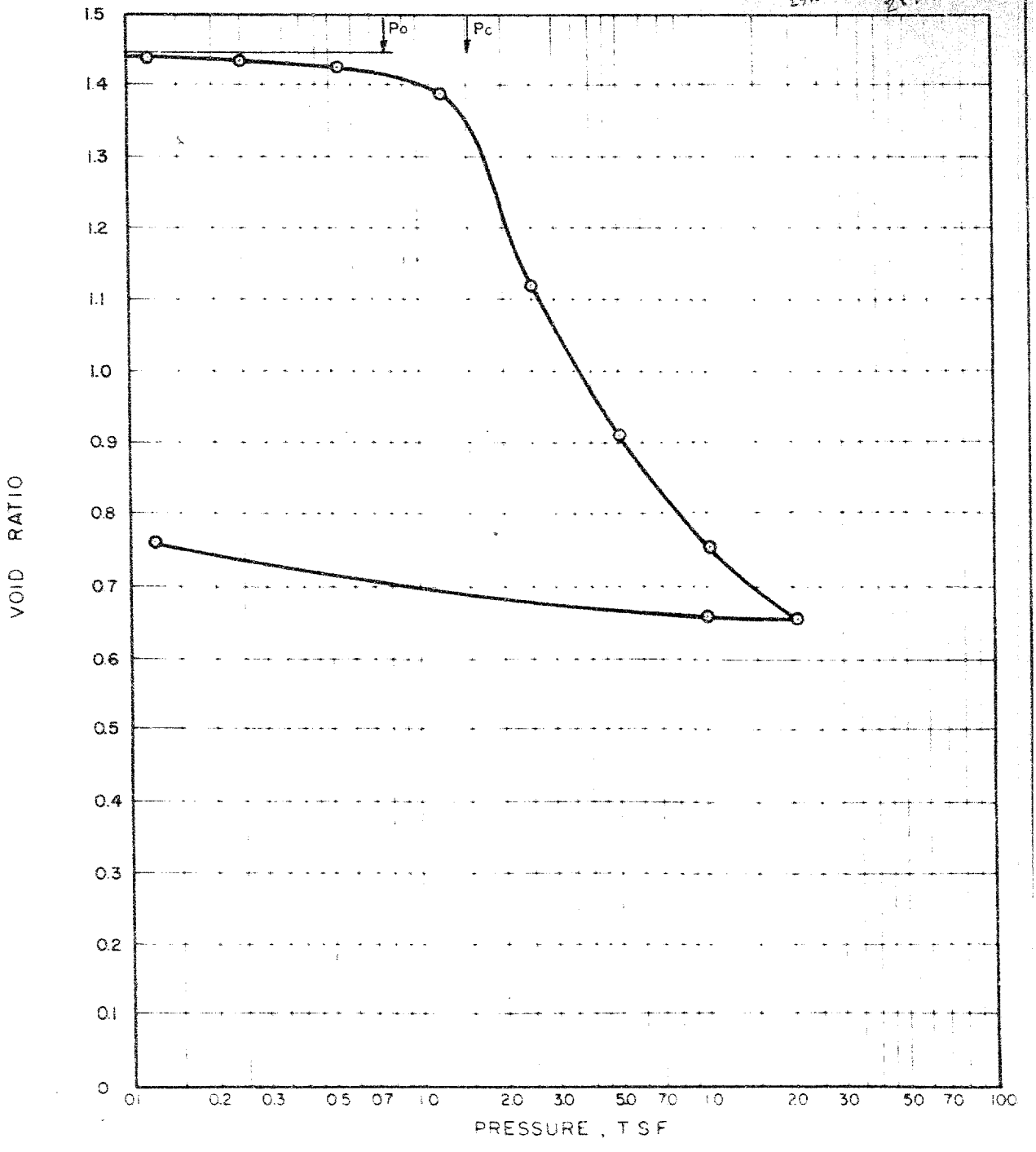
A.H. Bradford

H G ACRES & COMPANY LTD

DATE NOVEMBER 196

JOB No 907

PLATE XI



OVERBURDEN PRESSURE — P_o = 0.79 TSF

CONSOLIDATION PRESSURE — P_c = 1.51 TSF

NATURAL WATER CONTENT 52.5 %

LOADING INTERVAL 100% PRIMARY CONSOLIDATION

SAMPLE No 907 – CO – 5

TEST No 907 – 9 – 1

TEST DATE NOVEMBER 4, 1960

TESTED BY R.L.

H G ACRES & COMPANY LIMITED
CONSULTING ENGINEERS
NIAGARA FALLS CANADA

ONTARIO DEPARTMENT OF HIGHWAYS

WP - 274 - 60

CONSOLIDATION TEST

HOLE No 907–6 SAMPLE ELEV 289.8

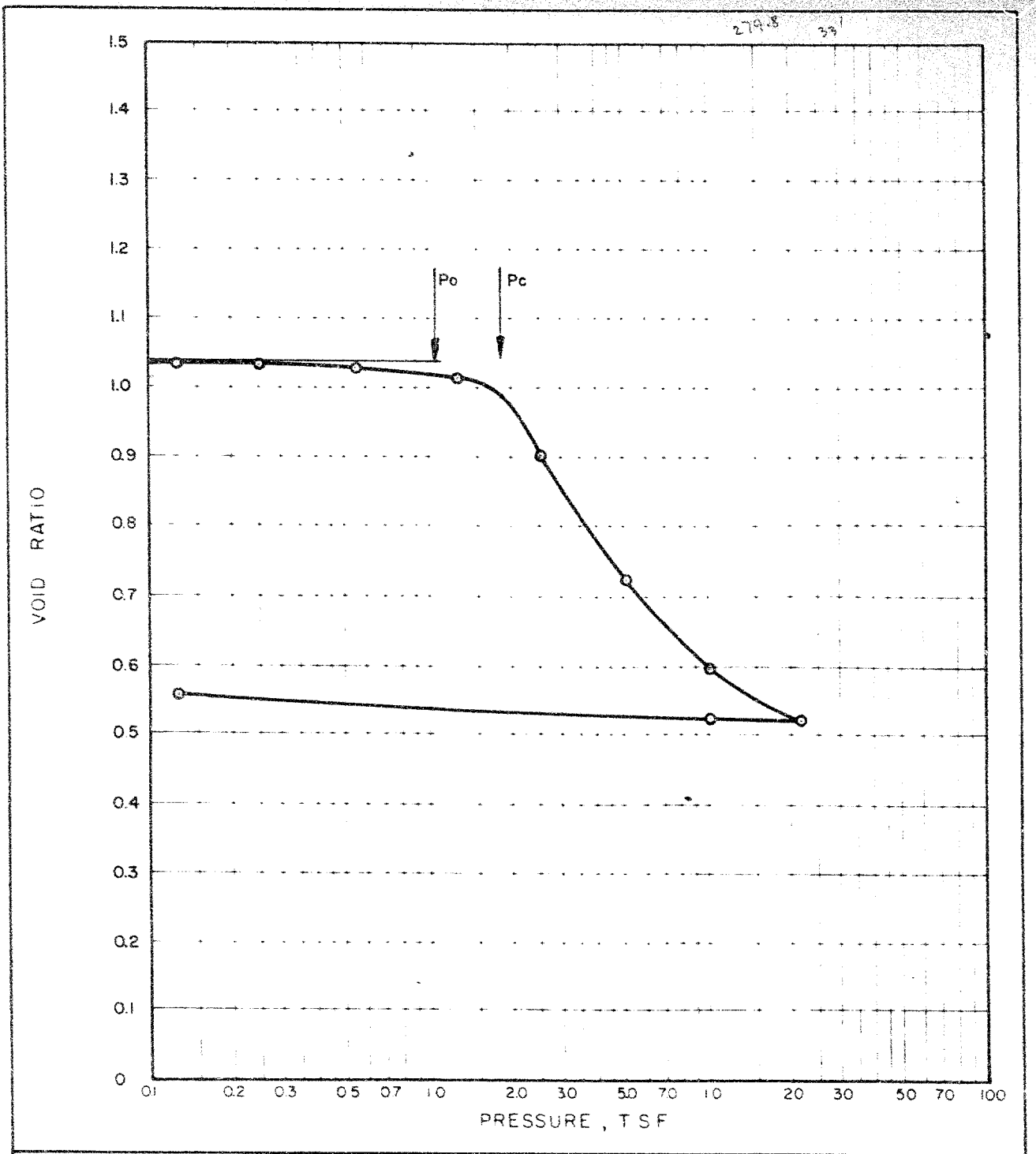
APPROVED

H G ACRES & COMPANY LTD

DATE NOVEMBER 1960

JOB No 907

PLATE XII



OVERBURDEN PRESSURE — P_o = 1.04 TSF
CONSOLIDATION PRESSURE — P_c = 1.83 TSF
NATURAL WATER CONTENT 37.5 %
LOADING INTERVAL 100% PRIMARY CONSOLIDATION

SAMPLE No 907—CO—7
TEST No 907—9—2
TEST DATE NOVEMBER 4, 1960
TESTED BY R.L.

H G ACRES & COMPANY LIMITED
CONSULTING ENGINEERS
NIAGARA FALLS CANADA

ONTARIO DEPARTMENT OF HIGHWAYS

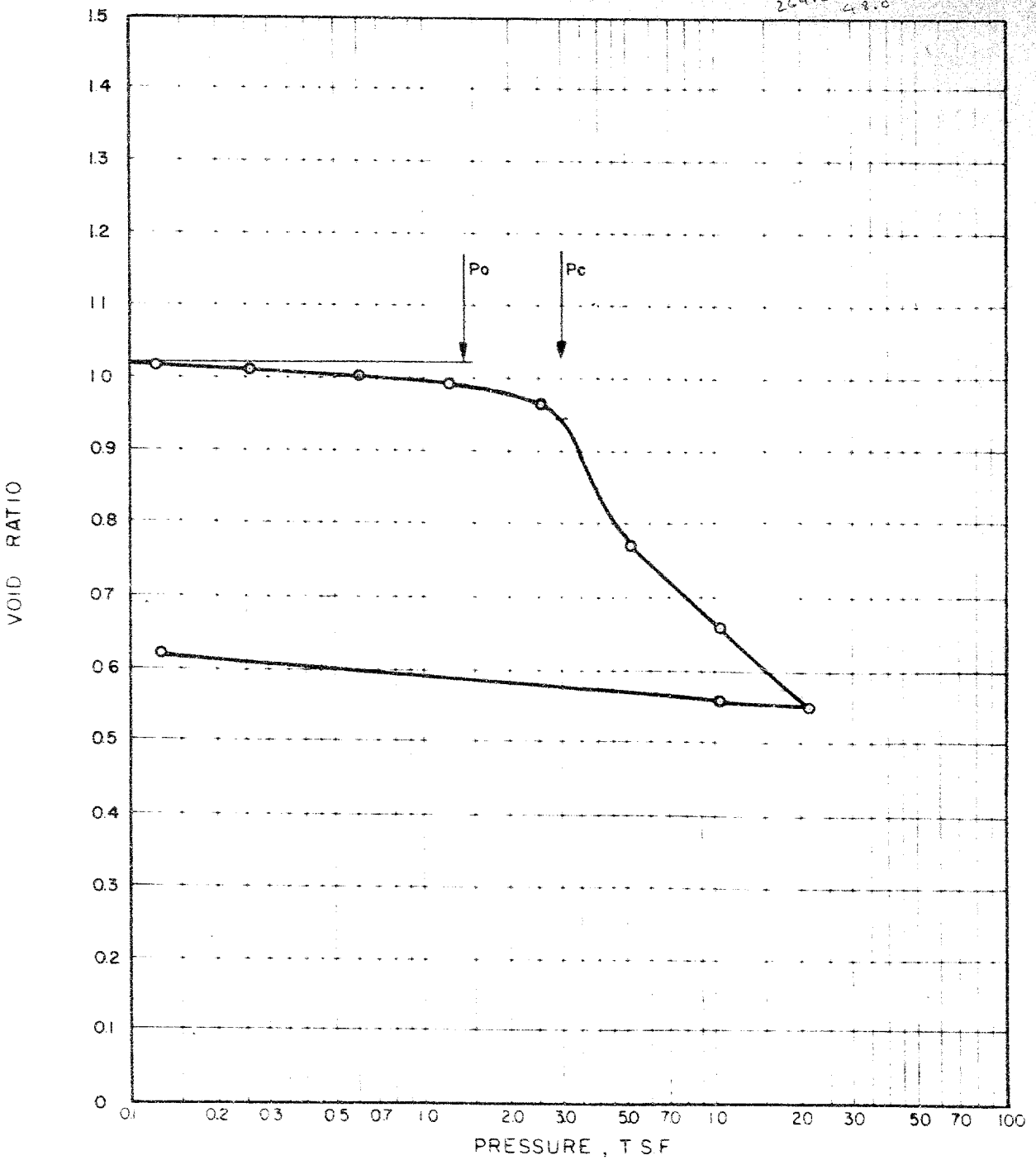
WP - 274-60

CONSOLIDATION TEST

HOLE No 907—6 SAMPLE ELEV 279.8

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

DATE NOVEMBER 1960
JOB No 907
PLATE XIII



OVERBURDEN PRESSURE — P_o = 1.41 TSF

CONSOLIDATION PRESSURE — P_c = 3.00 TSF

NATURAL WATER CONTENT 37.1 %

LOADING INTERVAL 100% PRIMARY CONSOLIDATION

SAMPLE No 907-CO-10

TEST No 907-9-3

TEST DATE NOVEMBER 10, 1960

TESTED BY R.L.

H G ACRES & COMPANY LIMITED
CONSULTING ENGINEERS
NIAGARA FALLS CANADA

ONTARIO DEPARTMENT OF HIGHWAYS

WP - 274 - 60

CONSOLIDATION TEST

HOLE No 907-6 SAMPLE ELEV 264.8

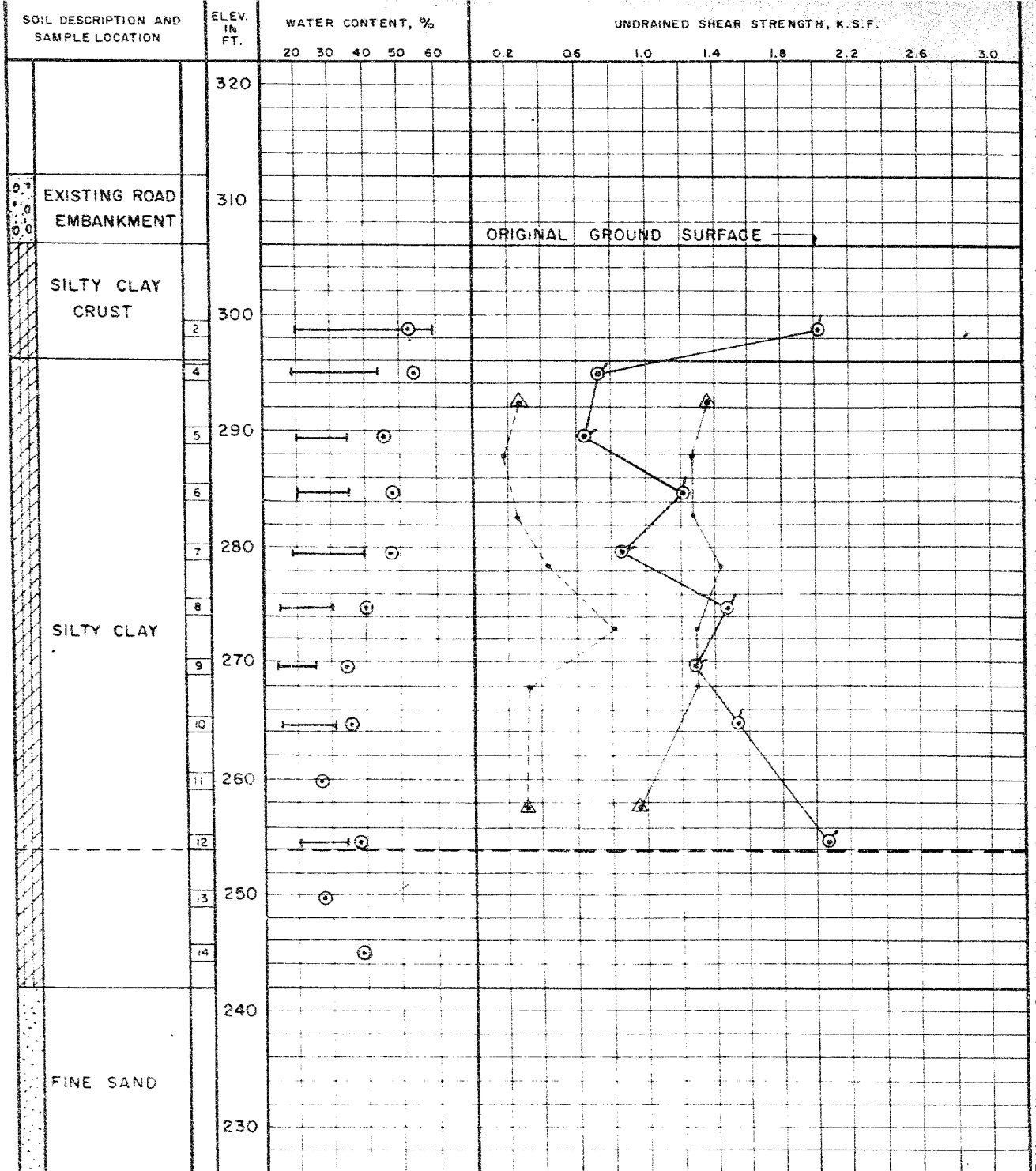
APPROVED

D. H. MacDonald
H G ACRES & COMPANY LTD

DATE NOVEMBER 1960

JOB No 907

PLATE XIV



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

ONTARIO DEPARTMENT OF HIGHWAYS

W.P. 274-60

SUMMARY OF DRILLING AND TEST RESULTS

HOLE 907-6

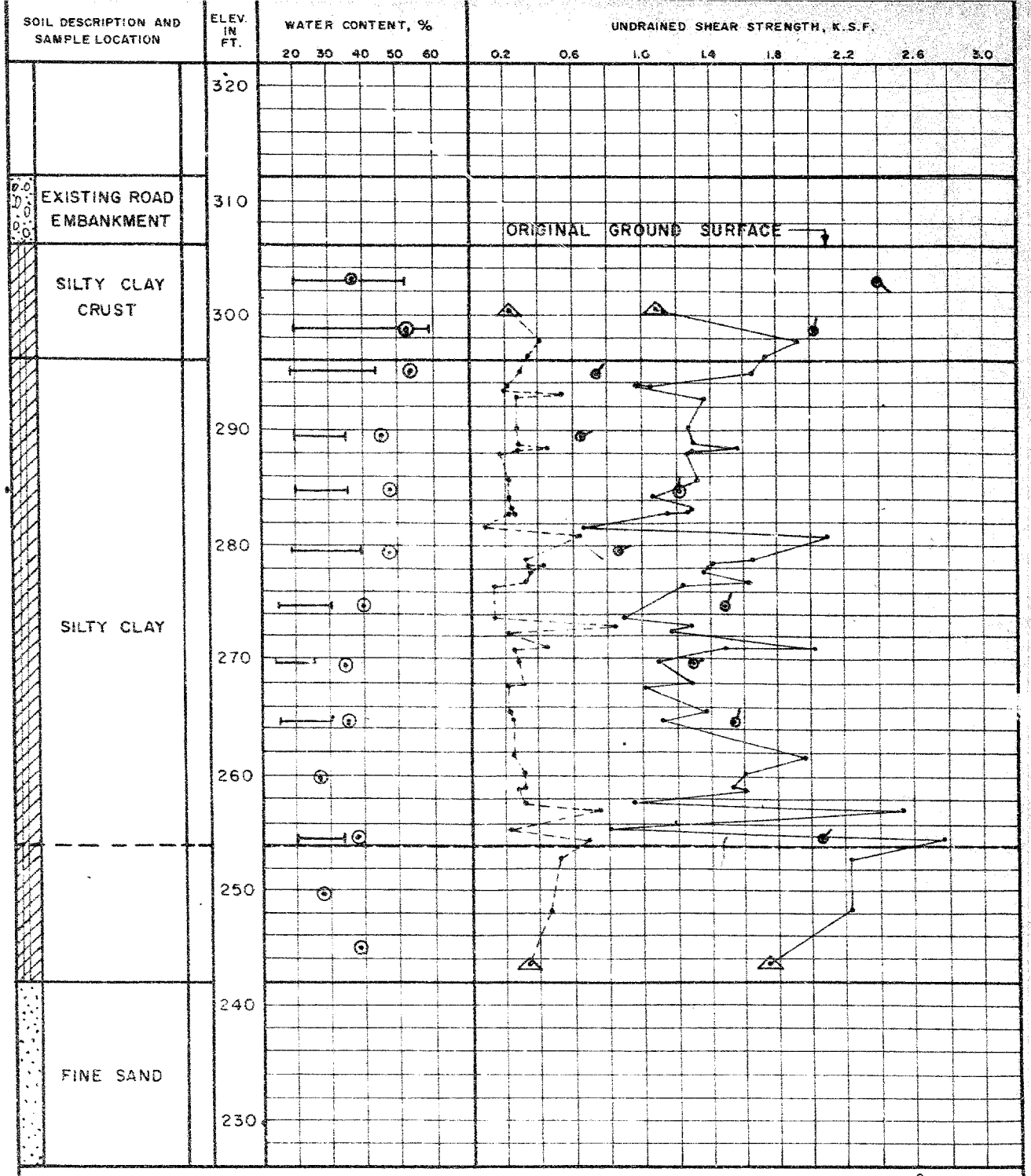
APPROVED

H.G. ACRES & COMPANY LTD.

DATE NOVEMBER 1960

JOB No. 907

PLATE XV



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

ONTARIO DEPARTMENT OF HIGHWAYS

W. P. 274-60

SUMMARY OF DRILLING AND TEST RESULTS

HOLES 907-1, 907-2, 907-3, 907-5, 907-6 & 907-8

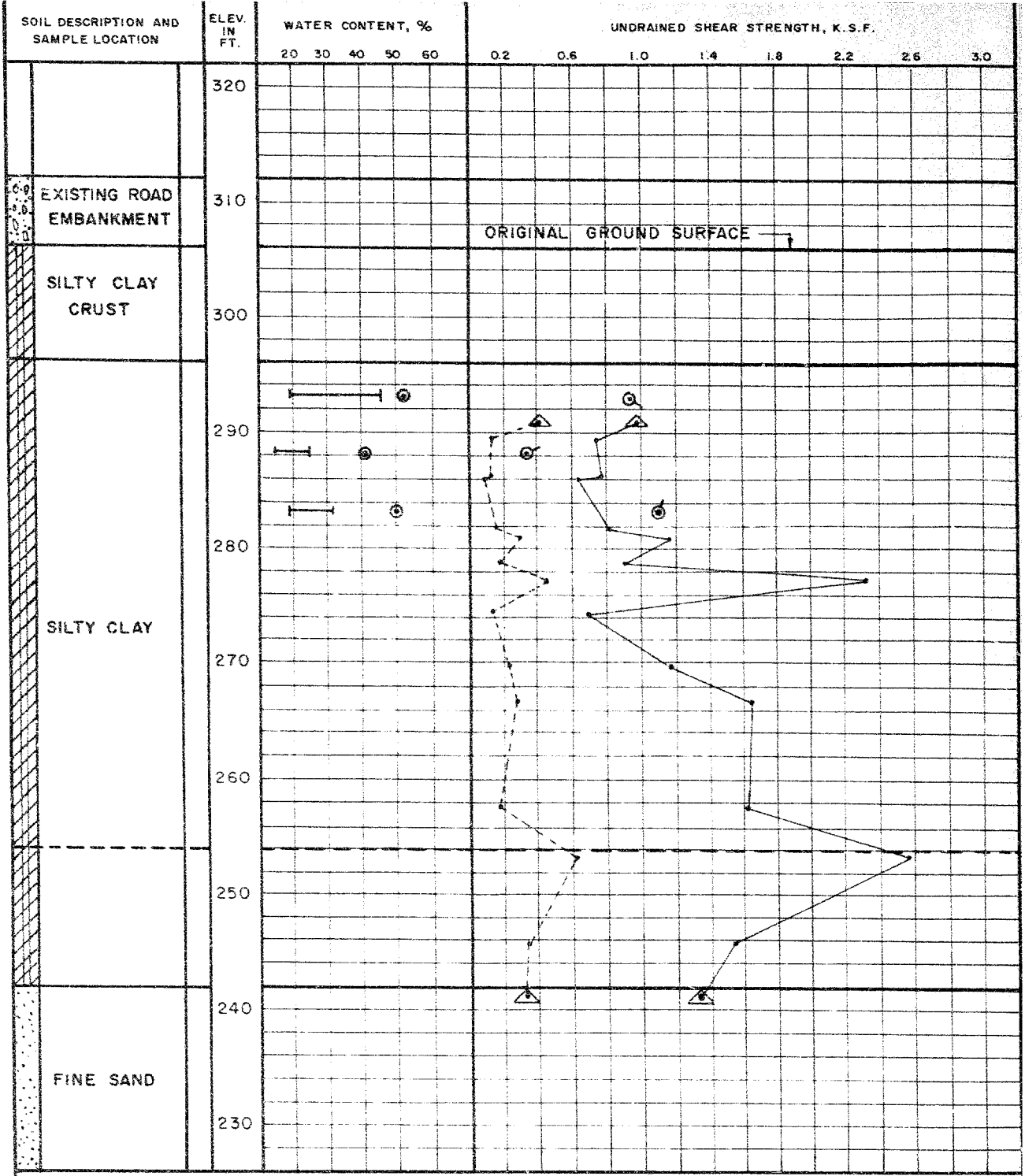
APPROVED

H. G. ACRES & COMPANY LTD.

DATE: NOVEMBER, 1960

JOB No. 907

PLATE XVI



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

ONTARIO DEPARTMENT OF HIGHWAYS

W.P. 274-60

SUMMARY OF DRILLING AND TEST RESULTS

HOLES 907-4, 907-7, 907-9

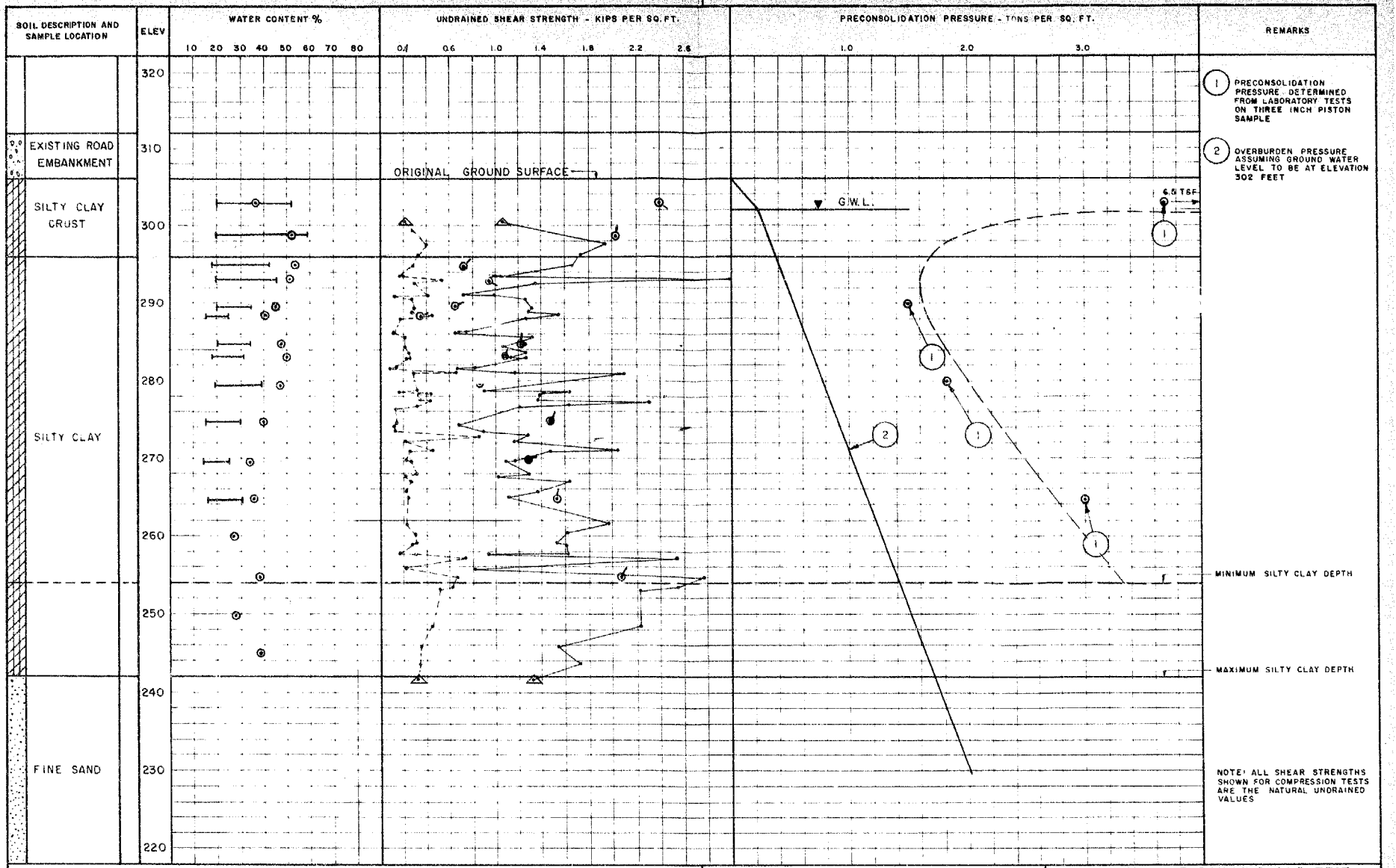
APPROVED

H.G. ACRES & COMPANY LTD.

DATE: NOVEMBER, 1960

JOB No. 907

PLATE XVII



3 SOIL SAMPLE

NATURAL WATER CONTENT

LIQUID LIMIT

PLASTIC LIMIT

UNDRAINED COMPRESSION TEST

FIELD VANE TEST

NATURAL STRENGTH

REMOULDED STRENGTH

0
15 5
10
FAILURE STRAIN

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

ONTARIO DEPARTMENT OF HIGHWAYS

W.P. 274 - 60

SUMMARY OF DRILLING AND TEST RESULTS

COMPARISON OF ALL TESTS

APPROVED
H. G. ACRES & COMPANY LIMITED

DATE NOVEMBER, 1960
JOB No. 907
PLATE - XVIII

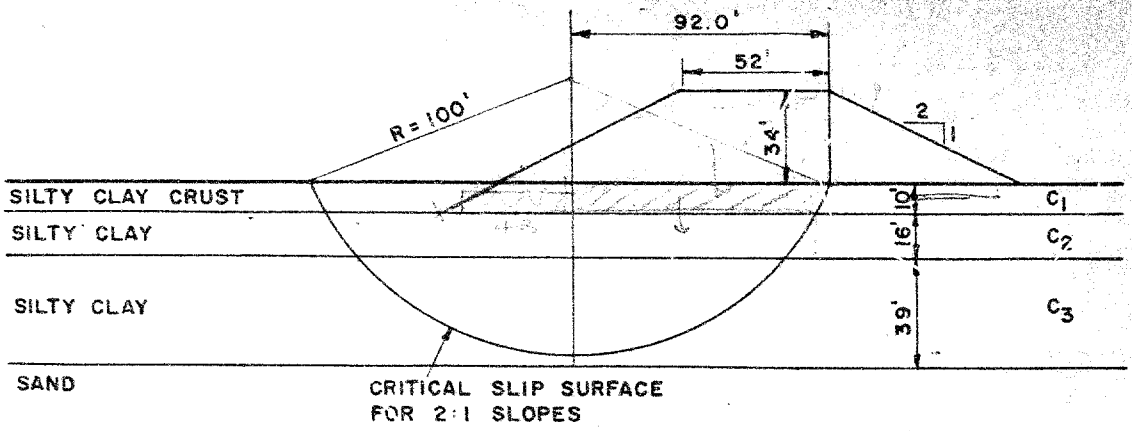


TABLE I

SHEAR STRENGTHS AND FACTORS OF SAFETY

SLOPES	1.5 TO 1		2 TO 1	
STATION	478 + 70 TO 483 + 00	477 + 00 TO 478 + 70	478 + 70 TO 483 + 00	477 + 00 TO 478 + 70
C_1 (PSF)	1300	1300	1300	1300
C_2 (PSF)	1100	800	1100	800
C_3 (PSF)	1100	1100	1100	1100
FACTOR OF SAFETY	1.54	1.48	1.58	1.52

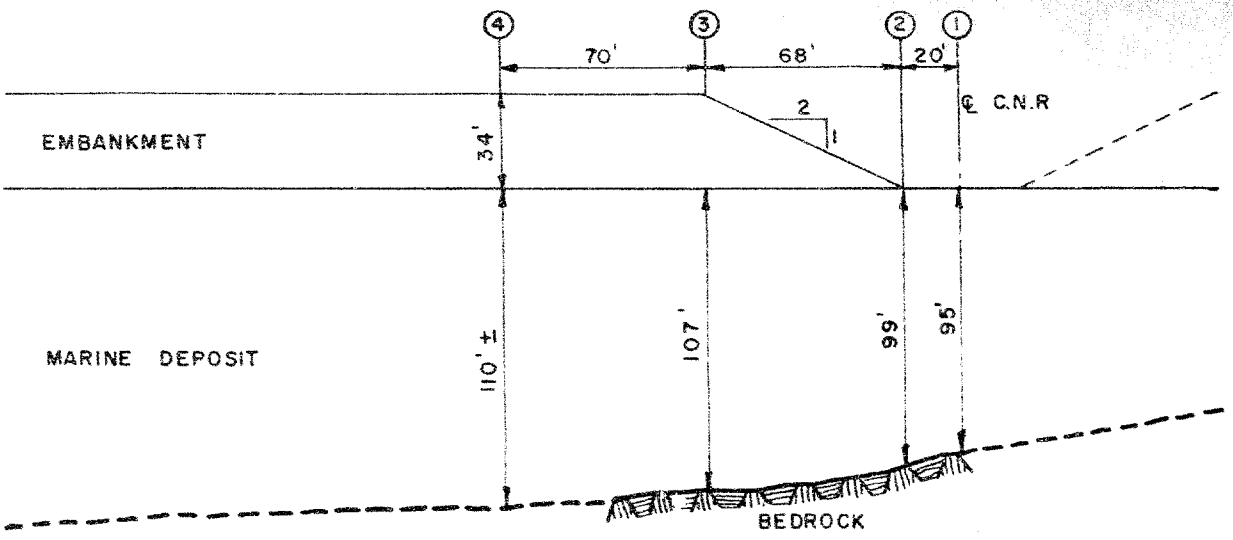
H G ACRES & COMPANY LIMITED
CONSULTING ENGINEERS
NIAGARA FALLS CANADA

ONTARIO DEPARTMENT OF HIGHWAYS

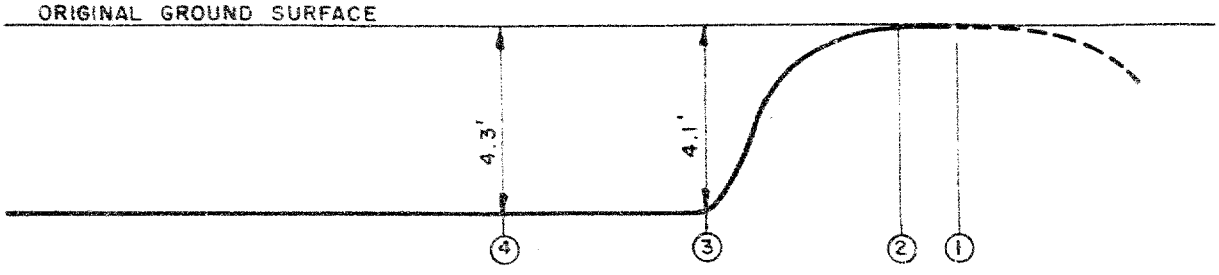
WP 274 - 60

SUMMARY OF STABILITY ANALYSES

APPROVED	DATE NOVEMBER 1960
D. H. Macdonald	SCALE / JOB NO 907
H G ACRES & COMPANY LIMITED	PLATE XIX



SECTION ALONG ℄ HIGHWAY 44



ELASTIC SETTLEMENT IN FEET	0.9	0.7	0	0
CONSOLIDATION SETTLEMENT IN FEET	3.4	3.4	0.1	0
ULTIMATE SETTLEMENT IN FEET	4.3	4.1	0.1	0

RESULTS OF SETTLEMENT CALCULATIONS

H G ACRES & COMPANY LIMITED
CONSULTING ENGINEERS
NIAGARA FALLS CANADA

ONTARIO DEPARTMENT OF HIGHWAYS

WP 274 - 60

FOUNDATION SETTLEMENTS DUE TO EMBANKMENT LOAD

APPROVED	DATE NOV. 1960
H G ACRES & COMPANY LIMITED	SCALE / JOB No 907
	PLATE - XX

#60-F-203

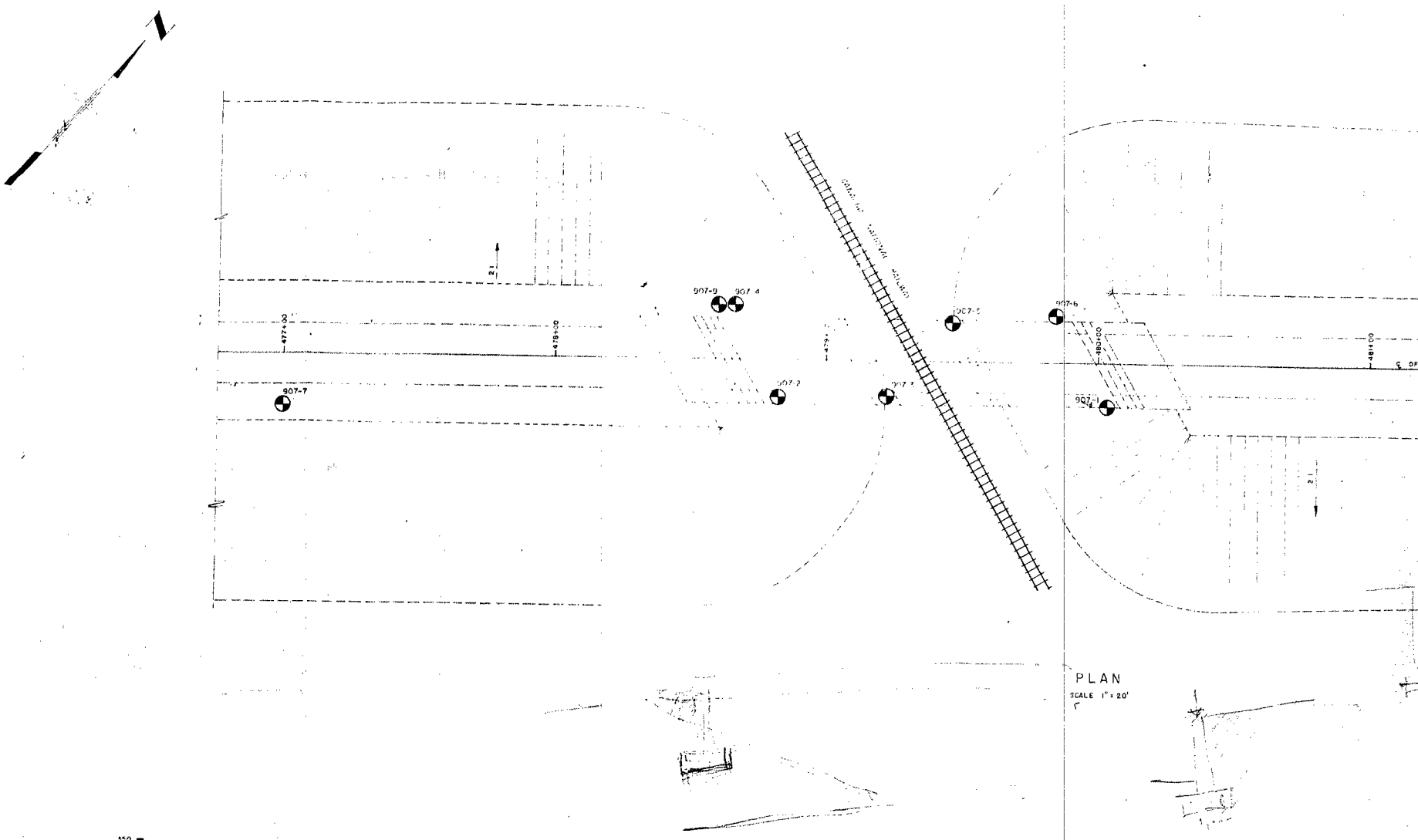
W.P.#274-60

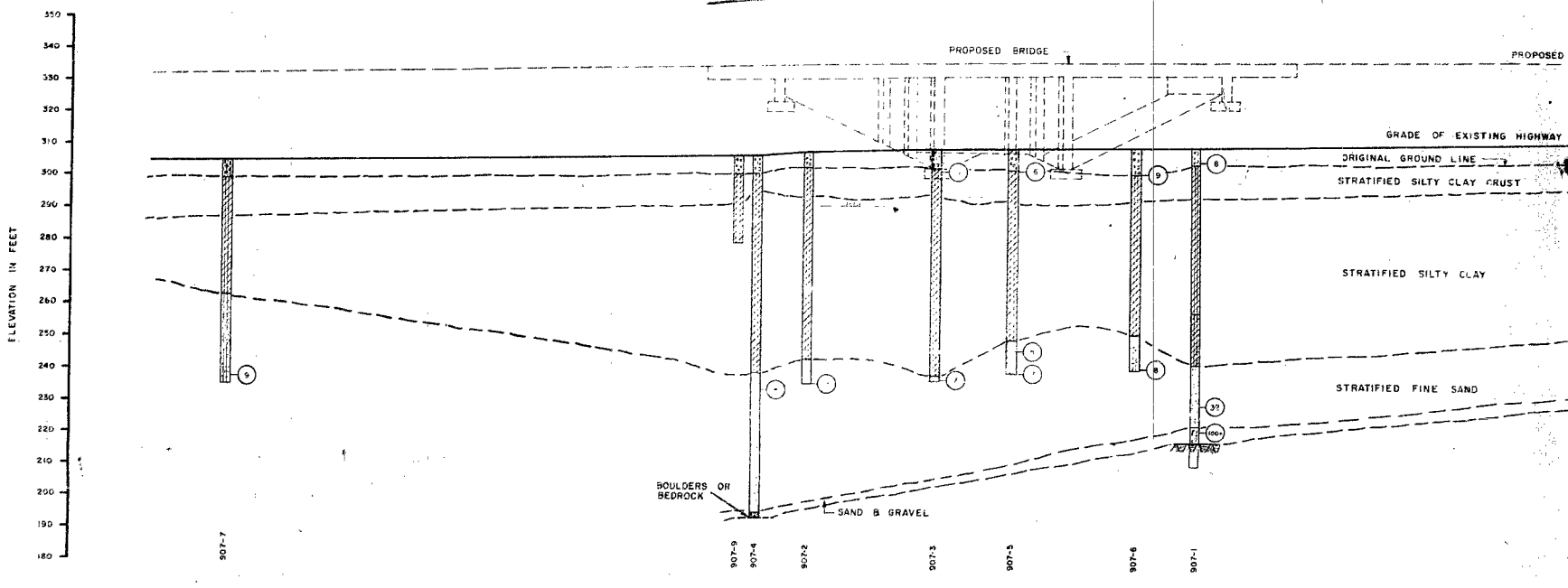
W.P.#275-60

Hwy. #44 E.

C.N.R.

HUNTLEY TWP.



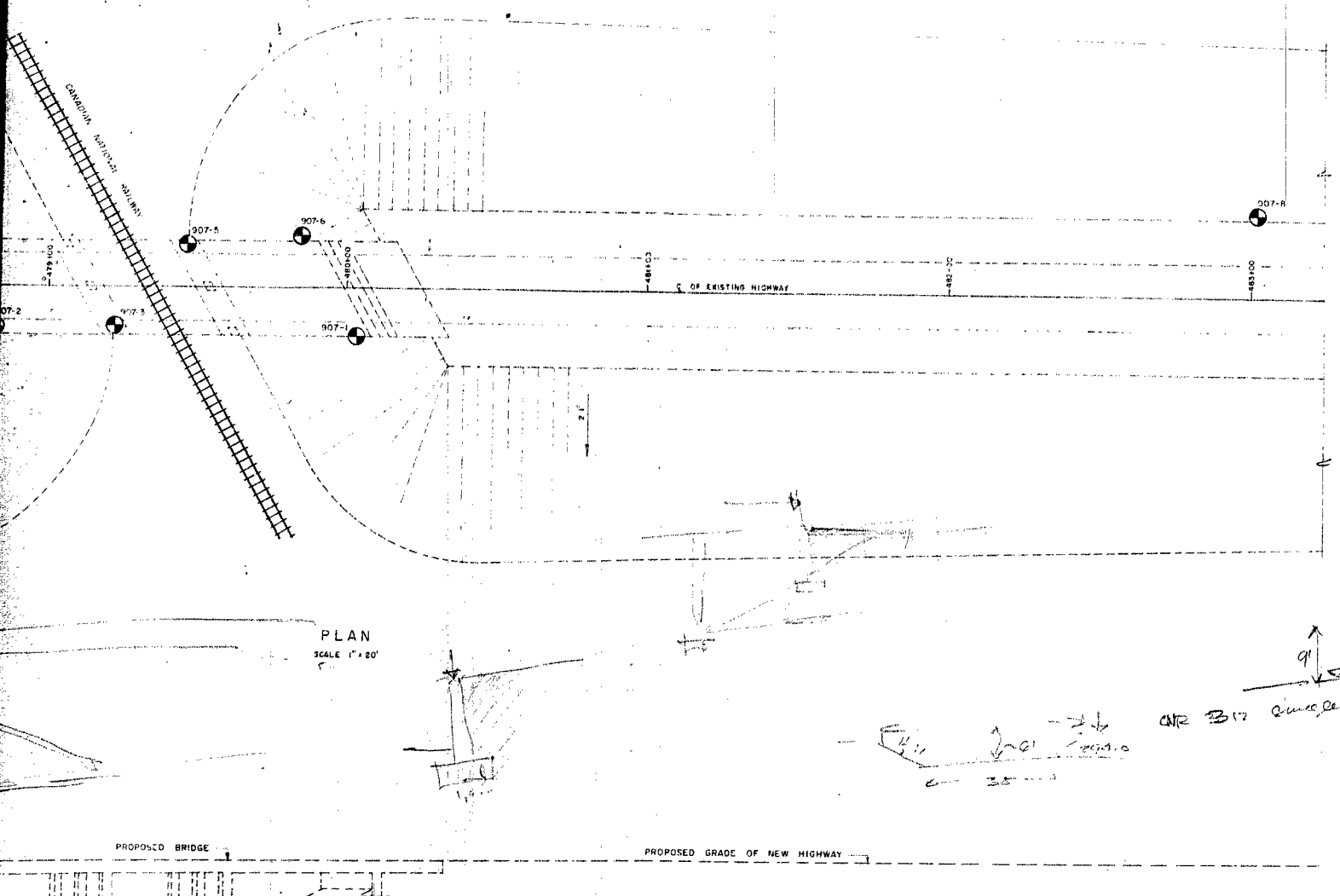


SECTION ALONG ℄ OF EXISTING HIGHWAY

SCALE 1" = 20'

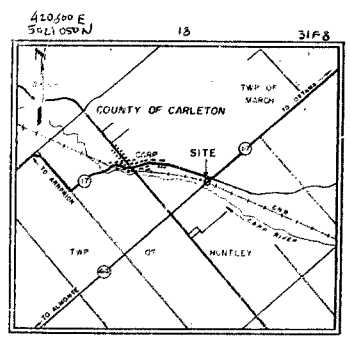
LEGEND

- ORGANIC SOIL
- CLAY
- SILT
- SAND
- GRAVEL
- BEDROCK
- WATER TABLE
- EXPLORATORY DRILL HOLE
- SWAMP
- (22) BLOWS PER FOOT FOR STANDARD PENETRATION TEST



SECTION ALONG ℄ OF EXISTING HIGHWAY

SCALE 1" = 20'



KEY PLAN
SCALE 1" = 1 MI

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

ONTARIO DEPARTMENT OF HIGHWAYS

WP - 274-60

EXPLORATORY HOLES
PLAN AND SECTION

APPROVED	DATE NOVEMBER 1960
D. H. MacDonald	SCALE AS NOTED / JOB No 907
H.G. ACRES & COMPANY LIMITED	PLATE - I

G 3660-1

LIMITS OF RAILWAY BOARD ESTIMATE GENERAL ORDER 948

COUNTY OF CARLETON

TOWNSHIP OF HUNTLEY

CON. II
LOT 16

LOT 15
CON. II

TO ALMONTE

THE KINGS HIGHWAY No. 44

22'0 BLACKTOP PAVEMENT

TO ARNPRIOR

HIGHWAY No. 17

CARP RIVER

CANADIAN NATIONAL RAILWAY

STEEL & CONC. BRIDGE SPAN 390

BETN CONS I & II

ROAD ALL'CE

PLAN
SCALE: 1 IN. = 100 FT.

LIMITS OF RAILWAY BOARD ESTIMATE GENERAL ORDER 948

PROFILE OF THE KINGS HIGHWAY No. 44
HOT. 479+31.25 HWY No. 44 = STA. 26+00 CAN. NAT. RWY. R.E. OF S.P.M.L.
SCALE: HOR. 1 IN. = 100 FT.
VERT. 1 IN. = 10 FT.

PROFILE OF BLACKTOP ROAD
38+93.37 = 492+32.76

PROFILE OF GRAVEL ROAD
0+00 = 494+43

STEEL & CONC. BRIDGE
SPAN 39'
473+46 7'9" Lt. Elev. 303.2
+54 7'9" Rt. Elev. 303.2

H.W.L. 297.9
S/L 295.36 JUNE 16/1958

GEODETIC ORIGIN
B.M. Elev. 305.91

TO ARNPRIOR

TO OTTAWA

TO ALMONTE

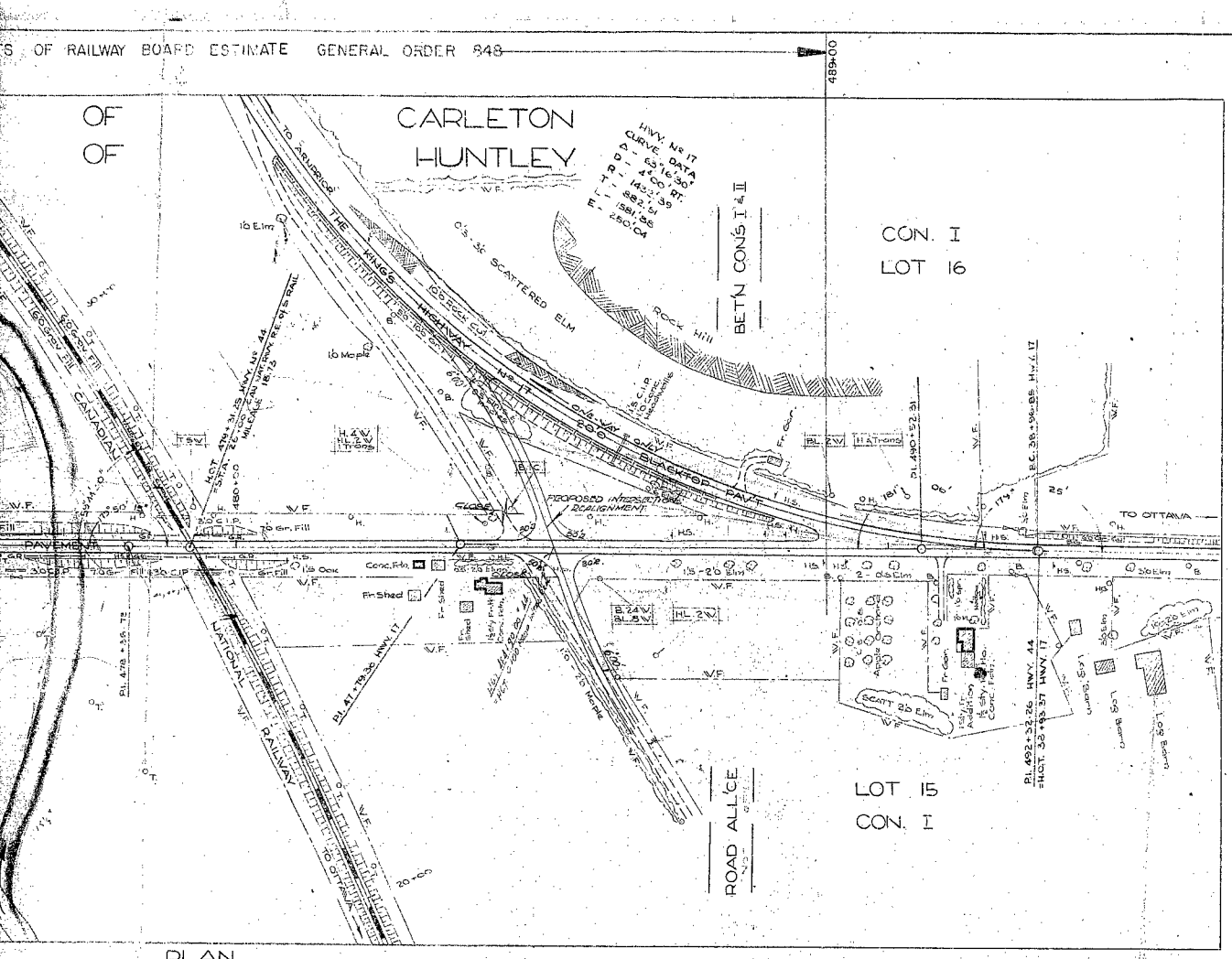
CAN. NAT. RWY.

GRAVEL ROAD

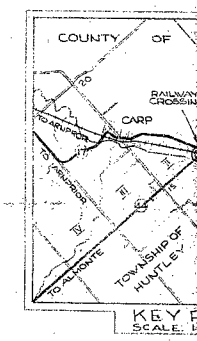
E. OF THE KINGS HWY. No. 44

G 3660-1

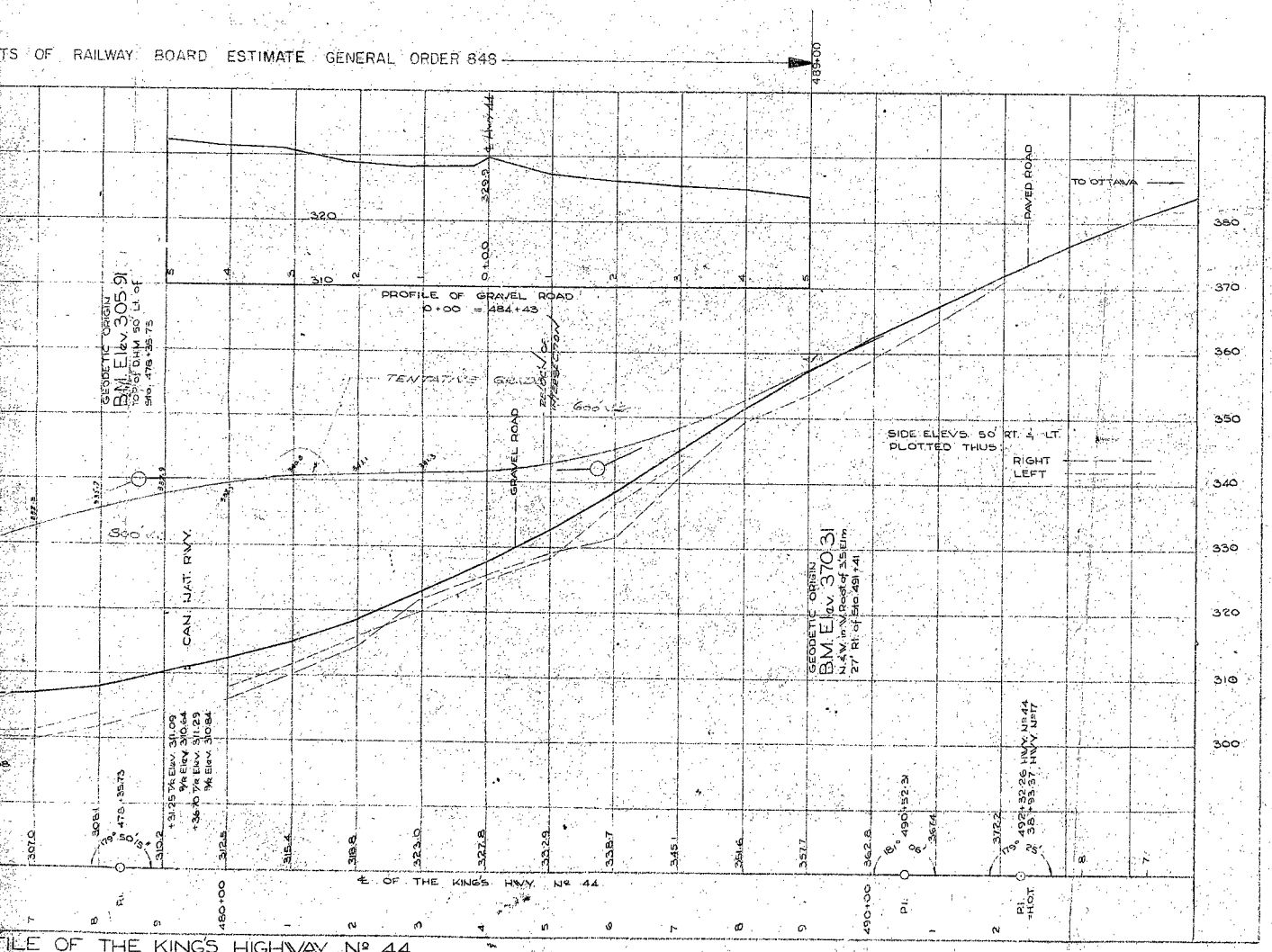
TS OF RAILWAY BOARD ESTIMATE GENERAL ORDER 848



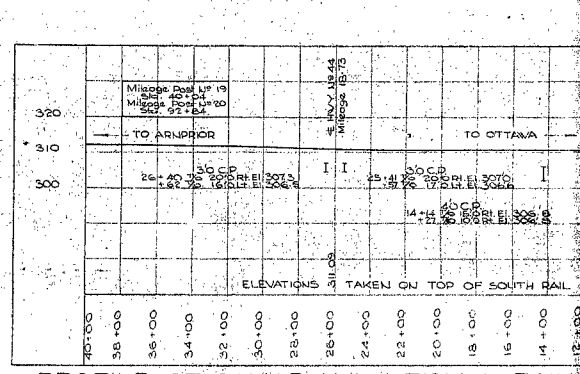
PLAN
SCALE: 1 IN. = 100 FT.



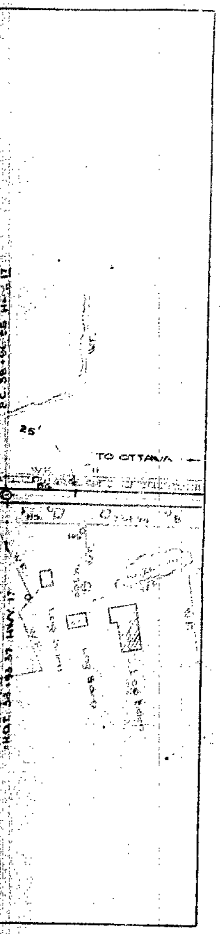
KEY P
SCALE: 1

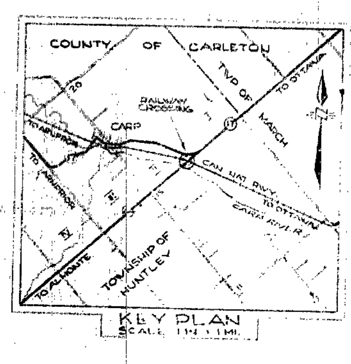


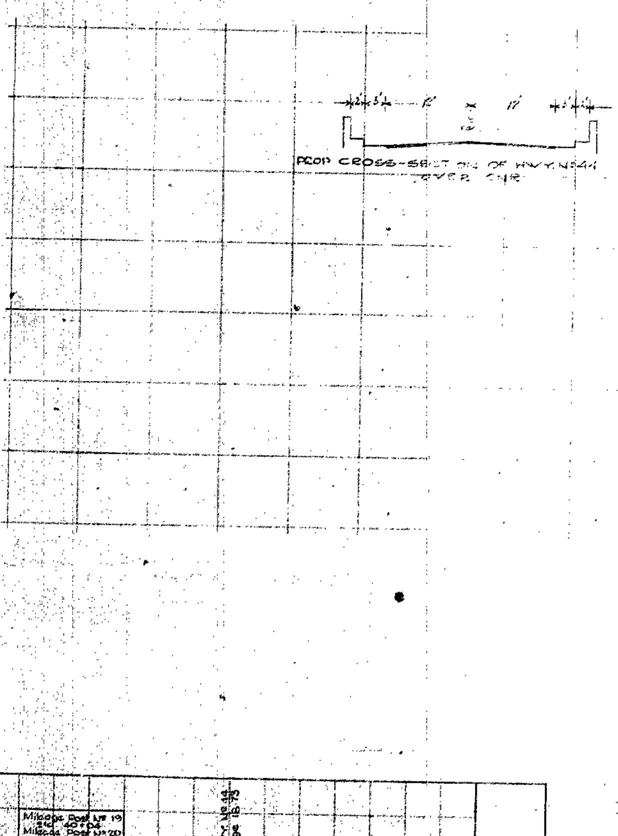
ILE OF THE KINGS HIGHWAY Nº 44
25 HWY Nº 44 = STA. 26+00 CAN. NAT. RWY. R.E. OF S. RAIL
SCALE: HOR. 1 IN. = 100 FT.
VERT. 1 IN. = 10 FT.

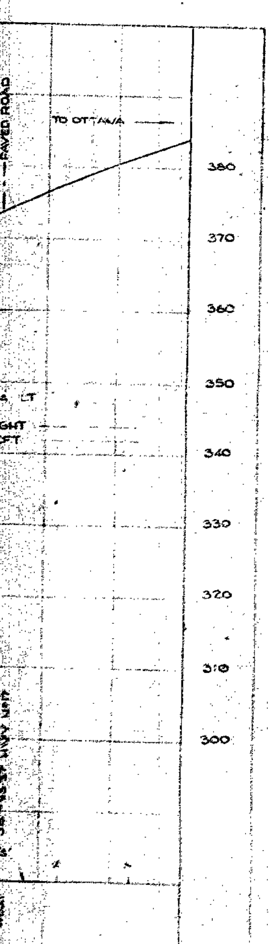


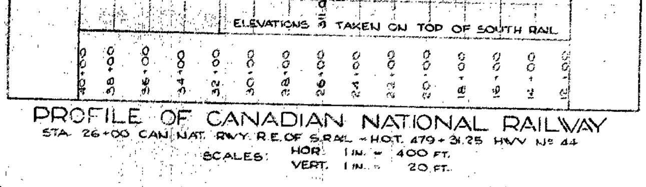
PROFILE OF CANADIAN NATIONAL RAILW
STA. 26+00 CAN. NAT. RWY. R.E. OF S. RAIL = H.O.T. 479+31.25 HWY. Nº 4
SCALES: HOR. 1 IN. = 400 FT.
VERT. 1 IN. = 20 FT.











PROFILE OF CANADIAN NATIONAL RAILWAY

STA. 26+00 CAN. NAT. RWY. R.E. OF S. RAIL = H.O.T. 479+31.25 HWY No 44

SCALES: HOR. 1 IN. = 400 FT. VERT. 1 IN. = 20 FT.

APPROVED

Deputy Minister

V.P. 274-60

ADDITIONS	REMARKS	BY
	THIS PLAN SUPERSEDES G 2660	

DEPARTMENT OF HIGHWAYS - ONTARIO
PLANNING & DESIGN BRANCH LOCATION SECTION

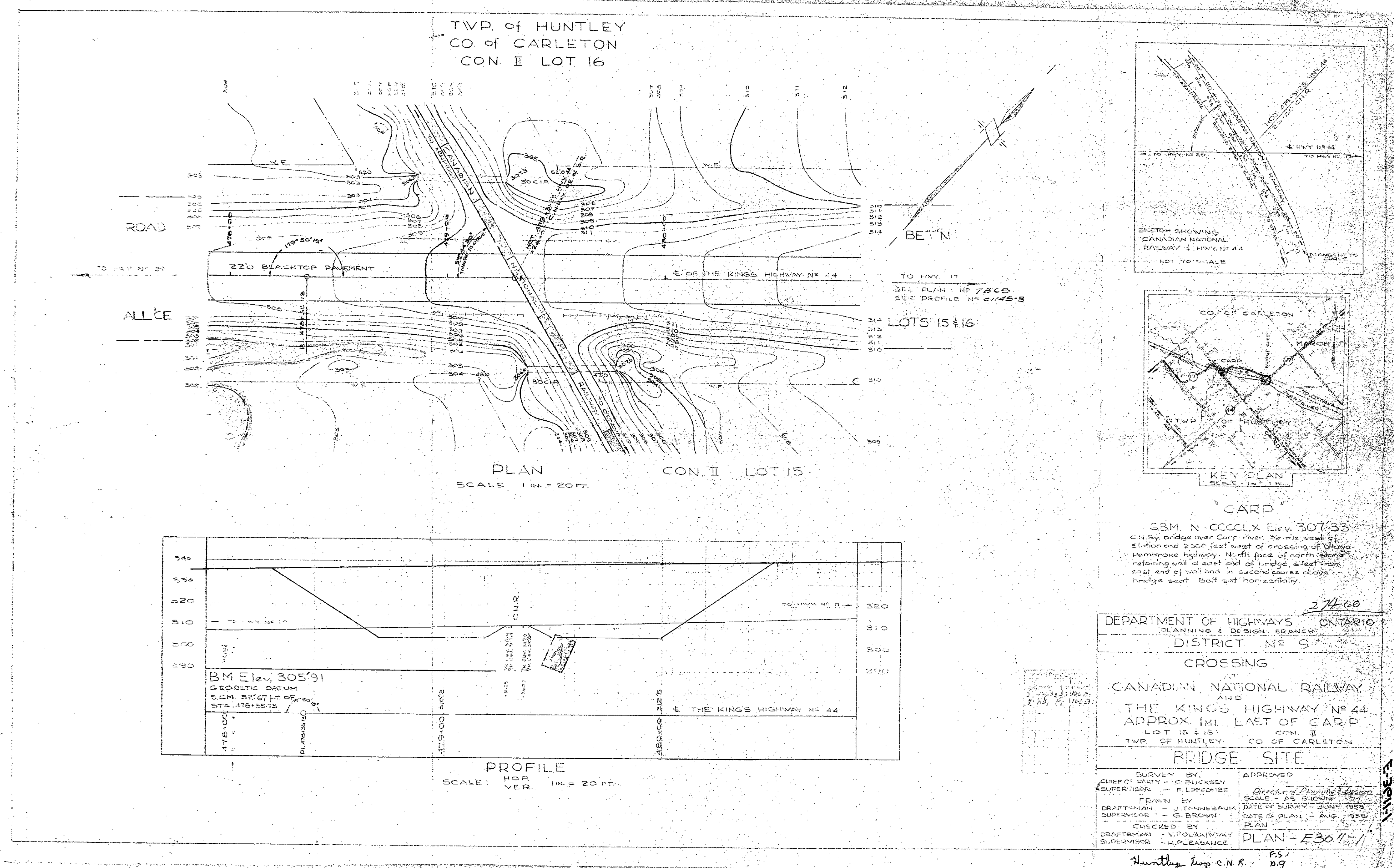
RAILWAY CROSSING PLAN

PROPOSED GRADE SEPARATION AT THE CANADIAN NATIONAL RAILWAY AND THE KING'S HIGHWAY No 44

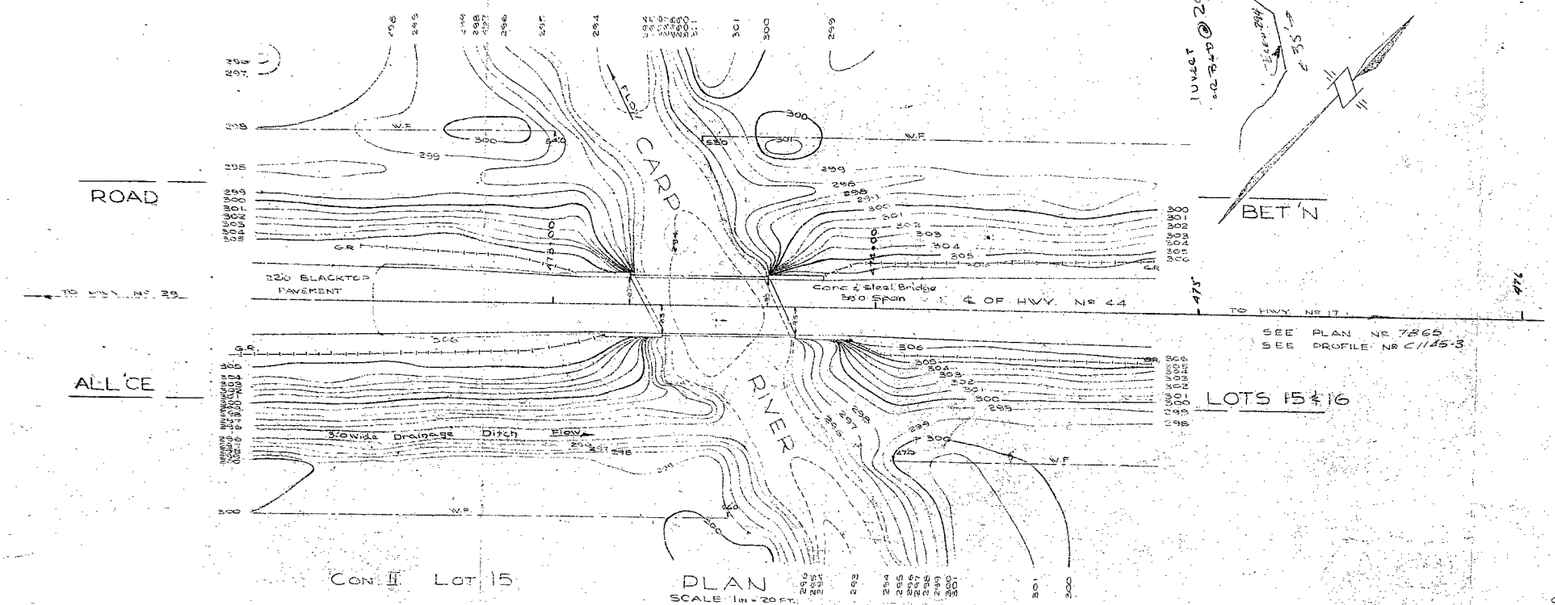
LOTS 15 & 16 CON. X
TOWNSHIP OF HUNTLEY COUNTY OF CARLETON

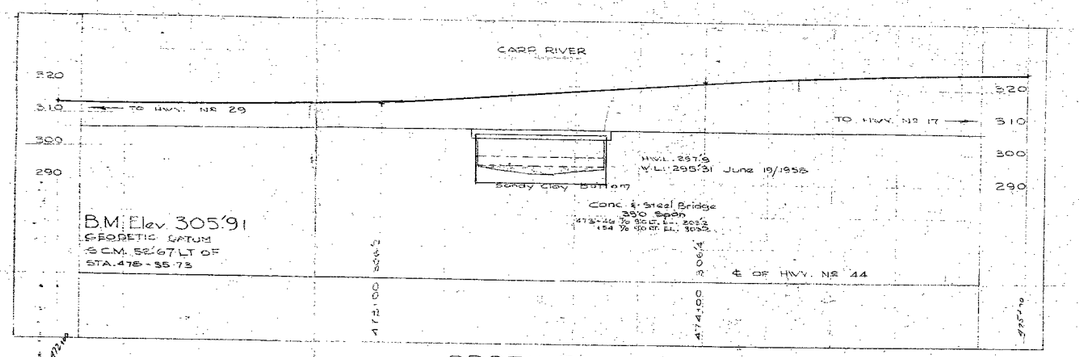
SCALE AS SHOWN	DISTRICT No 9 OTTAWA	APPROVED Director of Planning & Design
SURVEY BY CHIEF OF PARTY - C. BUCKSEY SUPERVISOR - F. LUSCOMBE		DATE OF SURVEY - JUNE/58 DATE OF PLAN
		W.O. No 34-59-270 SURVEY FILE No 20-59
DRAWN BY DRAFTSMAN - J. TANNEBAUM SUPERVISOR - J. UNDERDOWN		SEE PLAN No B-65 PROFILE STUDY PLAN No F 3905
CHECKED BY DRAFTSMAN - J. TANNEBAUM SUPERVISOR - J. UNDERDOWN		PLAN - G 2660-1

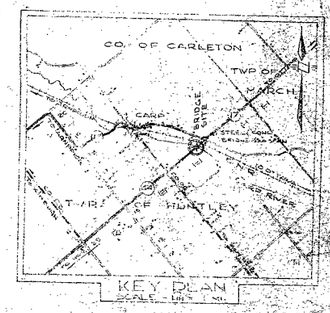
G 2660-1



CO. OF CARLETON
TWP. OF HUNTLEY
CON. II LOT 16







"CARP"

G.B.M. Nº CCCCLX Elev. 307.33

CN Ry. bridge over Carp river, ¾ mile west of station and 2000 feet west of crossing of Ottawa-Pembroke highway. North face of north stone in retaining wall at east end of bridge, 6" from east end of wall and in second course above bridge seat. Bolt set horizontally.

275+60

DEPARTMENT OF HIGHWAYS ONTARIO
PLANNING & DESIGN BRANCH
DISTRICT Nº 9

CROSSING AT CARP RIVER AND THE KINGS HIGHWAY Nº 44
APPROX 1MI. EAST OF CARP
LOT 15 & 16 CON. II
TWP. OF HUNTLEY CO. OF CARLETON

BRIDGE SITE

SURVEY BY	APPROVED
CHIEF OF PARTY - C. BUCKSEY	
SUPERVISOR - R. LOSCOMBE	Director of Planning & Design
DRAWN BY	SCALE - AS SHOWN
DRAFTSMAN - J. TAUNGBAUM	DATE OF SURVEY - JUNE 1958
SUPERVISOR - G. BROWN	DATE OF PLAN - AUG. 1958
CHECKED BY	PLAN - 61
DRAFTSMAN - V. POLAKIVSKY	PLAN - E38/24
SUPERVISOR H. PLEASANCE	

0.9