



THURBER ENGINEERING LTD.

**FOUNDATION REPORT FOR DESKTOP STUDY
HIGHWAY 401 / PALACE ROAD INTERCHANGE (IC582)
INTERCHANGE AND MEDIAN IMPROVEMENTS
GREATER NAPANEE, ONTARIO
SITE NO. 17-063.1/2
G.W.P. 4197-13-00**

Latitude: 43.269855

Longitude: -76.924320

Geocres Number: 31C-276

Report to

AECOM

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August 7, 2018
File: 10035

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Memos\Palace Road\Desktop Study - Palace Road.doc

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PART 1: FACTUAL INFORMATION

1 INTRODUCTION

This report presents a summary of the factual subsurface information for the existing Highway 401 and Palace Road interchange (IC582) improvements in the geographic Township of Richmond, in the Town of Greater Napanee, Ontario.

The purpose of this desktop study report is to summarize currently available subsurface information pertinent to the foundation aspects of the proposed structural rehabilitation works. The information includes previous foundation reports, technical memoranda, general arrangement and foundation layout drawings available from the Ministry of Transportation Ontario (MTO), geological reports and maps, and a site reconnaissance visit. It also presents preliminary geotechnical recommendations for use in assessment of the existing foundations and for preliminary design at the site. It is noted that the proposed structural alternatives are not yet defined. Additional investigation and analysis may be required in any subsequent detail design phase of the project.

Thurber carried out this desktop study as a sub-consultant to AECOM under the MTO Consultant Assignment Number 4015-E-0003.

2 SITE DESCRIPTION

2.1 General

The Highway 401 and Palace Road interchange (IC582) is located 3.8 km north east of Napanee and 0.7 km east of the Napanee River crossing. At this location, the existing overpass consists of twin single-span I-girder bridge structures with a thin slab concrete deck supported on concrete retaining wall type abutments. Both structures have total span length of about 11.6 m and width of about 13.7 m. Each structure accommodates 2 traffic



lanes, one speed change lane, and two narrow shoulders on Highway 401 over 2 traffic lanes on Palace Road. Select photographs of the structure are included in Appendix B.

2.2 Geology

The project area is situated within the physiographic region known as the Napanee Plain. The Napanee Plain is characterized by a thin veneer of glacial till underlain at relatively shallow depths by limestone bedrock of the Bobcaygeon Formation. Thick glacial sediments are present in the deep river and stream valleys in the region.

2.3 Topography and Land Use

The Highway 401 corridor addressed in this project generally runs in an east to west orientation along relatively flat terrain. The land adjacent to the Highways 401 and Palace Road interchange is mainly undeveloped and forested with residential/agricultural properties present to the north east. One commercial property is located to the south west. Approximately 200 m north of the interchange, the Napanee River runs in the general east to west direction. A hydro corridor is present to the immediate south of the interchange.

3 STUDY PRODECURES

The desktop study is based on geotechnical data gathered from available sources with no borehole drilling and sampling in this phase of the work.

Information on existing surface and subsurface conditions relevant to the foundations of the existing structures and embankments have been collected from the following sources:

- Review of existing foundation investigation and design reports for various structures available from the MTO GEOCRES system, and selected information from archived contract files.
- Review of contract drawings and a Value Engineering Study for the project site.
- Review of published geological information for the study area.
- Site reconnaissance visit by the Thurber project engineer to observe and document the existing structures, cuts, embankments and any visible geological/geotechnical features.

Imperial units in the original Geocres files have been converted to metric.

3.1 MTO GEOCRES Files

Existing foundation/geotechnical information relevant to the subject site has been obtained from the MTO GEOCRES library. The documents used for the desktop study were provided under GEOCRES File 31C00-063 and are listed below and are included in Appendix A.

Reference 1: Proposed Crossing Highway 401 Line “C”, Township of Fredericksburgh, Counties of Lennox & Addington, Ontario Department of Highways. W.P. 33-59. Prepared by Universal Geotechnique Limited. Dated December 1959.

Reference 2: Technical Memorandum for the Proposed Crossing – Highway 401 – Line ‘C’ Township of Fredricksburgh, Counties of Lennox & Addington – W.P. 33-59 – Dist. 8. Prepared by Ontario Department of Highways, Materials and Research Section. Dated January 11, 1960.

3.2 Contract Drawings

Contract drawings and quantity sheets were prepared by the MTO Eastern Region for the Palace Road overpass rehabilitation. This booklet included general arrangement drawings prepared by AECOM in February 2011.

3.3 Value Engineering Study

A Value Engineering Study (VE) was prepared by MMM Group Ltd. and Faithful Gould for the Highway 401/Palace Road Interchange in March 2009.

3.4 Geological Information

During the preparation of this report, reference was made to Chapman and Putnam, “The Physiography of Southern Ontario”, Third Edition, Ontario Geological Survey, Special Volume 2, Ministry of Natural Resources, 1984.

3.5 Site Reconnaissance Visit

A site reconnaissance visit was carried out by Thurber’s project engineer during the preparation of this report. The sites were visited and documented for visible geological/geotechnical features and for assessing structure, cut and embankment performance.

Based on the site observations, Palace Road to the south of Highway 401 is in a rock cut approximately 5 m deep. To the north, Palace Road is in a shallow cut, apparently in earth, on the north side and essentially at grade on the south side. There is no visible evidence of problems with the performance of the structure foundations. In particular, there is no evidence of settlement or sliding. Similarly, the immediate approach embankments in all four quadrants appeared to be performing satisfactorily.

4 DESCRIPTIONS OF SUBSURFACE CONDITIONS

A foundation investigation report was completed by the Department of Highways Foundation Section in January 1960 (Reference 1) for the proposed overpass. Five boreholes were drilled in



conjunction with Standard Penetration Tests (SPTs) to depths of 3.7 to 9.1 m below the original ground surface (Elevations 101.5 to 95.4 m). Bedrock was confirmed below the sampled depth by coring at all five borehole locations to depths ranging from 5.3 to 9.9 m below the original ground surface (Elevations 98.6 to 94.6 m). Dynamic cone penetration tests (DCPTs) were advanced adjacent to the fourth and fifth boreholes at the north of the site from surface to depths of approximately 5.2 m and 4.7 m respectively (Elevations 98.1 and 99.8 m).

The site was originally overlain by a layer of dark brown loam containing organic matter. This topsoil ranged in thickness from 0.6 to 1.3 m.

Below the topsoil, the site was underlain by a sand and silt to silty sand till with some gravel and trace organic inclusions. The upper portion of the till was generally loose to compact with N-values ranging from 4 to 15 blows for 0.3 m of penetration. However, near the centre of the site, the upper till had N-values ranging from 20 to 32 blows for 0.3 m of penetration indicating a compact density. The thickness of this layer ranged from 1.5 to 1.8 m, with the base of the layer lying at Elevations 100.5 to 103.8 m. Although this layer was described as clayey though visual identification, laboratory testing on selected samples indicated only trace clay was present.

The lower portion of the till at the north of the site was compact with N-values ranging from 16 to 19 blows for 0.3 m of penetration. To the south of the site, the till was compact to very dense with N-values ranging from 23 to 62 blows for 0.3 m of penetration. Higher N-values were identified in locations with higher gravel contents. The thickness of this layer ranged from 2.1 to 6.8 m, with the base of the layer lying at Elevations 101.5 to 94.9 m.

A layer of sand, gravel, and boulders were identified overlying the bedrock where rock coring was commenced within the till.

Grey limestone bedrock was encountered below the till at depths of 4.6 to 6.9 m, or Elevations ranging from 101.5 to 94.9 m. The original investigation described the limestone bedrock as “fairly sound” with occasional shale and sandstone partings. Core recovery in the bedrock ranged from 0 to 99 % with a majority between 80 and 95%.

Observed groundwater levels in the open boreholes upon completion of drilling varied between Elevations 103.3 and 103.5 m at the time of the investigation. These were short term observations made prior to the formation of existing approach cuts for this structure, and therefore likely did not represent stabilized groundwater conditions.

Artesian conditions were observed at the north west of the site at approximate Elevation 97.1 m. The initial flow rate was $3.2 \times 10^{-5} \text{ m}^3/\text{s}$ but dissipated within a period of two hours.

5 EXISTING FOUNDATIONS

The foundation investigation report completed by the Department of Highways Foundation Section in January 1960 (Reference 1) provided two design options for the structure at the interchange: an overpass and underpass. Both options would be supported on spread footings.

For the overpass, the investigation assumed that Palace Road would be depressed below the proposed Highway 401 to an elevation of 96.9 m and would require rock excavation for half of the site. An allowable bearing capacity of 1900 kPa was given to the spread footings directly supported on bedrock.

For the underpass, Palace Road would be elevated above the proposed Highway 401 and all footings would be founded in the overburden. The following founding elevations and bearing capacities, based on working stress design, were provided for the north and south abutments of the underpass:

Abutment	Elevation (m)	Bearing Capacity (kPa)
North	100.6	240
South	102.7	140

A technical memorandum (Reference 2) accompanied the foundation investigation report (Reference 1) and recommended that the underpass structure be selected. As per the foundation investigation report, the structure was to be supported on spread footings founded at the elevations outlined above. An allowable footing pressure of 240 kPa was given for the footings at the north and south abutment.

The existing structure is an overpass that carries Highway 401 over a Palace Road, contrasting the recommendations made in the technical memorandum.

The original construction drawings for the structures dated April 1960, show that the abutment footings for the EB structure bear on bedrock. However, it is apparent that the abutment footings for the WB structure must bear on soil, if constructed as shown on the drawings. The thickness of soil between the underside of footing and the top of bedrock could be as great as 2.5m.

Based on the founding elevations calculated from the drawings and soil conditions provided in the foundation investigation report, the original design bearing resistances are interpreted to be as follows:

	Footing	Assumed Founding Elevation (m)	Working Stress Bearing Capacity(kPa)
Eastbound	East	96.8 to 97.3	1,900
	West	96.3 to 96.7	1,900
Westbound	East	97.2 to 97.6	240
	West	96.8 to 97.1	240

The bearing capacities given in working stress analysis are analogous to the SLS reaction given in Limit State Design.

6 FUTURE ANALYSIS OF EXISTING FOUNDATIONS

Based on the founding elevations calculated from the drawings and soil conditions provided in the foundation investigation report and using present day accepted methods of foundation analysis, the following values may be used in assessing the structure:

	Footing	Assumed Founding Elevation (m)	SLS (kPa)	Factored ULS (kPa)
Eastbound	East	96.8 to 97.3	*	2,000
	West	96.3 to 96.7	*	2,000
Westbound	East	97.2 to 97.6	250	400
	West	96.8 to 97.1	250	400

* The bedrock may be considered to be an unyielding stratum and the SLS condition will not govern foundation design.

6.1 Structure Rehabilitation

In general, if the load demands of the rehabilitated structure can be met by the geotechnical resistances shown above, no further foundation analysis is required. However, if the factored ULS resistance or SLS reaction given above are exceeded as a result of the rehabilitation, supplementary site investigation and analysis will be required.

6.2 EB Structure Widening

For widening of the EB structure to the south, it is recommended that the new construction be supported on spread footings bearing on bedrock. These may be designed on the basis of a factored ULS geotechnical resistance of 2,000 kN and the SLS condition may be assumed not to govern. Widening of the EB structure to the north should also bear on bedrock but site investigation is recommended to confirm the bedrock elevations to the limit of widening.

6.3 WB Structure Widening

For widening of the WB structure to the south, the new footings may be designed using the geotechnical resistance and reaction values given above. As the footing is extended southward, it may begin to bear on bedrock. This is not considered to be a problem as it will minimize the risk of differential settlement between the existing structure and the new construction.

Since the local bedrock elevations fall towards the north, it is recommended that supplementary site investigation and geotechnical analysis be carried out to support the

design of any such widening. Use of the geotechnical SLS reaction value of 250 kN given above implies a potential settlement of up to 25 mm. This means either differential movement between the existing and new construction or load shedding to the existing structure if the new construction is tied to it. This problem would be minimized by founding new construction of the bedrock

7 FUTURE WORK

Supplementary geotechnical investigation and analysis may be required in the following situations:

- Widening of either structure, either to define the bedrock surface or to characterize the soil conditions to the north
- Construction activities, including rehabilitation that will require roadway protection to be designed.

8 MISCELLANEOUS

Ms. Deanna Pizycki, E.I.T. and Mr. Alastair Gorman, P.Eng. prepared the Desktop Foundation Investigation Report. Dr. P.K. Chatterji, P.Eng. a Designated Principal Contact for MTO Foundations projects, reviewed the report.

THURBER ENGINEERING LTD.



Deanna Pizycki
Geotechnical Engineer-in-Training

Alastair Gorman, P.Eng.
Senior Associate / Senior Geotechnical Engineer



P.K. Chatterji, Ph.D., P.Eng.
Review Principal, Designated MTO Contact

Appendix A
Geocres Files

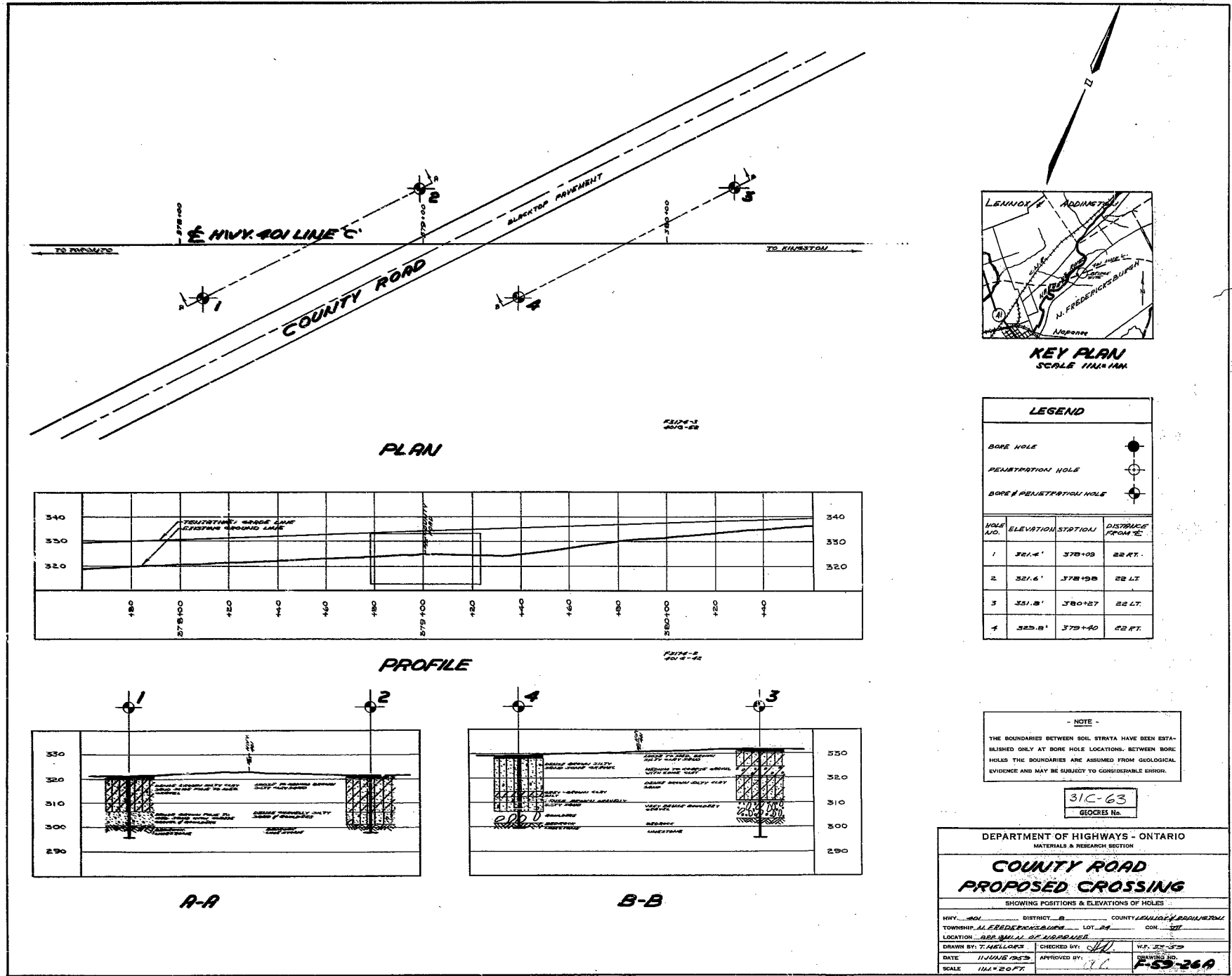
W.P. 33-59

HWY. 401

COUNTY ROAD

PROP. CROSSING

31C-63



Memo to Mr. A. M. Teye, *Date* January 11, 1960.
Bridge Engineer. *Subject* FOUNDATION INVESTIGATION -
From Materials & Research Section. Universal Geotechnique, Ltd

Attention: Mr. S. McCombie.

Re: Proposed Crossing - Hwy. 401 - Line 1C¹,
Township of Fredericksburgh, Counties of
Lennox & Addington - W.P. 33-59 - Dist.8.

This memo accompanies a report on the subsoil conditions at the above site, submitted by Universal Geotechnique, Ltd.

Reference to the boring results presented in this report shows that a relatively shallow deposit of sandy glacial till overlies limestone bedrock at the site. The factual data presented in the report have been reviewed and we submit the following design recommendations:-

1. Spread footing support for the proposed underpass structure is recommended. An allowable footing pressure of 2 1/2 tons/sq.ft. is recommended for footing elevations, as follows:-

North Abutment	Elevation 330.0'
South Abutment	Elevation 337.0'

2. An artesian condition was noted in Boring No. 4 at an elevation of 325.0'. This condition was not observed in any of the other borings and is not believed to be general over the site. Inflow into small diameter borings can result from the intersection of very permeable sand and gravel seams in till formations. If these permeable seams are not continuous over the site, excavation bottom instability will not be general. Should local piping result in the excavation for the North abutment, the artesian head can be balanced by flooding the excavation to elevation 335.0' and placing footing

cont'd. /2 ...

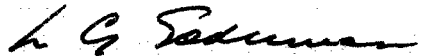
Recommendations - (cont'd.) ...

2. (cont'd.) ...

concrete underwater to elevation 333.0'. With this concrete in place, the excavation can then be dewatered.

3. The strength and compressibility of the subsoil at this site is such that approach embankment side slopes of 2:1 will be adequate.

If clarification of the above comments is desired, please contact our Office.



IGS/MdEF
Attach.

L. G. Soderman,
PRINCIPAL SOILS & FOUNDATIONS ENGINEER

cc: Messrs. A. M. Toye (2)
H. A. Tregaskes
D. G. Ramsay
I. Campbell
T. A. Sharpe
J. E. Gruspier
A. Watt
Foundation Section
Gen. Files.

BA982

UNIVERSAL
GEOTECHNIQUE
LIMITED



59-F-226C

REPORT

on

FOUNDATION INVESTIGATION

for

PROPOSED CROSSING HIGHWAY 401 - LINE "C"

TOWNSHIP OF FREDERICKSBURGH

COUNTIES OF LENNOX & ADDINGTON

ONTARIO DEPARTMENT OF HIGHWAYS

(W.P. 33-59)

Report N° T.411/59

100 University Avenue,
Toronto 1, Ontario.

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Bedrock In Cut - Highway N° 2	Photograph
Borehole Logs	BH.1 to 5

REPORT

on

FOUNDATION INVESTIGATION

for

PROPOSED CROSSING HIGHWAY 401 - LINE "C"

TOWNSHIP OF FREDERICKSBURGH

COUNTIES OF LENNOX & ADDINGTON

ONTARIO DEPARTMENT OF HIGHWAYS

(W.P. 33-59)

INTRODUCTION

The Ontario Department of Highways are planning a Crossing of Highway 401 and a County Road Linking Napanee & Camden East.

To determine the subsurface conditions for purposes of foundation design, the Materials & Research Section of the D.H.O. authorized Universal GEOTECHNIQUE Limited to proceed with an investigation at the proposed site in accordance with their requirements stated in letter of authorization dated 8th December, 1959, and this Report contains the results of the subsurface exploration together with information relative to foundation design and construction.

AVAILABLE INFORMATION

D.H.O. plan E-3689-1 indicated the tentatively chosen locations for 5 exploratory boreholes and drawing N° 2 accompanying this Report has been reproduced therefrom and shows the actual positions of the boreholes as carried out on site.

Whilst it is probable that the bridge will be designed as an Overpass with the County Road depressed below the normal grade of Highway 401, consideration may be given to an Underpass whereby the County Road would be elevated above the major highway. If the Overpass is adopted it is understood that the appropriate grade of the County Road would be elevation 318.

THE SITE

The site is situated about 2 miles north-east of Napanee on a slope that dips in a north-westerly direction adjacent to Williams Street.

SUBSURFACE EXPLORATION

Subsurface exploration was carried out during the period 17th to 24th of December, 1959, and comprised 3 exploratory boreholes and 2 dynamic cone penetration tests located in positions as shown on drawing N° 2. The weather during the period of exploration was particularly severe with temperatures going below zero accompanied by winds on an exposed site. These freezing conditions resulted in failure of a water supply from a small creek a few hundred feet away, and all supplies had thereafter to be transported by truck from a considerable distance.

The locations of the boreholes were staked and the ground surface elevations adjacent to the boreholes obtained by the Staff of GEOTECHNIQUE who had a Soils Engineer in charge of field operations at the site throughout the entire period of exploration.

During the operation of soil boring, soil samples were obtained generally at intervals of 2-1/2 feet to a depth of 15 feet and thereafter at intervals of about 5 feet, and where noticeable changes of strata occurred the depths of such changes were recorded.

The state of compaction of the essentially cohesionless strata was determined by the standard penetration test taken during the operation of soil sampling. (The standard penetration test, as referred to in this Report, involves the recording of the number of blows (N) of a 140 lb. hammer falling 30 inches that are required to drive a 2 inch diameter split barrel sampler 1 foot into the soil at the bottom of the borehole).

A continuous record of the general state of compaction of the strata was also obtained adjacent to boreholes BH.4 & BH.5 by means of a dynamic cone penetration test carried to a depth where virtually refusal conditions were encountered and the results of these tests are given on drawing N° 4.

Rock was encountered in all boreholes and diamond core drilling was carried out in each hole to prove bedrock: Drilling was carried 15 feet into the rock in BH.2 to give information concerning any variations in depth and allow positive identification.

Visual examination and classification of all soil samples and rock cores was carried out in the laboratory and a few samples were subjected to additional examination and testing: The descriptions of the strata obtained from the foregoing examination together with the results of the standard penetration tests are given on the borehole logs included with this Report.

Subsurface conditions given in this Report are those indicated by material encountered in the boreholes. The accuracy of extrapolation to obtain the soil profile should be associated directly with the geological conditions and inversely with the spacing of the boreholes.

GEOLOGICAL FEATURES

The site is situated in a region known as the Napanee Plain and its physiography is governed by the underlying limestone that is covered by a thin mantle of glacial drift.

From the information obtained from the exploratory boreholes it may be concluded that the strata down to the explored depths can be classified as follows:

TOP SOIL

Dark brown loam containing organic matter covers the site. Its considerable thickness of up to 3-1/2 feet is due to prevailing marshy conditions.

SANDY TILL

From 12 feet to about 27 feet of loose to dense silty sand containing gravel and boulders is present on the site beneath the top soil. The upper few feet are slightly clayey but it exhibits a tendency to become coarser with depth. Some of the precambrian gravel in the till is decomposed.

BEDROCK

The bedrock is represented by the limestones of the Trenton - Black River formation, the limestone is often argillaceous and contains thin partings of shaley material. Fault breccia was observed in boreholes BH.2 & 3, but it exhibits complete healing and should not affect the characteristics of otherwise generally fairly sound bedrock.

GROUND WATER

Free water was encountered at an elevation of 339 to 339.5'. Water under artesian pressure was observed at an approximate elevation of 318.5' in borehole BH.4. It was initially flowing at a rate of 1/2 gallon/min. but the pressure dissipated within two hours. pH of the ground water is from 6.4 to 6.8.

LABORATORY TESTS

In addition to visual examination of all soil samples and rock cores, certain of the soil samples were subjected to mechanical analyses and the grading curves resulting therefrom are given in the appendix.

DISCUSSION

The results of the subsurface exploration disclose that beneath a few feet of top soil there exists a varying depth of glacial till lying directly on the bedrock which was encountered at elevations varying from about 333 to about 311 in the five exploratory boreholes.

The glacial till is essentially cohesionless and the results of the mechanical analyses show that it is generally well-graded. Variation in the degree of compaction will be noted however.

If an Overpass structure is adopted with the county road depressed to about elevation 318, rock excavation will be necessary over more than half the site but the foundations of the bridge can then be supported directly on the bedrock. The allowable bearing capacity of spread footings supported on the bedrock may be taken as 20 tons/sq.ft.

Referring now to suitable foundations for the alternative of an Underpass whereby the county road would be elevated above the proposed Highway 401, it will be seen that the overburden consisting of sands and gravel in a generally firm state of compaction except for a relatively looser state encountered particularly in borehole BH.5. This variation in the density of the overburden and the looser condition of the deposits in the vicinity of BH.4 down to about elevation 330 and in the vicinity of BH.5 to the bedrock is not ideal for spread footings. However, satisfactory spread footings could be constructed at the following elevations in relation to the stated allowable bearing capacity:

Abutment	Borehole	Elevation of Footing	Allowable Bearing Capacity tons/sq.ft.
South	BH.2 & 3	337	2.5
North	BH.4 & 5	330	1.5

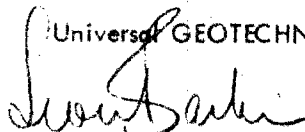
It must be observed however that the underlying bedrock appears very uneven and the thickness of overburden beneath the footings will vary correspondingly.

CONCLUSIONS

The results of the subsurface exploration and subsequent study indicate the following conclusions with respect to foundation design:

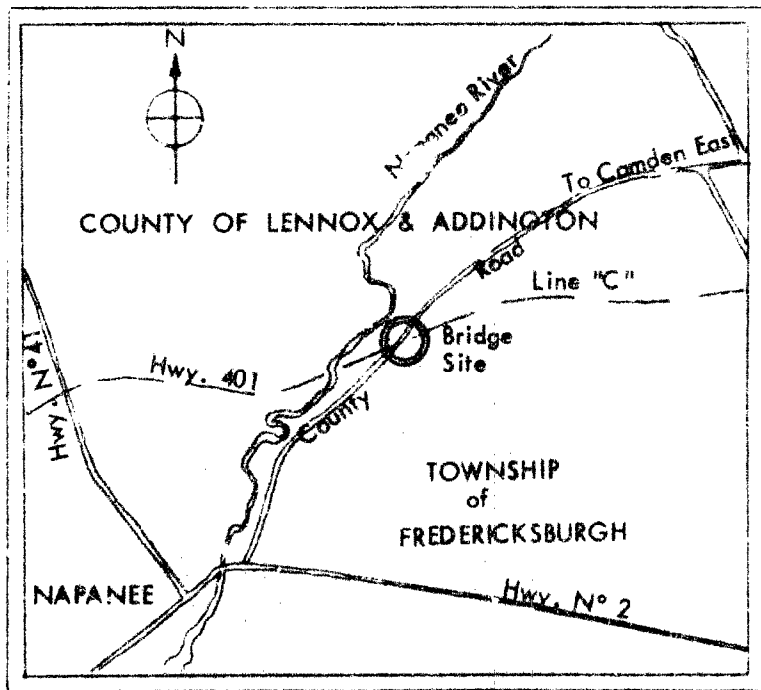
- (1) The overburden consists of essentially cohesionless glacial deposits showing reasonably well-graded characteristics and existing in a generally firm state of compaction below an elevation of about 330.
- (2) Bedrock underlies the site generally at a depth of less than 30 feet below the ground surface. In the five exploratory boreholes the bedrock elevation varied from about 333 to 311 giving quite significant changes within a relatively short distance. Contours of the bedrock surface beneath the site would show a sharp change in direction.
- (3) The ground water table beneath the site existed at elevation ± 339 in December, 1959.
- (4) With the county road depressed to about elevation 318, the foundations of the bridge could be designed for an allowable bearing capacity of 20 tons/sq.ft. on the bedrock. Adequate permanent drainage of the ground water to a few feet below elevation 318 would then be necessary with relation to the county road.

- (5) If the county road is elevated above the proposed Highway 401, spread footings can be supported on the glacial sands and gravel at the elevations given previously in this Report with the related allowable bearing capacities: Care should be taken that no footing is founded partly on bedrock, a minimum thickness of 2 feet of overburden being maintained between the underside of the footing and the underlying rock surface.
- (6) If it is desirable to impose higher bearing pressures on the sands and gravel, especially on the deeper and looser deposits near BH.5, and to obtain more uniformity in the density of these deposits, sand piles or possibly compaction by the Vibroflotation process should be considered: These processes would also enable the underside of the footings to be located at a higher elevation close to the existing ground water table. By suitable compaction the allowable bearing capacity can be raised to 3 or 4 tons/sq.ft. at the higher elevation and construction below the present water table avoided.

Universal GEOTECHNIQUE Limited,

L. Baskin, P.Eng.
Engineering Geologist.

Report N° T.411/59

December, 1959.



KEY PLAN

SCALE 1" = 1 Mile

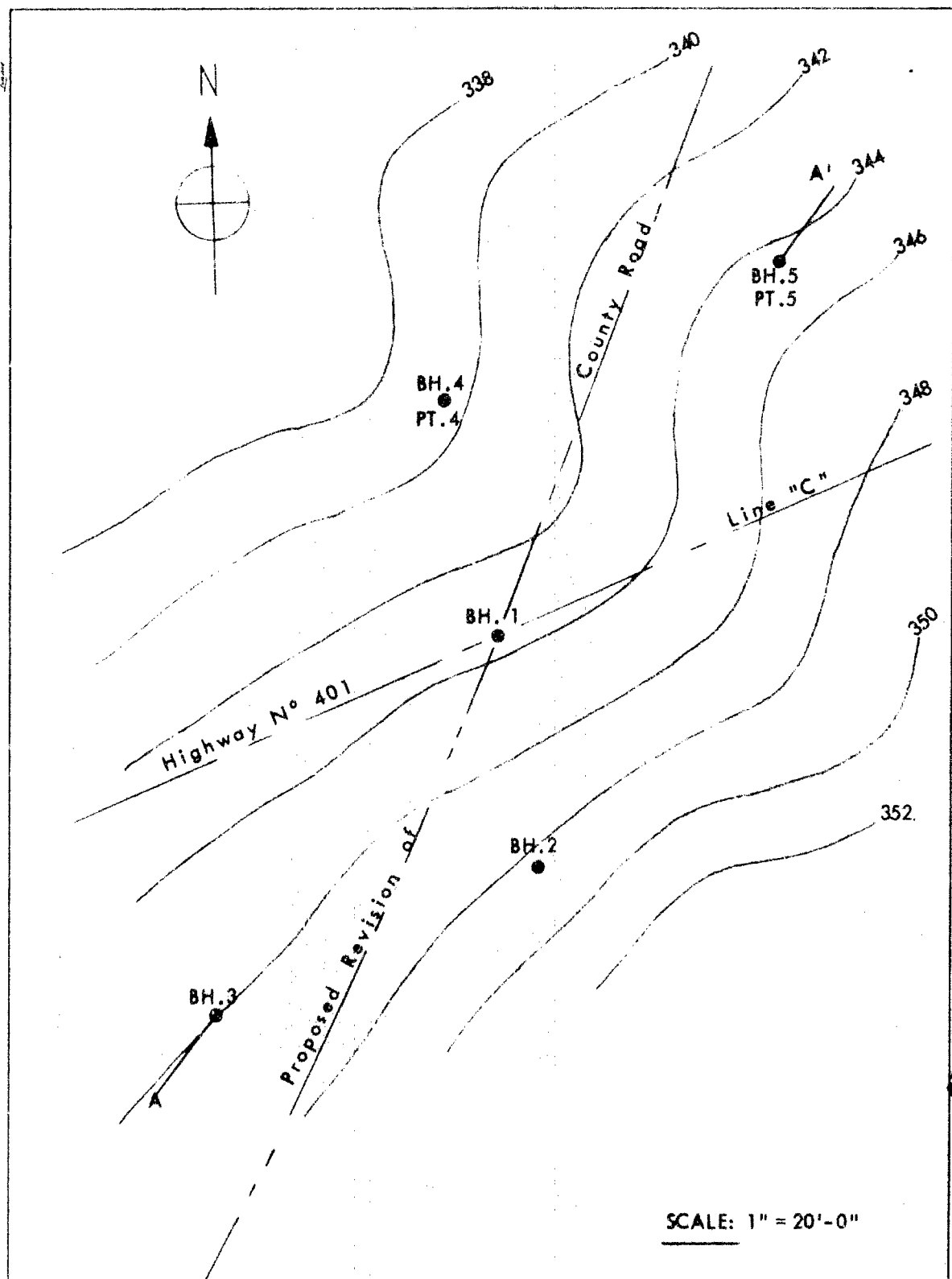
PROJECT Proposed Crossing Hwy. 401 - Line "C"
Napanee

TITLE Key Plan

DRG. NO. 1 ORDER NO. T.411/59



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This sketch is a copy of part of plan E-3689-1 supplied by D.H.O.

PROJECT Proposed Crossing Hwy. 401 - Line "C"
Napanee

TITLE Borehole Location Plan

DRG NO. 2 ORDER NO. T.411/59

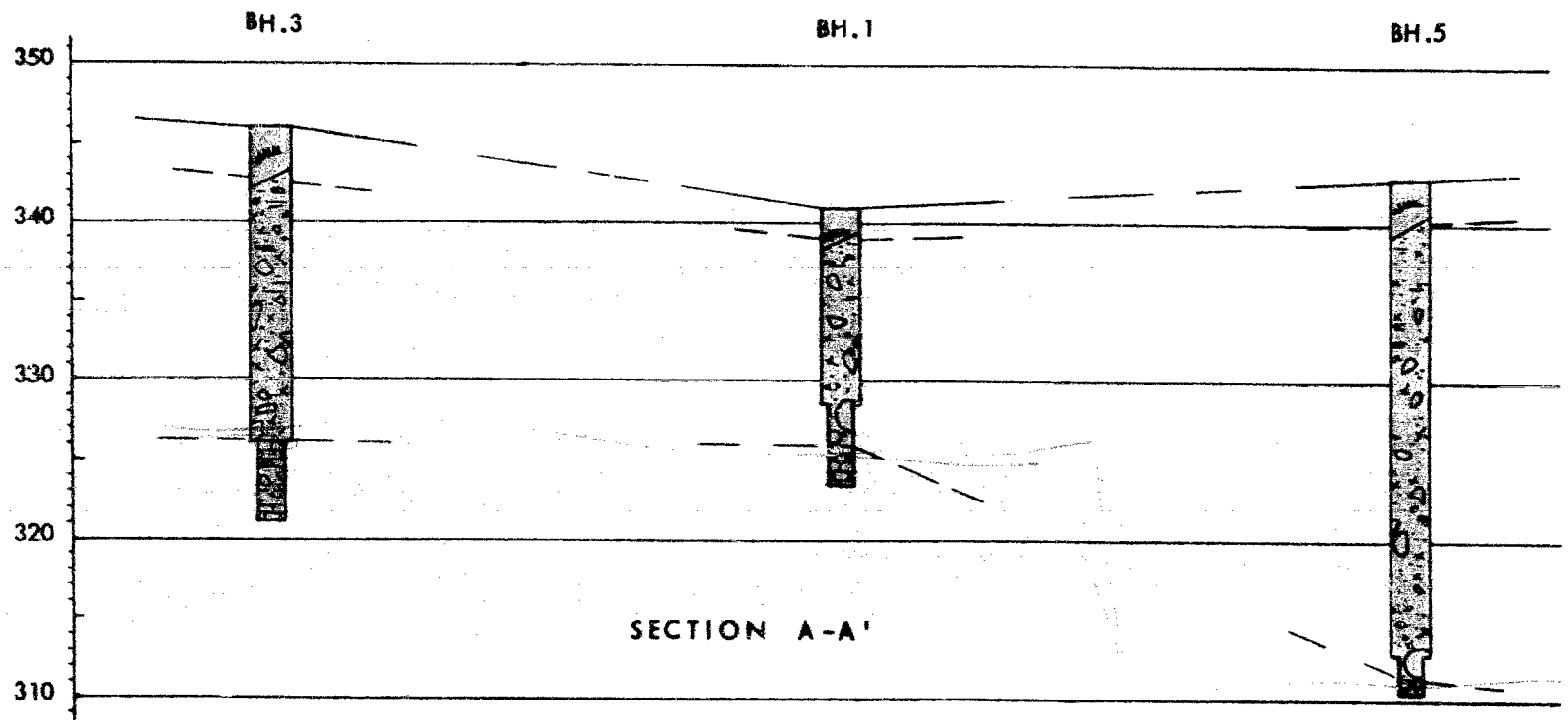


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PROJECT Proposed Crossing Hwy. 401 - Line "C"
TITLE Geological Section
Nippon
DRG. NO. 3 ORDER NO. T.411/59



UNIVERSAL
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LIMITED



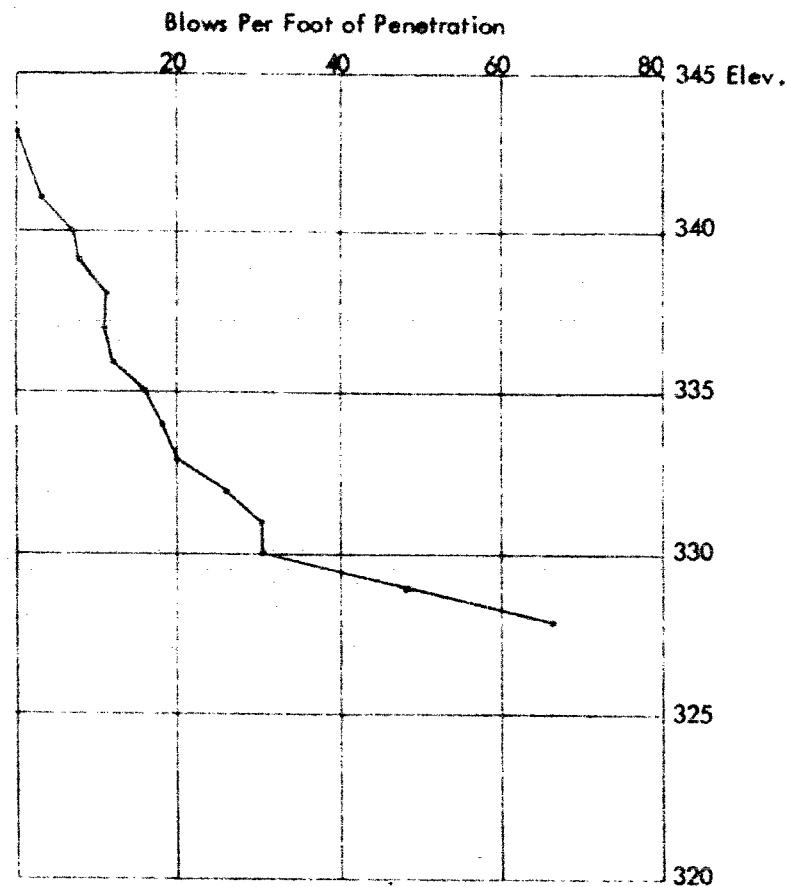
LEGEND

-  TOP SOIL
-  SANDY TILL
-  BEDROCK

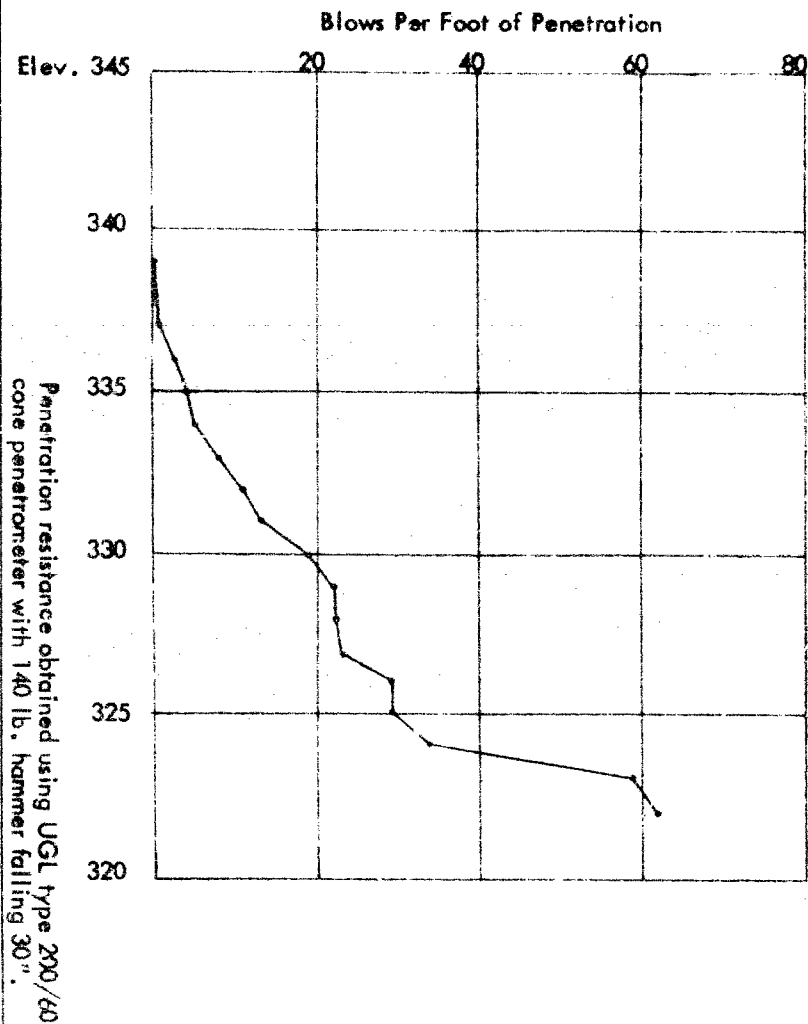
SCALE

Horizontal 1" = 20'-0"
Vertical 1" = 10'-0"

PT. 5



PT. 4



PROJECT Proposed Crossing Hwy. 401 - Line "C"
 TITLE Dynamic Penetration Test Diagrams
 DRG. NO. 4 ORDER NO. T. 411/59



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SOIL MECHANICS LABORATORY MECHANICAL ANALYSIS

PROJECT Proposed Crossing Hwy. 401 - Line "C", Napane, Ontario. BORING NO. BH 1 & 5 SAMPLE NO. _____ DATE OF TEST 30th December, 1959.

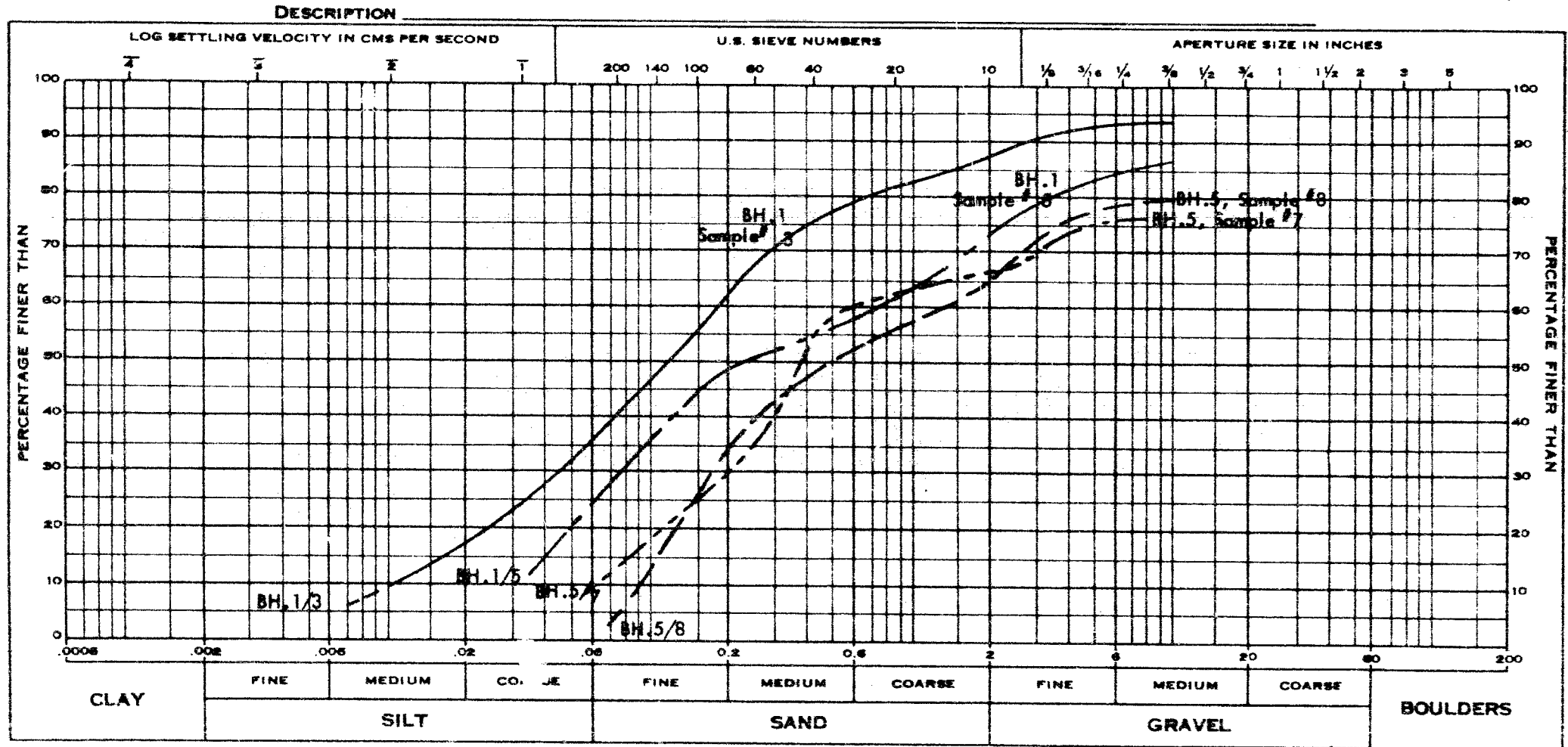


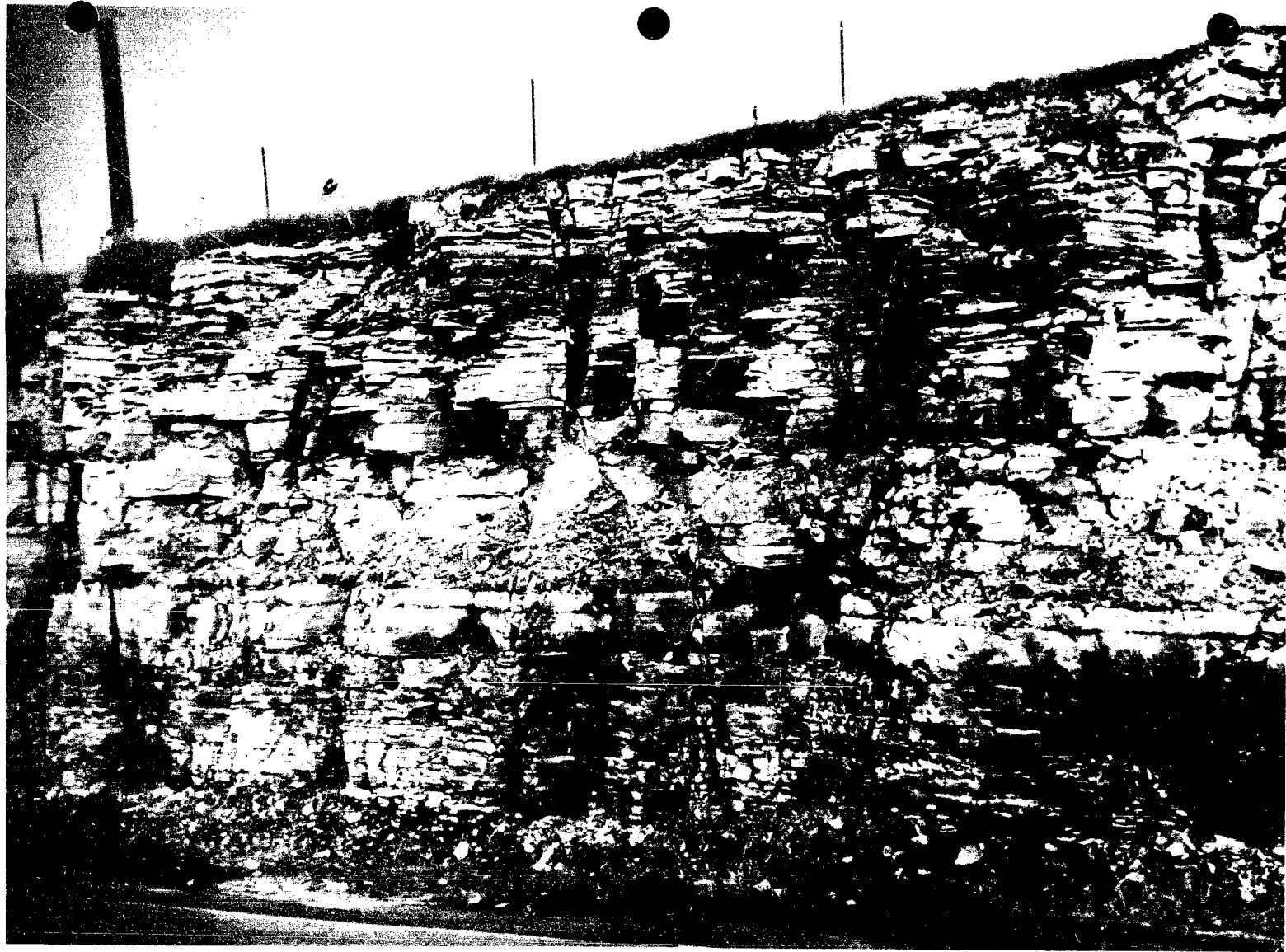
FIG. NO. 1



UNIVERSAL
GEOTECHNIQUE
LIMITED



BEDROCK AS EXPOSED IN CUT ON HIGHWAY N° 2
(about 2 miles from the proposed site)



BEDROCK AS EXPOSED IN CUT ON HIGHWAY N° 2
(about 2 miles from the proposed site)

SOIL MECHANICS LABORATORY

BOREHOLE LOG

PROJECT Proposed Crossing Hwy. 401 - Line "C", Napanee, Ontario ORDER NO. I.411/59
 CLIENT Ontario Department of Highways W.P. 33-59

BOREHOLE NO. BH.1 DIAMETER 2-1/2" & AX CASING BX

BOREHOLE LOCATION See Sketch INCLINATION Vertical BEARING ---

DESCRIPTION OF STRATA	ELEVATION	LEGEND	SAMPLE	DEPTH	THICKNESS	N	REMARKS
Dark brown loam with organic matter. TOP SOIL.	+341.0			Zero			
Loose brown somewhat clayey SAND with gravel & some organic matter.			• 1			5	Wet. Medium to high dry strength.
Firm brown somewhat clayey silty SAND with fine to medium subangular gravel.			• 2			20	do
Firm to dense do			• 3			32	do
Firm brown silty SAND with fine to medium subangular gravel.			• 4			23	Wet. Medium dry strength.
do			• 5	12'-3"		62(3")	do High N due to gravel.
Sand and gravel.				15'-0"			
Grey crystalline limestone. Varied jointing. Fairly sound rock.				17'-6"			15' to 17'-6" core recovery 99%.
				End of Borehole			

SCALE: 1" = 5'-0" • DISTURBED SAMPLE

■ UNDISTURBED SAMPLE

SOIL MECHANICS LABORATORY

BOREHOLE LOG

PROJECT Proposed Crossing Hwy. 401 - Line "C", Napanee, Ontario ORDER NO. T.411/59
W.P. 33-59CLIENT Ontario Department of HighwaysBOREHOLE NO. BH.2 DIAMETER 2-1/2" & AX CASING BXBOREHOLE LOCATION See Sketch INCLINATION Vertical BEARING ---FORM G-1A 800
UNITED STATES GEOLOGICAL SURVEY

DESCRIPTION OF STRATA	ELEVATION	LEGEND	SAMPLE	DEPTH	THICKNESS	N	REMARKS
Dark brown loam with organic matter. TOP SOIL.	+ 348.0			Zero			
Dark brown silty SAND with gravel and some organic matter.			1			5	Damp. Medium dry strength.
Loose brown somewhat clayey silty SAND with fine to coarse subangular gravel. Some gravel decomposed.			2			4	Moist. Medium to high dry strength.
do			3			5	(8") do
Decomposed boulder			4			43	(4")
Brown fine to coarse SAND with gravel.			5				
Firm light brown silty generally fine SAND with fine to medium subangular gravel.			6			23	Wet. Medium dry strength.
Dense light brown generally fine SAND with some fine gravel.			7			55	Wet. Low dry strength.
Dark argillaceous limestone with black shale partings. Exhibits horizontal bedding. Jointing from parallel to 45° to core length. Sound rock.				15'-0"			15'-0" to 19'-8" core recovery 99%
do							19'-8" to 21'-6" core recovery 90%
do							21'-6" to 23'-4" No recovery.
At 24' to 24'-9" grey limestone. Broken core.							23'-4" to 25'-0" core recovery 70%
Grey to dark grey limestone with black shale partings. Includes breccia containing sandstone fragments. Some jointing parallel to 20° to core length. Horizons of solution cavities. Probable healed fault zone. Fairly sound rock.				30'-0"			25'-0" to 30'-0" core recovery 95%
				End of Borehole			

SCALE: 1" = 5'-0" • DISTURBED SAMPLE

■ UNDISTURBED SAMPLE

SOIL MECHANICS LABORATORY

BOREHOLE LOG

PROJECT Proposed Crossing Hwy. 401 - Line "C", Napanee, Ontario ORDER NO. L411/59
 CLIENT Ontario Department of Highways W.P. 33-59

BOREHOLE NO. BH.3 DIAMETER 2-1/2" & AX CASING BX

BOREHOLE LOCATION See Sketch INCLINATION Vertical BEARING ---

DESCRIPTION OF STRATA	ELEVATION	LEGEND	SAMPLE	DEPTH	THICKNESS	N	REMARKS
	+346.0			Zero			
Dark brown loam with organic matter. TOP SOIL.			• 1			4	Damp
Loose brown somewhat clayey silty fine to coarse SAND with fine subangular gravel. Traces of organic matter.			• 2			7	Moist. Medium to high dry strength.
Loose brown somewhat clayey silty SAND with fine to medium subangular gravel, pockets of medium to coarse sand.			• 3			7	Wet. Medium to high dry strength.
Dense light brown silty fine to coarse SAND with fine to medium subangular gravel.			• 4			43	Wet. Medium dry strength.
do			• 5			39	Moist. Medium dry strength.
			• 6			34	do
			• 7	19'-10"		16	(10") No recovery
20' to 22' grey to dark grey argillaceous limestone. Occasional shale partings.							20'-0" to 25'-0" core recovery 95%
22' to 24' breccia includes sandstone fragments.							
24' to 25' grey sandy limestone with solution cavities. Some jointing at 45° to core length.				25'-0"			
				End of Borehole			

SCALE: 1" = 5'-0" • DISTURBED SAMPLE

■ UNDISTURBED SAMPLE

SOIL MECHANICS LABORATORY

BOREHOLE LOGPROJECT Proposed Crossing Hwy. 401 - Line "C", Napanee, Ontario ORDER NO. T.411/59CLIENT Ontario Department of Highways W.P. 33-59BOREHOLE NO. BH.4 DIAMETER 2-1/2" & AX CASING BXBOREHOLE LOCATION See Sketch INCLINATION Vertical BEARING ---













DESCRIPTION OF STRATA	ELEVATION	LEGEND	SAMPLE	DEPTH	DI. CASING	N	REMARKS
Dark brown loam with organic matter. TOP SOIL.	+ 339.0	UNDISTURBED	• 1	Zero		4	Moist.
Very loose brown somewhat clayey silty generally fine SAND with fine to medium subangular gravel. Some organic concentrations.			• 2			2	Wet. Medium to high dry strength.
Loose light brown somewhat clayey silty SAND with fine subangular gravel.			• 3			11	do
			• 4			23	No recovery.
Firm light brown generally fine silty SAND with fine to coarse subangular gravel.			• 5	artesian		34	Moist. Low to medium dry strength. High N due to gravel. Water under artesian pressure rising to 340'.
			• 6	20'-0"		-	Wash sample 20'-0" to 22'-6" core recovery 50%.
Sand, gravel & boulders.				22'-6"			22'-6" to 25'-0" core recovery 80%.
Grey limestone with varied jointing. Broken core.				25'-0"			
				End of Borehole			

SCALE: 1" = 5'-0" • DISTURBED SAMPLE

■ UNDISTURBED SAMPLE

SOIL MECHANICS LABORATORY

BOREHOLE LOGPROJECT Proposed Crossing Hwy. 401 - Line "C", Napanee, Ontario ORDER NO. I.411/59CLIENT Ontario Department of Highways W.P. 33-59BOREHOLE NO. BH.5 DIAMETER 2-1/2" & AX CASING BXBOREHOLE LOCATION See Sketch INCLINATION Vertical BEARING ---

DESCRIPTION OF STRATA	ELEVATION	LEGEND	SAMPLE	DEPTH	THICKNESS	N	REMARKS
	+343.0			Zero			
Dark brown loam with organic matter. TOP SOIL.			• 1			6	Damp.
			• 2			10	Wet. No recovery.
Brown to grey generally fine silty SAND. Little clay.			• 3			15	Wet. No recovery. 7' - 10' wash sample.
Firm brown generally fine silty SAND with fine to medium subangular gravel.			• 4			19	Moist. Medium dry strength.
do			• 5			16	do
Light brown fine silty SAND with fine to medium subangular gravel.			• 6			-	
Firm brown somewhat silty fine to coarse SAND with fine to medium subangular gravel.			• 7			16	Moist. Low to medium dry strength.
Firm brown generally medium to coarse SAND with fine gravel.			• 8			18	Wet. Low dry strength.
do			• 9			-	do
Sand, gravel & boulders.				30'-0"			
Grey argillaceous limestone with joints at 20° to core length.				31'-6"			30' to 31'-6" core recovery 20%
Broken core.				32'-6"			31'-6" to 32'-6" core recovery 75%.
			End of Borehole				

SCALE: 1" = 5'-0" • DISTURBED SAMPLE

■ UNDISTURBED SAMPLE

Appendix B
Site Photographs



Palace Road Looking North



Palace Road Looking South



Highway 401 Looking West Over Palace Road Structure