

Mr. A. M. Toye,
Bridge Engineer.

July 20, 1960.

Materials & Research Section.

REVIEW OF FOUNDATION REPORT

Attention: Mr. S. McCombie.

Re: Orford Twp. Bridge No. 6,
Rwy. 401 - District No. 1,
W.P. 91-59.

Please note that the memo accompanying the foundation report for the above site, states that spread footings may be used to support the structure provided that the spread footings are placed at approx. Elev. 683.0'. This memo indicates that a water problem will exist during construction of these spread footings, and, as an alternative, suggests the use of displacement piles, thus eliminating the need for excavation to Elev. 683.0'.

A review of the preliminary bridge plan shows that a piled foundation has been adopted, but that the underside of the pile cap has been placed at approx. Elev. 683.0'. If this procedure is followed, the same water problem exists as stated for the spread footing design.

It is suggested that you consider the following alternatives:-

- 1) If excavations are to be carried to Elev. 683.0', a spread footing design should be considered.
- 2) If a piled foundation is used, the bottom of the pile cap should be located just below frost level, or approx. Elev. 686.0'.

L. G. Soderman,
PRINCIPAL FOUNDATIONS ENGR.

Per:



(K. Peaker,

FIELD SUPERVISING FOUNDATIONS ENGR.

KP/MdeF

cc: Foundations Office
Gen. Files.

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

May 2, 1960.

FOUNDATION INVESTIGATION -- by
Universal Geotechnique, Limited

Attention: Mr. S. McCombie.

Re: Proposed Interchange Cty. Rd. to Highgate,
Lots 8 & 9 on Hwy. 401, Oxford Township,
W.P. 91-59 -- District No. 1.

This memo accompanies the foundation report for the above proposed structure, submitted by Universal Geotechnique, Ltd. We have reviewed the data and conclusions contained in this report, and submit the following comments for your consideration:-

1. Soil strata at the site consist of an upper layer of fine silty sand 14 feet thick overlying a stiff stratum of glacial till. Groundwater elevation has been given as 4 feet below existing ground surface.
2. It is our opinion that excavation below groundwater level in the fine silty sand stratum will require a system of closely spaced well points. The fine silty sand at this site is particularly susceptible to "piping" and "quicking".
3. Because of the combination of a stratum of fine silty sand and high groundwater table, the following alternative means of obtaining footing support, are recommended:-
 - (a) Found simple spread footings at elevation 683.0' at the South abutment location, and 684.0' at the North abutment. The net safe allowable footing pressure that can be used at this elevation is 2-1/2 tons/sq.ft. for footings having a minimum width of 6 feet. The minimum depth of cover above the underside of the footings should be 5 feet. Dewatering will not be a problem at this foundation elevation.

cont'd. /2 ...

3. (cont'd.) ...

- (b) Spread footings loaded to a net safe intensity of 4 tons/sq.ft. can be designed provided the footings are founded on the stiff till stratum at elevation 673.0'. This foundation elevation would necessitate a sheeted excavation with sheet piling penetrating the till stratum for a depth of at least 4 feet.
- (c) A pile-supported foundation would eliminate the anticipated dewatering problem if shallow spread footings, as in (a) are not adopted. Large displacement type piles, i.e., timber or monotube, driven to practical refusal in the stiff till layer, are recommended. Design capacities of 40 tons/pile for large displacement type piling should be obtained at or above a tip elevation of 660.0'.

4. The approach embankments can be designed using a standard 2:1 slope.

If we can be of assistance in substantiating or clarifying comments made in this memo, please contact our office.

L. G. Soderman

LGS/MdeF
Attach.

L. G. Soderman,
PRINCIPAL SOILS & FOUNDATIONS ENGINEER

cc: Messrs. A. M. Toye (2) ✓
H. A. Tregaskes
D. G. Ramsay
A. Gater
G. J. Howell
J. Roy
A. Watt

Foundations Office
Gen. Files.

UNIVERSAL
GEOTECHNIQUE
LIMITED



BA 1036

REPORT

on

FOUNDATION INVESTIGATION

for

PROPOSED INTERCHANGE

COUNTY ROAD TO HIGHGATE & HIGHWAY 401

COUNTY OF KENT

for

ONTARIO DEPARTMENT OF HIGHWAYS

(W.P. 91-59)

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REPORT

on

FOUNDATION INVESTIGATION

for

PROPOSED INTERCHANGECOUNTY ROAD TO HIGHGATE & HIGHWAY 401COUNTY OF KENT

for

ONTARIO DEPARTMENT OF HIGHWAYS

(W.P. 91-59)

INTRODUCTION

The Ontario Department of Highways are planning an Interchange at Kent County Road N° 20 and Highway 401.

In order to determine the subsurface conditions for purposes of foundation design the Materials & Research Section of the DHO authorized Universal GEOTECHNIQUE Limited to proceed with an investigation at the proposed site generally in accordance with their requirements as stated in a letter of authorization dated 14th of March, 1960, and this Report contains the results of the subsurface exploration together with information relative to foundation design.

AVAILABLE INFORMATION

DHO plan F-3531-4 shows the proposed location of the interchange relative to the existing County Road and also the suggested positions for exploratory boreholes and dynamic cone penetration tests. Drawing N° 2 accompanying this Report is an enlargement of the foregoing plan to indicate the actual positions of the boreholes and penetration tests as carried out on the site relative to the proposed intersection of the County Road and Highway 401.

The construction of the bridge to carry the County Road over Highway 401 will involve an embankment about 25 feet high.

THE SITE

The site of the proposed bridge is located at the intersection of the existing County Road N° 20 with the proposed route of Highway 401 about one mile north of Highgate, Lots 8 & 9, Orford Township in the County of Kent, Ontario.

SUBSURFACE EXPLORATION

Subsurface exploration was carried out during the period 27th of March to the 2nd of April, 1960, under the supervision of a Soils Engineer in charge of field operations and comprised 3 exploratory boreholes and 5 dynamic cone penetration tests located in positions as shown on drawing N° 2.

As the County Road did not carry through traffic at the time of the exploration, borehole BH.2 was located at the proposed intersection of the County Road and Highway 401.

The originally intended positions of all boreholes and penetration tests were staked and the ground surface elevations obtained by a Survey Crew of DHO.

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 the spacing was increased to about 5 feet. Where noticeable changes of strata occurred the depths of such changes were recorded.

The state of compaction of essentially cohesionless strata and the general consistency of cohesive strata were determined by standard penetration tests 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 or consistency was also obtained adjacent to all boreholes and at two other positions by means of dynamic cone penetration tests which were carried to depths where virtually refusal conditions were encountered. The results of these tests are given graphically on drawings included in the appendix.

Visual examination and classification of all soil samples was carried out in the laboratory and a number of samples were subjected to additional examination and testing. The descriptions of the strata obtained from such examination together with the results of standard penetration tests are given on the borehole logs, and a summary of the laboratory tests is given in Table N° 1.

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 on the northern slope of the Blenheim moraine, just below the beaches built by glacial Lake Warren. A number of sand islets, gravel bars and spits surround the area, with a pronounced sand bar encroaching on the southern extremity of the site.

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

FILL

About 1 foot of sand and gravel forming part of the County Road construction was encountered in borehole BH.2.

TOP SOIL

A thin layer approximately 6 inches thick of brown sandy loam containing organic matter and constituting the top soil is present at the location of boreholes BH.1 and 3.

BROWN SAND

From 13 feet to 14 feet of generally firm silty sand containing some fine gravel occurs immediately beneath the top soil in BH.1 and 3 and beneath the fill in BH.2. The sand tends to become less silty with depth.

BROWN TILL

Brown silty clay containing fine to medium gravel was encountered in all the boreholes and constitutes the underlying till. It exhibits a somewhat irregular dessication with the consistency in the weathered zone classified as very stiff to hard. Where the dessication is absent the consistency of the clay is generally stiff.

GROUND WATER

Free water was encountered in the sand stratum at elevation 684 at the south end of the site and at elevation 683 at the north end of the site during the period of exploration. The pH of water extracted from soil samples N° 2 & 4 from borehole BH.3 averaged 5.0.

LABORATORY TESTS

In addition to visual examination of all soil samples certain other tests were performed and a summary of the results is given in Table N° 1 in the appendix.

DISCUSSION

The results of the subsurface exploration disclosed that the site of the proposed bridge is underlain by approximately 14 feet of fine silty sand beneath which there exists glacial till that is generally characterized by a dessicated crust extending for several feet beneath its upper surface.

The fine silty sand stratum exists in a generally firm state of compaction whilst the underlying glacial till has a consistency varying from hard near its upper surface to stiff at slightly lower depths. A study of the geological section through the site therefore leads to the conclusion that the foundations for the proposed highway bridge could be supported either on the sand stratum or on the underlying glacial till with the proviso that if footings are supported on the glacial till advantage should be taken of the presence of the dessicated crust.

If normal spread footings were founded at elevation 680 to 675 on the uniformly graded fine sand an allowable bearing capacity of 2.0 tons/sq.ft. could be adopted for design purposes.

If the underside of the foundations were to be located at elevation 675 to 672 then an allowable bearing capacity of 2.5 tons/sq.ft. could be adopted.

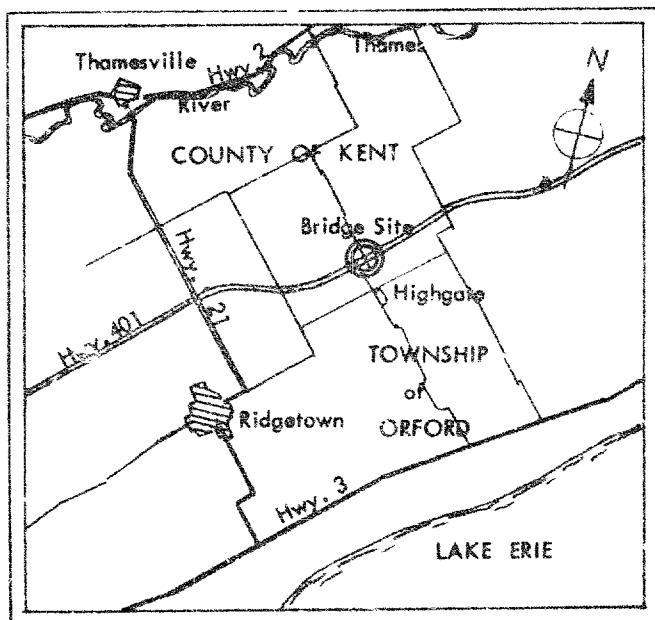
CONCLUSIONS

From a consideration of the soil conditions as disclosed by the subsurface exploration the following conclusions concerning the foundations may be drawn:

- (1) The subsurface conditions beneath the proposed site of the bridge consist of a stratum of generally firm fine sand which extends to approximately elevation 674. Beneath this stratum of sand there exists stiff glacial till having a hard dessicated crust extending for several feet below its upper surface.
- (2) The most suitable type of foundation would be spread footings and these can either be supported on the sand stratum or on the underlying glacial till.
- (3) The allowable bearing capacity for the design of spread footings located at elevation 680 to 675 may be taken as 2.0 tons/sq.ft.
- (4) The allowable bearing capacity for the design of spread footings located at elevation 675 to 672 may be taken as 2.5 tons/sq.ft.
- (5) No particular difficulty need be anticipated in dewatering the sand stratum for purposes of constructing the foundations but due to the uniformly graded fine sand precautions must be taken to ensure that the method of dewatering does not loosen this material below the elevation at which the foundations will be located.
- (6) The subsurface conditions beneath the site are such that no instability of the approach embankments need be anticipated.

Universal GEOTECHNIQUE Limited,

L. Baskin
L. Baskin, P. Eng.



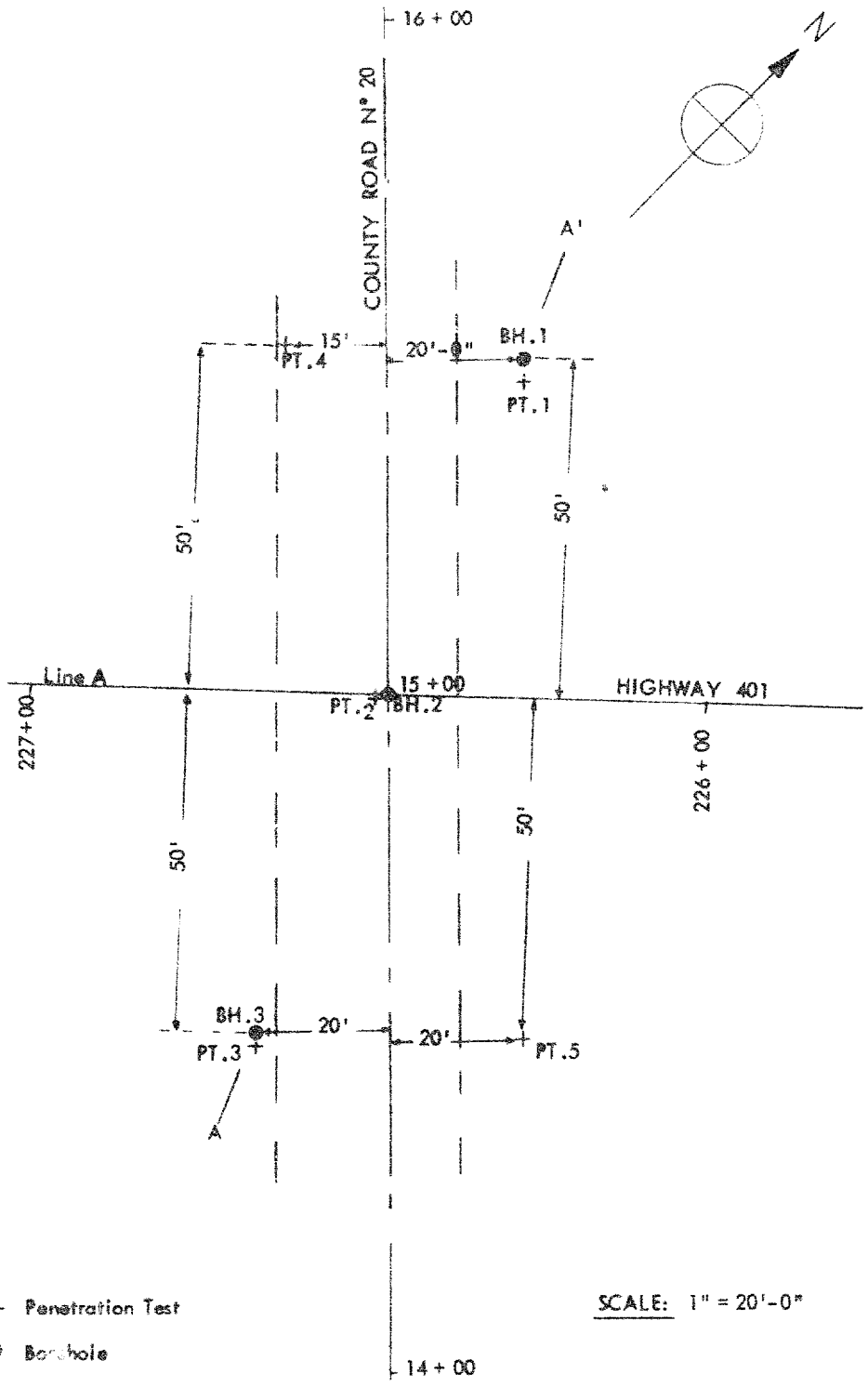
KEY PLAN

Scale: 1" = 4 Miles

PROJECT Interchange County Road to Highgate
(W.P. 91-39)
TITLE Key Plan
DRG. NO. 1 ORDER NO. T.428/60



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- + Penetration Test
- Borehole

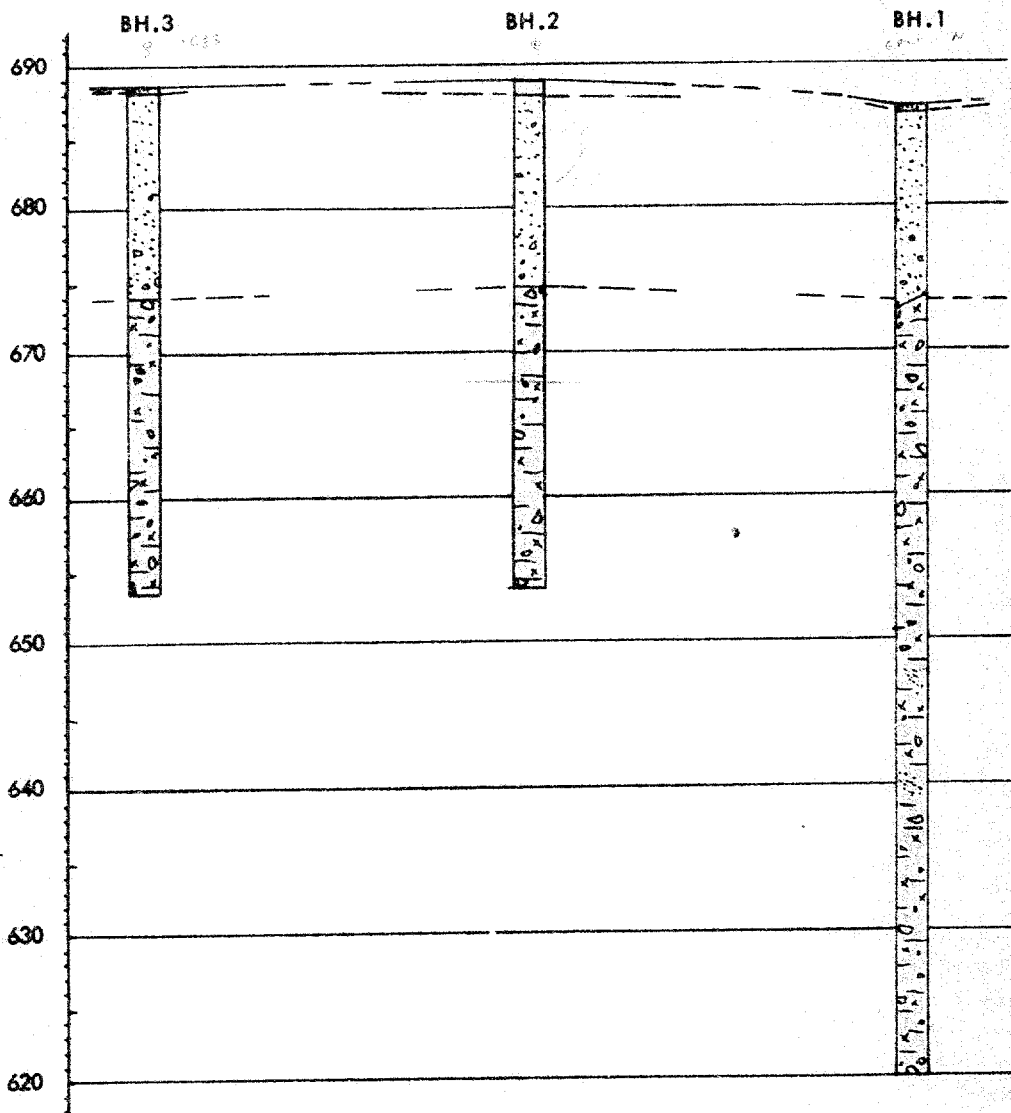
SCALE: 1" = 20'-0"

This sketch is an enlargement of part of plan N° F3531-4 supplied by D.H.O.

PROJECT Interchange County Road to Highgate
(W.P. 91-59)
TITLE Borehole Location Plan
DRG. NO. 2 ORDER NO. T.428/60







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SECTION A-A'

LEGEND

-  FILL
-  TOP SOIL
-  SAND
-  TILL

SCALE

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

PROJECT Interchange County Road to Highgate
(W.P. 91-59)

TITLE Geological Section

DRG. NO. 3 ORDER NO. T.428/60



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



UNIVERSAL

GEOTECHNIQUE

LIMITED

SOIL MECHANICS LABORATORY

BOREHOLE LOGPROJECT Interchange County Road to Highgate & Hwy. 401 (W.P. 91-59) ORDER NO. I.428/60CLIENT Ontario Department of HighwaysBOREHOLE NO. BH.1 DIAMETER 2-1/2" CASING 2-1/2"BOREHOLE LOCATION See Sketch INCLINATION Vertical BEARING ---

DESCRIPTION OF STRATA	ELEVATION	LEGEND	SAMPLE	DEPTH	THICKNESS	N	REMARKS
Brown sandy loam with organic matter. Firm brown fine silty SAND with occasional fine gravel.	687.0 686.5		• 1	Zero 0'-6"		17	Damp. Low to medium dry strength.
do			• 2			28	Moist. Low to medium dry strength.
Firm brown fine somewhat silty SAND, some fine gravel.	680		• 3			16	Wet. Low dry strength.
do			• 4			17	do
do			• 5			18	No recovery.
Greyish brown clay with gravel.			• 6			32	No recovery.
Hard greyish brown silty CLAY with fine to medium subangular gravel.	670		• 7			32	Damp. High dry strength
Stiff do			• 8			16	do
do	660		• 9			15	do
do			• 10			16	do
do			• 11			18	do
Stiff greyish brown silty CLAY with fine to medium subangular gravel and sand pockets.	650		• 12	40'-0"		21	do
	647.0						

FORM G-1A 300
UNITED STATES GEOLOGICAL SURVEY

SCALE: 1" = 5'-0" • DISTURBED SAMPLE

■ UNDISTURBED SAMPLE


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GEOTECHNIQUE

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SOIL MECHANICS LABORATORY

BOREHOLE LOGPROJECT Interchange County Road to Highgate & Hwy. 401 (W.P. 91-59) ORDER NO. I.428/60CLIENT Ontario Department of HighwaysBOREHOLE NO. BH.1 DIAMETER 2-1/2" CASING 2-1/2"BOREHOLE LOCATION See Sketch INCLINATION Vertical BEARING FORM G-14 (B00)
UNIVERSITY OF TORONTO

DESCRIPTION OF STRATA	ELEVATION	LEGEND	SAMPLE	DEPTH	THICKNESS	N	REMARKS
Stiff greyish brown silty CLAY with fine to medium subangular gravel, occasional sand pockets.	647.0		• 13	40'-0"		20	Damp. High dry strength.
do			• 14			18	do
do	640		• 15			16	do
do	630		• 16			26	do
Contains large pocket of grey fine to coarse sand.			• 17	67'-0"		22	do
Stiff greyish brown silty CLAY with fine to medium subangular gravel.	620		End of Borehole				

SCALE: 1" = 5'-0" • DISTURBED SAMPLE

■ UNDISTURBED SAMPLE

SOIL MECHANICS LABORATORY

BOREHOLE LOG






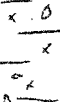
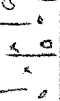
PROJECT Interchange County Road to Highgate & Hwy. 401 (W.P. 91-59) ORDER NO. T.428/60

CLIENT Ontario Department of Highways

BOREHOLE NO. BH.2 DIAMETER 2-1/2" CASING 2-1/2"

BOREHOLE LOCATION See Sketch INCLINATION Vertical BEARING

FORM G-1A 800
UNITED STATES GEOLOGICAL SURVEY

DESCRIPTION OF STRATA	ELEVATION	LEGEND	SAMPLE	DEPTH	THICKNESS	N	REMARKS
Brown sand and gravel. FILL.	688.9			Zero			
Firm brown fine silty SAND, slight iron staining and occasional fine gravel.	687.9		• 1	1'-0"		19	Damp. Low to medium dry strength.
do			• 2			18	Moist. Low to medium dry strength.
			• 3			14	Wet. Low dry strength.
Firm brown somewhat silty fine SAND with fine gravel.	680						
			• 4	14'-0"		22	Damp. High dry strength.
Very stiff greyish brown silty CLAY with fine to medium subangular gravel.	674.9						
			• 5			22	do
do	670		• 6			24	do
Stiff do			• 7			26	do
do	660						
			• 8	35'-0"		27	do
do	653.9			End of Borehole			

SCALE: 1" = 5'-0" • DISTURBED SAMPLE

■ UNDISTURBED SAMPLE

SOIL MECHANICS LABORATORY

BOREHOLE LOGPROJECT Interchange County Road to Highgate & Hwy. 401 (W.P.91-59) ORDER NO. T.428/60CLIENT Ontario Department of HighwaysBOREHOLE NO. BH.3 DIAMETER 2-1/2" CASING 2-1/2"BOREHOLE LOCATION See Sketch INCLINATION Vertical BEARING —FORM G-1A B-60
UNIVERSITY OF TORONTO

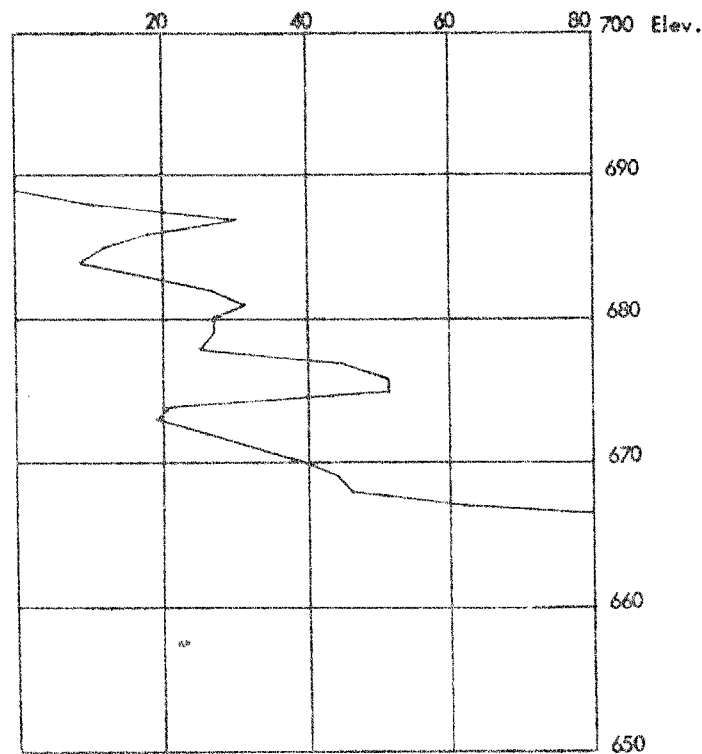
DESCRIPTION OF STRATA	ELEVATION	LEGEND	SAMPLE	DEPTH	THICKNESS	N	REMARKS
Brown sandy loam with organic matter. Firm brown fine silty SAND, some iron staining, occasional fine gravel.	688.7			Zero 0'-6"			
do			• 1			13	Damp. Low to medium dry strength
			• 2			32	Moist. Low to medium dry strength
Firm brown somewhat silty fine SAND with fine gravel.	680		• 3			19	Wet. Low dry strength.
Grey do Hard greyish brown silty CLAY with fine to medium subangular gravel.	674.2		• 4	14'-6"		32	do Damp. High dry strength.
do	670		• 5			56	do
Very stiff do			• 6			32	do
Stiff do	660		• 7			23	do
do	653.7		• 8	35'-0"		21	do
				End of Borehole			

SCALE: 1" = 5'-0" • DISTURBED SAMPLE

■ UNDISTURBED SAMPLE

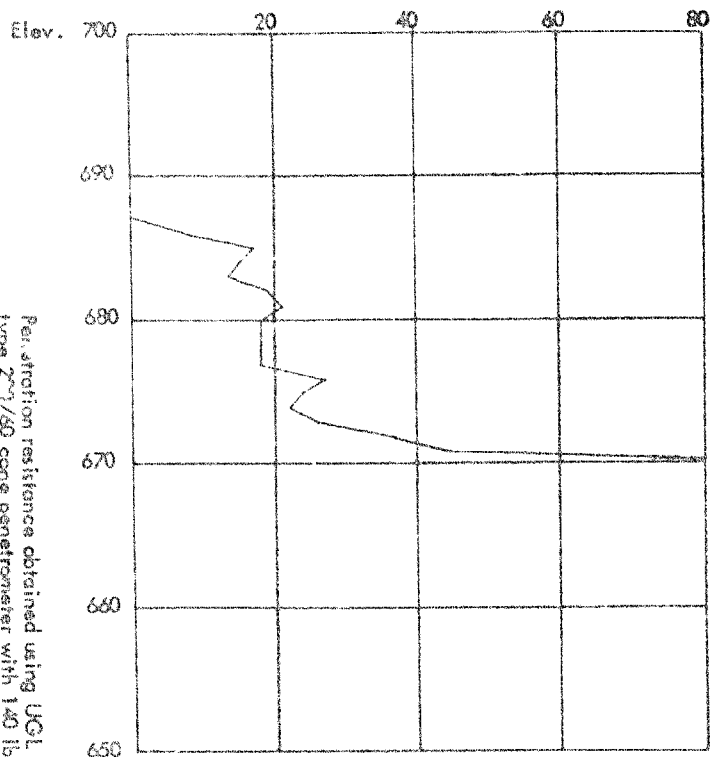
PT. 2

Blows Per Foot of Penetration



PT. 1

Blows Per Foot of Penetration



Penetration resistance obtained using UCL
Type 271/80 cone penetrometer with 140 lb.
hammer falling 30".

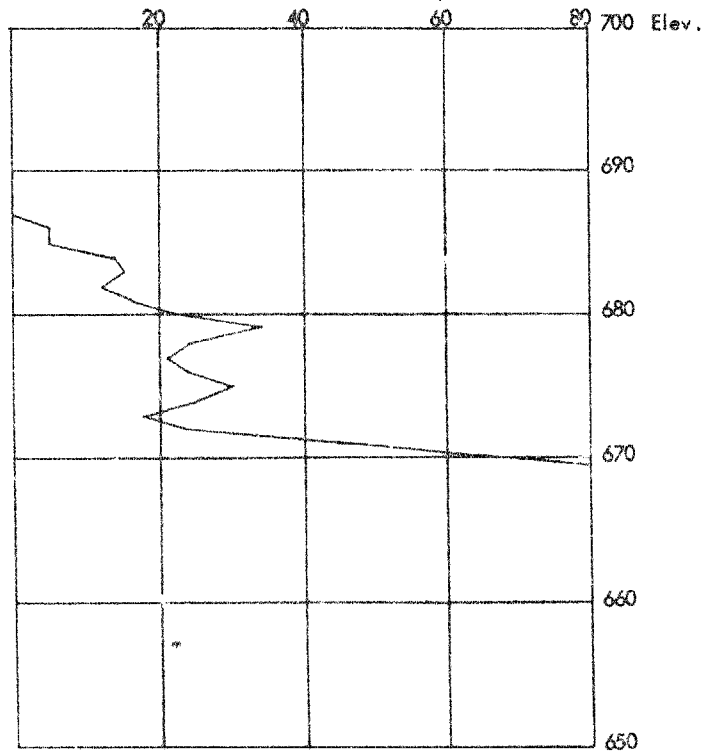
PROJECT Interchange County Road to Highway
TITLE Dynamic Penetration Test Diagrams
DRG. NO. 4 ORDER NO. T. 428/60



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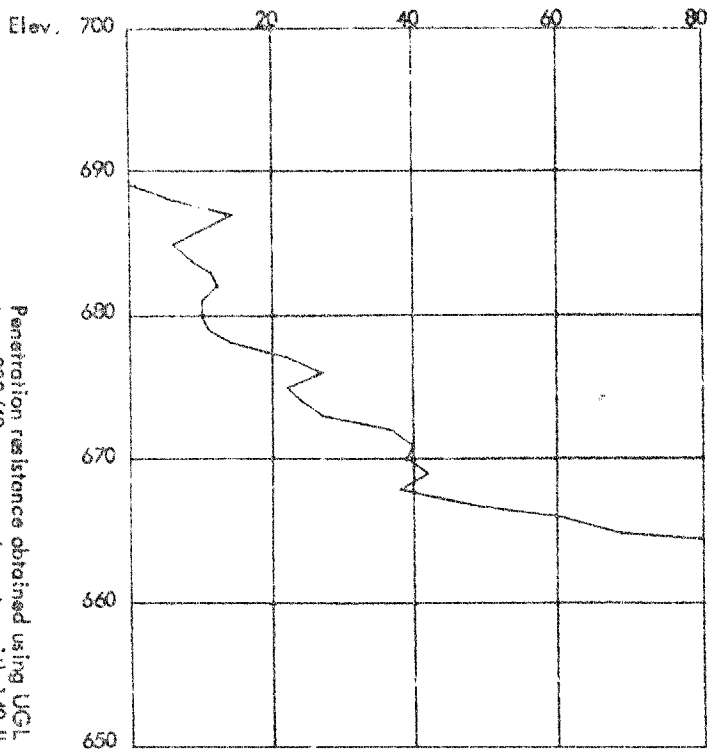
PT. 4

Blows Per Foot of Penetration



PT. 3

Blows Per Foot of Penetration



Penetration resistance obtained using UCL
type 200/60 cone penetrometer with 140 lb.
hammer falling 30".

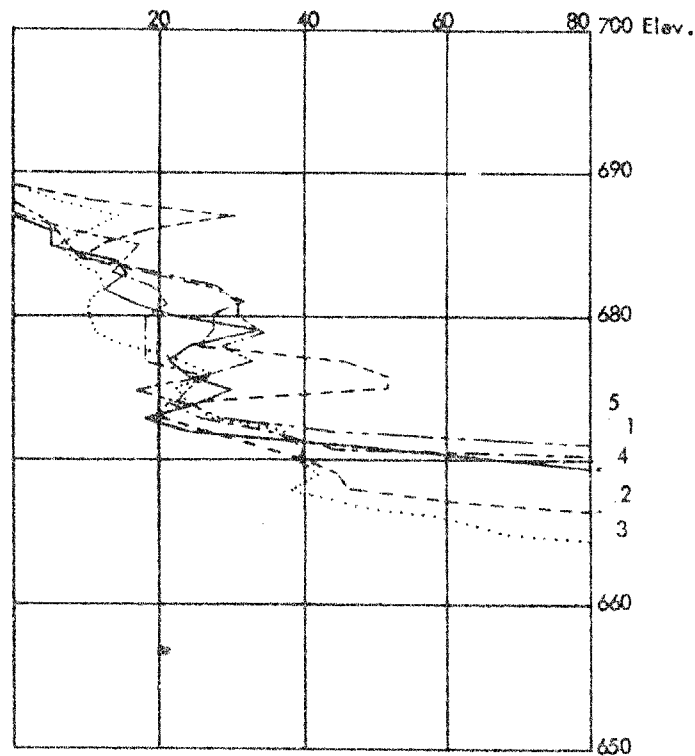
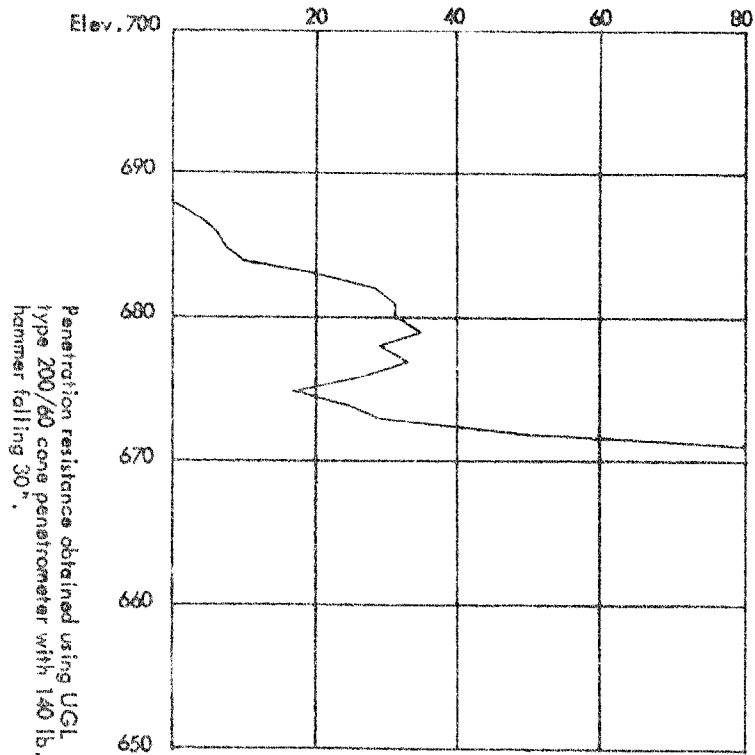
PROJECT Interchange County Road to Highway
(W.P. 91-59)
TITLE Dynamic Penetration Test Diagrams
DRG. NO. 5 ORDER NO. T. 428/40



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GEOTECHNICAL
LIMITED

PT. 5

Blows Per Foot of Penetration



COMBINED PLOTTING OF PENETRATION TESTS

PROJECT Interchange County Road to Hickade
TITLE Dynamic Penetration Test Diagrams
DRG. NO. 6 ORDER NO. T.428/60



UNIVERSAL
GEOTECHNIQUE
LIMITED

SOIL MECHANICS LABORATORY MECHANICAL ANALYSIS

T.428/60

PROJECT Interchange County Road to Highgate. (W.P. 91-59)

BORING NO. BH.1

SAMPLE NOS. 2 & 4

DATE OF TEST 13th April, 1960.

DESCRIPTION _____

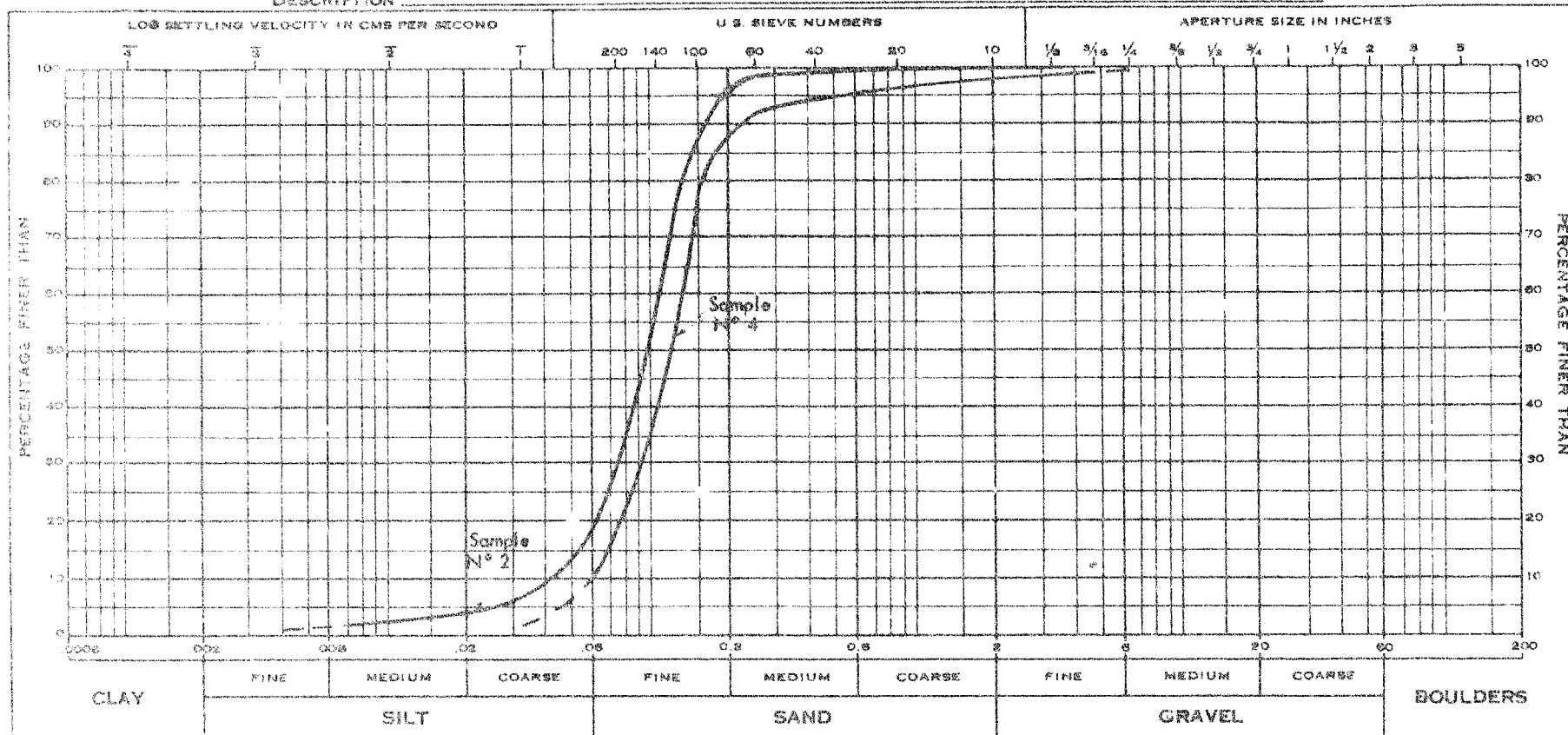


FIG. No. 1



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TABLE N° 1
SUMMARY OF LABORATORY TESTS

Borehole N°	Sample N°	Sample Type	Elevation	Natural Density lbs./cy.ft.	Natural Moisture Content %	Liquid Limit	Plastic Limit	Plasticity Index	Unconfined Compression Strength lbs./sq.ft.
BH. 1	2	S.B.	682		17.6				
	6	"	672		16.5				
	8	"	665		20.8				
	9	"	660		20.4				
	11	"	654		19.2				
	12	"	648		20.9				
	15	"	637		19.0				
	16	"	626		17.4				
	17	"	621		17.4				
BH. 2	4	"	674	132	17.6 16.1				8000
	5	"	668	138	18.3 17.9	32.5	17.9 17.2	15	* 6400
	6	"	664		19.8 20.1				* 5200 * 4000 (remould)
	7	"	659	139	20.7 20.2	30.2	15.7 16.6	14	* 4000 * 2800 (remould)

* At 20% Strain

S.B. = 2" O.D. Split Barrel Sampler

PROJECT Interchange County Road to Highway
TITLE Laboratory Tests (W.P. 91-591)
DRG. NO. ORDER NO. 1 401 000



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GEOTECHNIQUE
LIMITED

#60-F-250C

W.P. #91-59

HWY #401

COUNTY RD. #20

INTERCHANGE

TO HIGHGATE

