

#60-F-249C

W.P. # 92-59

HWY # 401

COUNTY RD. TO

DUART

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

April 20, 1960.  
FOUNDATION INVESTIGATION -- by  
Universal Geotechnique, Limited.

Attention: Mr. S. McCombie.

Re: Proposed Crossing County Road  
to Duart and Hwy. 401, County  
of Kent, Dist. No. 1 - W.P. 92-59

The foundation report prepared by the Consultant, Universal Geotechnique, Ltd., for the above site, has been reviewed by the Foundation Section. Comments arising from this review are summarized below:-

1. The predominant material at this site was found to be a stiff to very stiff silty clay till. From ground surface to the contact of this clay till, a 10-foot layer, consisting of fill, topsoil and sand, exists.
2. The proposed structure may be supported on spread footings. These spread footings should be designed for a net bearing pressure of 3 T/ft.<sup>2</sup>. The spread footings should be founded at elevation 699', approximately 10 to 11 feet below original ground surface.
3. The ground water table at the time of the investigation, was found approx. 2 ft. below the surrounding ground level. Excavation for spread footings will be below the ground level, and thus seepage water into excavations is to be expected. It is felt that the quantity of water entering these excavations will be minor, and adequately handled by pumping. If spread footings are not poured immediately after the completion of the excavation, a concrete working slab should be placed to prevent softening of the supporting material.

cont'd. /2 ...

Recommendations: (cont'd.) ...

4. Ultimate settlements of the bridge structure, due to the bridge dead load and the embankment loads, will be of the order of 6 to 9". These settlements will be complete in approx. 50 years. If a single-span structure is used, differential settlements will be negligible. In the event that a multi-span structure is desired, this structure should be simply supported.
5. If a multi-span structure is proposed with the abutments supported on piles, driven through the fill, steel 'H' piles should not be used. Steel tube displacement type piles will meet refusal at elevation 695 $\frac{1}{2}$  and will be capable of carrying loads of 30 tons/pile.
6. No problems associated with the stability of the approach embankments is anticipated.

If we can be of further assistance in connection with this report, please contact the Foundation Section.

L. G. Soderman,  
PRINCIPAL SOILS & FOUNDATIONS ENGR.  
Per:

*K. Peaker*

(K. Peaker,  
FOUNDATION FIELD SUPERVISING ENGR.)

KP/MdeF  
Attach.

cc: Messrs. A. M. Toye (2)  
H. A. Tregaskes  
D. G. Ramsay  
A. Gater  
G. U. Howell  
J. Roy  
A. Watt  
  
Foundations Office  
Gen. Files.

UNIVERSAL  
**GEOTECHNIQUE**

LIMITED



REPORT

on

FOUNDATION INVESTIGATION

for

PROPOSED CROSSING

COUNTY ROAD TO DUART & HIGHWAY 401

COUNTY OF KENT

for

ONTARIO DEPARTMENT OF HIGHWAYS

(W.P. 92-59)

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REPORT

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COUNTY OF KENT

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ONTARIO DEPARTMENT OF HIGHWAYS

(W.P. 92-59)

INTRODUCTION

The Ontario Department of Highways are planning a crossing of Highway 401 at Kent County Road N° 21 to Duart.

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 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 Underpass and the suggested locations for exploratory boreholes and dynamic cone penetration tests. Drawing N° 2 accompanying this Report is an enlargement of the foregoing plan and shows 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 Underpass will involve an embankment about 25 feet high to carry the County Road over Highway 401.

THE SITE

The site of the proposed bridge is located on the existing County Road N° 21 approximately two miles North of Muirkirk, lots 16 and 17, Orford Township in the County of Kent, Ontario.

## SUBSURFACE EXPLORATION

Subsurface exploration was carried out during the period 21st to 31st of March, 1960, under the supervision of a Soils Engineer in charge of field operations and comprised 5 exploratory boreholes and 6 dynamic cone penetration tests located in positions as shown on drawing N° 2.

When the exploration in borehole BH.1 did not disclose any appreciable dessicated upper crust in the brown till, it was decided to carry out borehole BH.4 and again when BH.4 disclosed an appreciable dessicated layer, BH.1A was carried out and confirmed the impression that the apparent absence of the dessicated crust was local.

In order not to obstruct traffic on the County Road, borehole BH.2 was relocated 15 feet West of the originally intended position and an additional dynamic cone penetration test PT.6 was carried out 15 feet East of the originally intended location of BH.2.

The originally intended positions of all boreholes and penetration tests were staked and 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 and carried to depths where virtually refusal conditions were encountered and 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 are 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 near the eastern extremity of the Blenheim moraine: A few hundred yards West of the site the moraine separates into two strands which protrude eastward to the North and South of the site. Between these two strands there existed a shallow embayment of the glacial Lake Warren.

The fine grey sands that overlie the brown till of the moraine were undoubtedly deposited by the waters of glacial Lake Warren and where shallow depressions existed on the surface of the till, a thin layer of grey silty lacustrine clay containing organic matter separates the grey sands from the brown till.

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:

#### FILL

From 1-1/2 to 4 feet of sand and gravel forming part of the County Road construction was encountered in all boreholes.

#### TOP SOIL

Up to 2-1/2 feet of brown loam containing organic matter underlies the fill.

#### GREY SAND

Loose to firm fine grey sand containing some fine gravel occurs immediately beneath the top soil, the thickness of this deposit varying from about 5 to nearly 8 feet.

#### GREY CLAY

A thin layer of firm grey silty clay containing a high percentage of organic matter was encountered in boreholes BH.2, 3 and 4. In BH.2 and 3 the stratum is only about 6 inches thick whilst in BH.4 similar clay is present in very thin layers of less than a half inch thick within a sand stratum.

#### BROWN TILL

Brown silty clay containing fine to medium gravel was encountered in all boreholes and constitutes the underlying till. It exhibits an 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 grey sand stratum at approximately elevation 708.5.

#### 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 have disclosed that the site of the proposed bridge is underlain by a limited thickness of fill and top soil followed by up to about 8 feet of sand which exists in a variable state of compaction ranging from loose to firm. Beneath the sand stratum there exists a very thin layer of clay with organic matter. Underlying the foregoing strata there exists glacial till which is generally characterized by a dessicated crust extending for several feet below its upper surface.

Study of the geological section through the site and the loose state of compaction in which the sand stratum exists in parts leads to the conclusion that the foundations for a heavily loaded highway bridge should not be placed directly on such a sand stratum.

The underlying till would provide excellent support for normal spread footings located at elevation 699 and an allowable bearing capacity of 3.0 tons/sq.ft. could be adopted for design purposes.

Thus, unless some means is used for compacting the loose sand stratum it is desirable that spread footings should be founded on the underlying glacial till, and it would certainly appear that compaction of the limited depth of sand would not be economical and in any event a thin stratum of lacustrine clay exists between the sand and the underlying till.

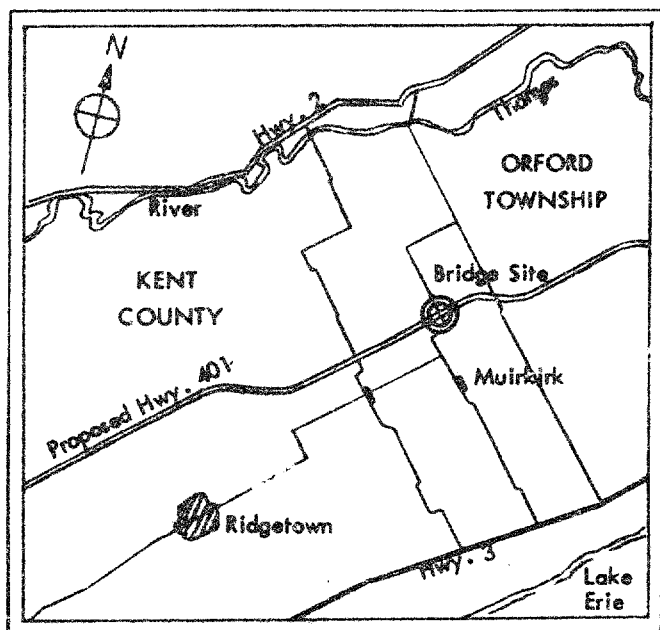
## CONCLUSIONS

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 consist of a limited thickness of fill and top soil followed by a stratum of loose to firm sand which extends to almost elevation 700. Beneath the foregoing deposits hard to stiff glacial till exists.
- (2) The most suitable type of foundation would be spread footings and due to the loose state of compaction of the sand stratum in certain areas it would appear desirable to support the foundations directly on the hard underlying glacial till at an elevation of about 699.
- (3) The allowable bearing capacity for the design of spread footings located at elevation 699 may be taken as 3.0 tons/sq.ft.
- (4) No particular difficulty need be anticipated in dewatering the sand stratum for purposes of constructing the foundations on the till.
- (5) The subsurface conditions are such that no instability of the approach embankments need be anticipated.

Universal GEOTECHNIQUE Limited,

  
L. Baskin, P.Eng.



**KEY PLAN**

Scale: 1" = 4 Miles

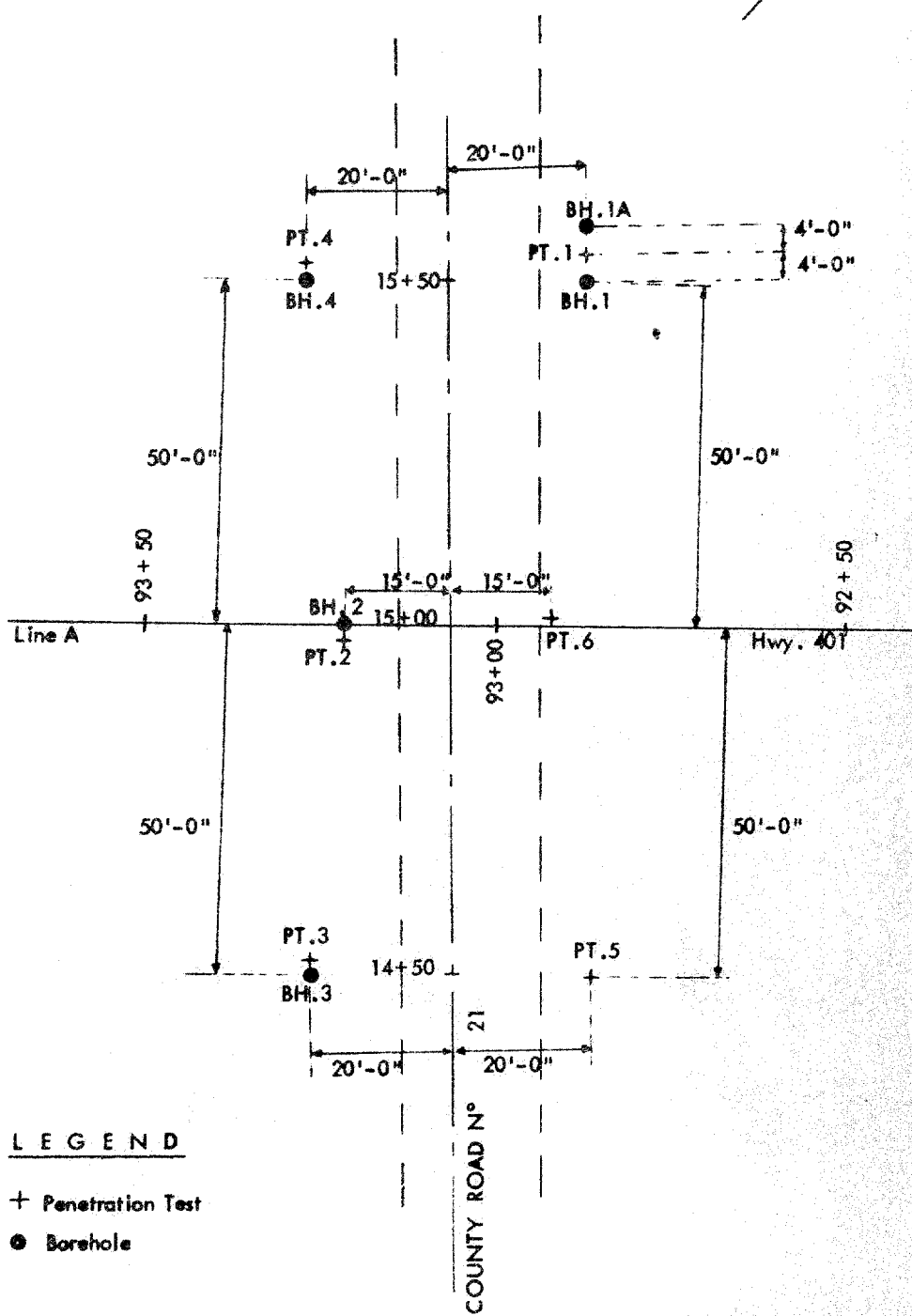
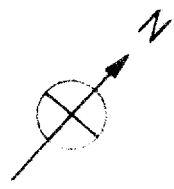
PROJECT Crossing County Road to Dwart & Hwy. 401  
(W.P. 92-59)

TITLE Key Plan

DRG. NO. 1 ORDER NO. T.429/60



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LEGEND

- + Penetration Test
- Borehole

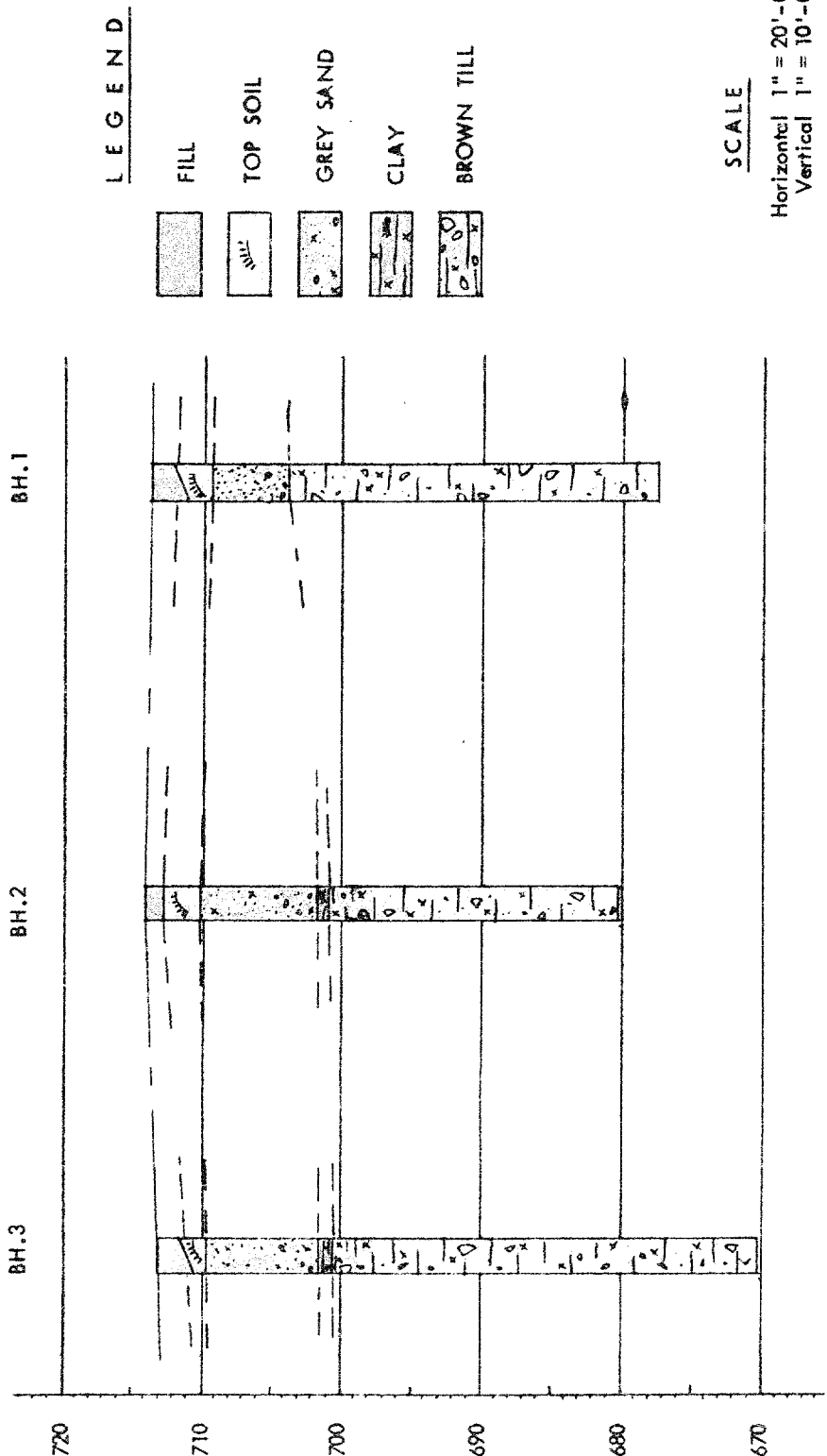
SCALE: 1" = 20'-0"

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

PROJECT <u>Crossing County Road to Duart &amp; Hwy. 401</u>	
(W.P. 92-59)	
TITLE <u>Borehole Location Plan</u>	
DRG. NO. <u>2</u>	ORDER NO. <u>T.429/60</u>



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PROJECT Crossing County Road to Duart & Hwy. 401  
(W.P. 92-59)  
TITLE Geological Section  
DRG. NO. 3 ORDER NO. T.429/60



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**GEOTECHNIQUE**  
LIMITED

SOIL MECHANICS LABORATORY












**BOREHOLE LOG**

PROJECT Crossing County Road to Duart & Hwy. 401 (W.P. 92-59) ORDER NO. T.429/60

CLIENT Ontario Department of Highways

BOREHOLE 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 sand with gravel, FILL.	713.9			Zero			
Loose brown loam with some organic matter. TOP SOIL.			• 1	4'-3"	Free Water	10	Damp.
Loose grey fine to medium SAND.			• 2			7	Moist. No dry strength.
Loose to firm grey fine to medium SAND with some fine gravel.			• 3	9'-9"		15	Wet. No dry strength.
Hard brown silty CLAY with fine to medium subangular gravel.			• 4			26	Damp. High dry strength.
Very stiff do			• 5			13 (9")	do
do			• 6			13	do
Stiff do			• 7			13	do
do			• 8			14	do
do			• 9			13	do
do			• 10	36'-0"		12	do
				End of Borehole			

FORM G-1A 800  
UNITED STATES GEOLOGICAL SURVEY

SOIL MECHANICS LABORATORY

**BOREHOLE LOG**

PROJECT Crossing County Road to Duart & Hwy. 401 (W.P. 92-59) ORDER NO. T.429/60

CLIENT Ontario Department of Highways

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

BOREHOLE LOCATION See Sketch INCLINATION Vertical BEARING       

FORM G-1A 300  
UNIVERSAL GEOTECHNIQUE

DESCRIPTION OF STRATA	ELEVATION	LEGEND	SAMPLE	DEPTH	THICKNESS	N	REMARKS
Same as BH.1	713.9			Zero			
Very stiff brown silty CLAY with fine to medium subangular gravel.			• 1 [ST1] • 2 [ST2] • 3	14'-0"		20	Damp. High dry strength. No recovery No recovery
Stiff brown silty CLAY with fine to medium subangular gravel.				31'-0"		13	No recovery
				End of Borehole		13	Moist. High dry strength.












SCALE: 1" = 5'-0" • DISTURBED SAMPLE

■ UNDISTURBED SAMPLE

## SOIL MECHANICS LABORATORY

## BOREHOLE LOG

PROJECT Crossing County Road to Duart & Hwy. 401 (W.P. 92-59) ORDER NO. I.429/60CLIENT Ontario Department of HighwaysBOREHOLE NO. BH.2 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 sand and gravel. FILL.	714.2			Zero			
Loose dark brown loam with organic matter. TOP SOIL.			1	1'-3"		9	Damp.
Loose dark grey fine to medium somewhat silty SAND.			2	Free Water		7	Moi. Low dry strength.
do			3			6	Wet. Low dry strength.
With some fine gravel.			4	11'-3"		13	Moist. High dry strength.
Firm dark grey brown silty CLAY with black organic concentrations.			5	11'-9"		33	Damp. High dry strength.
Hard brown silty CLAY with fine to medium subangular gravel.			6			32	do
do			7			18	do
Very stiff do			8			14	Moist. High dry strength.
Stiff do							
do			ST1	34'-0"			do 3" recovery

SCALE: 1" = 5'-0" • DISTURBED SAMPLE

■ UNDISTURBED SAMPLE

## SOIL MECHANICS LABORATORY

BOREHOLE LOGPROJECT Crossing County Road to Duart & Hwy. 401 (W.P. 92/59) ORDER NO. I.425/60CLIENT Ontario Department of HighwaysBOREHOLE NO. BH.3 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 silty sand with gravel, some organic matter. FILL. Loose brown sandy clay, organic concentrations, probably TOP SOIL.	713.2			Zero			
Firm dark brown somewhat silty fine SAND.			• 1	3'-3"	Free Water	6	Damp.
do			• 2			17	Moist. Low dry strength.
With fine gravel.			• 3			18	Wet. No dry strength.
do			• 4	11'-3"		13	do Moist. High dry strength.
Stiff grey silty CLAY with some shells, traces of bedding.			• 5	11'-9"		33	Damp High dry strength.
Hard brown silty CLAY with fine to medium subangular gravel.			• 6			32	do
Very stiff do			• 7			26	do
do			• 8			23	do
Stiff to very stiff do			• 9			15	do
Stiff do			• 10			17	No recovery
do			• 11			20	Damp.
do			• 12	43'-0"		14	High dry strength. do
				End of Borehole			

SCALE: 1" = 5'-0" • DISTURBED SAMPLE

■ UNDISTURBED SAMPLE



## SOIL MECHANICS LABORATORY

## BOREHOLE LOG

PROJECT Crossing County Road to Duart & Hwy. 401 (W.P. 92-59) ORDER NO. T.429/60CLIENT Ontario Department of HighwaysBOREHOLE NO. BH.4 DIAMETER 2-1/2" CASING 2-1/2"BOREHOLE LOCATION See Sketch INCLINATION Vertical BEARING       FORM G-1A 800  
UNITED STATES GEOLOGICAL SURVEY

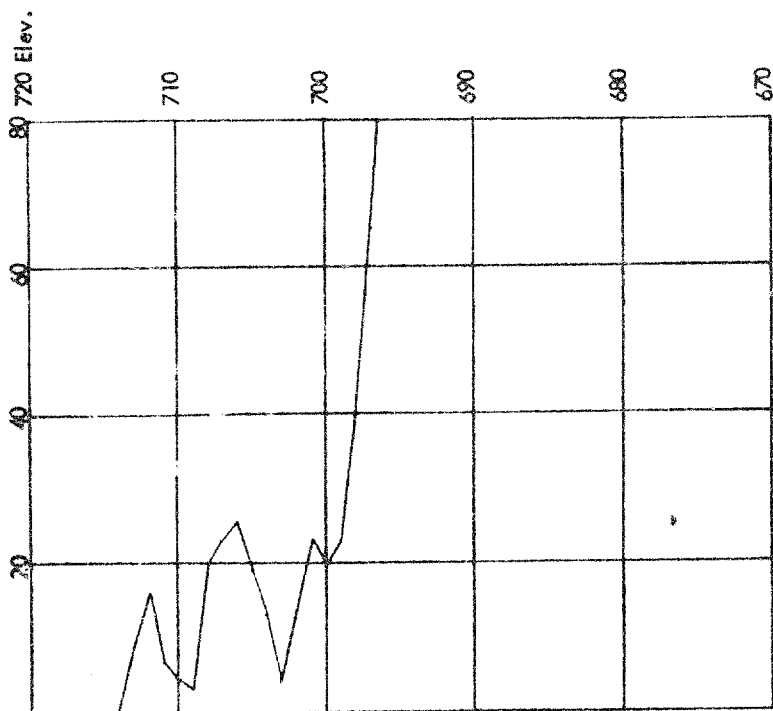
DESCRIPTION OF STRATA	ELEVATION	LEGEND	SAMPLE	DEPTH	THICKNESS	N	REMARKS
Dark brown silty sand and gravel. FILL.	713.5			Zero			
Brown clayey sand and gravel iron stained. Probably FILL.			• 1	2'-6"		8	Damp.
Firm grey fine to medium somewhat silty SAND.			• 2	Free Water		17	Moist. Low dry strength.
Loose grey SAND with layers of grey silty clay with dark organic concentrations.			• 3	9'-0"		12	Clay: Moist. High dry strength.
do			• 4	12'-0"		23	do Clay: Damp. High dry strength.
Stiff to very stiff brown silty CLAY with fine to medium subangular gravel.			• 5			23	Damp. High dry strength.
Very stiff brown silty CLAY with fine to medium subangular gravel.			• 6			20	do
Stiff do			ST1 • 7			19	No recovery Damp. High dry strength.
do			ST2 • 8			19	No recovery Damp. High dry strength.
do			• 9			17	do
do			ST3 • 10			19	No recovery.
			ST4 • 10	41'-0"		19	No recovery.
			End of Borehole				

SCALE: 1" = 5'-0" • DISTURBED SAMPLE

■ UNDISTURBED SAMPLE

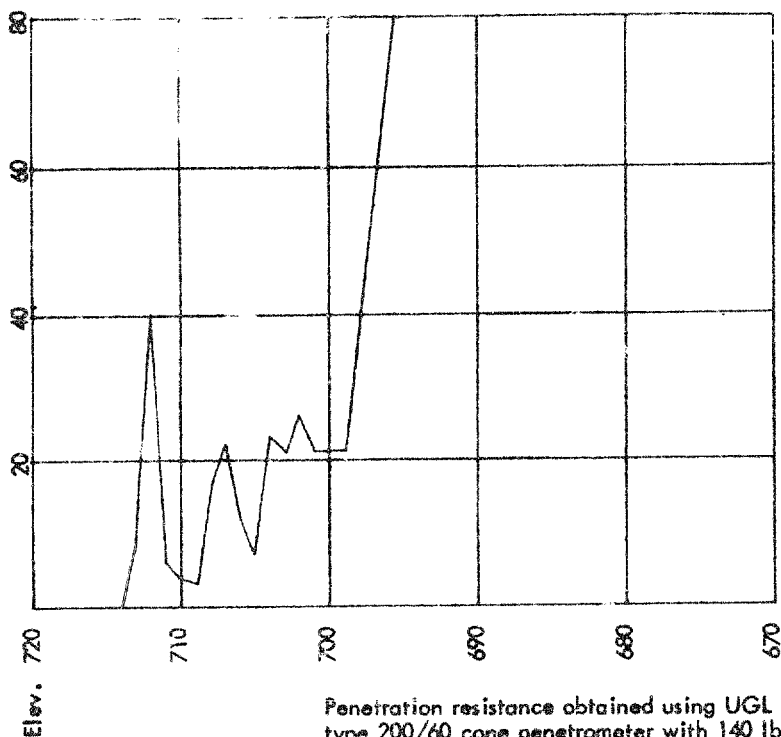
PT. 2

Blows Per Foot of Penetration



PT. 1

Blows Per Foot of Penetration



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

PROJECT Crossing County Road to Quart & Hwy. 401

(W.P. 92-59)

TITLE Dynamic Penetration Test Diagrams

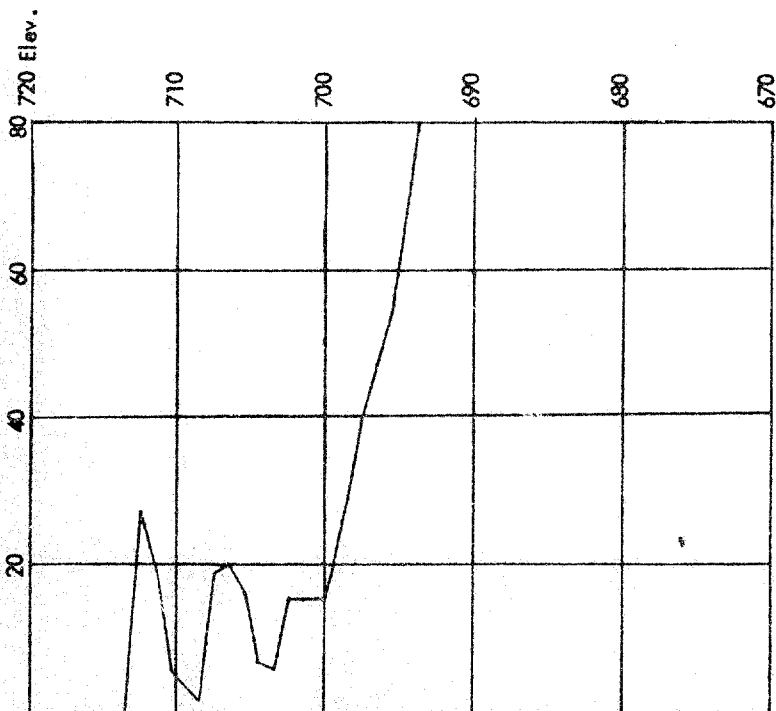
DRG. NO. 4 ORDER NO. I. 22/60



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LIMITED

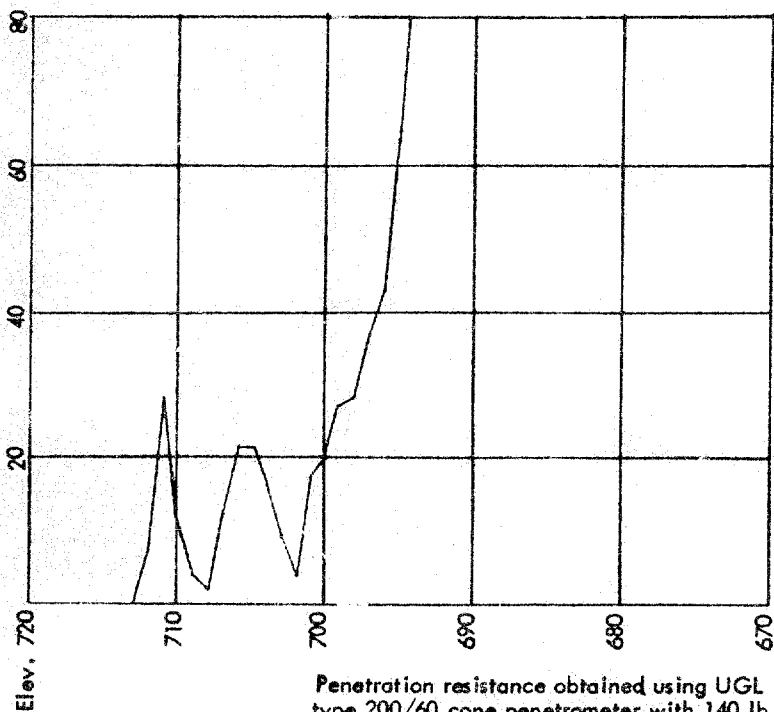
PT. 4

Blows Per Foot of Penetration



PT. 3

Blows Per Foot of Penetration



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

PROJECT Crossing County Road to Duart & Hwy. 401

(W.P. 92-59)

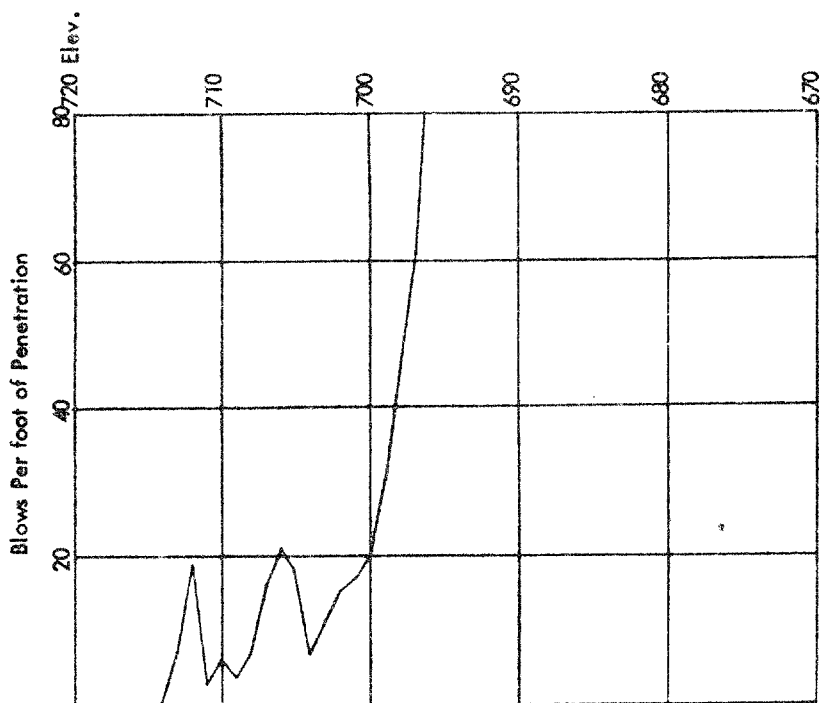
TITLE Dynamic Penetration Test Diagrams

DRG. NO. 5 ORDER NO. T.429/60

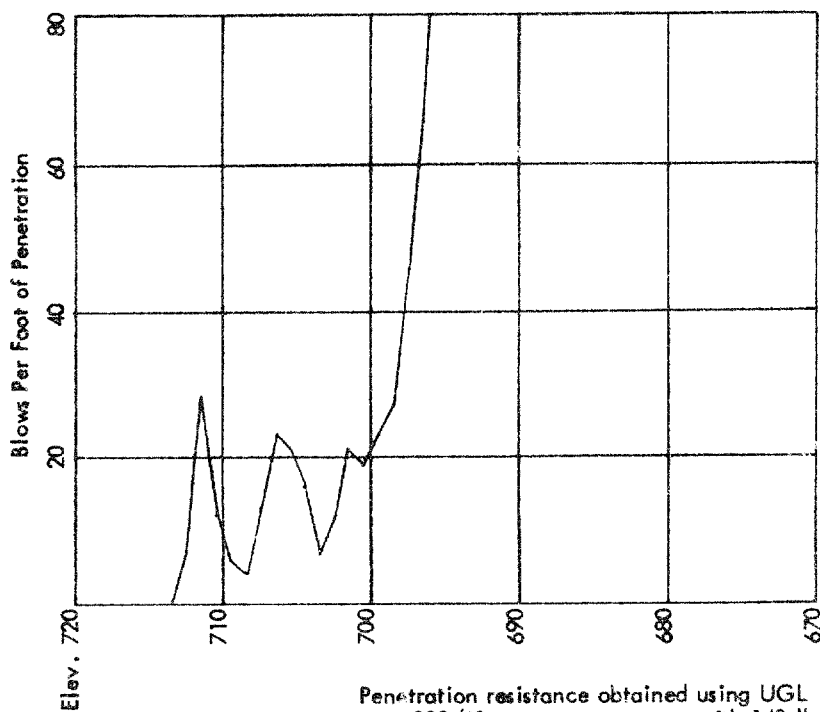


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PT. 6



PT. 5



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

PROJECT Crossing County Road to Duart & Hwy. 401

TITLE Dynamic Penetration Test Diagrams (W.P. 92-59)

DRG. NO. 6 ORDER NO. T.429/60



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TABLE N° 1  
SUMMARY OF LABORATORY TESTS

Borehole N°	Sample N°	Elevation	Natural Density lbs./cu.ft.	Natural Moisture Content %	Liquid Limit	Plastic Limit	Plasticity Index	Unconfined Compression Strength lbs./sq.ft.
BH. 1	4	702.0		19.2				
	6	696.5	140	17.6				* 7300
	8	688.0		18.5				
	10	678.0		17.8				
BH. 1A	1	696.0	138	17.2				* 8000
BH. 2	4	702.0		35.0				
	5	699.5		17.8				
	6	697.5		15.2				
	7	693.0		17.9				
	8	685.5		18.2				
	ST. 1	680.5		18.5	29.2	15.2	14	
BH. 3	4	701.0		30.3				
	5	698.5	139	16.0				* 16000
	6	694.0	137	15.6				8000
	7	688.5	144	17.8				8000
	8	683.5	137	18.8	29.5	14.7	14.8	* 5000
								* 3900 (remould)
	11	670.0	144	19.0	29.2	14.0	15.2	* 4700
								* 2800 (remould)
BH. 4	3	703.5	117	30.7				* 1300

\* At 20% Strain

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