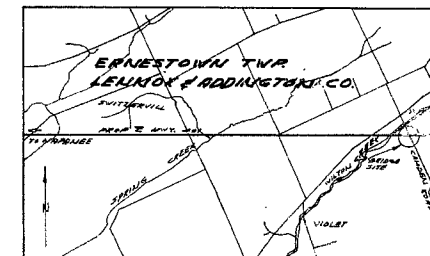
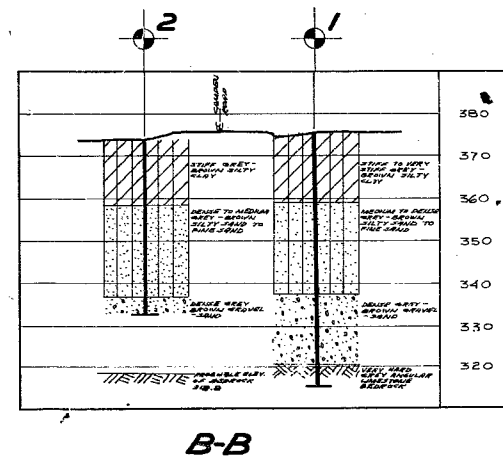
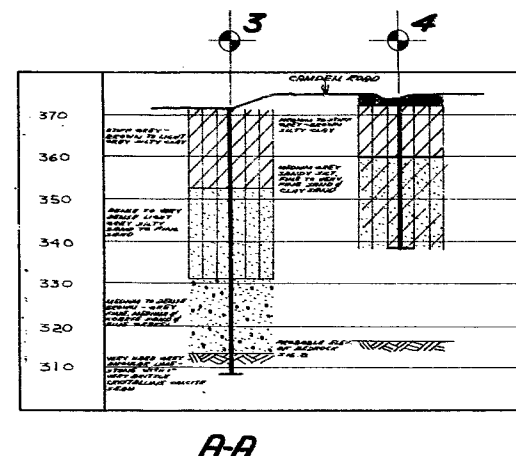
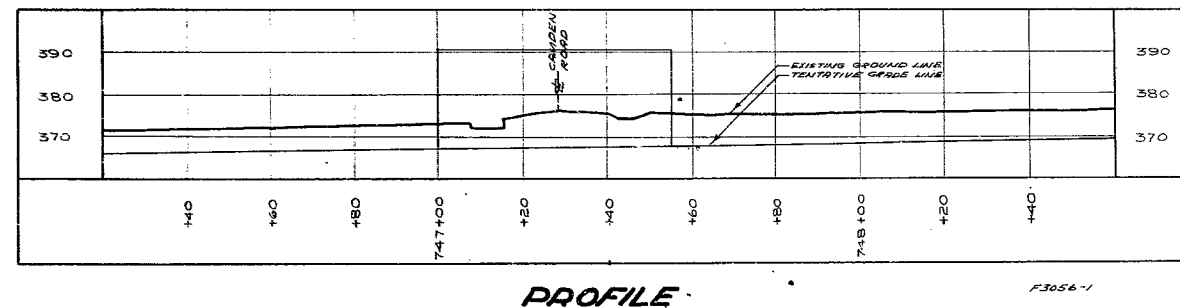
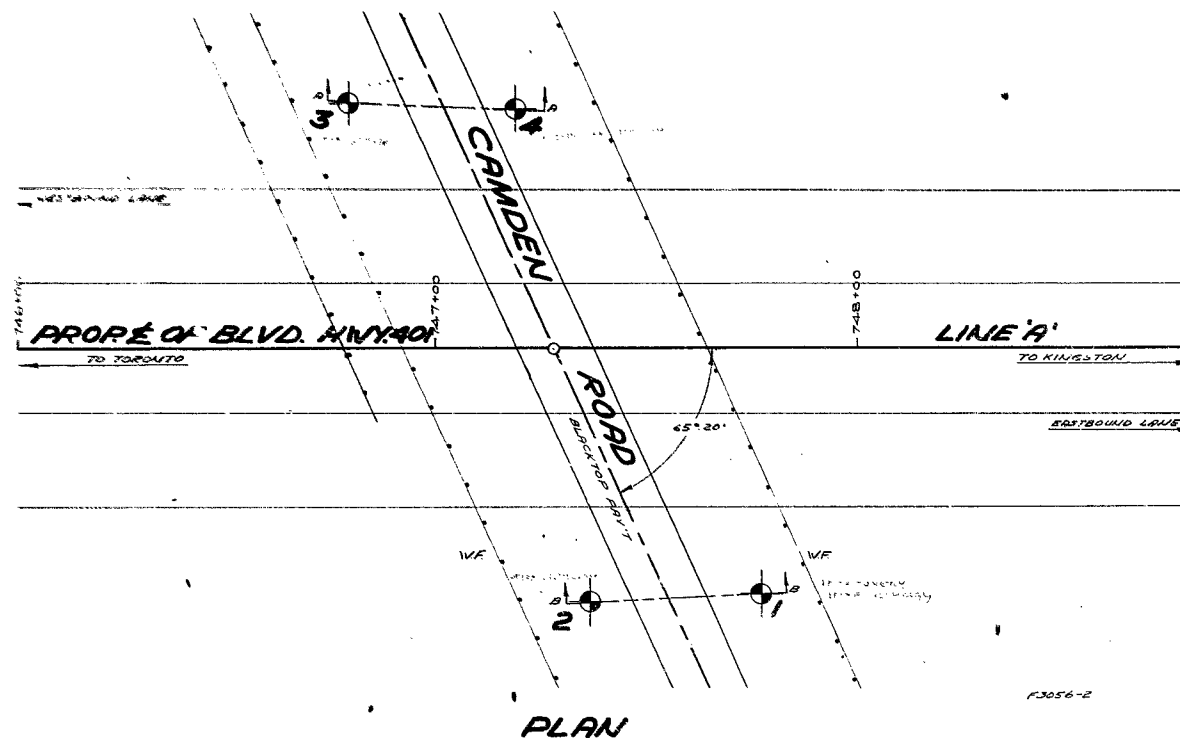


# 59-F-24  
W.P. # 36-59  
Hwy. # 401  
CAMDEN RD.  
CON. # 5  
6 MILES N.E. OF  
NAPANEE



LEGEND			
BORE HOLE			
PENETRATION HOLE			
BORE & PENETRATION HOLE			
HOLE NO.	ELEVATION	STATION	DISTANCE FROM E.
1	375.7	747+77	58' PT.
2	373.9	747+36	60' PT.
3	371.8	746+79	58' LT.
4	374.9	747+18	57' LT.

- NOTE -

THE BOUNDARIES BETWEEN SOIL STRATA HAVE BEEN ESTABLISHED ONLY AT BORE HOLE LOCATIONS. BETWEEN BORE HOLES THE BOUNDARIES ARE ASSUMED FROM GEOLOGICAL EVIDENCE AND MAY BE SUBJECT TO CONSIDERABLE ERROR.

DEPARTMENT OF HIGHWAYS - ONTARIO  
MATERIALS & RESEARCH SECTION

**CAMDEN ROAD  
PROPOSED CROSSING**

SHOWING POSITIONS & ELEVATIONS OF HOLES

HWY. 401 DISTRICT 10 COUNTY LENOX & RADDINGTON  
TOWNSHIP ERNESTOWN LOT 2021 CON. 1  
LOCATION R.R. 6 MI. N.E. OF RADDINGTON  
DRAWN BY: T. MELLOPS CHECKED BY: J. H. W. W.P. 36-59  
DATE 17 JUNE 59 APPROVED BY: J. H. W. DRAWING NO. F55-24A  
SCALE 1 IN. = 20 FT.



ONTARIO  
DEPARTMENT OF HIGHWAYS

283

CH 4 - 2576

**Memo to** Mr. A. M. Toye, **Date** July 21, 1959.  
Bridge Engineer. **Subject** FOUNDATION INVESTIGATION -  
**From** Materials & Research Section. W.P. 36-59 - W.J. F-59-24

Attention: Mr. S. McCombie.

Re: Proposed Underpass at Camden Rd. & Hwy. 401,  
Lots 20 & 21, Con. V, Twp. of Ernestown --  
Approximately 6 Miles N.E. of Napanee.

This memo accompanies our detailed report on the foundation conditions existing at the above noted structure site. Your attention is drawn to the following principal comments:-

- (1) Soil types at this site consist of -
  - (a) an upper stratum of stiff silty clay approximately 15 feet thick;
  - (b) a dense stratum of silty sand to sand approximately 40 feet in thickness; and
  - (c) sound limestone bedrock which was contacted at a depth below existing ground surface of 55 feet.
- (2) The strength and compressibility characteristics of the upper stiff clay layer are such that spread footing support can be obtained at Elev. 562.0' in this layer. An allowable bearing pressure of 2 1/2 tons/sq.ft. has been recommended for footings founded at Elev. 562.0'.
- (3) The subsoil can safely support the approach embankments proposed at this site.

If we can be of further assistance regarding the above structure site, please contact our office.

LGS/MdeF

Encl.

cc: Messrs. A. M. Toye

H. A. Tregaskes

D. G. Ramsay

S. Markiewicz

Mr. J. Gruspier

L. E. Walker

A. Watt

Foundation Office

Gen. Files.

L. G. Soderman,

PRINCIPAL SOILS & FOUNDATIONS ENGINEER.

# FOUNDATION INVESTIGATION

for

Proposed Underpass at Camden Road  
and Highway No. 401,  
Lots 20 & 21, Con. V, Twp. of Ernestown,  
Approx. 6 Mi. N.E. of Napanee.

---

Plan No: F-3056-2

Profile No: F-3056-4

## Distribution:

Mr. A. M. Toye, Bridge Engineer.	(2)
Mr. H. A. Tregaskes, Construction Engineer.	(1)
Mr. D. G. Ramsay, Rd. Design Engineer.	(1)
Mr. S. Markiewicz, Project Design Engr., Kingston.	(1)
Mr. J. E. Gruspiez, Regional Soils Engr., Kingston.	(1)
Mr. L. E. Walker, District Engr., Kingston.	(1)
Mr. A. Watt, Ontario Water Resources Commission.	(1)
Foundation Section.	(1)
Gen. notes.	(1)

W.P. 36-59.

W.J. F-59-24.

## DESCRIPTION OF SITE AND GEOLOGY

Presented in this report are the results of a foundation investigation carried out recently at the site of the proposed underpass carrying Camden Road over Highway No. 401 about 8½ miles East of Napanee.

The site is located in a broad flat valley with Milton Creek meandering in a flat flood plain about 300 ft. wide along the North side of the valley. The valley, believed to be a glacial channel, cuts through the Napanee Limestone Plain. It is bounded on the South by a small escarpment of limestone bedrock about 300 ft. to 350 ft. south of the proposed centre line of Highway No. 401 and then another flat plain terminated by a higher escarpment of bedrock at 900 ft. to 1000 ft. South of Highway No. 401. The North side of the valley is mainly cultivated farmland sloping up evenly with no signs of bedrock. Soil deposits in the valley are fairly well stratified and are believed to be mainly glacial outwash or alluvial in origin.

The valley is mainly cultivated farmland with few trees. Trees lining Camden Road were felled at the time of the foundation investigation.

## DESCRIPTION OF FIELD WORK

The field work, commenced on April 2, 1959 and completed on April 10, 1959, was carried out by skid-mounted coredrill machines adapted for soil-sampling and consisted of four sampled boreholes with adjacent dynamic cone penetration tests. Boreholes were advanced using conventional wash-boring procedures with samples taken at depth intervals of 3 to 10 feet. In the upper strata of cohesive silty clay, 2" Ø thin-walled undisturbed Shelby tube samples were taken. One insitu vane test result was obtained in Borehole 3 at a depth of 18 ft. but in general the silty clay was too stiff to obtain field shear strength values. In the cohesionless granular materials below, a 2" O.D. split-barrelled spoon sampler was used. The dimensions of this sampler and the energy used in driving it conform to the requirements of the Standard Penetration Test.

In Boreholes 1 and 3, 5 ft. long 1 1/4" Ø AX Rock Cores were taken and at Boreholes 2 and 4 the probable elevation of bedrock was determined from the dynamic cone penetration tests.

The results of the field and laboratory tests are presented in the borehole logs and are also detailed in tabular form.

Drawing No. F 59-24A shows the borehole locations and the subsoil profile.

#### SUBSOIL CONDITIONS

The subsoil consists of three main strata between ground level and bedrock:

- a. From ground level (approx. 374.0) to about 15 ft.:

Medium to very stiff grey-brown silty clay

- b. From 15 ft. to 37 ft. approx.:

Medium to very dense light grey to grey-brown silty sand  
to fine sand

- c. From 37 ft. to 55 ft. approx.:

Medium to dense grey-brown layered gravel sand

These strata are underlain by very hard grey angular limestone bedrock.

a. Silty Clay - This material is predominantly grey-brown in colour and varies in consistency from medium to very stiff. Laboratory shear strength values range between 1300 and 5000 p.s.f. Between elevations 364.0 and 368.0, there appears to be a stiff layer with shear strengths in excess of 3500 p.s.f. Above and below this zone the shear strength ranges from 1300 to about 3000 p.s.f.

The average moisture content of this material was found to be 30% and Atterberg limit tests gave an average liquid limit of 50% and an average plastic limit of 27%. The average unit weight is 120 lbs. per cu. ft.

Two consolidation tests at elevation 363.0 approximately (i.e. about 11 feet below mean Ground Level) showed the silty clay to be over-consolidated

and of relatively low compressibility.

b. Silty Sand to Fine Sand - Throughout the site the silty clay was found to be underlain by a layer, approximately 22 feet thick, of light grey to grey-brown silty sand to fine sand. Dynamic cone blows and standard penetration test results indicate that the material is medium dense to very dense (N varies from 11 to 78; Average: 33). The stratum contains a few thin bands of gravel and silty clay at the top, also some clay sand and silt (Borehole No. 4) and some medium sand, but generally retains the characteristics of a silty to fine sand. The average unit weight determined from five relatively undisturbed samples near the top of the stratum is 133 p.c.f.

c. Gravel Sand - This material is predominantly grey-brown in colour and consists mainly of rounded medium to coarse river sand with fairly frequent layers of fine to medium gravel. Standard penetration test results indicate the material to be dense (N varies from 33 to 41).

d. Bedrock - Bedrock was encountered at depths between 55 ft. and 58 ft. (between elevations 313.3 and 320.3). Rock core recovered from Boreholes 1 and 3 showed the material to be very hard grey angular limestone with an average crushing strength of about 26,000 p.s.i. A 1" thick seam of crystalline calcite in the core from Borehole 3 is brittle but is not expected to cause any trouble.

#### WATER CONDITIONS

At the time of the investigation there was considerable thawing of snow and also rain and the ditches on either side of Camden Road were practically full of water. As a result the water table at the time was very near the surface (9" to 3' 6" below ground level). No artesian water conditions were encountered.

FOUNDATION CONSIDERATIONS

As has been already noted under "Subsoil Conditions", the layer of silty clay from the surface to about 15 feet varies in consistency from medium to very stiff. Shear strength values in this stratum indicate that adequate foundation support for spread footings can be obtained throughout the whole depth of the stratum.

The proposed profile grade for Highway No. 401 necessitates a cut about 7 or 8 feet deep in the vicinity of the proposed structure. Since footings should be placed about 5 feet below the profile grade elevation (approx. 367.0) in order to avoid any danger from frost action, the layer of very stiff silty clay, between elevations 364.0 and 368.0 approximately, cannot be utilized for footing support. However, if spread footings are placed at elevation 362.0 approx. (i.e. 5 ft. below Profile Grade) an allowable shear strength of about 1600 p.s.f. can be used for design purposes. Using this shear strength and a factor of safety of 2 it has been calculated that a maximum allowable bearing capacity of 2.5 tons per sq. ft. may be used in the design of spread footings from 4 to 8 feet wide, at elevation 362.0 or below.

Due to the small depth of clay below this elevation and the relatively low compressibility of the clay, settlements consequent upon the above loading will be small and will take place mainly during construction. The maximum differential settlement anticipated (due to variations in the depth of the silty clay layer and differences in the relative density of the sand) is about 1".

*See letter  
to Loderman  
No settlement*

Since adequate foundation support can be obtained in the silty clay layer, it is recommended that excavations for footings should not be carried down as far as the surface of the silty sand layer as this might give rise to more serious water problems in the bottom of the excavation, apart from being



more expensive due to the additional depth of excavation and footings.

It has already been noted that, at the time of the foundation investigation, the water table was within 3' 6" of the ground surface throughout the site. Hence, with footing excavations down to elevation 362.0 in the silty clay, there may be some seepage of water during excavation depending upon the seasonal variations in the water table. However, as the material to be excavated is mainly stiff and relatively impervious this seepage is not expected to create too much difficulty.

No approach fill stability problems are anticipated provided that all topsoil is removed before placing the embankment fill.

#### FOOTINGS FOR FORMWORK DURING CONSTRUCTION

If the necessary cut for Highway No. 401 is excavated prior to construction of the structure, footing plates for formwork can safely be placed on the exposed surface of the silty clay provided that this material has not been unduly softened by standing or running water. The footing plates for the formwork should preferably be square in shape and sufficiently large in size such that the bearing capacity on the soil does not exceed a maximum value of 2.5 tons per sq. ft. <sup>2'0" & no settlement see letter to Anderson</sup>

However, if it is desired to build the structure in advance of grading operations, footing plates anywhere other than on the existing paved County road should be placed on sound material 2 or 3 feet below the existing ground level. Here again the footing plates should be square in shape and should be designed to a maximum bearing capacity of 2.5 tons per sq. ft.

#### CONCLUSIONS AND RECOMMENDATIONS

1.) The soil types at the site of the proposed structure consist of a surface layer of medium to very stiff grey-brown silty clay about 15 feet thick underlain by alluvial or outwash deposits of silty sand and fine sand followed

by medium to coarse sand and gravel. Very hard limestone bedrock was found at about 55 feet.

2.) The surface layer of silty clay is sufficiently stiff to provide adequate foundation support and footings in this material are considered preferable to footings on the surface of the silty sand below.

3.) It is therefore recommended that the structure be founded on spread footings in the silty clay about 5 feet below the proposed profile grade for Highway No. 401 (i.e. at elevation 362.0 approx.)

4.) At this elevation a maximum allowable bearing capacity of 2½ tons per sq. ft. may be used for footings 4 to 8 feet in width.

5.) The maximum differential settlement anticipated (due to variations in the depth of the silty clay layer and differences in the relative density of the silty sand) is about 1". *Neglect diff. settlement, if pressure less than 2 tons/sq. ft. (see letter to Sodarman)*

6.) Problems due to water seeping into the excavations are not likely to present too much difficulty depending upon seasonal variations of the water table.

7.) No embankment stability problems are anticipated provide that all topsoil is removed before placing the embankment fill.

8.) Footings for formwork during construction should preferably be square in shape and may be designed to a maximum allowable bearing capacity of 2½ tons per sq. ft. provided that they are placed on sound material about 2 or 3 feet below existing ground level.

*B. J. Mackenzie.*

B. J. Mackenzie,

Foundation Engineer.

APPENDIX I.

TABLE NO. I.

## SUMMARY OF FIELD &amp; LABORATORY TESTS

JOB F-59-24W.P. 36-59

HOLE NO.	SAMP NO.	SAMPLE DEPTH (FEET)	MATERIAL DESCRIPTION	PENET'N RESIST. BLOWS/FT.	MOIST. CONT. %	PLASTIC LIMIT %	LIQUID LIMIT %	SHEAR STRENGTH p.s.f.	UNIT WEIGHT p.c.f.	REMARKS
1	T1	3'-5'	Stiff brown silty clay.	14	29.0	-	-	2130	121.0	Average Crushing Strength: - 23,000 p.s.i.
	T2	6'-8'	Very stiff brown silty clay.	43	27.9	22.2	40.7	5590	123.0	
	T3	9'-11'	Very stiff grey-brown sandy clay.	33	31.5	27.8	54.8	-	-	
	T4	12'-14'	Stiff grey clay.	31	31.3	27.9	56.7	3040	114.5	
	T5	15'-16.5'	Medium grey silty clay.	31	23.7	17.6	24.5	1960	126.5	
	" )	16.5'-17'	Dense brownish-grey silty sand.	-	20.3	-	-	-	130.0	
	T6	20'-22'	Dense grey silty sand.	31	18.8	-	-	-	131.0	
	T7	24'-26'	Medium grey-brown fine sand.	13	19.5	-	-	-	127.0	
	S8	28'-29.5'	Dense grey-brown fine sand.	38	-	-	-	-	-	
	S9	35'-36.5'	Medium grey-brown silty sand.	28	-	-	-	-	-	
	S10	40'-41.5'	Dense grey-brown medium to coarse sand.	41	-	-	-	-	-	
	S11	50'-51.5'	Dense grey-brown gravel-sand.	33	-	-	-	-	-	
2	R12	55.4'-60.4'	Very hard grey angular limestone.	-	-	-	-	-	-	Average Crushing Strength: - 23,000 p.s.i.
	T1	3'-5'	Stiff brown silty clay.	11	31.2	-	-	3100	121.0	
	T2	6'-8'	Stiff grey-brown silty clay.	28	30.3	-	-	3640	117.0	
	T3	9'-11'	Stiff grey-brown silty clay.	24	37.1	24.5	55.7	2590	116.0	
	T4	15'-17'	Dense grey-brown silty sand.	56	17.1	-	-	-	136.5	
	T5	20'-22'	Medium grey sandy silt.	20	14.8	-	-	-	142.0	
	S6	30'-31.5'	Medium grey-brown fine sand.	26	-	-	-	-	-	
	S7	40'-41.5'	Sample not recovered.	37	-	-	-	-	-	

cont'd. /2 ...

## SUMMARY OF FIELD & LABORATORY TESTS

JOB F-59-24

W.P. 36-59

[illegible]

## SUMMARY OF FIELD & LABORATORY TESTS

JOB F-59-24

W.P. 36-59

HOLE NO.	SAMP NO.	SAMPLE DEPTH (FEET)	MATERIAL DESCRIPTION	PENET'N RESIST. BLOWS FT	MOIST. CONT. %	PLASTIC LIMIT %	LIQUID LIMIT %	SHEAR STRENGTH p.s.f.	UNIT WEIGHT p.c.f.	REMARKS
4	T1	3'-5'	Medium grey-brown silty clay.	15	18.8	-	-	1330	116.8	
	T2	6'-8'	Stiff grey-brown silty clay.	20	38.1	33.8	53.0	2185	114.0	
	T3	9'-10.5'	Stiff grey-brown silty clay.	43	36.1	33.5	57.8	3840	121.5	
	T4	15'-17'	Sample not recovered.	19	-	-	-	-	-	
	S5	20'-21.5'	Medium grey sandy silt.	24	-	-	-	-	-	
	S6	25'-26.5'	Medium grey fine to very fine sand.	21	-	-	-	-	-	
	S7	30'-31.5'	Medium grey clay sand.	11	-	-	-	-	-	
	S8	35'-36.5'	Medium grey fine to very fine sand.	11	-	-	-	-	-	
			S-1 - Denotes Split Spoon Sample.							
			T-1 - Denotes Thin-Walled Shelby Sample.							
			R-1 - Denotes Rock Core Sample.							

**DEPARTMENT OF HIGHWAYS - ONTARIO**  
**MATERIALS AND RESEARCH SECTION**

W.P. 36-59 BORE HOLE NO. 1.  
JOB F-59-24 STATION 7+77 (58' Rt.)  
DATUM Elev. 375.7 COMPILED BY B.K.  
BORING DATE April 3/59 CHECKED BY B.J.M.

2" DIA. SPLIT TUBE -----  
2" SHELBY TUBE -----  
2" SPLIT TUBE -----  
2" DIA. CONE -----  
2" SHELBY -----  
CASING -----

**LEGEND**

1/2 UNCONFINED COMPRESSION (Qu) ----- O  
VANE TEST (C) AND SENSITIVITY (S) ----- +  
NATURAL MOISTURE AND LIQUIDITY INDEX ----- LI  
LIQUID LIMIT ----- X  
PLASTIC LIMIT -----

SYMBOL	DESCRIPTION	ELEV. FEET	DEPTH FEET	STRENGTH AND PENETRATION RESISTANCE			
				2000	4000	6000	8000
	Ground Level.	375.7		50	100	150	200
	Stiff to very stiff grey-brown silty clay.	359.2	10				
	Medium to dense grey-brown silty sand to fine sand.	337.7	20				
	Dense grey-brown gravel-sand.	320.3	30				
	Very hard grey angular limestone bedrock	315.3	40				
	AX core: 55'-5" to 60'-5"	60'-5"	50				
	100% recovery.	End of B.H.	60				
	Average crushing strength:		70				
	23,000 p.s.i.		80				

CONSISTENCY		SAMPLE	NATURAL UNIT WT. P.C.F.
MOIST. CONTENT- % DRY WT.			
20	40	60	
			TW1 121.0
			TW2 123.0
			TW3 -
			TW4 114.5
			TW5 128.3
			TW6 131.0
			TW7 127.0
			SS8 -
			SS9 -
			SS10 -
			SS11 -
			RC -

Borehole No. 1

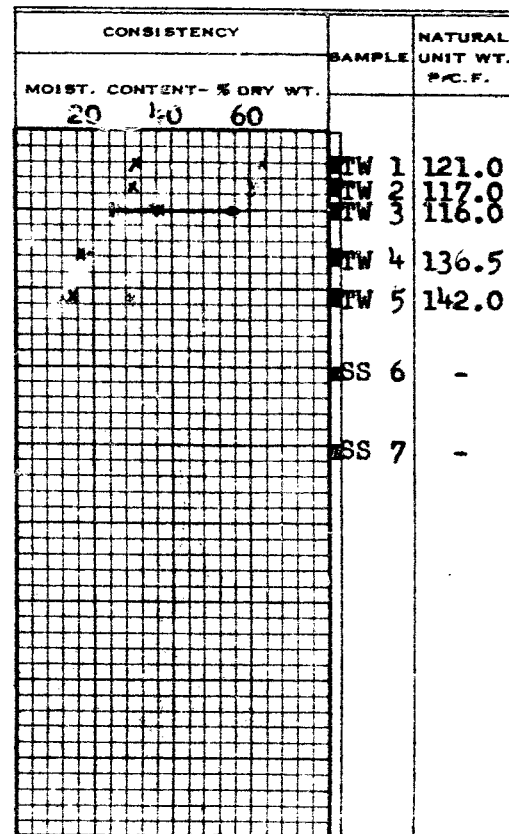
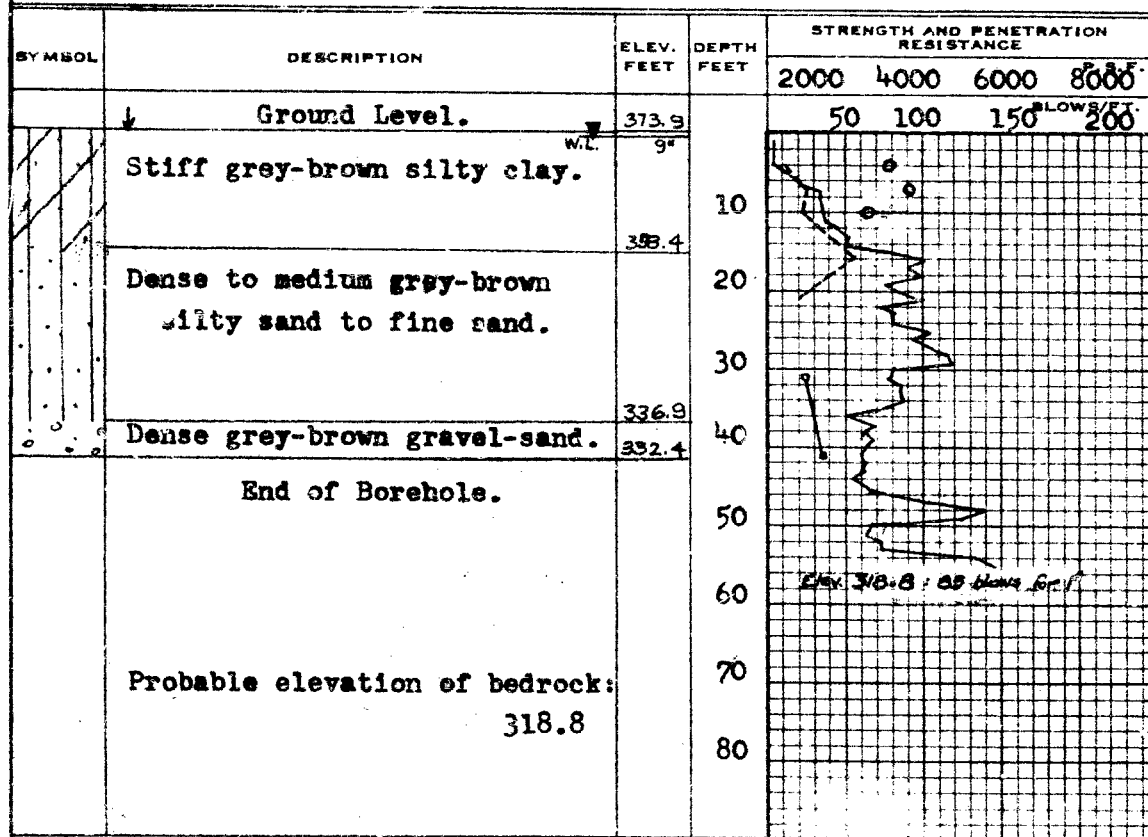
**DEPARTMENT OF HIGHWAYS - ONTARIO**  
**MATERIALS AND RESEARCH SECTION**

W.P. 36-59 BORE HOLE NO. 2.  
 JOB F-59-24 STATION 7+7+36 (60' Rt.)  
 DATUM Elev. 373.9 COMPILED BY B.K.  
 BORING DATE Apr. 7/59 CHECKED BY B.J.M.

2" DIA. SPLIT TUBE \_\_\_\_\_  
 2" SHELBY TUBE \_\_\_\_\_  
 2" SPLIT TUBE \_\_\_\_\_  
 2" DIA. CONE \_\_\_\_\_  
 2" SHELBY \_\_\_\_\_  
 CASING \_\_\_\_\_

**LEGEND**

1/2 UNCONFINED COMPRESSION (Qu) \_\_\_\_\_ O  
 VANE TEST (C) AND SENSITIVITY (S) \_\_\_\_\_ +  
 NATURAL MOISTURE AND LIQUIDITY INDEX \_\_\_\_\_ LI  
 LIQUID LIMIT \_\_\_\_\_ X  
 PLASTIC LIMIT \_\_\_\_\_



Borehole No. 2.



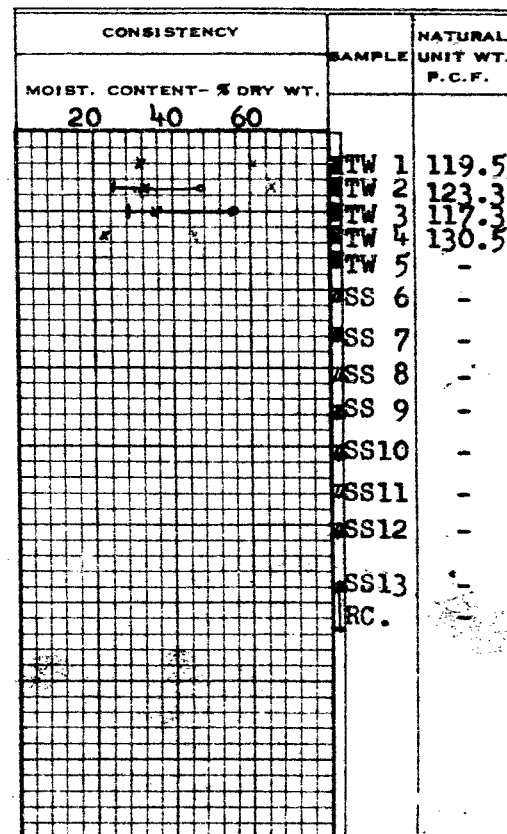
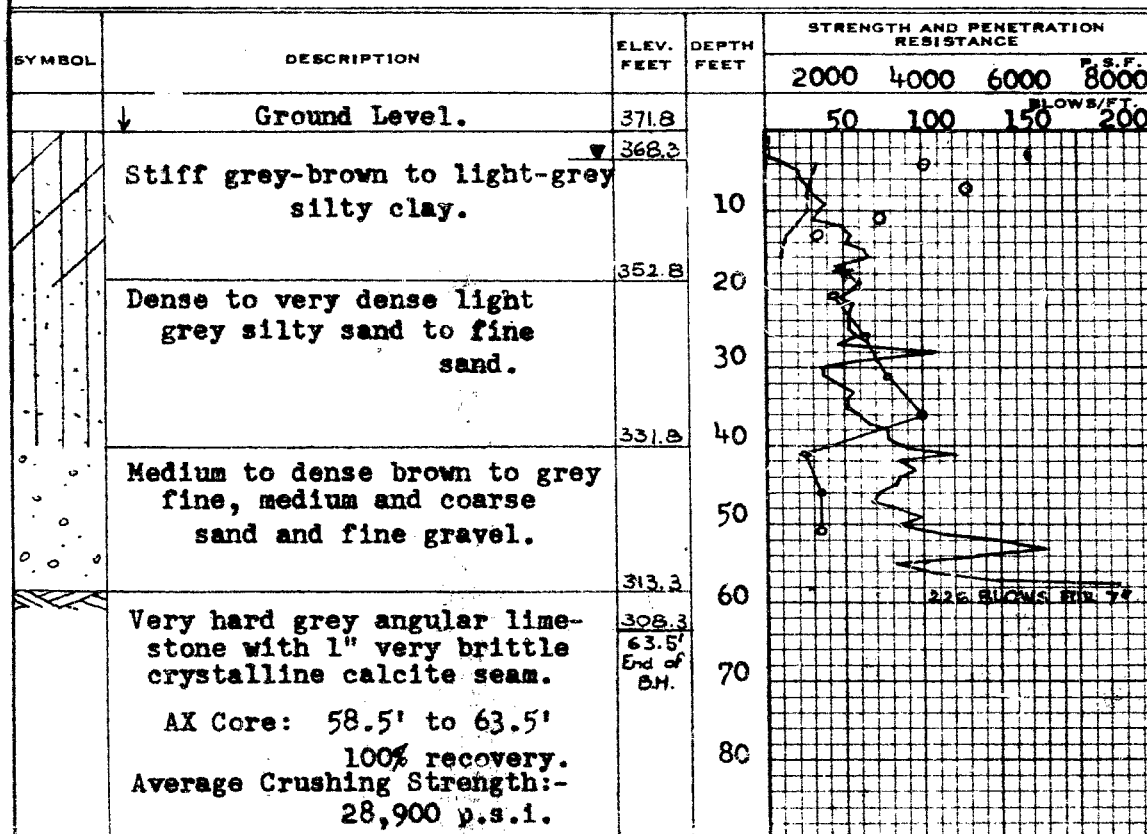
# DEPARTMENT OF HIGHWAYS - ONTARIO MATERIALS AND RESEARCH SECTION

W.P. 36-59. BORE HOLE NO. 3.  
JOB F-59-24. STATION 746+79(58' Lt.)  
DATUM Elev. 371.8 COMPILED BY B.K.  
BORING DATE Apr. 6/59 CHECKED BY B.J.M.

2" DIA. SPLIT TUBE  
2" SHELBY TUBE  
2" SPLIT TUBE  
2" DIA. CONE  
2" SHELBY  
CASING

## LEGEND

1/2 UNCONFINED COMPRESSION ( $Q_u$ ) — O  
VANE TEST (C) AND SENSITIVITY (S) — +  
NATURAL MOISTURE AND LIQUIDITY INDEX — LI  
LIQUID LIMIT — X  
PLASTIC LIMIT — I



Borehole No. 3.

## MATERIALS AND RESEARCH SECTION

BORE HOLE NO. 4.  
STATION 747+18 (57' Lt.)

COMPILED BY B.K.  
CHECKED BY B.J.M.

2" DIA. SPLIT TUBE -----  
2" SHELBY TUBE -----  
2" SPLIT TUBE -----  
2" DIA. CONE -----  
2" SHELBY -----  
CASING -----

## LEGEND

1/2 UNCONFINED COMPRESSION (Qu) --- O  
VANE TEST (C) AND SENSITIVITY (S) --- +  
NATURAL MOISTURE AND LIQUIDITY INDEX --- LI  
LIQUID LIMIT --- X  
PLASTIC LIMIT ---

SYMBOL	DESCRIPTION	ELEV. FEET	DEPTH FEET	STRENGTH AND PENETRATION RESISTANCE			
				2000	4000	6000	8000 P.S.F. BLOWS/FT.
	Ground Level.	374.9		50	100	150	200
	Black Muck.	1.8' 2.5'					
	Medium to stiff grey-brown silty clay.	359.9 15.0'	10 20 30				
	Medium grey sandy silt, fine to very fine sand and clay sand.	338.4' 36.5'	40 50 60 70 80				
	End of Borehole.						
	Probable elevation of bedrock: 316.8.						

CONSISTENCY		SAMPLE	NATURAL UNIT WT. P.C.F.
MOIST. CONTENT - % DRY WT.			
20	40	60	
			TW 1 116.8
			TW 2 114.0
			TW 3 121.5
			TW 4 -
			SS 5 -
			SS 6 -
			SS 7 -
			SS 8 -

Borehole No. 4.