

A. M. Toye

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

November 7, 1960.
D.H.O. FOUNDATION REPORT
W.J. 60-F-75 -- WP254-60-2

Attention: Mr. S. McCombie.

Re: St. David's Interchange & Hwy. #8,
District #4.

This memo accompanies our detailed foundation report on the subsoil conditions existing at the above site.

The conclusions and recommendations to be followed in your future design work, are summarized in the report, and are self-explanatory.

If we can be of further assistance in connection with this project, do not hesitate to contact our Office.

L. G. Soderman,
PRINCIPAL FOUNDATIONS ENGR.

Per:

AS/MdeF
Attach.

cc: Messrs. A. M. Toye (2) ✓
H. A. Tregaskes
D. G. Ramsay
I. C. Campbell
R. E. Richardson
T. J. Kovich
A. Watt
Foundations Office
Gen. Files

A. Stermac
(A. Stermac,
FOUNDATIONS OFFICE ENGR.)

FOUNDATION INVESTIGATION

For

St. David's Interchange & Hwy. #8,
W.J.60-F-75, District 4, WP254-60-2

1. INTRODUCTION:

It is proposed to build an underpass structure to carry the new St. David's Road over the relocated Hwy. #8. The location of this site is about two miles West of the town of St. David's.

A soil investigation was carried out in order to determine the subsoil stratification, the soil properties and recommend the type of foundations at the site of the new proposed structure. The results of this investigation together with the discussion and recommendations are given in the following paragraphs of this report.

2. Description of site and geology:

The site is located in the physiographic area referred to as "Niagara Escarpment". The topography of the terrain is mostly flat to undulating farmland and orchards.

It is believed that this area was covered by the late Iroquois Lake. The lake waters have leveled the undulating till terrain by eroding and by depositing clay.

The bedrock in this area is mainly Queenston Shale.

3. Field and Laboratory work:

The field investigations were carried out by means of a skid-mounted core-drill machine adapted for soil sampling.

The investigations consisted of four boreholes. The boreholes were made by the conventional wash boring method.

Cont'd /2...

3. Field and Laboratory work: (Cont'd) ...

In cohesive soils, samples were extracted by means of a 2" I.D. thin-walled Shelby tube sampler. Also, supplementary shear measurements were obtained by means of in-situ vane tests. In non-cohesive soils, sampling was done by means of a 2" O.D. split-barrelled spoon sampler. The dimensions of the spoon sampler and the energy used in driving it conform to the requirements of the Standard Penetration Test. A dynamic cone resistance profile was established by driving a 2" diameter cone from the existing ground surface to refusal depth.

The split-spoon samples were visually examined and identified in the field. The Shelby samples were carefully scaled and taken to the laboratory where routine tests for index properties were carried out on selected representative samples.

Laboratory and field test results have been summarized in Table No. 1 and the locations of the boreholes are shown on drawing No. 60-F-75A, under Appendix I.

4. SUBSOIL CONDITIONS:

1. General

The investigations at the site revealed the following subsoil stratification:

The top layer is a hard brown grey clay of intermediate plasticity which, with depth, changes to medium to stiff grey clay. Under this material lies the very dense glacial silty sandy clay till. Underlying the till is the bedrock which is red Queenston Shale.

2. Hard Brown grey clay:

The top 20 ft. material forms the crust of the clay stratum.

Cont'd /3...

4. SUBSOIL CONDITIONS: (Cont'd) ...

2. Hard Brown grey clay:

The material in this section is oxidized and desiccated, apparently from exposure, and is brown in colour. Some grey seams or lenses were also encountered. The textural analysis performed in the laboratory, show that about 95% of the material passes Tyler sieve No. 200 and of this, about 60% is smaller than 0.002 mm. The Atterberg limits are 43% liquid limit, 21% plastic limit. The average material moisture content is 23%. The measured unit weight " γ " is about 125 p.c.f. The samples could only be extracted by means of the split spoon sampler. Accordingly, no direct shear measurements could be made. However, judging from the Standard penetration resistance blows (27-56 blows per foot) it can be assumed that the material is in a very stiff to hard state.

3. Medium - Stiff grey clay:

Under the top brown crust is the grey clay material. The laboratory test results indicate that the textural composition and other index properties of this material are identical with the brown material on the top. The material in this section of the layer has not been exposed and therefore kept its initial grey colour and also has retained a higher moisture content (30-36%).

Undisturbed Shelby samples were extracted and laboratory shear strength measurements (1000 - 1800 p.s.f.) made. These results show that the material in this layer is of a medium to stiff consistency.

4. Dense brown grey silty sandy clay till:

The horizon of glacial till material was intersected under the

grey clay layer. This layer extends from elevation 322 ft. down to elevation 293 ft. The layer is made up of silty, sandy, clay till with pebbles and grits. At intervals seams of sand or silty sand were also encountered. The density of the layer was measured by Standard Penetration tests while sampling. The results of these tests (about 100 blows or more per foot) indicate that the layer is in a very dense state. The measured moisture content in the layer is not more than 10%.

5. Shale Bedrock:

The above discussed overburden material is underlain by shale bedrock. The bedrock was drilled by means of AXT diamond bit. Core samples indicate that the bedrock is solid red Queenston Shale.

5. GROUND WATER CONDITION:

During the explorations it was not possible to detect a defined ground water level. Calculations based on laboratory measurements of unit density and moisture content percentage, indicate that the silty clay layer is fully saturated.

6. DISCUSSION AND RECOMMENDATIONS:

The presence of sound bedrock overlain by a very dense till stratum at approximately 60 feet below groundlevel indicates that the use of point bearing piles is possible. Steel H piles driven to practical refusal could certainly take a safe load of 60 or more tons per pile.

Because of economy reasons, spread footings for the structure are considered. Taking an average value of shear strength of the upper clay layer as 1.2 T.S.F., a footing width of 8 ft., and a foundation

6. DISCUSSION AND RECOMMENDATIONS: (Cont'd)...

depth of 6 feet, a safe (F.S. = 3) net bearing capacity of 2.6 T.S.F. is obtained. Because of the presence of a softer layer at greater depth 2.0 T.S.F. are recommended.

It is estimated that settlements of the order of 1.0 inch would result under such spread footings.

The greatest height of the approach embankment is 16 feet and no stability problems are foreseen. However, due to the embankment load, settlements of the order of 2 inches are expected. This estimate is based on the results of the observation of the settlements of the approach embankments of the Homer bridge which is close to the investigated site and where the ground conditions are similar.

In order to reduce or even eliminate the influence of the embankment settlements on the structure, it is recommended to build the approach embankments ahead of the structure. Again, based on the Homer bridge approach embankment observations, it is estimated that a few months (2-3) would be sufficient for this.

7. SUMMARY:

The proposed structure is at Hwy. 8 and St. David's road intersection.

The subsoil stratigraphy at this site is made up of a top clay layer which extends from ground elevation (386 ft.) down to elevation 322 ft. The upper 20 ft. of this layer is brown desiccated hard material and forms the crust. The lower 40 ft. is grey material in a medium to stiff state of consistency. Below this material is a layer of very dense, pebbly, sandy-clay till which extends down to approx. elevation 293. ft.

Cont'd /6...

7. SUMMARY: (Cont'd)...

Underlying this till layer, is bedrock which was proven to be red Queenston shale.

Spread footings placed 5-6 feet below groundlevel, approx. 8 feet wide, are recommended. A safe net load of 2.0 T.S.F. can be used for design purposes. Settlements in the order of 1 inch are to be expected under this load.

No stability problems are foreseen for the approach embankments. About 2 inches of settlement are expected under the embankment. To eliminate the influence of the embankment on the structure, it is recommended to build the embankments ahead of the structure. It is believed that already a 2-3 month long interval would suffice.

No water problems are foreseen for this site.

8. MISCELLANEOUS:

The field work was carried out during Aug. 15 to Aug. 31, 1960, under the supervision of Project Foundation Engineer V. Korlu. All the laboratory testing was done by the Materials and Research Section.

Report Prepared by:

V. Korlu
V. Korlu
Project Foundation Engineer

November 1960.

Report Approved by:

A. Stermac
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A. Stermac
Foundation Office Engineer

APPENDIX I

SUMMARY OF FIELD & LABORATORY TESTS

JOB 60-F-75

W.P. 254-60-2

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	S1	5'-6.5'	Hard brown grey silty clay	51	17.5	-	-	-	-	
	S2	10'-11.5'	" " " "	29	19.4	-	-	-	-	
	S3	15'-16.5'	" " " "	17	28.6	23.0	48.5	-	-	
	S4	20'-21.5'	Med. to stiff grey silty clay	15	28.0	-	-	-	-	
	S5	25'-26.5'	" " " "	14	28.7	-	-	-	-	
	VANE	28'		-	-	-	-	>2000	-	
	T6	30'-31.5'	" " " "	P	33.1	19.3	45.6	1735	121.0	
	VANE	36.5'		-	-	-	-	>2000	-	
	T7	40'-41.5'	" " " "	P	37.6	22.9	47.3	1280	118.0	
	VANE	46.5'		-	-	-	-	1440	-	Sens: 3.3
	T8	50'-51.5'	" " " "	P	38.2	23.1	52.0	1060	118.0	
	VANE	56.5'		-	-	-	-	1280	-	Sens: 4.0
	S9	64'-65'	Dense brown grey silty sandy clay till	80	9.3	-	-	-	-	
	S10	75'-76.5'	" " " "	50-7"	12.9	-	-	-	-	
2	S11	85'-86.5'	" " " "	78	-	-	-	-	-	
	RC12	91.5'-96.5'	Queenston shale	-	-	-	-	-	-	
	S1	3'-4.5'	Hard brown grey silty clay	36	18.3	-	-	-	-	
	S2	6'-7.5'	" " " "	56	21.3	21.2	47.2	-	126.0	

SUMMARY OF FIELD & LABORATORY TESTS

JOB 60-F-75

W.P. 254-60-2

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
2	S3	10'-11.5'	Hard brown grey silty clay	28	20.2	-	-	-	115.0	
	S4	15'-16.5'	" " " "	16	28.0	-	-	-	-	
	S5	20'-21.5'	Med. to stiff grey silty clay	20	27.6	-	-	-	-	
	S6	25'-26.5'	" " " "	17	28.7	-	-	-	-	
	S7	30'-31.5'	" " " "	14	34.1	-	-	-	-	
	T8	35'-36.5'	" " " "	P	31.0	22.1	44.7	1575	119.5	
	VANE	41.5'		-	-	-	-	1600	-	Sens: 4.0
	T9	45'-46.5'	" " " "	P	35.0	22.5	45.5	1155	119.0	
	VANE	51.5'		-	-	-	-	1440	-	Sens: 4.0
	T10	55'-56.5'	" " " "	P	32.2	21.0	31.6	1280	118.5	
	S11	64.5'-65.5'	Dense brown grey silty sandy clay till	80	37.8	-	-	-	-	
3	S1	3'-4.5'	Hard brown grey silty clay	35	21.2	-	-	-	120.0	
	S2	6'-7.5'	" " " "	56	21.5	21.9	43.8	-	124.0	
	S3	10'-11.5'	" " " "	27	27.6	-	-	-	-	
	S4	15'-16.5'	" " " "	15	30.0	-	-	-	-	
	S5	20'-21.5'	Med. to stiff grey silty clay	9	30.2	-	-	-	-	
	T6	25'-26.5'	" " " "	P	29.6	22.6	46.2	1870	120.0	
	VANE	31.5'		-	-	-	-	1840	-	Sens: 2.6

SUMMARY OF FIELD & LABORATORY TESTS

JOB 60-F-75

W.P. 254-60-2

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
3	T7	35'-36.5'	Med. to stiff grey silty clay	P	31.8	21.2	43.6	910	118.5	
	VANE	41.5'		-	-	-	-	1680	-	Sens: 3.5
	T8	45'-46.5'	" " " "	P	35.9	21.4	44.1	-	-	
	VANE	51.5'		-	-	-	-	1680	-	Sens: 3.3
	T9	55'-56.5'	" " " "	P	32.1	21.2	43.4	880	120.0	
	S10	63.5'-64.5'	Dense brown grey silty sandy clay till	65-7"	9.2	-	-	-	-	
4	S1	3'-4.5'	Hard brown grey silty clay	37	20.2	-	-	-	119.0	
	S2	6'-7.5'	" " " "	44	21.2	-	-	-	118.0	
	S3	10'-11.5'	" " " "	37	20.6	-	-	-	121.0	
	S4	15'-16.5'	" " " "	27	21.4	17.7	33.1	-	-	
	S5	20'-21.5'	" " " "	29	22.6	-	-	-	125.0	
	S6	25'-26.5'	Med. to stiff grey silty clay	12	28.8	-	-	-	-	
	T7	35'-36.5'	" " " "	P	30.8	20.4	44.4	1570	119	
	VANE	41.5'		-	-	-	-	1920	-	Sens: 4.0
	T8	45'-46.5'	" " " "	P	34.0	22.0	45.2	1290	116	
	VANE	51.5'		-	-	-	-	1680	-	Sens: 3.5
	T9	55'-56.5'	" " " "	P	31.4	20.4	39.3	750	121	
	S10	65'-66.5'	Dense brown grey silty sandy clay	71-7"	9.5	-	-	-	-	

JOB 60-F-75
W.P. 254-60-2

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	S11	75'-76.5'	Dense brown grey silty sandy clay till	88-7"	14.5	-	-	-	-	
	S12	85'-85.5'	" " " "	82-7"	-	-	-	-	-	
			S denotes split spoon							
			T " shelby tube							

DEPARTMENT OF HIGHWAYS - ONTARIO

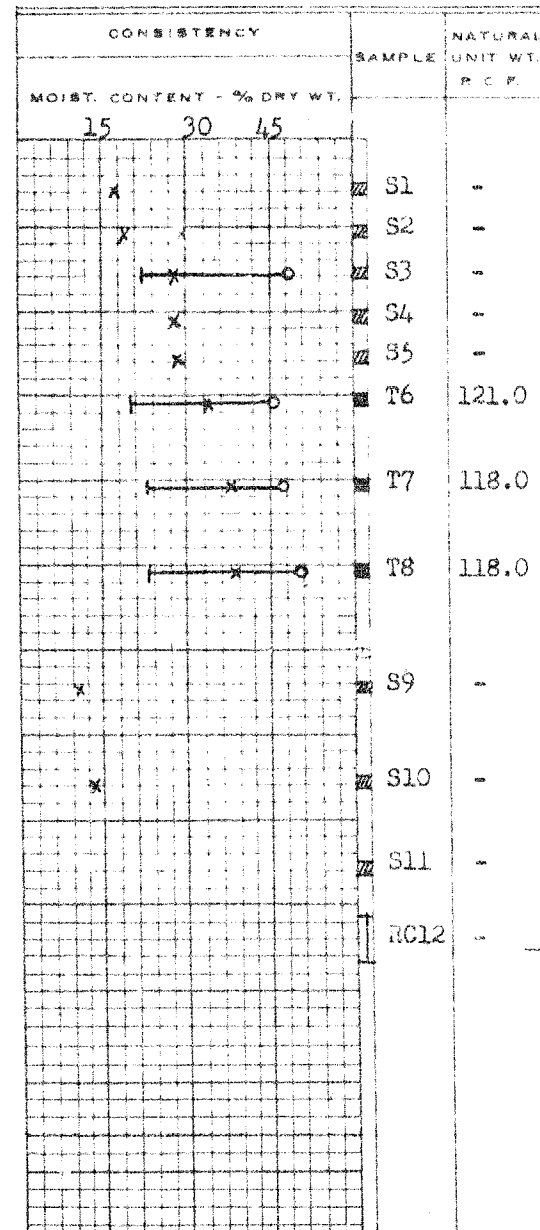
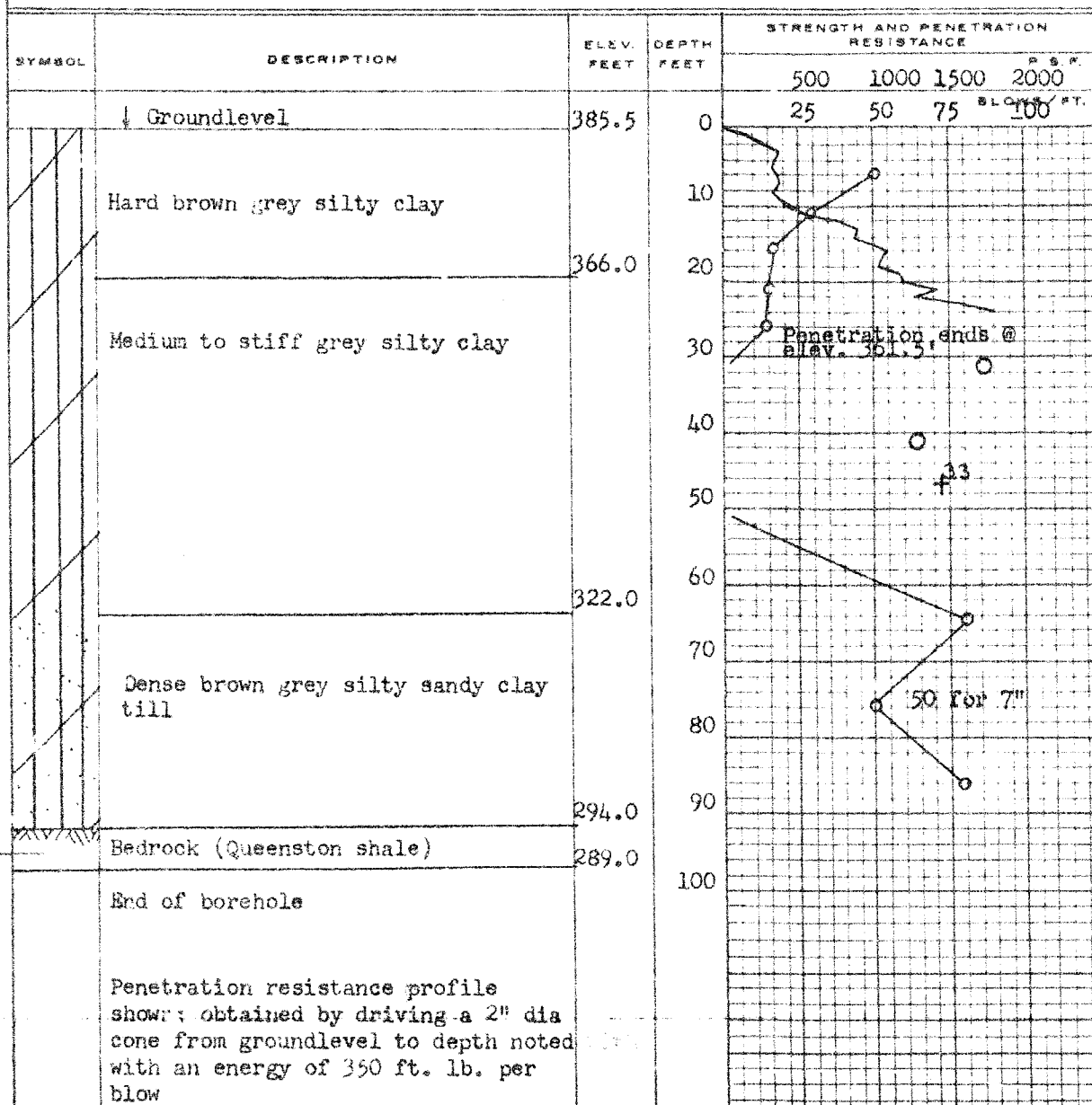
MATERIALS AND RESEARCH SECTION

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 JOB 60-F-75 STATION 86+30 (70' Lt.)
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 BORING DATE Aug. 31/60 CHECKED BY V.K.

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) +^S
 NATURAL MOISTURE AND LIQUIDITY INDEX LI
 LIQUID LIMIT X
 PLASTIC LIMIT ---



OFFICE REPORT ON SOIL EXPLORATION

DEPARTMENT OF HIGHWAYS - ONTARIO

MATERIALS AND RESEARCH SECTION

W.P. 254-60-2 BORE HOLE NO. 2

JOB 60-F-75 STATION 86+60 (70ft. Lt.)

DATUM 386.0' COMPILED BY B.K.

BORING DATE Sept. 8/60 CHECKED BY V.K.

2" DIA. SPLIT TUBE _____

2" SHELBY TUBE _____

2" SPLIT TUBE _____

2" DIA. CONE _____

2" SHELBY _____

CASING _____

LEGEND

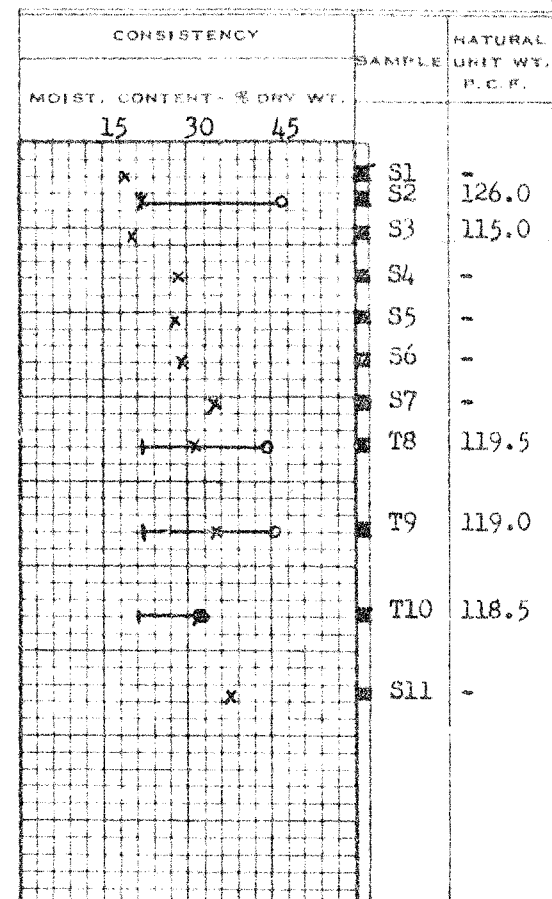
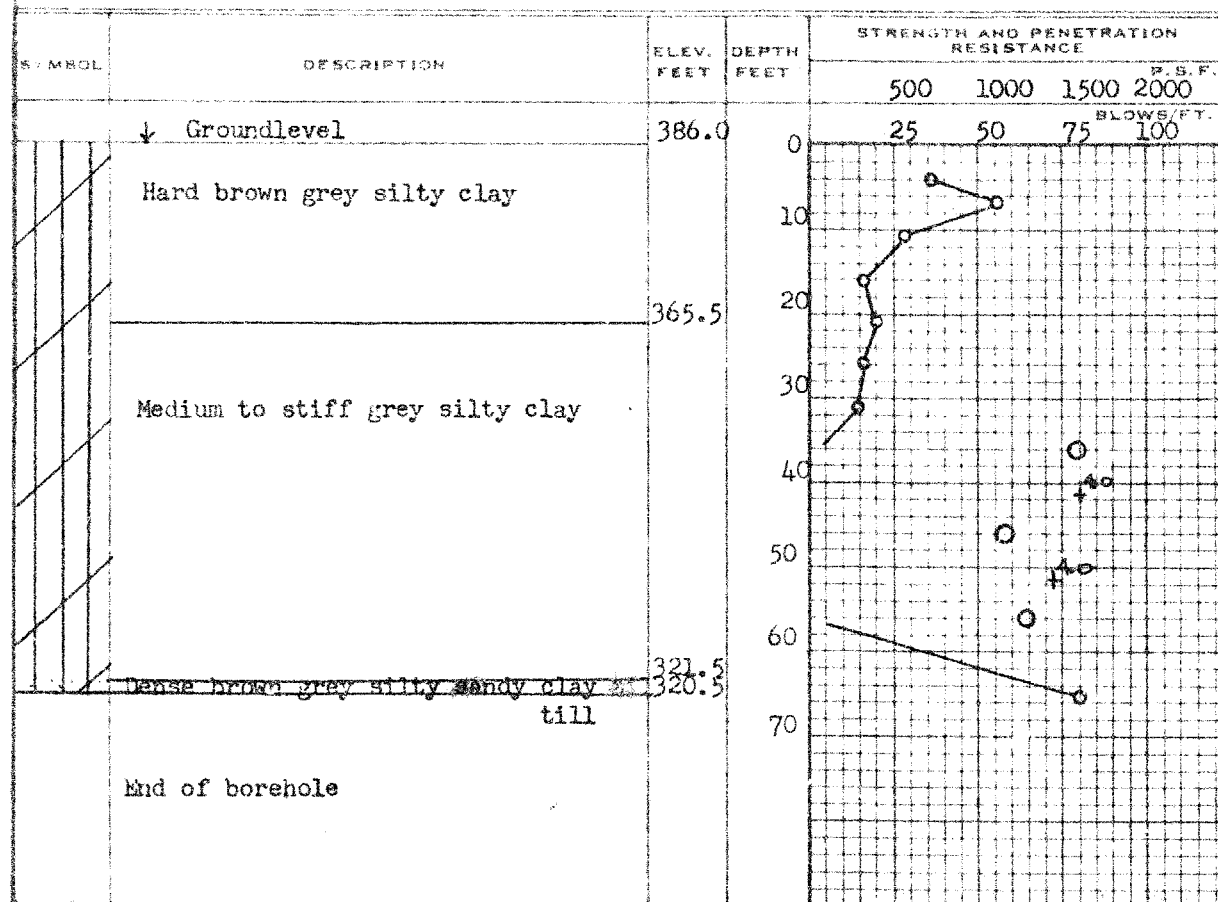
1/2 UNCONFINED COMPRESSION (Q_u) _____ ○

VANE TEST (C) AND SENSITIVITY (S) _____ +

NATURAL MOISTURE AND LIQUIDITY INDEX _____ X

LIQUID LIMIT _____

PLASTIC LIMIT _____



DEPARTMENT OF HIGHWAYS - ONTARIO MATERIALS AND RESEARCH SECTION

W.P. 254-60-2

BORE HOLE NO. 3

JOB 60-F-75

STATION 86+30 (70' ft. R.L.)

DATUM 386.0'

COMPILED BY B.K.

BORING DATE Sept. 9/60

CHECKED BY V.K.

2" DIA. SPLIT TUBE

2" SHELBY TUBE

2" SPLIT TUBE

2" DIA. CONE

2" SHELBY

CASING

LEGEND

1/2 UNCONFINED COMPRESSION (Q_u)

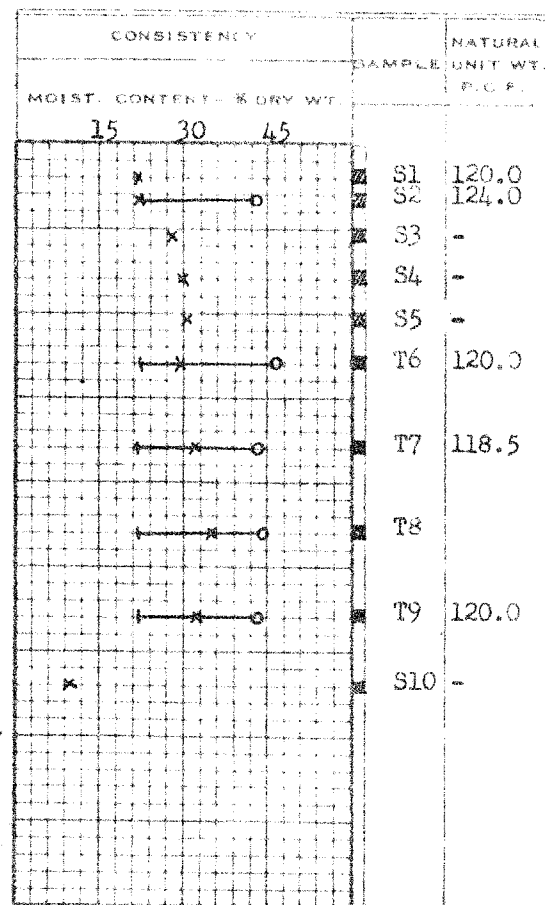
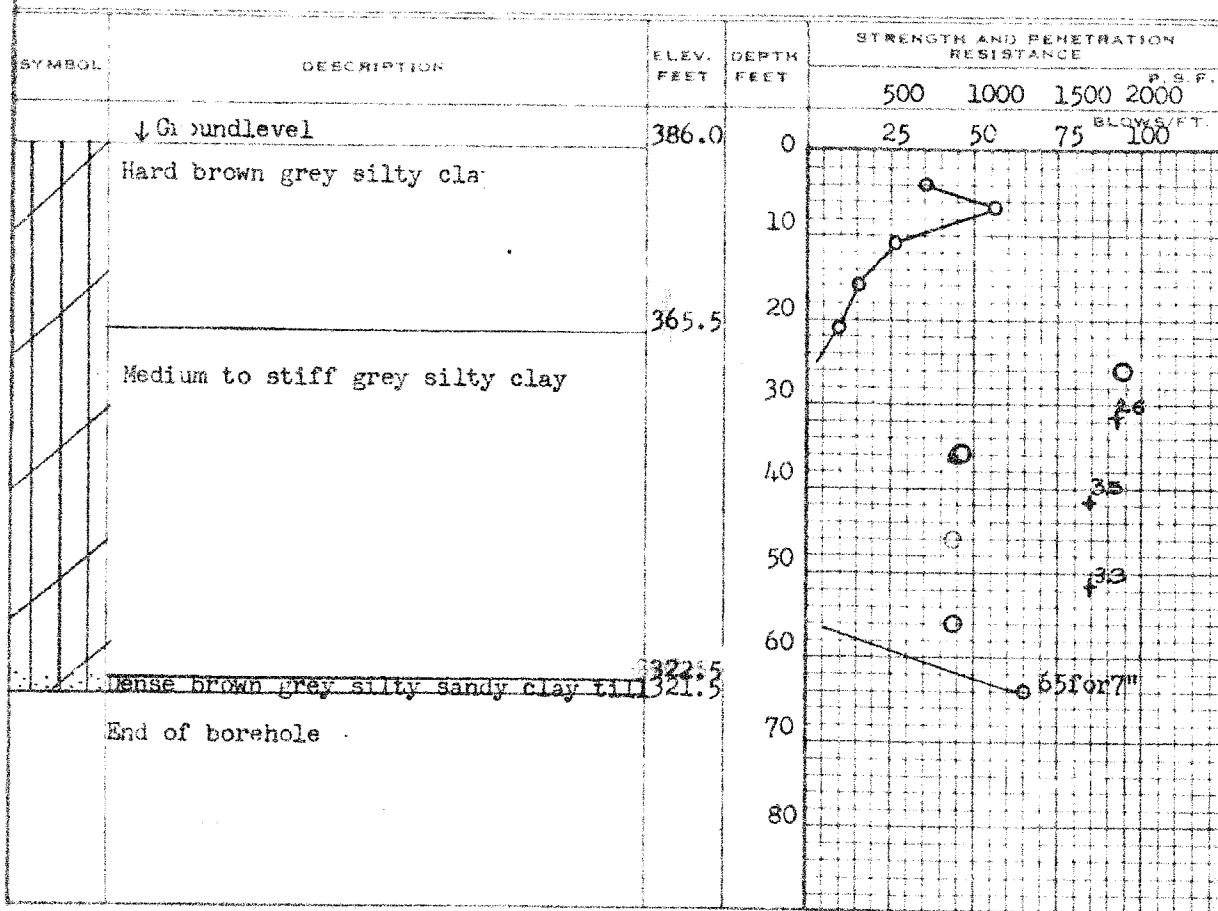
VANE TEST (C) AND SENSITIVITY (S)

NATURAL MOISTURE AND

LIQUIDITY INDEX

LIQUID LIMIT

PLASTIC LIMIT



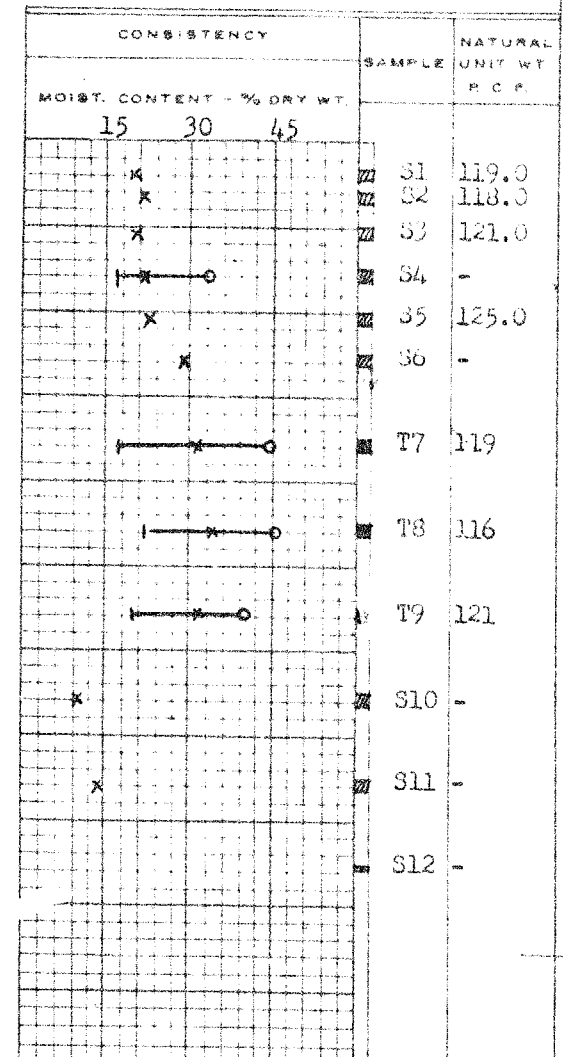
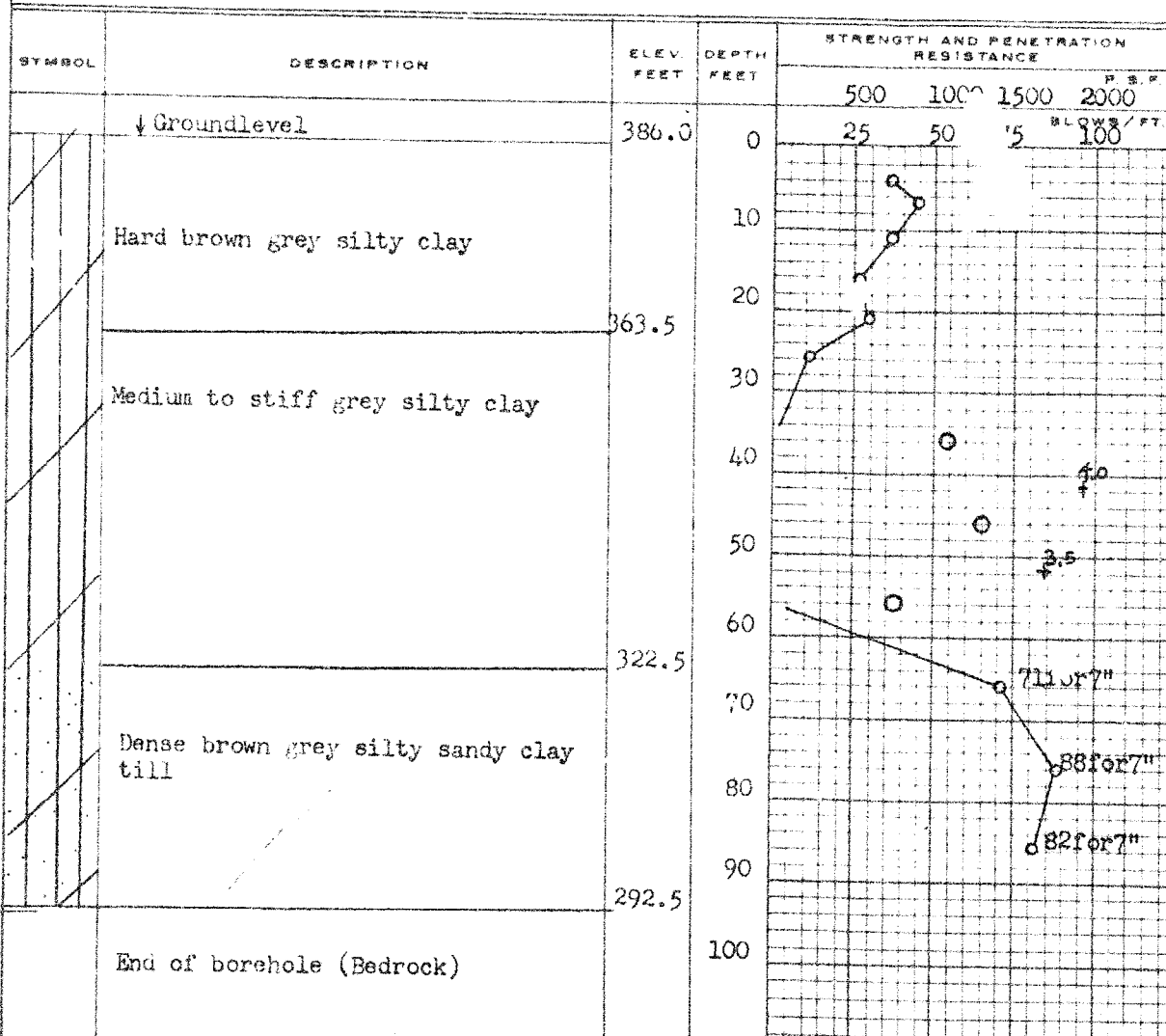
DEPARTMENT OF HIGHWAYS - ONTARIO

MATERIALS AND RESEARCH SECTION

W.P. 254-60-2 BORE HOLE NO. 4
 JOB 60-F-75 STATION 86+60 (70' Rt.)
 DATUM 386.0' COMPILED BY B.K.
 BORING DATE Sept. 13/60 CHECKED BY V.K.

LEGEND

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



#60-F-75

W.P.#254-60-2

Hwy. #8 :

ST. DAVIDS RD.

INTERCHANGE

