

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

September 22, 1960.
D.H.C. FOUNDATION INVESTIGATION
W.J. 60-F-62 -- W.P. 110-60.

Attention: Mr. E. McCombie.

Re: Queen Elizabeth Way and County Road No. 22
(Approx. 7 Miles West of St. Catharines),
Twp. of Louth, County of Lincoln, Ont. 4.

Accompanying this memo, is our detailed report on
the subsoil conditions existing at the above site.

Summarized in this report, are our conclusions and
recommendations which we believe, should prove adequate for
your future design work.

If we can be of further assistance in connection
with this project, please contact our Office.

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

A. Sternac

(A. Sternac,
FOUNDATIONS OFFICE ENGR.)

AS/MSAF
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.

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FOUNDATION INVESTIGATION

At

Queen Elizabeth Way and County Road No. 22,
(Approx. 7 Miles West of St. Catharines),
Twp. of Louth, County of Lincoln, Dist. 4.
W.J. 60-F-62 -- W.P. 110-60.

1. INTRODUCTION:

It is intended to construct an underpass which would carry County Road No. 22 over the Queen Elizabeth Way. The site of the proposed Underpass is located approx. 7 miles West of the Town of St. Catharines, Twp. of Louth, County of Lincoln. At this location the chainage of the Queen Elizabeth Way is 2+17.00 and of the County Road No. 22, 21+77.23.

In order to determine the soil properties and decide on the type of foundation, an investigation was carried out by this Section. Results and the discussion of the field and laboratory investigations, as well as conclusions and recommendations for the future design work, are contained in the following paragraphs of this report.

2. DESCRIPTION OF SITE AND GEOLOGY:

The area in which the structure site is located is flat. As can be seen from the enclosed plan, it is located on both sides of the Queen Elizabeth Way.

Physiographically, the site is located in the Iroquois Plain, in the Niagara Fruit Belt. The sand layers are underlain by decomposed and sound Queenston shale. The decomposed shale is reddish clay.

3. FIELD AND LABORATORY WORK:

In order to obtain sufficient information on the types and properties of the subsoil, five sampled boreholes, supplemented by the same number of dynamic cone penetration holes, were carried out at this particular site.

cont'd. 1/2 ...

3. FIELD AND LABORATORY WORK: (cont'd.) ...

Samples were taken at depth intervals of 3 and 5 feet. The hard nature of the soil prevented the taking of relatively undisturbed samples. Samples recovered in the split spoon were used for determining the liquid and plastic limits, moisture contents, and grain-size curves.

Boreholes 1, 2, 3 & 4 were terminated in the underlying very hard disintegrated red shale stratum at a depth of about 31 ft. below existing ground level.

Borehole No. 5 was carried down only to a depth of 16.5 ft. below existing ground level and terminated at the beginning of the stratum of disintegrated red shale.

The elevations as well as the locations (chainages) of the boreholes, are given on Drawing No. 60-F-62A, attached to this report (Appendix I).

Under Appendix I, borehole logs with penetration results, are also given.

Laboratory testing was confined to the determination of liquid limits, plastic limits, moisture contents, and grain size distribution curves.

The plasticity chart and the grain size distribution curves are given under Appendix I.

4. SUBSOIL CONDITIONS:

4.1 General:

The stratigraphy of the soil at the site was found to be quite uniform. Three main types of soil were encountered and they are:-

4.2 Med. Hard Sandy Silty Clay:

This material forms the top layer on the site and extends to about 12 - 14 feet below ground level. The sand percentage in this layer is small and varies between 3 and 9%; the amount of

cont'd. /3 ...

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

4.2 Med. Hard Sandy Silty Clay: (cont'd.) ...

particles smaller than 0.002 mm. is between 30 - 40% in this material the rest is silt.

As can be seen from the enclosed plasticity chart, the clay is of low to medium plasticity. This layer is stiff to very stiff with an average 'N' value of over 20. The hardness of this layer increases with depth.

The liquid limit for this material varies from 32 to 41 and the plastic limit varies from 16 to 18.

The average moisture content in this layer is 20.4.

4.3 Hard Sandy Silty Clay:

Underlying the stiff to very stiff sandy, silty clay layer, is a light grey layer of hard sandy silty clay. It is not easy to determine the exact depth where these two materials meet because they are quite similar.

The sand percentage in this layer is around 23%; the amount of particles smaller than 0.002 mm. is approx. 30%; the rest is silt.

Similarly, as the layer described in 4.2, this layer is also of low plasticity.

This layer is in a hard condition with an average 'N' value of about 44. An increase in hardness with depth is clearly distinguishable.

This layer extends to approx. 19'-0" below ground elevation.

The liquid limit for this material varies from 23 to 32 and the plastic limit from 14 to 18.

The representative value of moisture content in this layer is 12.8.

cont'd. /4 ...

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

4.4 Very Hard Disintegrated Red Shale:

This material was encountered below the hard sandy, silty clay stratum. The average 'N' value for this material is more than 200 blows/foot.

Two soil profiles, one along the East, and one along the West side of the proposed site, have been prepared and are shown on Drawing No. 60-F-62A.

5. GROUND WATER CONDITIONS:

The water table at the time of the investigation, was at about 3'-6" to 4'-8" below ground elevation.

No artesian water conditions were encountered during the investigation.

6. DISCUSSION AND RECOMMENDATIONS:

As can be seen from the previously described soil stratigraphy the soil consists mainly of stiff, very stiff to hard sandy, silty clay. Such a material can provide adequate support for spread footings. Based on the number of blows of the Standard Penetration Test, ('N' \approx 25), an allowable pressure of 3.0 T/sq.ft. can be used for the design. Footings should be placed at a minimum depth of 5 feet below ground level in order to provide for frost protection.

The footings for the framework for the construction can be placed on the exposed sandy, silty clay layer approx. 2'-0" to 2'-6" below ground elevation. Precaution should be taken that the ground on which these temporary footings will be placed is not softened by running or standing water, and that it is sound and does not contain decayed organic matter. The safe load that can be attributed to these footings should not exceed 1 ton/sq.ft.

cont'd. /5 ...

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

No stability problems of the approach fills are anticipated provided the organic surface layer is removed prior to the embankment placement. The embankment should be well compacted and should have 2:1 slopes.

No serious dewatering problems are expected in the footing excavations.

7. SUMMARY:

The stratification of the soil is quite uniform. The upper 12 - 14 ft. thick layer is of med. hard sandy, silty clay and is underlain by a layer of hard sandy silty clay which, in turn, is underlain by a very hard layer of disintegrated red shale.

Because of the stiff to hard character of the upper layer, spread footings are proposed for the structure. The bottom of the footings should not be above Elev. 268.0'. The safe load can be taken as 3 Tons/sq.ft.

To select the most suitable type of structure, is left to the structural engineer's discretion.

Problems due to water seeping into the excavation are not likely to present too much difficulty as the material has a relatively low permeability.

Footings for the falsework can be placed on the exposed sandy, silty clay layer provided it is not softened by water and it is sound material (no organic matter). The safe load should not be in excess of 1 Ton/sq.ft.

No stability problems of the approach embankment fills are anticipated. The top organic layer should be removed prior to the placing of the embankments.

cont'd. /6 ...

8. MISCELLANEOUS:

The field work was carried out during the period of July 8, 1960 to July 14, 1960, by the D.H.C. skid-mounted core drills, adapted for soil sampling, under the supervision of Mr. W. W. Kulmatickas, Project Engineer, Foundation Section.

September 1960.

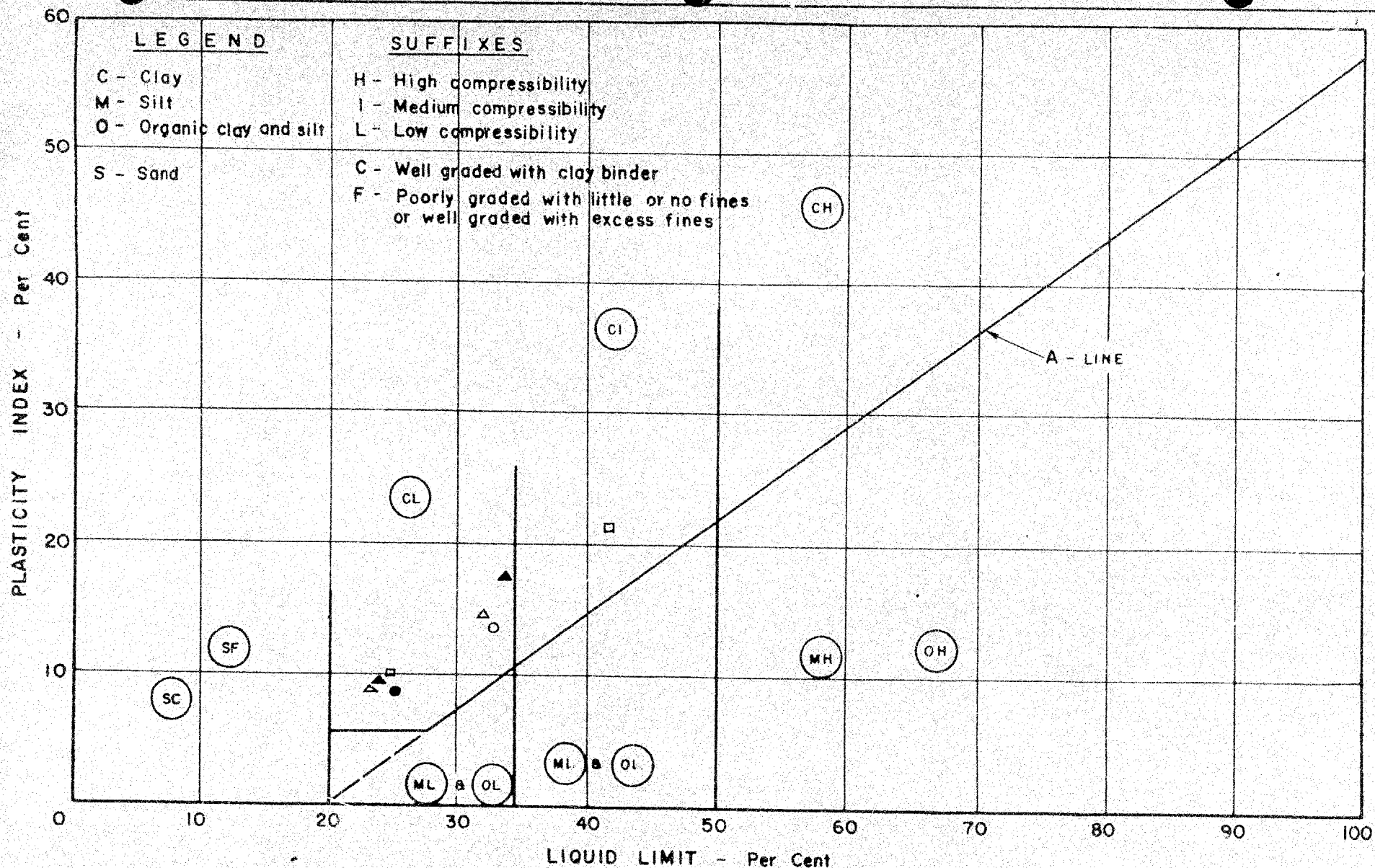
REPORT PREPARED BY:

H. J. Silby
.....
for W. W. Kulmatickas
Project Foundation Engr.

REPORT APPROVED BY:

A. Stermac
.....
A. Stermac,
Foundation Office Engr.

APPENDIX I



NOTES

BH#1 ○

BH#2 ●

BH#3 △

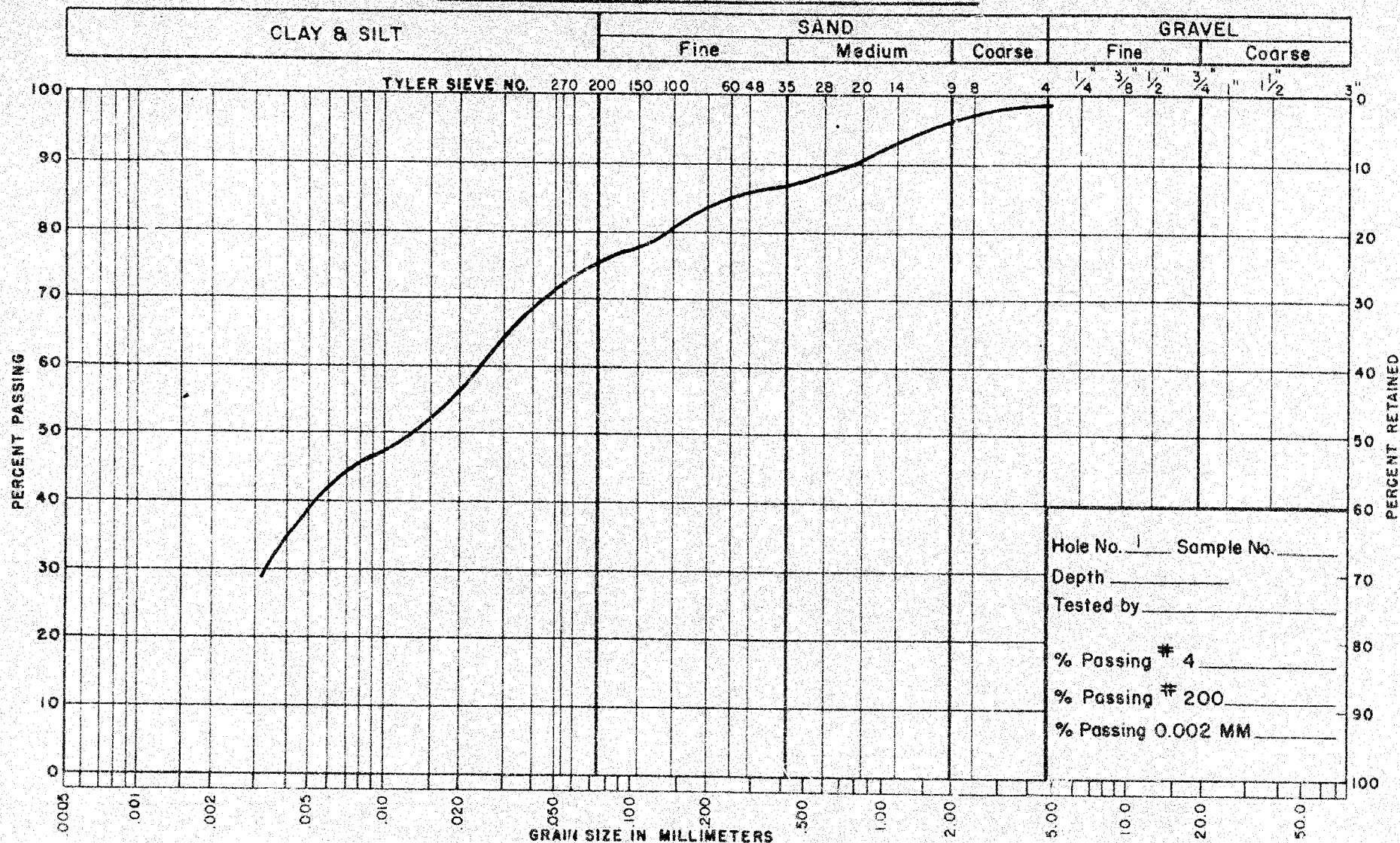
BH#4 ▲

BH#5 □

DEPARTMENT OF HIGHWAYS - ONTARIO
MATERIALS & RESEARCH SECTION
PLASTICITY CHART

Job No. 60-F-62 W.P. No.

UNIFIED SOIL CLASSIFICATION SYSTEM

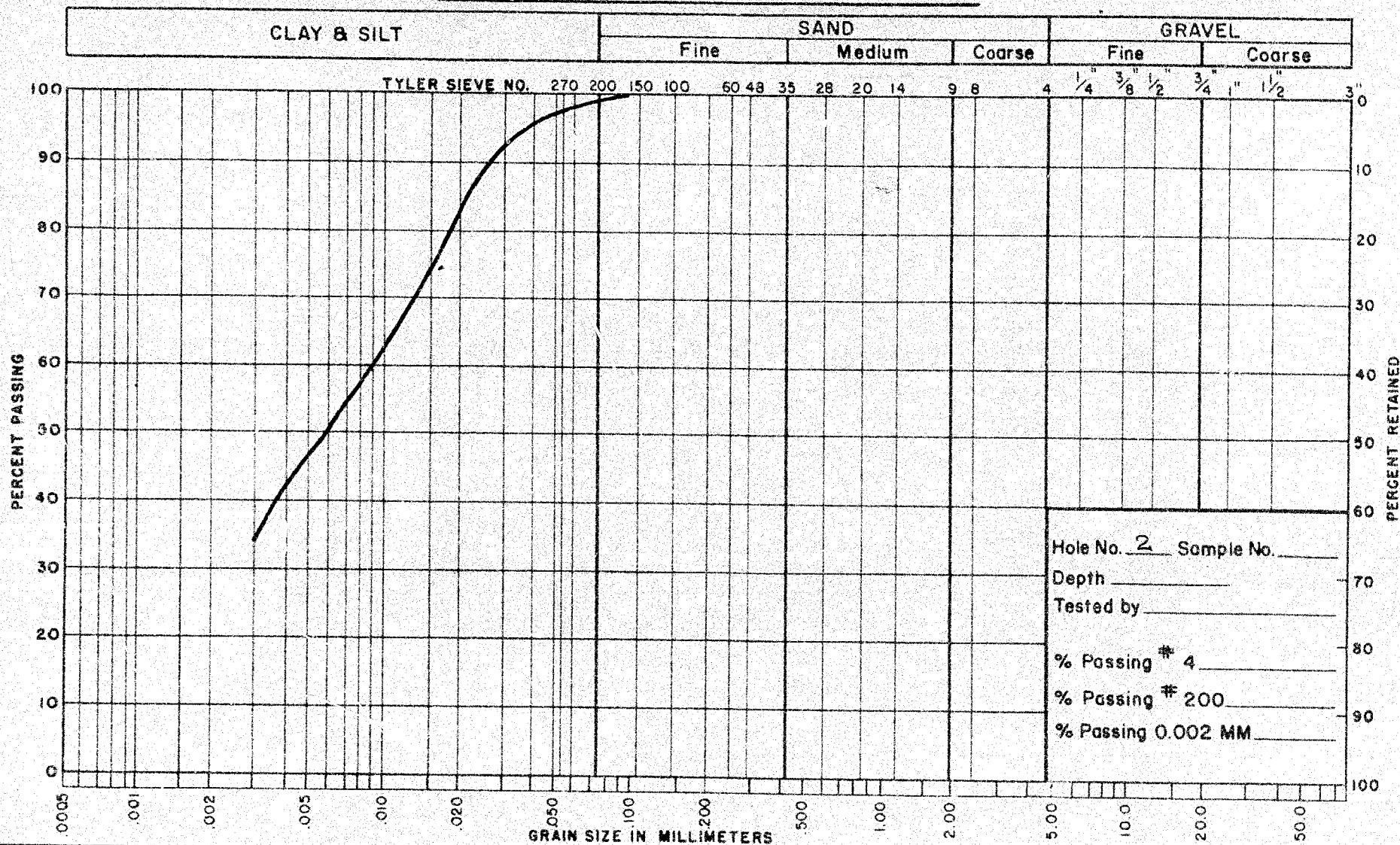


NOTES — AT 15'-0" BELOW GROUND EL.

DEPARTMENT OF HIGHWAYS - ONTARIO
 MATERIALS & RESEARCH SECTION
GRAIN SIZE DISTRIBUTION

Job No. 60-F-62 W.P. No. _____
 Location Q.E.W. & COUNTY RD No. 22

UNIFIED SOIL CLASSIFICATION SYSTEM



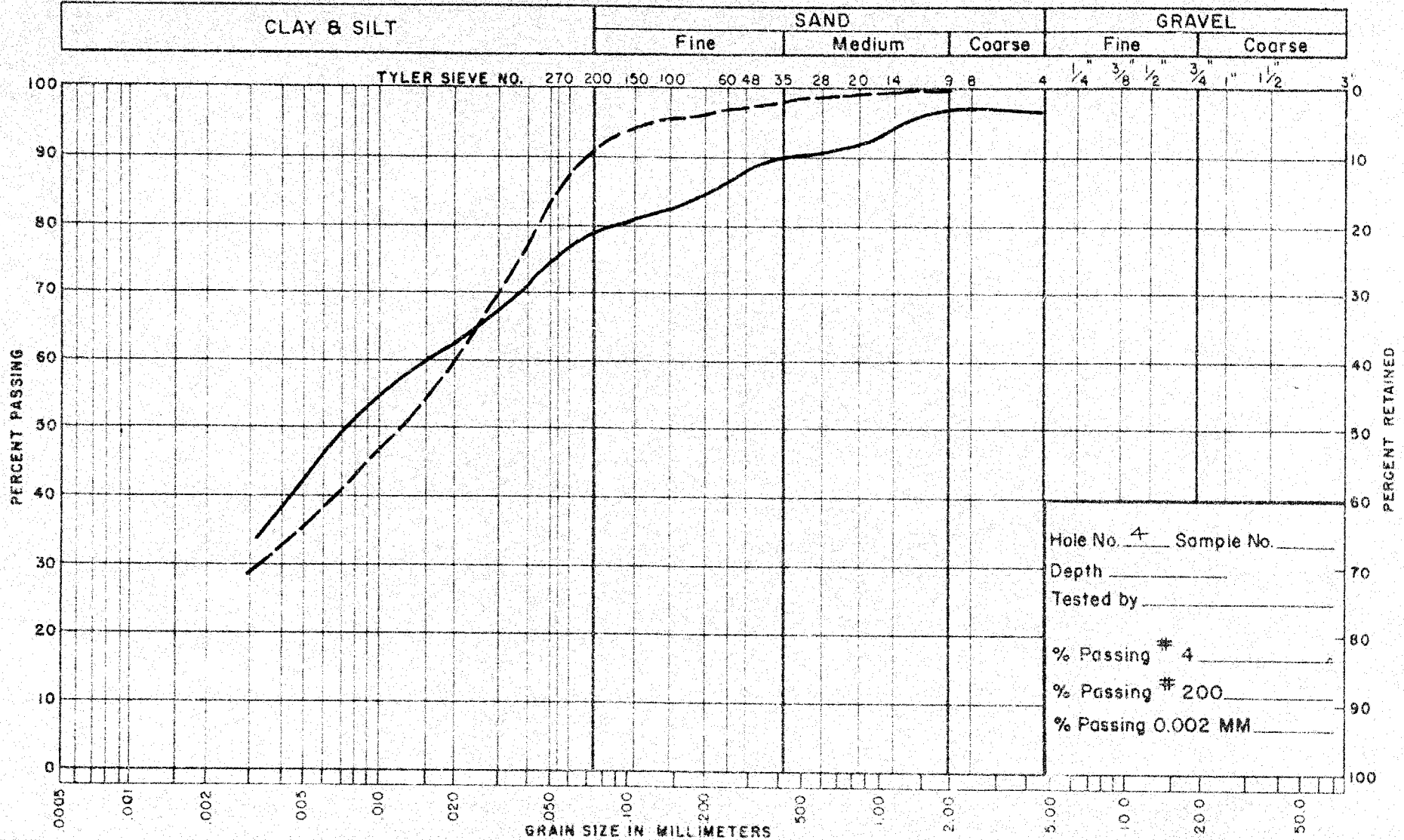
NOTES AT 10'-0" BELOW GROUND EL.

DEPARTMENT OF HIGHWAYS - ONTARIO
MATERIALS & RESEARCH SECTION
GRAIN SIZE DISTRIBUTION

Job No. 60-F-62 W.P. No. _____

Location G.E.W. & COUNTY RD. No. 22

UNIFIED SOIL CLASSIFICATION SYSTEM

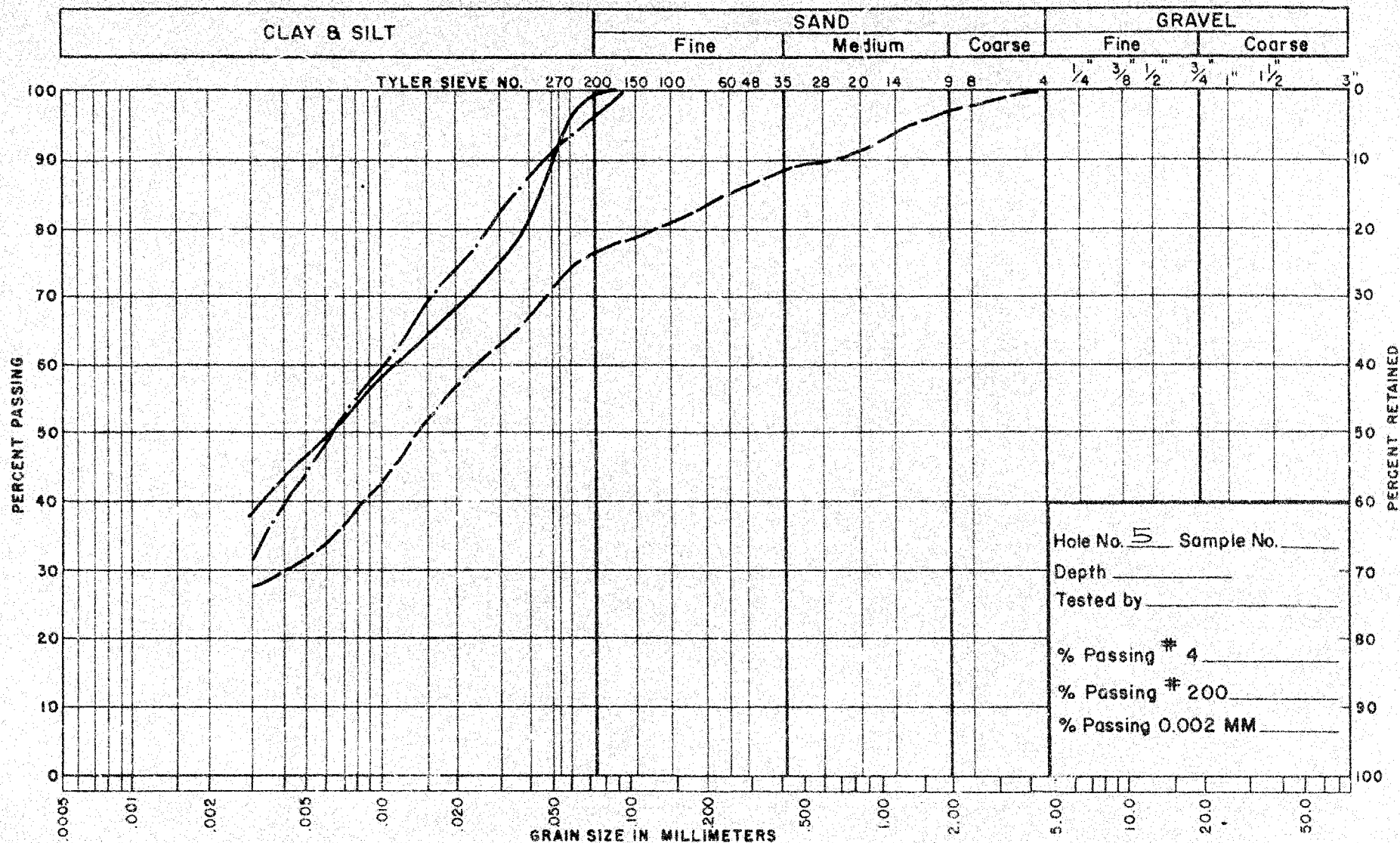


NOTES — AT 15'-0" BELOW GROUND EL.
 --- AT 6'-0" BELOW GROUND EL.

DEPARTMENT OF HIGHWAYS - ONTARIO
 MATERIALS & RESEARCH SECTION
GRAIN SIZE DISTRIBUTION

Job No. 60-F-62 W.P. No. _____
 Location Q.E.W. E COUNTY ROAD No. 22

UNIFIED SOIL CLASSIFICATION SYSTEM



NOTES B

- AT 15'-0" BELOW GROUND EL.
- AT 9'-0" BELOW GROUND EL.
- .- AT 6'-0" BELOW GROUND EL.

DEPARTMENT OF HIGHWAYS - ONTARIO
MATERIALS & RESEARCH SECTION
GRAIN SIZE DISTRIBUTION

Job No. 60-F-62 W.P. No. _____
Location Q.E.W. & COUNTY RD. No. 22

SUMMARY OF FIELD & LABORATORY TESTS

JOB 60-F-62

W.P. 110-60

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	3'-4.5'	Very stiff sandy silty clay of low plasticity	20	-	-	-	-	-	
	S2	6'-7.5'	Stiff sandy silty clay of low plasticity	12	22.4	-	-	-	-	
	S3	10'-11.5'	Hard sandy silty clay of low plasticity	41	16.6	-	-	-	-	
	S4	15'-16.5'	Hard sandy silty clay of low plasticity	42	12.2	18.7	32.4	-	-	
	AS5	25'-26.5'	Very hard desintegrated Red shale	-	-	-	-	-	-	
	AS6	30'-31'	Very hard desintegrated Red shale	-	-	-	-	-	-	
2	S1	3'-4.5'	Stiff sandy silty clay of low plasticity	14	-	-	-	-	-	
	S2	6'-7.5'	Hard sandy silty clay of low plasticity	57	13.7	-	-	-	-	
	S3	10'-11.5'	Very stiff sandy silty clay of low plasticity	28	16.9	16.5	24.8	-	-	
	S4	15'-16.5'	Hard sandy silty clay of low plasticity	39	-	-	-	-	-	
	AS5	30'-30.6'	Very hard desintegrated Red shale	-	-	-	-	-	-	

SUMMARY OF FIELD & LABORATORY TESTS

JOB 60-F-62

W.P. 110-60

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.s.f.	REMARKS
3	S1	3'-4.5'	Stiff sandy silty clay of low plasticity	8	-	-	-	-	-	
	S2	6'-7.5'	Stiff sandy silty clay of low plasticity	13	20.0	-	-	-	-	
	S3	10'-11.5'	Hard sandy, silty clay of low plasticity	32	19.2	18.1	32.2	-	-	
	S4	15'-16.5'	Hard sandy, silty clay of low plasticity	42	15.1	14.5	23.2	-	-	
	AS5	20'-21.5'	Very hard desintegrated Red shale	-	-	-	-	-	-	
	AS6	25'-25.3'	Very hard desintegrated Red shale	-	-	-	-	-	-	
	AS7	30'-30.1'	Very hard desintegrated Red shale	-	-	-	-	-	-	
4	S1	3'-4.5'	Stiff sandy silty clay of low plasticity	14	-	-	-	-	-	
	S2	6'-7.5'	Very stiff silty clay of medium plasticity	18	18.4	16.9	34.1	-	-	
	S3	10'-11.5'	Stiff sandy silty clay of low plasticity	11	26.2	-	-	-	-	
	S4	15'-16.5'	Hard sandy silty clay of low plasticity	45	12.2	14.9	23.7	-	-	
	S5	20'-21.5'	Very hard red shale	172-8"	-	-	-	-	-	

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	S6	25'-26.5'	Very hard red shale	110-4"	-	-	-	-	-	
	S7	30'-30.2'	Very hard red shale	100-2"	-	-	-	-	-	
5	S1	3'-4.5'	Stiff sandy silty clay of low plasticity	7	-	-	-	-	-	
	S2	6'-7.5'	Very stiff silty clay of medium plasticity	20	21.2	20.9	41.4	-	-	
	S3	9'-10'	Hard sandy clay of low plasticity	32	-	-	-	-	-	
	S4	15'-16.5'	Very hard sandy clay of low plasticity	54	11.8	14.6	23.6	-	-	
	S5	17.3'-17.5'	Very hard Red shale	50-2"	-	-	-	-	-	
			S denotes split spoon sample							
			AS " AX split spoon sample							

SUMMARY OF FIELD & LABORATORY TESTS

JOB 60-F-62

W.P. 110-60

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	S1	3'-4.5'	Stiff sandy silty clay of low plasticity	8	-	-	-	-	-	
	S2	6'-7.5'	Stiff sandy silty clay of low plasticity	13	20.0	-	-	-	-	
	S3	10'-11.5'	Hard sandy, silty clay of low plasticity	32	19.2	18.1	32.2	-	-	
	S4	15'-16.5'	Hard sandy, silty clay of low plasticity	42	15.1	14.5	23.2	-	-	
	AS5	20'-21.5'	Very hard desintegrated Red shale	-	-	-	-	-	-	
	AS6	25'-25.3'	Very hard desintegrated Red shale	-	-	-	-	-	-	
	AS7	30'-30.1'	Very hard desintegrated Red shale	-	-	-	-	-	-	
4	S1	3'-4.5'	Stiff sandy silty clay of low plasticity	14	-	-	-	-	-	
	S2	6'-7.5'	Very stiff silty clay of medium plasticity	18	18.4	16.9	34.1	-	-	
	S3	10'-11.5'	Stiff sandy silty clay of low plasticity	11	26.2	-	-	-	-	
	S4	15'-16.5'	Hard sandy silty clay of low plasticity	45	12.2	14.9	23.7	-	-	
	S5	20'-21.5'	Very hard red shale	172-8"	-	-	-	-	-	

DEPARTMENT OF HIGHWAYS - ONTARIO
MATERIALS AND RESEARCH SECTION

W.P. 110-60	BORE HOLE NO. 1
JOB 60-F-62	STATION 2432 (54' Lt)
DATUM 276.3'	COMPILED BY B. K.
BORING DATE July 8/60	CHECKED BY W.W.K.

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

LEGEND

1/2 UNCONFINED COMPRESSION (Qu)	0
VANE TEST (C) AND SENSITIVITY (S)	+8
NATURAL MOISTURE AND	11
LIQUIDITY INDEX	X
LIQUID LIMIT	
PLASTIC LIMIT	

SYMBOL	DESCRIPTION	ELEV. FEET	DEPTH FEET	STRENGTH AND PENETRATION RESISTANCE		CONSISTENCY		SAMPLE	NATURAL UNIT WT. P.C.H.
				P. S. F.		MOIST. CONTENT - % DRY WT.			
	↓ G. L.	276.3	0						
	Topsoil	275.0							
	Stiff to very stiff sandy w.l. silty clay	272.5							
		262.6							
	Hard sandy, silty clay	257.8							
	Very hard desintegrated Red shale	245.3							
	End of borehole								
Penetration resistance profile shown obtained by driving a 2" dia cone from groundlevel to depth noted with an energy of 350 ft. lb. per blow									

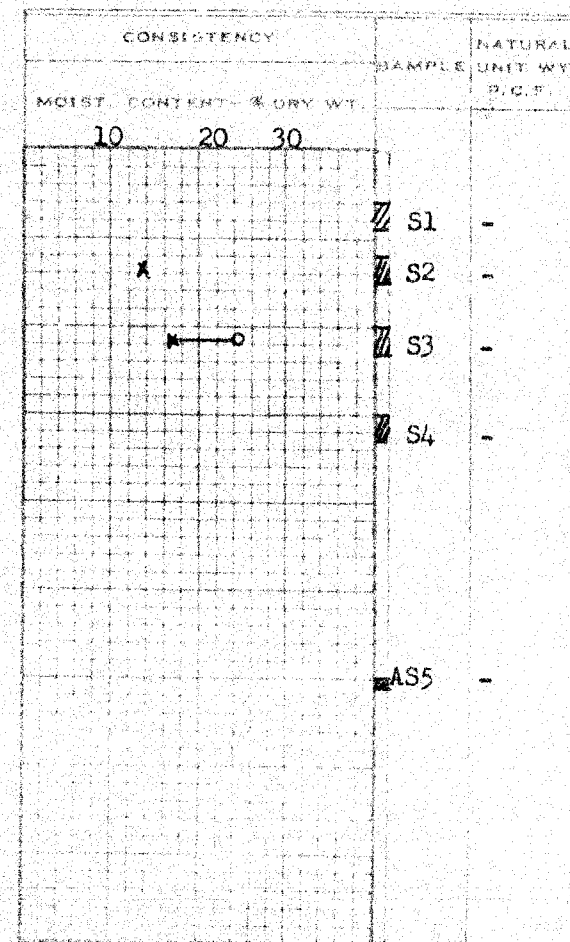
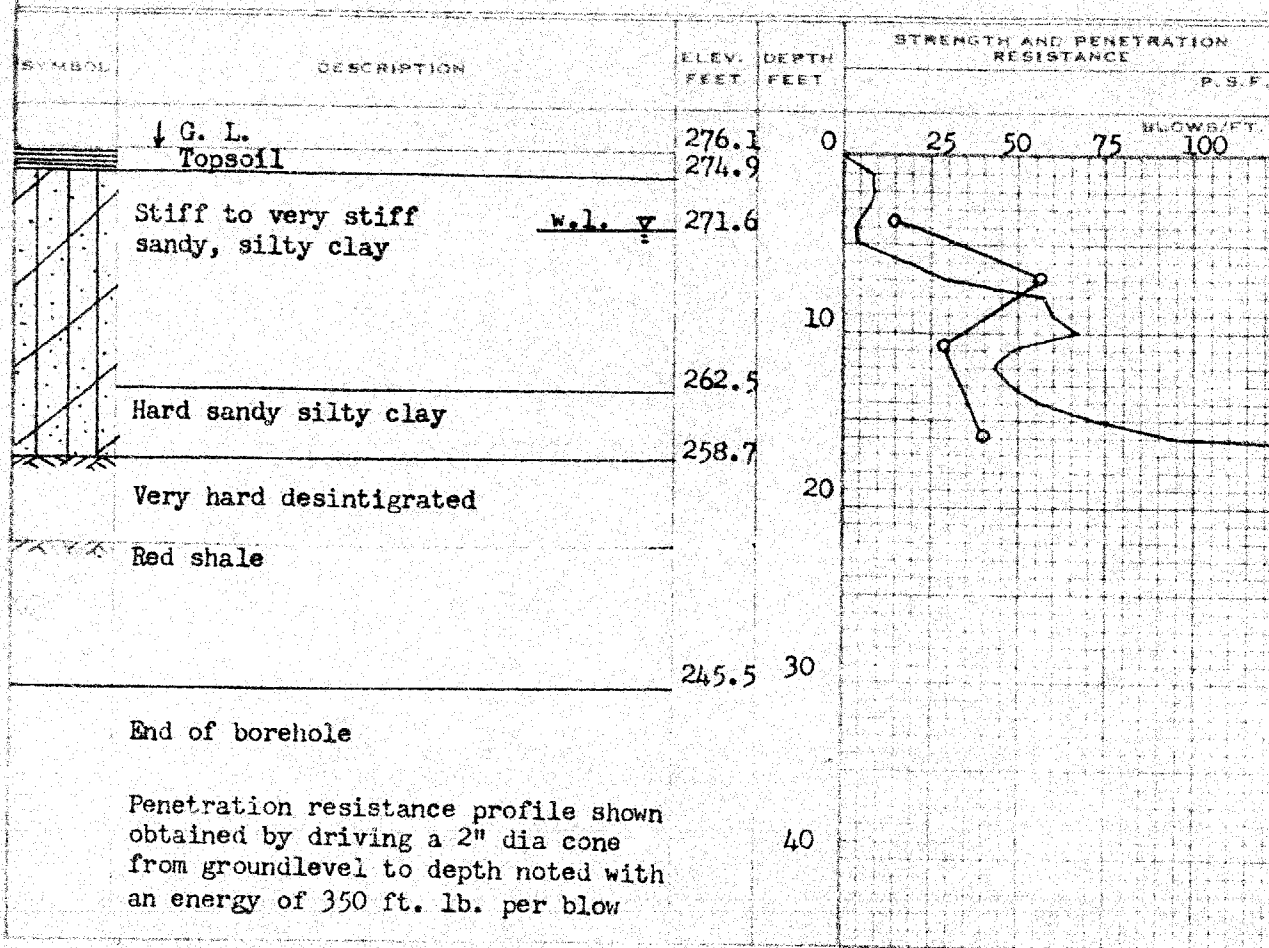
DEPARTMENT OF HIGHWAYS - ONTARIO
MATERIALS AND RESEARCH SECTION

W.P. 110-60 BORE HOLE NO. 2
 JOB 60-P-62 STATION 2+02 (54' Lt.)
 DATUM 276.1' COMPILED BY B. K.
 BORING DATE July 8/60 CHECKED BY W.W.K.

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) +s
 NATURAL MOISTURE AND LIQUIDITY INDEX LI
 LIQUID LIMIT X
 PLASTIC LIMIT



DEPARTMENT OF HIGHWAYS - ONTARIO
MATERIALS AND RESEARCH SECTION

W. P. 110-60

BORE HOLE NO. 3

JOB 60-F-62

STATION 2432 (49' Rt)

DATUM 275.8

COMPILED BY B. K.

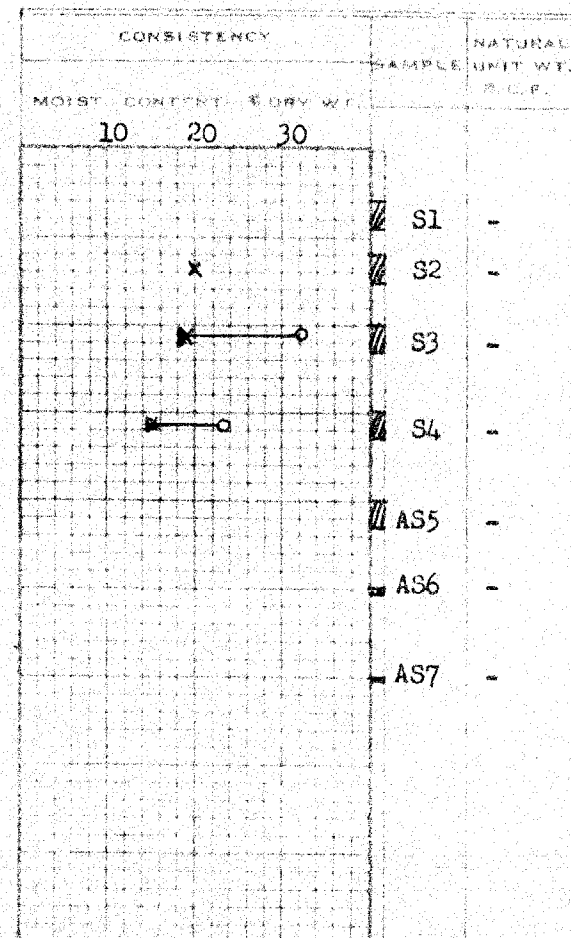
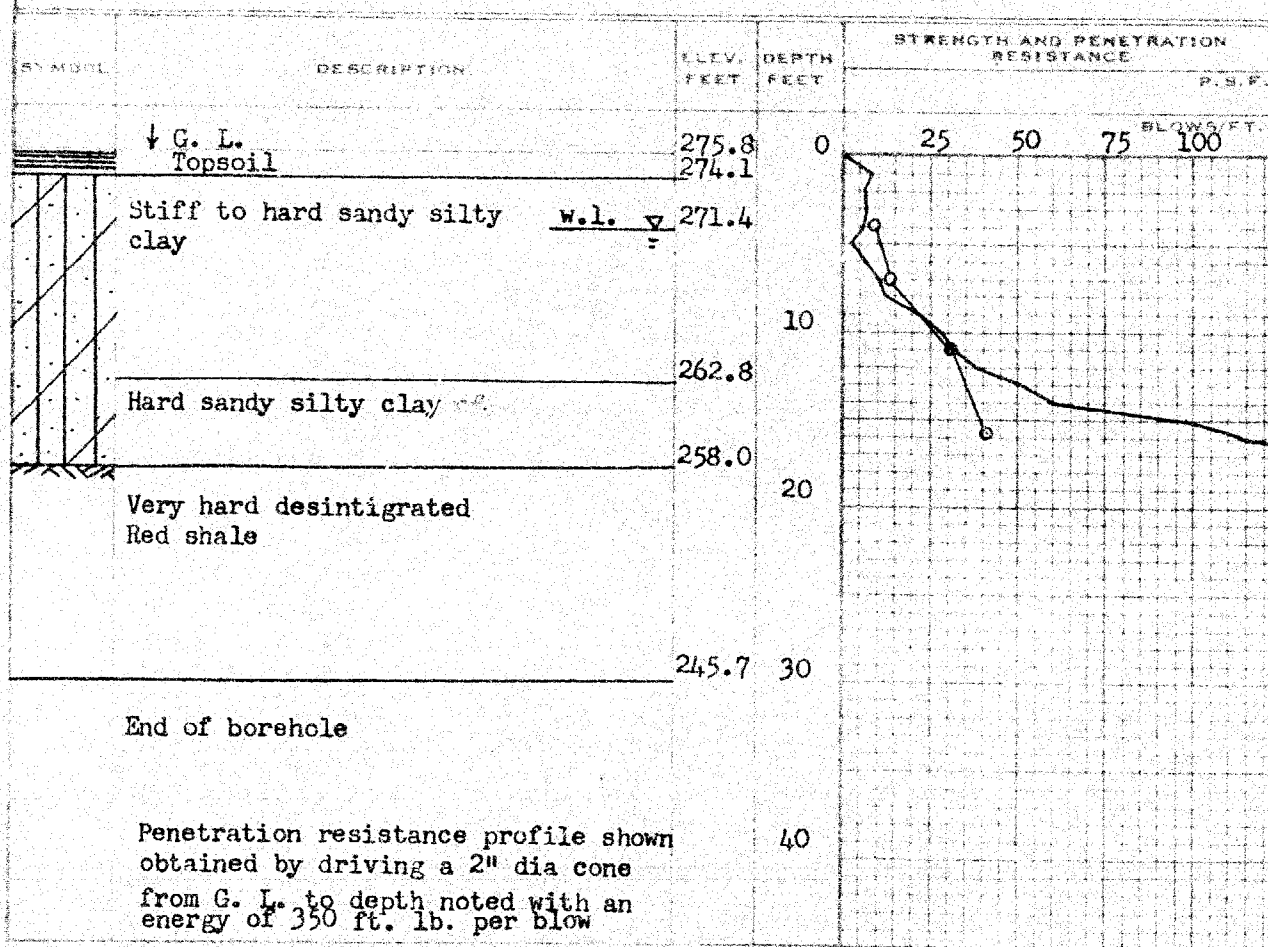
BORING DATE July 12/60

CHECKED BY W.K.

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

LEGEND

1/2 UNCONFINED COMPRESSION (QU) _____ 0
VANE TEST (C) AND SENSITIVITY (S) _____ +
NATURAL MOISTURE AND _____ LI
LIQUIDITY INDEX _____ X
LIQUID LIMIT _____
PLASTIC LIMIT _____



DEPARTMENT OF HIGHWAYS - ONTARIO

MATERIALS AND RESEARCH SECTION

W.P. 110-60 BORE HOLE NO. 4

JOB 60-F-62 STATION 2+02 (49' Rt)

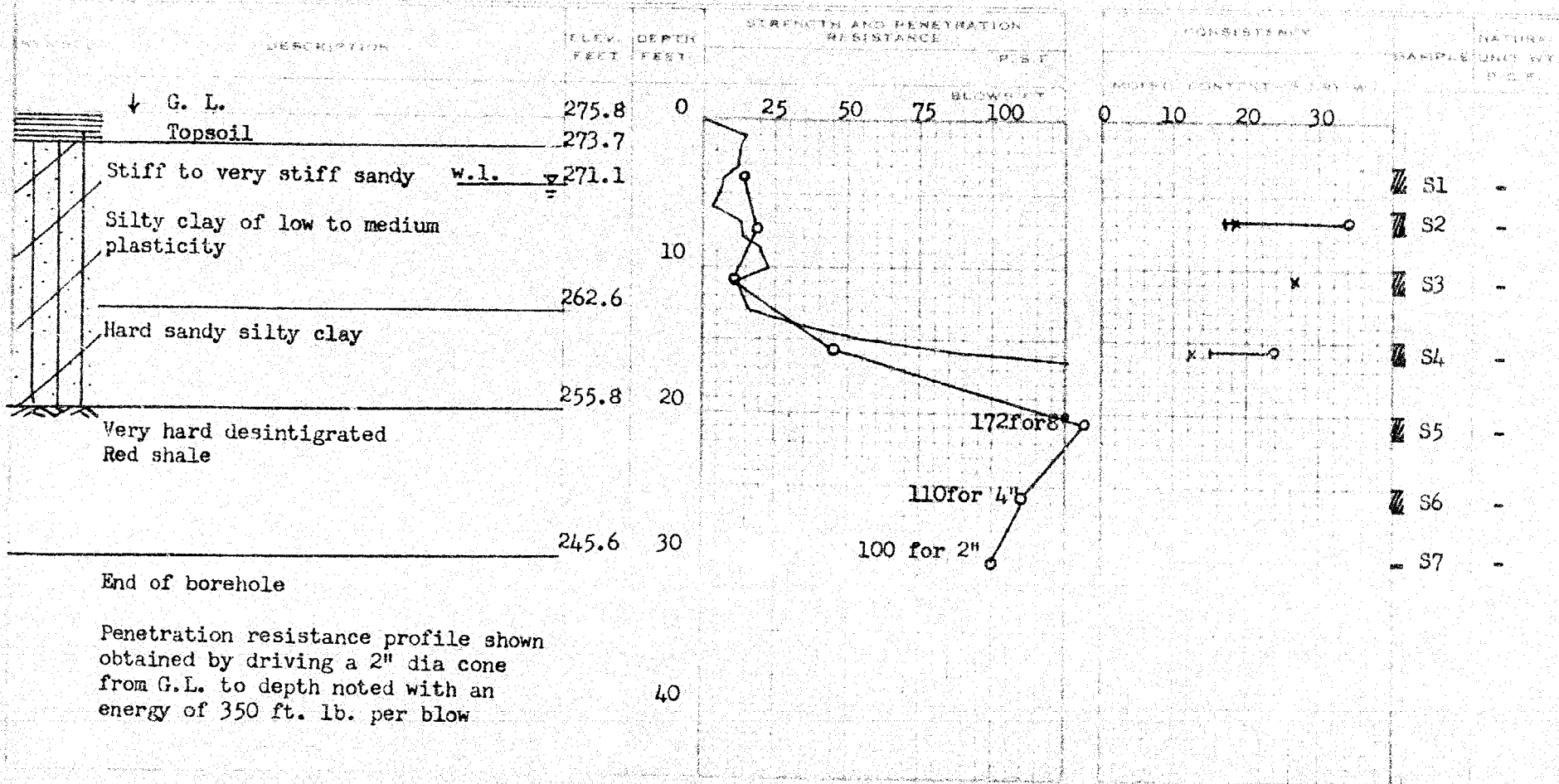
DATUM 275.8' COMPILED BY B. K.

BORING DATE July 12/60 CHECKED BY W.K.

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

LEGEND

1/2 UNCONFINED COMPRESSION (QU) \bigcirc
 VANE TEST (C) AND SENSITIVITY (S) \times
 NATURAL MOISTURE AND LIQUIDITY INDEX \times
 LIQUID LIMIT \times
 PLASTIC LIMIT \times



DEPARTMENT OF HIGHWAYS - ONTARIO

MATERIALS AND RESEARCH SECTION

W.P. 110-60

BORE HOLE NO. 5

JOB 60-F-62

STATION 2+17.6

DATUM 274.4'

COMPILED BY B. K.

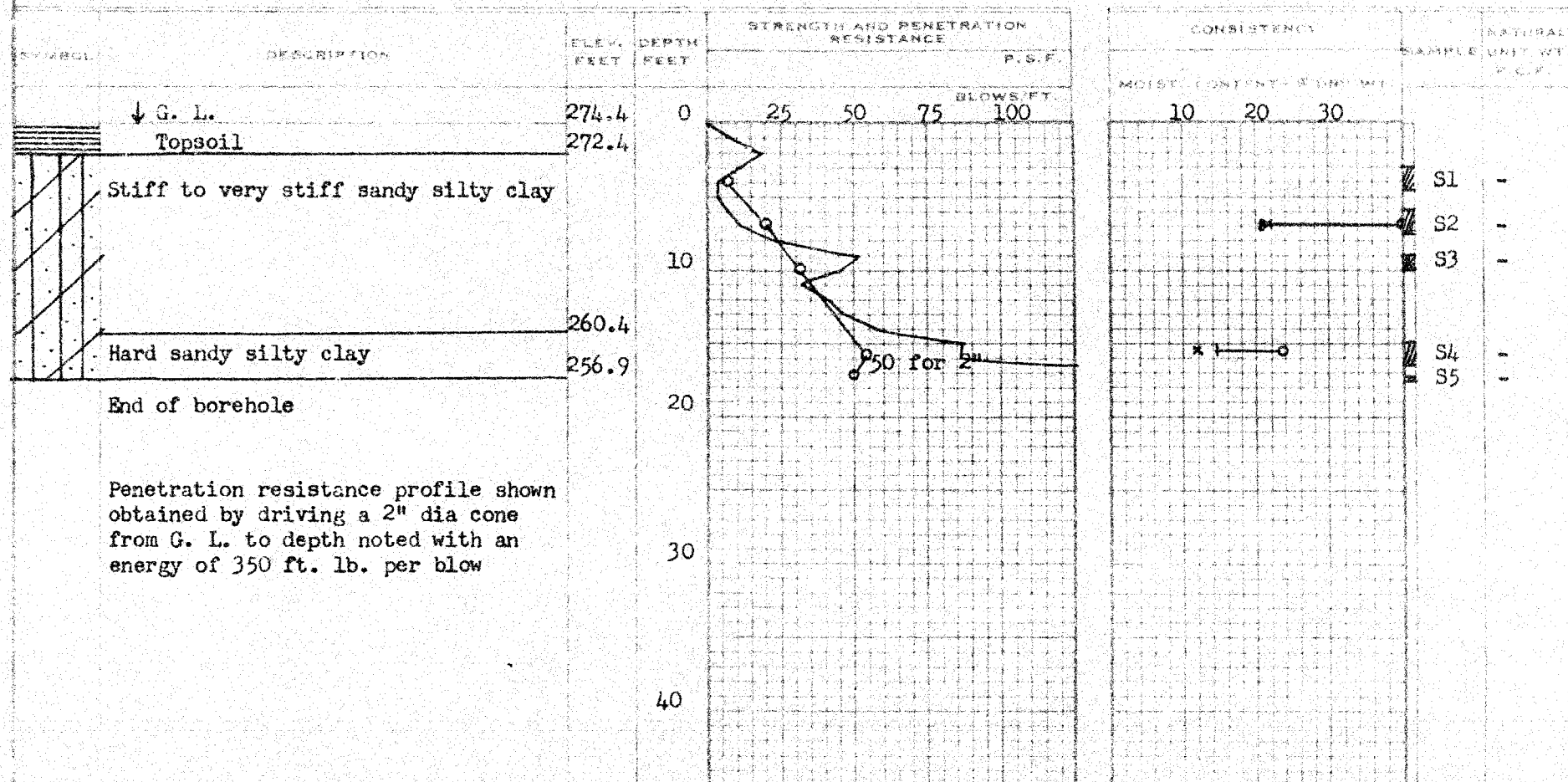
BORING DATE July 14/60

CHECKED BY W.W.K.

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

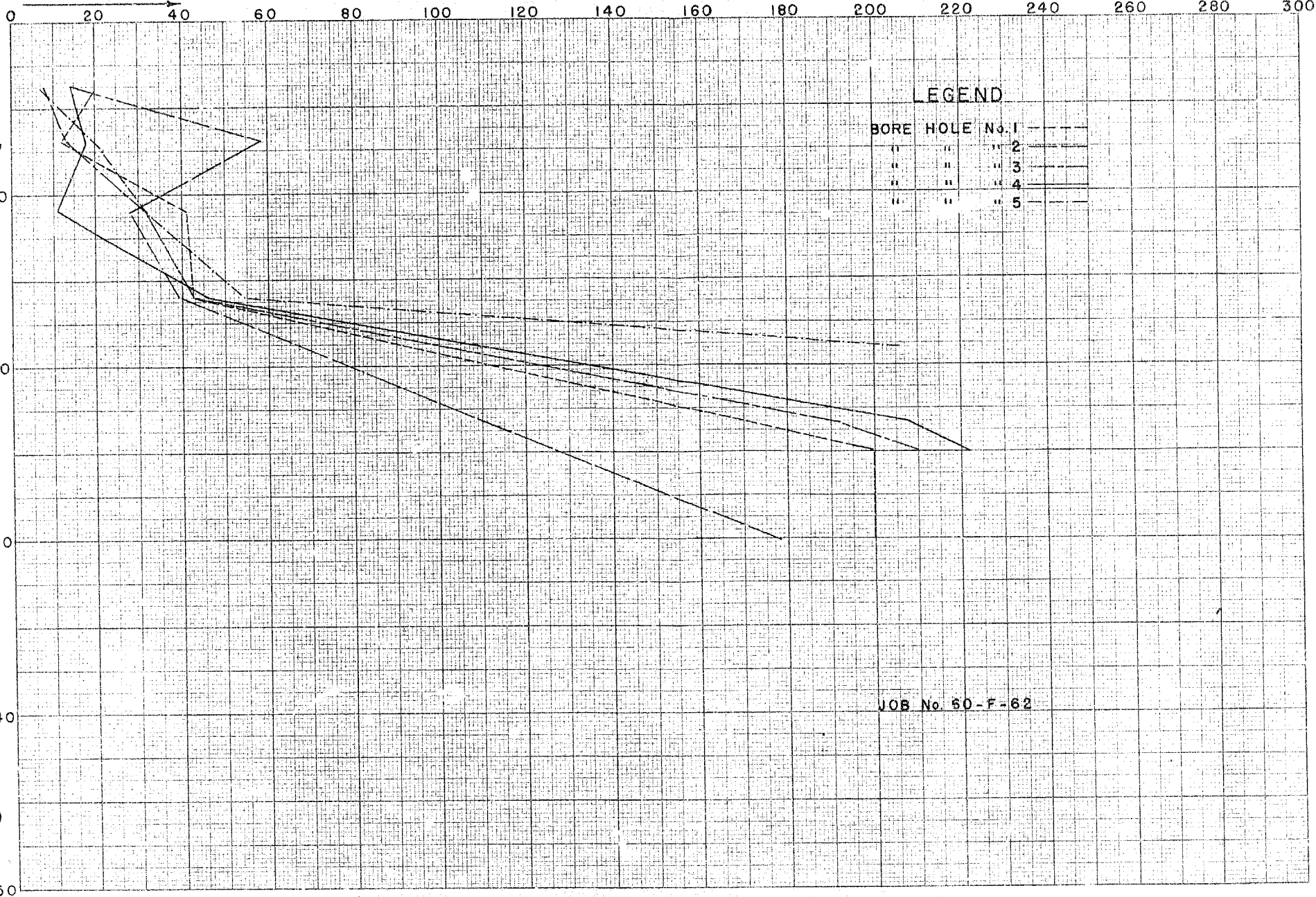
LEGEND

1/2 UNCONFINED COMPRESSION (Q_u)
 VANE TEST (C) AND SENSITIVITY (S)
 NATURAL MOISTURE AND LIQUIDITY INDEX
 LIQUID LIMIT
 PLASTIC LIMIT



BLOWS PER FOOT

DEPTH IN FEET



LEGEND

BORE HOLE	No. 1	---
"	"	" 2
"	"	" 3
"	"	" 4
"	"	" 5

JOB No. 60-F-62

350-10466
PLATE 1 OF 1
350-10466

#60-F-62

W.P. # 110-60

Q.E.W. E'

CTY. RD. # 22

7 MILES W. OF

ST. CATHARINES

