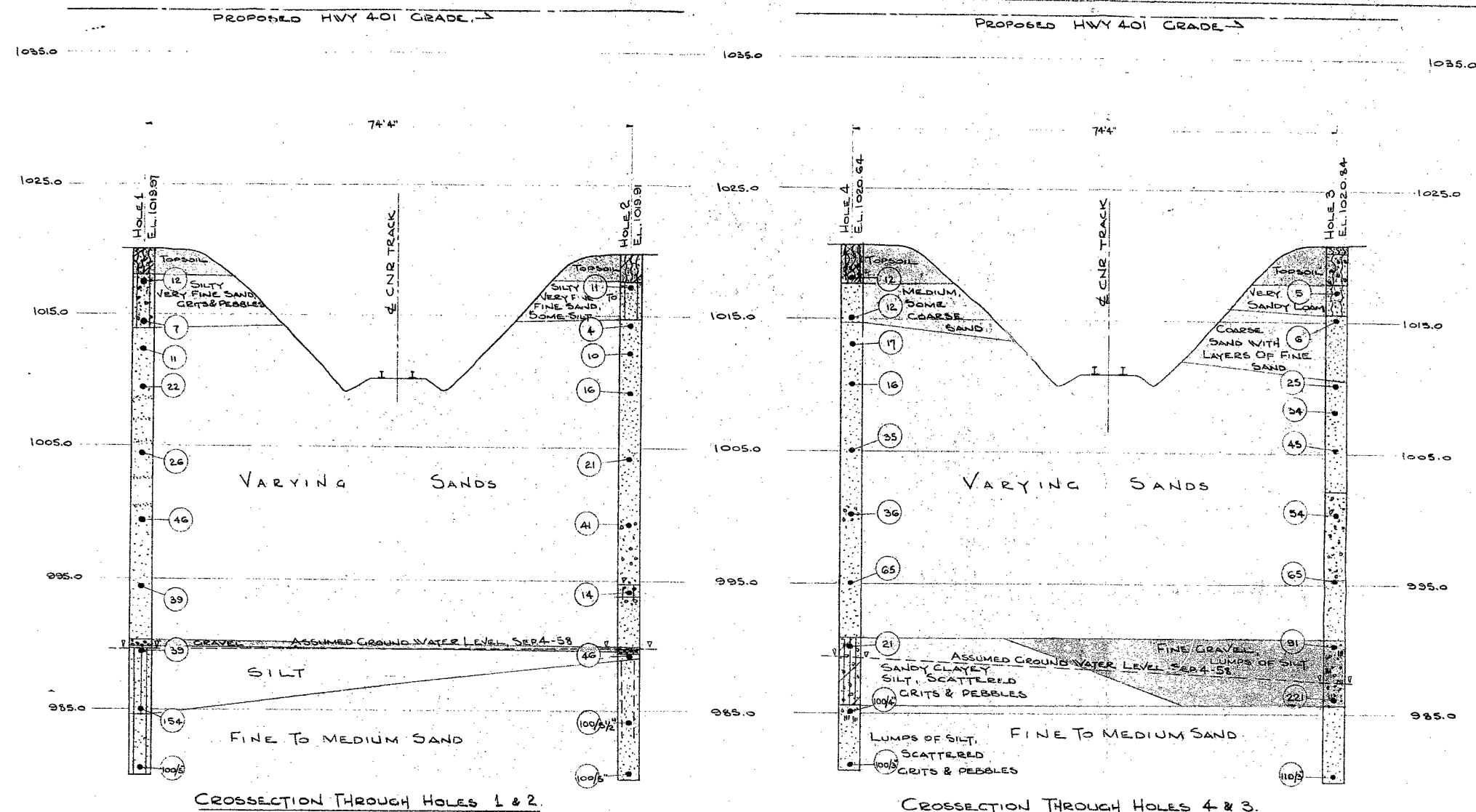
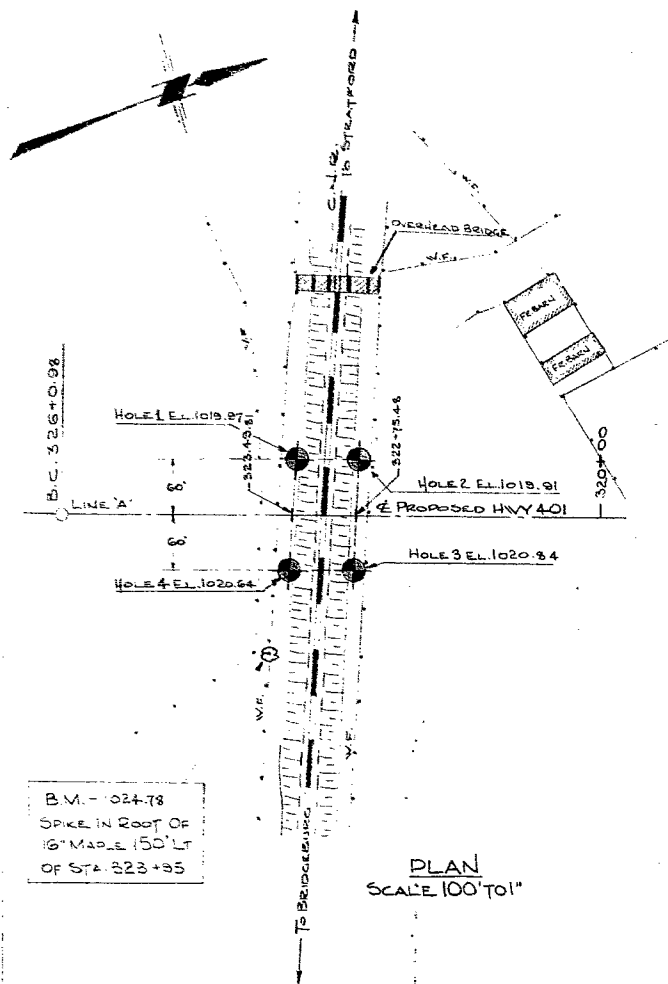
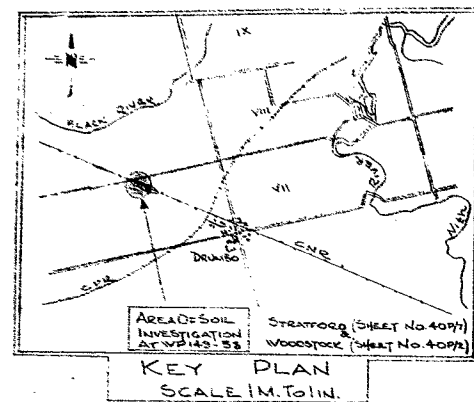


#58-F-234-C
W.P. 149-58
HWY.# 401, C.N.R
OVERHEAD.
BLENHEIM RD.



LEGEND
 ● TEST HOLE
 ○ BLOWS/FOOT

PROFILES
 SCALE HOR. 10' TO 1"
 VERT. 5' TO 1"

NOTE: PLEASE SEE BOREHOLE LOGS
 FOR COMPLETE SOIL DETAILS.



e.m. peto & associates ltd.
 SOIL SITE INVESTIGATION
 AT
 HWY 401-BLENHEIM TWP
 NO. 6 C.N.R. CROSSING.
 FOR
 DEPARTMENT OF HIGHWAYS OF ONTARIO.
 OUR JOB No. 58104 DATE SEP. 8. 58
 CLIENTS PLAN No. W.P. 143-58 PER. C.T.

e. m. peto associates ltd.

YOUR REFERENCE:-

W. P. 149-58

OUR REFERENCE:-

58104

850 roselawn avenue,

TORONTO, ONTARIO.

RUssell 1 - 4955.

September 11th, 1958.

58-F-234C.

**The Department of Highways of Ontario.
280 Davenport Road,
Toronto, Ontario.**

Attention: Mr. J. C. McAllister

**Re: Soil Site Investigation,
Blenheim Township #6, C. N. R.**

Dear Sirs:

We refer to your verbal instruction, of August 27th, 1958, to carry out a soil investigation at this site.

We now have pleasure in submitting herewith four (4) copies of the soils report for this site.

The soil conditions, test results and our findings are discussed in detail in the soils report. Here for your convenience we are summarizing our conclusions and recommendations for your attention.

1. Generally four soil strata arise on this site. They are:-
 - a) A reddish to dark brown sandy loam topsoil with organic matter, two to three feet in thickness.
 - b) A stratum of varying grey to brown compact to dense sands, with occasional seams of silt, and containing grits and pebbles, and generally becoming coarser with improved grading with depth. This stratum arises below the topsoil down to a depth of 30 feet below ground surface. The upper layers of this stratum are frost susceptible.

- c) A thin layer of gravel overlying a layer of light brown dense silt varying in thickness, which is evident in holes #1 and 2 only. A five foot layer of light brown compact sandy till in hole #4 only, whilst in hole #3 the silt layer is not evident, but is replaced by a fine gravel layer, approximately 5 feet in thickness.
 - d) A stratum of fine to medium grey to brown, very dense sand varying in thickness from 5 feet to 9 feet in the test holes, which were all terminated at a depth of 40 to 41 feet in this material.
2. A free water table exists on this site at elevations ranging from 989.22 to 989.91 on September 4th, 1958. We consider this water table may rise to elevation 994.00 approximately, during a reasonably wet season.
3. The soil conditions are suitable for either continuous strip footings with restrictions regarding elevation due to the possible fluctuation of the water table, or a pile foundation using either a displacement pile or steel "H" piles. On this site the latter type of pile has certain practical advantages which do not apply to the displacement pile. However, the choice as to type of foundation will, we believe, rest on such factors as the design requirements of the structure adopted, site conditions with particular reference to the C. N. R. rulings, as well as economic considerations.
4. The bearing capacities recommended for strip footings placed at a depth of 15 feet below ground surface are:-
- Footing of minimum width 5 feet - 3.1 tons per square foot.
Footing of minimum width 10 feet - 4.6 tons per square foot.
- The loadings incorporate a factor of safety of 3 and provide for a total settlement not exceeding 1", and assume a minimum surcharge of 4 feet. Loadings for intermediate size footings may be interpolated from these values.

4. (Cont'd)

Piles should be driven through the non uniform layers of the material arising on this site and into the very dense material arising at depths of 35 to 40 feet below ground surface. They will thus be partly friction and partly bearing piles.

5. We have considered the soil conditions from the aspect of embankment design, and we have concluded that they present no problem of stability affecting such a structure, provided normal subgrade compaction, and removal of topsoil, practices are observed.

6. Having in mind the design needs for the bridge abutment walls, we tested a sample of the more inferior sand encountered on this site in order to give some indication of properties of this local material. Accordingly for design purposes we recommend the adoption of the following values:-

$$C = 0$$

$$\phi = 35^\circ$$

$$W = 125 \text{ lbs. per cubic foot.}$$

$$\delta = 25^\circ \text{ for the angle of friction between walls and sand.}$$

7. The natural material is reasonably free draining and therefore we do not consider subsoil drains should be necessary for the structure. Nevertheless, we do advise the incorporation of weep hole drains, or some alternative means of draining the material immediately behind the abutment walls.

We believe we have considered all the points arising from this investigation, however, in the event that you wish to discuss any matter arising from the soils report, we shall be pleased to be of further service.

Yours very truly,

E. M. PETO ASSOCIATES LTD.,



E. M. Peto, P. Eng.

CFF:ab

THE DEPARTMENT OF HIGHWAYS OF ONTARIO

SOILS REPORT

for

HIGHWAY 401 OVERPASS - TOWNSHIP OF BLENHEIM #6 C. N. R.

by

E. M. PETO ASSOCIATES LTD.,

TORONTO, ONTARIO

SEPTEMBER, 1958.

e. m. peto associates ltd., 850 roselawn avenue, Toronto 10, Ontario

Job No. 58194

Client's Ref. No. W. P. 149-58

Date September 11th/58

Report on

SOIL SITE INVESTIGATION

at

BLENNHEIM TOWNSHIP # 6 C. N. R.

for

THE DEPARTMENT OF HIGHWAYS OF ONTARIO

INTRODUCTION:

We were authorized verbally, on August 27th, 1958 by Mr. J. C. McAllister to carry out a soil investigation at this site.

The object of the investigation was to determine:

- a) The Existing soil and water conditions.
- b) The types of foundation suitable for such soil conditions.
- c) The elevation for such foundations together with appropriate bearing capacities.
- d) Any other information pertinent to the design and construction of the proposed structure.

PROGRAMME:

August 28th, 1958: Location and reconnaissance of site by Field Engineer.

August 29th, 1958: Test holes set out, staked and levelled by Field Engineer. Crew moved onto site.

August 30th, 1958: Driving and sampling test hole #3.

September 1st, 1958: Completion of hole #3. Driving and completion of test hole #2.

September 2nd, 1958: Driving and completion of hole #1.

September 3rd, 1958: Driving and completion of Hole #4.

September 4th, 1958: Final check of water levels.

SOIL ENGINEERING & LABORATORY TESTING, ROAD SUBGRADE INVESTIGATION,
EARTHWORKS CONTROL & PAVEMENT DESIGN, SUPERVISION & CONSULTATIONS.

report

for

The Department of Highways

Sheet No. 2.

PROGRAMME (Cont'd)

September 4th, 1958: Crew moved to site of W. P. 150-58.

GENERAL INFORMATION:

a) Test holes were driven and sampled in accordance with our standard procedure detailed in Appendix II.

Four test holes were driven, and terminated at depths of 40 to 41 feet.

b) The ground elevation of the test holes was referred to your datum, which was a spike in the root of a 1.3 feet maple, 150 feet left of Station 323 + 95. The elevation of this datum was taken as 1024.78.

c) Details and descriptions of the soils and conditions are entered up on a borehole log prepared for each test hole and which are included in the Appendix to the report.

d) Locations of the test holes are shown on a plan prepared from your Drawing No. F3526. Two soil profiles through each pair of test holes have also been prepared and together with the plan, forms part of the Appendices to the report.

SITE AND GEOLOGY:

The site is located in a cutting for the C.N.R. single track, 1060 feet S.W. of the level crossing on Concession road VIII, which is one mile North of Drumbo in the Township of Blenheim. The railway cutting is approximately 11 feet deep and the immediate approaches to the top of the cutting are reasonably level, over farm land, which is now under a crop of corn.

The site is located in an extension of the physiographic region known as the Ingersoll moraine and forms part of a series of disconnected morainic hills between Woodstock and the Nith River. This moraine consists of a loose, loamy or sandy till.

SOIL CONDITIONS:

Generally four strata arise on this site. They consist of:-

- i) A layer of topsoil material of silty and sandy loam with organic matter, varying in depth from 2 to 3 feet.
- ii) Varying sands, containing, in some instances, grits, pebbles, and fine gravel, together with some silt. This stratum arises immediately below the topsoil and persists to a depth of 30 feet.
- iii) A thin layer of gravel 4 inches thick occurs at a depth of 30 feet, in holes 1 and 2; in hole 3 this stratum is about 5 feet thick whilst in hole 4 it has changed to a mixture of sand, silt and clay, possibly a sandy till, with scattered grits and pebbles, also 5 feet in thickness.
- iv) A stratum of silt, arising at a depth of 30'4" in holes 1 and 2. At a depth of 35 feet in hole 1, it appears to grade into a fine to medium sand down to a depth of 40 feet where this hole was terminated. In hole 2 this stratum is very much thinner, the change to a fine to medium sand with some silt occurring at a depth of 31 feet. This hole was terminated in this material at a depth of 40 feet.

The silt stratum is not apparent, in holes 3 and 4, there the fine gravel and sand silt clay mixture noted in paragraph (iii) above changes at a depth of 35 feet to a fine to medium sand, which in hole 4 only contains some silt lumps and scattered pebbly gravel. These two test holes were terminated in the fine to medium sand material at depths of 41 and 40 feet respectively.

Having in mind the nature of the geological formation of the soils on this site, the material is inevitably somewhat diverse or heterogeneous in character. However, broadly speaking it would appear from the series of grading analyses carried out on the sands arising between depths of 3 feet to 30 feet in all the holes, that the upper material from approximately 3 feet to 18 feet is a poorly graded fine silty sand. The silt content being considerably higher in the upper levels. It is a frost susceptible material. Below a depth of 18 to 20 feet the grading of the material generally is very much improved and in fact complies with the grading envelope specified for a Granular "B" type material.

SOIL CONDITIONS: (Cont'd)

Below the 30 feet depth in holes 1 and 2 the consistency limit test and particle size distribution analysis confirm the visual classification of silt for this material arising down to depths of 35 feet and 31 feet in these two holes respectively. Unfortunately the difficulty arising from the very dense condition of the material at this depth and below precluded the recovery of samples other than washed samples, nevertheless it appears that the sand content down to depths of 40 feet in all the holes increases considerably.

Generally the density of the soils arising on this site increases with depth in all the test holes. Down to depths of 10 feet below ground surface, which is approximately the depth of the existing railway cutting, the material is classified as loose or very loose to compact. From a depth of 10 feet in all the holes the density increases fairly steadily with depth becoming very dense at a depth of 35 feet. However, in holes 2 and 4 at depths of 25 feet and 30 feet respectively the density temporarily decreases sharply, whilst in hole 1 it decreases slightly from 20 to 25 feet, remaining uniformly dense to 30 feet before showing a sharp increase again at 35 feet.

In all holes without exception the material below 35 feet is very dense and at this point the penetration test results show a very marked increase, and the material below this depth is classified as very dense.

The penetration test results are presented graphically (Appendix I) with the depth below ground surface plotted against the number of blows per foot of penetration.

Three conclusions regarding the density of these soils can be drawn from this form of presentation of the penetration test results. These are:

- a) A generally steady increase in the density of the material throughout the holes, down to a depth of 20 feet. The rate of this increase is reasonably uniform.
- b) A belt of non uniform material appears to exist between depths of 25 to 30 feet.

SOIL CONDITIONS: (Cont'd)

- c) A sharp increase in the density in all the holes below a depth of 30 feet. Here again the rate of this increase in density is reasonably uniform in all the test holes.

WATER CONDITIONS:

Wash water was not used in any of the holes until the depths detailed below were reached:

Borehole #1 - 11 feet, Borehole #2 - 8 feet.
Borehole #3 - 16 feet, Borehole #4 - 15 feet.

Accordingly the moisture contents recorded down to these depths can be regarded as representing the natural moisture conditions at the date of the investigation. They are variable with depth, and this variation is probably related to the fines content of the material. Generally they are not abnormal, although in borehole #1 at depths of 5 to 6 feet and 7 to 8 feet they are fairly high; a similar comment applies to the material at a depth of 10 to 11 feet in borehole #4.

Water levels in the holes were checked daily during the course of the investigation, following bailing on completion of each hole, and the final readings taken in each of the holes on the 4th September are as follows:-

<u>Test Hole #</u>	<u>Depth below G. L.</u>	<u>Elevation</u>	<u>Remarks</u>
1	30'5"	989.55	Casing Withdrawn
2	30'0"	989.91	Casing Withdrawn
3	33'3"	987.59	Casing Withdrawn
4	31'5"	989.22	Casing to 30 feet.

WATER CONDITIONS: (Contd')

During the course of the observations the range of fluctuation in depth of W. L. above and below the depths recorded on September 4th, were:-

Hole #1 29'5" to 32'11".

Hole #2 28'2" to 31'1".

Hole #3 32'7" to 33'4".

Hole #4 31'5" to 31'7".

At the farm adjoining the site there is a deep well within 150 yards of the proposed crossing. The ground and water level elevations at this well taken on September 4th were:

<u>Ground Elevation</u>	<u>Water Level</u>	<u>Bottom of Well</u>
1023.30	999.30	986.30

The normal depth to water is 30 feet approximately, giving a normal elevation of the water table of 993.30.

The water level shown on the borehole logs is the final reading taken on September 4th, 1958.

TEST RESULTS:

A consistency test was carried out in the material arising in hole #1 at a depth of 34 to 35 feet, sample 14 with the following result.

<u>L. L.</u>	<u>P. L.</u>	<u>P. I.</u>	<u>Classification (Casagrande)</u>	
20.5	16.6	4.0	M. H.	Silt.

Mechanical analyses were carried out on samples recovered at varying depths in each of the boreholes, and the details of these is given in tabular form as follows:

report

for The Department of Highways

Sheet No. 7.

<u>B. L. #</u>	<u>DEPTH</u>	<u>SAMPLE #</u>	<u>GRAVEL</u>	<u>SAND</u>	<u>SILT</u>	<u>CLAY</u>
1	7' - 7'7"	3		40	60	
1	20' - 21'	7	7	86	7	
1	30'4" - 31'	12		17	64	19
2	7' - 8'	3		93	7	
2	20' - 21'	8	14	81	5	
2	30'4" - 31'	11		9	81	10
3	10' - 11'	5		83	37	
3	12' - 13'	4		72	28	
3	20' - 21'	6	27	62	4	
3	25' - 25'6"	7	42	55	3	
4	10' - 11'	4		36	61	3
4	20' - 21'	7	15	82	3	
4	30' - 31'	11	10	43	36	11

Quick Drained Triaxial Compression Test

One such test was performed on representative remoulded samples of the more inferior sand near the surface in order to give some indication of the typical properties of this local material.

As a result of this test the properties for this type of material were determined as,

$$C = 0$$

$$\phi = 38^{\circ}$$

TEST RESULTS:**Quick Drained Triaxial Compression Test: (Cont'd)**

The details of the three samples tested are given in tabular form below.

Sample from borehole #4. Depth 7 - 8 feet. Sample No. 3.

Type of Test: Quick Drained.

Material Light brown very fine sand.

Test Number	1	2	3
Lateral press. lbs./sq. in.	10	30	60
Wt. of sample before test gm.	154.5	152.5	151.5
Wt. of sample after test gm.	153.0	150.5	143.3
Length inches	3.00	3.00	3.00
Area sq. inches	1.588	1.588	1.588
M/C before test %	20.3	20.3	20.3
M/C after test %	18.7	17.8	13.8
γ_w before test lb./cu. ft.	124.0	122.0	121.2
γ_w after test lb./cu. ft.	125.0	124.0	123.5
γ_d before test lb./cu. ft.	103.0	101.2	100.5
γ_d after test lb./cu. ft.	105.2	105.6	113.0
Sr before test %	89.9	88.0	84.0
Sr after test %	88.5	84.0	79.5
e before test	.600	.630	.640
e after test	.570	.560	.460

CONCLUSIONS AND RECOMMENDATIONS:

1. The soils arising on this site consist of four strata. Their boundaries are fairly clearly defined to a depth of 30 feet, but between depths of 30 and 35 feet the material is somewhat variable. These strata consist of:-
 - a) A pale to dark or reddish brown sandy loam topsoil containing organic matter, varying in thickness from 2 to 3 feet.

CONCLUSIONS AND RECOMMENDATIONS:

1. (Cont'd)

- b) A brown to grey compact to dense varying sand generally about 27 feet thick, with a fair silt content in the upper 15 to 18 feet; below this depth the grading improves considerably. In test hole #3 the sand stratum appears to persist throughout the full depth of the hole.**
- c) A thin layer, 4" thick, of gravel overlying a layer of light brown dense silt of varying thickness in holes #1 and 2. This silt layer is not evident in hole #3 whilst in hole #1 the material is a light brown compact sand, silt clay mixture with scattered grits and pebbles, 5 feet in thickness.**
- d) A stratum of grey to brown very dense, fine to medium sand with some silt, in each of the holes and varying in thickness from 5 to 9 feet.**

- 2. The sands in the upper 15 to 18 feet in the sand stratum referred to in (b) above are frost susceptible.**
- 3. There is a free water table at this site. At the date of the investigation, the elevation of the water table in the test holes varied between 989.22 and 989.91, which is between 30 and 31 feet below ground surface.**
- 4. The soil conditions are suitable for either a continuous strip foundation or a pile foundation.**
- 5. The recommended bearing capacity of the sand stratum at a depth of 15 feet for strip or continuous footings is,**

Minimum width of 5 feet. 3.1 tons per square foot.

Maximum width of 10 feet. 4.6 tons per square foot.

CONCLUSIONS AND RECOMMENDATIONS:**5. (Cont'd)**

These values include a safety factor of 3 and assume a minimum surcharge of 4 feet and provide for settlement not exceeding 1". For footings of intermediate sizes the bearing capacities may be interpolated from the values recommended. Furthermore these values may be increased by 0.15 tons per square foot for each foot of increase in the surcharge over and above 4 feet. However, in the event of a footing of 10 feet in width being required at depths greater than 15 feet we do not recommend that footings of such width should be placed at a depth greater than 17 feet below existing ground surface. Likewise we would restrict the depth of the minimum size footing to a maximum of 20 feet below ground surface.

These restrictions on the depth of footings are necessary to provide for the fluctuation in water table, which local information suggests may rise four feet above the level recorded on September 4th, 1958.

- 6.** Displacement or steel "H" piles are suitable types for these soil conditions. However, in view of the belt of non uniform material which appears to exist at depths of 25 to 30 feet below ground surface, we are of the opinion that displacement piles should be driven through this in order to bear on the very dense stratum at depth. However, having in mind the compact to dense stratum of material overlying this non uniform layer we feel that where displacement piles are used, this type of pile will have to be jettied into position.

Steel "H" piles will penetrate these compact to dense layers without the use of jetting and may therefore be preferred, where and if, piles are considered necessary from a structural design aspect or for reasons of site conditions. Such piles must be driven into the very dense material arising at depths of 35 to 40 feet, and some difficulty in driving these piles through the upper dense layers can be anticipated.

CONCLUSIONS AND RECOMMENDATIONS: (Cont'd)

7. In considering the various merits of these types of foundation, we feel that the decision as to choice will be influenced by type of structure, site conditions particularly in regard to the requirements of the C. N. R. , as well as the economic aspect of the design adopted.
8. Turning now to considerations of the embankments, and abutment wall design, and assuming the soil conditions found on the site are representative of those in the immediate vicinity, we can confirm that the construction of the proposed embankment presents no stability problem, provided normal precautions regarding compaction of subgrade and removal of topsoil are observed. We are not aware of the type of material to be used for the construction of the embankment and for that reason we have carried out only one quick drained triaxial test on a representative sample of the more inferior sand found near the surface. This data gives some indication of the properties of this material, and they are reasonably conservative figures for abutment design purposes, based on the assumption that the material used will probably be of better quality and will be placed to an accepted standard of compaction.

Accordingly, for design purposes we recommend the adoption of the following values, for

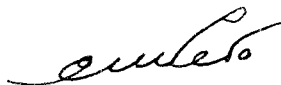
$$\phi = 35^{\circ}$$

$$W = 125 \text{ lbs. per cubic foot.}$$

$$\delta = 25^{\circ} \text{ angle friction between wall and material.}$$

9. The natural material is reasonably free draining, accordingly subsoil drains should not be necessary, however, this should not preclude the use of weep hole drains or some alternative method of draining the material immediately behind the abutment walls.

E. M. PETO ASSOCIATES LTD.,



E. M. Peto, P. Eng.

CFF:sb

BOREHOLE LOG

Checked By CEH

W. T. GROUND WATER TABLE IN SOIL

SOIL DESCRIPTION	COLOR	Density or Consistency	Depth Elevation	Legend	Sample No and Condition	Sample Type	No. of Blows per Ft.	WATER LEVELS, SOIL MOISTURE & REMARKS
		SCALE 3' TO 1"						
GROUND SURFACE			0' 0"					
LOAM WITH ORGANIC MATTER	REDDISH-BROWN		1019.97	(Symbol)	(X)	S.S.	12	MOIST. SLIGHTLY MOIST M.C = 12.3%
SILT V FINE SAND, GRITS & PEBBLES	LT. BROWN	COMPACT	5' 0"	(Symbol)	(X)	S.S.	7	M.O.IST. M.C = 18.9%
AS ABOVE	LT. BROWN	LOOSE	6' 0"	(Symbol)	(X)	S.S.	11	MOIST. LOWER PART OF SAMPLE COARSER M.C = 4.4%
VERY FINE SAND SEAMS OF SILT	LT. BROWN	LOOSE To COMPACT	10' 0"	(Symbol)	(X)	S.S.	22	SLIGHTLY MOIST. M.C = 5.1% WASH WATER USED BELOW 11 FT
V.FINE SAND, SEAMS OF SILT	PALE BROWN	COMPACT		(Symbol)	(X)	S.S.	26	MOIST.
AS ABOVE	AS ABOVE		15' 0"	(Symbol)	(X)	N.S.		
VERY FINE SAND WITH LAYERS OF MEDIUM SAND	BROWN WITH GREY	COMPACT	20' 0"	(Symbol)	(X)	S.S.	46	MOIST.
MEDIUM SOME COARSE SAND & GRAVEL	GREY-BROWN	DENSE		(Symbol)	(X)	S.S.	39	VERY MOIST.
FINE TO MED. SAND	LT. BROWN		25' 0"	(Symbol)	(X)	N.S.		
FINE TO MED. SAND	LT. BROWN	DENSE		(Symbol)	(X)	S.S.	154	MOIST
AS ABOVE	AS ABOVE		30' 0"	(Symbol)	(X)	N.S.		
GRAVEL WITH CLAYEY SILT, LUMPY, SILT 30-40-50%	LT. BROWN	DENSE	- 2 -	(Symbol)	(X)	S.S.	100/5"	HOLE TERMINATED.
SILT	DITTO	DITTO		(Symbol)	(X)	N.S.		
SILT WITH FINE TO COARSE SAND	LT. BROWN		35' 0"	(Symbol)	(X)	S.S.		
FINE TO MEDIUM SILTY SAND	GREY		40' 0"	(Symbol)	(X)	N.S.		
		V.DENSE	979.97					

BOREHOLE LOG

Borehole No. 2

Boring Date SEP. 1 1958

Checked By C.F.F.

ABBREVIATIONS

 UNDISTURBED

 FAIR

 DISTURBED

LOST

5.5. 2" STANDARD SPLIT TUBE SAMPLE

S. L. SPLIT BARREL WITH LINERS

S. T. THIN-WALLED SHELBY TUBE SAMPLE

W. S. WASH SAMPLE

R. C. ROCK CORE

V. T. IN SITU VANE SHEAR TEST

Q/u UNCONFINED COMPRESSIVE STRENGTH

W.L. WATER LEVEL IN CASING

W. T. GROUND WATER TABLE IN SOIL

SOIL DESCRIPTION	COLOUR	Density or Consistency	Depth Elevation	Legend	Sample No. and Condition	Sample Type	No. of Blows per Ft.	WATER LEVELS, SOIL MOISTURE & REMARKS
		SCALE 5 TO 1"						
GROUND SURFACE			0'0"					
SANDY LOAM WITH ORGANIC MATTER	0"-6" DK. BROWN		1019.91					MOIST
SILTY V. FINE SAND	LT. BROWN	LOOSE TO COMPACT			1	S.S.	11	SLIGHTLY MOIST
	REDDISH BROWN		5'0"					SLIGHTLY MOIST M.C. 8.4%
FINE SAND, SOME SILT	AS ABOVE	V. LOOSE TO LOOSE			2	S.S.	4	SLIGHTLY MOIST M.C. 6.1%
FINE SAND	PALE BROWN	LOOSE TO COMPACT			3	S.S.	10	SLIGHTLY MOIST M.C. 5.0%
			10'0"					WASH WATER USED BELOW 8 FT.
AS ABOVE	AS ABOVE	COMPACT			4	S.S.	16	SLIGHTLY MOIST
			15'0"					
FINE TO MEDIUM SAND	GREY	COMPACT			5	S.S.	21	WET
			20'0"					
FINE TO COARSE SAND, GRITS & PEBBLES	GREY	DENSE			6	S.S.	41	WET
FINE TO MEDIUM SAND, GRITS & PEBBLES	GREY				7	W.S.		
			25'0"					
VERY FINE SILTY SAND MIXED WITH GRITS & PEBBLES	LT. BROWN	COMPACT			8	S.S.	14	WET
FINE TO MEDIUM SAND	GREY-BROWN				9	W.S.		
			30'0"					V.T. 30'0" SEP. 4-'58 EL. 983.91
30'0"-30'4" FINE GRAVEL MIXED WITH V. FINE SILTY SAND FROM 30'4"-31'0" SILT	LT. BROWN	DENSE			10	S.S.	40	30'0"-30'4" SATURATED FROM 30'4" MOIST
FINE TO MEDIUM SAND, SOME SILT	LT. BROWN				11	W.S.		
	GREY		35'0"					
AS ABOVE	AS ABOVE	V. DENSE			12	S.S.	100/5 1/2	
FINE TO MEDIUM SAND	GREY				13	W.S.		
					14	W.S.		
		V. DENSE	40'0"		15	S.S.	100/5"	
			979.91					
		HOLE TERMINATED						

BOREHOLE LOG

Checked By C.F.F.

ABBREVIATIONS

W.T. GROUND WATER TABLE IN SOIL

SOIL DESCRIPTION	COLOR	Density or Consistency	Depth Elevation	Legend	Sample No and Condition	Sample Type	No. of Blows per Ft	WATER LEVELS, SOIL MOISTURE & REMARKS
		SCALE 5' TO 1"						
GROUND SURFACE			0'0"					
0"-6" V. SANDY LOAM, ROOTS	DK. BROWN		1020.94					MOIST
V. SANDY LOAM, SCATTERED PEBBLES	PALE BROWN							SLIGHTLY MOIST
V. SANDY LOAM	MIXED BROWN	LOOSE	3'0"		1	S.S.	5	SLIGHTLY MOIST M.C. 7.5%
COARSE SAND WITH LAYERS OF FINE SAND	LT. BROWN & MIXED BROWN	LOOSE			2	S.S.	6	SLIGHTLY MOIST M.C. 4.5%
					2A	2 S.L.	PUSHED	
			10'6"					
VERY FINE SILTY SAND	V. PALE BROWN	COMPACT			3	S.S.	25	MOIST M.C. 7.0%
AS ABOVE	AS ABOVE	DENSE			4	S.S.	34	MOIST M.C. 5.3%
			15'0"					M.C. 21.0% AT 14'6"
AS ABOVE	AS ABOVE	DENSE			5	S.S.	45	VERY MOIST M.C. 9.3%
			18'0"					WASH WATER USED BELOW 16 FT
COARSE SAND & FINE GRAVEL	GREY-BROWN		20'0"					
AS ABOVE	AS ABOVE	DENSE TO VERY DENSE			6	S.S.	54	WET
AS ABOVE, COARSER FINE SAND	AS ABOVE LT. BROWN	V. DENSE	25'5"		7	S.S.	65	WET MOIST FOR FINE SAND. CHANGE AT 25'5" IN SAMPLE 7.
FINE TO MEDIUM SAND	LT. BROWN				8	W.S.		
			30'0"					
FINE GRAVEL LUMPS OF SILT	GREY-BROWN	V. DENSE			9	S.S.	91	WET.
		V. DENSE	35'0"		10	S.S.	221	W.T. 33'3" SEP 4-58 EL. 987.55
FINE TO MEDIUM SAND	LT. BROWN				11	W.S.		
AS ABOVE	AS ABOVE	V. DENSE	41'0"		12	W.S.	110/3"	NOTE: SAMPLE FROM 40'0" TO 41'0" WAS LOST DURING RECOVERY.
			379.84					
		HOLE TERMINATED						

BOREHOLE LOG

Checked By C.F.F.

ABBREVIATIONS

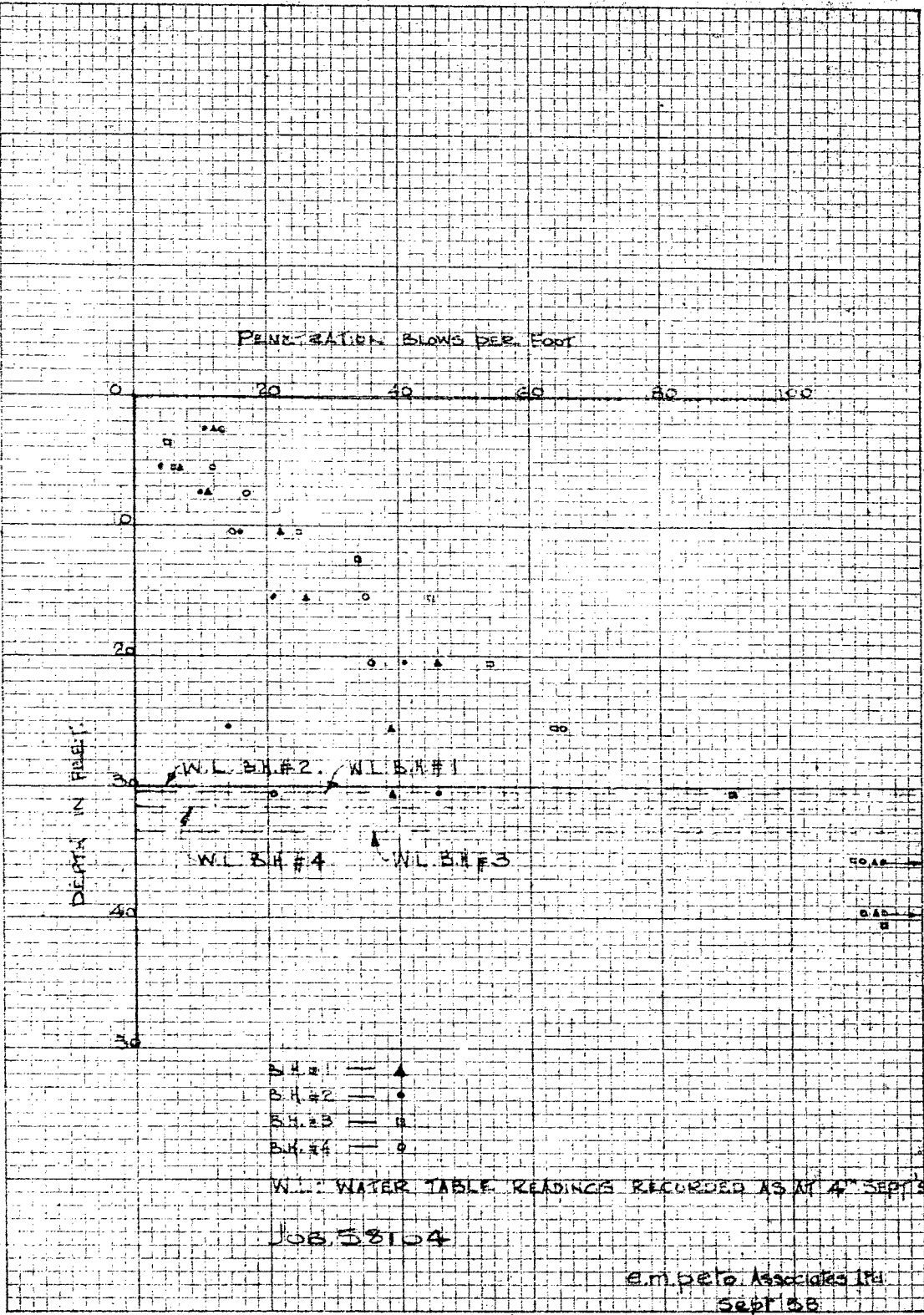
W. T. GROUND WATER TABLE IN SOIL

SOIL DESCRIPTION	COLOR	Density or Consistency	Depth Elevation	Legend	Sample No and Condition	Sample Type	No. of Blows per Ft.	WATER LEVELS, SOIL MOISTURE & REMARKS
GROUND SURFACE		SCALE 5 TO 1	0'0"					
TOP SOIL, SANDY LOAM MIXED WITH ORGANIC MATTER	V.DK. BROWN		1020 GA					LESS THAN PLASTIC LIMIT.
SILT Y LOAM, SCATTERED GRITS & PEBBLES, SOME ORGANIC MATTER	LT. BROWN	LOOSE TO COMPACT	3'0"		1	X S.S.	12	SLIGHTLY LOWER THAN PLASTIC LIMIT. M.C. 11.1%
			5'0"		2	X S.S.	12	SLIGHTLY MOIST M.C. 2.5%
MEDIUM WITH SOME COARSE SAND	LT. REDDISH-BROWN	LOOSE TO COMPACT			3	X S.S.	17	MOIST M.C. 5.4%
VERY FINE SAND	LT. BROWN	COMPACT			4	X S.S.	16	MOIST M.C. 18.9%
			10'0"					
VERY FINE SANDY SILT	AS ABOVE	COMPACT						
			15'0"		5	/ X S.S.	35	MOIST M.C. 11.8% WASH WATER USED BELOW 15 FT
VERY FINE SAND	AS ABOVE	COMPACT TO DENSE			6	/ X W.S.		
FINE TO MEDIUM SAND	BROWN							
			20'0"		7	/ X S.S.	36	WET.
COARSE TO MED. SAND, SCATTERED GRAVEL & PEBBLES	GREY-BROWN	DENSE			8	/ X W.S.		
FINE TO MEDIUM SAND	BROWN							
			25'0"		9	/ X S.S.	65	WET.
COARSE TO MEDIUM SAND	GREY-BROWN	VERY DENSE			10	/ X W.S.		
FINE TO MEDIUM WITH SOME COARSE SAND	BROWN							
			30'0"		11	/ X G.S.	21	WETTER THAN PLASTIC LIMIT. V.L. 31.5" SEP. 4-58 EL. 988.22 HOLE Cased TO 30'0"
SANDY CLAYBY SILT WITH SCATTERED GRITS & PEBBLES (SANDY TILL)	LT. BROWN	COMPACT						
			35'0"					
FINE TO MED. SAND WITH LUMPS OF SILT, SCATTERED PEBBLY GRAVEL	BROWN	V. DENSE			12	/ X S.S.	100/4"	SATURATED
					13	/ X W.S.		
FINE SAND	LT. BROWN	V. DENSE			14	/ X S.S.	100/3"	
			40'0"					
			980 GA					
		HOLE TERMINATED						

APPENDIX I

LABORATORY TESTS

KENNEL & CARR CO. AUSTIN, TEXAS
10 X 10 TO THE INCH 3882



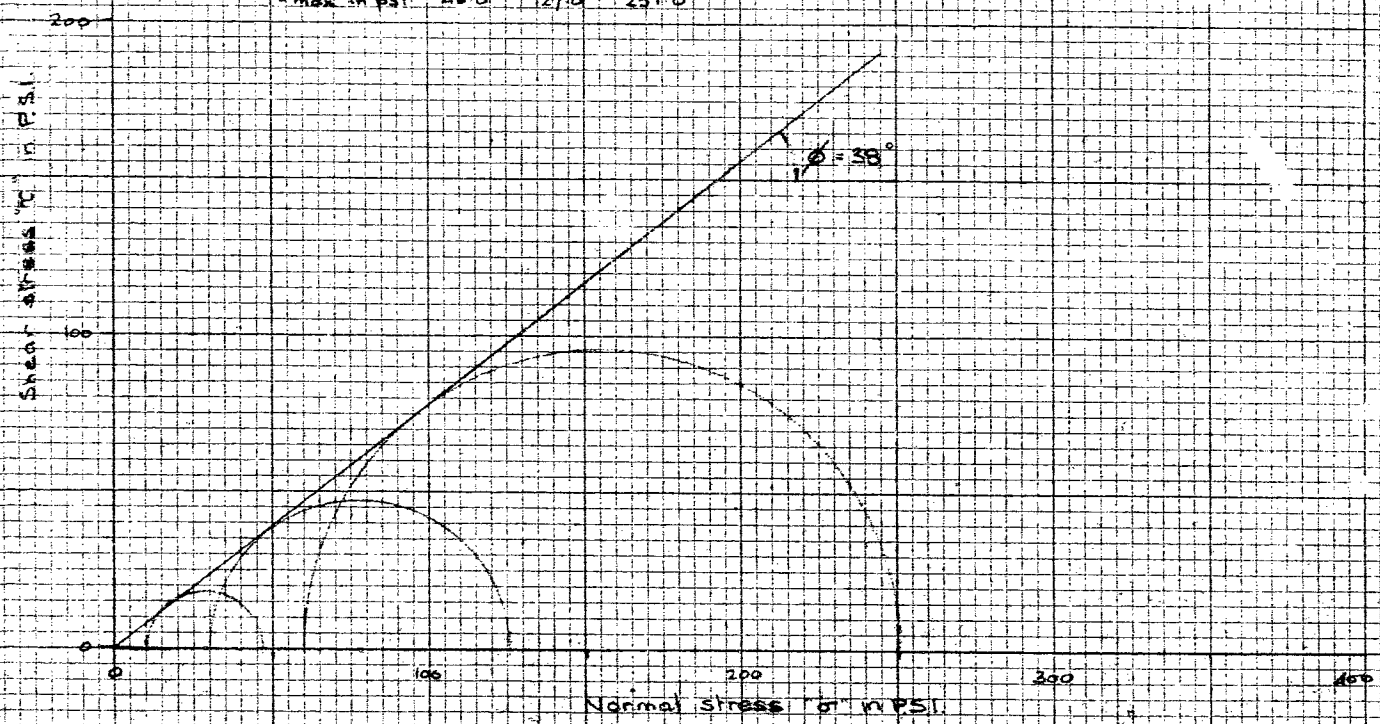
Quick drained triaxial compression test

Job No. 38104

Light brown very fine sand 5.14" Sample # 3 7.0" - 8.0"

σ_{min} in psi 1.0 30 60

σ_{max} in psi 46.6 27.0 251.0



e.m. petro Associates Ltd
P.M.A. Sept 11 1958

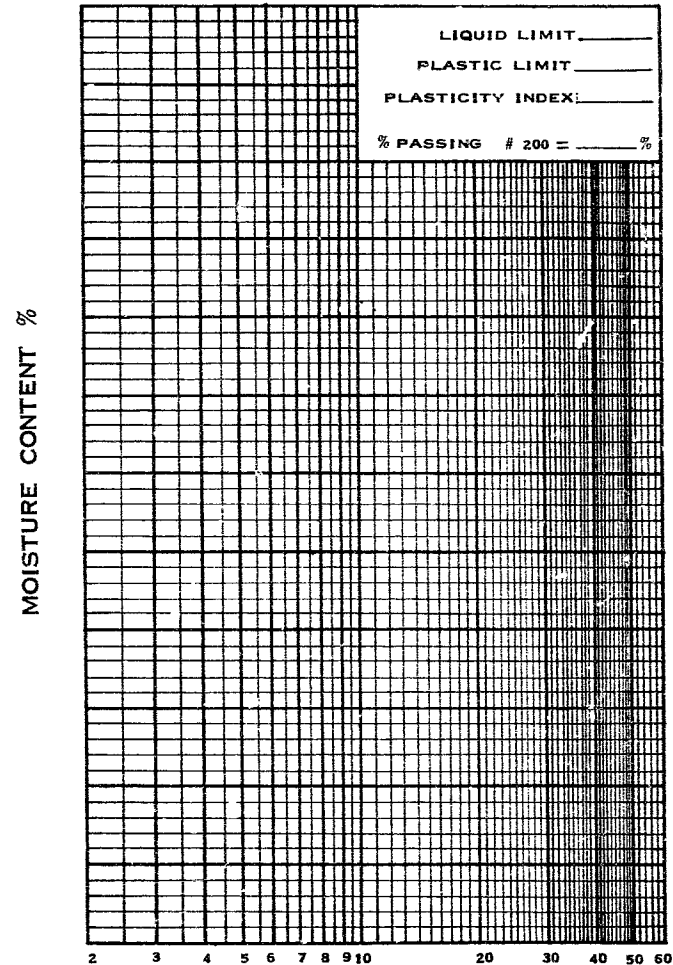
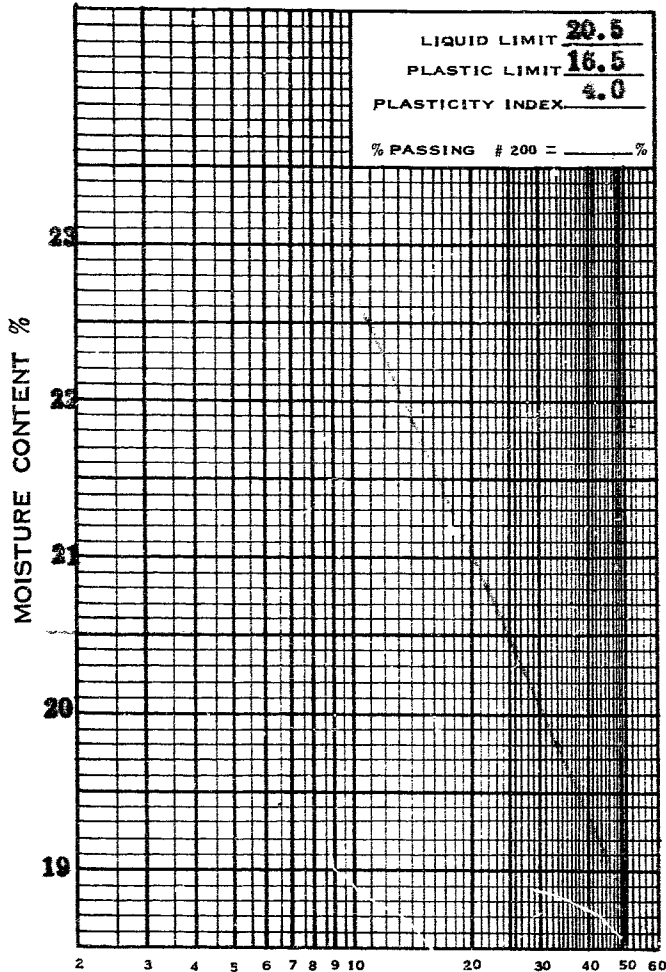
e. m. peto associates ltd.
SOIL TESTING LABORATORY

LIQUID LIMIT TEST

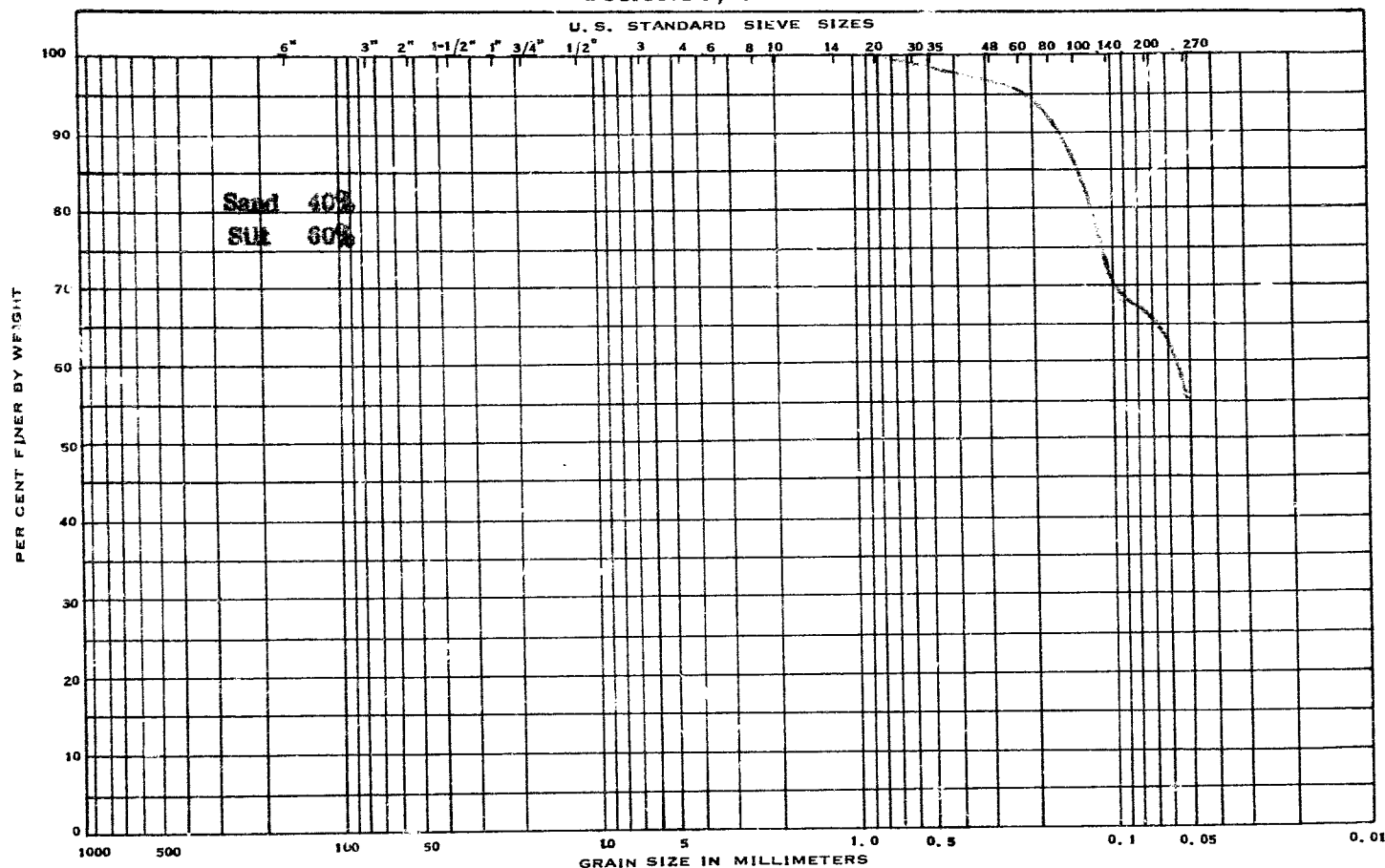
FLOW LINE CHARTS

JOB NO. 58104 PROJECT Hwy. 401 C.N.R. Crossing
SAMPLE FROM B.R. 1 Sample 14
DEPTH 34' - 35'

SAMPLE FROM _____
DEPTH _____



e. m. peto associates ltd.
TORONTO, ONTARIO



BOULDERS	STONES	GRAVEL	COARSE SAND	MED. SAND	FINE SAND	COARSE SILT	MED. SILT
----------	--------	--------	-------------	-----------	-----------	-------------	-----------

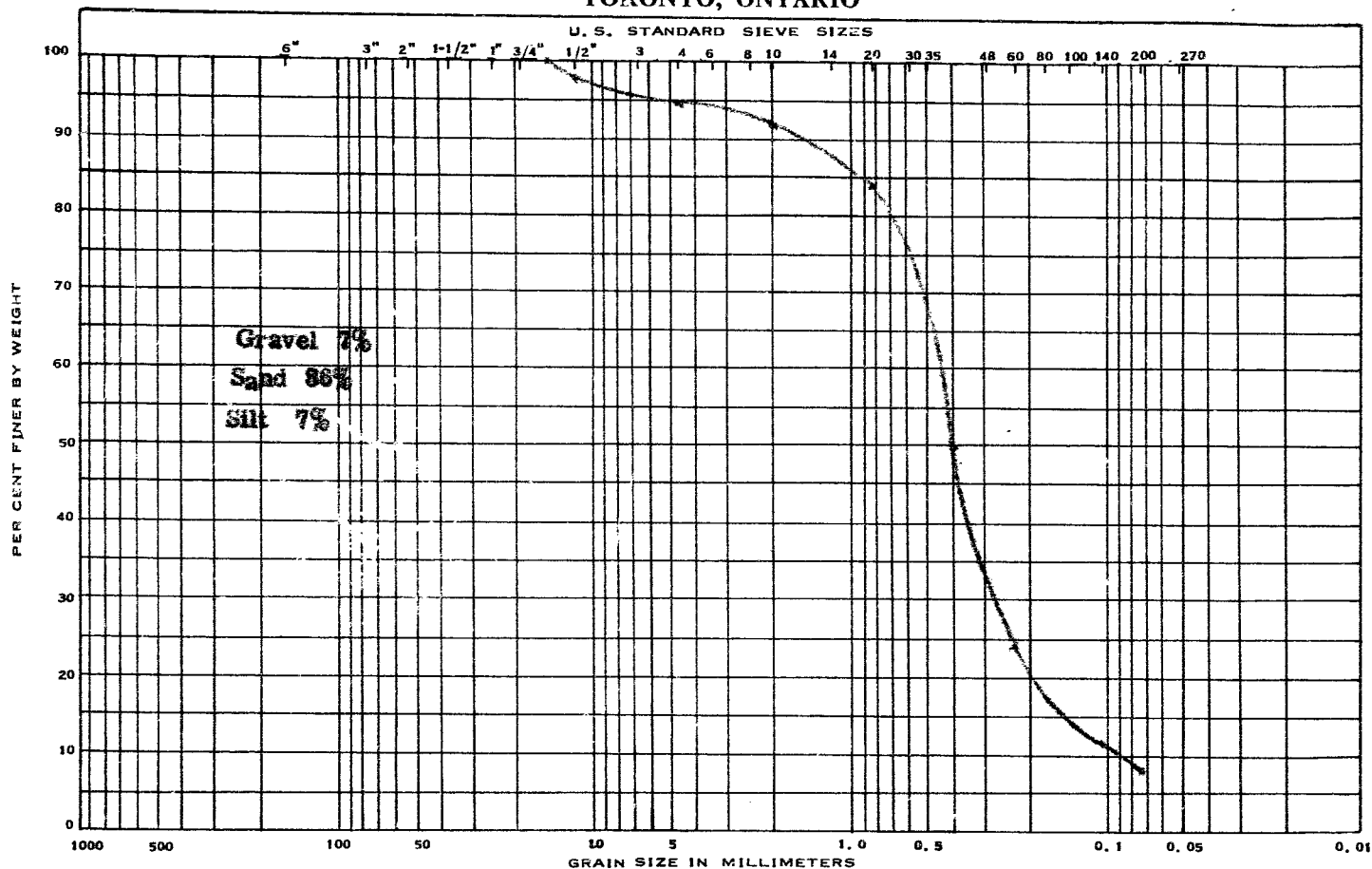
MASS. INST. OF TECH. CLASSIFICATION

JOB NAME Hwy 401 C.N.R. Crossing JOB NO. 58104 HOLE NO. 1 SAMPLE NO. 3

DEPTH 7177' ELEVATION _____ REMARKS Light brown very fine sand silt.

GRAIN SIZE DISTRIBUTION DIAGRAM
COARSE MATERIALS

e. m. peto associates ltd.
TORONTO, ONTARIO



BOULDERS	STONES	GRAVEL	COARSE SAND	MED. SAND	FINE SAND	COARSE SILT	MED. SILT
----------	--------	--------	-------------	-----------	-----------	-------------	-----------

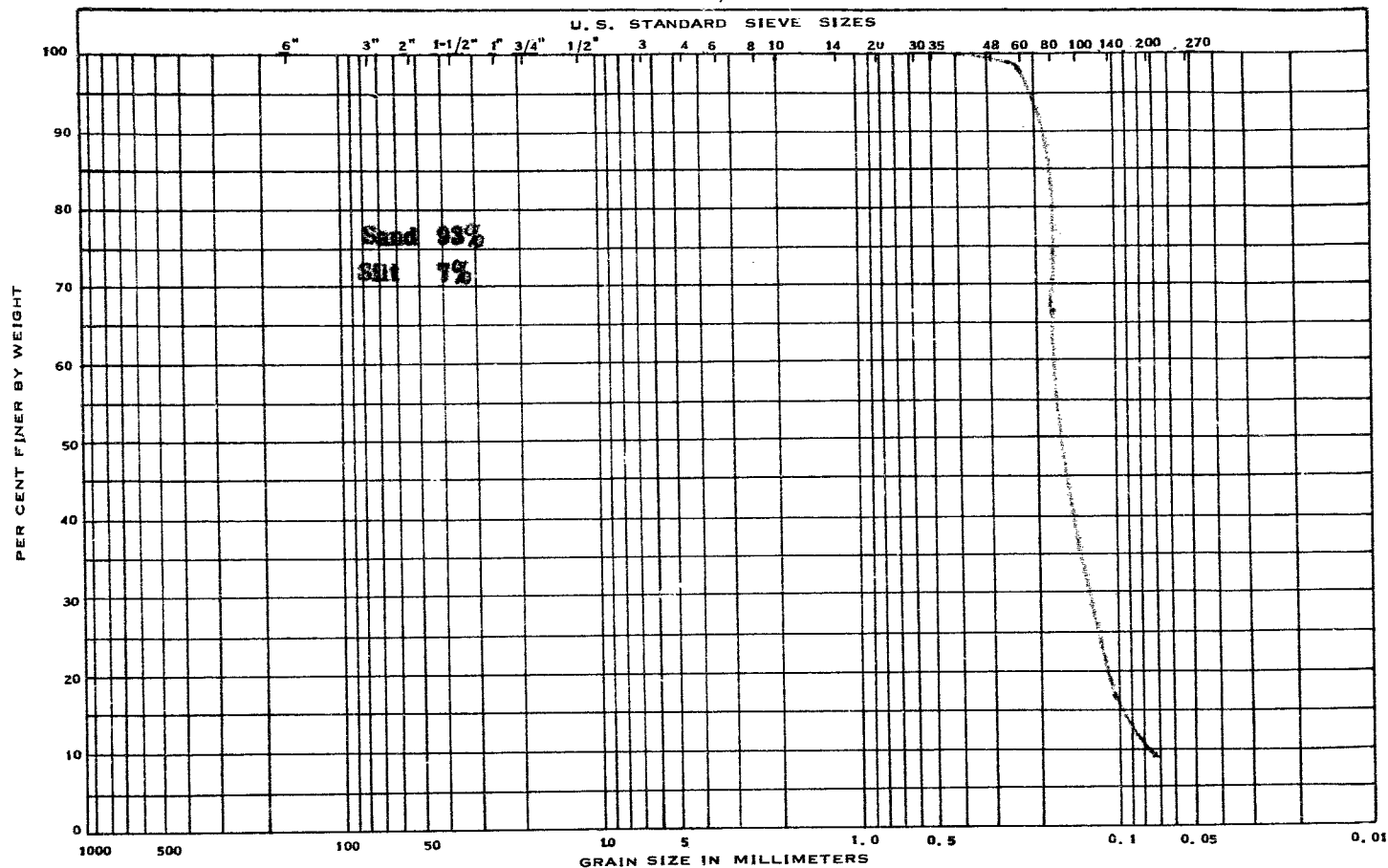
MASS. INST. OF TECH. CLASSIFICATION

JOB NAME Hwy. 401 - C.N.R. Crossing JOB NO. 58104 HOLE NO. 1 SAMPLE NO. 7

DEPTH 20'-21' ELEVATION _____ REMARKS Grey brown medium with some coarse sand and gravel.

GRAIN SIZE DISTRIBUTION DIAGRAM
COARSE MATERIALS

e. m. peto associates ltd.
TORONTO, ONTARIO



BOULDERS	STONES	GRAVEL	COARSE SAND	MED. SAND	FINE SAND	COARSE SILT	MED. SILT
----------	--------	--------	-------------	-----------	-----------	-------------	-----------

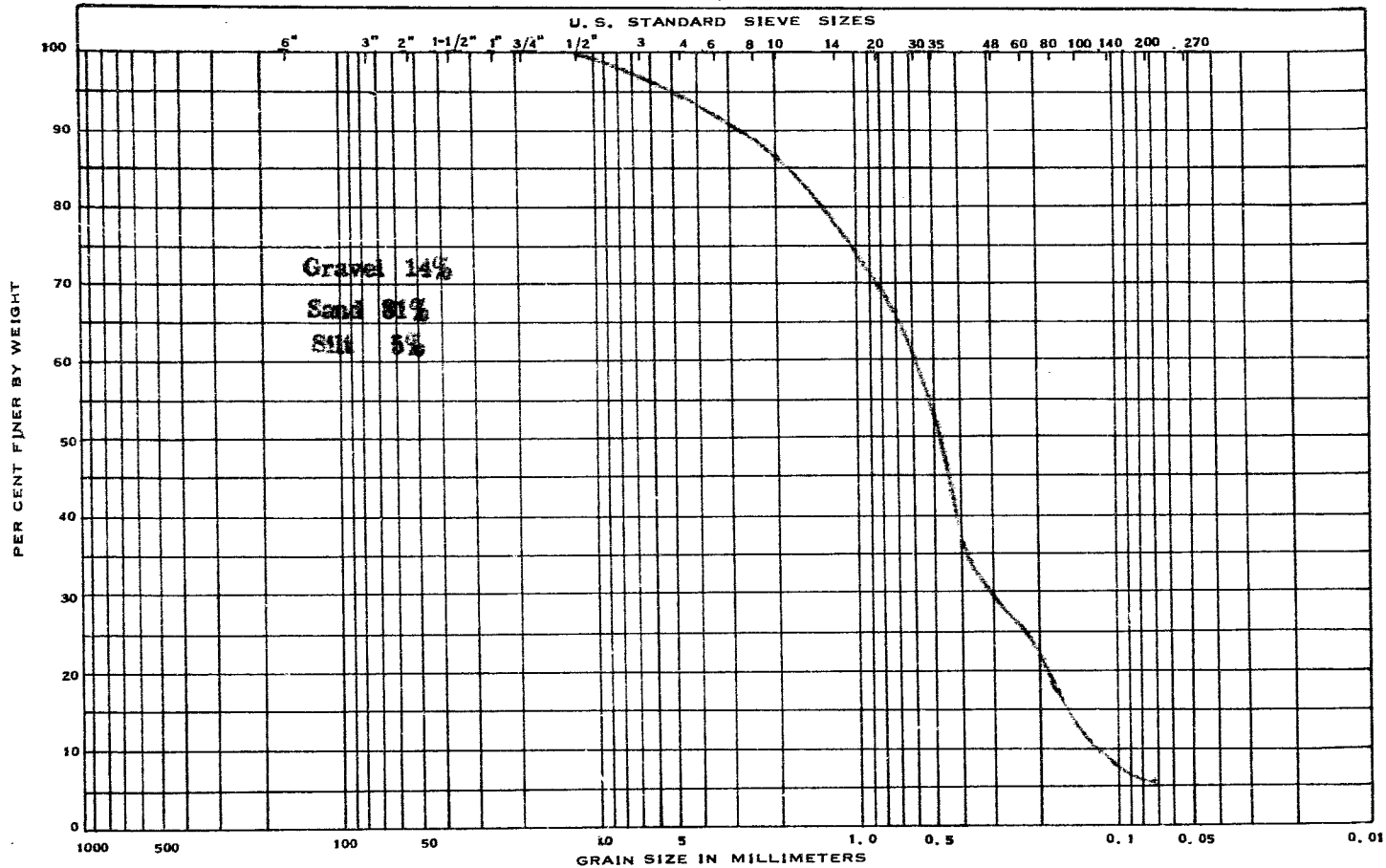
MASS. INST. OF TECH. CLASSIFICATION

JOB NAME Hwy. 401 C. N. R. Crossing JOB NO. 58104 HOLE NO. 2 SAMPLE NO. 3

DEPTH 7' - 2" ELEVATION _____ REMARKS Pale brown fine sand.

GRAIN SIZE DISTRIBUTION DIAGRAM
COARSE MATERIALS

e. m. peto associates ltd.
TORONTO, ONTARIO



BOULDERS	STONES	GRAVEL	COARSE SAND	MED. SAND	FINE SAND	COARSE SILT	MED. SILT
----------	--------	--------	-------------	-----------	-----------	-------------	-----------

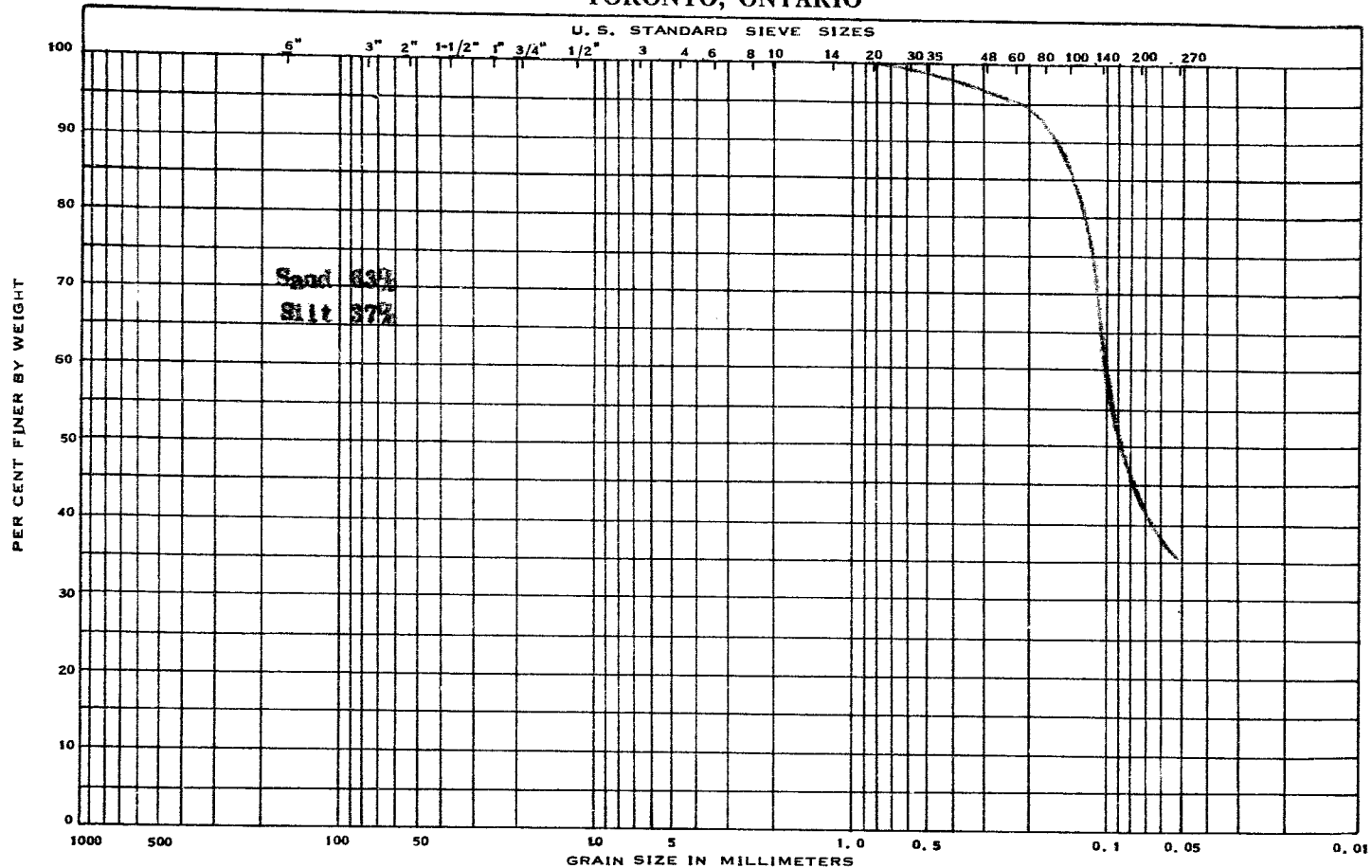
MASS. INST. OF TECH. CLASSIFICATION

JOB NAME May. 401 C.N.R. Crossing JOB NO. 58104 HOLE NO. 2 SAMPLE NO. 6

DEPTH 20'-21' ELEVATION _____ REMARKS Grey fine-coarse sand, grits and pebbles.

GRAIN SIZE DISTRIBUTION DIAGRAM COARSE MATERIALS

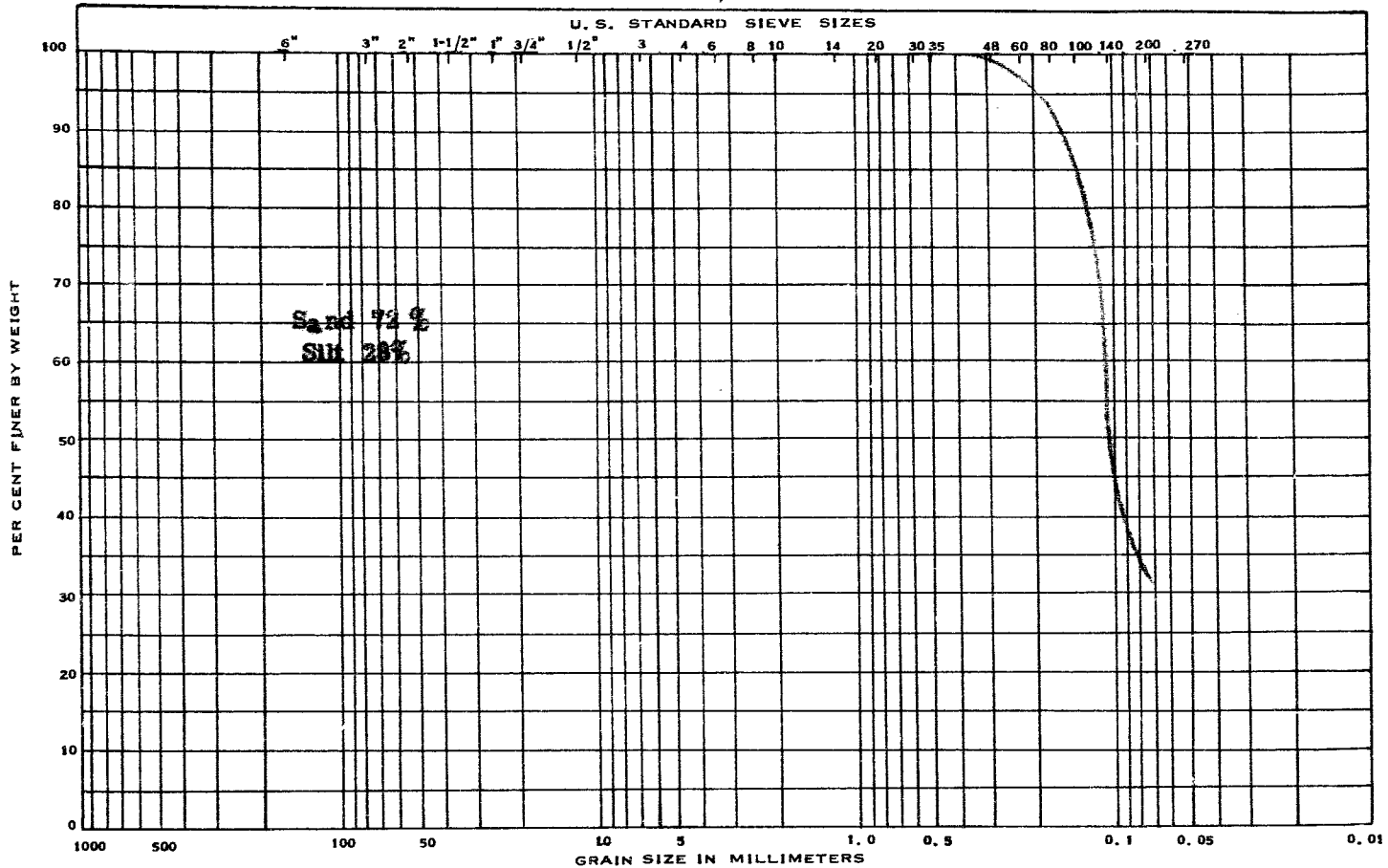
e. m. peto associates ltd.
TORONTO, ONTARIO



BOULDERS	STONES	GRAVEL	COARSE SAND	MED. SAND	FINE SAND	COARSE SILT	MED. SILT
----------	--------	--------	-------------	-----------	-----------	-------------	-----------

Hwy. 401 C.N.R. Crossing
JOB NAME 10-11
DEPTH
ELEVATION
REMARKS
MASS. INST. OF TECH. CLASSIFICATION 58104
HOLE NO. 3
SAMPLE NO. 5
very pale brown fine silty sand.

e. m. peto associates ltd.
TORONTO, ONTARIO



BOULDERS	STONES	GRAVEL	COARSE SAND	MED. SAND	FINE SAND	COARSE SILT	MED. SILT
----------	--------	--------	-------------	-----------	-----------	-------------	-----------

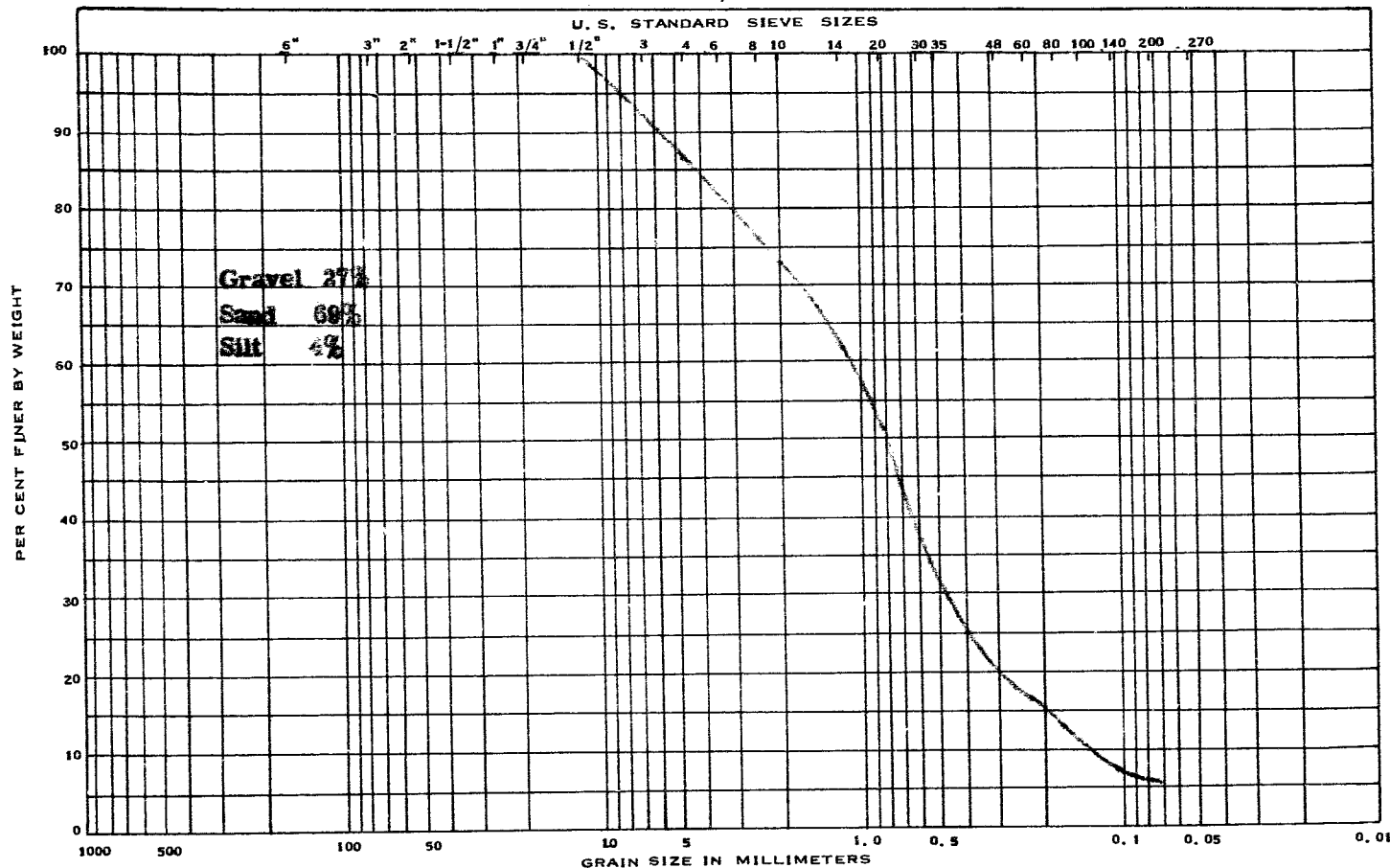
MASS. INST. OF TECH. CLASSIFICATION

JOB NAME Hwy. 401 - C.N.R. Crossing JOB NO. 58104 HOLE NO. 3 SAMPLE NO. 4

DEPTH 12'-13' ELEVATION _____ REMARKS Very pale brown very fine silty sand.

GRAIN SIZE DISTRIBUTION DIAGRAM COARSE MATERIALS

e. m. peto associates ltd.
TORONTO, ONTARIO



Gravel 27%
Sand 69%
Silt 4%

BOULDERS	STONES	GRAVEL	COARSE SAND	MED. SAND	FINE SAND	COARSE SILT	MED. SILT
----------	--------	--------	-------------	-----------	-----------	-------------	-----------

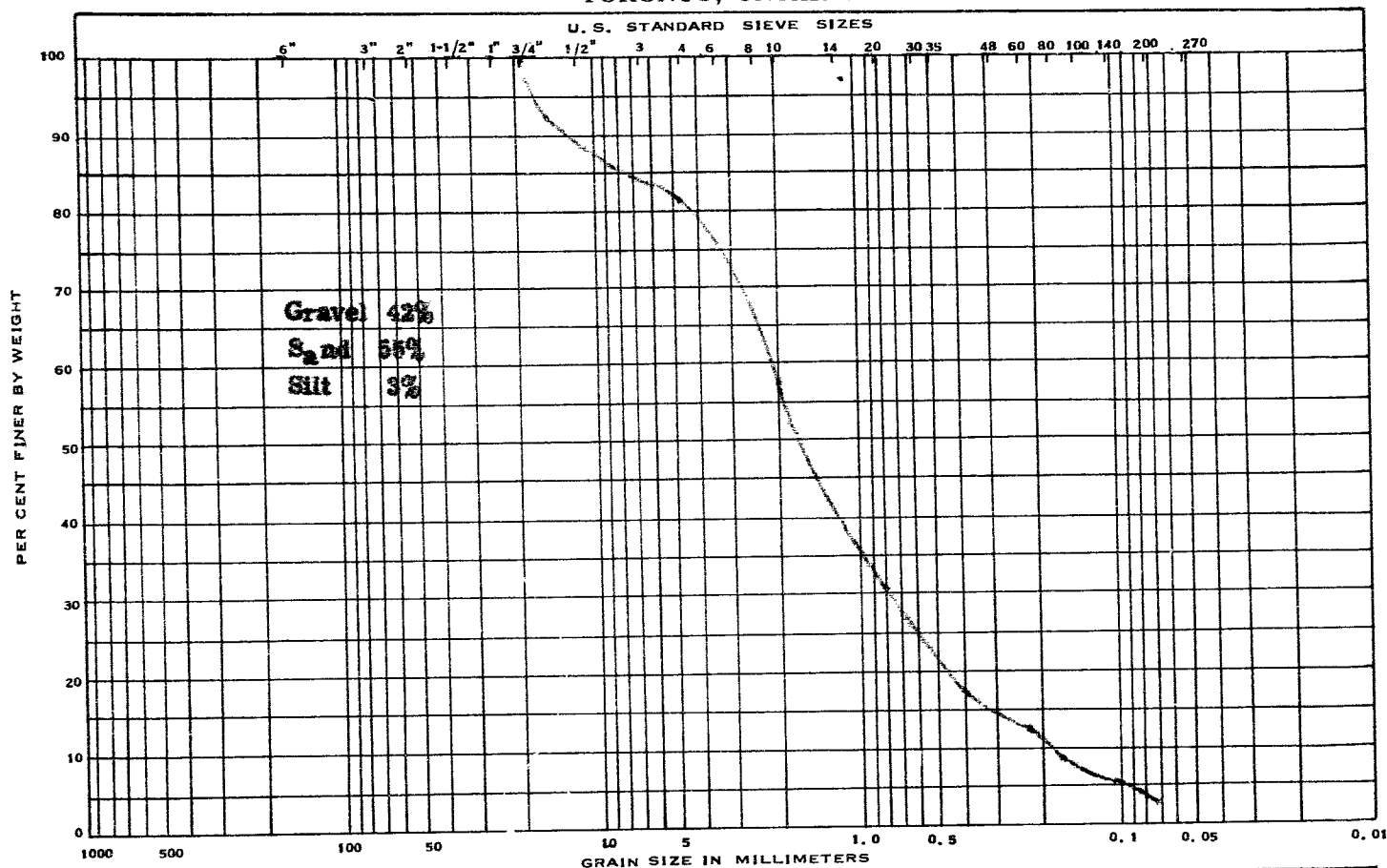
MASS. INST. OF TECH. CLASSIFICATION

JOB NAME Hwy. 401 - C.N.R. Crossing JOB NO. 58104 HOLE NO. 3 SAMPLE NO. 6

DEPTH 20'-21' ELEVATION _____ REMARKS Grey brown coarse sand and fine gravel.

GRAIN SIZE DISTRIBUTION DIAGRAM
COARSE MATERIALS

e. m. peto associates ltd.
TORONTO, ONTARIO



BOULDERS	STONES	GRAVEL	COARSE SAND	MED. SAND	FINE SAND	COARSE SILT	MED. SILT
----------	--------	--------	-------------	-----------	-----------	-------------	-----------

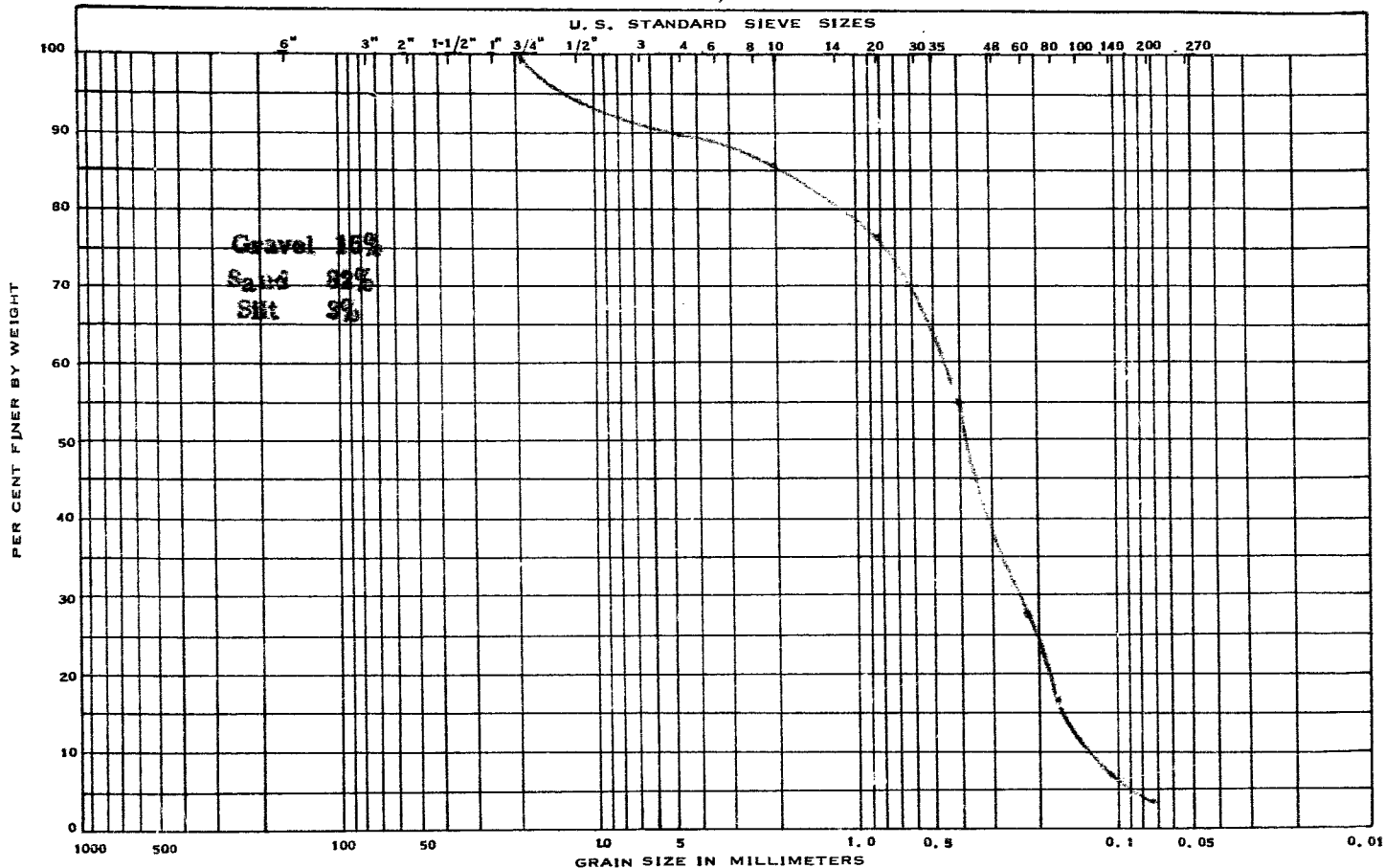
MASS. INST. OF TECH. CLASSIFICATION

JOB NAME Hwy. 401 - C.N.R. Crossing JOB NO. 58104 HOLE NO. 3 SAMPLE NO. 7

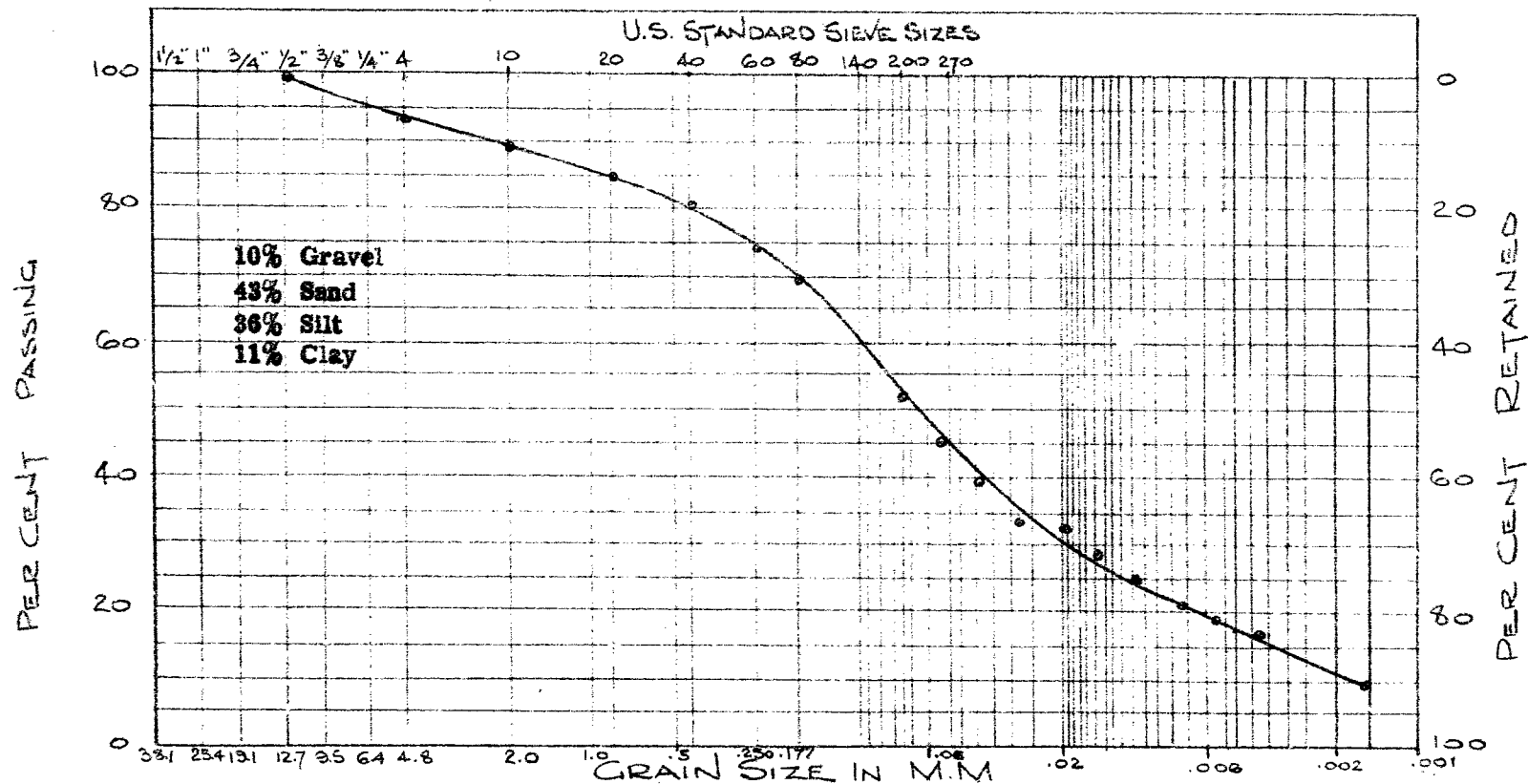
DEPTH 25'-25'5" ELEVATION _____ REMARKS Greybrown coarse sand and fine gravel.

GRAIN SIZE DISTRIBUTION DIAGRAM
COARSE MATERIALS

e. m. peto associates ltd.
TORONTO, ONTARIO



E.M. PETO ASSOCIATES LTD.



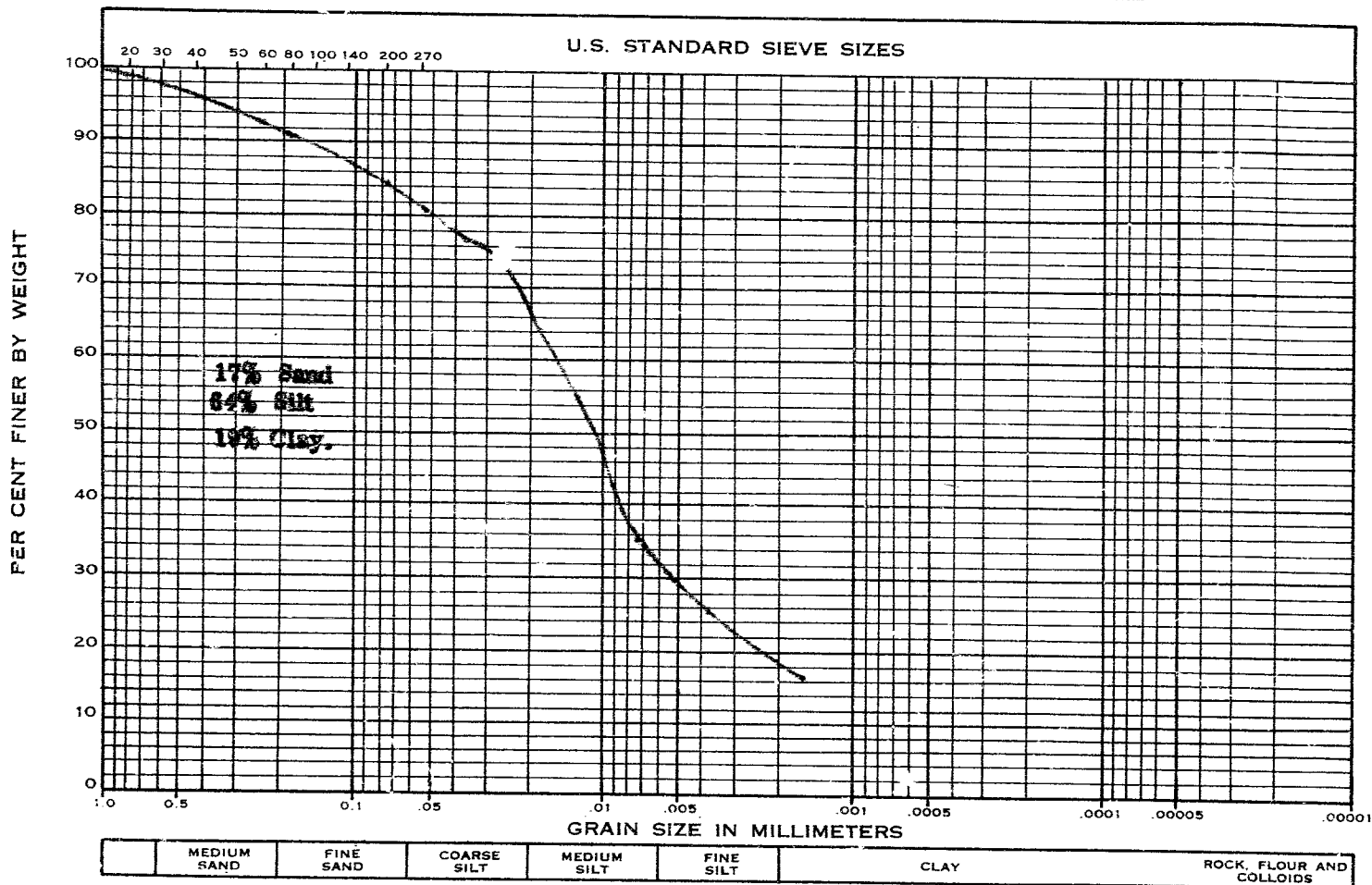
GRAVEL	COARSE SAND	MEDIUM SAND	FINE SAND	COARSE SILT	MEDIUM SILT	FINE SILT	CLAY
--------	-------------	-------------	-----------	-------------	-------------	-----------	------

M.I.T. CLASSIFICATION.

JOB NAME Hwy. 401 C.N.R. Crossing JOB NO. 58104 BOREHOLE NO. 4 SAMPLE NO. 11

DEPTH 30'-31' ELEVATION _____ REMARKS Light brown sandy till.

E. M. PETO ASSOCIATES LTD.
HYDROMETER GRAIN SIZE DISTRIBUTION DIAGRAM

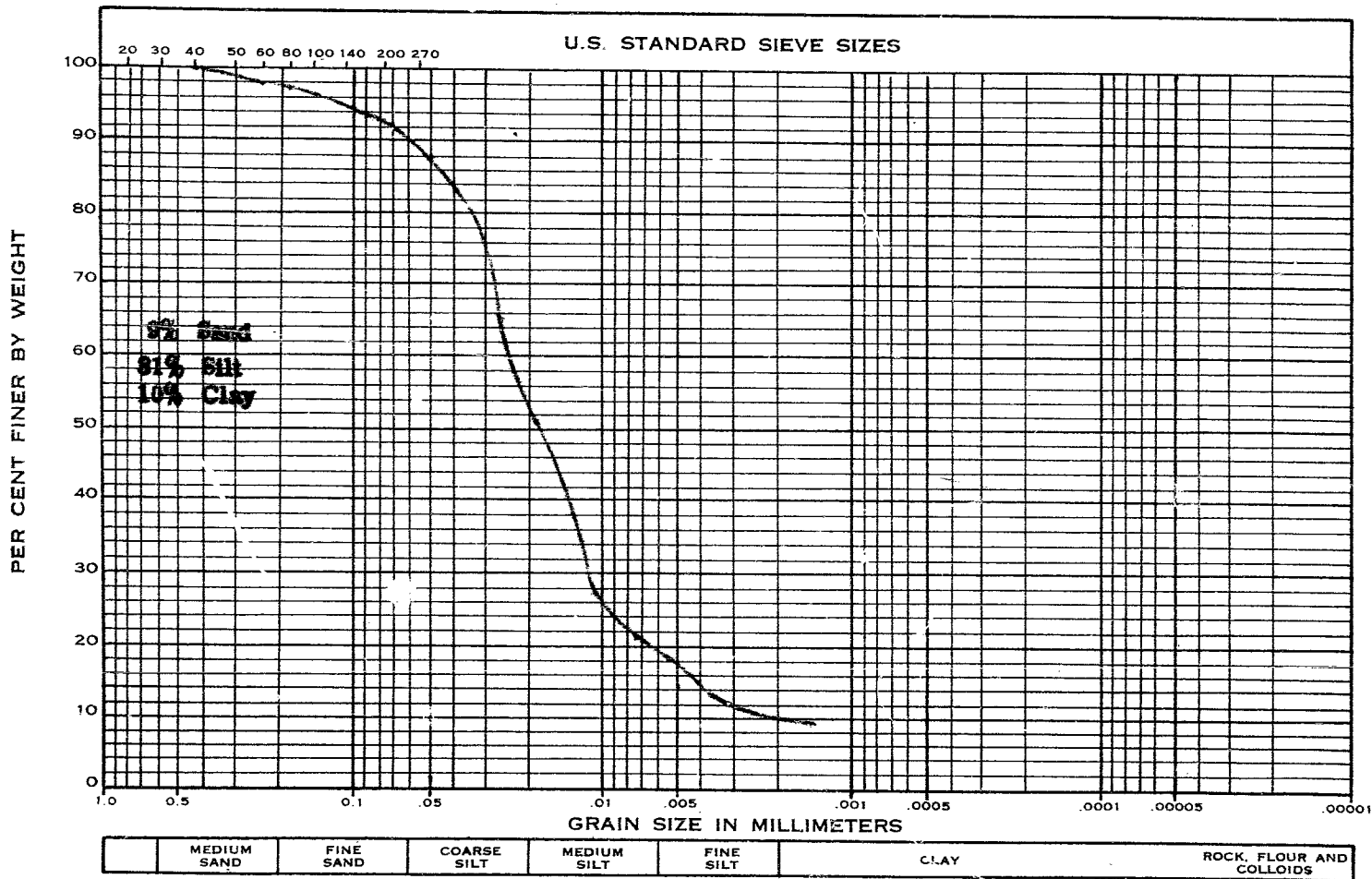


M.I.T. CLASSIFICATION

JOB NAME Ewy. 401 C.N.R. Crossing JOB No. 58104 BOREHOLE No. 1 SAMPLE No. 12

DEPTH 30'4"-31' ELEVATION _____ REMARKS Light brown fine clayey silt.

E. M. PETO ASSOCIATES LTD.
HYDROMETER GRAIN SIZE DISTRIBUTION DIAGRAM

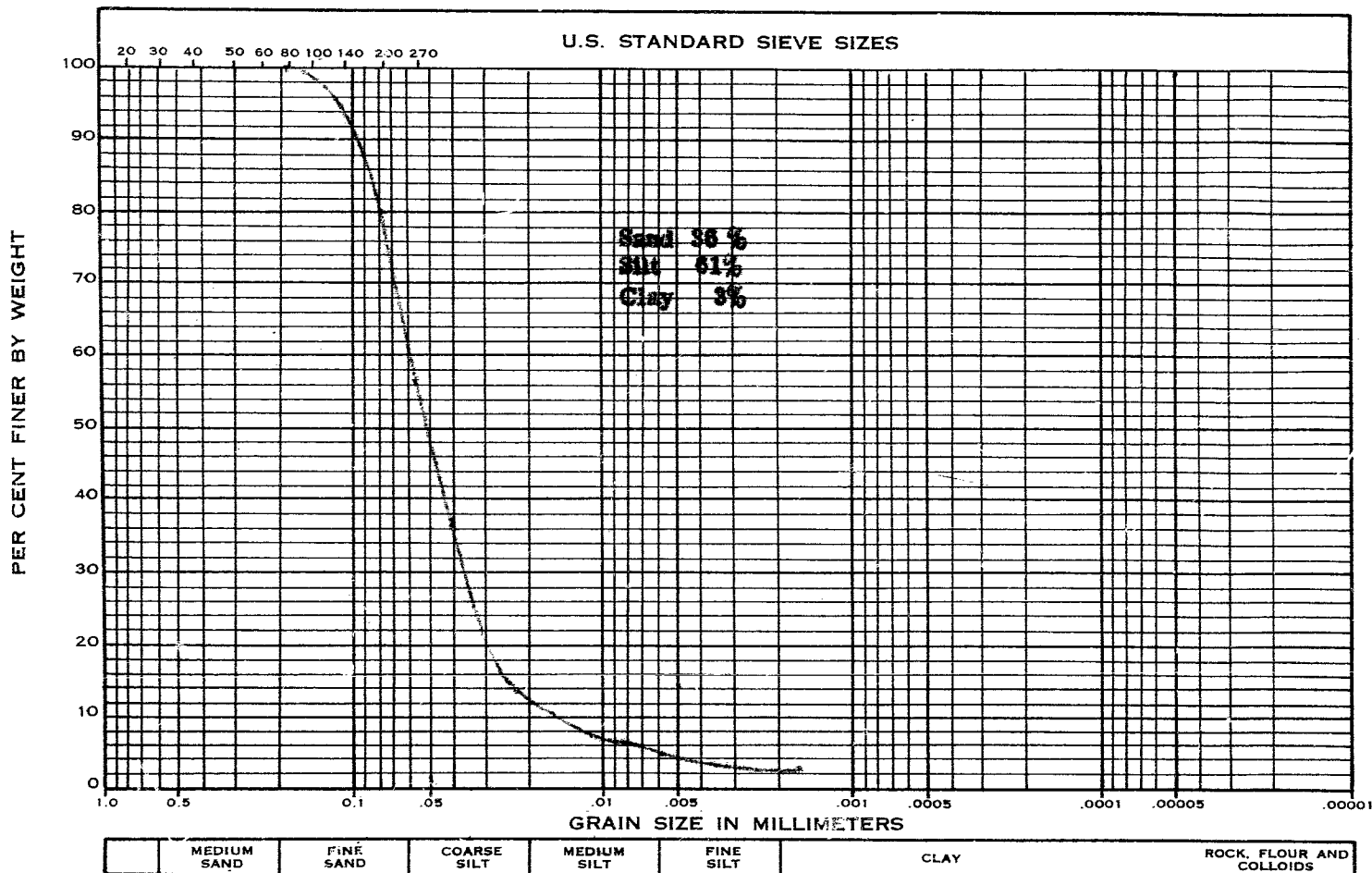


M.I.T. CLASSIFICATION

JOB NAME Hwy. 401 C.N.R. Crossing JOB No. 58104 BOREHOLE No. 2 SAMPLE No. 10

DEPTH 30'4" - 31'0" ELEVATION _____ REMARKS Light brown slightly clayey silt.

E. M. PETO ASSOCIATES LTD.
HYDROMETER GRAIN SIZE DISTRIBUTION DIAGRAM



M.I.T. CLASSIFICATION

JOB NAME **Hwy. 401 C.N.R. Crossing** JOB No. **58104** BOREHOLE No. **4** SAMPLE No. **4**

DEPTH **10' - 11'** ELEVATION _____ REMARKS **Light brown very sandy silt.**

APPENDIX II

METHOD OF OPERATION

The field investigation work is carried out by means of a skid-mounted diamond drill rig.

Standard sampling procedures are followed. Casing is driven and cleaned, either by tubes or by wash water.

Samples are recovered ahead of the casing at frequent intervals, with either a 2 inch or 3 inch O. D. split barrel sampling tube, Shelby tube, or split barrel sampling tube fitted with brass liners and special sharp cutting nose.

The standard penetration test results are recorded when sampling with the regular 2 inch O. D. split barrel sampler, these being the number of blows of a 140 pound hammer falling 30 inches, required to drive the sampling tube a distance of one foot into undisturbed soil.

The Dutch cone probe test is made by driving the drill rods into the ground with a 2-1/4" - 90° cone tip. The number of 4200 inch pound blows per foot of penetration are recorded, as in the standard penetration test.

Where required, "in situ" shear strength tests are made ahead of the casing, using modified Acker vane test equipment.

Disturbed samples are visually classified in the field, sealed in sample jars, and are re-examined, and tested as necessary, in the soils laboratory. Undisturbed samples are returned to the laboratory for later examination and testing, as required.

The test holes are bailed at the end of the day and on completion. Subsequent water level readings are taken for the duration of the field work. Water pressure readings are recorded when Artesian water conditions are encountered. Moisture content samples are recovered at frequent intervals to assist in the soil classification and the interpretation of water table results.