

## E. M. PETO ASSOCIATES LIMITED

1287 Caledonia Road,  
Toronto 19, Ontario.

Our Job Number 61190

RUSSELL 9 - 1126.

December 22nd, 1961.

The Department of Highways  
of Ontario,  
East Block,  
Parliament Buildings,  
Toronto 2, Ontario.

Co  
Essex

Attention: Mr. T. Stermac, P. Eng.  
The Principal Foundation Engr.

Dear Sirs,

Re: Soil Site Investigation At  
Proposed Crossing at  
Puce River and The Kings  
Highway No. 98 (W.P. 294-61)

We have pleasure in submitting herewith fourteen (14)  
copies of our soil investigation report on this site.

The report deals in some detail with soil conditions  
encountered and in the final section we have given observations and  
conclusions regarding the proposed foundation at the site investigated.

"Continued"

For your convenience we summarize our findings:

- (a) The main soil deposit at the site is a silty clay soil which is of glacial origin (till soil). It was found to be homogeneous in lateral and vertical extent with low activity and liquidity index. The upper desiccated or weathered crust was found to extend to 35 - 40 feet below existing grade, and it may be assumed to be slightly overconsolidated.
- (b) The allowable bearing values were calculated from shear and settlement criterion and were found, depending on the footing width and amount of settlement, to vary between 1.25 ksf and 4.27 ksf for foundations placed at elevation 600.0 and 1.94 ksf and 5.89 ksf for foundations placed at elevation 595.0 .
- (c) The bearing values for foundations placed at elevation 595.0 are higher than for foundations placed at elev. 600.0 due to the increase in overburden pressures as due to the extensive depth of deposit identical contact pressures at elevation 600.0 or 595.0 will cause nearly identical settlements.

(d) No difficulties in excavation are foreseen and the excavations may be carried out in a unsupported vertical cut.

(e) No ground water problem is anticipated at the site during construction operations.

We trust that our report is complete. Should you, however, have some questions arising from this report, please do not hesitate to contact us.

Yours very truly,

E. M. PETO ASSOCIATES LTD.

A handwritten signature in dark ink, appearing to be 'E. M. Peto', written in a cursive style.

E. M. Peto, P. Eng.

BL/ap

THE DEPARTMENT OF HIGHWAYS  
OF ONTARIO

SOIL SITE INVESTIGATION  
AT  
PROPOSED CROSSING AT PUCE RIVER  
AND THE KINGS HIGHWAY NO. 98  
(W. P. 234 - 61)

E. M. PETO ASSOCIATES LIMITED

1287 Caledonia Road,  
Toronto 19, Ontario.

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BOREHOLE LOGS

SITE PLAN and PROFILE

## **A. INTRODUCTION:**

We were authorized (verbally by Mr. T. Stermac , P. Eng., the Principal Foundation Engineer on November 27th, 1961) to carry out a sub-soil investigation at the proposed crossing of Puce River and Highway #98 , in the Township of Maldstone, County of Essex.

The investigation was called for in order to determine the subsoil stratification, the soil properties and to arrive at the safe bearing values for the proposed bridge foundations.

The proposed bridge will be 46 feet wide and have a span of 33 feet.

## **B. GENERAL INFORMATION:**

1. The test holes were put down in accordance with our standard procedure as outlined in Appendix A.
2. The location of the test holes and probe holes and the inferred soil profile is shown on the attached site plan.
3. The details of the test holes and probe holes (elevation at the existing grade, terminal depth and the diameter of the casing) were as follows:

**B. GENERAL INFORMATION:**

**3. (Cont'd)**

<u>Test Hole</u>	<u>Elevation at Existing Grade</u>	<u>Terminal Depth in ft.</u>	<u>Diameter of Casing</u>
1	609.4	41'0"	BX (2-1/2")
2	607.2	41'0"	4"
<b>Probe Holes</b>			
1	609.1	18'10" )	Cone
2	607.3	19'11" )	
3	605.5	22'10" )	
4	610.5	21'11" )	

4. The elevations as given above, in the following report, borehole logs and drawing refer to B. M. which was N & W in S.E. Root of 2.5' Elm 77.5' Rt. of Sta. 205 + 21 having elevation 611.77.

5. The laboratory test results are given in Appendix B.

6. The graph of geotechnical soil properties versus elevation and the grading envelope for the deposit encountered is given in Appendix C.

### C. SITE DESCRIPTION:

The investigated site is located at the Puce River crossing of Highway #98. Puce River has cut a gully about 10 feet deep and 50 feet wide in a very flat plain that surrounds the site. Two ditches, one on the north side and one on the south side, run parallel to the highway; the south ditch being considerably deeper and further from the paved portion of the highway. The existing steel and concrete bridge at the site is in a poor structural condition; the materials exhibiting effects of corrosion due to exposure to atmospheric conditions. At the time of this soil investigation very little water was flowing in the river and no active erosion was observed. However, part of the south end of the east abutment was exposed to the water level. This fact points to possible erosion taking place during flood conditions, where the water velocity is increased.

### D. GEOLOGY OF THE SITE

The site is situated within the St. Clair Clay Plains. The clay soil revealed by this investigation has a glacial origin (being a clay till), and the bulk of it is normally consolidated with a preconsolidated crust extending to the 30 to 40 ft. depth. The bedrock at the site (Dundee or Norfolk limestone and chert) is around elevation 515.



**E. SOIL CONDITIONS:**

At the depth investigated the following soil strata were encountered

- a) Topsoil and clayey fill
- b) Silty clay with grits and pebbles.

The brief description of each soil layer and its physical characteristics is given below:

a) Topsoil and clayey fill

The depth of this uppermost layer reached 2 feet at both test holes.

At test hole 1 it was a clayey fill with minor organic content, dark grey in colour.

At test hole 2 it was described as clayey topsoil.

b) Silty clay

The main deposit at the site investigated consists of silty clay. The upper 10 to 15 feet (at test hole 1 - 15 feet; at test hole 2 - 10 feet) of this deposit was found to be grey brown to mottled grey-brown in colour due to desiccation or weathering effect. The remainder of the silty clay deposit was grey in colour.

According to the results of the field and laboratory tests the following may be stated:

## E. SOIL CONDITIONS: (Cont'd)

### i) Standard Penetration Tests

The N-values are seen to decrease with depth. Maximum N-value of 34 was recorded at test hole 1 at 7'0" to 8'6" depth, and a minimum of 8 also at testhole 1 at a depth of 30'0" - 31'6". At test hole 2 there are indications that from about 30 feet depth an increase in N-values may take place.

Further it is seen that the N-values from test hole 1 to an elevation of about 580 are higher than at test hole 2.

### ii) Cone Penetration Tests

This condition was evident in the results of the cone penetration tests; thus Probe 3 gave the lowest results with the results of probes 1 and 4 forming the upper limits.

### iii) Particle Size Distribution

In appendix C the envelopes of the particle size curves for various depths are given. It is seen that they fall within narrow grading limits. The clay fraction was calculated on average to be 34% with upper and lower limits at 27% and 38%.

**E. SOIL CONDITIONS: (Cont'd)**

**iv) Atterberg Limits and Natural Moisture Contents**

The distribution of Atterberg Limits with depth is shown in Appendix C. The average values of Atterberg Limits were:

Liquid Limit: 37.0%  
(35.7% to 38.9%)

Plastic Limit: 17.0%  
(15.1% to 17.7%)

Plasticity Index: 20.0%  
(18.0% to 21.5%)

It is seen that very little variation in values of Atterberg Limits exist with depth. According to A. Casagrande the results fall within the range of plasticity values for glacial lake clays.

**v) Activity**

The values of activity (i. e. ratio of plasticity index to clay fraction) was calculated to be in average of 0.59 with very minor variations. Accordingly the deposit encountered can be classified as an inactive clay containing an insignificant percentage of active clay minerals.

E. SOIL CONDITIONS: (Cont'd)

vi) Liquidity Index

The average Liquidity Index value for the deposit was calculated to be 0.21. Thus it suggests that the deposit may be a pre-consolidated deposit one, probably, to the effect of desiccation or weathering, and that this "desiccated" crust reaches the investigated depth (i. e. 46 feet below the existing grade).

vii) Undrained Shear Strength

The results of the unconfined shear test results versus elevation are given in Appendix C. It is seen that the average curve decreases with depth which indicates that the tests were performed on the samples from "upper" zone, i. e. that thickness of the deposit in which desiccation or weathering took place, and which has obtained higher shear strength.

The ratio of undrained shear strength over the overburden pressure was calculated to be in average of 0.39. This value indicates that the soil deposit investigated is lightly overconsolidated.

The "linear" extrapolation of the average undrained shear strength curve gives a value of 1.0 tons per sq. ft. at elevation 600.0.

E. SOIL CONDITIONS : (Cont'd)

viii) Consolidation Characteristics

Two consolidation tests were carried out on samples from test hole 2 (15'8" to 16'0" and 35'8" to 36'0" depth). The details of the test results is given in graphical form (e-log p curve) and tabular form in Appendix B.

The coefficient of volume decrease  $m_v$  has been determined from the laboratory e-log p curve which were not adjusted for sample disturbance. The  $m_v$  values of this test were practically identical and the average value of  $m_v = 0.0102$  sq. ft. per ton (or 0.0051 sq. ft. per kip) may be given.

ix) Summary of data

Densities: wet  $\gamma_w = 131.8$  p.c.f.

dry  $\gamma_d = 108.0$  p.c.f.

Moisture content 19.7%  
(14.3% - 23.2%)

Liquid Limit 37.6%  
(35.7% - 38.9%)

Plastic Limit 17.0%  
(15.1% - 17.7%)

Plasticity Index 20.6%  
(18.0% - 21.5%)

E. SOIL CONDITIONS: (Cont'd)

Liquidity Index 0.21  
(0.11 - 0.30)

Clay fraction 34%

Activity 0.59

$S_u/p_o$  0.39

Void ratio  $e$ , 0.61

Coefficient of volume decrease  $m_v = 0.0102$  sq. ft. per ton.

## **F. OBSERVATIONS and CONCLUSIONS**

### **I. General Observations**

- (a) The silty clay deposit as encountered at the site appears, according to the field and laboratory test results, uniform in lateral and vertical extent.
- (b) From the data presented in the report it is evident that the silty clay deposit has a desiccated or weathered crust extending to some 35 to 40 feet in depth and the upper 10 to 15 feet of this crust was grey-brown in colour.
- (c) Further it may be stated that the silty clay deposit, based on data presented, is a till material with some degree of overconsolidation of the upper crust. The determination of pre-consolidation pressure, using Casagrande's method was not successful.

### **II. Allowable Bearing Values**

- (a) As a most suitable foundation elevation, elevation 600.0 is recommended, which will be some 2 feet below the present river bed. This foundation elevation is thus the uppermost recommended elevation.

F. OBSERVATIONS and CONCLUSIONS - Cont'd

(b) The foundations for the proposed bridge are assumed to be 46 feet in length (equal to the width of proposed bridge). The calculation of allowable bearing values was made for footing widths varying from 2 to 10 feet wide.

(c) The allowable bearing values presented below were calculated on the basis of shear and settlement consideration.

(d) The settlement analysis was carried out adopting an  $m_v$  value of 0.0051 sq. ft./kip.

(e) From the shear strength consideration only the allowable bearing values (F.S. = 3 against shear failure) are:  
(Length of foundation 46 feet)



**F. OBSERVATIONS and CONCLUSIONS - Cont'd**

<u>F. Elev.</u>	<u>Width of Footing in Ft.</u>	<u>Allowable Bearing Value in p.s.f.</u>
600.0	2	4273
	4	3946
	6	3852
	8	3786
	10	3759
595.0	2	5890
	4	4876
	6	4532
	8	4386
	10	4275

(f) The settlements arising from the use of bearing values as given above for footings placed at elevation 600.0 are:

<u>Footing Width in Ft.</u>	<u>Bearing Value in p.s.f.</u>	<u>Settlement in inches.</u>
2	4273	1.30
4	3946	1.92
6	3852	2.51
8	3786	3.04
10	3759	3.49

F. OBSERVATIONS and CONCLUSIONS - Cont'd

(g) Combining the shear and settlement criterion, the following are the allowable bearing values in p.s.f.

These have a factor of safety of not less than 3 against shear failure, and limit the amount of settlement to 1.0, 1.5, 2.0 inches respectively.

F. Elev. 600.0

Footing size (in ft.)	S = 1.0"	S = 1.5"	S = 2.0"
2 x 46	3764	4273(x)	4273(x)
4 x 46	2444	3484	3946(x)
6 x 46	1814	2574	3344
8 x 46	1424	2024	2574
10 x 46	1264	1764	2284

and for Footing Elev. 595.0

2 x 46	4443	5880(x)	5880(x)
4 x 46	3103	4143	4876(x)
6 x 46	2473	3233	4003
8 x 46	2083	2683	3233
10 x 46	1943	2443	2943

(x) Note: These values are limited by shear strength consideration.

F. OBSERVATIONS and CONCLUSIONS - Cont'd

- (h) The graphical representation of the allowable bearing values versus footing sizes as given above is attached in Appendix "D".
- (i) The time-settlement relationship could not be estimated due to the lack of information about the lower limit of compressible stratum.

III. Constructional Problems

- (a) The excavations to the required foundation depth will stand unsupported in vertical cut. (assuming that fill and topsoil material is removed).
- (b) No ground water problem is anticipated during the excavation and construction period except due to some seepage of surface water.
- (c) No difficulty in excavation will be met to the required foundation depth.

E. M. PETO ASSOCIATES LTD.

*C. F. Freeman*

C. F. Freeman, P. Eng.,  
Chief Engineer.

APPENDIX "B"

LABORATORY TEST RESULTS

## E. M. PETO ASSOCIATES LIMITED

UNCONFINED COMPRESSION TEST DATA SHEET

Job Number 61190

Borehole Number	Sample Number	Depth Feet	Elevation Feet	Nat. M. C.	Wet Density p.c.f.	Dry Density p.c.f.	Degree of Saturation %	Void Ratio, e	Strain at Failure %	u/c Shear Strength p.s.f.
1	11	32'6"-33'	576.6	23.4	129.5	105	100	.65	20	1000
1	12	36'-36'6"	573.1	20.5	137.0	114.0	100	.52	20	1150
2	6A	15'0"-15'4"	592.0	19.4	134	112.0	100	.55	20	1300
2	6B	15'4"-15'8"	591.6	21.0	132	109	100	.60	20	760
2	8B	21'-21'6"	595.9	22.7	131	106.5	100	.63	20	1460
2	12	30'6"-31'0"	576.9	19.9	131	109	94	.60	20	1425
2	12	31'0"-31'6"	575.9	24.0	132	106.5	100	.53	20	1380
2	16	38'6"-39'0"	568.4	23.9	129.5	104.5	100	.56	20	730
2	16	39'0"-39'6"	567.9	24.0	130.5	105.5	100	.65	20	810

# Consolidation Test Results

Applied Pressure K.S.F.	Void Ratio e	Coeff. of Compress- ibility av. sq. ft./K	Coeff. of Volume de- crease Mv sq. ft./K	t 90 in min.	Coeff. of Consoli- dation Cv sq. in./min.
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## Test Hole #2 Depth 15'-8" - 16'-0"

0	0.620	0			
0.25	0.620				
0.50	0.618	0.0080	0.0049	2.9	0.0407
1.0	0.614	0.0080	0.0050	5.3	0.0220
2.0	0.604	0.0100	0.0062	15.2	0.0076
4.0	0.583	0.0105	0.0066	10.9	0.0103
8.0	0.565	0.0045	0.0029	9.0	0.0120
16.0	0.536	0.0036	0.0025	8.2	0.0125

## Test Hole #2 Depth 35'-8" - 36'-0"

0.0	0.690	0	0		
0.25	0.680				
0.50	0.688	0.0080	0.0047	2.6	0.0453
1.0	0.682	0.0120	0.0071	6.8	0.0171
2.0	0.669	0.0130	0.0076	9.9	0.0115
4.0	0.646	0.0105	0.0063	7.0	0.0158
8.0	0.615	0.0083	0.0051	9.0	0.0118
16.0	0.576	0.0049	0.0031	7.4	0.0135

PROPOSED CROSSING AT RUCF RIVER AND HWY 78  
Consolidation Test Pressure void ratio curve

Borehole # 2  
 Sample # 6  
 Depth 15' 8" - 16' 0"

Void ratio

Lot # 61190

sample 758001471 DEC 61

Pressure (lb/sq ft)

PROPOSED CROSSING AT PACE RIVER AND HWY 98  
Consolidation Test Pressure void ratio curve.

Borehole # 2  
Sample # 14  
Depth 358'-360'

100 # 6N90

e.m.p.to associates inc. drc'ly

Pressure  $\text{Kg/cm}^2$



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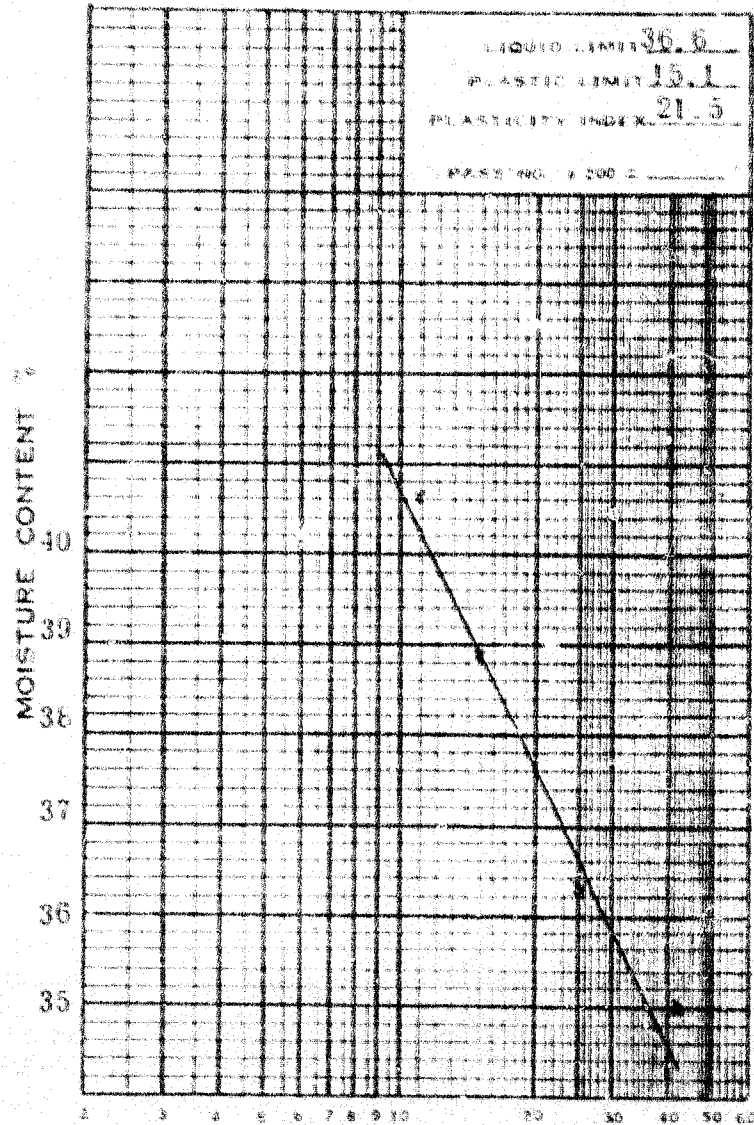
Toronto 13, Ontario

LIQUID LIMIT TEST

Job No. 01190 Project: LUCE RIVER A-192

SAMPLE FROM P.H. #1 SA #3

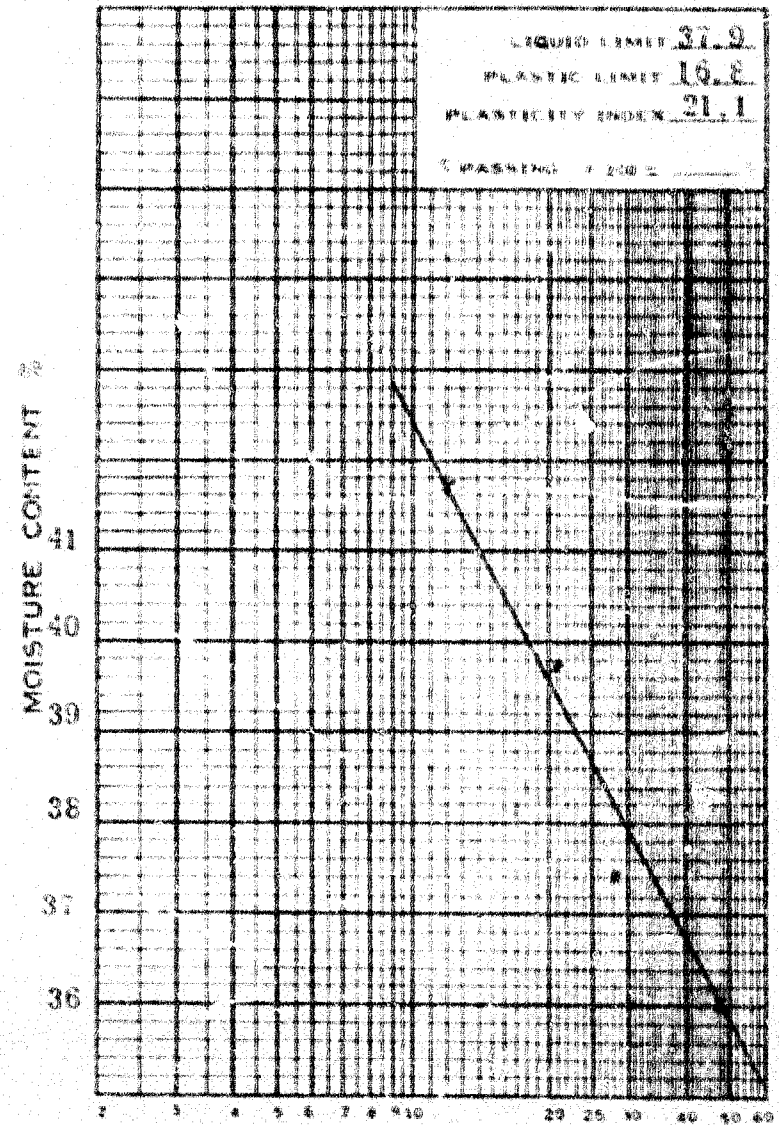
DEPTH 5'-5'6"



FLOW LINE CHARTS

SAMPLE FROM P.H. #1 SA #6

DEPTH 12'-13'6"



NO. OF BLOWS (LOG SCALE)

e. m. peir associates ltd.

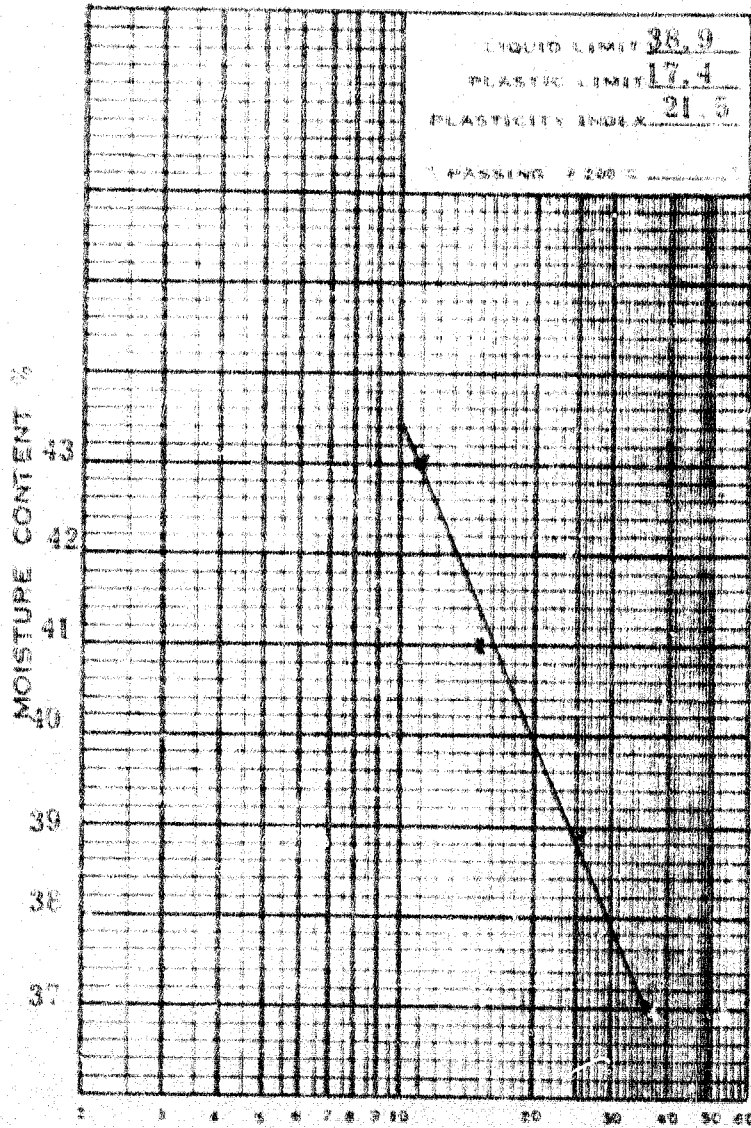
Toronto 18, Ontario

### LIQUID LIMIT TEST

Job No. 61190 PROJECT: PUCE RIVER & #98

SAMPLE FROM P.H. #1 SA #0

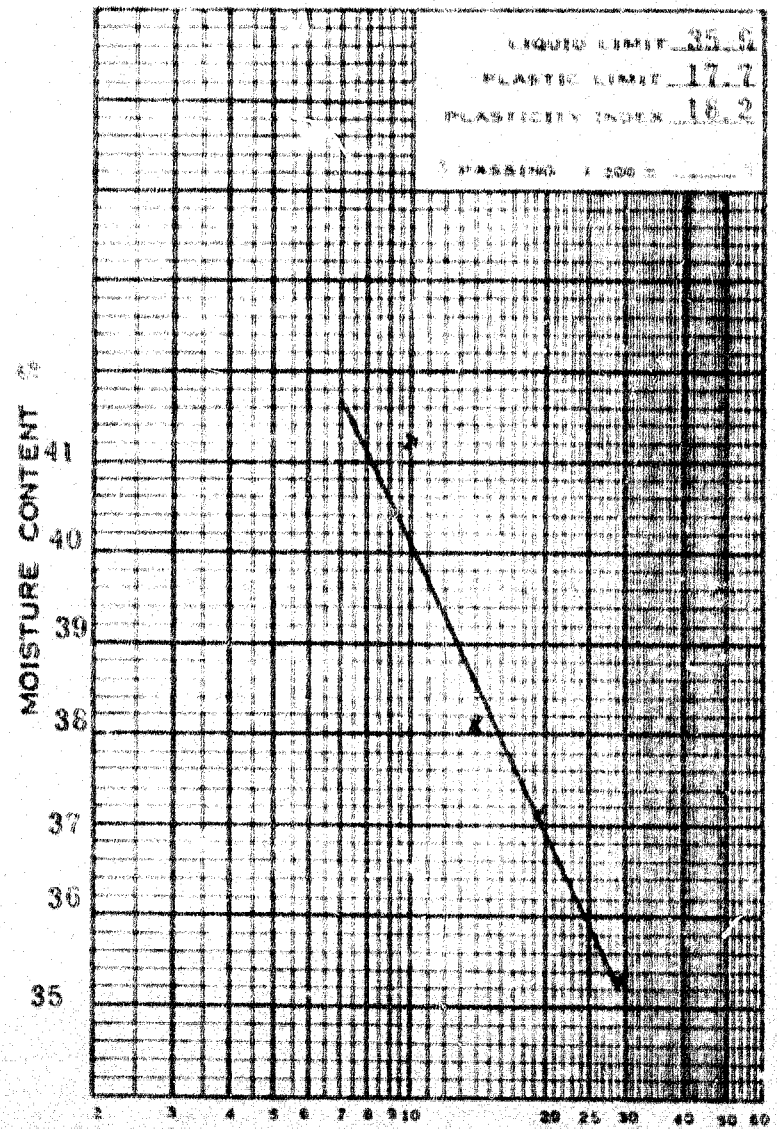
Depth 25'-26'0"



### FLOW LINE CHARTS

SAMPLE FROM P.H. #1 SA #13

Depth 30'0" - 35'0"



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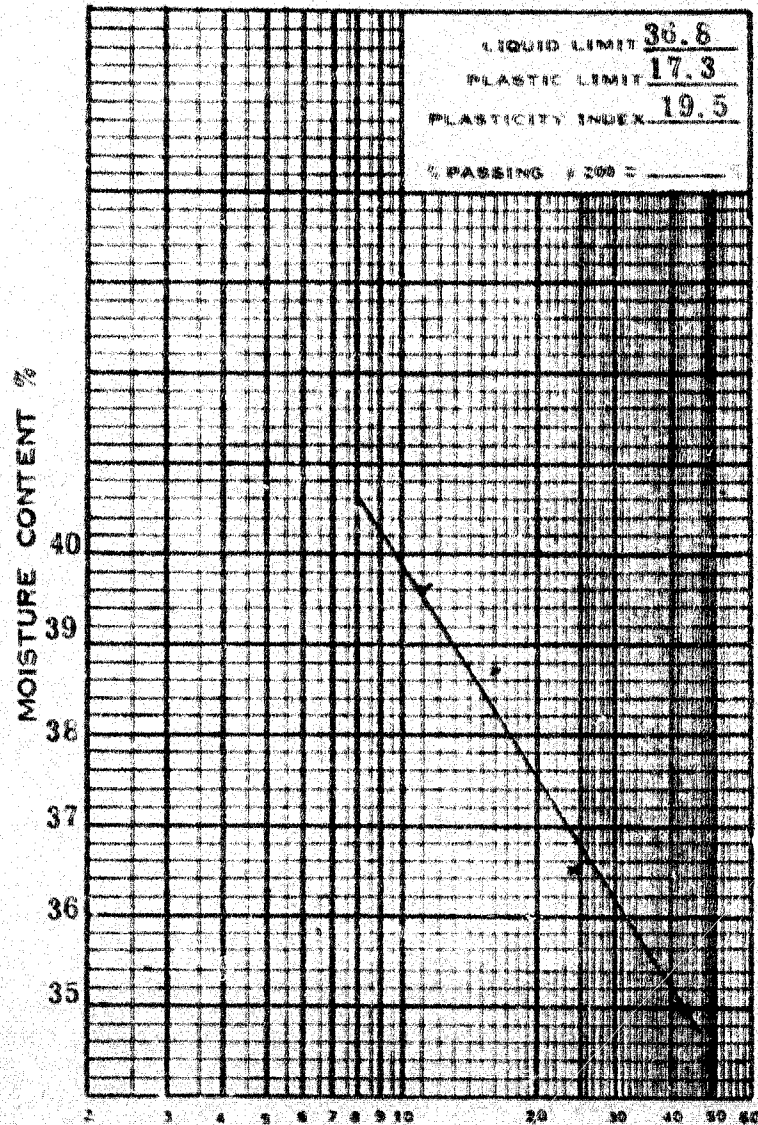
Toronto 18, Ontario

LIQUID LIMIT TEST

Job No. 61190 PROJECT PACE River & #98

SAMPLE FROM P.H. #2 SA #5

DEPTH 10' - 11'6"

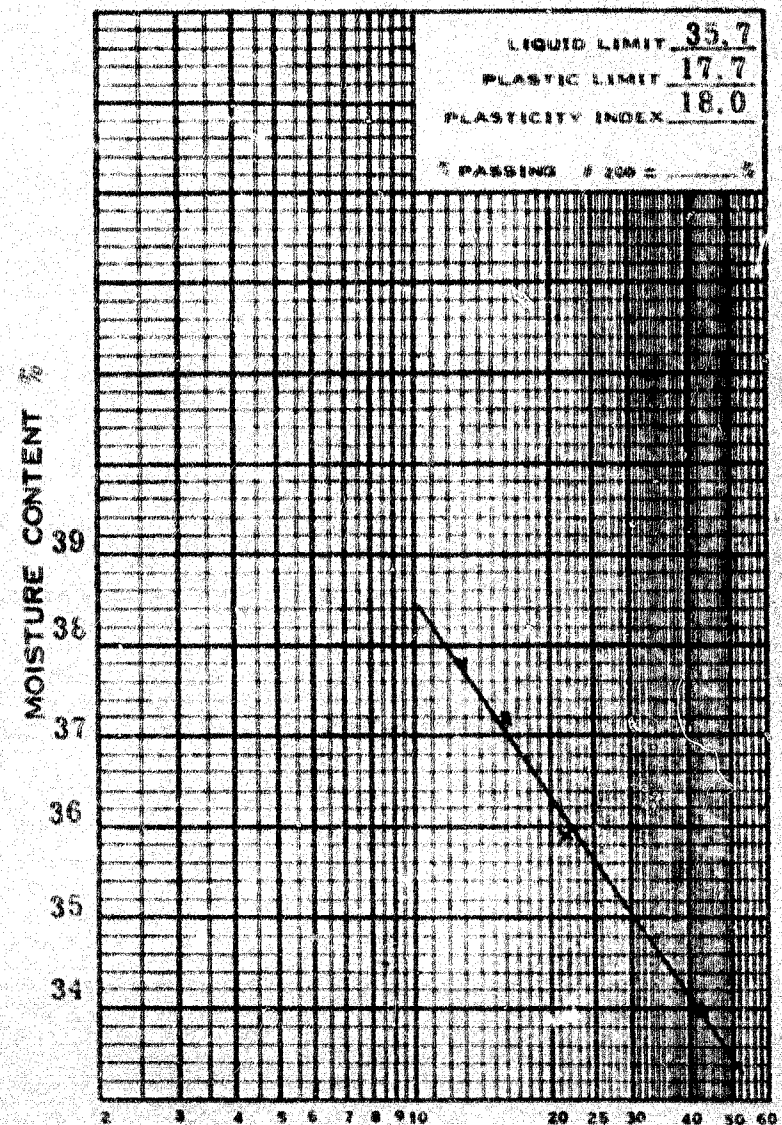


NO. OF BLOWS (Log Scale)

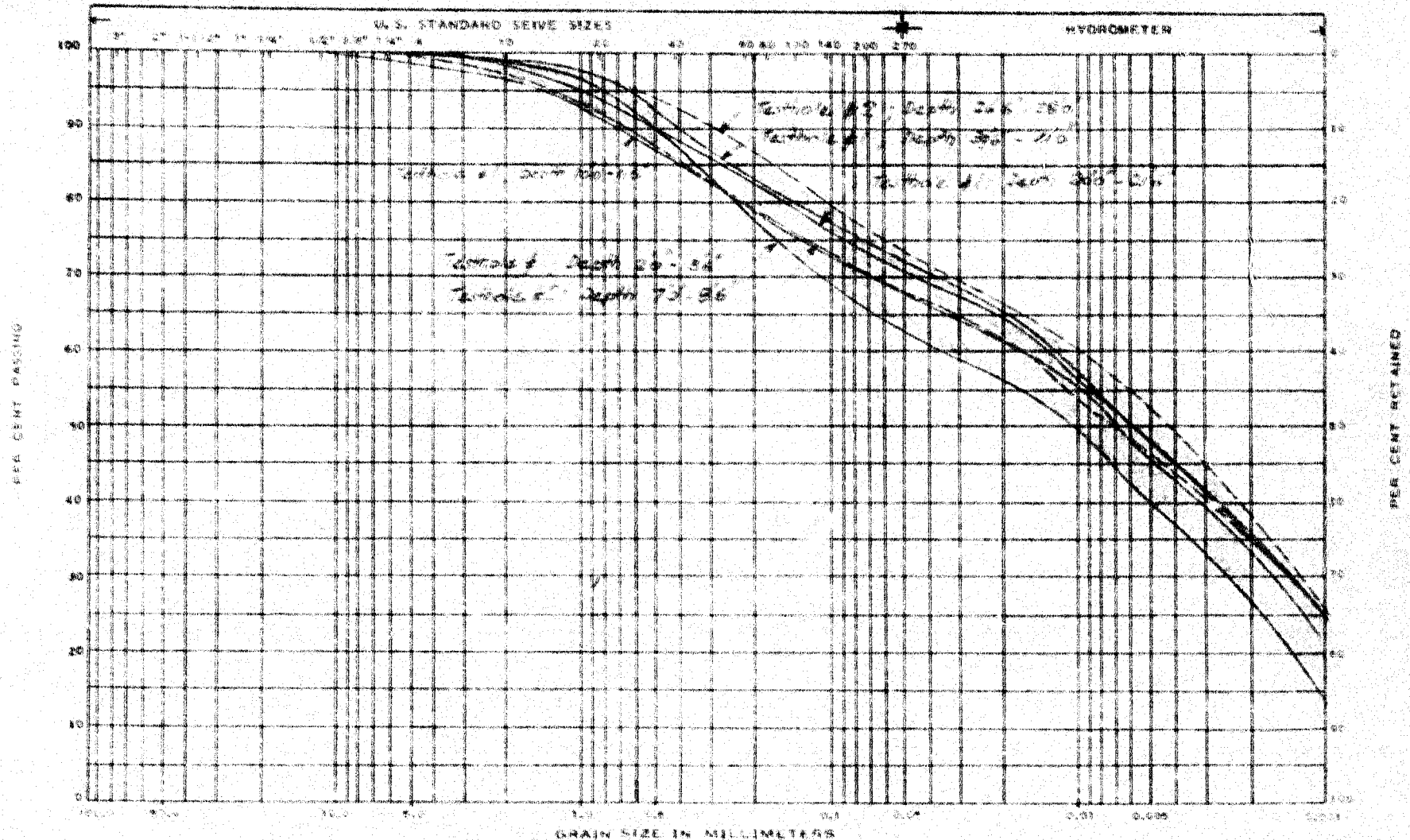
FLO-7 LINE CHARTS

SAMPLE FROM P.H. #2 SA #13

DEPTH 32'0" - 33'6"

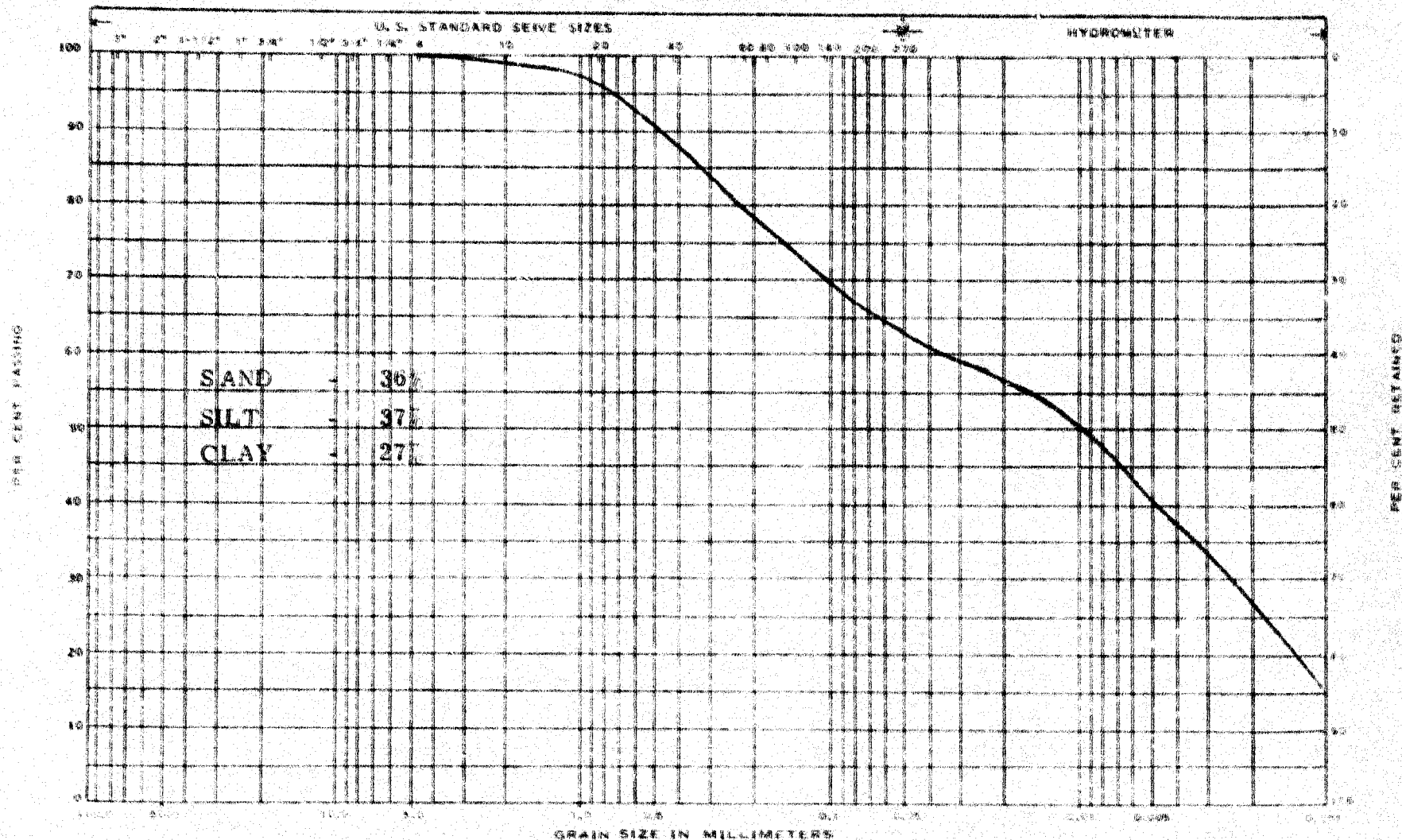


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Toronto 18, Ontario



STONES	GRAVEL	COARSE SAND	MED. SAND	FINE SAND	COARSE SILT	MED. SILT	FINE SILT	CLAY
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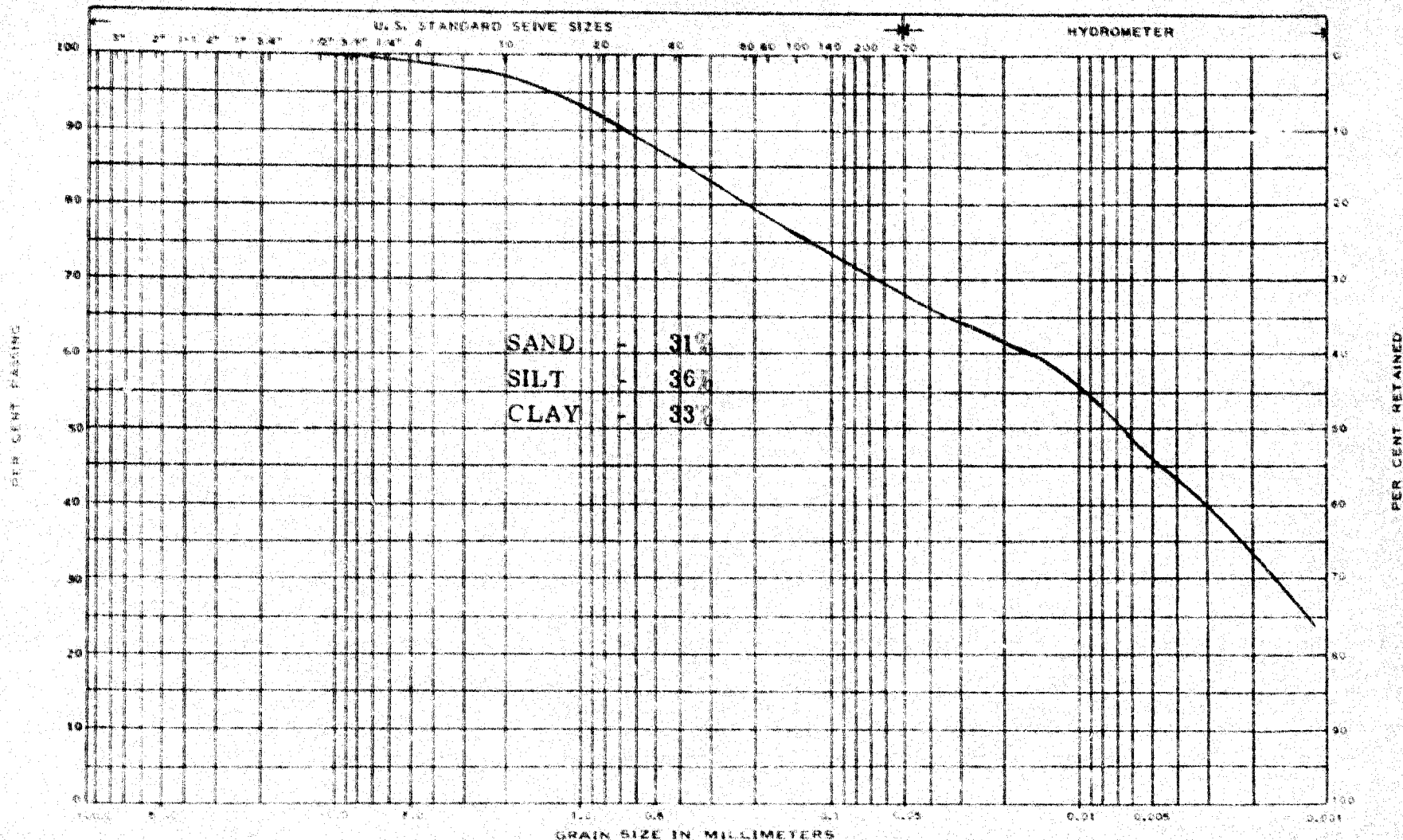
MASS INST. OF TECH. CLASSIFICATION

JOB NAME Puce River and #98 JOB NO. 61190 HOLE NO. 1 SAMPLE NO. 2  
DEPTH 2'-3'6" ELEVATION \_\_\_\_\_ REMARKS Silty clay to clayey silt

GRAIN SIZE DISTRIBUTION

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Toronto 19, Ontario



JOB NAME Puce River & #98

JOB NO. 61190

HOLE NO. 1

SAMPLE NO. 5

DEPTH 10'-11'6"

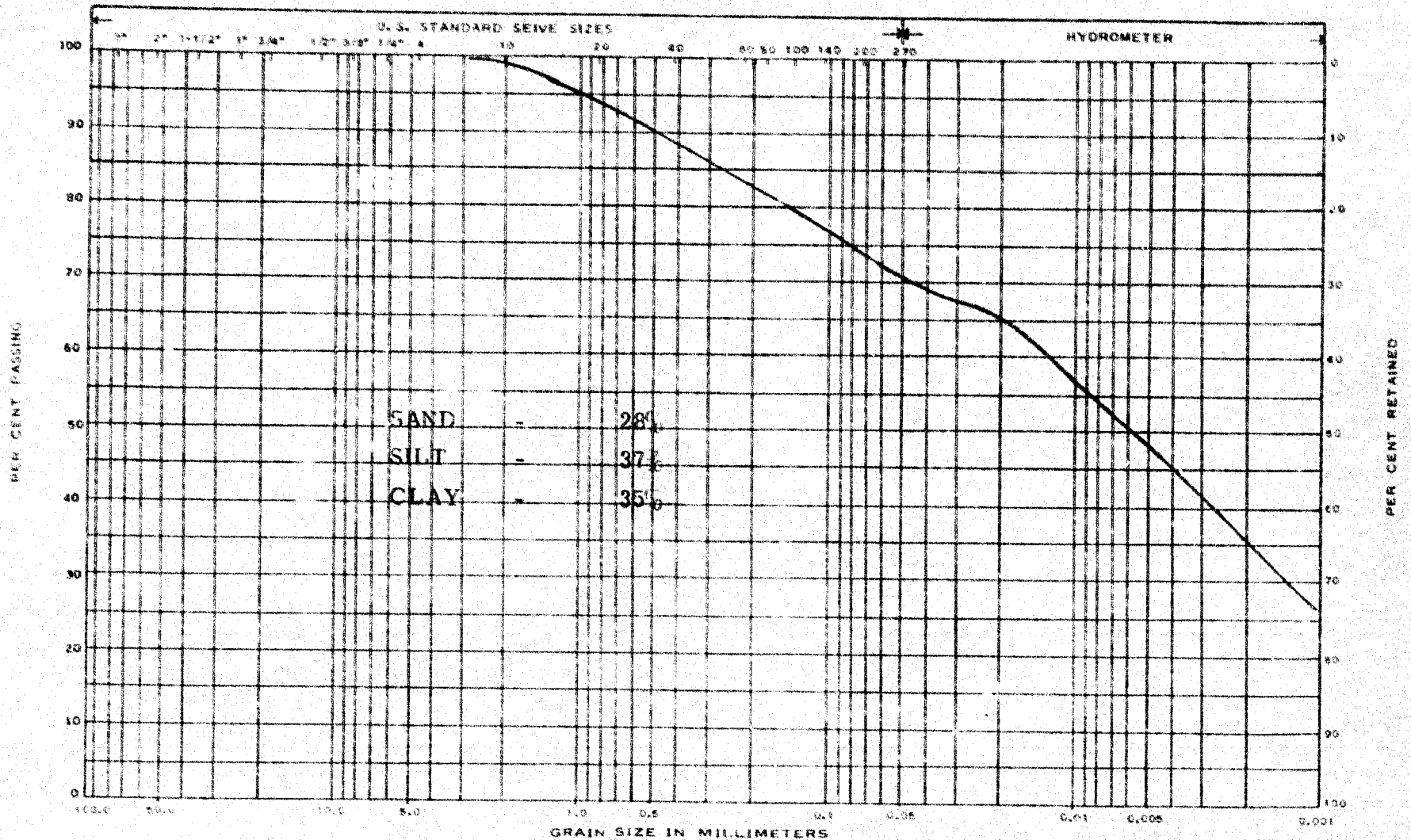
ELEVATION

REMARKS

Silty Clay

GRAIN SIZE DISTRIBUTION

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Toronto 19, Ontario



GRAVEL	COARSE SAND	MED. SAND	FINE SAND	COARSE SILT	MED. SILT	FINE SILT	CLAY
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MASS. INST. OF TECH. CLASSIFICATION

JOB NAME Puce River & #98

JOB NO. 61190

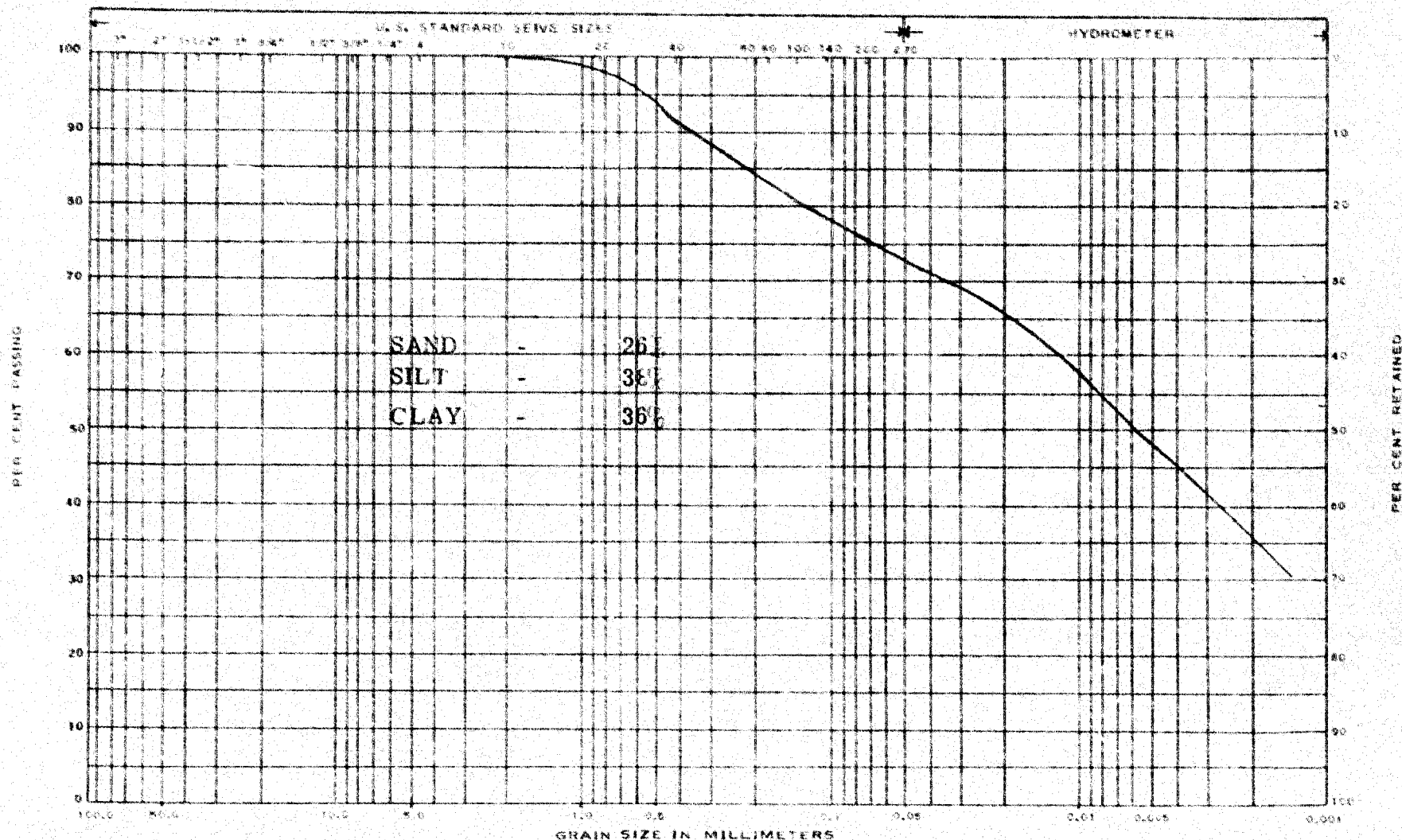
HOLE NO. 1 SAMPLE NO. 8

DEPTH 20'-21'6" ELEVATION \_\_\_\_\_ REMARKS Silty Clay

GRAIN SIZE DISTRIBUTION

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Toronto 19, Ontario



STONES	GRAVEL	COARSE SAND	MED. SAND	FINE SAND	COARSE SILT	MED. SILT	FINE SILT	CLAY
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MASS. INST. OF TECH. CLASSIFICATION

JOB NAME Puce River & #98

JOB NO. 61190

HOLE NO. 1

SAMPLE NO. 15

DEPTH 39'6" - 41'

ELEVATION

REMARKS

Silty Clay

GRAIN SIZE DISTRIBUTION



**Toronto 19, Ontario**



MASS. INST. OF TECH. CLASSIFICATION

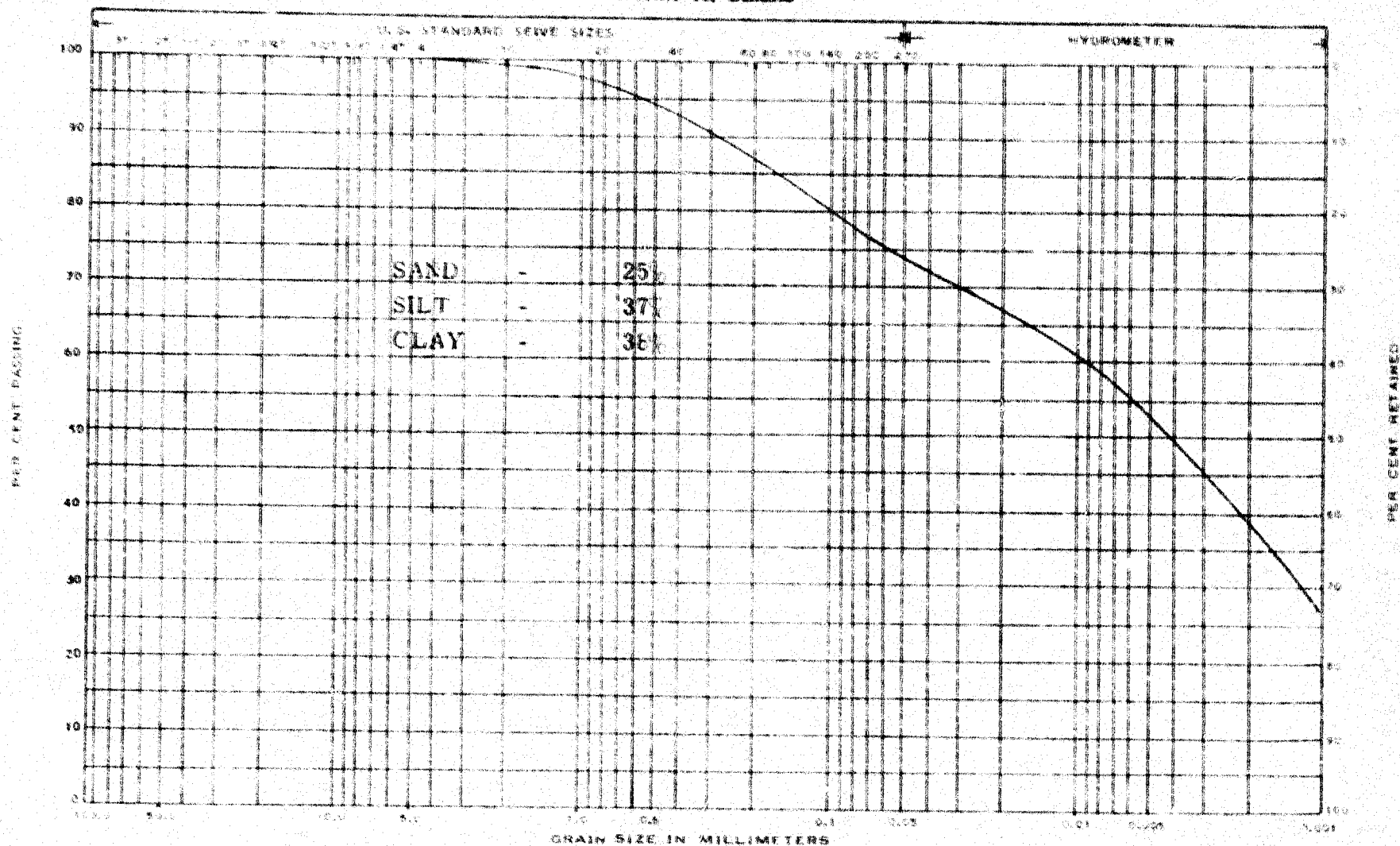
HOLE NO. 2 SAMPLE NO. 4

DEPTH 7'-8'6" ELEVATION \_\_\_\_\_ REMARKS Silty Clay

### GRAIN SIZE DISTRIBUTION

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Toronto 19, Ontario



MASS. INST. OF TECH. CLASSIFICATION

JOB NAME Puce River & #98

JOB NO. 61190

HOLE NO. 2

SAMPLE NO. 11

DEPTH 26' 6" - 28'

ELEVATION

REMARKS

Silty clay

GRAIN SIZE DISTRIBUTION

APPENDIX "C"

GEOTECHNICAL SOIL PROPERTIES

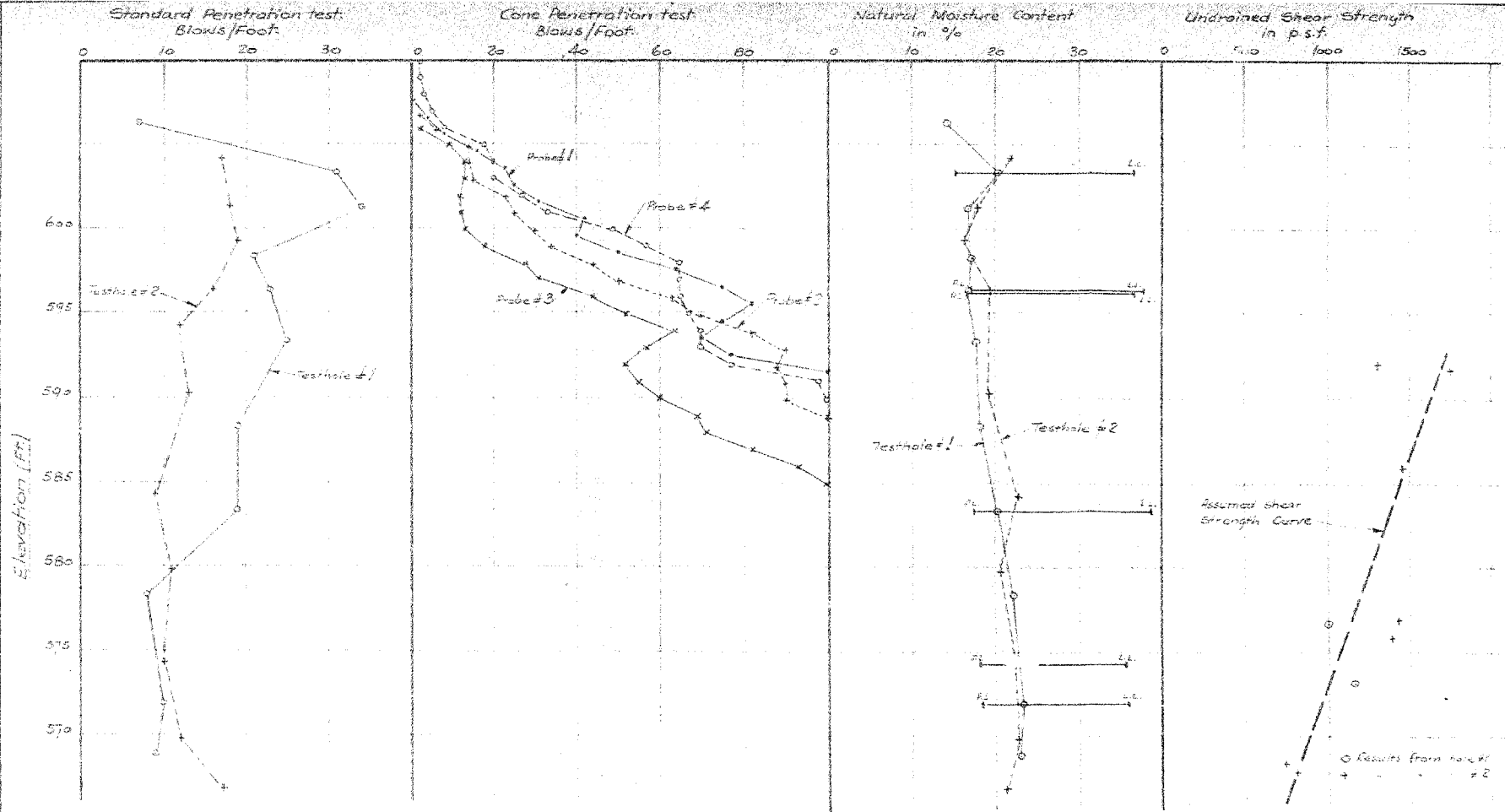
e. m. peto associates ltd.

DRILLER' DAILY FIELD RECORD SHEET

Date. Dec.. 21, 1961.....  
Order No.... 81190.....

CONE PENETRATION TEST

Depth		Probe Hole Number			
From	To	1	2	3	4
0	1	1/2	2	2	2
1	2	1/2	6	9	2
2	3	4	14	13	3
3	4	8	14	13	5
4	5	16	15	12	8
5	6	23	23	12	18
6	7	25	25	13	20
7	8	31	30	18	20
8	9	42	34	23	27
9	10	40	44	31	33
10	11	50	50	44	49
11	12	64	63	53	57
12	13	75	70	64	65
13	14	82	82	57	65
14	15	75	90	52	65
15	16	70	88	55	67
16	17	77	90	60	70
17	18	115	90	69	70
18	19	100/10"	102	71	87
19	20		100/11"	82	98
20	21			93	100/11"
21	22			103	
22	23			100/10"	
23	24				
24	25				
25	26				



GEOTECHNICAL PROPERTIES OF SOIL.

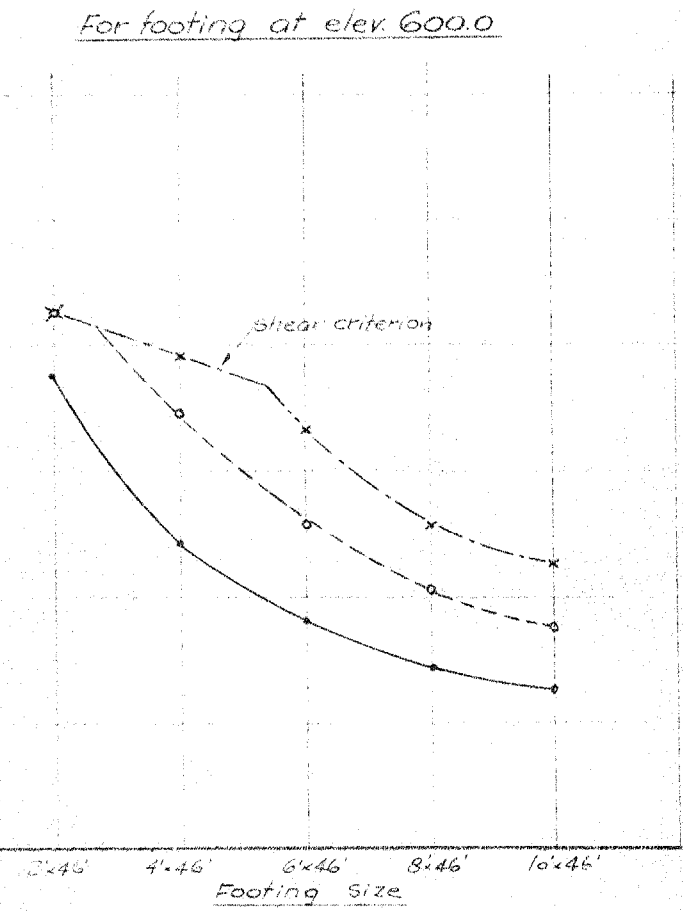
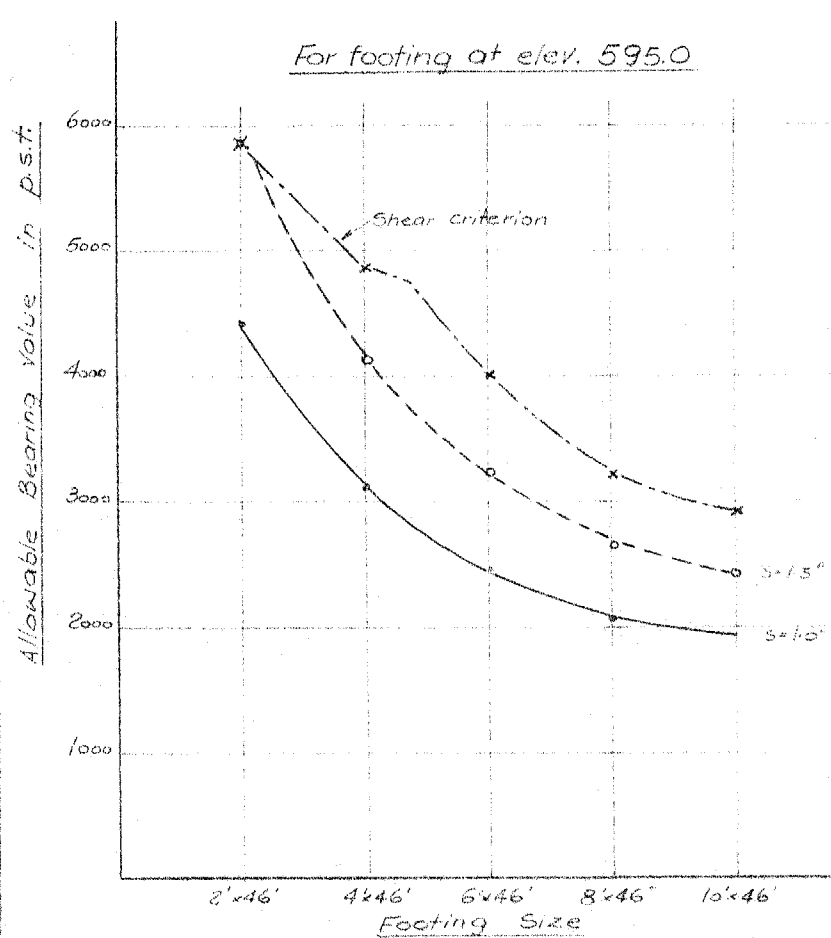
Job # 6/190  
 empeto associates, Inc.  
 Dec. 61.

APPENDIX "D"

ALLOWABLE BEARING VALUES  
VERSUS FOOTING SIZES

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# ALLOWABLE BEARING VALUES.



**e. m. peto associates ltd.**  
**SOIL ENGINEERING SERVICE - TORONTO, ONTARIO**

**BOREHOLE LOG**

Job Name Puce River & Highway # 98

Job No. 61190

Borehole No. 1

Client Department of Highways

Casing BX

Boring Date Dec 5 & 6, 1961

Elevation Geodetic

Compiled By U.J.V.

Checked By B.L.

**SAMPLE CONDITION**



UNDISTURBED



FAIR



DISTURBED



LOST

**SAMPLE TYPE**

A.S. AUGER SAMPLE  
 C.S. CASING SAMPLE  
 S.S. 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

**ABBREVIATIONS**

V.T. IN SITU VANE SHEAR TEST  
 C. SOIL SHEAR STRENGTH LBS/SQ.FT.  
 W.L. WATER LEVEL IN CASING  
 W.T. GROUND WATER TABLE IN SOIL  
 W.T.P.L. WETTER THAN PLASTIC LIMIT  
 D.T.P.L. DRIER THAN PLASTIC LIMIT

SOIL DESCRIPTION	COLOUR	Density or Consistency	Depth Elevation	Legend	Sample No. and Condition	Sample Type	No. of Blows per Ft.	Natural Moisture Content	WATER LEVELS & REMARKS
Existing Grade	El. 609.4		0'0"						
Clay fill with minor org. matter and roots	Dk. grey		2'0"		1	CS			
Silty clay with grits & pebbles	Mottled grey and brown	Firm	5'0"		2	SS	7	14.3	D.T.P.L. Hole wet in bottom (Surface water)
"	"	V. stiff to hard	10'0"		3 3A	SS	31	20.4	About PL Hole dry
"	Brown-grey	Hard	15'0"		4 4A	SS	34	16.6	About PL Hole dry
"	"	V. stiff	20'0"		5 5A	SS	21	17.1	About PL Hole dry
As above, seam with roots	"	"	25'0"		6 6A	SS	23	16.7	About PL Hole dry
As above	Grey	"	30'0"		7 7A	SS	25	17.7	About PL Hole dry
"	"	"	35'0"		8	SS	19	18.1	Getting softer at 19' W.T.P.L. Hole dry
"	"	"	40'0"		9	SS	19	20.3	W.T.P.L. Started to use wash water at 26'6" Getting gradually softer 25 to 30 feet
"	"	Firm to stiff	45'0"		10 11	SS 2"SL	8	22.0	W.T.P.L.
"	"	Stiff	50'0"		12 13 14	2"SL SS 2"SL	10	23.2	W.T.P.L.
"	"	"	55'0"		15	SS	9	22.8	W.T.P.L.
HOLE TERMINATED AT 41'0"									Dec. 5/61 at 5:00 P.M. hole bailed out to 32'3" hole open to 35'9" Dec. 6/61 at 8:00 A.M. water at 30'0" below ground level and hole open to 35'9"







SOIL ENGINEERING SERVICE - TORONTO, ONTARIO

## BOREHOLE LOG

Job Name Puce River & Highway # 98 Job No. 61190  
Client Department of Highways Casing 4"  
Elevation Geodetic Compiled By U.J.

Borehole No. 2  
Boring Date Dec. 6 & 7, 1961  
Checked By B.L.

SAMPLE CONDITION

	UNDISTURBED
	FAIR
	DISTURBED
	LOST

SAMPLE TYPE

A.S. AUGER SAMPLE  
C.S. CASING SAMPLE  
S.S. 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

### ABBREVIATIONS

V.T.	IN SITU VANE SHEAR TEST
C.	SOIL SHEAR STRENGTH LBS/SQ.FT.
W.L.	WATER LEVEL IN CASING
W.T.	GROUND WATER TABLE IN SOIL
W.T.P.L.	WETTER THAN PLASTIC LIMIT
D.T.P.L.	DRIER THAN PLASTIC LIMIT

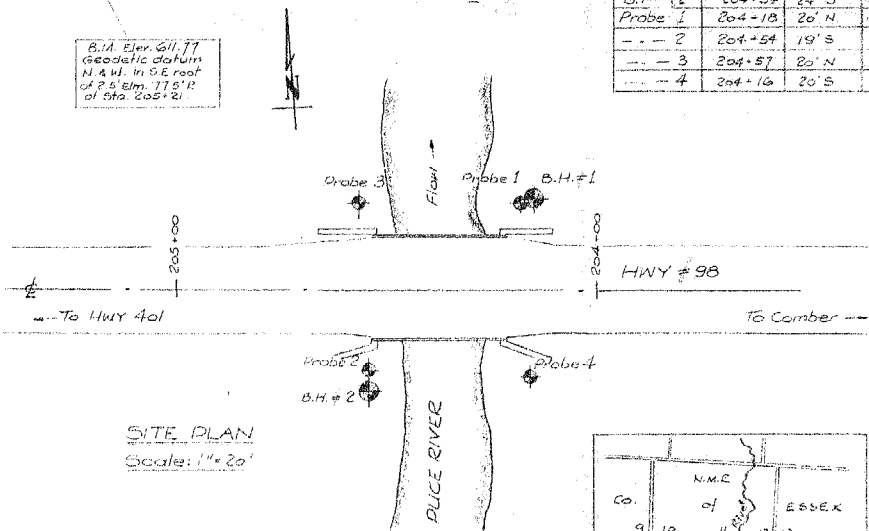
SOIL DESCRIPTION	COLOUR	Density or Consistency	Depth Elevation	Legend	Sample No and Condition	Sample Type	No. of Blows per Ft	Natural Moisture Content	WATER LEVELS & REMARKS
Existing Grade El. 607.2			0'0"						
Clay topsoil	Dark grey		2'0"		1	CS			M.
Silty clay with grits & pebbles	Brown-grey	Stiff to v. stiff	5'0"		2	SS	17	21.0	About PL Hole dry
"	Mottled grey and brown	V. stiff	10'0"		3	SS	18	17.9	About PL Hole dry
"	"	"	15'0"		4	SS	10	16.4	S.W.T.P.L. Hole dry Getting gradually softer
"	Grey	Stiff to v. stiff	20'0"		5	SS	16	19.5	W.T.P.L. Hole dry
"	"	Stiff	25'0"		5A	SS	12		Getting gradually softer
"	"	"	30'0"		6A	3"SL			"
"	"	"	35'0"		6B	3"SL			
"	"	"	40'0"		7A	SS	13	19.3	W.T.P.L. Hole dry
"	"	"	45'0"		8A	2"SL			
"	"	Firm to stiff	50'0"		8B	2"SL			
"	"	"	55'0"		9A	SS	9	22.5	W.T.P.L. Hole dry
"	"	"	60'0"		10A	3"SL			
"	"	Stiff	65'0"		11A	SS	11	20.3	W.T.P.L. Hole dry
"	"	"	70'0"		12A	2"SL			
"	"	"	75'0"		12B	2"SL			
"	"	"	80'0"		13	SS	10	22.2	W.T.P.L. Hole dry
"	"	"	85'0"		13A	SS			
"	"	"	90'0"		14A	3"SL			
"	"	"	95'0"		14B	3"SL			
"	"	"	100'0"		15	SS	12	22.7	W.T.P.L. Hole dry
"	"	"	105'0"		15A	SS			
"	"	"	110'0"		16A	2"SL			
"	"	"	115'0"		16B	2"SL			
"	"	Stiff to v. stiff	120'0"		17	SS	17	21.2	W.T.P.L. Hole dry
			125'0"		17A	SS			
HOLE TERMINATED AT 125'0"									

2.5' Elev.

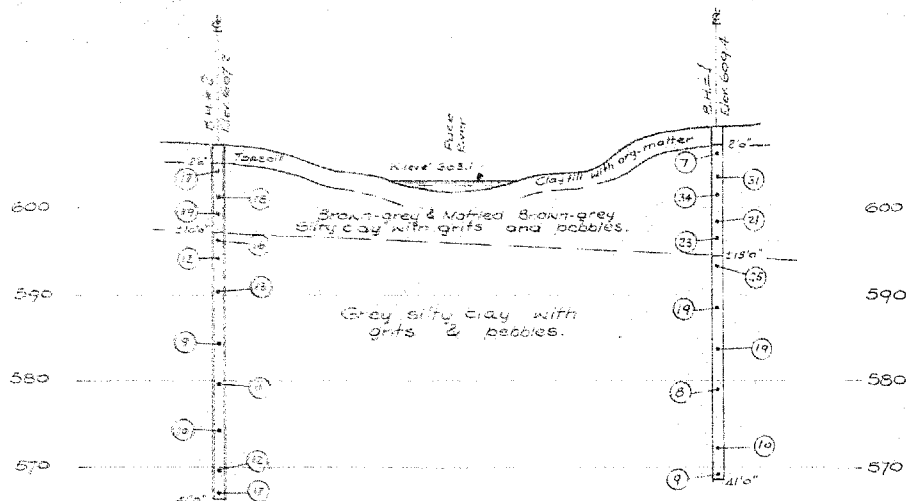
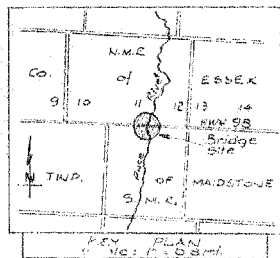
COUNTY OF ESSEX  
TWP. OF MAIDSTONE  
CON. N.M.R. LOT XI

B.M. Elev. 611.77  
Geodetic datum  
N. & W. in S.E. roof  
of 2.5' Elev. 175' R.  
of Sta. 204+21

	Chainage	Offset	Elevation
B.H. #1	204+15	21' N	609.4
B.H. #2	204+54	24' S	607.2
Probe 1	204+18	20' N	609.1
--- 2	204+54	19' S	607.3
--- 3	204+57	20' N	606.5
--- 4	204+16	20' S	610.5



SITE PLAN  
Scale: 1" = 20'



SECTION ON HOLES 2 & 1  
Scale: 1" = 10' (Natural)

- LEGEND**
- Borehole
  - Probe
  - Sand Foot (Gr. Penetration test result)

**NOTE**

See borehole logs for complete soil data.



Job # 61190  
empeto associates ltd.  
Dec. 1961

## APPENDIX E

### CALCULATION OF ALLOWABLE BEARING VALUES

#### Assumptions

- (1) On the basis of the available shear strength test results and on the general knowledge of the area a value of 2000 psf (i.e.  $1 \frac{1}{2}$  tons) is assumed at elevation 600.0.
- (2) It is most likely that the shear strength of the designated portion of the deposit exceeds the value as assumed above, but due to lack of shear strength results this value is taken into calculation of the bearing capacity.
- (3) The foundation elevation 600.0 (some 2 feet below river bed level) is assumed to be the most suitable foundation elevation from constructional and hydrological (some) point of view. Thus the foundation elevation 600.0 is being proposed on the upper foundation elevation.
- (4) The length of foundation is assumed to be the width of the proposed bridge, i.e. 46 feet.  
The span of the proposed bridge will be 33 feet therefore distance between the abutments may be assumed to be 33 feet.

The calculation is presented in a table form

Found. Elev.	Width of Found. B.	Length of Found. L	Depth of Found. D	$N_c$	$\frac{s_u N_c}{3}$	$P_o$	$q_a$ psi
600.0	2.0	46.0	2.0	6.01	4009	264	4273
	4.0	46.0	2.0	5.52	3682	264	3946
	6.0	46.0	2.0	5.38	3588	264	3852
	8.0	46.0	2.0	5.28	3522	264	3786
	10.0	46.0	2.0	5.24	3495	264	3759

and for foundation elevation 595.2 the average  $s_u = 1710$  psi

is taken (see the graph of  $s_u$  versus elevation) and the calculation is then:

595.0	2.0	46.0	7.0	8.52	4967	923	5890
	4.0	46.0	7.0	6.78	3953	923	4876
	6.0	46.0	7.0	6.19	3609	923	4532
	8.0	46.0	7.0	5.94	3463	923	4386
	10.0	46.0	7.0	5.75	3352	923	4275

for elevation 590.0 the  $s_u$  is then taken as an average value for a depth of  $2 \frac{1}{2}$  ft of foundation width.

Found. Elev.	Width of Footing B	Length of Found. L	Depth of Found. D	Average $s_u$	$N_c$	$\frac{s_u N_c}{3}$	$P_o$	$q_a$
590.0	2.0	46.0	12.0	1630	9.00	4890	1582	6472
	4.0	46.0	12.0	1600	8.03	4283		5865
	6.0	46.0	12.0	1590	7.04	3731		5313
	8.0	46.0	12.0	1575	6.54	3434		5016
	10.0	46.0	12.0	1565	6.25	3260		4842

Note  $N_c$  was calculated according to Skempton's

expression

$$N_c = 5 \left( 1 + \frac{D}{5B} \right) \left( 1 + \frac{B}{5L} \right)$$

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SETTLEMENT ANALYSIS

1. Magnitude of the consolidation settlement

Footing: 2' x 46'

Name of Job Puce River & Hwy. # 98 Date Dec. 27, 1961

Job No. 61190

Elevation	Depth ΔH	Calculation of the Influence Factor					ΔP	ΔP <sub>av</sub>	Coefficient of Volume Change m <sub>v</sub>	ΔH	Settlement ΔS
		Z	D = 2 b/s	L = 46 1/s	I <sub>0</sub> 1/4	I <sub>0</sub> '					
		3	4	5	6	7					
600.0		0	∞	∞	0.250	1.000	4009				
595.0		5	0.200	4.600	0.061	0.244	978				
590.0		10	0.100	2.300	0.031	0.124	497	1403	0.0051	10.0	0.072
585.0		15	0.067	1.530	0.021	0.084	337				
580.0		20	0.050	1.150	0.016	0.064	257	350	0.0051	10.0	0.018
575.0		25	0.040	0.920	0.011	0.044	176				
570.0		30	0.033	0.770	0.008	0.032	128	182	0.0051	10.0	0.009
565.0		35	0.029	0.660	0.007	0.028	112				
560.0		40	0.025	0.575	0.005	0.020	80	109	0.0051	10.0	0.006
555.0		45	0.022	0.510	0.004	0.016	64				
550.0		50	0.020	0.460	0.003	0.012	48	64	0.0051	10.0	0.003

0.108 ft.  
= 1.30 in..

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SETTLEMENT ANALYSIS

1. Magnitude of the consolidation settlement

Footing : 4' x 46'

Name of Job Puce River & Hwy. # 98 Date Dec. 27, 1961

Job No. 61190

Elevation	Depth A.H.	Calculation of the Influence Factor					$\Delta p$	$\Delta p_{av}$	Coefficient various pressure $m_v$	$\Delta H$	Settlement $\Delta S$ ft
		$z$	$B = 4$ $B/z$	$L = 46$ $L/z$	$10/z$	$I_0$					
		1	2	3	4	5					
600.0		0	$\infty$	$\infty$	0.250	1.000	3682				
595.0		5	0.400	4.600	0.113	0.452	1664	1865	0.0051	10.0	0.095
590.0		10	0.200	2.300	0.058	0.232	854				
585.0		15	0.134	1.530	0.038	0.152	560	587	0.0051	10.0	0.030
580.0		20	0.100	1.150	0.029	0.116	427				
575.0		25	0.080	0.920	0.022	0.088	324	329	0.0051	10.0	0.017
570.0		30	0.067	0.770	0.017	0.068	250				
565.0		35	0.057	0.660	0.014	0.056	206	206	0.0051	10.0	0.011
560.0		40	0.050	0.575	0.011	0.044	162				
555.0		45	0.044	0.510	0.009	0.036	133	135	0.0051	10.0	0.007
550.0		50	0.040	0.460	0.008	0.032	118				

0.160 ft.  
= 1.92 inches

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# SETTLEMENT ANALYSIS

## 1 Magnitude of the consolidation settlement

Footings: 6' x 46'

Name of Job **Puce River & Hwy. # 98** Date **Dec. 27, 1961** Job No. **61190**

Elevation	Depth Z ft	Calculation of the Influence Factor					ΔP	ΔPa	Coefficient of Volume Compression m <sub>v</sub>	Δσ	Settlement ΔS
		Z	B = 6 6/2	L = 46 4/2	1σ/4	I <sub>σ</sub>					
		3	4	5	6	7					
600.0		0	∞	∞	0.250	1.000	3588				
595.0		5	0.600	4.600	0.157	0.628	2253				
590.0		10	0.300	2.300	0.084	0.336	1206	2301	0.0051	10.0	0.117
585.0		15	0.200	1.530	0.057	0.228	818				
580.0		20	0.150	1.150	0.042	0.168	603	847	0.0051	10.0	0.043
575.0		25	0.120	0.92	0.033	0.132	474				
570.0		30	0.100	0.770	0.025	0.100	359	476	0.0051	10.0	0.024
565.0		35	0.086	0.660	0.021	0.084	301				
560.0		40	0.075	0.575	0.016	0.064	230	299	0.0051	10.0	0.015
555.0		45	0.067	0.510	0.014	0.056	201				
550.0		50	0.060	0.460	0.012	0.048	172	201	0.0051	10.0	0.010

0.209 Feet  
= 2.51 inches

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SETTLEMENT ANALYSIS

1. Magnitude of the consolidation settlement

Footings: 8' x 46'

Name of Job Puce River & Hwy. # 98 Date Dec. 27, 1961 Job No. 61190

Elevation	Depth ft	Calculation of the Influence Factor					cp	Apr	Coefficient of Volume Decrease mv	dh	Settlement AS
		Z	B= 8 B/L	L= 46 L/Z	I <sub>0</sub> /4	I <sub>0</sub>					
		3	4	5	6	7	8	9	10	11	12
600.0		0	∞	∞	0.250	1.000	3522				
595.0		5	0.800	4.600	0.185	0.740	2606	2592	0.0051	10.0	0.132
590.0		10	0.400	2.300	0.114	0.456	1606				
585.0		15	0.267	1.530	0.079	0.316	1113	1144	0.0051	10.0	0.058
580.0		20	0.200	1.150	0.057	0.228	803				
575.0		25	0.160	0.920	0.042	0.168	592	606	0.0051	10.0	0.031
570.0		30	0.133	0.770	0.033	0.132	465				
565.0		35	0.114	0.660	0.026	0.104	366	371	0.0051	10.0	0.019
560.0		40	0.100	0.575	0.021	0.084	296				
555.0		45	0.089	0.510	0.018	0.072	254	254	0.0051	10.0	0.013
550.0		50	0.080	0.460	0.015	0.060	211				

0.253 feet  
= 3.04 inches



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SETTLEMENT ANALYSIS

Footings: 10' x 46'

1. Magnitude of the consolidation settlement

Name of Job Puce River & Hwy. # 98 Date Dec. 27, 1961

Job No. 61190

Elevation	Depth ΔH	Calculation of the Influence Factor					ΔP	ΔP <sub>av</sub>	Coefficient of Volume Decrease m <sub>v</sub>	ΔH	Settlement ΔS
		Z	B = 10 B/2	L = 46 L/2	I <sub>0</sub> /4	I <sub>0</sub>					
		3	4	5	6	7					
600.0		0	∞	∞	0.250	1.000	3495				
595.0		5	1.000	4.600	0.204	0.816	2852				
590.0		10	0.500	2.300	0.136	0.544	1901	2801	0.0051	10.0	0.143
585.0		15	0.334	1.530	0.095	0.380	1328				
580.0		20	0.250	1.150	0.069	0.276	965	1363	0.0051	10.0	0.070
575.0		25	0.200	0.920	0.053	0.212	741				
570.0		30	0.167	0.770	0.041	0.164	573	750	0.0051	10.0	0.038
565.0		35	0.143	0.660	0.033	0.132	461				
560.0		40	0.125	0.575	0.027	0.108	377	466	0.0051	10.0	0.024
555.0		45	0.111	0.510	0.022	0.088	308				
550.0		50	0.100	0.460	0.019	0.076	266	313	0.0051	10.0	0.016

0.291 feet  
= 3.49 inches

## SETTLEMENT ANALYSIS

Footings: 2' x 46'

Name of Job Puce River & Hwy.#98 Date Dec. 27, 1961

[illegible]

## SETTLEMENT ANALYSIS

Footings: 2' x 46'

Name of Job Puce River & Hwy. #98 Date Dec. 27, 1961

Job No. 61190

[illegible]

## SETTLEMENT ANALYSIS

Footings: 4' x 40'

Name of Job Puce River & Hwy.#98 Date Dec. 27, 1961

[illegible]

## SETTLEMENT ANALYSIS

Footings: 4' x 46'

Name of Job Puce River & Hwy. # 98 Date Dec. 27, 1961

Job No. 61190

[illegible]

## SETTLEMENT ANALYSIS

Lower boundary at 10% of  $p_0$

Job No. 61190

[illegible]

## SETTLEMENT ANALYSIS

Footings: 6' x 46"

Lower boundary at 10% of  $p_0$

Job No. 61190

[illegible]

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# SETTLEMENT ANALYSIS

## 1. Magnitude of the consolidation settlement

Footings: 6' x 46'

Lower boundary at 10% of  $P_0$

Name of Job Puce River & Hwy. # 98 Date Dec. 27, 1961

Job No 61190

Elevation	Depth A H	Calculation of the Initial & Final					$\Delta P$	$\Delta P_{av}$	Coefficient of Volume Change $\Delta S$	$\Delta H$	Settlement $\Delta S$
		2	B.	L.	$\Delta P$ $\frac{1}{2}$	$\Delta P_{av}$					
1	2	3	4	5	6	7	8	9	10	11	12
600.0		0	1.000	3000			2000				
595.0		5	0.628	1884	1924	0.098	1256				
590.0		10	0.336	1008			672	1283	0.065		
585.0		15	0.228	684	708	0.036	456				
580.0		20	0.168	504			336	472	0.024		
575.0		25	0.132	396	398	0.020	264				
570.0		30	0.100	300			200	265	0.014		
565.0		35	0.084	252	266	0.007	168				
						0.161 feet		184.5	0.005		
						1.93 inches			0.108 feet		
									= 1.30 inches		



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# SETTLEMENT ANALYSIS

## 1. Magnitude of the consolidation settlement

Footings: 8' x 46'

Name of Job Puce River & Hwy. # 98 Date Dec. 27, 1961

Job No. 61190

Elevation	Depth $\Delta H$	Calculation of the Influence Factor					$\Delta P$	$\Delta P_{av}$	Coefficient of Volume Decrease $\Delta V/V$	$\Delta h$	Settlement $\Delta S$
		$Z$	$B/L$	$L/P$	$I_{FV}$ $\Delta P_{av}$	$I_{FS}$ $\Delta S$					
		3	4	5	6	7					
600.0		0	1.000	3000			2000				
595.0		5	0.740	2220	2208	0.113	1480				
590.0		10	0.456	1368			912	1472	0.075		
585.0		15	0.316	948	974	0.049	632				
580.0		20	0.228	684			456	649	0.033		
575.0		25	0.168	504	516	0.026	336				
570.0		30	0.132	396			264	344	0.018		
565.0		35	0.104	312	316	0.016	208				
560.0		40	0.084	252			168	211	0.011		
555.0		45	0.072	216	216	0.011	144				
550.0		50	0.060	180			120	144	0.007		

0.215 feet  
= 2.58 inches

0.144 feet  
= 1.73 inches

Z. Elev 600	Settlement in inches				
	Too long				
	2 x 46	4 x 46	6 x 46	8 x 46	10 x 46
	1.30	1.92	2.51	3.09	3.19
	1.14	1.73	2.48	3.04	3.49

lower beam values  
at 10%  $\frac{1}{2}$  in

$\Delta p$  for various amounts of settlement  
(Elev 600.0)

$s = 1.0''$        $s = 1.5''$        $s = 2.0''$

2 x 46	3520	shear	shear
4 x 46	2180	3120	shear
6 x 46	1550	2310	3080
8 x 46	1160	1760	2310
10 x 46	1010	1520	2020

Based on allowable bearing values which will give a given amount of settlement  $\Delta p$  as determined above +  $p_0$ .  
As the thickness of components larger in probability range 15-90.  
But the footings if placed lower (elev 195.0) will gain on bearing value only the difference in overburden pressure, as the net pressures will cause identical deformations for elev 600 or 595.

Accordingly the allowable bearing values for various permissible amounts of settlements are:

F. Elev. 600.0

$$(q_0 = \Delta p + p_0) \quad \text{where } p_0 = 264 \text{ psf}$$

Footing size in ft	$s = 1.0''$	$s = 1.5''$	$s = 2.0''$
2 x 46	3784	4276 <sup>(*)</sup>	4273 <sup>(*)</sup>
4 x 46	2444	3081	3946 <sup>(*)</sup>
6 x 46	1814	2574	3344
8 x 46	1424	2024	2574
10 x 46	1284	1784	2284

(\*) Note: These values are given by shear strength consideration

F. Elev. 595.0

$$(p_0 = 923 \text{ psf})$$

Footings size in ft	$s = 1.0''$	$s = 1.5''$	$s = 2.0''$
2 x 46	4443	5890 <sup>(*)</sup>	5890 <sup>(*)</sup>
4 x 46	3103	4143	4876 <sup>(*)</sup>
6 x 46	2473	3233	4003
8 x 46	2083	2683	3233
10 x 46	1943	2443	2943

#61-F-231C

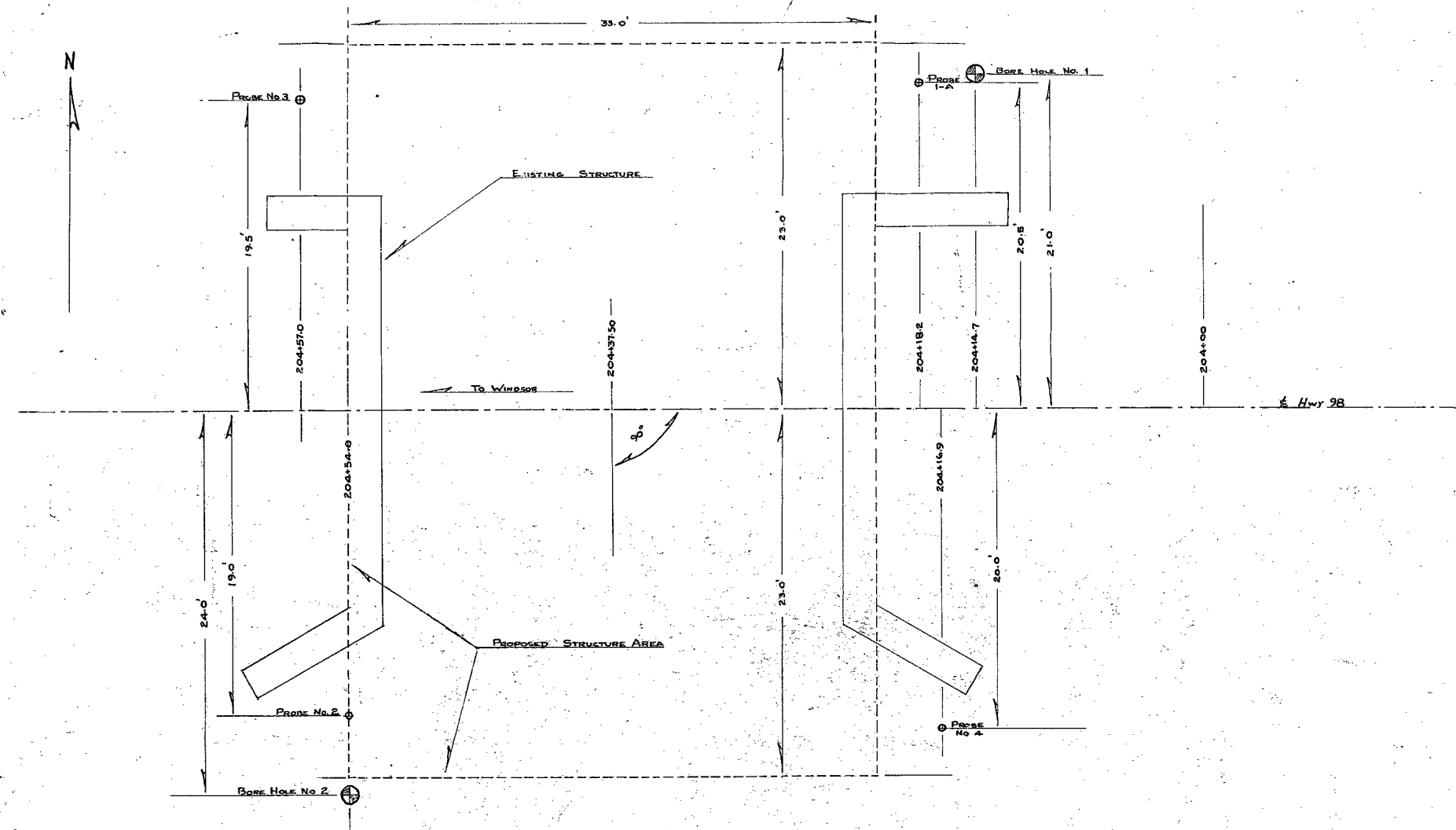
W.P. # 234-61

Hwy. #98

PROPOSED

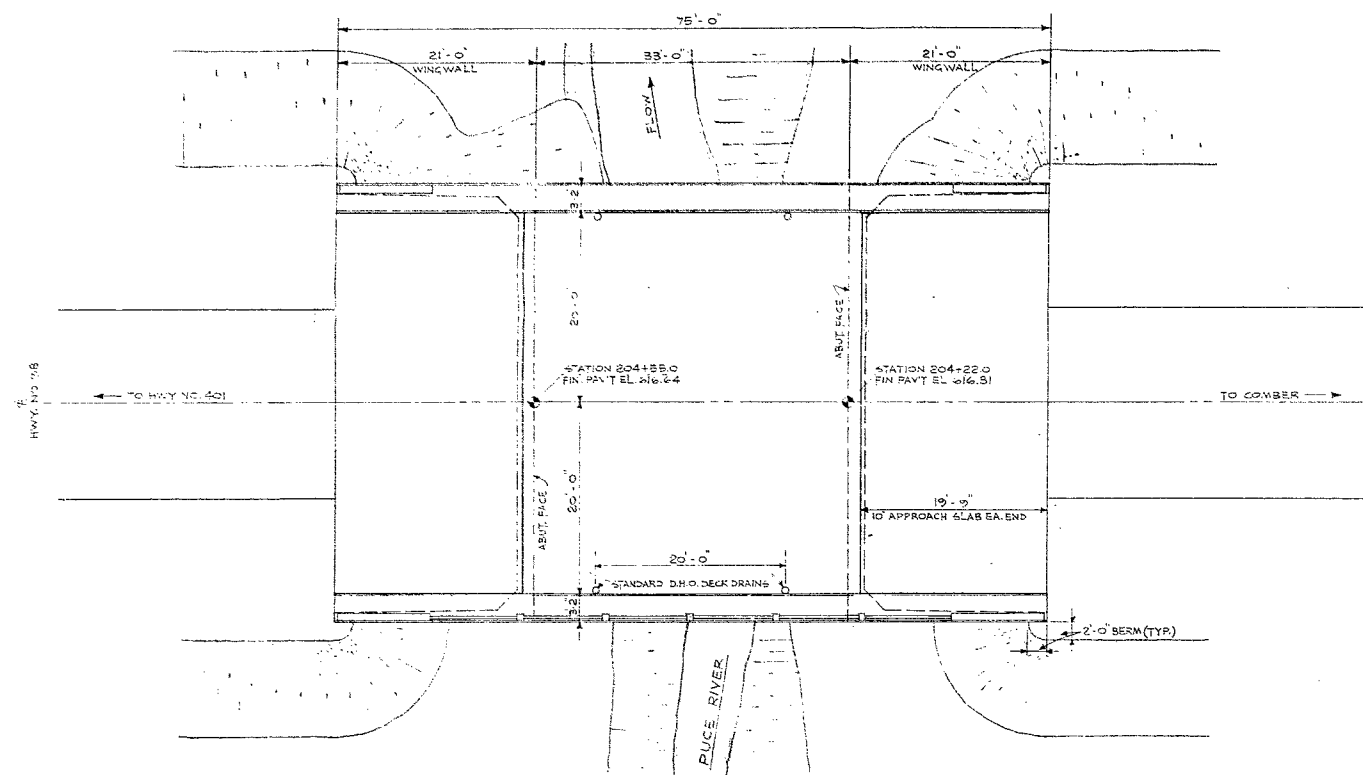
CROSSING AT

PUCE RIVER

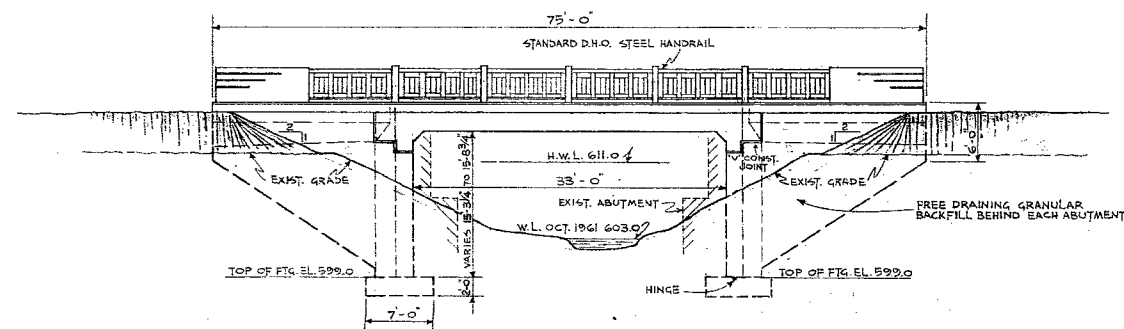


LOCATION No & DESCRIPTION	ELEVATION ORIG. GROUND	DEPTH OF BORE OR PROBE	DATE
Bore Hole No. 1	609.4	41.0'	Dec. 7, 61
Probe No. 1-A	609.1	18.8'	Dec. 7, 61
Bore Hole No. 2	607.2	41.0'	Dec. 8, 61
Probe No. 2-A	607.3	19.9'	Dec. 7, 61
Probe No. 3	606.5	22.6'	Dec. 8, 61
Probe No. 4	610.5	21.9'	Dec. 8, 61
WATER LEVEL	603.1	—	Dec. 7, 61
STREAM BED (MEAN)	602.4	—	Dec. 7, 61

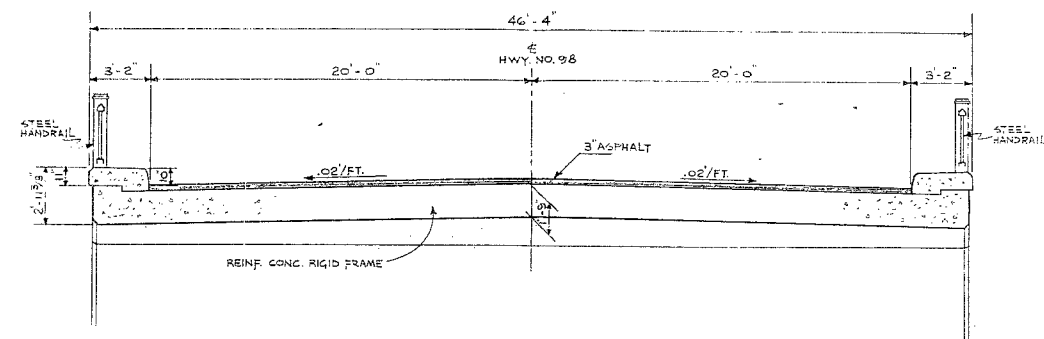
CONFIRMATION OF BORE HOLE LOCATIONS  
ON  
W.P. 234-61, HWY. # 98, PUCE RIVER  
BRIDGE  
3.9 MI. E. OF HWY. # 114, DISTR # 1, CHATHAM  
REFER TO DWG. No. E-4050-1



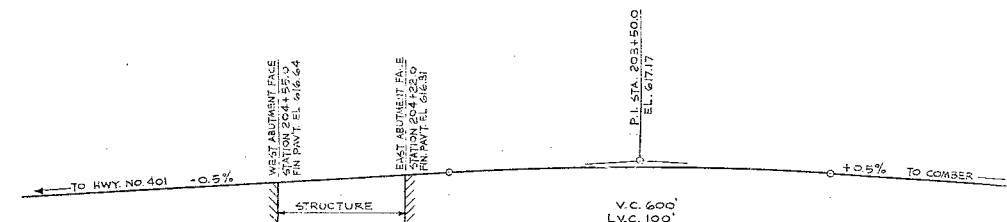
PLAN  
SCALE: 1/8" = 1'-0"



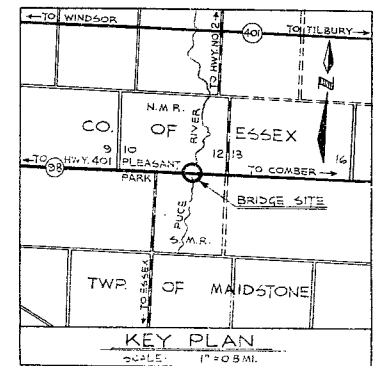
ELEVATION  
SCALE: 1/8" = 1'-0"



CROSS SECTION THRU DECK  
SCALE: 1/4" = 1'-0"



PROFILE ALONG FINISHED CROWN OF HIGHWAY NO. 98



**PRELIMINARY**

D.H.O. W.P. 234-61 M.M.D. JOB NO. 5700-6

M. M. DILLON & CO. LTD.  
CONSULTING ENGINEERS  
LONDON TORONTO

DEPARTMENT OF HIGHWAYS-ONTARIO  
BRIDGE OFFICE-TORONTO

**PUCE RIVER BRIDGE**  
CROSSING OF HWY. NO. 98

THE KING'S HIGHWAY NO. 98 DIST. NO. 1  
CO. ESSEX  
TWP. MAIDSTONE LOT XI CON. N.M.R.

GENERAL LAYOUT

APPROVED MAR 19 1962

BRIDGE ENGINEER				DESIGN ENGINEER			
DESIGN	J.A.C.	CHECK	A.P.	CONTRACT	NUMBERS		
DRAWING	G.L.B.	CHECK	D.H.R.	LOADING			
TRACING		CHECK		DESIGN			
DATE				DATE			

REVISIONS	DATE	BY	DESCRIPTION

D5031-P-1