

63-F-245 M

CTY BRIDGE

C-12-10

HICKORY CREEK
PLYMPTON TWP.

B.A. 1784

E. M. PETO ASSOCIATES LTD.

Job No. 63179

1287 Caledonia Road,
Toronto 19, Ontario.
789-1126-7

December 31st, 1963.

The County of Lambton,
c/o J. A. Monteith Associates Ltd.,
Consulting Engineers,
P.O. Box 579,
Petrolia, Ontario.

Attention: Mr. J. W. Ingram, P. Eng.

Gentlemen:

Re: Subsoil Investigation,
County Bridge C-12-10,
Hickory Creek

We have pleasure in submitting five copies of our Report
No. 63179, on the above subsoil investigation. One additional copy
has been forwarded directly to Mr. O. van Deurs, Lambton County
Engineer.

The presently given conclusions mainly consider your proposals
contained in letter of December 6th, 1963, which indicate that the
structure will be a high level bridge with footings at elevation 396 and
with embankment grade at elevation 627.

The alternative, culvert-type structure foundations, as well as alternative pile foundations were discussed in our preliminary report of October 27th, 1963.

While we consider the investigation to be complete within your terms of reference, we would gladly provide additional assistance should you wish to discuss further any aspects of this work.

Yours very truly,

E. M. PETO ASSOCIATES LTD.,

A handwritten signature in dark ink, appearing to read 'E. M. Peto', is written over the typed name.

E. M. Peto, P. Eng.

RK:sb

THE COUNTY OF LAMBTON,
C/O J. A. MONTEITH ASSOCIATES LTD.
CONSULTING ENGINEERS.

SUBSOIL INVESTIGATION

COUNTY BRIDGE C-12-10

HICKORY CREEK

E. M. PETO ASSOCIATES LTD.

1287 Caledonia Road,
Toronto 19, Ontario.

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A. INTRODUCTION:

The work described in this report was authorized verbally on 16th September, 1963, by Mr. G. W. Ingram, P. Eng. of J. A. Monteith Associates Ltd., Consulting Engineers.

In connection with the proposed realignment of Lambton County Road No. 12, a new crossing is to be provided over the Hickory Creek, in the location indicated on the Key-plan included on the enclosed drawing. This Company was requested to provide a subsoil investigation and foundation consultation for the above project.

Originally, consideration was given to providing either a reinforced concrete or a steel multi-plate arch culvert, or, alternatively, a high level bridge structure.

Following completion of the field work, a preliminary report was submitted dated October 27th, 1963. The report contained preliminary information on the subsoil conditions and preliminary recommendations with regard to the culvert-type or high level bridge foundations.

A. INTRODUCTION: (Cont'd)

Following submission of the preliminary report, we were informed that it was decided to abandon the idea of a culvert-type structure in favour of a high level bridge. This proposal was discussed in a further letter from us, dated 2nd December 1963, in which it was recommended to support the footings of the bridge on the stratum of very stiff sandy clay till. Thereupon, we were informed by the Consulting Engineers that our suggestion has been accepted, and that it is proposed to support the footings at elevation 596.0. The embankment grade at the crossing is to be approximately at elevation 627.0.

The present is the final report on this subsoil investigation, and the conclusions are centred around the above final proposals of footing and embankment grades.

B. GENERAL INFORMATION:

1. Four holes were performed at this site, in the positions chosen by Mr. G. W. Ingram, P. Eng., and indicated directly to our drilling foreman. Two of the test holes proved shale bedrock by diamond drilling, while the remaining two test holes were put down sufficiently deep to confirm the stratification of overburden.

B. GENERAL INFORMATION: (Cont'd)

2. The field work was carried out by our drilling rig unit No. 3, between 27th September and 3rd October, 1963 and the test holes were put down using a standard skid-mounted diamond drilling rig. Our standard drilling and sampling procedures were followed.

Special measures were taken in dealing with ground water under artesian pressure, encountered in a sandy stratum immediately above the bedrock. The equilibrium level of this water head was measured by means of borehole casing projecting above ground. After completion of relevant boreholes, the artesian water was sealed immediately above the level of its source with a cement and sand mixture.

3. Ground elevations in the positions of the test holes were supplied to us by Messrs. J. A. Monteith Associates, and are Geodetic. The elevations are entered on the borehole logs and drawing.

4. Laboratory testing of soil samples, apart from water content measurements, consisted of Atterberg Limit tests and unconfined compression tests with volumetric analysis. The results are appended to this report.

C. SOIL CONDITIONS:

Details of the subsoil conditions encountered in the test holes are described on the borehole logs, while simplified subsoil profiles, in the form of sections through the test holes are presented on the appended drawing and include inferred levels of contacts between the various strata.

The main geotechnical properties of the subsoil, viz. the water contents and Atterberg limits, standard penetration resistance (N-values) and the undrained shear strength are plotted against elevation on Fig. 1. The undrained shear strength is also plotted against water content on Fig. 2. The results of unconfined compression tests, together with volumetric analysis, are listed on Table E.

Other relevant information regarding the subsoil conditions may be summarized as follows:

The softest deposit, which is the critical stratum in bearing capacity and settlement considerations, is the silty clay with silt seams, occurring between the average depth of 4 and 17 ft below the existing grade, or between the average elevations 609.5 and 596.8. The analysis of shear strength test results indicated that in bearing capacity of foundation and embankment stability analysis the undrained shear strength of this deposit can be taken as 2,000 lb/sq. ft. This figure supercedes the value of 1,600 lb/sq. ft. given in our preliminary report No. 63179 of October 27th, 1963, at which time full results of laboratory testing was not available.

C. SOIL CONDITIONS: (Cont'd)

The silty and sandy clay with pebbles (sandy clay till) which follows below the average depths of 17 ft or elevation 596.8, has an undrained shear strength of 3,700 lb/sq. ft, increasing with depth to over 5,000 lb/sq. ft.

A variable, sandy and gravelly deposit follows the sandy clay till, and is in an extremely dense state of packing. This stratum contains ground water under artesian pressure, the head of which corresponded to elevations 621.2 in test hole 1 and 619.7 in test hole 3.

The black shale bedrock was in very sound condition below elevations 574.9 in test hole 1 and 574.1 in test hole 3. Above these levels, about 2 ft of broken shale was penetrated, mixed with sand and silt.

D. CONCLUSIONS AND RECOMMENDATIONS:

1. Bridge foundations

According to information obtained from the Consulting Engineers, it is now proposed that the crossing should have a form of a high level bridge, the footings of which would be located at elevation 596. This corresponds to the surface of the very stiff sandy clay till stratum, which in the four test holes commenced between the elevations 595.4 to 598.4. The allowable net bearing capacity at elevation 596 is 4.0 ton/sq. ft, as stated in our previous communications, the settlement of foundations placed at this level will in all probability be negligible.

D. CONCLUSIONS AND RECOMMENDATIONS:

1. Bridge Foundations (Cont'd)

As was communicated earlier, the allowable bearing capacity of foundations placed above the sandy clay till would be limited to between 1.5 to 2.0 ton/sq. ft, and the settlement aspect would have to be given consideration.

If the footings are placed, as proposed, at elevation 596, and with the embankment fill behind abutments extending not appreciably higher than to elevation 627, no potential danger of rotational failure of abutments is anticipated. The earth in front of the abutments would contribute to the resisting forces against a rotational failure but only the mass of soil above the lowest probable depth of stream scour should be considered in this respect. However, with a spill-through type of abutment, it is doubtful whether any of the fill in front of the structure can be relied upon safely, with the possible exception of the soil above the foundation block.

2. Embankments

The embankment grade is to extend to the approximate elevation 627, so that only about 15 ft of fill will be placed over the area of the test holes. Under these conditions, an adequate factor of safety against a possible slip failure of the embankments will be assured. The safe slopes of the embankments will depend on the type of material used as fill, rather than on the foundation conditions.

D. CONCLUSIONS AND RECOMMENDATIONS:

2. Embankments (Cont'd)

No test holes were performed on the valley slopes, but visual observation indicated that these slopes consist of sand, and the present steep grades indicate that they are in a stable condition.

The stability of the embankments could be impaired if the artesian water pressure, presently restrained by the two clay strata, were to act directly on the base of the embankments. This could occur if the clay was penetrated by borings or excavations ranging below the depth of 25 ft. It is therefore recommended that no such borings or excavations should be conducted in the immediate area of the embankments, unless measures are adopted for a permanent release of the artesian pressure.

Some consolidation of the silty clay strata is anticipated below the embankment but it is not expected to exceed 3 to 4 inches.

The silty clay which will be recovered in excavation for bridge footings and creek diversion can be used as fill in embankment construction with the exception of any wet and dilatant pockets of silt. However, the material must be regarded as frost susceptible, and should not be used immediately below road surface. Little soil with organic matter was observed in the test holes, but if encountered in the excavation it should not be used as controlled fill.

D. CONCLUSIONS AND RECOMMENDATIONS:

2. Embankments (Cont'd)

Most of the material which will be recovered in excavations of cuttings in the slope of the valley at the bridge approaches, if it proves to be sandy, may form a satisfactory embankment fill.

E. M. PETO ASSOCIATES LTD.,

B. Lewis,

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

2K:sb

Job No. 63179

December, 1963.

Report Prepared By:

R. Kulesza, P. Eng.

TABLE 'A'

Job No. 63179

A T T E R B E R G L I M I T T E S T R E S U L T S

Soil Type	BH/So. No.	Depth ft.	Liquid Limit %	Plastic Limit %	Plasticity index -	In-situ water content %
Silty clay with silt seams	1/9	11.5	33.9	18.4	15.5	24.9
	4/8	13	36.2	18.3	17.9	26.1
Silty and sandy clay; with some pebbles	1/16	26	30.2	16.4	13.8	15.3
	3/16	31	25.0	15.8	9.2	14.5

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E. M. PETO ASSOCIATES LTD.

UNCONFINED COMPRESSION TEST DATA SHEET

TABLE 'B'

Corehole Number	Sample Number	Depth Interval	Nat. M. C %	Wet Density p.c.f.	Dry Density p.c.f.	Void Ratio, e	% Strain at Failure	u/c Shear Strength p.s.f.
1	7	9'8"-10'0"	22.3	125	102	0.65	20	2100
1	8	11'0"-11'4"	23.6	125.5	101.5	0.66	20	2920
1	9	10'6"-12'	23.4	123.0	99.5	0.69	20	1780
1	11	15'4"-15'8"	13.0	132.5	117	0.44	20	3400
1	15	25'0"-21'6"	13.4	136.0	120.0	0.41	20	6150
1	17	30'-31'6"	16.7	143.0	122.5	0.45	17	6350
2	6	5'-6'	23.6	121.5	98.5	0.71	20	2000
2	7	11'-11'6"	24.2	123.5	99.5	0.69	20	2100
2	10	20'-21'	15.5	136.0	118.0	0.43	20	3450
3	9	10'8"-11'	35.6	119.0	88.0	0.96	10	1950
3	11	11'6"-13'	25.3	129.5	103.5	0.67	20	1450
3	12	15'-16'6"	23.4	132.5	107.0	0.63	20	1650
3	13	18'-19'6"	16.1	143.0	123.0	0.44	20	4300
3	14	20'-21'6"	16.4	142.5	122.5	0.44	16	3800

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E. M. PETCO ASSOCIATES LTD.

UNCONFINED COMPRESSION TEST DATA SHEET

TABLE 'B' Cont'd.

Borehole Number	Sample Number	Depth Feet	M. C. Tin No	Nat. M.C. %	Wet Density p.c.f.	Dry Density p.c.f.	Void Ratio, e.	% Strain at Failure	u/c Shear Strength p.s.f.
4	5	7'-8'6"	22.1		130.5	106.5	0.20	20	3450
4	6	10'6"-11'0"	22.9		124.5	101.5	0.66	20	2430
4	7	11'0"-11'6"	27.0		122	96.0	0.76	20	1460
4	9	15'6"-16'0"	19.0		125.5	105.5	0.57	20	1700
4	10	16'0"-16'6"	24.6		124	99.0	0.68	13	2600
4	11	21'-21'9"	14.3		136.0	119.0	0.54	20	4650
4	12	25'-26'6"	11.0		147.5	133.0	0.30	20	5200

GEOTECHNICAL SOIL PROPERTIES

APPENDIX

FIG. 1

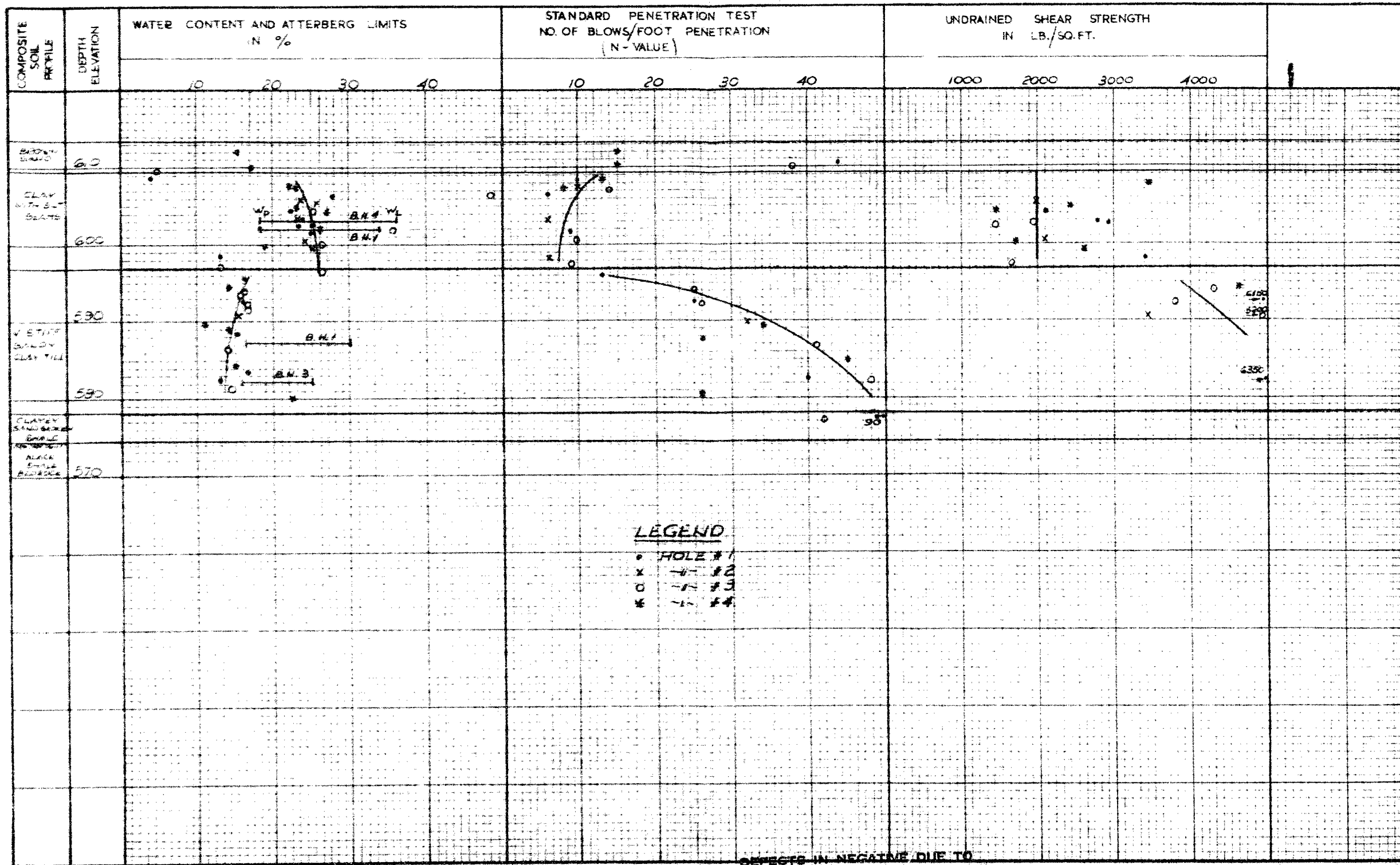


FIG. 2

RELATIONSHIP BETWEEN WATER CONTENT AND UNDRAINED SHEAR STRENGTH

LEGEND

- CLAY WITH SILT SEAMS
 $w_L = 35, w_P = 18$
- x SANDY CLAY FILL
 $w_L = 25, w_P = 16$

UNDRAINED SHEAR STRENGTH c_u , KIP/FT²

WATER CONTENT, $w\%$

DB # 62179
E.M. 1270 GESSOL CRES. 10
DEC 1963

e. m. peto associates ltd.

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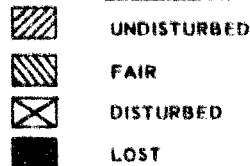
BOREHOLE LOG

Job Name County Bridge C 12-10
Client The County of Lambton
Elevation

Job No. 63172
Casing 4" to 15' BX to 38"
Compiled By R. Q.

Borehole No. 1
Boring Date Oct. 18, 2003
Checked By

SAMPLE CONDITION



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
M. MOIST
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
A.P.L. ABOUT PLASTIC LIMIT

SOIL DESCRIPTION	COLOUR	Density or Consistency	Depth Elevation	Legend	Sample No. and condition	Sample Type	No. of Blows per Ft.	WATER LEVELS & REMARKS
Sandy Topsoil	black		0'					
Fine to medium silty sand with gravel			1'3"					
Fine to coarse sand with fine gravel, some silt	light brown	dense				S.S.	44	stone driven by S.S. dry
Layers of clay and silt	grey	soft to firm	5'3"			SS	22/6"	10/12"
			8'6"			SS	6	27.7 WTPL
Laminated clay	"	Firm to stiff				SS	9	24.2 WTPL
Silty clay with sand & pebbles, fissured	"	V. stiff	15'11"			3" sl		
Clay with layers of silt		stiff	17'6"				2/6"	wash water used from 18'
			19'6"				7/6"	16.2 WTPL
Silty clay, fissured	"	v. stiff				SS	25	16.1 DTPL
Silty clay with some fine sand & grits, fissured	"	"				SS	26	15.3 DTPL
			22'0"					
Silty clay with some fine sand & grits	"	hard				SS	40	12.9 DTPL
Layers of broken rock			34'7"					
			34'10"			SS	27/8"	
Sand & broken rock	black	V. dense	37'10"				23/6"	Less dense at 37'10"
			38'9"					Re-fined at 38'9"
Shale bedrock, v. sound	"	hard				R.C.		Diamond drilled from 38'9" to 43'10", recovery 3'10" (75%)
			43'10"					

Testhole terminated at 43 ft. 10 in.

Groundwater observations.

No free water to 18' below which washwater was used.
Casing to 38' hole to 38'9" groundwater overflowing casing just above ground level
" " " " hole to 43'10" groundwater slowly overflowing casing extending to 7'6" above ground

The testhole was cemented and artesian conditions blocked off.

e. m. peto associates ltd.

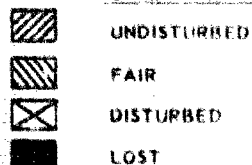
SOIL ENGINEERING SERVICE - TORONTO, ONTARIO

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CONDITION OF ORIGINAL DOCUMENT

BOREHOLE LOG

Job Name County Bridge C-12-10 Job No. 60170 Borehole No. 3
 Client The County of Lambton
241 E. A. Macdonell & Assoc. Casing 1 1/2" I.D. BN to 30' 1" Boring Date September 27 & 28, 1963
 Elevation Compiled By RR Checked By

SAMPLE CONDITION



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
 M. MOIST
 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
 A.P.L. ABOUT PLASTIC LIMIT

SOIL DESCRIPTION	COLOR	Density or Consistency	Depth (Feet)	Legend	Sample No. and Condition	Sample Type	No. of Blows per Ft.	Notes	WATER LEVELS & REMARKS
Sandy top soil	Brown		0'6"		1	C.S.			
Fine to med. silty sand with fine to med. gravel	Light brown	Dense	3'0"		3	SS	38	1.5	Dry
Mixed silt and clay	grey-brown	Firm			5		14	48.6	
Silty clay to clayey silt with organic content	grey	Firm to soft			6		9	25.2	W.T.P.L.
Layers of clay and silt	Ditto	Firm	10'		7	3"SL			
Laminated clay with some grits		Firm to stiff	12'		11	SS	10	26.4	W.T.P.L.
Ditto	Ditto	Ditto			12	SS	9	26.1	D.T.P.L.
Silty clay with some fine sand & a few pebbles, fissured	Ditto	V. Stiff	18'6"		13		25	15.5	
Ditto	Ditto	Ditto			14	SS	26	16.6	Wash water used from 20'
			23'6"			2"SL			
Ditto	Ditto	Hard			15	SS	41	14.1	Stiffer and more at 23'6"
									Softer layer at 28'2"
As above, v. fissured	Ditto	Ditto			16	SS	48	14.5	
			33'6"						Softer at 33'6"
Silty clay and Silt					17	SS	42		
Clayey silt, changing to mixture of silt, clay and sand with broken shale	Dark grey	V. dense	36'0"						
Mostly coarse sand, some fine gravel	Black		37'2"		18	WS			
Shale bedrock, v. sound	Ditto	Hard	39'1"			R.C.			Diamond drilled from 39'1" to 44'3" recovery 5'1" (94%)
			44'3"						

TESTHOLE TERMINATED AT 44'3"

Ground water observations

No free water to 20 ft, below which wash water used.

Casing at 20', hole to 36'6", ground water slowly overflowing casing at ground level; some gas observed, but did not catch flame. Casing extended to 10'7" above ground level, overnight steady water level 6'6" above ground.

Casing at 39'1", testhole to 44'3" (in shale). Steady water level 6'1" above ground. Testhole cemented to 16'6" to cut off artesian condition.

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

DEFECTS IN NEGATIVE DUE TO
CONDITION OF ORIGINAL DOCUMENT

Job Name County Bridge G-14-10 Job No. 63179 Borehole No. 4
 Client County of Lambton, Casing 4" to 4" B.S. 19 15" Boring Date Sept. 10, 1963
 Elevation Compiled By R. V. Checked By

SAMPLE CONDITION



UNDISTURBED



FAIR



DISTURBED



LOST

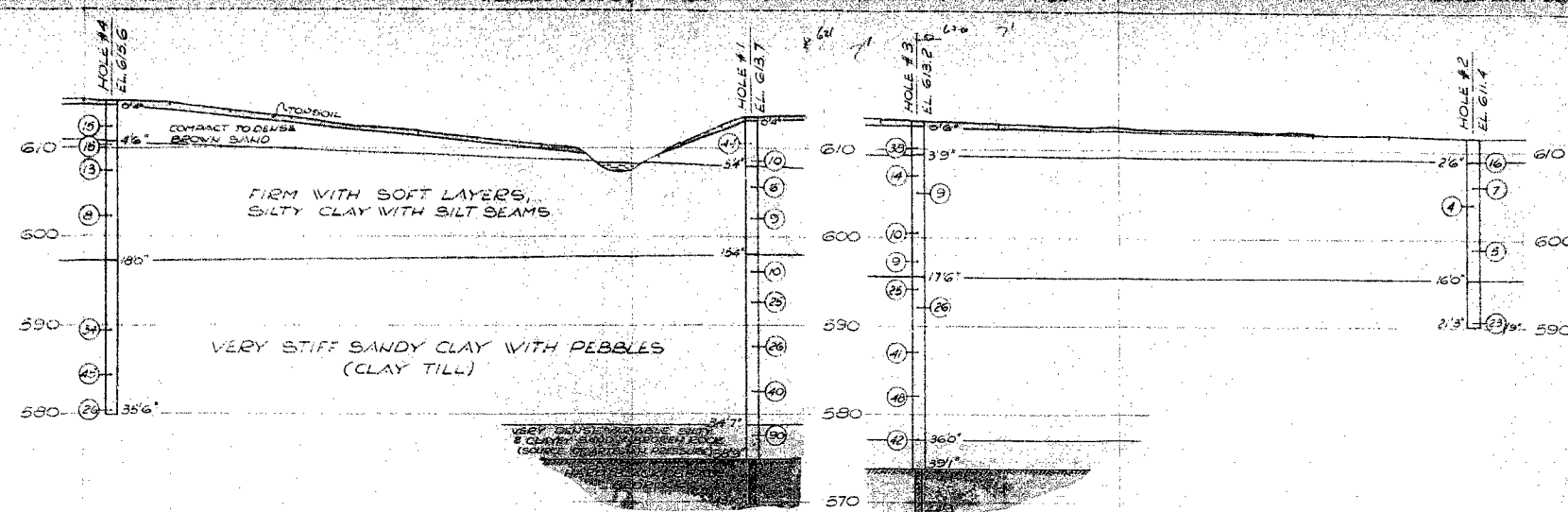
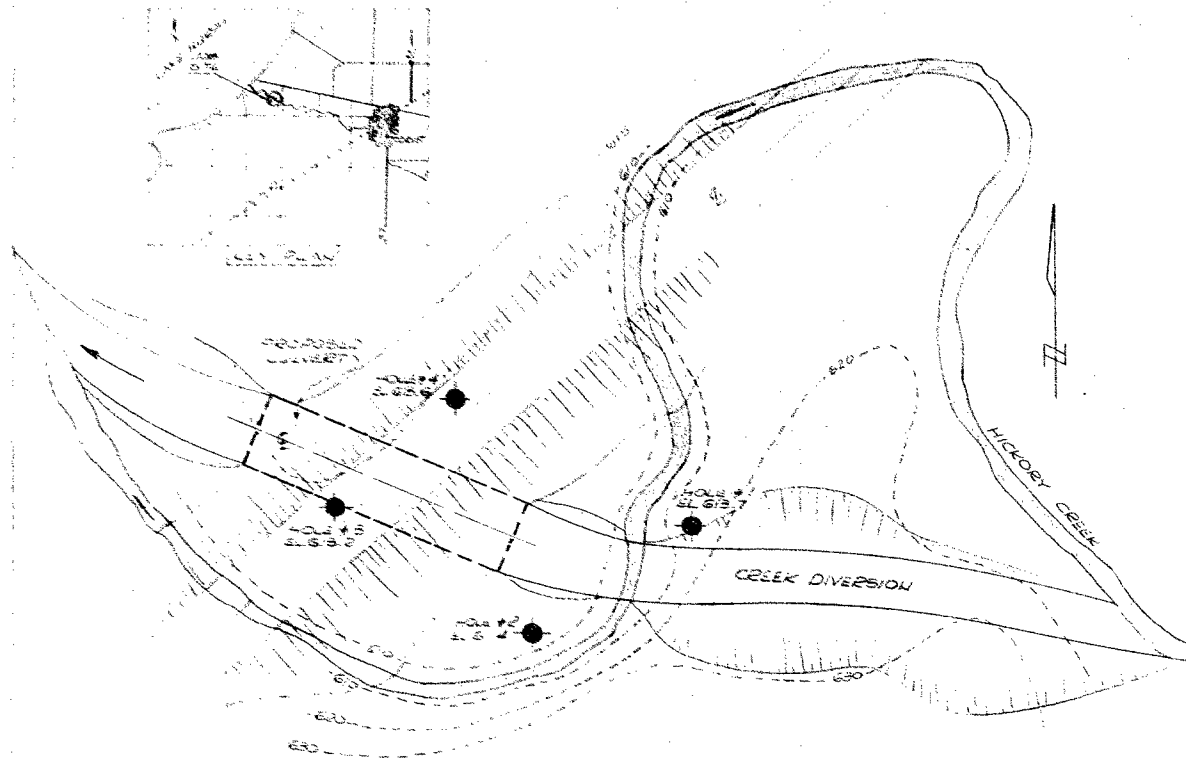
SAMPLE TYPE

A.S. AUGER SAMPLE
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W.S. WASH SAMPLE
R.C. ROCK CORE

ABBREVIATIONS

V.T.	IN SITU VANE SHEAR TEST
M.	MOIST
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
A.P.L.	ABOUT PLASTIC LIMIT

[illegible]



LEGEND

- BOREHOLE
- (B)— BLOW'S/FOOT S.P.T.

NOTES

- a) SEE BOREHOLE LOGS FOR COMPLETE SOIL DETAILS.
- b) BOREHOLE LOCATIONS AND ELEVATIONS HAVE BEEN SUPPLIED BY J.A. MONTEITH & ASSOC.

NOTE: The actual soil stratification has been verified from data obtained at the borehole locations only. The inferred contacts shown are based on geological evidence and these may vary from those shown between borings.



THE COUNTY OF LAMBTON
% J.A. MONTEITH & ASSOCIATES

COUNTY BRIDGE C-12-10
HICKORY CREEK

PREPARED BY
e.m. peto associates ltd.

JOB NO. 63179	DATE DEC 1963	DRAWN BY K.K.	CHECKED BY RK
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DEFECTS IN NEGATIVE DUE TO
CONDITION OF ORIGINAL DOCUMENT

Mr. K. L. Kleinsteinber,
Municipal Bridge Liaison Engr.,
Bridge Division.

Foundation Section,
Rm. 107, Lab. Bldg.

Attn: Mr. G.C.E. Burkhardt.

April 8, 1964

Your Memo - April 7/64

County of Lambton,
Bridge over Hickory Creek,
Lot 48, Con. F.L.H.,
Twp. of Plympton,
Structure Site No. 15-318.
Your File No. BA 1784

The above report submitted by the soils consultant,
F. W. Peto Associates Ltd., has been reviewed and we agree
with the recommendations made therein.

From the foundation point of view, spread footings
using a design load of 4 T/sq.ft. at El. 596 are suitable
for the subsoil conditions. However, if other conditions
such as scour dictate, the alternative of using end-bearing
piles may be used. The piles should be driven to practical
refusal and a design load of 60 T. may be used, for example,
for steel 12 BP 53 H-piles.

We trust that the foregoing information will prove
adequate for your design work. Should there be any other
queries, please feel free to contact our Office.

KYL/MdeF

KYL
K. Y. Lo,
SUPERVISING FOUNDATION ENGINEER

cc: Foundations Office ✓
Gen. Files