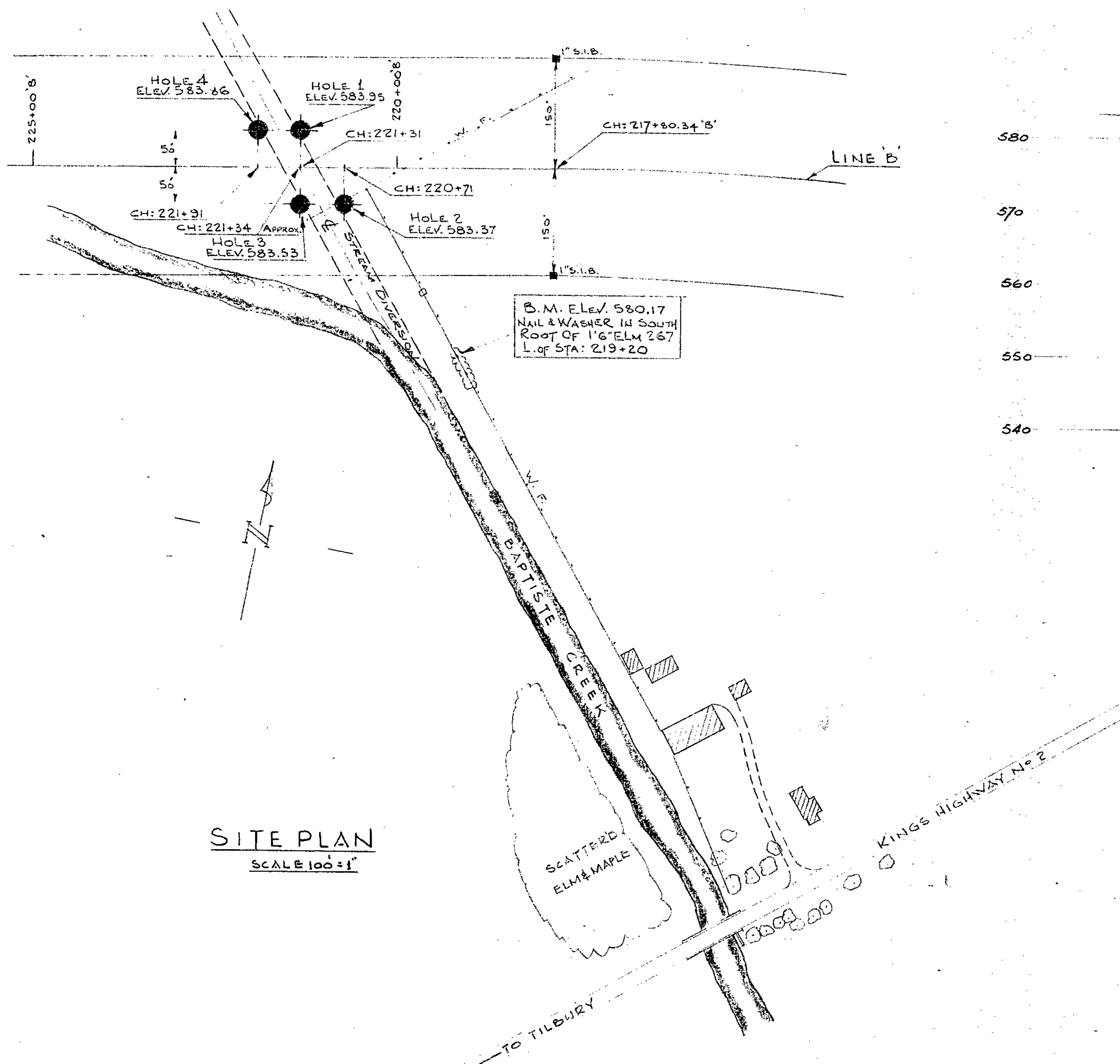
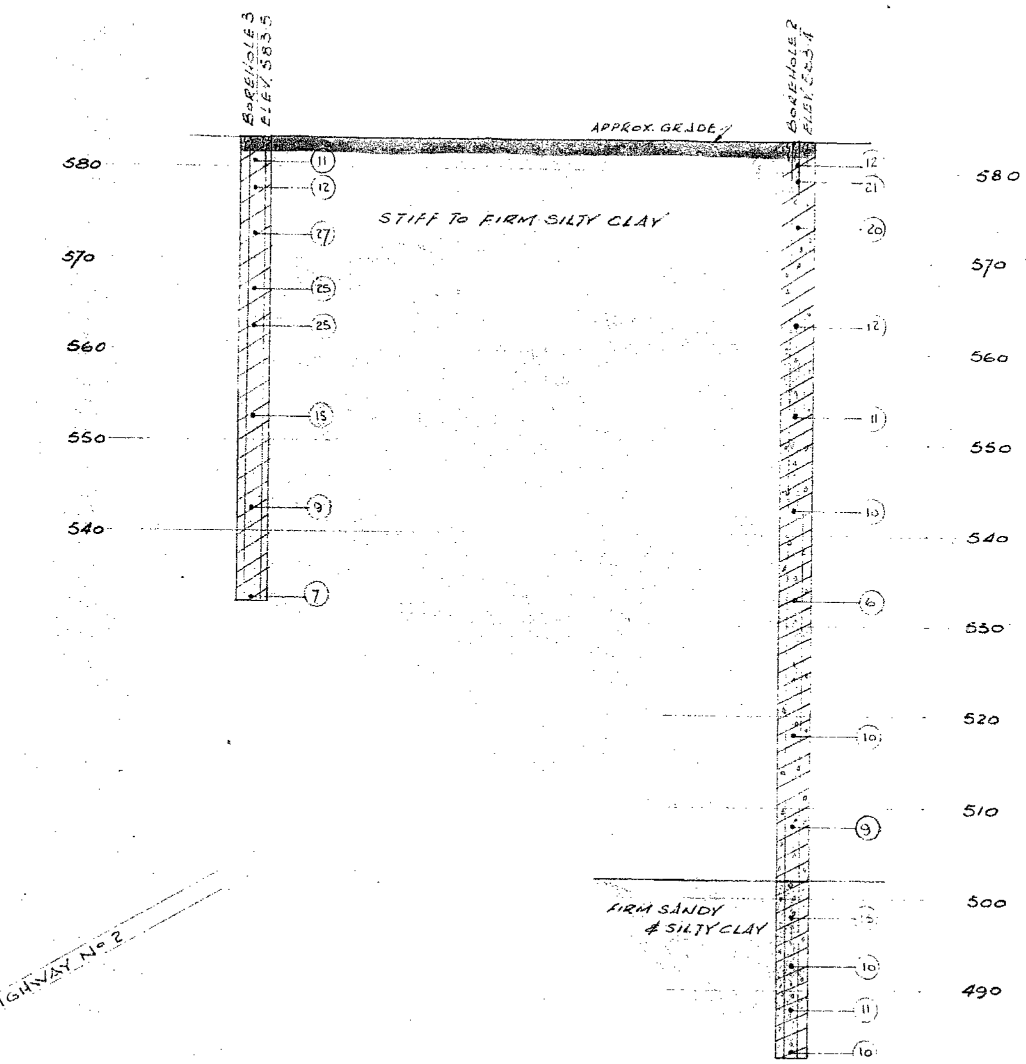
#59-F-206C
W.P. #164-58
HWY. #401
BAPTISTE
CREEK
CROSSING
TILBURY EAST



SITE PLAN

SCALE 100' = 1"



SECTION THROUGH HOLES 3 & 2

PROFILE SCALE VERT. 10' = 1" HOR. 10' = 1"

LEGEND

BOREHOLE

BLOWS / FOOT

REGISTERED PROFESSIONAL ENGINEER
E. M. PETO
PROVINCE OF ONTARIO

e.m. peto & associates ltd.

SOIL SITE INVESTIGATION
AT
HWY. 401-BAPTISTE CREEK CROSSING
(WORKS PROJECT 164-58)
FOR
DEPT. of HIGHWAYS of ONTARIO

OUR JOB No.- 58160 DATE- 16 FEB 1959

CLIENTS PLAN No.- F5534-7 PER- C.J.W. & G.T.

AN INDEPENDENT ORGANIZATION PROVIDING A COMPLETE SOIL ENGINEERING & INVESTIGATION SERVICE

e. m. peto associates ltd.

YOUR REFERENCE:-

OUR REFERENCE:- 58160

850 roselawn avenue,
TORONTO 19, ONTARIO.
RUssell 1-4955.

March 5th, 1959.

The Department of Highways of Ontario,
Bridge Design Office,
280 Davenport Road,
TORONTO, Ontario..

For the attention of Mr. J.C. McAllister.

Re: Soil Investigation
Hwy. 401 - Baptiste Creek Crossing
W.P. 164-55, Tilbury East.

Dear Sir,

As requested by Mr.L. Soderman of the D.H.O. Foundation section, we have reviewed our report for the above project. In order that our approach be realistic we have fully discussed the design requirements with the Consulting Engineers for this structure, A.D. Margison and Associates Limited,.

The bridge will probably be a single, 50 foot span rigid frame structure, on a 30° skew. Differential settlements of up to 2 or 3 inches could be tolerated. The absolute maximum footing elevation will be elevation 571.0, two feet below stream bed, and the most probable footing position will be elevation 569.0. The footing depth is governed by frost protection requirements, and by recommendations made in the D.H.O. hydrology report. It should be noted that our original report correctly anticipated the footing elevation.

An approximation obtained from the Consultants of the end reaction at each end of the bridge, considering full dead load plus some provision for live load, etc., is 1200 kips. The long dimension of the footings is virtually fixed at 53 feet.

We present below a table of values for footings at elevation 570.0. No additional bearing capacity due to surcharge is considered because of the proximity of the footings to the creek.

Sheet 2. (Continued)

Footing Dimension	Actual Soil Pressure at Base of Footing P.S.F.	Actual Safety Factor against Shear Failure if C=2500 P.S.F.	Maximum Theoretical Settlement under Centre of Footing:-INS.
53' x 4'	5000	2.58	0.42"
53' x 6'	3780	3.90	
53' x 7'	3240	4.57	6.35"
53' x 8'	2835	5.26	
53' x 10'	2203	6.[illegible]4	0.10"

The foregoing table of values points out rather clearly the fact that under the given magnitude of load the settlements will be nearly the same, regardless of the unit soil pressure. We would consider that a permanent factor of safety against shear failure of 2.58 is ample for this site. Therefore any footing dimension within the range given in the table may safely be used.

Differential settlements between the two ends of the bridge should be small, although the fact that the bridge will be built on a skew tends to aggravate this condition.

Some differential movement between the bridge abutments and the highway embankments behind them will probably also develop with time.

We trust that this letter will provide the Consultants with the additional information required for their design.

Yours very truly,

E. M. PETO ASSOCIATES LIMITED.

EMP/fh.

E.M. Peto, P. Eng.

e. m. peto associates ltd.

YOUR REFERENCE:-

OUR REFERENCE:- 58160

850 roselawn avenue,
TORONTO 19, ONTARIO.
RUssell 1-4955.

February 20th, 1959.
59 - F - 206 C

Bridge Office,
Department of Highways of Ontario,
280 Davenport Road,
Toronto, Ontario.

Re: Soil Investigation
Hwy. 401 - Baptiste Creek Crossing
W. P. 164-58, Tilbury East

Attention: Mr. J. C. McAllister

Dear Sirs;

We are pleased to submit herewith four copies of our soils report for the above project. This is not a problem site, and the only matter of concern is the settlements which could potentially arise under a structure founded at or near the surface.

For your convenience we summarize briefly below our findings and recommendations.

1. The site is located on a very flat lacustrine clay plain, and the soils consist of water-laid sediments of extensive thickness.

2. The soil types encountered were:

a) A 4 to 6 foot thick surface layer of weathered silty clay and clayey silt with fine sand content, grits and pebbles. There is also some organic vegetable matter in the upper 12 to 18 inches. The soil is mottled grey-brown in colour, and is drier than the plastic limit. It is not subject to major volume changes accompanying soil moisture variation.

b) Approximately a 76 to 78 foot thick stratum of silty clay with grits, in a stiff to firm condition. The shear strength, C, of this soil is approximately 4000 p.s.f. down to elevation 562, and then drops off until a constant value of approximately 1000 p.s.f. is reached at elevation 524. This soil is of low to medium compressibility, and has been over-consolidated in the past.

c) A layer of sandy and silty clay till with grits, which occurs generally below the 82 foot depth, and probably extends to the 120 foot depth. This soil is grey in colour, firm to stiff in consistency, and probably has a very low compressive index. It may be assumed that very little, if any, consolidation of this stratum will take place.

3. Although the position of the ground water table could not be definitely established by the field crew due to the low permeability of the silty clay it may be assumed that the true ground water table coincides with the water level in Baptiste Creek or Lake St. Clair (approx. elevation 575). The soil is fully saturated below this elevation.

4. A large multi-span box culvert may be suitable at this site, and this alternative warrants consideration.

5. If a bridge is used we recommend that it be a statically determinate structure which could tolerate some differential settlement.

Such a bridge may be supported on large spread footings founded at or slightly below the new stream bed level. Safe allowable loadings in the order of 3500 p.s.f. may be used.

Total settlements under such loading can be considerable, but differential settlements should be small because of the uniform soil conditions.

6. If a culvert is not used, it would be preferable if the new stream channel is excavated with side slopes of 2:1.

7. There should be no undue construction difficulties at this site.

We believe this report to be complete, and to contain all the information you require. However, if we may be of any further assistance please do not hesitate to contact us.

Yours very truly,

E. M. PETO ASSOCIATES LTD.,

E. M. Peto, P. Eng.

THE DEPARTMENT OF HIGHWAYS OF ONTARIO

SOILS REPORT

for

HWY. 401 - BAPTISTE CREEK CROSSING

W.P. 164 - 58, TILBURY EAST

February, 1959

e. m. peto associates ltd.

e. m. peto associates ltd., 850 roselawn avenue, Toronto 19, Ontario

Job No. 58160 Client's Ref. No. Date February 19th, 1959.

Report on

SOIL SITE INVESTIGATION
at
HWY. 401 - BAPTISTE CREEK CROSSING
W.P. 164-58, TILBURY EAST
for
DEPARTMENT OF HIGHWAYS OF ONTARIO

INTRODUCTION:

We were retained, by letter from Mr. J. C. McAllister, dated December 2nd, 1958, to carry out a soils investigation for the proposed Highway 401 crossing of the re-alignment of Baptiste Creek. At the same time we were issued with D. H. O. profile F3534-8 and plan No. F3534-7, on which four suggested soil test holes were shown.

The object of the investigation was to determine:

a) the existing soil conditions at the site.
b) any pertinent ground water information.
c) the most suitable foundation types for the site.
d) any other factors affecting the design or construction of the proposed structure.

PROGRAMME OF WORK:

December 11th, 1959: Reconnaissance of site by Field Engineer. Test holes staked out, levels taken.
January 5th, 1959: Crew #2 moved to site from Little Baptiste Creek crossing.
January 6th, 1959: Field work commenced by crew #2.
January 13th, 1959: Crew #3 moved to site from Tilbury Creek crossing, commenced work at borehole 2.
January 15th, 1959: Field work completed by both crews.
January 16th, 1959: Crews loaded drills and equipment, travelled to Toronto.

GENERAL INFORMATION:

a) Our standard soil sampling procedures, described in Appendix II, were followed throughout the course of the investigation.

b) All samples obtained at the site were carefully examined, and tested as necessary, in our laboratory. Detailed individual borehole logs and a summary of the test results are appended, together with pertinent graphical data. A site plan showing the borehole locations is also attached.

c) The clay soil encountered is relatively impermeable, and it was not possible, during the limited duration of our work at this site to clearly establish the position of the ground water table. However, this is discussed in more detail in the section of the report sub-titled "Water Conditions".

d) All elevations in this report were obtained by using the D. H. O. bench mark near the site. This is a nail and washer in the South root of a 1'6" elm tree 267 feet left of station 219 + 20. The elevation of this bench mark was taken to be 580.17 (Geodetic datum).

SITE AND GEOLOGY:

The site investigated lies on a cultivated, flat field adjacentto a bend in the Baptiste Creek, The topography is very flat, and surface drainage is generally poor in the entire Tilbury area. Although it is not known if Baptiste Creek is a man-made drainage and irrigation channel, it is obvious that some improvements have been made to its channel at some time in the past, and 3 to 8 foot high levees of excavated material flank the stream at some points along its course. It is unlikely that serious flooding of this stream could occur.

The site lies in the physiographic region known as the St. Clair Clay Plain, an area with extensive beds of water-laid sediments overlying a till plain.

SOIL CONDITIONS:

Soil conditions at this site are uniform, and are fairly consistent withresults obtained at the nearby Little Baptiste Creek crossing site. For this reason we have been able to reduce somewhat the amount of laboratory testing. The soil strata encountered were:

a) Weathered Surface Layer

This soil type, resulting from weathering action on the silty clay beneath, extends only to a depth of 4 to 6 feet. However, the shape of the strength versus elevation and moisture content versus elevation curves in Appendix I suggests that dessication of the silty clay, with accompanying overconsolidation as the effective intergranular stresses were increased, extended with diminishing influence to a depth of approximately 50 to 55 feet.

SOIL CONDITIONS:

a) Weathered Surface Layer (Cont'd)

The surface layer consists generally of a mottled grey-brown silty clay and clayey silt with fine sand content, and grits and pebbles. Organic vegetable matter is present in the upper 12 inches to 18 inches, which have been cultivated. The clayey silt in this layer is generally non-plastic, and the siltyclay drier than the plastic limit indicating that it is not fully saturated. The shrinkage limits of this soil and of the silty clay immediately beneath it were determined to be 16.5 to 16.6%, and therefore although some soil volume changes would accompany soil moisture variations, these would not be of a serious nature.

The unit weight of this soil for design purposes may be taken to be 125 p.c.f.

b) Silty Clay

Directly underlying the weathered surface layer, and extending to a depth of approximately 82 feet below surface, is a stratum of silty clay which was probably laid down by two successive glacial lakes.

This soil is a stiff to firm, plastic silty clay containing fragments of black shale and Devonian limestone derived from the underlying bedrock in the area. Typical gradings of this material are as follows: 44-46% clay, 40% silt, 14-16% grits and sand. The upper half of this stratum tends to be stratified.

The Atterberg limits throughout the silty clay stratum are very consistent, but it is the natural moisture content in relation to these parameters which varies. This soil is only slightly wetter than the plastic limit near its top boundary, but below the 50 foot depth the natural moisture content assumes a near constant value slightly less than half way between the liquid and plastic limits. By volumetric analyses it has been determined that the silty clay soil is fully saturated.

The soil shear strength, C, in the upper crust is approximately 4000 p.s.f. down to elevation 562, and the shear strength then reduces markedly until a constant value of approximately 1000 p.s.f. is reached below elevation 524. The soil has low sensitivity throughout.

A consolidation test was carried out on an undisturbed 3" diameter sample from the 25 foot depth in this stratum, corresponding to the middle of the 50 or 55 foot dessicated zone. Although the true pre-consolidation stress history of the soil was obscured (a peculiarity of the soil in this area, partly attributable to the content of grits and silt), a small degree of over-consolidation was indicated. A steep rebound slope was obtained, showing that the soil would tend to swell upon removal of existing overburden stresses. The upper 50 feet of the silty clay stratum is of low compressibility, with a corrected compressive index of the order of .104 to .130. The soil appears to be of low to medium compressibility below the 50 foot depth.

SOIL CONDITIONS:

b) Silty Clay (Cont'd)

The average wet density of the silty clay was determined to be 132.9 p.c.f. above the 50 foot depth, and 128.6 p.c.f. below the 50 foot depth, but because of the position of the ground water table only the submerged unit weights are effective below elevation 574.5.

c) Sandy and Silty Clay, Grits

Beneath the 81'6" or 85 ft. depth at this site is a soil stratum deposited by an earlier glacial lake, Lake Maumee. Geologically speaking this soil is a clay till, and it differs from the silty clay above only in that it has more frequent and larger rock fragments, and contains some very fine sand. The clay till is firm to stiff in consistancy, and grey in colour. It probably has a low compressive index.

The deepest borehole at this site was terminated at the 101 foot depth, and did not completely penetrate the clay till. However, from comparison with results at two nearby bridge sites, we believe that the total thickness of silty clay and clay till is approximately 120 feet, and the soil then becomes a very dense, sandy till.

WATER CONDITIONS:

The soil at this site was found to be saturated virtually throughout its full depth, with the exception of some 8 to 10 feet at surface. The average ground surface elevation at the site is 583.7, and the stream water level was 574.5 at the time of our investigation. The level of Lake St. Clair is approximately 575 to the same datum.

Because of the impermeability of the clay soil no reliable ground water information was obtained during the short duration of our investigation on site. However, we must assume that the true ground water table coincides with either Baptiste Creek water level or the level of Lake St. Clair.

At the time our crews left the area, the four uncased holes at this site had remained fairly well open, and the final observed water levels ranged from 30 feet to 43 feet below ground surface.

ENGINEERING CONSIDERATIONS:

1. We understand that it is presently proposed to dig a major diverson of Baptiste Creek to straighten the alignment, and that the new channel is to be some 40 feet wide. Highway 401 will cross the new diverson on a small skew, and the proposed final highway elevation at the crossing is approximately 586, only 3 feet higher than existing grade.

ENGINEERING CONSIDERATIONS: (Cont'd)

2. The usual corrections for sample disturbance could not be applied properly to the consolidation test e-log p curve, but a good approximation of the true field compression curve was obtained, and the compressive index was taken as the slope of the virgin branch of this curve.

3. The shear strength properties of the silty clay, particularly of the upper "crust", are such as to provide ample soil bearing capacities to support a bridge structure. The additional subsoil pressure due to the highway approach embankments, which are only about 3 feet high, would be very small, and need not be considered. However, settlement is an important consideration, and it is our opinion that a safety factor of 4 should be used for the following reasons:

   a) the resulting allowable bearing pressure will still be of sufficient magnitude that very large footing sizes would not be required.

   b) the static yield or creep value of the soil would not be exceeded, thus minimizing the settlement. Primary compression due to elimination of pore water from the soil could still occur, but the possibility of secondary compression due to rearrangement of the soil particles would be precluded.

   The recommended allowable bearing pressure of large rectangular footings under either end of a bridge at this site would be given by:

$$q_{allowable} = \frac{5.70 \quad C}{S.F.} \left(1 + 0.3 \frac{B}{L}\right)$$

   From considerations of the shear strength profile, a value of C = 2500 p.s.f. may be used.

   Because of the proximity of the footings to the new stream channel, no additional bearing capacity due to surcharge is allowed.

$$q_{allowable} = 3515 \left(1 + 0.3 \frac{B}{L}\right) \text{ p.s.f.}$$

   Where B = width of rectangular footing
   L = length of footing.

4. Total settlements can be considerable if the allowable loading given above is fully utilized, since the net new load on the soil in this case will fully equal the applied footing pressure, and almost all of the soil consolidation will take place along the virgin compression branch.

ENGINEERING CONSIDERATIONS:

4. (Cont'd)

For footings at elevation 570, the underlying thickness of compressible silty clay would be approximately 75 feet. Settlement of the sandy and silty clay till at depth is considered negligible.

Settlement will be a very long-term process in the silty clay stratum, because of the boundary drainage conditions. The underlying clay till is relatively impermeable.

RECOMMENDATIONS AND CONCLUSIONS:

1. A large multi-span, reinforced concrete box culvert may be suitable for this site, and this possibility should be considered.

2. If a bridge structure is to be used, we recommend that it be a statically determinate type, because of the danger of settlement.

   Scour is not considered serious in this area and in a clay soil of this type, and therefore the bridge footings may be placed at or slightly lower than the elevation of the new stream channel bed.

   For large rectangular spread footings safe allowable loadings in the order of 3500 p.s.f. may be used.

3. Although differential settlements between the two ends of the bridge should be small due to the uniformity of the soil stratification, considerable differential settlement between the bridge and the approach embankments can be expected.

4. If a culvert is not used, the new stream channel should be excavated with side slopes of 2:1, although steeper slopes would be stable, and revetment of the slopes for scour protection would not be required.

5. We foresee no undue construction problems connected with this site. Excavations, even below the stream water level, can be maintained in a dry condition because of the impermeability of the soil.

E. M. PETO ASSOCIATES LTD.,

E. M. Peto, P. Eng.

MM:sb

e. m. peto associates ltd.

SOIL ENGINEERING SERVICE – TORONTO, ONTARIO

BOREHOLE LOG

Job Name: Highway 401 - Baptiste Creek Crossing. Job No. 58160 Borehole No. 1.

Client: Dep't. of Highways of Ontario. Casing: BX (2½" Dia.) Boring Date: Jan. 6th.-12th. 1959.

Datum: Geodetic. Compiled By: M. Mindess. Checked By: E.M. Peto.

SAMPLE CONDITION

- UNDISTURBED
- FAIR
- DISTURBED
- LOST

SAMPLE TYPE

- 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
- Q u UNCONFINED COMPRESSIVE STRENGTH
- W.L. WATER LEVEL IN CASING
- W.T. GROUND WATER TABLE IN SOIL

SOIL DESCRIPTION	COLOUR	Density Moisture	Depth Elevation	Legend	Sample No. and Condition	Sample Type	No. of Blows per Ft.	WATER LEVELS, SOIL MOISTURE & REMARKS
			0' 0" 583.95					
SILTY CLAY, GRITS AND PEBBLES, SOME FINE SAND.	MOTTLED GREY-BROWN.	STIFF			1 (fair)	S.S.	14	NAT. M.C.=17.5%. DRIER THAN PLASTIC LIMIT.
			5' 0"					
CLAYEY AND SANDY SILT, GRITS AND PEBBLES	MOTTLED GREY-BROWN	COMPACT			2 (disturbed)	S.S.	20	MOIST, NON-PLASTIC. NATURAL M.C.= 16.9%.
			10' 0"					
SILTY CLAY, GRITS AND PEBBLES.	GREY-BROWN.	STIFF			3 (disturbed)	S.S.	25	NAT. M.C.=18.9%. AT PLASTIC LIMIT.
			15' 0"					
STRATIFIED SILTY CLAY, GRITS AND PEBBLES, THIN FINE SAND SEAM.	BROWNISH-GREY.	VERY STIFF			4 (fair)	S.S.	32	NAT. M.C.= 20.0%. DRIER THAN PLASTIC LIMIT.
			20' 0"					
STRATIFIED SILTY CLAY, GRITS AND PEBBLES.	DARK GREY.	STIFF			5 (fair)	S.S.	27	NAT. M.C.=16.6%. AT PLASTIC LIMIT.
			25' 0"					
STRATIFIED SILTY CLAY, BLACK GRITS.	GREY	STIFF			6 (fair)	S.S.	22	NAT. M.C.=15.2%. WETTER THAN PLASTIC LIMIT.
			30' 0"					
					7 (undisturbed/lost)	2" S.L.	TAPPED	
AS ABOVE, NUMEROUS GRITS.	GREY	STIFF			8 (fair)	S.S.	23	WETTER THAN PLASTIC LIMIT.
			35' 0"					
SILTY CLAY, GRITS.	GREY	FIRM			9 (disturbed)	S.S.	14	NAT. M.C.=21.0%. MUCH WETTER THAN PLASTIC LIMIT.
			40' 0"					
					10 A B C (undisturbed)	2" S.L.	PUSHED	
STRATIFIED SILTY CLAY, GRITS	GREY	FIRM			11 (disturbed)		14	MUCH WETTER THAN PLASTIC LIMIT.
			45' 0"					
					12 (lost)	2" S.L.	PUSHED	
			50' 0"					
					13 (undisturbed)	2" S.L.	PUSHED	
SILTY CLAY, GRITS	GREY	FIRM.			14 (disturbed)	S.S.	10	MUCH WETTER THAN PLASTIC LIMIT.
			55' 0"					
					15 (undisturbed)	2" S.L.	PUSHED	
			60' 0"					
AS ABOVE	"	"	60' 8" 523.3		16 (disturbed)	S.S.	7	AS ABOVE. SPECIFIC GRAVITY=2.76.

HOLE TERMINATED NO STIFFENING OR REFUSAL.

c. m. peto associates ltd.

SOIL ENGINEERING SERVICE — TORONTO, ONTARIO

BOREHOLE LOG

Job Name: Highway 401 - Baptiste Creek Crossing. Job No. 58100 Bore hole No. 2.

Client: Dep't. of Highways of Ontario. Casing: BX ($2\frac{1}{2}$" Dia.) Boring Date: Jan. 12th. - 15th. 1959.

Datum: Geodetic. Compiled by: M. Mindess. Checked by: E.M. Peto.

SAMPLE CONDITION: UNDISTURBED; FAIR; DISTURBED; LOST

SAMPLE TYPE: S.S. ...; S.L. ...; S.T. THIN WALLED ... SAMPLE; W.S. WASH SAMPLE; R.C. ROCK CORE.

ABBREVIATIONS: ...

Soil Description	Colour	Consistency	Depth	Sample No.	Type	N	Remarks
			0' 0" / 583.4				
ORGANIC SANDY AND CLAYEY SILT	GREY-BLACK						
CLAYEY SILT, MANY GRITS, MINOR ORGANIC CONTENT	MOTTLED GREY-BROWN	FIRM		1	S.S.	12	NAT. M.C.=18.0% DRIER THAN PLASTIC LIMIT
AS ABOVE	AS ABOVE	STIFF	5' 0"	2	S.S.	21	NAT. M.C.=16.1% DRIER THAN PLASTIC LIMIT
STRATIFIED SILTY CLAY, GRITS, OCCASIONAL THIN 1/32" SAND SEAMS	BROWNISH-GREY	STIFF	10' 0"	3	S.S.	20	NAT. M.C.=16.9% DRIER THAN PLASTIC LIMIT
			15' 0"	4 A B C	2" S.L.	TAPPED	
STRATIFIED SILTY CLAY, MANY BLACK GRITS	GREY	FIRM	20' 0"	5	S.S.	12	NAT. M.C.=20.3% WETTER THAN PLASTIC LIMIT
			25' 0"	6 A B C	2" S.L.	PUSHED	
SILTY CLAY, GRITS, INDISTINCTLY STRATIFIED	GREY	FIRM	30' 0"	7	S.S.	11	NAT. M.C.=20.0% WETTER THAN PLASTIC LIMIT
			35' 0"	8 A B C	2" S.L.	PUSHED	SPECIFIC GRAVITY=2.75
SILTY CLAY, GRITS	GREY	FIRM	40' 0"	9	S.S.	10	NAT. M.C.=22.7% MUCH WETTER THAN PLASTIC LIMIT
			45' 0"	10 A B C	2" S.L.	PUSHED	
AS ABOVE	GREY	SOFT	50' 0"	11	S.S.	6	NAT. M.C.=27.7% MUCH WETTER THAN PLASTIC LIMIT
			55' 0"	12	2" S.L.	PUSHED	
				13	2" S.L.	PUSHED	
			60' 0"	14 A B C	2" S.L.	PUSHED	
AS ABOVE	GREY	FIRM	65' 0"	15	S.S.	10	NAT. M.C.=24.2% MUCH WETTER THAN PLASTIC LIMIT
			70' 0"	16 A B C	2" S.L.	PUSHED	SMALL NATURAL GAS POCKET ENCOUNTERED WHEN HOLE FIRST REACHED 71'6". ALL THE PRESSURE HAD DISSIPATED BY THE NEXT MORNING
SILTY CLAY, GRITS	GREY	FIRM	75' 0"	17	S.S.	9	NAT. M.C.=24.5%
			80' 0"	18 A B C	2" S.L.	PUSHED	
SILTY CLAY, BLACK SHALE FRAGMENTS UP TO 2" SIZE	GREY		81' 6" / 501.9	19	2" S.L.	TAPPED	MUCH WETTER THAN PLASTIC LIMIT
SANDY AND SILTY CLAY	GREY TO GREY-BLACK	FIRM	85' 0"	20	S.S. W.S.	13	
SILTY CLAY, GRITS	GREY	FIRM	90' 0"	21	S.S.	10	
SILTY CLAY, BLACK SHALE FRAGMENTS TO 1" SIZE	GREY	FIRM	95' 0"	22	S.S.	11	MUCH WETTER THAN PLASTIC LIMIT
SILTY CLAY, GRITS	GREY, SOME POCKETS BROWNISH-RED	FIRM	101' 0" / 482.4	23	S.S.	10	MUCH WETTER THAN PLASTIC LIMIT NAT. M.C.=33.3%

HOLE TERMINATED. NO STIFFENING OR REFUSAL.

e. m. peto associates ltd.

SOIL ENGINEERING SERVICE – TORONTO, ONTARIO

BOREHOLE LOG

Job Name: Highway 401 - Baptiste Creek Crossing. Job No. 58160 Borehole No. 3.

Client: Dep't. of Highways of Ontario. Casing: 4" Pipe Boring Date: Jan.13th.- 14th. 1959.

Datum: Geodetic. Compiled By: P.M. Aylett Checked By: M.Mindess

SAMPLE CONDITION

- UNDISTURBED
- FAIR
- DISTURBED
- LOST

SAMPLE TYPE

- 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
- 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
Depth of Frost=2'0"			0'0" / 583.5'					
Silty Clay, Considerable Organic Content, Few Grits.	Dark Grey-Brown				1	Sample from Casing		Moist
Silty Clay, Grits.	Mottled Grey-Brown	Firm			2	S.S.	11	Nat. M.C.=21.1% At Plastic Limit.
			5'0"					
As Above	As Above	Firm.			3	S.S.	12	Nat. M.C.=20.0% Wetter than Plastic Limit.
			10'0"					
As Above, Many Grits.	Brownish Grey.	Stiff			4	S.S.	27	Nat. M.C.=17.4% At Plastic Limit.
			15'0"					
					5	3" S.T.	(50)	
Silty Clay, Grits	Grey.	Stiff.			6	S.S.	25	Nat. M.C. 18.3% At Plastic Limit.
			20'0"					
As Above, with Black Shale Frags.	Grey	Stiff.			7	SS.	25	Nat. M.C.=17.5% Wetter than Plastic Limit
			25'0"					
Silty Clay, Grits Stratified.	Grey.				8	3"ST.	(38)	
			30'0"					
As Above	Grey.	Stiff.			9	S.S.	15	Nat. M.C.=19.7% Wetter than Plastic Limit.
			35'0"					
As Above	Grey.				10	3"ST.	(20) (20)	
			40'0"					
As Above	Grey.	Firm.			11	SS	9	Nat. M.C.=22.3% Much Wetter than Plastic Limit
			45'0"					
As Above	Grey				12	3"ST.	(15) (25)	
			50'0"					
As Above	Grey	Firm.	51'0" / 532.5'		13	SS.	7.	Nat. M.C.=24.4% Much Wetter than Plastic Limit.

Hole Terminated — No Refusal.

e. m. peto associates ltd.

SOIL ENGINEERING SERVICE – TORONTO, ONTARIO

BOREHOLE LOG

Job Name: Highway 401 - Baptiste Creek Crossing. Job No. 58160 Borehole No. 4.

Client: Dep't. of Highways of Ontario. Casing: BX (2½" dia.) Boring Date: Jan. 12th. - 13th. 1959.

Datum: Geodetic. Compiled By: P.M. Aylett. Checked By: M. Mindess.

SAMPLE CONDITION

- UNDISTURBED
- FAIR
- DISTURBED
- LOST

SAMPLE TYPE

- 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
- 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
DEPTH OF FROST = 2'0"			0' 0" 583.9'					
SILTY CLAY, MINOR SAND POCKETS, GRITS	MOTTLED GREY-BROWN	FIRM	5' 0"		1 (fair)	S.S.	14	NAT. M.C. = 16.4%. DRIER THAN PLASTIC LIMIT.
AS ABOVE, WITH SHALE FRAGMENTS	AS ABOVE	STIFF	10' 0"		2 (fair)	SS	27	NAT. M.C. = 15.2%. DRIER THAN PLASTIC LIMIT.
SILTY CLAY, MANY GRITS, SMALL SAND POCKETS	GREYISH-BROWN	VERY STIFF	15' 0"		3 (fair)	SS	32	NAT. M.C. = 19.3%. AT PLASTIC LIMIT.
SILTY CLAY, GRITS STRATIFIED	GREY	STIFF	20' 0"		4 (fair)	SS	20	NAT. M.C. = 15.9%. WETTER THAN PLASTIC LIMIT.
AS ABOVE	GREY	STIFF	25' 0"		5A (lost) / 5B (disturbed)	S.S. / AUGER	15 / –	WETTER THAN PLASTIC LIMIT.
AS ABOVE	GREY		30' 0"		6	2" S.L.	TAPPED	
AS ABOVE	GREY	STIFF	35' 0"		7 (fair)	S.S.	15	NAT. M.C. = 17.0%. WETTER THAN PLASTIC LIMIT.
AS ABOVE	GREY		40' 0"		8A / 8B	2" S.L.	TAPPED	
AS ABOVE	GREY	FIRM	45' 0"		9 (disturbed)	S.S.	12	NAT. M.C. = 22.3%. MUCH WETTER THAN PLASTIC LIMIT.
AS ABOVE	GREY		50' 0"		10	2" S.L.	PUSHED	
AS ABOVE	GREY	FIRM	51' 0" 532.9'		11 (disturbed)	S.S.	10	MUCH WETTER THAN PLASTIC LIMIT.

HOLE TERMINATED — NO REFUSAL

APPENDIX I

LABORATORY TEST RESULTS

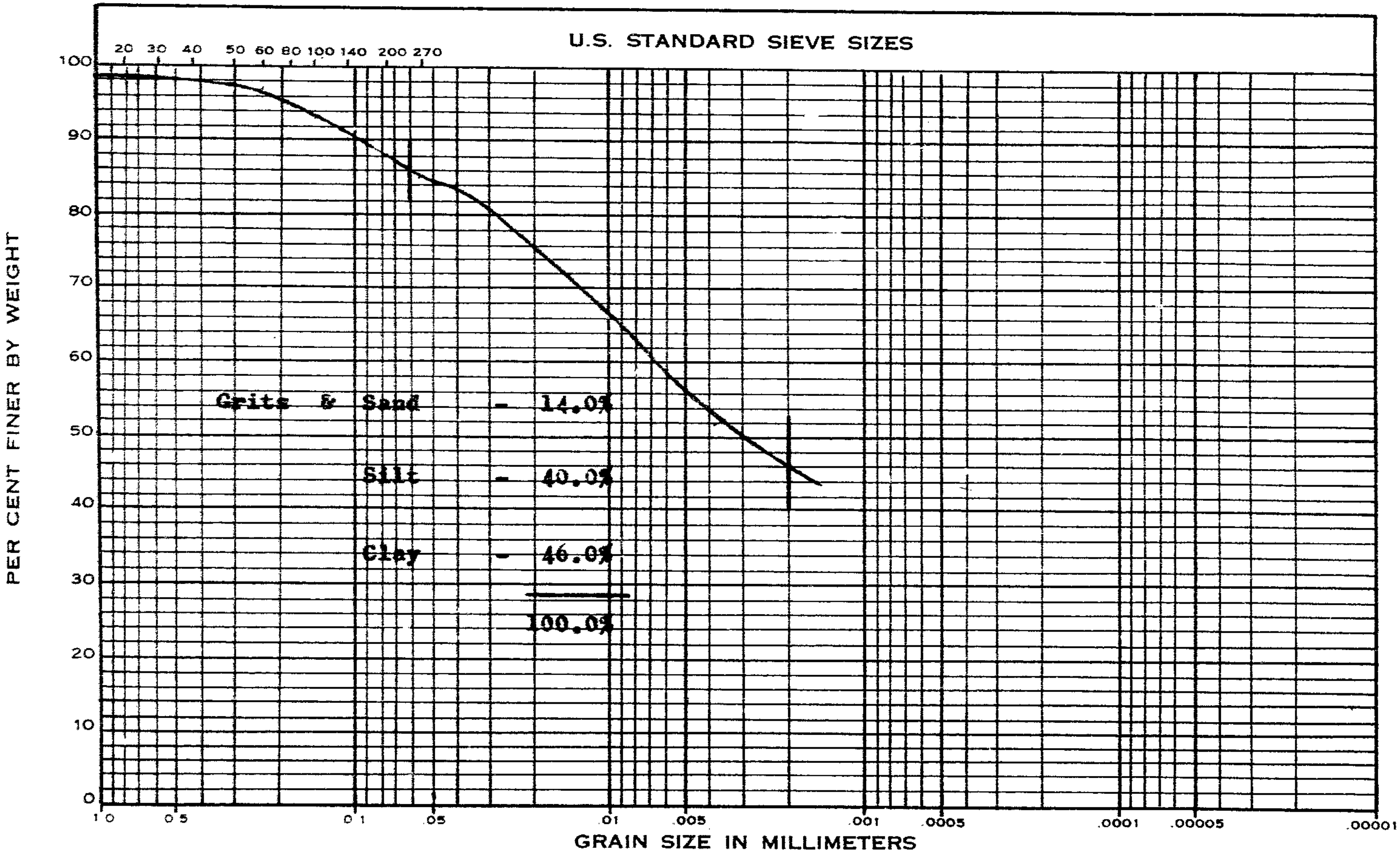
SHRINKAGE LIMITS

Job No. 58189

Borehole Number	2	4
Sample Number	3	2
Depth	9' - 10'	5' - 6'
Wt. of dish & wet soil - gms	51.37	52.49
Wt of dish & dry soil - gms	40.95	42.27
Wt. of dish gms	17.35	17.67
Wt. of water gms	10.42	10.22
Wt. of dry soil - gms (Wo)	23.60	24.60
Moisture Content % (W)	44.4	41.60
Volume of dish c.c. (V)	19.20	19.35
Volume of dry soil c.c. (Vo)	12.65	13.18
Shrinkage Volume c.c. (V-Vo)	6.55	6.17
Shrinkage Limit = (Ws) $W - \frac{(V-Vo)}{Wo} \times 100\%$	16.6	16.5
Shrinkage Ratio (R) = $\frac{Wo}{Vo}$	1.870	1.870
S. G. = $\frac{1}{1/R - Ws/100}$	2.71	2.70

E. M. PETO ASSOCIATES LTD.

HYDROMETER GRAIN SIZE DISTRIBUTION DIAGRAM



	MEDIUM SAND	FINE SAND	COARSE SILT	MEDIUM SILT	FINE SILT	CLAY	ROCK, FLOUR AND COLLOIDS

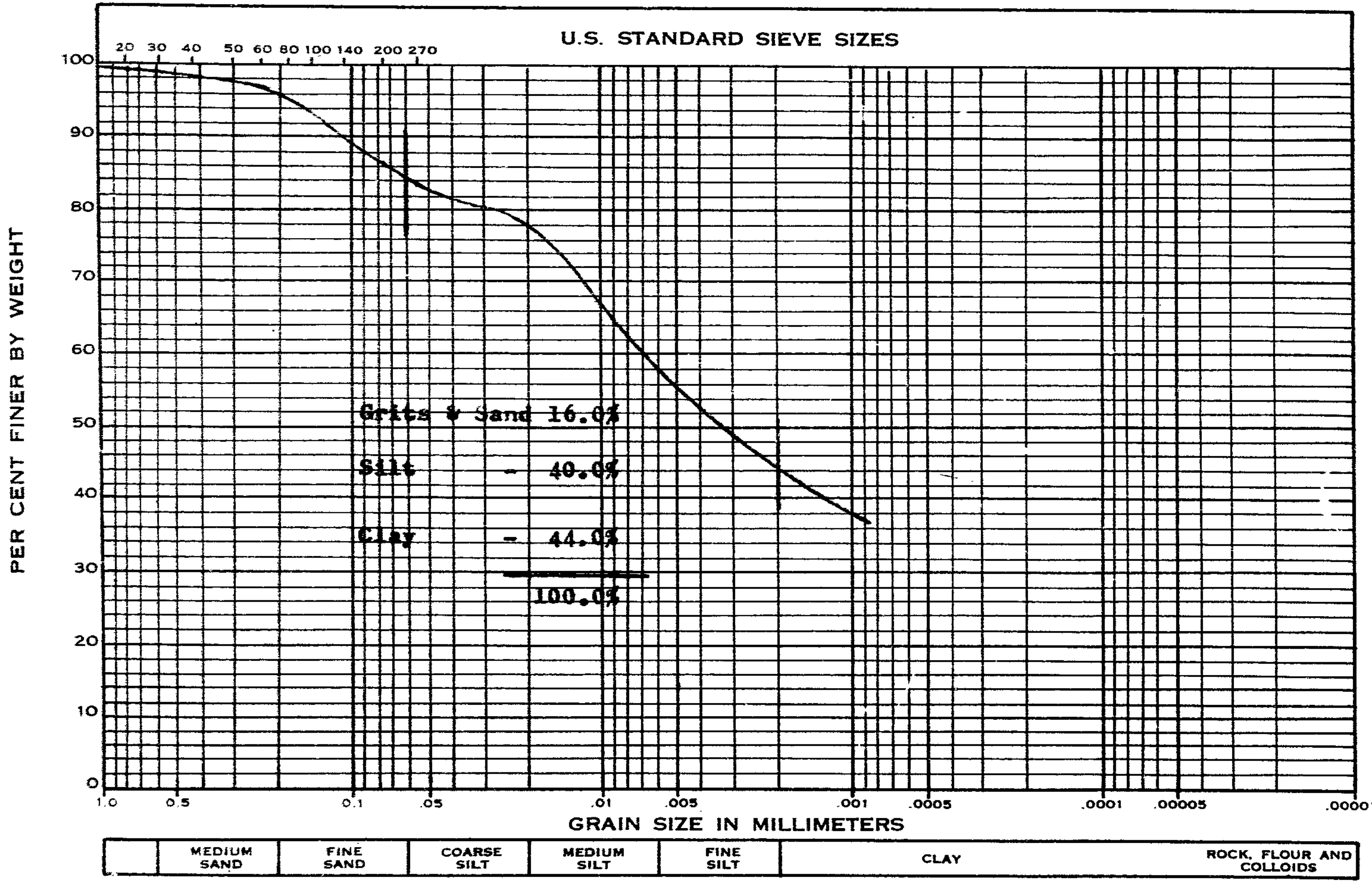
M.I.T. CLASSIFICATION

JOB NAME Hwy. 401-Baptiste Creek Crossing. JOB No. 58160 BOREHOLE No. 2 SAMPLE No. 5

DEPTH 20'-21' ELEVATION 562.9 REMARKS Typical Grading Silty Clay Soil, Tilbury Area.

E. M. PETO ASSOCIATES LTD.

HYDROMETER GRAIN SIZE DISTRIBUTION DIAGRAM



M.I.T. CLASSIFICATION

JOB NAME: **Hwy. 401 - Baptiste Creek Crossing.** JOB No. 58160 BOREHOLE No. 1 SAMPLE No. 16

DEPTH: 59'8"-60'8" ELEVATION: 523.8 REMARKS: Typical Grading Silty Clay Soil.

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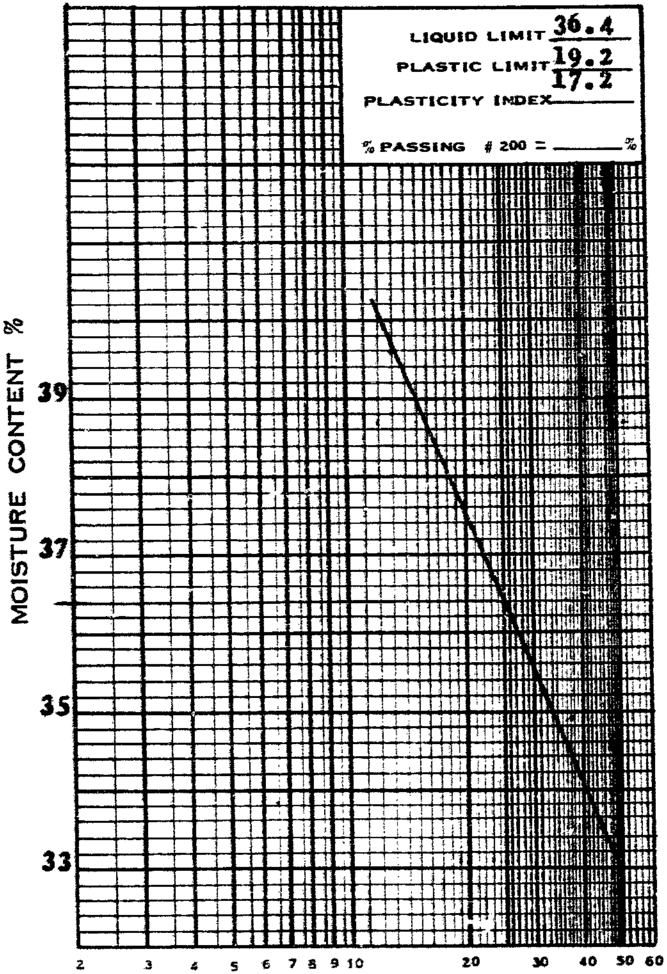
SOIL TESTING LABORATORY

LIQUID LIMIT TEST — **FLOW LINE CHARTS**

Job No. 58160 Project Hwy. 401 - Baptiste Creek Crossing.

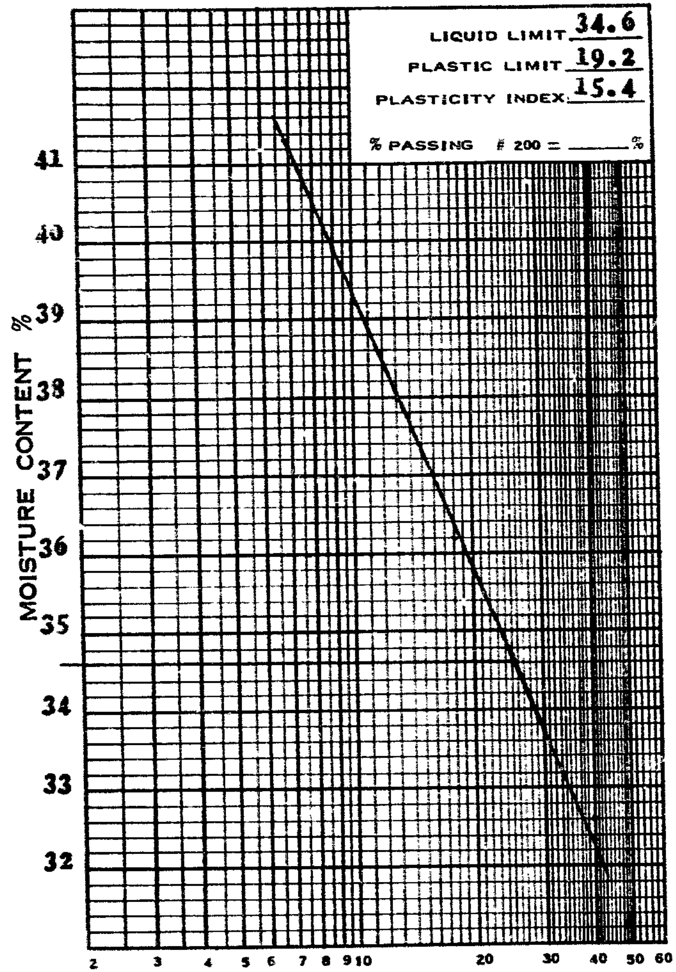
Sample From B.H.4. Sample # 2.
Depth 5' - 6'

Liquid Limit 36.4
Plastic Limit 19.2
Plasticity Index 17.2
% Passing # 200 = ____ %



Sample From B.H.2. Sample # 3.
Depth 9' - 10'.

Liquid Limit 34.6
Plastic Limit 19.2
Plasticity Index 15.4
% Passing # 200 = ____ %



NO. OF BLOWS (Log Scale)

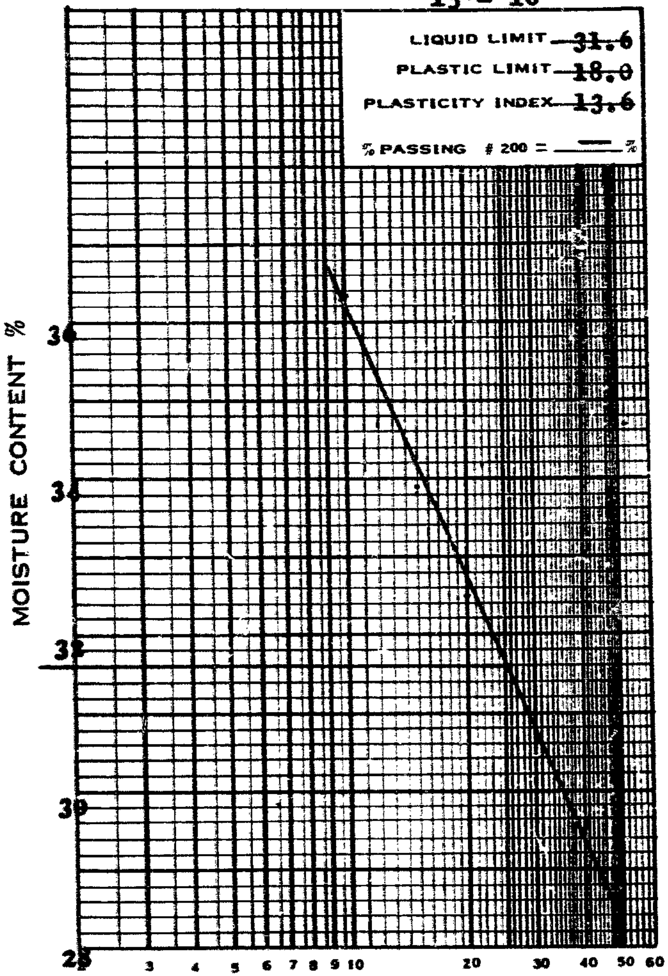
e. m. peto associates ltd.
SOIL TESTING LABORATORY

LIQUID LIMIT TEST **FLOW LINE CHARTS**

Job No. 38160 Project Hwy. 401 - Baptiste Creek Crossing.

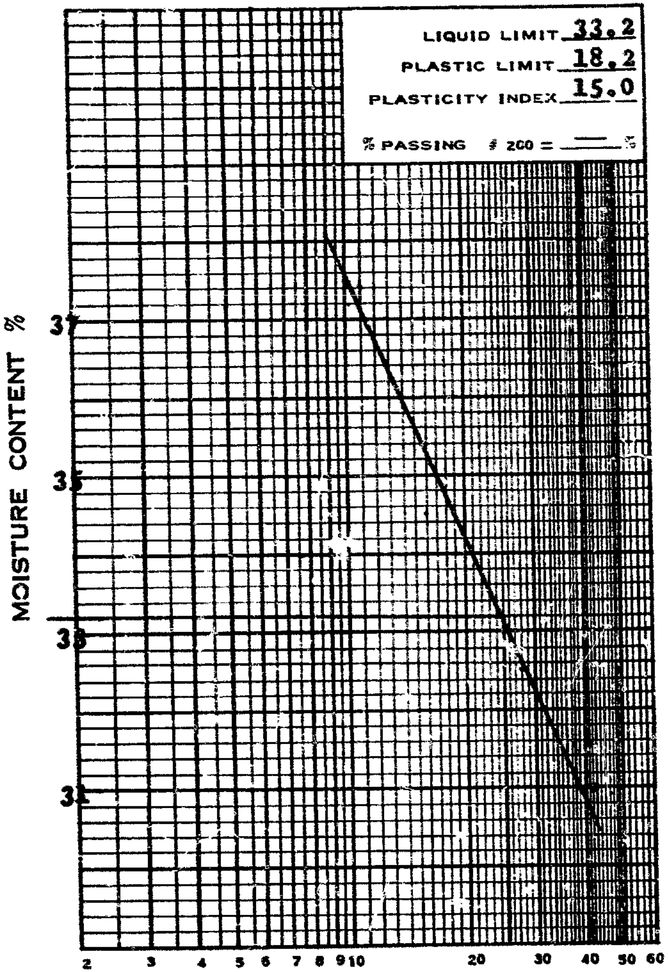
Sample From B.H.4. Sample # 4.
Depth 15' - 16'

Liquid Limit 31.6
Plastic Limit 18.0
Plasticity Index 13.6
% Passing # 200 = — %



Sample From B.H.1. Sample # 5.
Depth 20' - 21'

Liquid Limit 33.2
Plastic Limit 18.2
Plasticity Index 15.0
% Passing # 200 = — %



NO. OF BLOWS (Log Scale)

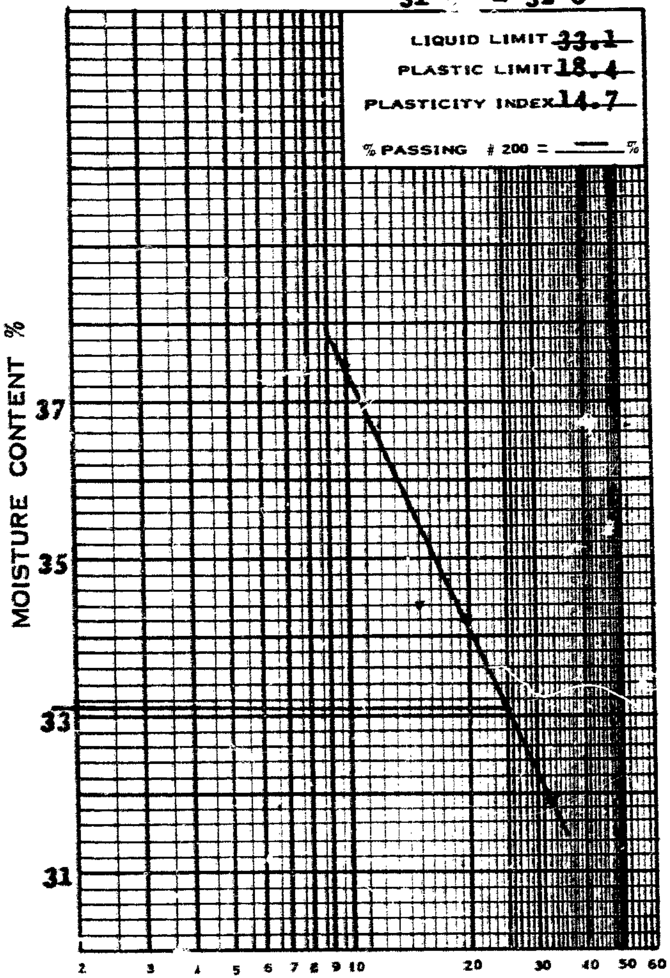
e. m. peto associates ltd.
SOIL TESTING LABORATORY

LIQUID LIMIT TEST **FLOW LINE CHARTS**

JOB NO. 58160 PROJECT Hwy. 401 - Baptiste Creek Crossing.

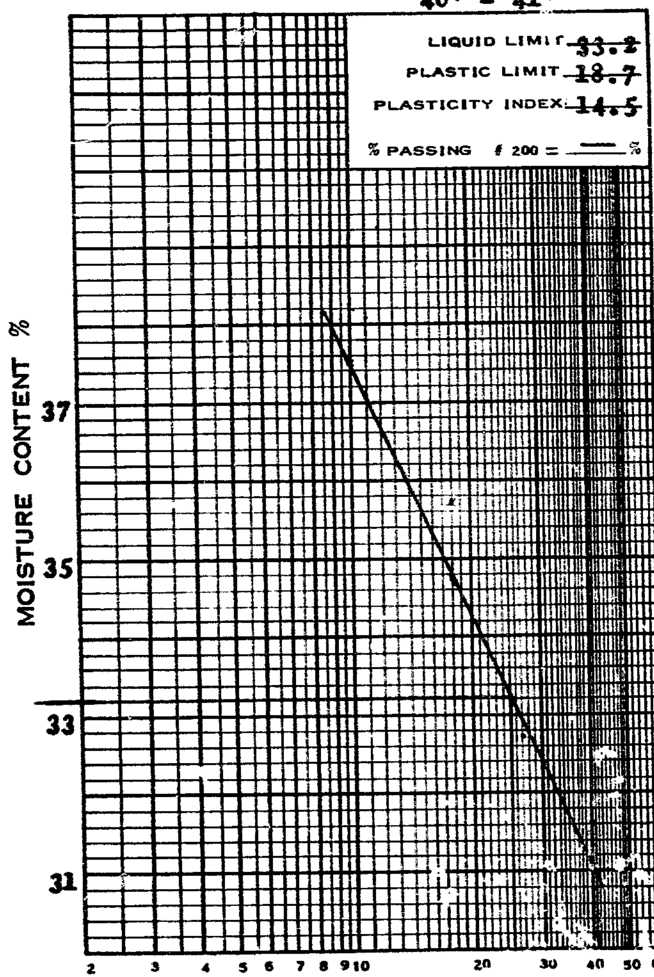
SAMPLE FROM B.H.# 1. Sample # 8.

DEPTH 31'[illegible] - 32'8"



SAMPLE FROM B.H.# 2. Sample # 9.

DEPTH 40' - 41'



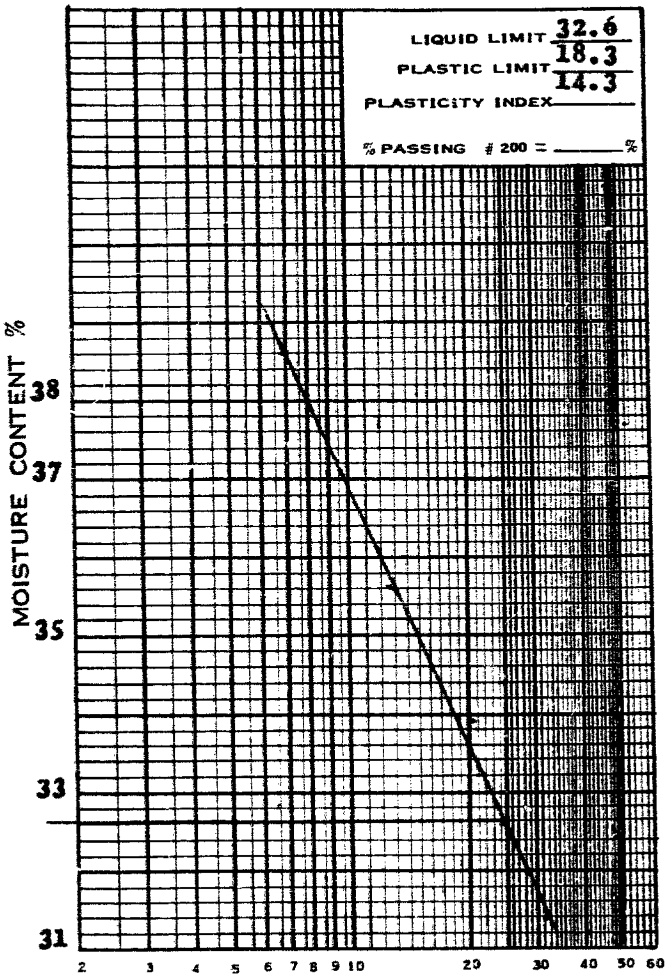
NO. OF BLOWS (LOG SCALE)

e. m. peto associates ltd.
SOIL TESTING LABORATORY

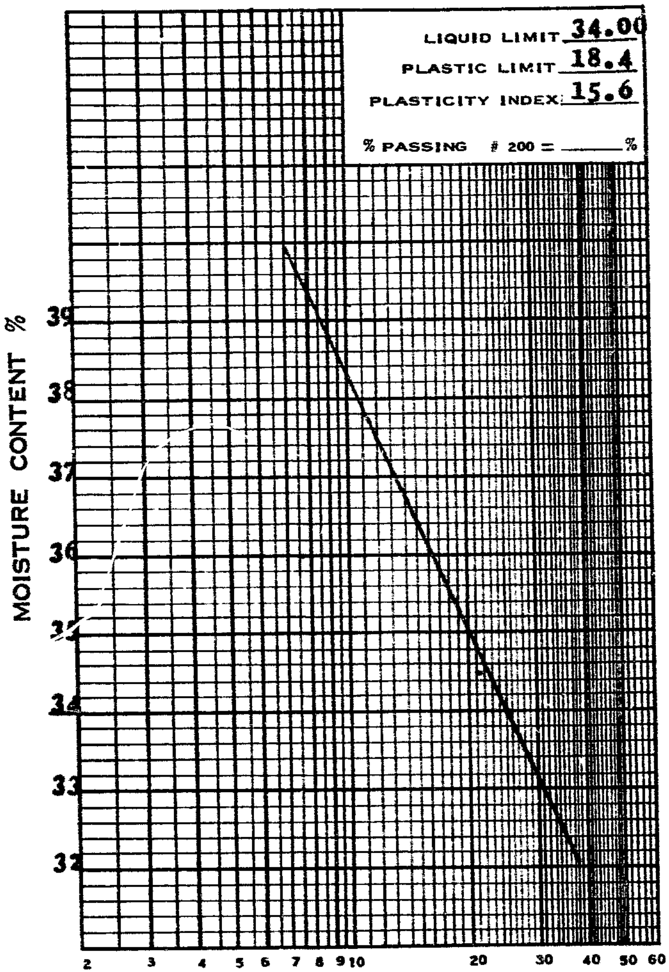
LIQUID LIMIT TEST — **FLOW LINE CHARTS**

Job No. 58160 Project Hwy. 401 - Baptiste Creek Crossing.

Sample From B.H.3. Sample # 13.
Depth 50' - 51'



Sample From B.H.2. Sample # 15.
Depth 65' - 66'



NO. OF BLOWS (Log Scale)

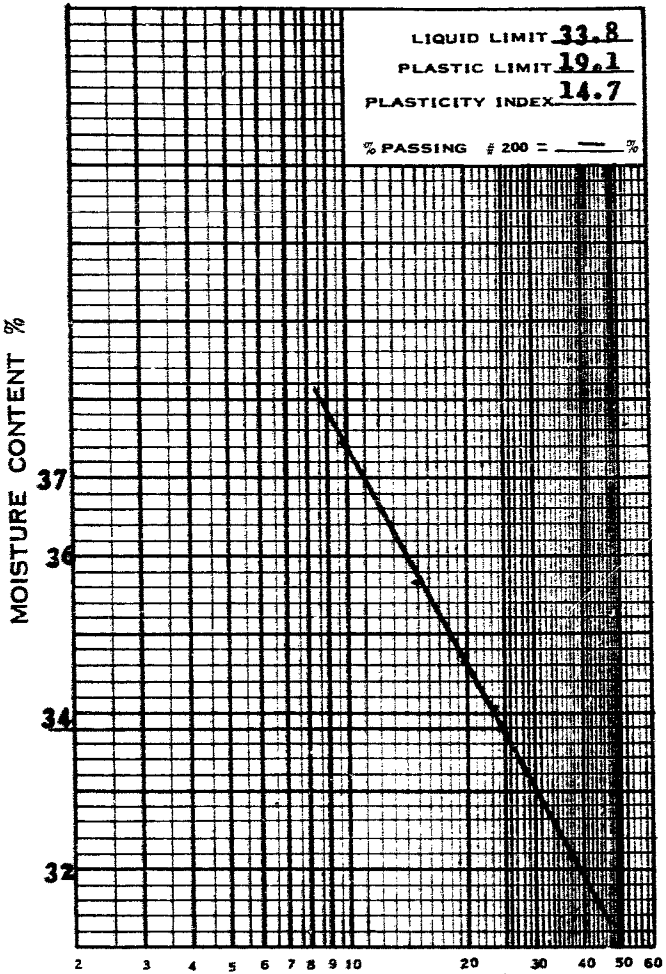
e. m. peto associates ltd.

SOIL TESTING LABORATORY

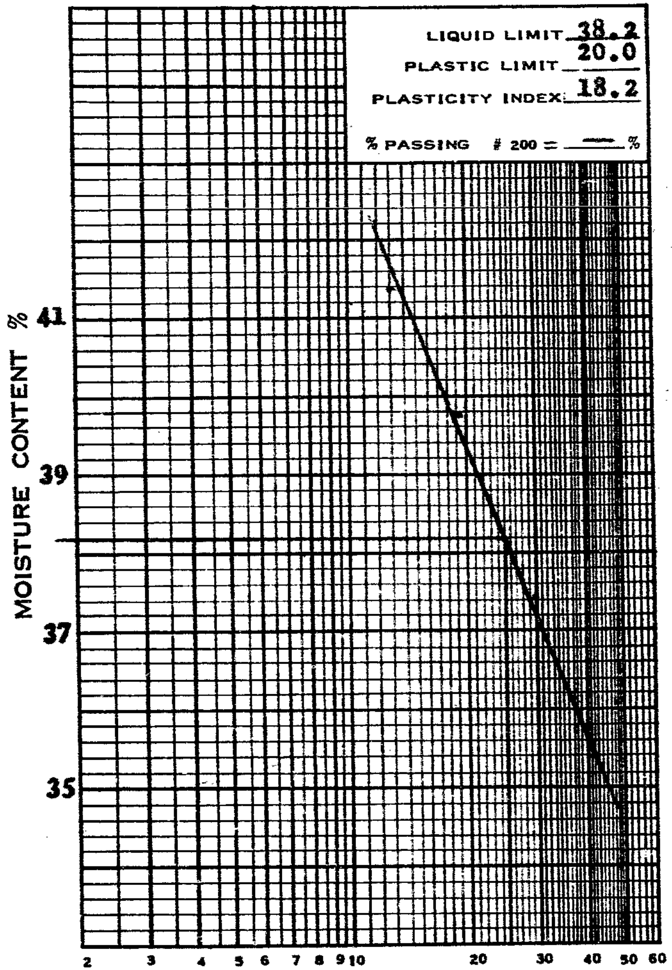
LIQUID LIMIT TEST | **FLOW LINE CHARTS**

Job No. 58160 Project Hwy. 401 - Baptiste Creek Crossing.

Sample From B.H.# 2. Sample # 17.
Depth 75'- 76½'



Sample From B.H.# 2.Sample # 21.
Depth 90' - 91'



NO. OF BLOWS (Log Scale)

e. m. peto associates ltd.

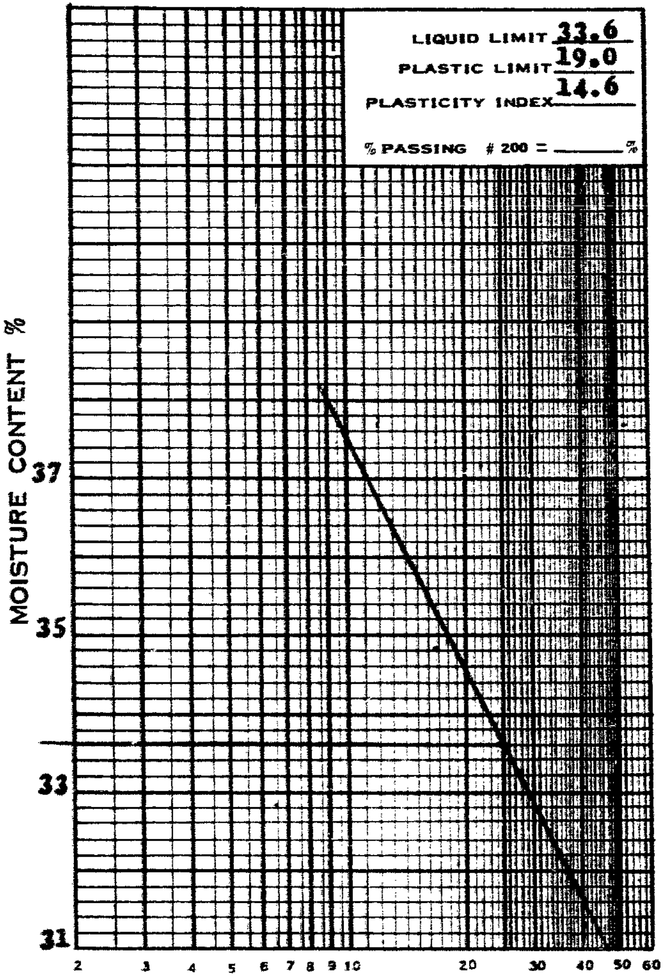
SOIL TESTING LABORATORY

LIQUID LIMIT TEST — FLOW LINE CHARTS

JOB NO. 58160 PROJECT Hwy. 401 - Baptiste Creek Crossing.

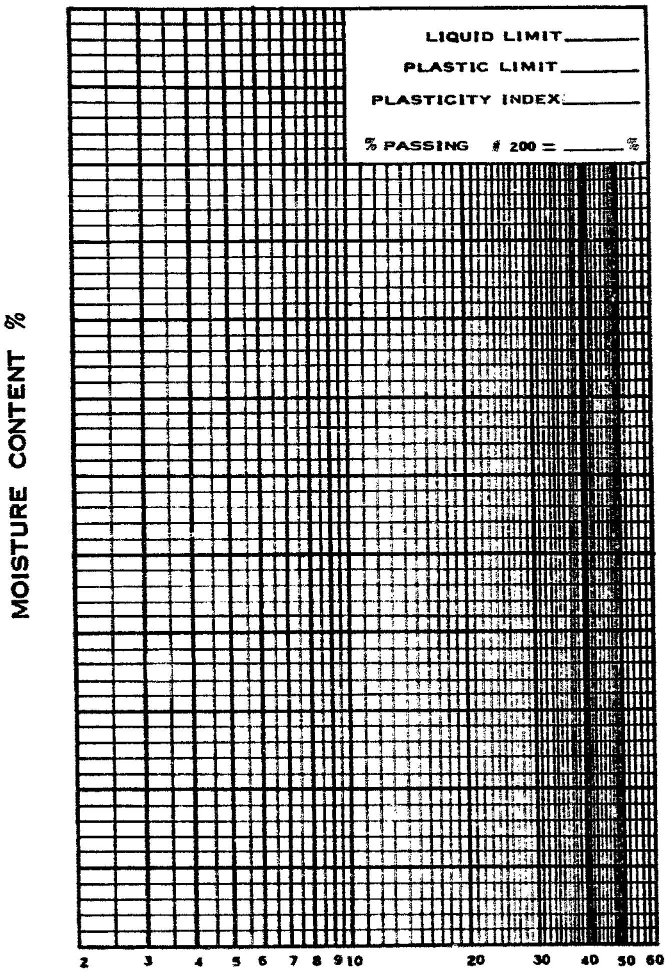
SAMPLE FROM B.H.# 2.Sample # 23.

DEPTH 100' - 101'

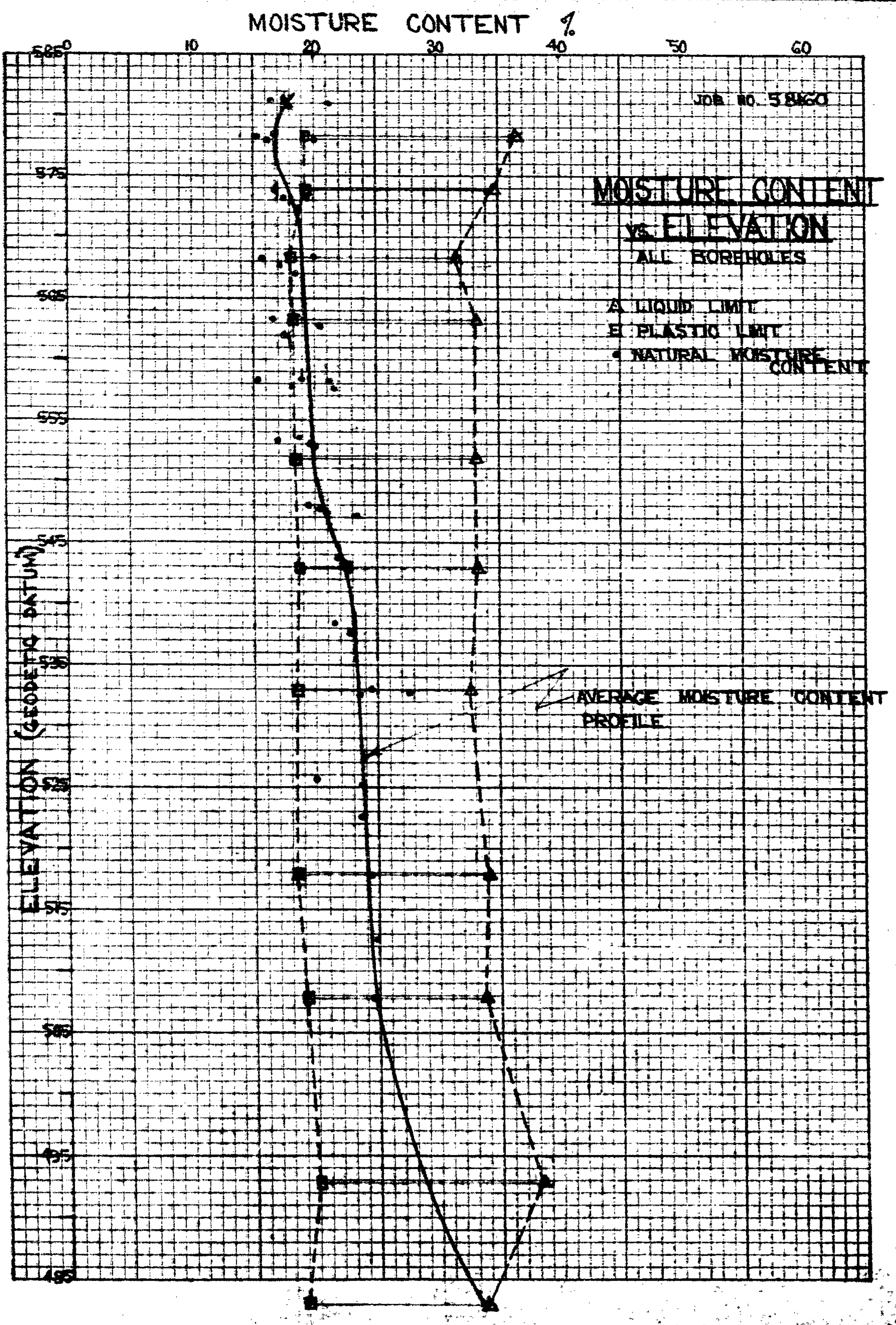


SAMPLE FROM

DEPTH



NO. OF BLOWS (LOG SCALE)



K+E 10 X 10 TO THE INCH 359-5G
KEUFFEL & ESSER CO. MADE IN U.S.A.

SUMMARY OF SOIL SHEAR STRENGTH TESTS

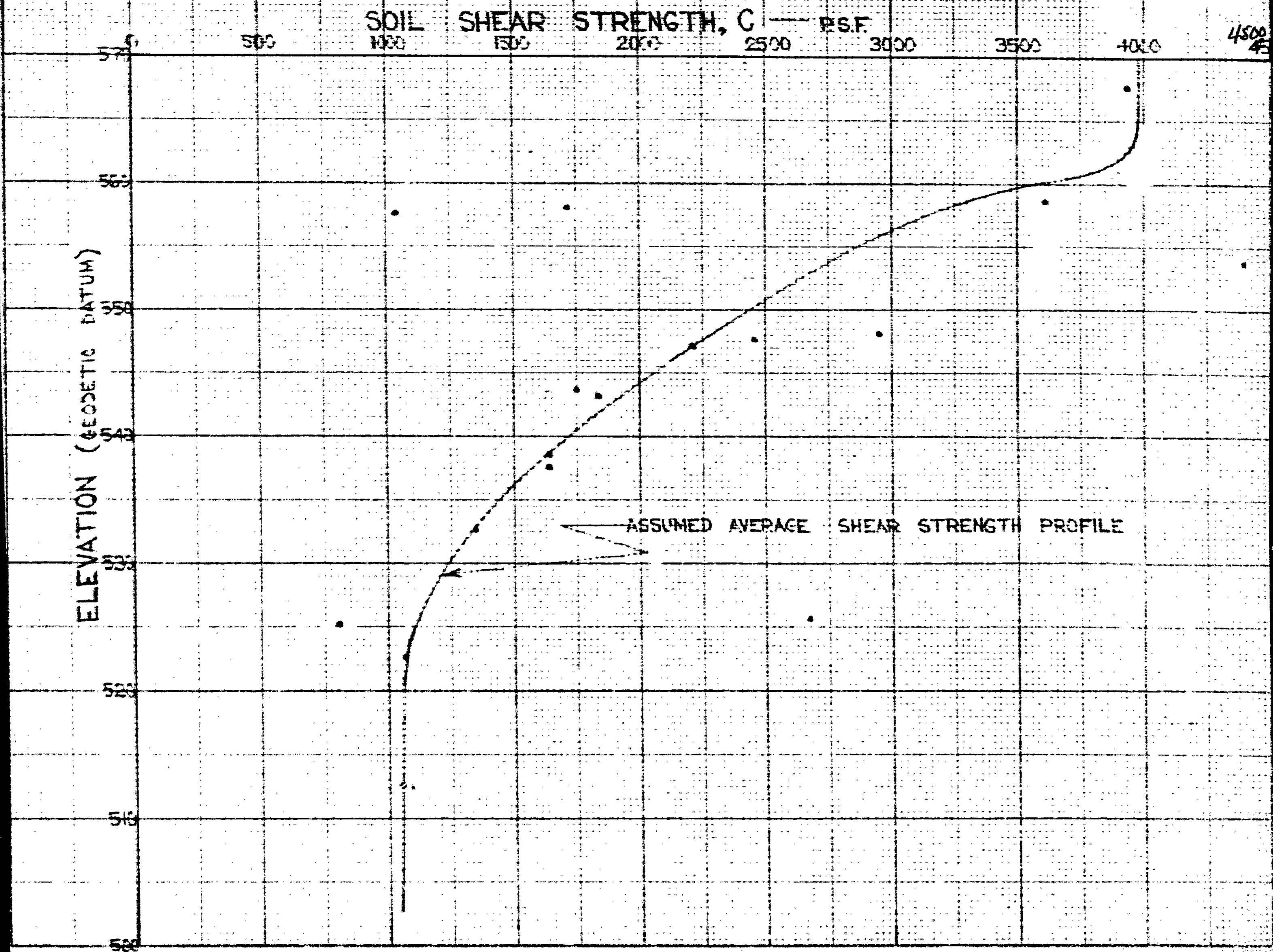
Job No. 58160

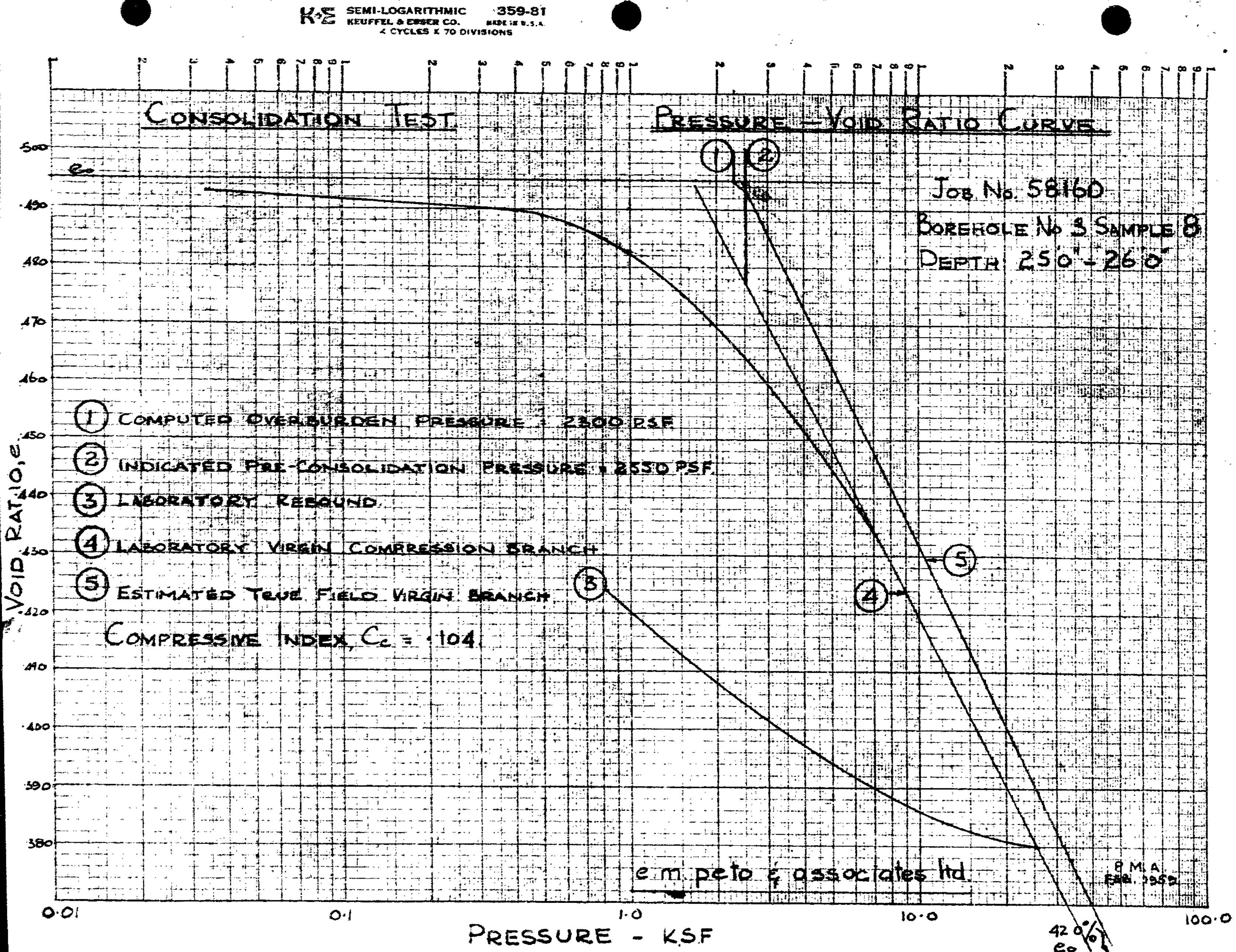
Bore-Hole #	Sample No.	Depth	Elevation	Nat. M. C. %	Wet Density p. c. f.	Degree of Saturation %	Void Ratio, e	% Strain at Failure	Soil Shear Strength C, p. s. f.
1	7A	30' - 30'6"	553.7	18.9	134.4	100	.491	20	4395
	10A	40' - 40'6"	543.7	21.8	132.0	100	.570	14.5	1750[x]
	10B	40'6" - 41'	543.2	22.6	132.2	100	.561	20	1838
	13A	51' - 51'6"	532.7	23.4	128.3	100	.621	20	1345
	15A	58' - 58'6"	525.7	20.0	128.0	100	.605	8.5	2672[x]
	15B	58'6" - 59'	525.2	23.6	128.9	100	.621	20	804
2	4B	15'6" - 16'	567.6	17.1	135.0	99.0	.467	20	3935
	6A	25' - 25'6"	558.1	21.1	131.6	100	.553	20	1722
	6B	25'6" - 26'	557.6	21.5	130.1	100	.580	9.5	1038[x]
	8B	35'6" - 36'	547.6	20.4	133.7	100	.521	20	2460
	8C	36' - 36'6"	547.1	23.2	134.0	100	.560	11.5	2210[x]
	10B	45'6" - 46'	537.6	22.8	129.6	100	.604	16.7	1640
	14B	60'6" - 61'	522.6	23.6	128.9	100	.615	20	1065
	16B	70'6" - 71'	512.6	24.9	128.9	100	.632	13.3	1050
4	6A	25' - 25'6"	558.6	19.0	135.8	100	.478	20	3608
	8B	35'6" - 36'	548.1	19.3	135.2	100	.486	20	2950
	10A	45' - 45'6"	538.6	21.6	130.9	100	.588	20	1640

[x]Denotes 1/2 x deviator stress from quick triaxial compression test
Lateral pressure approximately = overburden pressure.

SHEAR STRENGTH versus ELEVATION

JOB NO. 58160





K&E SEMI-LOGARITHMIC 359-81
KEUFFEL & ESSER CO. MADE IN U.S.A.
4 CYCLES X 70 DIVISIONS
CONSOLIDATION TEST
PRESSURE – VOID RATIO CURVE
JOB No. 58160
BOREHOLE No 3 SAMPLE 8
DEPTH 25'0" - 26'0"
1
COMPUTED OVERBURDEN PRESSURE : 2300 PSF
2
INDICATED PRE-CONSOLIDATION PRESSURE : 2550 PSF
3
LABORATORY REBOUND
4
LABORATORY VIRGIN COMPRESSION BRANCH
5
ESTIMATED TRUE FIELD VIRGIN BRANCH
COMPRESSIVE INDEX, C_c = ·104
e₀
·500
·490
·480
·470
·460
·450
·440
·430
·420
·410
·400
·390
·380
VOID RATIO, e
0·01
0·1
1·0
10·0
100·0
PRESSURE - KSF
42% e₀
e m peto & associates ltd
P.M.A.

APPENDIX I E

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 assi' in the soil classification and the interpretation of water tal.. results.