

#60-F-243C

WP# 302-60

HWY#97

PROPOSED

PHELAN CREEK

BRIDGE

Mr. A. M. Toye,
Bridge Engineer.

Materials & Research Section.

December 28, 1960.

REVIEW OF PRELIMINARY PLAN

by: Foundations Office.

Attention: Mr. Gavin Scott.

Re: W.P. 302-60,
Proposed Phelan Creek Bridge,
Hwy. No. 97, District No. 3.

From the Preliminary Plan D 4797-P1, showing the proposed design for the above mentioned structure, it is visible that the clear span is 45'-0" which is substantially more than the 30'-0" minimum required for hydrological reasons. Due to this enlarging, the scour danger is certainly reduced and sheet piles for scour protection can most probably be dispensed with. The final recommendation should come from the Hydrology Section.

As far as the necessity for sheet piles for construction is concerned, the widening of the span did not alter this requirement. The excavation will be made in the water bearing, permeable layer of silty sand with some gravel, and if water is pumped out of this excavation, a danger of blow-out of the bottom of the excavation will be created, as outlined in the foundation report. To prevent this, either underwater excavation with subsequent tremie concreting can be carried out, or the sheet piles driven as recommended in the report.

L. G. Soderman,
PRINCIPAL FOUNDATION ENGR.

Per:



(A. G. Stermac,
FOUNDATION OFFICE ENGR.)

AGS/MdeF

cc: Foundations Office ✓
Gen. Files.

OFFICE LOCATION
DOWNSVIEW AVE..
KEELE ST. - HIGHWAY 401
TORONTO, ONTARIO.



ONTARIO
DEPARTMENT OF HIGHWAYS

POSTAL ADDRESS
DEPARTMENT OF HIGHWAYS
PARLIAMENT BUILDINGS.
TORONTO 2, ONTARIO.

Bridge Division,
December 27, 1960.

MEMORANDUM TO:

Mr. L. Soderman,
Principal Soils & Foundations Eng.,
Department of Highways,
Room 107,
Downsview, Ontario.

Attention: Mr. M. D. Smith

RE: W.P. 302-60
Proposed Phelan Creek Bridge
Highway #97 District #3

Enclosed herewith is the preliminary plan D 4797-P1
showing our proposed design for the above structure.

You will note, that the proposed span is somewhat
larger than the 30' minimum required by for hydrological
reasons.

As the soil report indicated that sheet piling would
be required we would be pleased if you will confirm
that the foundation conditions shown are sound.

GS/et

cc. S. McCombie

cc. C. Grebski


Gavin Scott
Bridge Location Engineer.

Mr. A. M. Toye,

Bridge Engineer.

Materials & Research Section.

November 9, 1960.

FOUNDATION INVESTIGATION REPORT

by: H. Q. Golder & Associates, Ltd.

Attention: Mr. S. McCombie.

Re: Proposed Phelan Creek Bridge,
Hwy. 97, Hickson, Ontario.
W.P. 302-60 -- District No.3.

We have reviewed the above mentioned report and are in full agreement with the discussion and recommendations contained therein.

We also believe that the recommendations are self-explanatory and sufficient for your future design work. However, should there be any questions that you would like to discuss, please feel free to call on our Office.

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

Aster mac
(A. G. Stermac,
FOUNDATIONS OFFICE ENGR.)

AGS/MdeF
Attach.

cc: Messrs. A. M. Toye (2)
H. A. Tregaskes
D. G. Ramsay
A. Gater
L. D. Barrett
J. Roy
A. Watt

Foundations Office/
Gen. Files.

23-62-08

H. Q. GOLDER & ASSOCIATES LTD.

CONSULTING CIVIL ENGINEERS

H. Q. GOLDER
V. MILLIGAN

2446A BLOOR ST. W.
TORONTO 9
RO. 7-9201

REPORT

TO

DEPARTMENT OF HIGHWAYS, ONTARIO

ON

SITE INVESTIGATION, PROPOSED PHELAN CREEK BRIDGE

HIGHWAY 97

HICKSON, ONTARIO

Distribution:

- 10 copies - Department of Highways, Ontario,
Toronto, Ontario.
- 2 copies - H. Q. Golder & Associates Ltd.,
Toronto, Ontario.

November, 1960

6021

ABSTRACT

The results of an investigation carried out at the site of the proposed Phelan Creek crossing on Highway 97 about 0.7 miles east of Hickson, Ontario are reported. It was found that the site is underlain by about 3 feet of loose organic sandy silt followed by 8 to 12 feet of loose to compact silty sand with gravel overlying stiff to very stiff clayey silt till.

Recommendations are made for founding the abutments of the proposed 30 foot span bridge structure on spread footings in the silty sand stratum with maximum design loads not to exceed 3,000 pounds per square foot. It is also recommended that excavations for the footings be carried out in cofferdams and that the steel sheeting be left in place as scour protection.

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INTRODUCTION

1.

H. Q. Golder & Associates Ltd. has been retained by the Department of Highways, Ontario under the terms of a letter of authorization dated September 29th, 1960 to carry out an investigation for a proposed new bridge at Phelan Creek on Highway 97 about 0.7 miles east of Hickson, Ontario. The purpose of the investigation was to determine the soil conditions at the site and to provide the information required for the design of the foundations for the proposed bridge.

PROCEDURE

The field work for the investigation was carried out on October 4th, 5th, and 6th, 1960. Two boreholes were put down in BX size to depths of about 30 feet using a standard skid-mounted machine drillrig. The locations of the boreholes together with the inferred soil stratigraphy are shown on Drawing 1 at the rear of this report. Detailed logs of each borehole are given on the Records of Boreholes also at the rear of the report.

The samples obtained during the investigation were returned to our laboratory for testing, and those remaining after testing will be stored until April 1st, 1961, at which time you will be notified regarding their disposal. The results of the laboratory testing are plotted on the Record of Boreholes and on the figures at the rear of the report.

All elevations in this report are referred to Geodetic datum and were determined by reference to a bench mark cut on the

north corner of the west abutment wall of the existing bridge, 15 feet right of Station 162+92. The elevation of this bench mark was given as 1061.07.

SITE TOPOGRAPHY AND GEOLOGY

The site of the proposed bridge is located in the Oxford Till Plain, which is characterized by a gently rolling topography with the relief generally provided by glacial drumlins or broad, shallow stream valleys of which the valley of Phelan Creek is one.

As implied above, the area was overridden by the Wisconsin ice sheet, and glacial drift, capped in some instances by recent alluvial deposits, forms the dominant soil type. The drift is underlain by Norfolk limestone.

SOIL CONDITIONS

The following soil strata were encountered at the site:

Organic Sandy Silt

Beneath a thin layer of topsoil in Boreholes 1 and 2 there was about 3 feet of brown organic sandy silt with a trace of clay. From the results of the dynamic penetration tests, it is estimated that the relative density of this stratum is very loose to loose.

Silty Sand

The organic sandy silt was underlain by a stratum of brown and grey silty sand containing some gravel in the form of subangular limestone fragments. The material is stratified, with the individual layers ranging up to about 6 inches in thickness. The thickness of the stratum was about 12 feet in Borehole 1 and about 3 feet in Borehole 2. Four grain size analyses carried out on samples from this stratum are shown on Figure 1; the range in grain size distribution shown on this figure is indicative of the stratification.

The standard penetration resistances in this stratum ranged from 6 to 31 with an average of about 17 blows per foot. Thus the relative density ranges from loose to compact, but is generally compact.

Clayey Silt

A stratum of grey-brown clayey silt underlies the silty sand in both boreholes, and the stratum was penetrated to a depth of about 30 feet in each borehole. Some sand and gravel was also interspersed with the clayey silt, and occasional sand layers up to about 2 inches in thickness were encountered. It is considered that this stratum is probably a lodgment till.

Atterberg limits were carried out on samples of the clayey silt, and liquid limits were found to range from 16 to

Clayey Silt (continued)

21 with an average of 17.7 per cent. Plastic limits ranged from 11 to 13 with an average of 12.3 per cent. Natural water contents were generally at about the plastic limit with an average of 11.7 per cent. One wet unit weight of 146 pounds per cubic foot was measured.

It was possible to carry out one unconfined compression test on a sample from this stratum. The resultant undrained shear strength was about 2,000 pounds per square foot, but at an axial strain of about 18 per cent. The stress-strain curve for this test is shown on Figure 2.

From the results of the unconfined compression test and the standard penetration resistances, the consistency of the stratum is estimated to be stiff to very stiff.

Groundwater Conditions

Water levels in the boreholes during the investigation were approximately at creek level which was about elevation 1055.

DISCUSSION

General

It is understood that the existing bridge over Phelan Creek on Highway 97 is to be replaced by a 30 foot single span bridge located approximately as shown on Drawing 1.

General (continued)

The present profile grade is to be raised approximately 5 feet to elevation 1066.0 or some 5.5 feet above maximum recorded high water level in Phelan Creek. No other structural details are available at this time, but it is assumed that the proposed bridge would be a simple reinforced concrete structure.

Foundation Design

It is recommended that the bridge be founded on spread footings in the compact silty sand and gravel stratum at or below elevation 1047. The minimum standard penetration resistance, or 'N' value, obtained in the boreholes below elevation 1047 was 16 blows per foot. However, in comparing the 'N' values obtained with the results of dynamic penetration tests adjacent to the boreholes it is believed that the presence of gravel sizes may have influenced the standard penetration resistance of 2 inch open drive samplers. Consequently, it is recommended that maximum design loads not exceed 3,000 pounds per square foot.

Settlement of the bridge, when founded as recommended, should be smaller and within tolerable limits for a simple span structure.

Construction Procedure

Construction of the proposed footings will necessitate excavation approximately 5 feet below the present creek bed

Construction Procedure (continued)

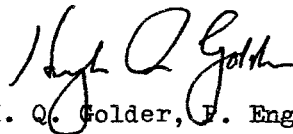
and about 13 feet below maximum recorded high water level. It is therefore recommended that the footings be constructed in steel sheet pile cofferdams. The cofferdam sheeting should be driven to a minimum penetration of 5 feet into the underlying stiff clayey silt stratum in order to prevent a possible blow due to unbalanced hydrostatic head.

In view of the possibility of scour in the silty sand stratum, it is further recommended that the steel sheeting be cut off at footing level and left in place following construction as scour protection.

It should be specified the backfill behind abutments is a clean granular material placed in lifts not exceeding 6 inches in thickness and well compacted. The organic sandy silt underlying topsoil at the site is not a suitable backfill material.



A. A. Gass, P. Eng.,



H. Q. Golder, P. Eng.

AAG:IMB
6021

November, 1960

ABBREVIATIONS

The standard abbreviations commonly employed on each "Record of Borehole", on the figures, and in the text of the report are as follows:

SAMPLE TYPES

A.S. - Auger Sample	H.C. - Back Core
C.S. - Chunk Sample	S.T. - Slotted Tube
D.O. - Drive Open	T.O. - Thin-walled, Open
D.S. - Denison Type Sample	T.P. - Thin-walled, Piston
P.S. - Pore Sample	W.S. - Wash Sample

PENETRATION RESISTANCES

Dynamic Penetration Resistance - The energy required to drive a 2 inch diameter, 60 degree cone attached to the end of the drilling rods into the ground; expressed in blows per foot, where each blow represents 4200 inch-pounds of energy.

Standard Penetration Resistance, N - The number of blows by a 140 pound hammer dropped 30 inches required to drive a 2 inch drive open sampler one foot into the ground.

W_h - Sampler advanced by static weight of sampling hammer

P_h - Sampler advanced by an hydraulic pressure

P_s - Sampler advanced by levering on drill rods

SOIL DESCRIPTION

The standard terminology for the descriptions of the consistency of cohesive soils and the relative density of cohesionless soils is as follows:

<u>Relative Density</u>	<u>N, Blows/ft.</u>	<u>Consistency</u>	<u>C, lb./sq.ft.</u>
Very Loose	0 to 4	Very Soft	30 to 250
Loose	4 to 10	Soft	250 to 500
Compact	10 to 30	Firm	500 to 1,000
Dense	30 to 50	Stiff	1,000 to 2,000
Very Dense	over 50	Very Stiff	2,000 to 4,000
		Hard	over 4,000

SOIL TESTS

C - Consolidation Test	C - Undrained Triaxial
H - Hydrometer Analysis	c - Consolidated Undrained Triaxial
K - Sieve Analysis	S _c - Drained Triaxial
HH - Combined Analysis, Sieve and hydrometer	U - Unconfined Compression
	V - Field Vane Test

Note: Undrained triaxial tests in which pore pressures are measured are shown as Q' or Q'_c .

SOIL PROPERTIES

γ - Total Unit Weight	K - Coefficient of Permeability
γ_d - Dry Unit Weight	c - Undrained Shear Strength
γ_b - Submerged Unit Weight	(ϕ Compressive Strength)
L_l - Liquid Limit	S_t - Sensitivity
Pl - Plastic Limit	θ' - Effective Angle of Shearing Resistance
w - Natural Water Content	c' - Effective Cohesion Intercept
G - Specific Gravity	C_c - Compression Index
e - Void Ratio	C_v - Coefficient of Consolidation

RECORD OF BOREHOLE 1

LOCATION SEE DRWG. No. 1

BORING DATE OCT. 5, 1960

DATUM

GEODETIC

BOREHOLE TYPE

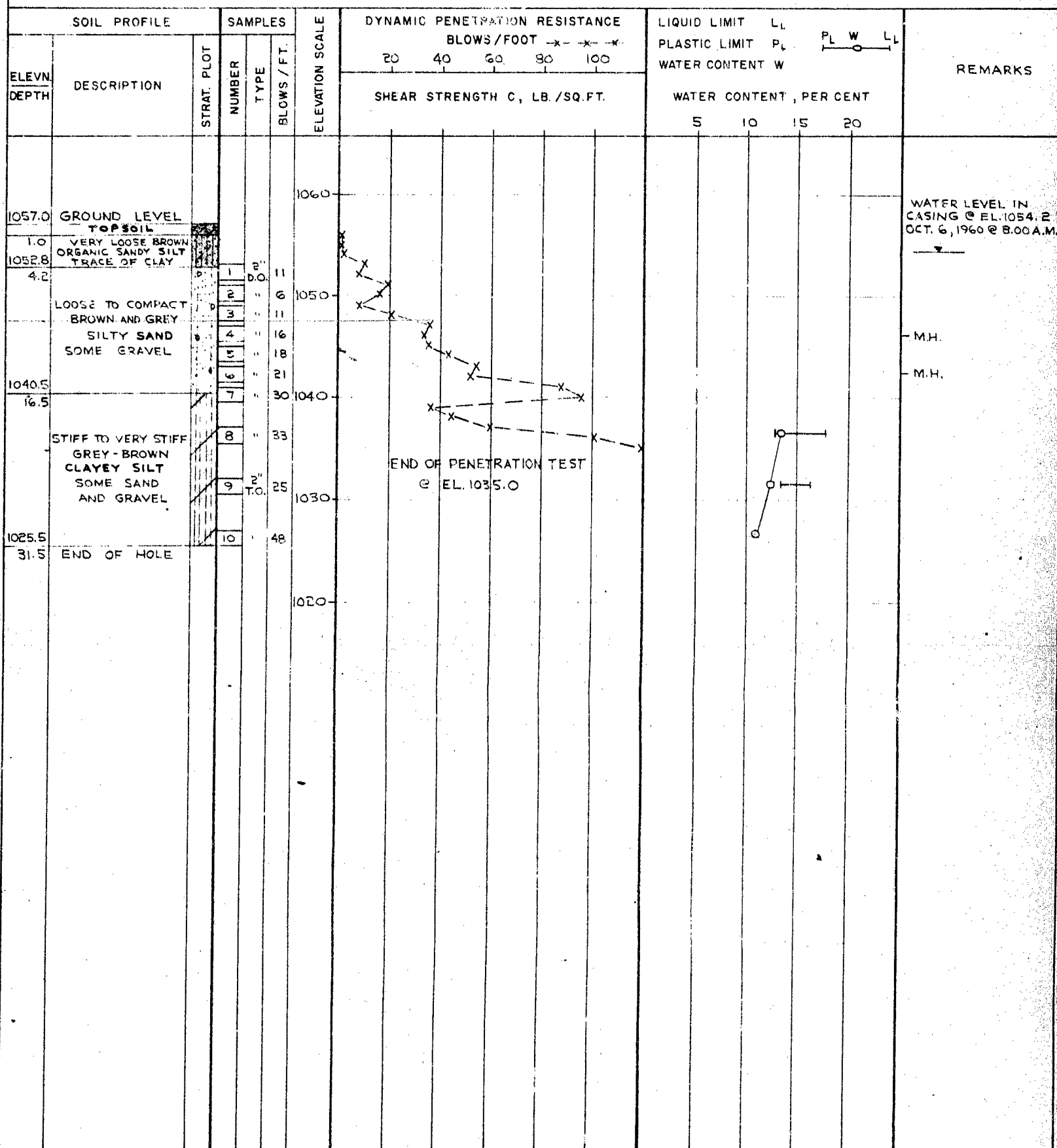
WASH BORING

BOREHOLE DIAMETER

BX CASING

SAMPLER HAMMER WEIGHT 140 LB. DROP 30 INCHES

PEN. TEST HAMMER WEIGHT 140 LB. DROP 30 INCHES



(a) Dynamic penetration resistance converted to 4200 inch lb. energy

(b) Abbreviations listed on page 7

VERTICAL SCALE
1 INCH TO 10 FEET

GOLDER & ASSOCIATES

DRAWN J.A.
CHECKED AAB

RECORD OF BOREHOLE 2

LOCATION SEE DRWG. No. 1

BORING DATE

OCT. 6, 1960

DATUM

GEODETIC

BOREHOLE TYPE

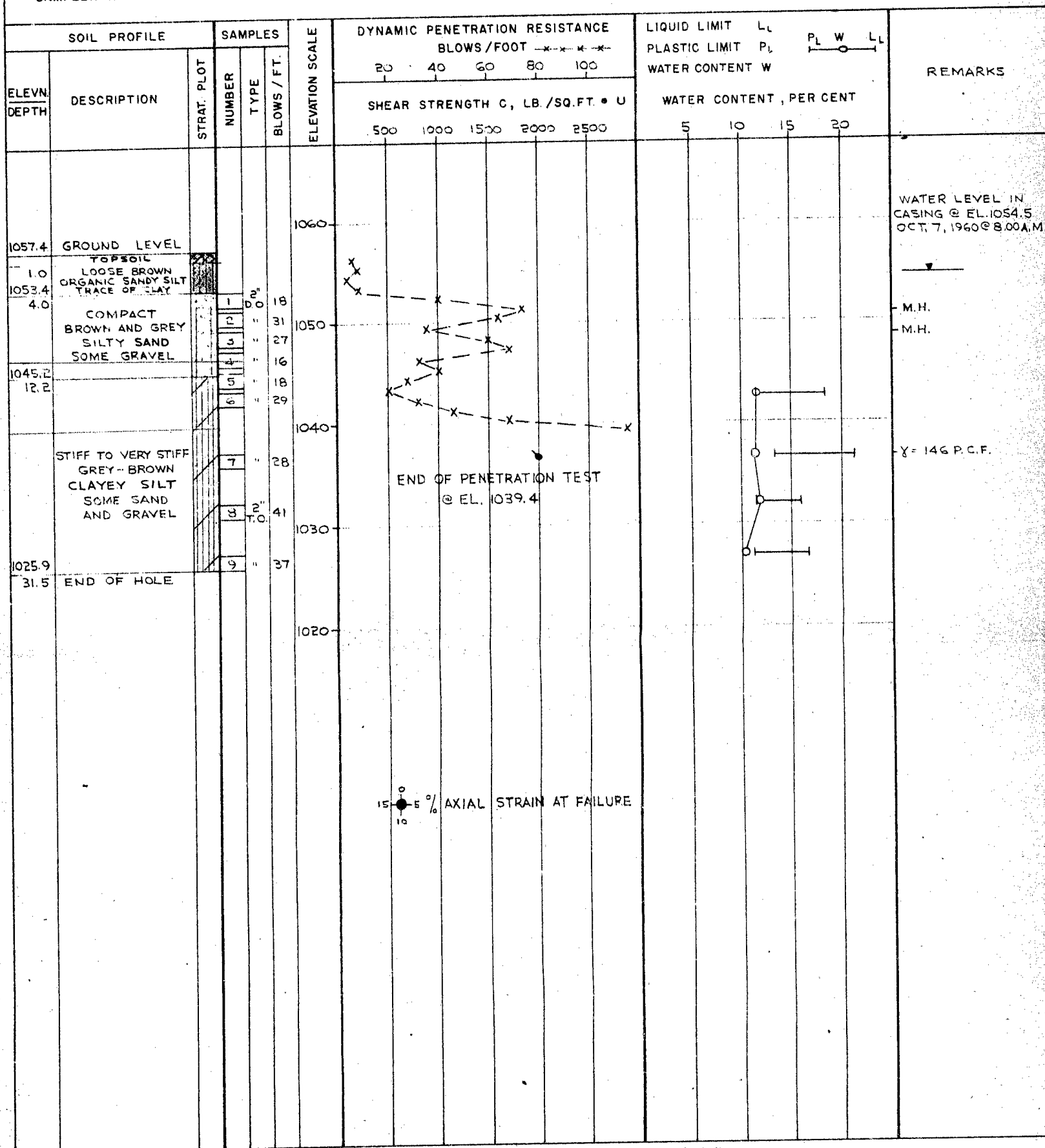
WASH BORING

BOREHOLE DIAMETER

BX CASING

SAMPLER HAMMER WEIGHT 140 LB. DROP 30 INCHES

PEN. TEST HAMMER WEIGHT 140 LB. DROP 30 INCHES



(a) Dynamic penetration resistance converted to 4200 inch lb. energy

(b) Abbreviations listed on page 7

VERTICAL SCALE
1 INCH TO 10 FEET

DRAWN J.A.

CHECKED *AD*

GOLDER & ASSOCIATES

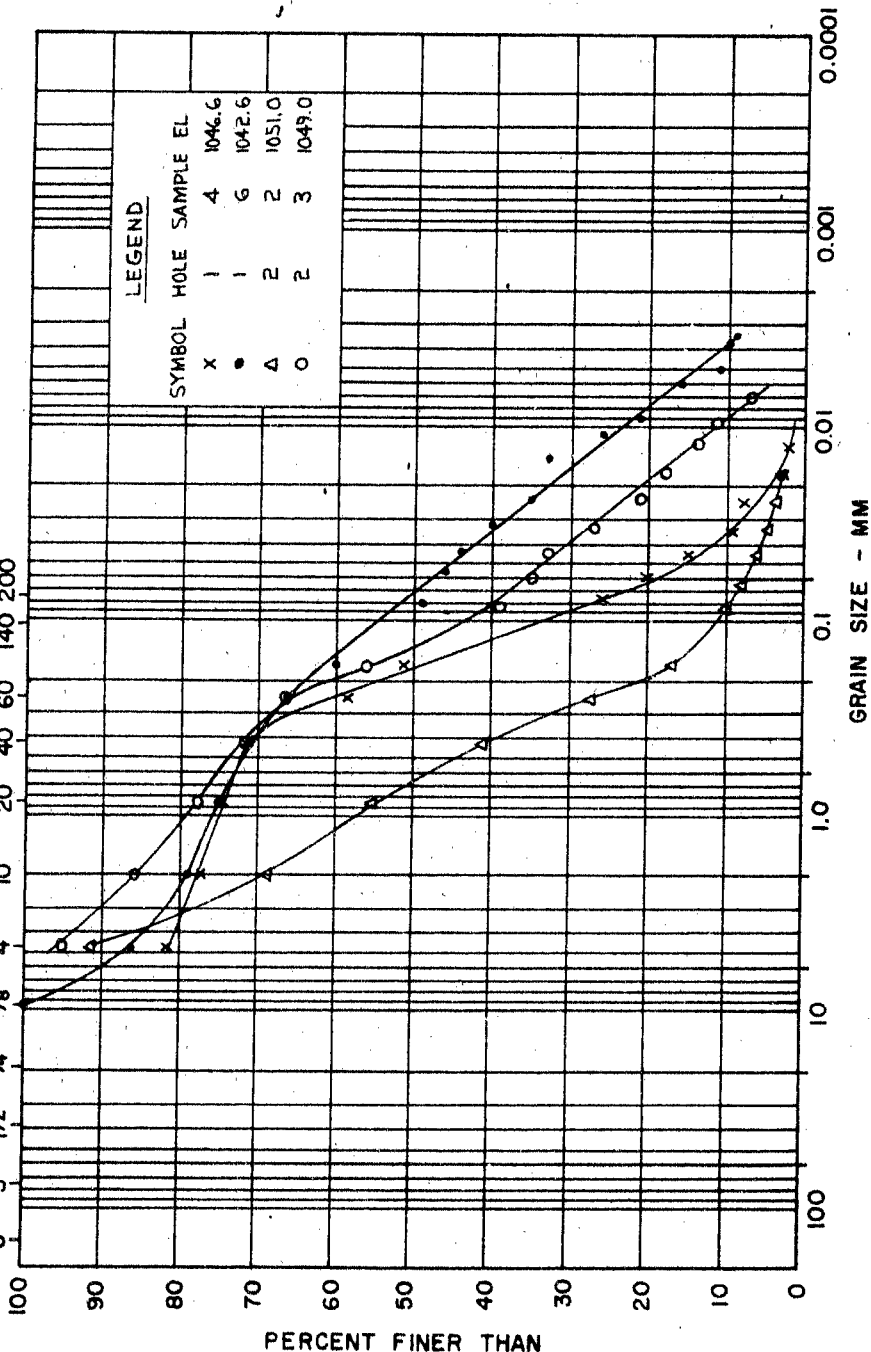
GRAIN SIZE DISTRIBUTION

FIGURE 1

M.I.T. GRAIN SIZE SCALE

SIZE OF OPENING - INS. U.S.S. SIEVE SIZE - MESHES / IN.

6" 3" 1 1/2" 3/4" 3/8" 200 140 60 40 20 10 4



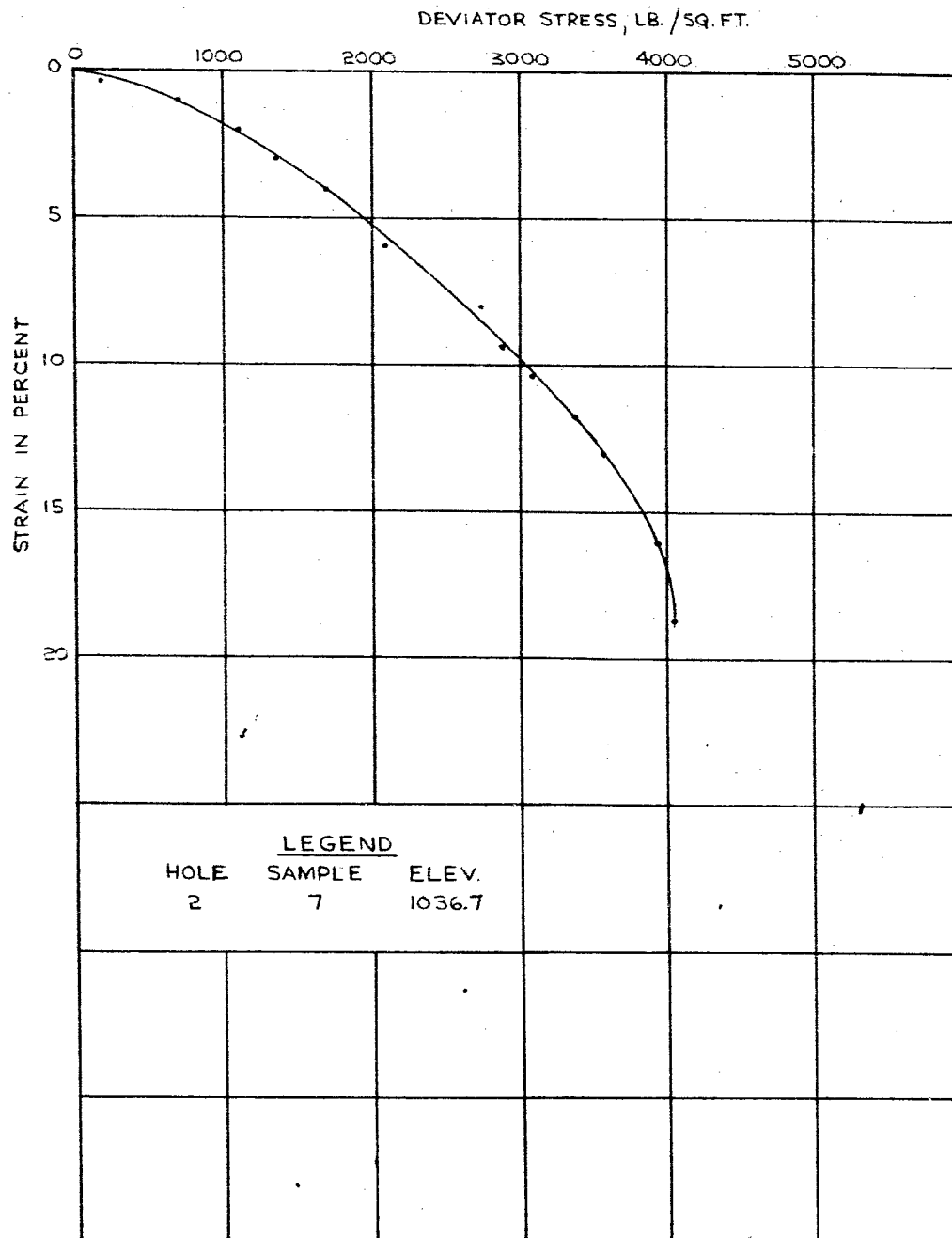
GOLDER & ASSOCIATES

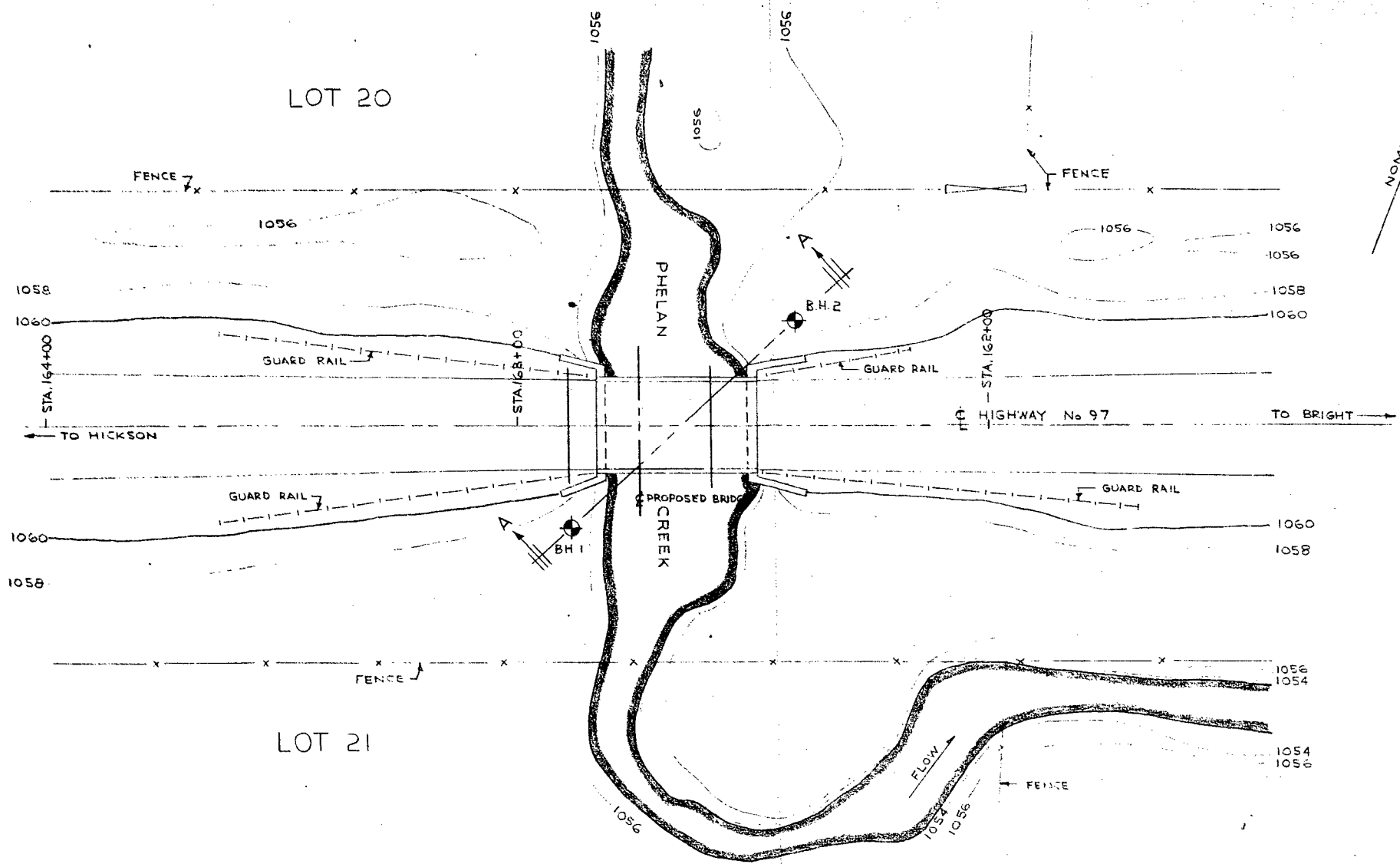
J.A.

UNCONFINED COMPRESSION TEST

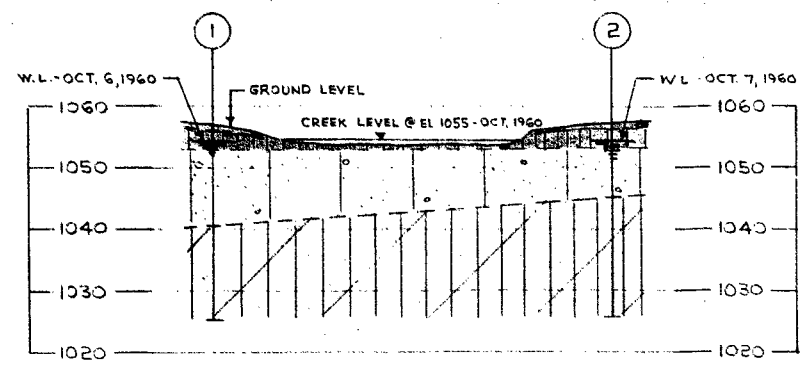
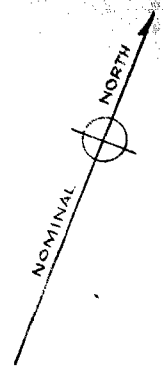
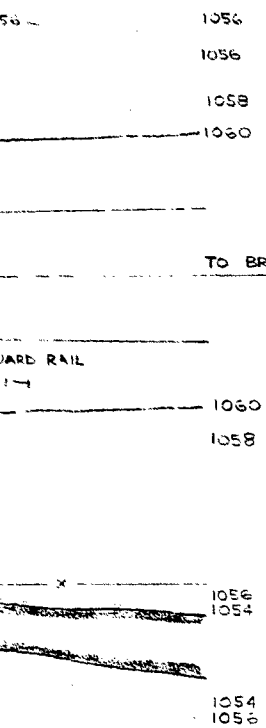
STRESS-STRAIN CURVE
CLAYEY SILT

FIGURE 2









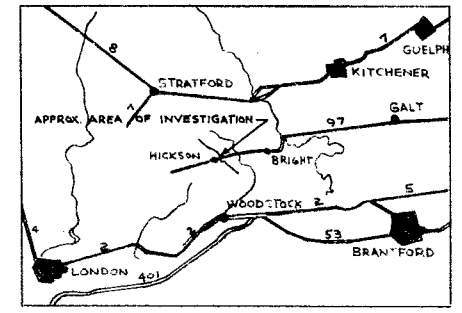
PLAN
SCALE: 1" = 20' 0"



SECTION A-A
SCALE: 1" = 20'-0"



STRATIGRAPHY

-  TOPSOIL
-  VERY LOOSE TO LOOSE BROWN ORGANIC SANDY SILT
-  LOOSE TO COMPACT BROWN AND GREY SILTY SAND
-  STIFF TO VERY STIFF GREY-BROWN CLAYEY SILT



KEY PLAN
SCALE: 1" = APPROX. 17 MILES

LEGEND

-  BOREHOLE WITH PENETRATION TEST IN PLAN
-  BOREHOLE IN ELEVATION

SPECIAL NOTE: DATA CONCERNING THE VARIOUS STRATA HAVE BEEN OBTAINED AT BOREHOLE LOCATIONS ONLY. BETWEEN BOREHOLES THE SOIL STRATIGRAPHY HAS BEEN INFERRED FROM GEOLOGICAL EVIDENCE AND SO MAY VARY FROM THAT SHOWN.

REFERENCE		DEPARTMENT OF HIGHWAYS, ONTARIO TORONTO PROPOSED PHELAN CREEK BRIDGE HICKSON ONTARIO		GOLDER & ASSOCIATES CONSULTING CIVIL ENGINEERS	
DRWG. No.	DESCRIPTION				
E - 3895	DEPARTMENT OF HIGHWAYS, ONTARIO PRESENT CROSSING AT PHELAN CREEK AND HIGHWAY 97 DATED JULY, 1960.	BORING PLAN AND SOIL STRATIGRAPHY		DATE: OCT. 11, 1960 SCALE: AS SHOWN	
				MADE J.A.	CHKD. J.B.
				APPD. J.B.	DRWG. No. 1

CALCULATIONS FOR

Phelan Cr Bridge

Check on b_g capacity

Testing at sk 1046. Ground sk 1061 F.

$$B = 12$$

$$L = 36$$

$$D = 15$$

From Meyerhof A.S.C.E. Paper No 866

$$q_s = \frac{NB}{30} \left(1 + \frac{D}{B} \right) - \text{Subgrade below W.T.}$$

$$q_s = \frac{NB}{30} \left(1 + \frac{D}{B} \right) = \frac{16 \times 12}{30} \left(1 + \frac{15}{12} \right) = 6.8 \text{ TSF}$$

$$q_a = \frac{N}{10} \text{ or } \frac{N(1 + \frac{1}{B})^2}{12}$$

$$= 1.5 \text{ TSF or } \frac{15(1.083)^2}{12} = 1.47 \text{ TSF}$$

Use, 1.5 TSF