

#60-F-244C

W.P. # 273-60

HWY # 97

PROPOSED

THAMES R.

BRIDGE



ONTARIO
DEPARTMENT OF HIGHWAYS

Memo to Mr. A. M. Toye, **Date** November 9, 1960.
Bridge Engineer. **Subject** FOUNDATION INVESTIGATION REPORT
From Materials & Research Section. **by:** H. Q. Golder & Associates, Ltd.

Attention: Mr. S. McCombie.

Re: Proposed Thames River Bridge,
Hwy. 97, Hickson, Ontario.
W.P. 273-60 -- District No.3.

MALCOLM BR.

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:

Astermac

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

AGS/MdeP

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.

H. Q. GOLDER & ASSOCIATES LTD.

CONSULTING CIVIL ENGINEERS

**H. Q. GOLDER
V. MILLIGAN**

**2446A BLOOR ST. W.
TORONTO 9
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REPORT

TO

DEPARTMENT OF HIGHWAYS, ONTARIO

ON

SITE INVESTIGATION, PROPOSED THAMES RIVER 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

6020

ABSTRACT

The results of an investigation carried out at the site of the proposed Thames River crossing on Highway 97 just east of Hickson, Ontario are reported. It was found that the site is underlain by 3 to 5 feet of loose granular material followed by a hard clayey glacial till.

Recommendations are made for founding the abutments of the proposed bridge on spread footings in the hard till stratum with maximum design loads not to exceed 6,000 pounds per square foot. It is also concluded that no unusual problems are likely to be encountered during construction.

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INTRODUCTION

1.

H. Q. Golder and 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 the Thames River on Highway 97 about 3.4 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 foundations for the proposed bridge.

PROCEDURE

The field work for the investigation was carried out between October 7th and October 11th, 1960 inclusive. Two boreholes were put down in BX size to depths of 30 and 23 feet using a standard skid-mounted machine drillrig. The locations of the boreholes together with the inferred soil stratigraphy are shown on Drawing 1. Detailed logs of each borehole are given on the Records of Boreholes.

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 Records 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

previously established at the site by the D.H.O. This bench mark is located north-west of the site in the root of a 15 inch maple, 34 feet right of Station 20+87. The elevation of this bench mark was given as 1052.59, Geodetic.

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 provided generally by glacial drum-lins or broad, shallow stream valleys of which the valley of the Thames 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:

Silty Sand and Gravel

From ground surface at Borehole 1 and beneath a thin layer of topsoil at Borehole 2 a stratum of brown silty sand and gravel with an occasional trace of clay was encountered. Its thickness was about 3 feet in Borehole 1 and 5 feet in

Silty Sand and Gravel (continued)

Borehole 2. The stratum is undoubtedly a geologically recent deposit of the Thames River.

One standard penetration resistance of 24 blows per foot was obtained in the stratum in Borehole 2 indicating a compact relative density. However, from the results of the dynamic penetration tests in both boreholes it is considered that the density of the stratum ranges from very loose to compact, but is generally loose.

Silty Clay

Underlying the silty sand and gravel in both boreholes was a stratum of brown to grey silty clay containing some sand and gravel in the form of subangular fragments of limestone. Relatively thin layers of silt and sand were also occasionally encountered within the stratum and ranged in thickness from a fraction of one inch to about one foot. The stratum was penetrated to a depth of 30 feet in Borehole 1 and 23 feet in Borehole 2, and was found to be so dense that the drill casing had to be advanced by drilling rather than driving alone. From the composition and high density of the stratum it is concluded that it is a lodgment till.

The liquid limits of the material ranged about 20 to 40 with an average of 31.2 per cent, and plastic limits

Silty Clay (continued)

ranged about 12 to 25 with an average of 17.5 per cent. Natural moisture contents ranged generally around the plastic limit and averaged 16.1 per cent. In some instances the natural water content was below the plastic limit. One wet unit weight of 135.8 pounds per cubic foot was measured.

Good samples of the silty clay were difficult to obtain. However one unconfined compression test could be carried out which gave an undrained shear strength of 8,500 pounds per square foot at an axial strain of about 9 per cent. The stress-strain curve for this test is shown on Figure 1.

Standard penetration resistances ranged from 29 to greater than 100 and were generally in excess of 50 blows per foot. It is concluded, therefore, that the consistency of the stratum ranges from very stiff to hard but is generally hard.

Groundwater Conditions

Groundwater conditions in the boreholes at the time of the investigation were observed to be approximately at river level which was about elevation 1035.

DISCUSSIONGeneral

It is understood that the existing temporary bridge at the Thames River is to be replaced by a 65 foot single-

General (continued)

span bridge located approximately as shown in Drawing 1 and that present profile grade is to be raised approximately 5 feet to elevation 1050. No other structural information was available at the writing of this report, but it is assumed that the proposed bridge would probably be a simple reinforced concrete structure.

Foundation Design

It is recommended that the bridge be founded on spread footings in the hard silty clay stratum at about elevation 1030. From the results of the laboratory testing it is clear that loads of up to 16,000 pounds per square foot could be carried safely in this stratum. However, in order to account for possible minor disturbance of the stratum during construction, it is recommended that maximum design loads not exceed 6,000 pounds per square foot although for a structure of the size proposed it is unlikely that it would be practical to utilize the whole of this recommended capacity. Possible settlements of the structure when founded as recommended should be negligible.

Construction Procedure

Excavation for the proposed footings is not likely to pose any unusual problems although it might prove necessary to sheet the excavation in the silty sand and gravel.

Construction Procedure (continued)

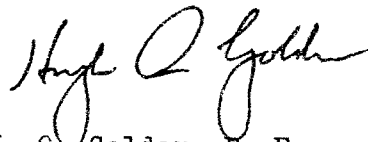
Dewatering by means of sumps would be satisfactory.

In view of the hard consistency of the till stratum and the existing river regime at the site scour protection should not be required for footings founded at the elevation recommended above.

It should be specified that the base of the abutments excavation should be sealed with concrete immediately and that the abutment should be backfilled with clean granular material placed in well-compacted layers not exceeding 6 inches in thickness. The silt till at the site is not a suitable backfill material to abutments.



A. A. Gass, P. Eng.



H. Q. Golder, P. Eng.

AAG:IMB
6020

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. - Rock 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. - Pott 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 sampler hammer

P_h - Sampler advanced by an hydraulic pressure

E_h - 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	Q - Undrained Triaxial
H - Hydrometer Analysis	Q _c - Consolidated Undrained Triaxial
M - Sieve Analysis	S - Drained Triaxial
MC - 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 _o - Saturated Unit Weight	c _p - Undrained Shear Strength (p Compressive Strength)
LL - Liquid Limit	S _t - Sensitivity
PL - Plastic Limit	φ - Effective Angle of Shearing Resistance
w - Natural Water Content	c' - Effective Cohesion Intercept
G - Specific Gravity	C _c - Compression Index
e - Void Ratio	C _y - Coefficient of Consolidation

RECORD OF BOREHOLE 1

LOCATION SEE DRWG. NO 1

BORING DATE OCT. 7-10, 1960

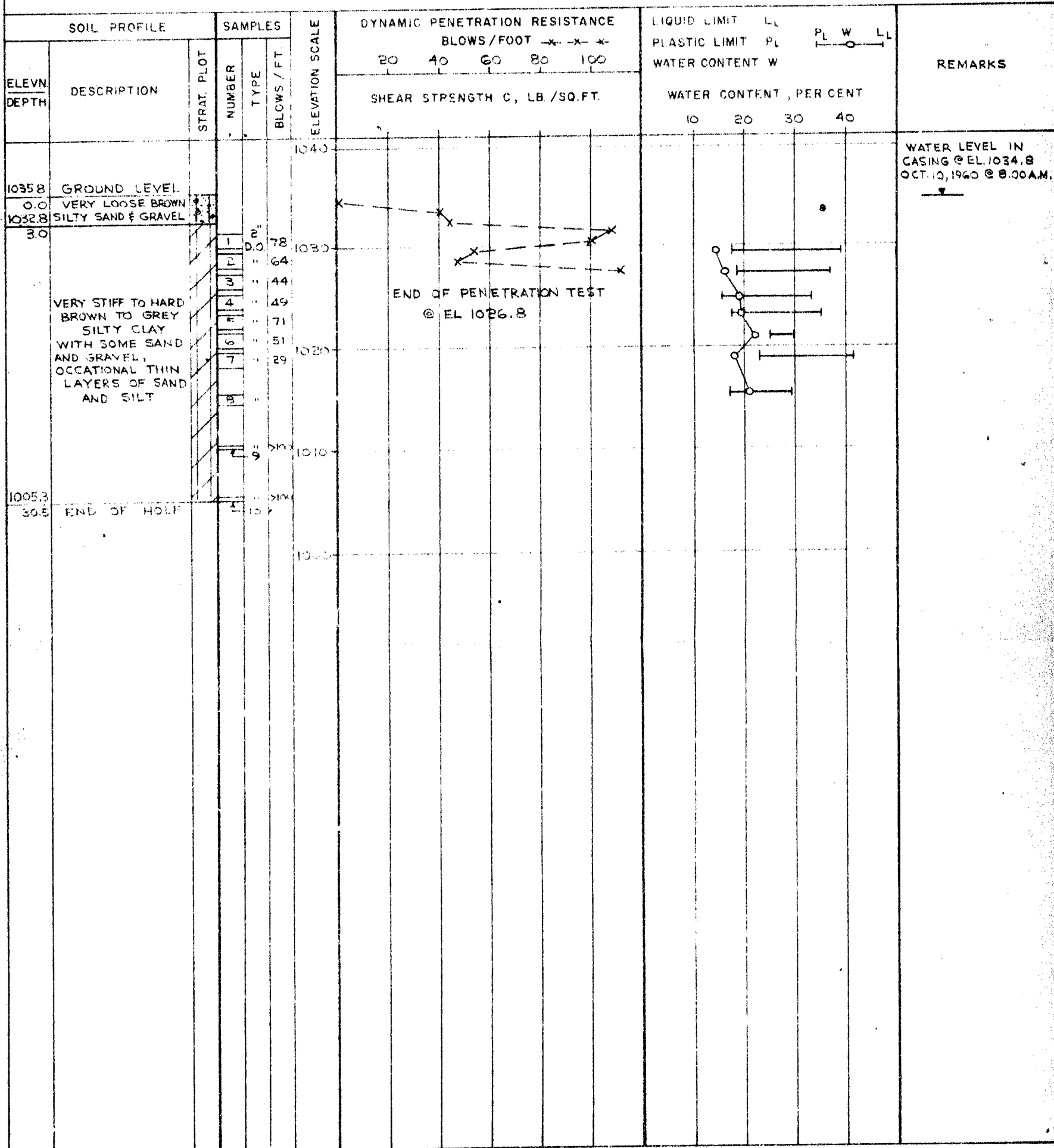
DATUM GEODETIC

BOREHOLE TYPE WASH BORING

BOREHOLE DIAMETER 8X 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 A.A.G.

RECORD OF BOREHOLE 2

LOCATION SEE DRWG. NO 1

BORING DATE OCT. 11 1960

DATUM

GEODETIC

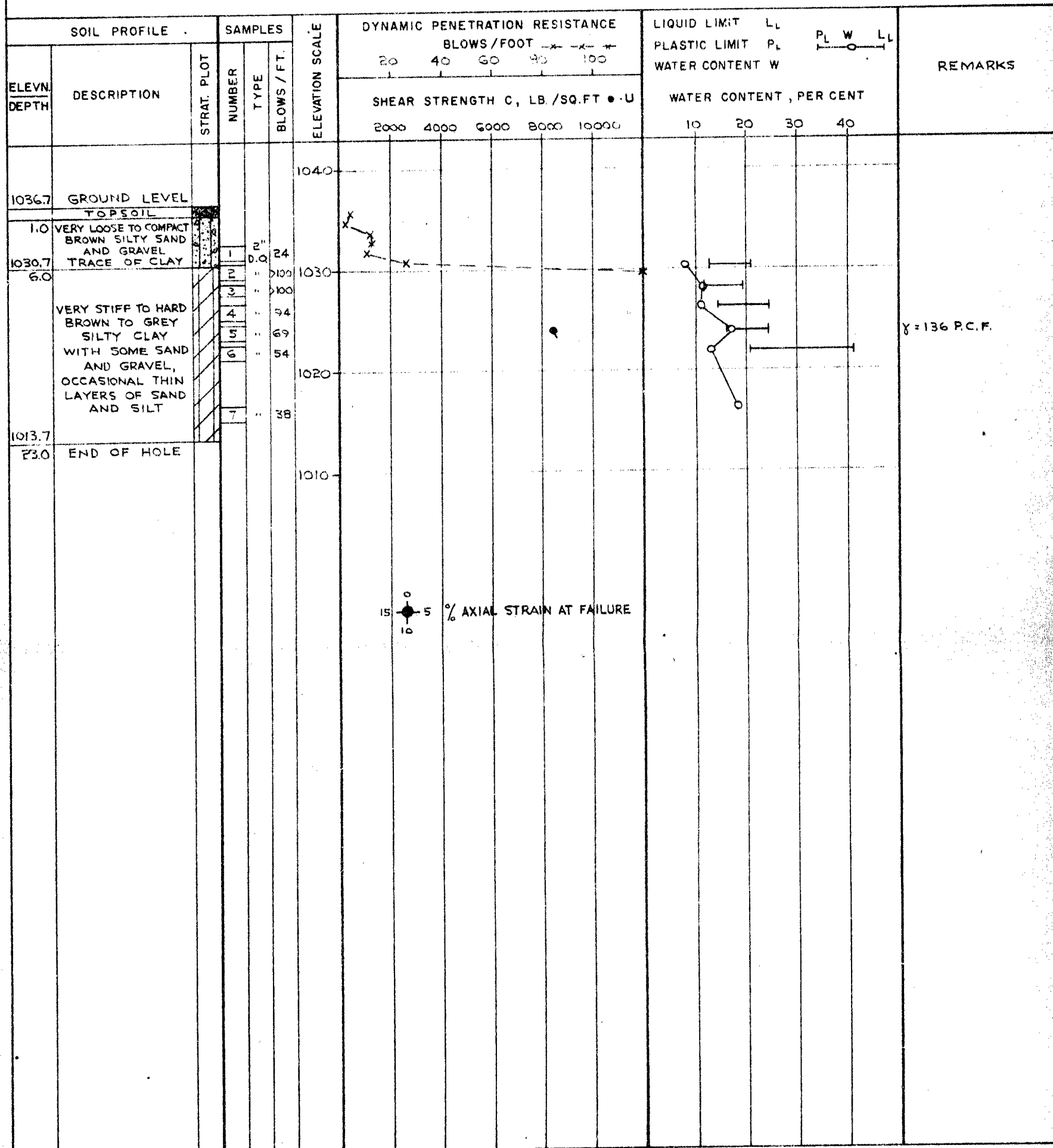
BOREHOLE TYPE WASH BORING

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

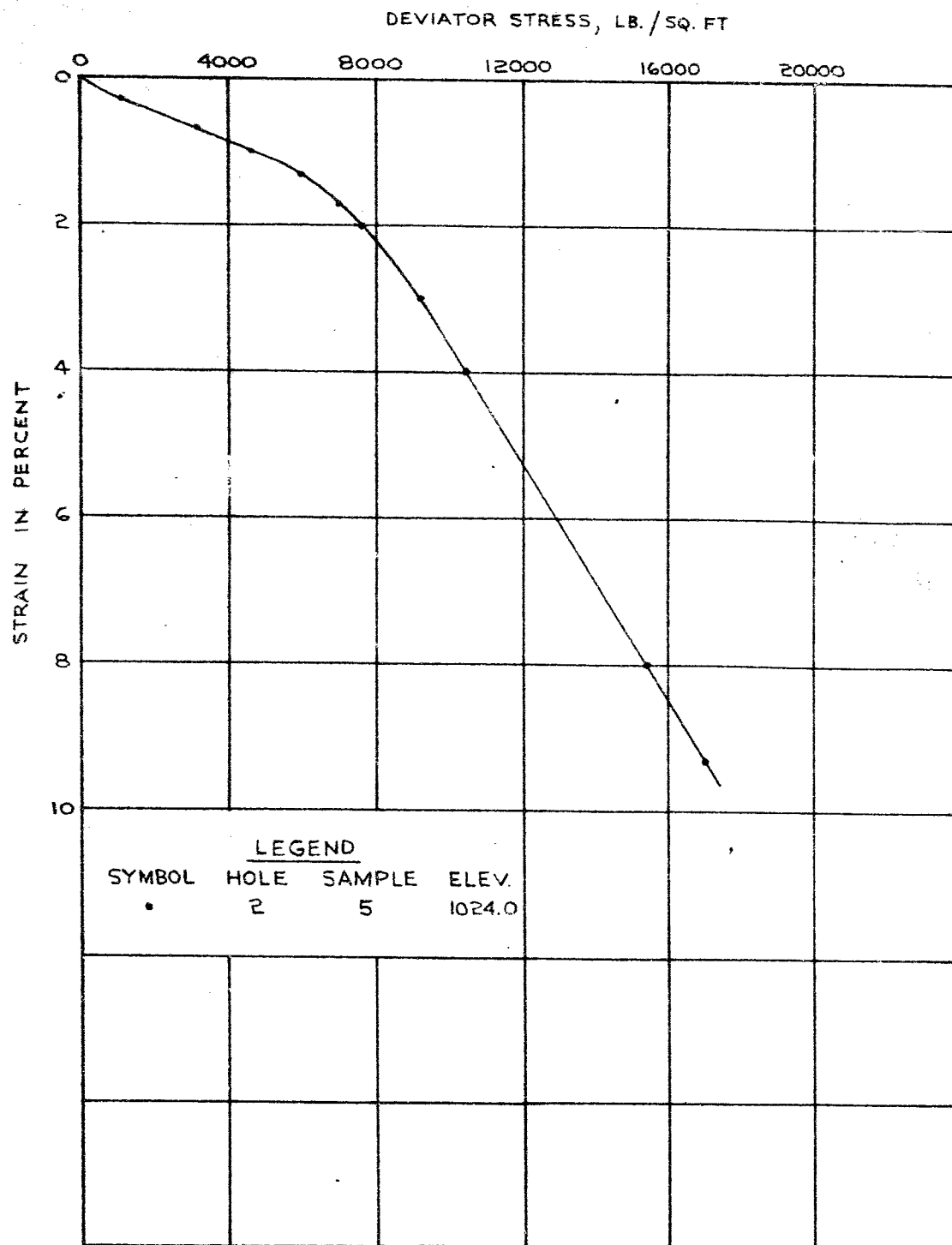
DRAWN J.A.
CHECKED A.A.G.

UNCONFINED COMPRESSION TEST

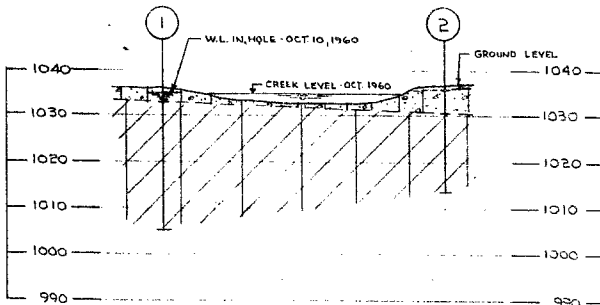
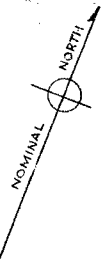
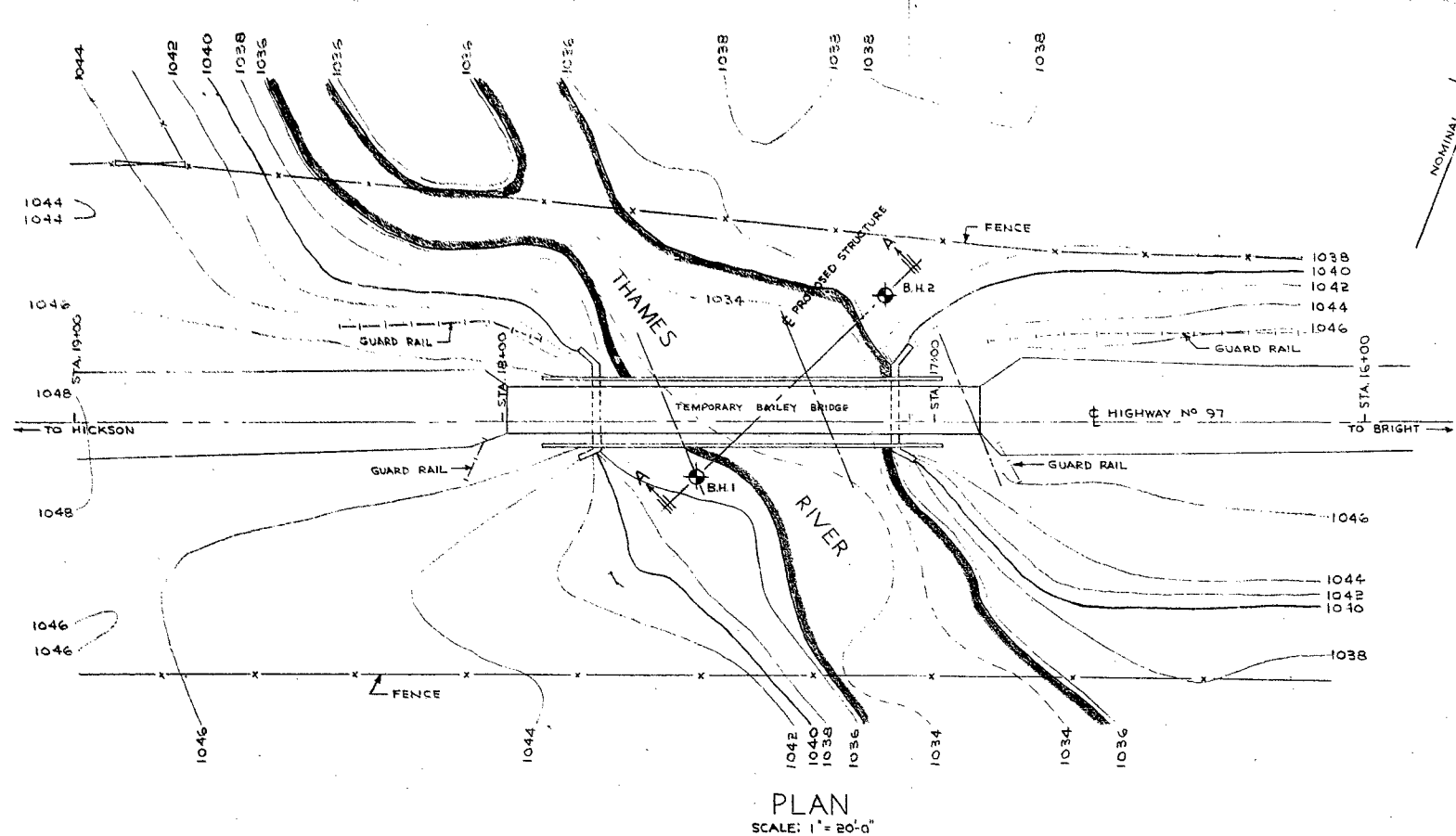
STRESS - STRAIN CURVE

GREY SILTY CLAY

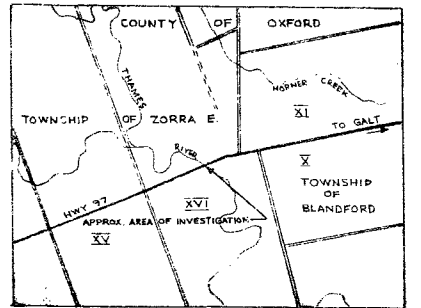
FIGURE 1



GOLDER & ASSOCIATES



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



KEY PLAN
SCALE: 1" = 0.8 MILES

LEGEND

- BOREHOLE WITH PENETRATION TEST IN PLAN
- BOREHOLE IN ELEVATION

STRATIGRAPHY

- TOPSOIL
- VERY LOOSE TO COMPACT BROWN SILTY SAND AND GRAVEL
- VERY STIFF TO HARD BROWN TO GREY SILTY CLAY

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	
DRWG. No.	DESCRIPTION
E-3896	DEPARTMENT OF HIGHWAYS, ONTARIO DISTRICT NO. 2 - PRESENT CROSSING AT THAMES RIVER AND HIGHWAY NO. 97 - BRIDGE SITE. DATED JULY 1960.

DEPARTMENT OF HIGHWAYS, ONTARIO
TORONTO
PROPOSED THAMES RIVER BRIDGE
HICKSON
BORING PLAN AND SOIL STRATIGRAPHY

GOLDER & ASSOCIATES
CONSULTING CIVIL ENGINEERS
DATE: OCT. 17, 1960 SCALE: AS SHOWN
MADE J.A. CHKD. A.A.G. APPD. A.A.G. DRWG. No. 1