

#60-F-247C

W.P.# 30-61

Hwy # 97

ALDER CREEK

BRIDGE



ONTARIO

DEPARTMENT OF HIGHWAYS

Memo to Mr. A. M. Toye, **Date** November 21, 1960.
Bridge Engineer. **Subject** FOUNDATION INVESTIGATION REPORT
From Materials & Research Section. by: H. Q. Golder & Associates, Ltd.


Attention: Mr. S. McCombie.

Re: Proposed Alder Creek Bridge,
Hwy. 97, Washington, Ontario.
W.P. 30-61 -- District No. 3.

We have reviewed the above mentioned report and have found the factual data well presented. We agree with the conclusions and recommendations given in the report, except that it is our opinion that a safe bearing pressure of 2.0 T/sq.ft. can be used. The Consultant's recommendation was obtained by using the minimum 'N' values. Since there is no indication of a looser layer from the dynamic penetration results, it is believed that taking 'N' values of 10 and 11, respectively, is too conservative.

Should any other queries arise with respect to this project, that you would like to discuss, please do not hesitate to contact our Office.

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


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

AGS/MdeF
Attach.

cc: Messrs. A. M. Toye (2)
H. A. Tregaskes
D. C. 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
RO. 7-9201**

REPORT

TO

DEPARTMENT OF HIGHWAYS, ONTARIO

ON

SITE INVESTIGATION, PROPOSED ALDER CREEK BRIDGE

HIGHWAY 97

WASHINGTON, ONTARIO

Distribution:

**10 copies - Department of Highways, Ontario,
Toronto, Ontario.**

**2 copies - H. Q. Golder & Associates Ltd.,
Toronto, Ontario**

November, 1960

6025

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ABSTRACT

The results of an investigation carried out at the site of the proposed Alder Creek crossing on Highway 97 about 3.1 miles east of Washington, Ontario are reported. It was found that the site is underlain by compact to dense sand strata overlying a very dense silty sand with gravel stratum at a depth of about 31 feet.

Recommendations are made for founding the abutments of the proposed 40 foot span bridge structure on spread footings in the lower 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.

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 October 19th, 1960 to carry out an investigation for a proposed new bridge at Alder Creek on Highway 97, about 3.1 miles east of Washington, 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 19th, 20th and 21st, 1960. Two boreholes were put down in BX size to depths of 42 and 23 feet respectively 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 30th, 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.

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

PROCEDURE (continued)

2.

root of a two foot diameter elm tree, 27 feet right of Station 65+59. The elevation of this bench mark was given as 974.65 geodetic.

SITE TOPOGRAPHY AND GEOLOGY

The site of the proposed bridge is located at the edge of the Oxford Till Plain which is characterized by a gently rolling topography with the relief provided by glacial drumlins or broad shallow stream valleys. The area was over-ridden by the Wisconsin ice sheet and glacial drift capped in some instances by recent alluvial or meltwater deposits forms the dominant soil type.

The major river close to the site is the Nith which flows in one of the sandy gravel spillways by which glacial drainage escaped from the Grand basin into the Thames. Alder Creek flows into the Nith River.

SOIL CONDITIONS

The following soil strata were encountered at the site:

Sand and Gravel

Beneath a thin layer of topsoil in Boreholes 1 and 2 there was a stratum of light brown medium to coarse sand with gravel up to $1\frac{1}{2}$ inches in size dispersed throughout. The thickness ranged from 9 feet in Borehole 1 to 7 feet in Borehole 2.

Sand and Gravel (continued)

Grain size distribution curves for two typical samples of the stratum are given on Figure 1. Individual grains were generally sub-rounded to rounded.

From the results of the dynamic penetration tests and the fact that standard penetration resistances or 'N' values ranging from 16 to 39 blows per foot were obtained in the stratum with an average value of 25 blows per foot, the relative density is estimated to be generally compact.

Sand

The sand and gravel was underlain by a stratum of grey fine to medium sand. The thickness was about 22 feet in Borehole 1 and was not penetrated in Borehole 2 at a depth of 23 feet. Four grain size analyses carried out on samples from this stratum are shown on Figure 2; the distribution curves indicate the uniformity of grain sizes. Individual grains were generally angular to sub-angular.

The standard penetration resistances in this stratum ranged from 10 to 52 blows per foot with an average of 27 blows per foot. Thus the relative density ranges from compact to dense.

Silty Sand

A stratum of grey silty sand was encountered in Borehole

SOIL CONDITIONS (continued)

4.

Silty Sand (continued)

1 below the sand stratum described above. The stratum was penetrated to a depth of 42 feet in Borehole 1. Thin irregular bands of light grey clayey silt and lenses of gravel up to $1\frac{1}{2}$ inches in size were occasionally encountered.

Two standard penetration resistances of 94 and 100 blows per foot were measured indicating the relative density of the stratum to be very dense.

Groundwater Conditions

Water levels in the boreholes during the period of the investigation were approximately at creek level which was about elevation 964.

DISCUSSION

General

It is understood that the existing bridge over Alder Creek on Highway 97 is to be replaced by a 40 foot single span bridge located approximately as shown on Drawing 1. The present profile grade is to be raised about 5 feet to elevation 977 or some 4.5 feet above maximum recorded high water level in Alder 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 sand stratum at or below elevation 957. The minimum standard penetration resistance, or 'N' value, obtained in Borehole 1 below elevation 957 was 10 blows per foot; in Borehole 2 it was 11 blows per foot. Taking into account the effect of overburden pressure on standard penetration resistance in this fine to medium sand stratum, it is recommended that maximum design loads not exceed 3,000 pounds per square foot. This assumes that the abutment footing will not be wider than 10 feet which is rational for the small span bridge proposed.

Total settlement of the bridge, when founded as recommended, should be less than one inch, which is within tolerable limits for a simple span structure.

Construction Procedure

Construction of the proposed abutment footings will necessitate excavation approximately 3 feet below the present creek bed and about 8 feet below normal creek 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 8 feet below footing grade in order to prevent a possible blow due to unbalanced hydrostatic head.

Construction Procedure (continued)

In view of the scour susceptibility of the sand stratum it is further recommended that the steel sheeting be left in place following construction as scour protection.

It should be specified that the backfill behind abutments is a clean granular material placed in lifts not exceeding 6 inches in thickness and well compacted. The sand and gravel stratum at the site should provide suitable backfill, provided topsoil is removed prior to its use.

for. K.M.
A. A. Gass, P. Eng.

VM:IMB
6025

K.M.
V. Milligan, P. Eng.



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	R.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.F. - Thin-walled, Fiston
P.S. - Poff 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.

N_h - Sampler advanced by static weight of sampling hammer

N_h - Sampler advanced by an hydraulic pressure

N_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 non-cohesive soils is as follows:

<u>Relative Density</u>	<u>N, Blows/ft.</u>	<u>Consistency</u>	<u>P, lb./sq.ft.</u>
Very Loose	0 to 4	Very Soft	30 to 250
Loose	4 to 10	Soft	250 to 500
Medium	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 - Unconsolidated Triaxial
H - Hydrometer Analysis	C _c - Consolidated Unconsolidated Triaxial
N - Sieve Analysis	S - Drained Triaxial
MB - Combined Analysis, Sieve and hydrometer	U - Unconfined Compression
	V - Field Vane Test

Note: Unconsolidated 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 - Unconsolidated Shear Strength (if Cohesive Strength)
γ_s - Submerged Unit Weight	c_u - Sensitivity
L_L - Liquid Limit	ϕ - Effective Angle of Shearing Resistance
P_L - Plastic Limit	c_d - Effective Cohesion Intercept
w - Natural Water Content	C_c - Compression Index
G - Specific Gravity	C_u - Coefficient of Consolidation
e - Void Ratio	

RECORD OF BOREHOLE 1

LOCATION SEE DRWG. No. 1

BORING DATE

OCT. 19-20, 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

SOIL PROFILE			SAMPLES		ELEVATION SCALE	DYNAMIC PENETRATION RESISTANCE					LIQUID LIMIT L_L				REMARKS
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE		BLOWS / FOOT					PLASTIC LIMIT P_L				
						20	40	60	80	100	P_L W L_L				
						SHEAR STRENGTH C , LB. / SQ. FT.					WATER CONTENT, PER CENT				
966.4	GROUND LEVEL														W.L. IN CASING @ EL. 963.3 - OCT. 20 1960 @ 8.00 A.M. M M M
0.0	COMPACT LIGHT - BROWN MEDIUM TO COARSE SAND WITH GRAVEL		1	26											
957.4			2	16											
90			3	21											
			4	10											
			5	23											
			6	27											
	COMPACT TO DENSE GREY FINE TO MEDIUM SAND		7	29											
			8	36											
			9	35											
			10	28											
935.4			11	52											
31.0	VERY DENSE GREY SILTY SAND WITH GRAVEL		12	94											
924.9			13	100											
41.5	END OF HOLE														

(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 V.M.

RECORD OF BOREHOLE 2

LOCATION SEE DRWG. No. 1

BORING DATE

OCT. 20-21, 1960

DATUM

GEODETIC

BOREHOLE TYPE

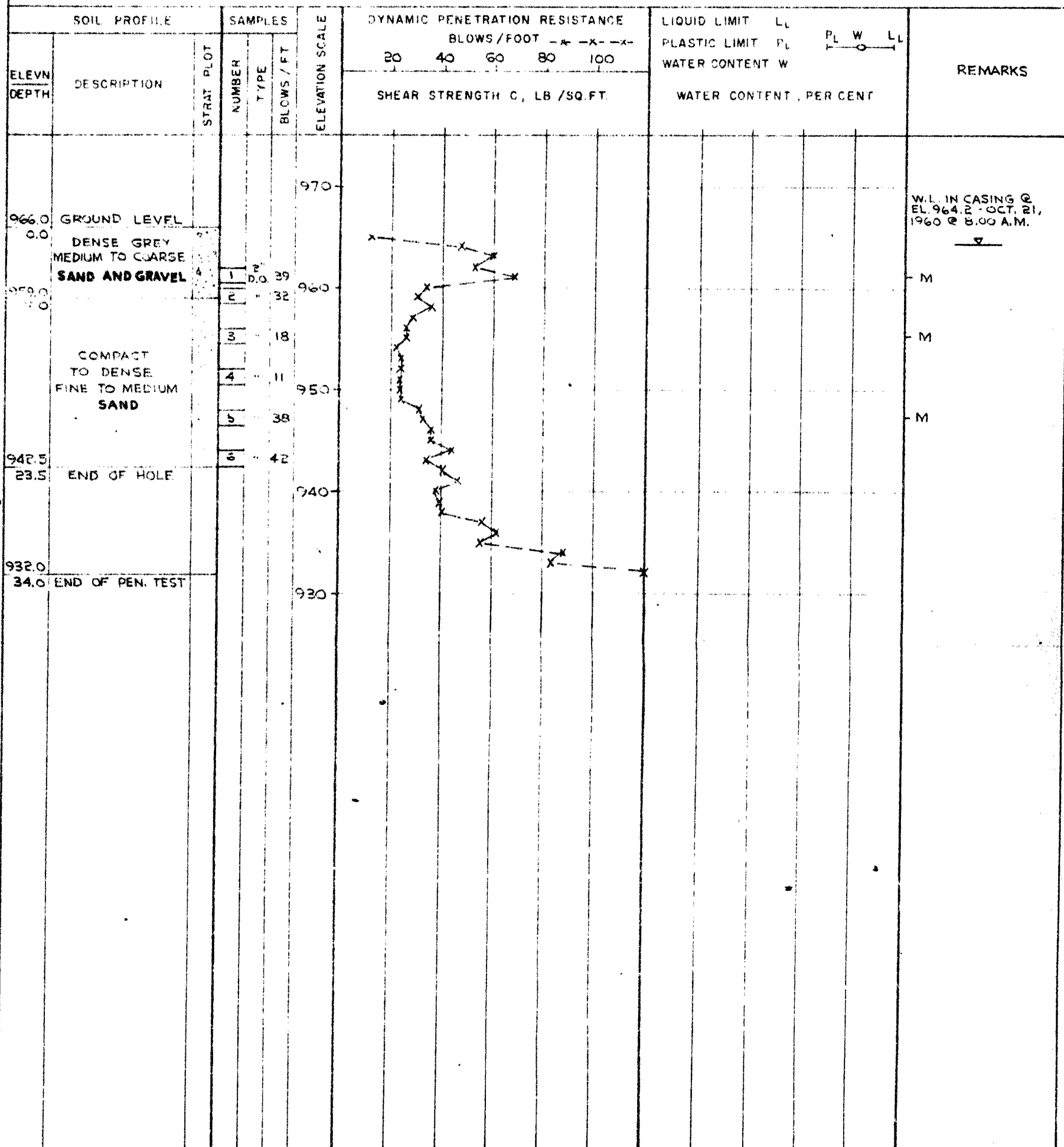
WASH BORING

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 K.M.

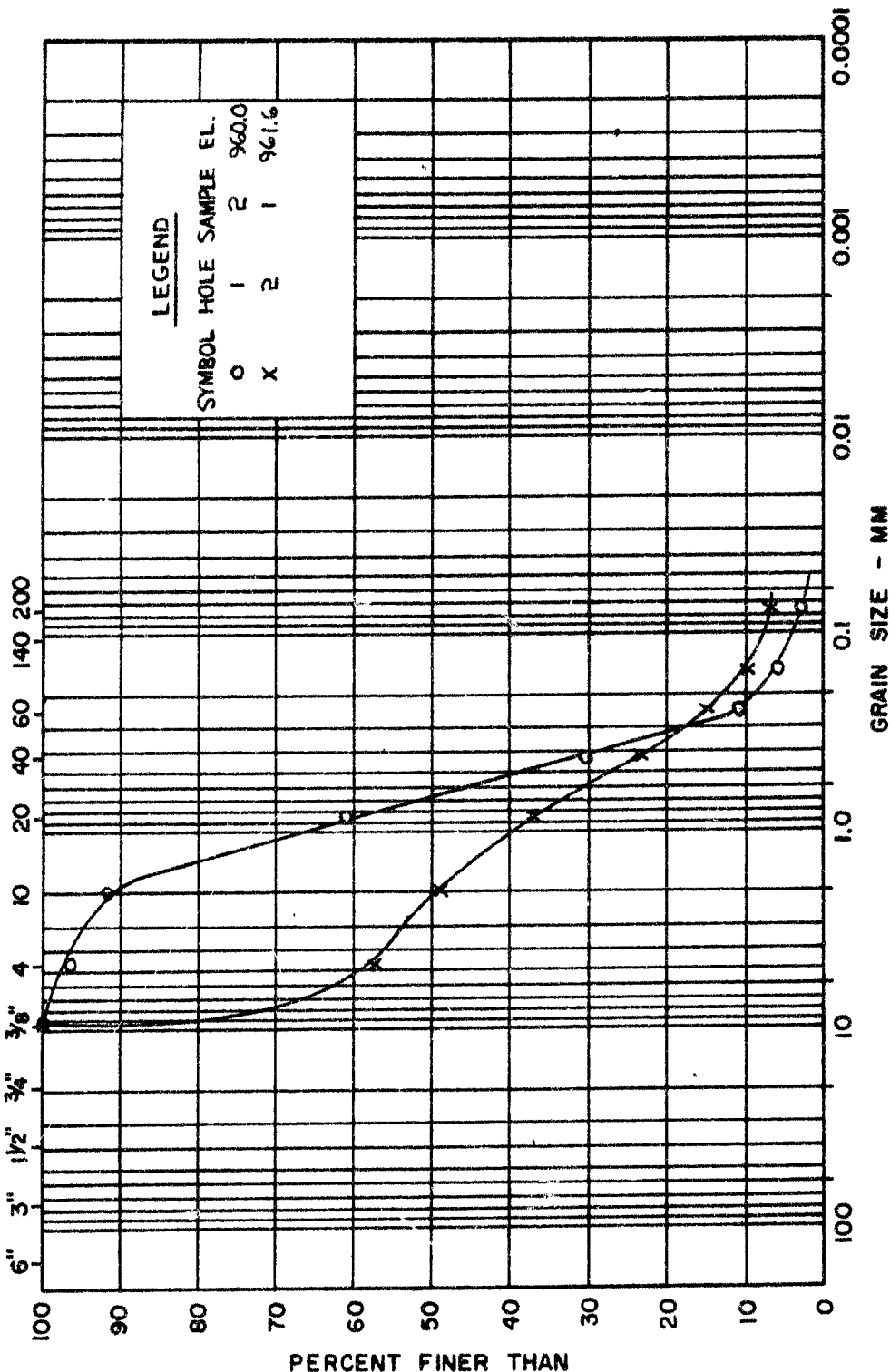
GRAIN SIZE DISTRIBUTION

COARSE SAND AND GRAVEL

FIGURE 1

M.I.T. GRAIN SIZE SCALE

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



PERCENT FINER THAN

GOLDER & ASSOCIATES

J.A.

GRAIN SIZE DISTRIBUTION

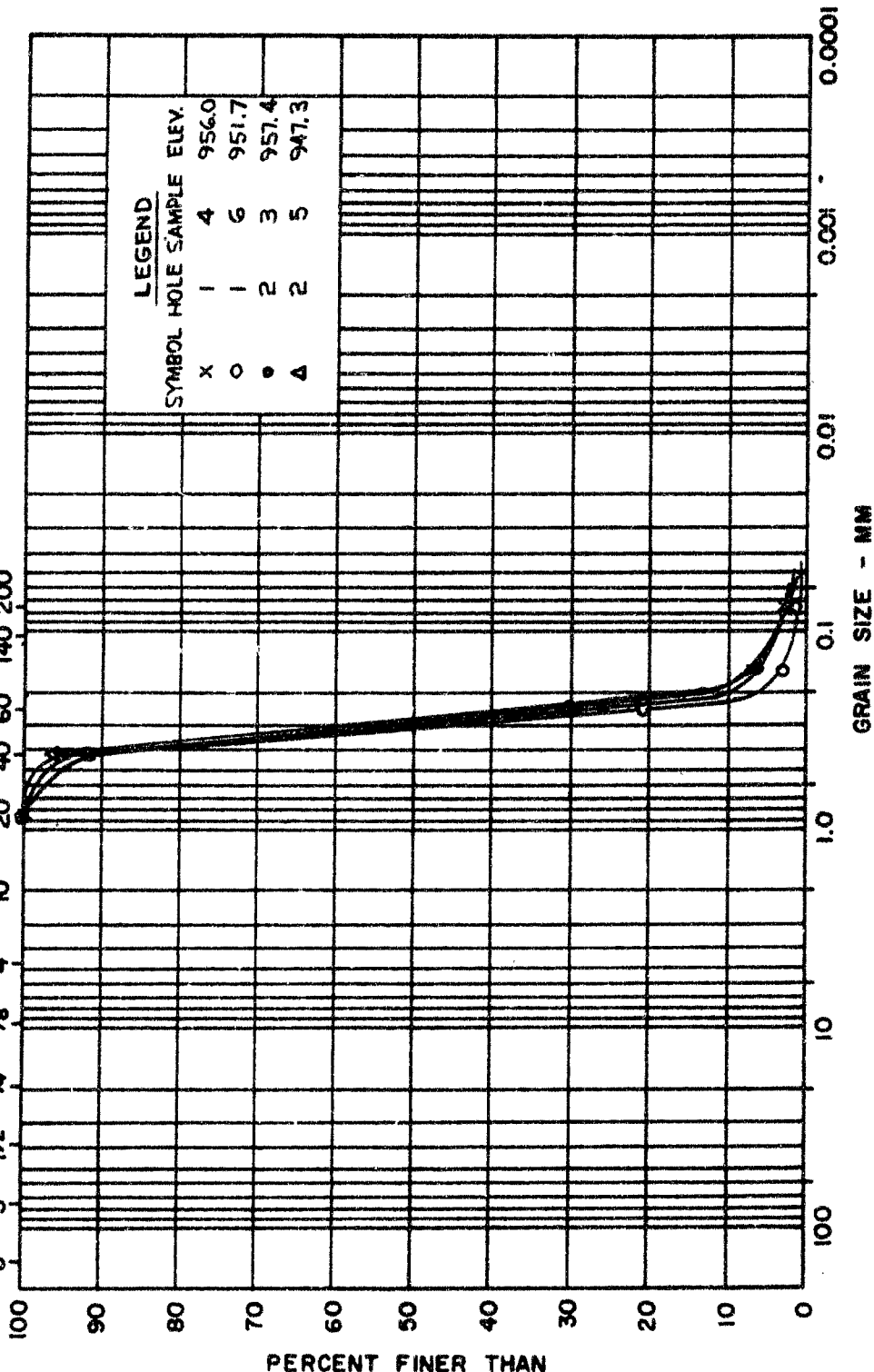
FINE TO MEDIUM SAND

FIGURE 2

M.I.T. GRAIN SIZE SCALE

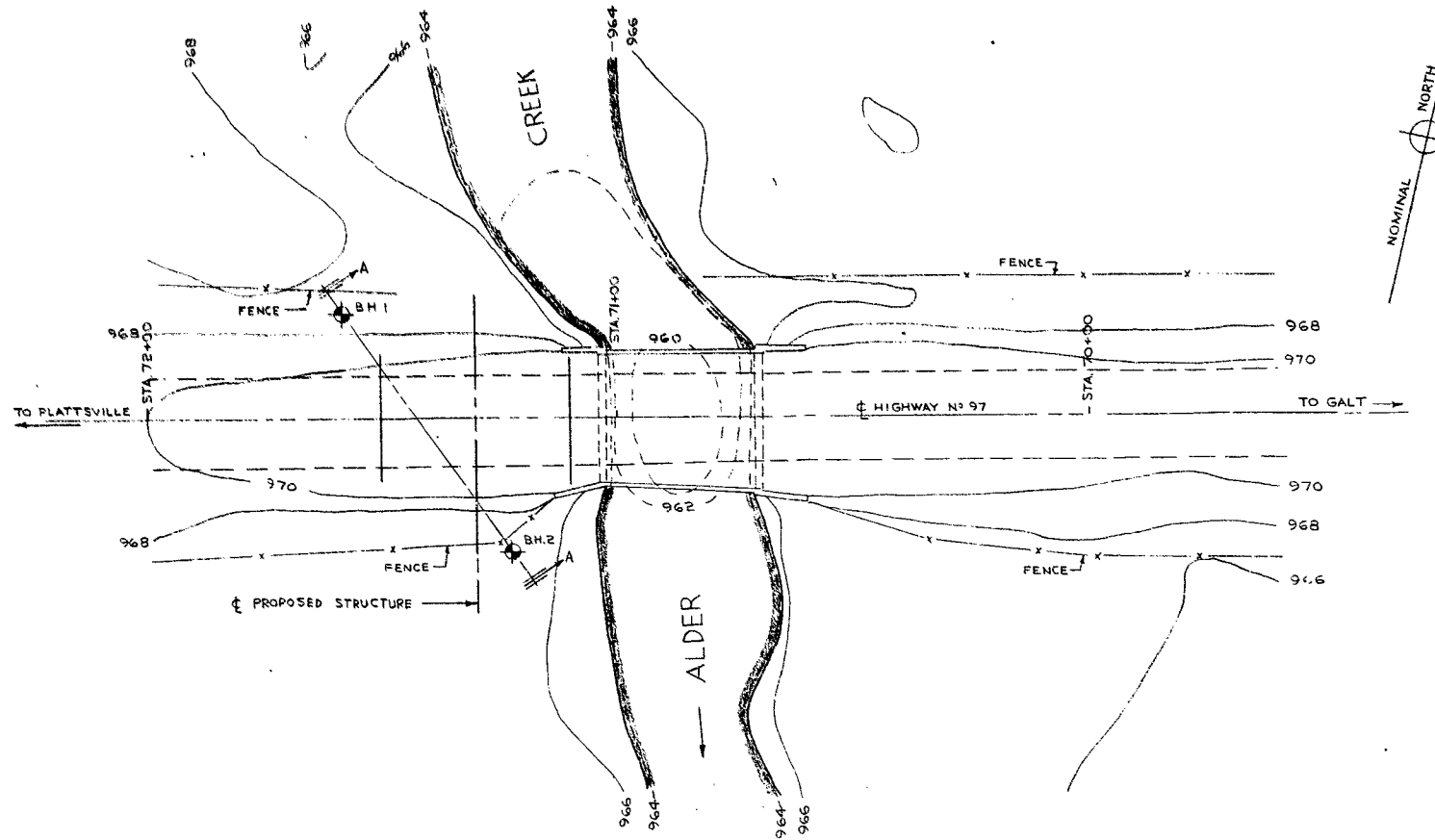
SIZE OF OPENING - INS. U.S.S. SIEVE SIZE - MESHES / IN.

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

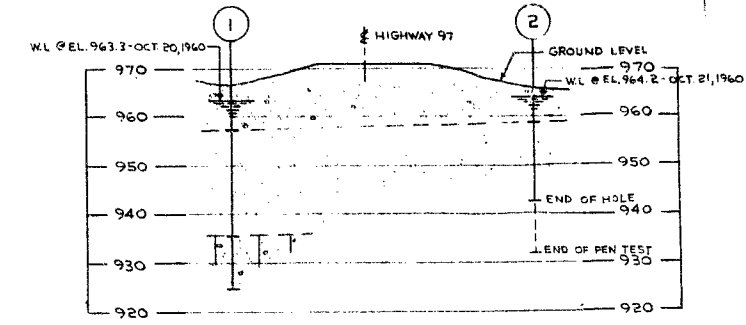


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PLAN
SCALE: 1" = 20'-0"

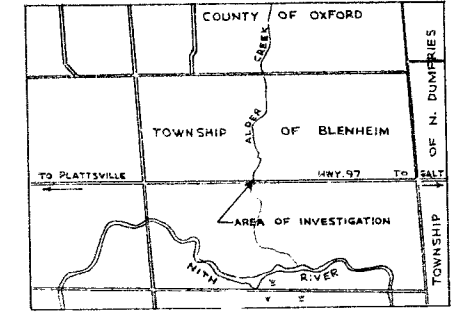


SECTION A-A
SCALE: 1" = 20'-0"

LEGEND

- BOREHOLE WITH PENETRATION TEST IN PLAN
- BOREHOLE IN ELEVATION

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



KEY PLAN
SCALE: 1" = 0.5 MILES

STRATIGRAPHY

- COMPACT TO DENSE BROWN AND GREY MEDIUM TO COARSE SAND & GRAVEL
- COMPACT TO DENSE GREY FINE TO MEDIUM SAND
- VERY DENSE GREY SILTY SAND WITH GRAVEL

REFERENCE	
DRWG. No.	DESCRIPTION
E-3911	DEPARTMENT OF HIGHWAYS, ONTARIO PRESENT CROSSING AT ALDER CREEK AND HIGHWAY NO. 97 - DATED AUGUST, 1960

DEPARTMENT OF HIGHWAYS, ONTARIO
TORONTO
PROPOSED ALDER CREEK BRIDGE
WASHINGTON
BORING PLAN AND SOIL STRATIGRAPHY

GOLDER & ASSOCIATES
CONSULTING CIVIL ENGINEERS
DATE: NOV. 9, 1960 SCALE: AS SHOWN
MADE J.A. CHKD. R.M. APPD. J.M. DRWG. No. 1