#62-F-227-C

W.P.# 179-61

HWY. #401 &

JONES CREEK

BRIDGE

DEPARTMENT OF HIGHWAYS ONTARIO

# MEMORANDUM

To: Mr. A. M. Toye,
Bridge Engineer,
Bridge Division.

Attention: Mr. S. McCombie.

From: Mr. A. G. Stermac,
Principal Foundation Engr.,
Foundation Section,
Materials & Research Division.

Date: January 7, 1963.

Our File Ref.

In reply to

Subject: FOUNDATION INVESTIGATION REPORT - BY
H. Q. Golder & Associates, Limited,
Proposed Jones Creek (East Branch)
Bridge, Highway 401 - Line 'G',
Gananoque, Ontario, District No. 8.
W.P. 179-61

Attached, we are forwarding to you the report for the above-mentioned site, submitted by the consultant, H. Q. Golder and Associates of Toronto.

We have reviewed the report and have found the factual data well presented and in general agreement with the recommendations contained in the report. However, it appears to us that providing the special tip for the H-piles, as recommended in the report, is not necessary, because driving of such piles, when they reach bedrock, requires special attention and has to be done very carefully. This special method or kind of piles would be warranted if the bedrock surface would be inclined in one direction and smooth at the same time. In such a case, the piles could, after reaching bedrock, slide along the surface and actually never achieve a solid grip or bearing.

In our case, the bedrock surface is irregular and if a pile slides a little, it will come to rest when it meets refusal a little deeper down. Because the bedrock surface or elevation was found to be irregular, the precise length of the piles cannot be determined in advance, and the design has to be therefore, flexible as suggested in the report.

If there are any queries in connection with this project, please feel free to contact our Office.

AGStermac
A. G. Stermac,
PRINCIPAL FOUNDATION ENGINEER

AGS/MdeF
Attach.
cc: Messrs. A. M. Toye (2)
H. A. Tregaskes
H. D. McMillan
J. Ford
E. A. Cash
J. E. Gruspier
T. J. Kovich
J. Roy
E. R. Saint
F. Norman
A. Watt
Foundations Office
Gen. Files.

D.H.O.
TORONTO
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BA 1564

# H. Q. GOLDER & ASSOCIATES LTD.

CONSULTING CIVIL ENGINEERS

H. Q. GOLDER
V. MILLIGAN
L. G. SODERMAN

2444 BLOOR STREET WEST
TORONTO 9, ONTARIO
767-9201
763-4103

REPORT

TO

DEPARTMENT OF HIGHWAYS, ONTARIO

ON

## SOIL CONDITIONS AND FOUNDATIONS
## PROPOSED JONES CREEK (EAST BRANCH) BRIDGE
## WP 179-61

GANANOQUE ONTARIO

Distribution:

15 copies - Department of Highways, Ontario, Toronto, Ontario.

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

December, 1962 6265

## ABSTRACT

The results of an investigation to determine the soil conditions at the site of the proposed crossing of Jones Creek (East Branch) on the proposed revision of Highway 401, Line G, near Gananoque, Ontario are reported and recommendations are given for the foundation design of the proposed structures and approach embankments.

The site is underlain by up to about 20 feet of silts and sands with some organic matter. This deposit is underlain by about 19 to 56 feet of soft to very stiff clayey silt containing layers of silty clay. The clayey silt either rests on bedrock or on compact to very dense silty sand and gravel which rests on bedrock.

The proposed structures may be founded on steel H piles end bearing on bedrock, as discussed in the report.

The approach embankments should be constructed with side slopes of 2 horizontal to 1 vertical.

Settlement of the proposed structures and approach embankments, if founded as recommended, should be minor.

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## INTRODUCTION

H. Q. Golder & Associates Ltd. were retained by the Department of Highways, Ontario by letter dated November 15, 1962 to carry out a soil investigation for the proposed Jones Creek (East Branch) bridge structures for proposed Highway 401, Line G, near Gananoque, Ontario.

The purpose of the investigation was to determine the soil conditions at the site and to make recommendations concerning the foundation design of the proposed structures and approach embankments.

## PROCEDURE

The field work was carried out between November 28, and December 18, 1962. In this period 6 borings, 5 of which had accompanying dynamic penetration tests and 6 additional dynamic penetration tests were put down by skid mounted machine drillrigs.

The locations of all borings and dynamic penetration tests put down during the investigation are shown on Figure 1 and sections of the inferred soil stratigraphy on Figures 2 and 3. Detailed logs of each boring and penetration test are given on the Records of Boreholes.

The soil samples obtained during the investigation were returned to our laboratory for examination and testing. The results of the laboratory testing are plotted on the Records of Boreholes and on the figures.

All borings were located with reference to the centreline of proposed Highway 401, Line G, as staked by others in the field. The borehole elevations were referred to a bench mark in the north root of a 3.2 feet twin Basswood 138 feet right of station 323+01 on the proposed revision of Highway 401, Line G. The elevation of the bench mark is given as 255.44, Geodetic, on Department of Highways, Ontario Plan E-4138-1, dated September, 1962.

## SITE TOPOGRAPHY AND GEOLOGY

The proposed site is located approximately 8 miles southwest of Brockville, Ontario within the physiographic region known as the "Leeds Knobs and Flats" (Chapman and Putman, 1951). This region consists primarily of scattered knobs of rock between which lie clay deposits laid down by the Champlain sea. The clay plains are typically gently undulating farmed land. The plain in which the site is located has been modified by the action of the East Branch of Jones Creek and has been a floodplain for the Creek.

Bedrock in this area consists of various types of altered sedimentary rocks, crystalline limestones and dolomites, gneisses and quartzites of the Grenville series of Precambrian Age, which are intruded, metamorphosed and deformed by bodies of granite, syenite and other igneous rocks (Wilson, 1946). The surface elevation of bedrock can vary appreciably within small areas.

## SOIL CONDITIONS

The site is covered by 1 to 2 feet of topsoil. Below this topsoil in boreholes 3, 4 and 5 was a stratum, up to about 5 feet in thickness, of mottled grey and brown clayey silt with some organic matter. One grain size distribution curve for this material is shown on Figure 4.

Underlying the clayey silt or the topsoil was a stratum of very loose to compact silts and sands with some organic matter mostly in the form of twigs. There were a few clayey silt or gravelly sand layers in this stratum. The maximum thickness of the stratum was about 16 feet in borehole 6. Eight grain size distribution curves obtained from samples of this material are shown on Figures 5 and 6.

A stratum of grey clayey silt, about 19 to 56 feet in thickness, was encountered below the silts and sands in all borings. Some layers of silty clay were noted in the clayey silt with increasing depth. The clay layers were, in many cases, fissured and the fissures formed "blocks" of clay typically 1/8 to 1/4 inches in size. The thickness of the clay layers was generally 1/4 to 1/2 inches but in a few cases was several inches.

The sensitivity to remoulding of the clayey strata, as measured by in situ vane shear tests, ranged from about 4 to 10. Examination of the samples recovered indicated that the silty clay layers were more sensitive to remoulding than the clayey silt. The Atterberg limits obtained from tests on the clayey silt and silty clay are summarized on the plasticity chart on Figure 8. The natural water content of the clayey silt generally was about and in some cases greater than the liquid limit.

Undrained triaxial compression tests were carried out on samples of the clayey stratum and the results are summarized on Figure 10 in a plot of undrained shear strength versus elevation, the shear strength being assumed to be half the compressive strength. Stress-strain curves for four of the triaxial compression tests are shown on Figure 9.

A stratum of compact to very dense silty sand and gravel with some boulders was encountered below the clayey stratum in boreholes 1, 2, 3, and 5 and was penetrated for a maximum depth of about 11 feet in borehole 2. Three grain size distribution curves obtained from samples of the material are shown on Figure 7.

Bedrock was encountered below the silty sand and gravel in borehole 3 and below the clayey strata in borehole 4 and was cored in AXT size in these borings. Bedrock is a hard, generally sound granitic type rock. One fissure was noted in the rock core recovered from borehole 4 about 2 feet below the rock surface.

WATER CONDITIONS

Piezometers or water level observation pipes were installed in all the boreholes at the site. Details of the installations are given on the Records of Boreholes. An artesian head of water up to about 4 feet above the present ground level was noted in the borings. The latest available water levels in the piezometers and observation pipes are given on the Records of Boreholes and on Figures 2 and 3.

## DISCUSSION

### General

It is proposed to span the proposed diversion of Jones Creek (East Branch) on the proposed revision of Highway 401, Line G, near Gananoque, Ontario by two bridge structures. Each bridge will have a single span of about 40 feet and will be at a skew angle of about 64 degrees to the centreline of the proposed revision of Highway 401, Line G. The proposed grade profile will necessitate approach embankments to the bridge structure up to about 14 feet in height above the existing ground level.

### Foundation Design

In view of the loose heterogeneous nature and low bearing capacity of the upper organic silts and sands at the site the proposed structures will have to be founded either in the clayey silt stratum or on bedrock. Spread footings in the clayey silt stratum would have to be founded at least 5 feet below the surface of the stratum; this would necessitate excavations as deep as 24 feet below the present ground level. Because of the relatively deep excavations required and because the possibility that the shear strength of the clayey silt could vary erratically, as shown on Figure 10 (elevation 215 to 230), we recommend that the foundations for the proposed structures be carried down to bedrock. Piles end bearing on rock would be the most suitable type of foundation. It should be noted that the upper surface of bedrock is very irregular and probably has some near vertical faces, such as those exposed at several localities close to the site. Pile lengths would vary from about 20 feet to greater than 70 feet. For this reason, we suggest that 12 inch x 53 pound steel H piles be used to support the proposed structures, as these piles can be readily altered in length at the site. It is further suggested that special reinforced tips be provided for the H piles in order that they may "bite" into any sloping rock surfaces to prevent possible slipping of the pile tip on the rock (Bjerrum, 1957). The H piles should be driven to a set of at least 12 blows per inch with a hammer of about 20,000 ft. lb. energy. A design load of 60 to 70 tons may be used for such piles if the tips are reinforced as suggested.

Pile caps should be founded at least 5 feet below the proposed bottom of Jones Creek (East Branch) diversion to avoid possible scour. As the ground water level is close to ground surface the excavations for the pile caps should be carried out inside steel sheet piling which is driven at least 5 feet into the clayey silt stratum to prevent instability of the excavations.

Settlement of the structures, if founded as recommended above, will be negligible.

Free draining granular backfill should be placed behind the proposed abutments. This backfill should extend at least 4 feet horizontally away from the abutment walls and have provision for drainage to ensure that no excess hydrostatic or ice pressures build up behind the walls. In the design of the abutments it is recommended that an earth pressure coefficient, K, of 0.3 be used, provided that some minor movement of the top of the abutment can be accommodated.

The approach embankments to the proposed bridge structures will have a height of about 11 feet above the existing ground level at the proposed bridge abutments. The embankments will have a maximum height of about 14 feet above ground level at station 319+00 on proposed Highway 401, Line G.

The embankments may be constructed of well compacted granular borrow or rockfill. The side slopes of the embankments should not exceed 2 horizontal to 1 vertical to ensure the overall and surficial stability of the embankments. All topsoil should be removed prior to construction of the embankments.

The embankments will settle due to consolidation of the subsoil under the additional weight of the fill. The portion of the settlement contributed by compression of the upper silts and sands is estimated to be about 3 to 4 inches; this should largely take place during construction. To estimate the probable settlement due to consolidation of the clayey strata, a consolidation test was carried out on a sample of a silty clay layer in this material. The results of this test are given on Figure 11. Based on this and assuming that the clayey silt stratum is largely over-consolidated we estimate that the probable settlement below the centre of a low embankment about 14 feet in height above the existing ground level due to consolidation of the clayey strata should be about 1 to 2 inches. The major portion of this settlement should occur in the first 6 to 12 months after construction.

N. R. McCammon

N. R. McCammon, P. Eng.

NMc/jb
6265

V. Milligan

December, 1962

V. Milligan, P. Eng.

# REFERENCES

BJERRUM, L., "Norwegian Experiences with Steel Piles to Rock", Geotechnique, Vol. VII, London, 1957.

CHAPMAN, L.J., AND PUTMAN, D.F., "The Physiography of Southern Ontario", University of Toronto Press, 1951.

WILSON, A.E., "Geology of the Ottawa - St. Lawrence Lowland, Ontario and Quebec", Geological Survey Memoir No. 241, Canada Department of Mines and Resources, Ottawa, 1946.

# LIST OF STANDARD 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
C.S. – Chunk Sample
D.O. – Drive Open
D.S. – Denison Type Sample
F.S. – Foil Sample
R.C. – Rock Core
S.T. – Slotted Tube
T.O. – Thin-walled, Open
T.P. – Thin-walled, Piston
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 4,200 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.

Sampler advanced by static weight – weight, hammer – Wh
Sampler advanced by pressure – pressure, hydraulic – Ph
Sampler advanced by pressure – pressure, manual – Pm

## SOIL DESCRIPTION

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

| Relative Density | N, Blows/ft. |
|---|---|
| Very Loose | 0 to 4 |
| Loose | 4 to 10 |
| Compact | 10 to 30 |
| Dense | 30 to 50 |
| Very Dense | over 50 |

| Consistency | c, lb/sq. ft. |
|---|---|
| Very Soft | Less than 250 |
| Soft | 250 to 500 |
| Firm | 500 to 1,000 |
| Stiff | 1,000 to 2,000 |
| Very Stiff | 2,000 to 4,000 |
| Hard | over 4,000 |

## SOIL TESTS

C – Consolidation Test
H – Hydrometer Analysis
M – Sieve Analysis
MH – Combined Analysis, Sieve and Hydrometer
Q – Undrained Triaxial
Qc – Consolidated Undrained Triaxial
S – Drained Triaxial
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

$\gamma$ – Total Unit Weight
$\gamma_d$ – Dry Unit Weight
$\gamma_b$ – Submerged Unit Weight
$L_L$ – Liquid Limit
$P_L$ – Plastic Limit
W – Natural Water Content
G – Specific Gravity
e – Void Ratio
K – Coefficient of Permeability
c – Undrained Shear Strength (½ Compressive Strength)
St – Sensitivity
Ø' – Effective Angle of Shearing Resistance
c' – Effective Cohesion Intercept
Cc – Compression Index
Cv – Coefficient of Consolidation

PROJECT No. 6265

# RECORD OF BOREHOLE 1

**LOCATION** SEE FIGURE 1 **BORING DATE** NOV. 28 - 29, 1962 **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**

| ELEVN. / DEPTH | DESCRIPTION | SAMPLE NUMBER | TYPE | BLOWS / FT. |
|---|---|---|---|---|
| 252.4 | GROUND LEVEL | | | |
| 0.0 | TOPSOIL | | | |
| 2.0 | LOOSE TO COMPACT BROWN TO GREY SILTY FINE SAND | 1 | 2" DO | 16 |
| | | 2 | " | 4 |
| 246.4 / 6.0 | FIRM GREY CLAYEY SILT TO SILTY CLAY | 3 | " | 4 |
| | | 4 | 2" TO | Pm |
| | | 5 | 2" DO | 2 |
| | | 6 | 2" TO | Pm |
| | | 7 | " | Pm |
| 227.4 | | 8 | 2" DO | 3 |
| 225.5 | SILTY SAND & GRAVEL | 9 | WS | - |
| 26.9 | END OF HOLE REFUSAL, PROBABLY BOULDER OR BEDROCK | | | |

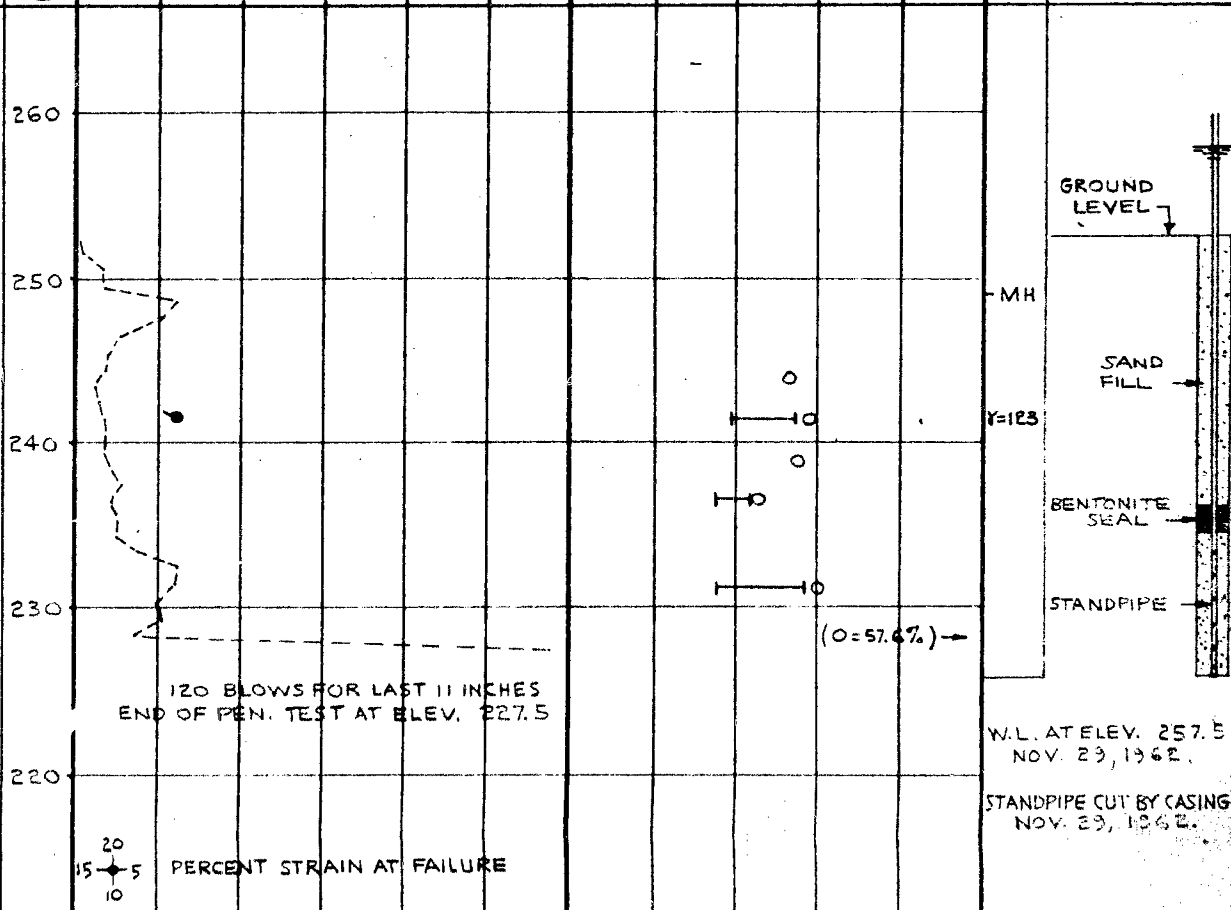
DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT ---- 20 40 60 80 100

SHEAR STRENGTH C, LB. / SQ.FT. ●-Q. 500 1000 1500 2000 2500

LIQUID LIMIT $L_L$ PLASTIC LIMIT $P_L$ WATER CONTENT W

WATER CONTENT, PER CENT 10 20 30 40

LAB. TESTING — STANDPIPE INSTALLATION




W.L. AT ELEV. 257.5 NOV. 29, 1962.

STANDPIPE CUT BY CASING NOV. 29, 1962.

VERTICAL SCALE 1 INCH TO 10'-0"

GOLDER & ASSOCIATES

DRAWN M.W.

CHECKED

PROJECT No. [illegible]

# RECORD OF BOREHOLE 2

LOCATION SEE FIGURE 1 BORING DATE NOV. 30-DEC. 2, 1962 DATUM GEODETIC

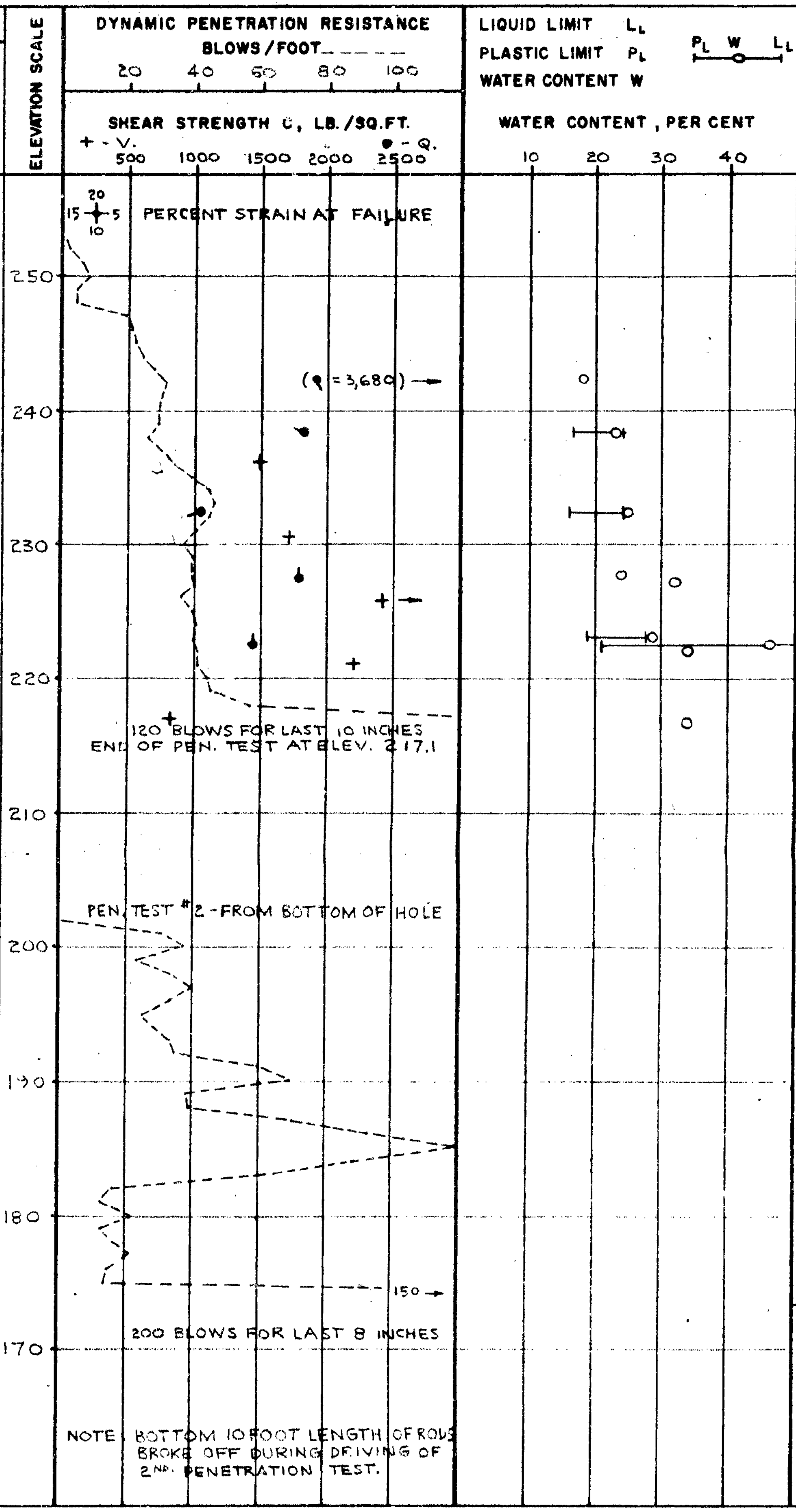
BOREHOLE TYPE WASH BORING BOREHOLE DIAMETER BX & NX CASING

SAMPLER HAMMER WEIGHT 140 LB. DROP 30 INCHES PEN. TEST HAMMER WEIGHT 140 LB. DROP 30 INCHES

## SOIL PROFILE / SAMPLES

| ELEVN. / DEPTH | DESCRIPTION | NUMBER | TYPE | BLOWS / FT. |
|---|---|---|---|---|
| 253.0 | GROUND LEVEL | | | |
| 0.0 | TOPSOIL | | | |
| 2.0 | LOOSE TO COMPACT SILTY SAND, SOME STRATIFICATION | 1 | 2" DO | 5 |
| | | 2 | " | 24 |
| 244.5 / 8.5 | STIFF TO VERY STIFF GREY CLAYEY SILT SOME ~~SILTY~~ CLAY & SANDY SILT LAYERS BELOW ELEV. 230± | 3 | 2" TO | 13 |
| | | 4 | " | Pm |
| | | 5 | " | Pm |
| | | 6 | " | Pm |
| | | 7 | " | Pm |
| | | 8 | 2" DO | 2 |
| 213.0 / 40.0 | COMPACT TO DENSE GREY SILTY SAND & GRAVEL | 9 | 2" TO | 10 |
| | | 10 | 2" DO | 32 |
| | | 11 | " | 17 |
| 202.0 / 51.0 | END OF HOLE | 12 | " | 11 |
| 173.3 / 79.7 | END OF PEN. TEST 2 | | | |

NOTE: BOREHOLE STOPPED AT EL. 202 DUE TO THE CASING BENDING. DYNAMIC PENETRATION TEST CARRIED OUT BELOW ELEV. 202.




## LAB. TESTING

MH

γ=133

γ=128

γ=125

γ=125

γ=120

C

MH

MH

## STANDPIPE INSTALLATION

GROUND LEVEL

SEAL

SAND FILL

STANDPIPE

W.L. IN STANDPIPE AT ELEV. 254.7 DEC. 18, 1962

VERTICAL SCALE 1 INCH TO 10'-0"

GOLDER & ASSOCIATES

DRAWN M.W.

CHECKED [illegible]

PROJECT No. 6265

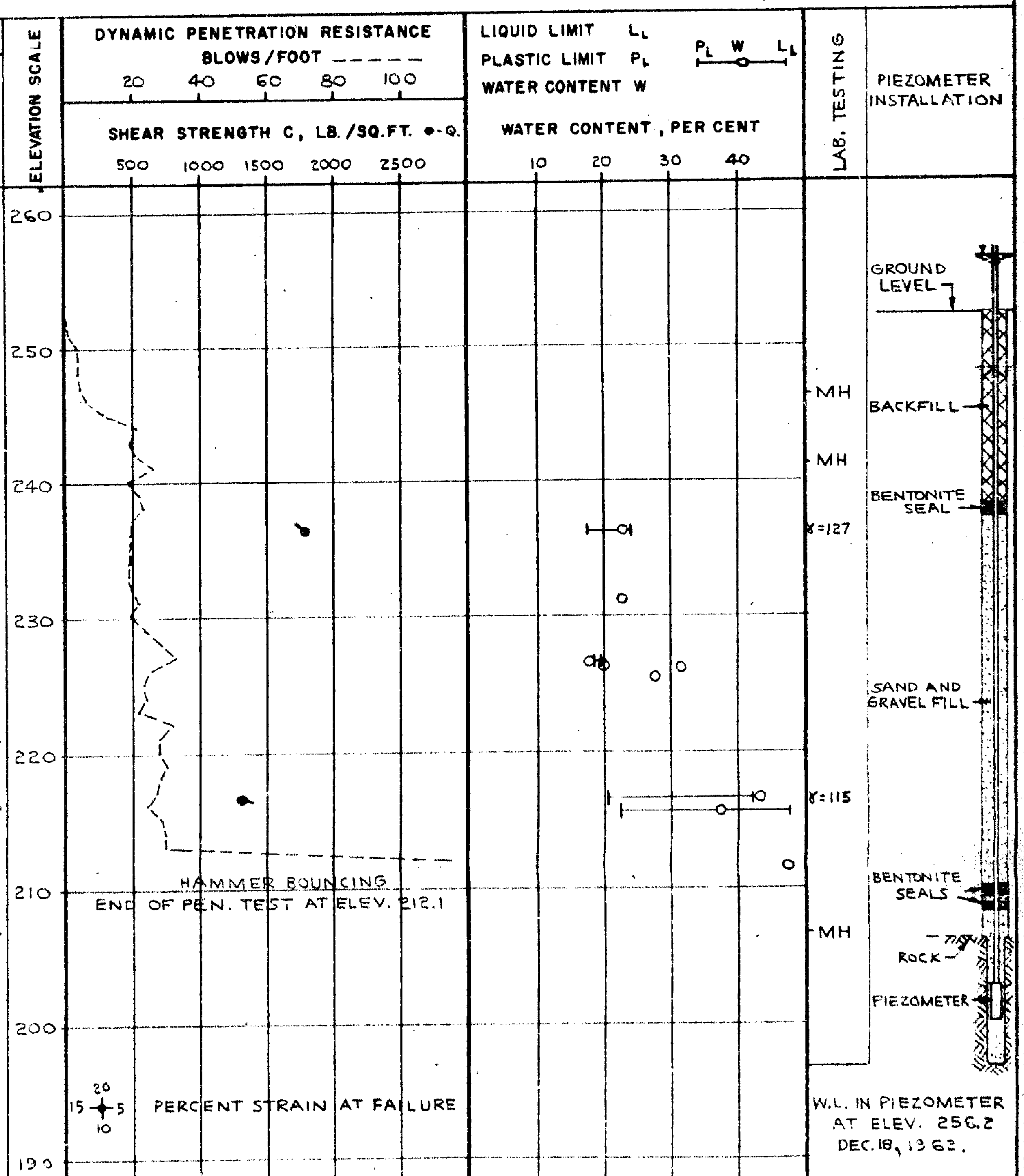
# RECORD OF BOREHOLE 3

**LOCATION** SEE FIGURE 1 **BORING DATE** DEC. 4-7, 1962 **DATUM** GEODETIC

**BOREHOLE TYPE** WASH BORING **BOREHOLE DIAMETER** NX & BX CASING

**SAMPLER HAMMER WEIGHT** 140 LB. **DROP** 30 **INCHES** **PEN. TEST HAMMER WEIGHT** 140 LB. **DROP** 30 **INCHES**

| ELEVN. / DEPTH | SOIL PROFILE – DESCRIPTION | SAMPLES – NUMBER | TYPE | BLOWS / FT. |
|---|---|---|---|---|
| 252.1 | GROUND LEVEL | | | |
| 0.0 | TOPSOIL | | | |
| 1.5 | FIRM MOTTLED GREY AND BROWN CLAYEY SILT SOME ORGANIC MATTER | 1 | 2" DO | 8 |
| 247.3 / 4.8 | VERY LOOSE STRATIFIED SILTY SAND & GRAVEL | 2 | " | 2 |
| 245.1 / 7.0 | LOOSE TO COMPACT GREY FINE SANDY SILT | 3 | " | 10 |
| 240.1 / 12.0 | STIFF GREY CLAYEY SILT OCCASIONAL SILTY CLAY & SANDY SILT LAYERS. LAYERING MORE MARKED BELOW ELEV. 230± | 4 | 2" TO | Pm |
| | | 5 | " | Pm |
| | | 6 | " | Pm |
| | | 7 | " | Pm |
| | | 8 | " | Pm |
| | | 9 | 2" DO | 5 |
| | VERY DENSE SILTY SAND AND GRAVEL | 10 | " | 87 |
| 207.1 / 45.0 / 46.0 | HARD GENERALLY SOUND PINK GRANITIC TYPE ROCK (BEDROCK) | 11 | AXT RC | - |
| | | 12 | " | - |
| 196.6 / 55.5 | END OF HOLE | | | |




VERTICAL SCALE
1 INCH TO 10'-0"

GOLDER & ASSOCIATES

DRAWN M.W.
CHECKED [illegible]

PROJECT No. 6365

# RECORD OF BOREHOLE 4

LOCATION SEE FIGURE 1 BORING DATE DEC. 7-10, 1962 DATUM GEODETIC

BOREHOLE TYPE WASH BORING BOREHOLE DIAMETER BX & NX CASING

SAMPLER HAMMER WEIGHT 140 LB. DROP 30 INCHES PEN. TEST HAMMER WEIGHT — LB. DROP — INCHES

| ELEVN. / DEPTH | DESCRIPTION | SAMPLE NUMBER | TYPE | BLOWS / FT. | LAB. TESTING |
|---|---|---|---|---|---|
| 252.6 | GROUND LEVEL | | | | |
| 0.0 | TOPSOIL | | | | |
| 2.0 / 246.3 | SOFT TO FIRM MOTTLED BROWN AND GREY CLAYEY SILT, SOME ORGANIC MATTER | 1 | 2" DO | 7 | MH |
| | | 2 | " | 3 | |
| 6.3 / 238.1 | SOFT GREY-BROWN SILT TO SANDY SILT WITH SOME ORGANIC MATTER | 3 | " | 3 | |
| 14.5 / 219.1 | SOFT TO VERY STIFF GREY CLAYEY SILT SOME SILTY CLAY LAYERS BELOW ELEV. 223 | 4 | " | 6 | |
| | | 5 | 2" TO | Pm | γ=128 |
| | | 6 | " | Pm | |
| | | 7 | " | Pm | |
| 33.5 / 209.1 | HARD GENERALLY SOUND PINK GRANITIC TYPE ROCK ONE FISSURE AT ELEV. 217 (BEDROCK) | 8 | AXT RC | - | |
| | | 9 | " | - | |
| 43.5 | END OF HOLE | | | | |

DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT

SHEAR STRENGTH C, LB./SQ.FT. ●-Q. (500, 1000, 1500, 2000, 2500)

(● = 3,980)

LIQUID LIMIT $L_L$ PLASTIC LIMIT $P_L$ WATER CONTENT W

WATER CONTENT, PER CENT (10, 20, 30, 40)

(NON PLASTIC)

ELEVATION SCALE: 260, 250, 240, 230, 220, 210, 200

20 / 15 – 5 / 10 PERCENT STRAIN AT FAILURE

PIEZOMETER INSTALLATION: GROUND LEVEL; SEAL; BACKFILL; BENTONITE & CEMENT SEAL; SAND FILL; BENTONITE & CEMENT SEAL; ROCK; PIEZOMETER

W.L. IN PIEZOMETER AT ELEV. 256.1 DEC. 18, 1962

VERTICAL SCALE 1 INCH TO 10'-0"

GOLDER & ASSOCIATES

DRAWN M.W.

CHECKED M.H.B.

PROJECT No. 6265

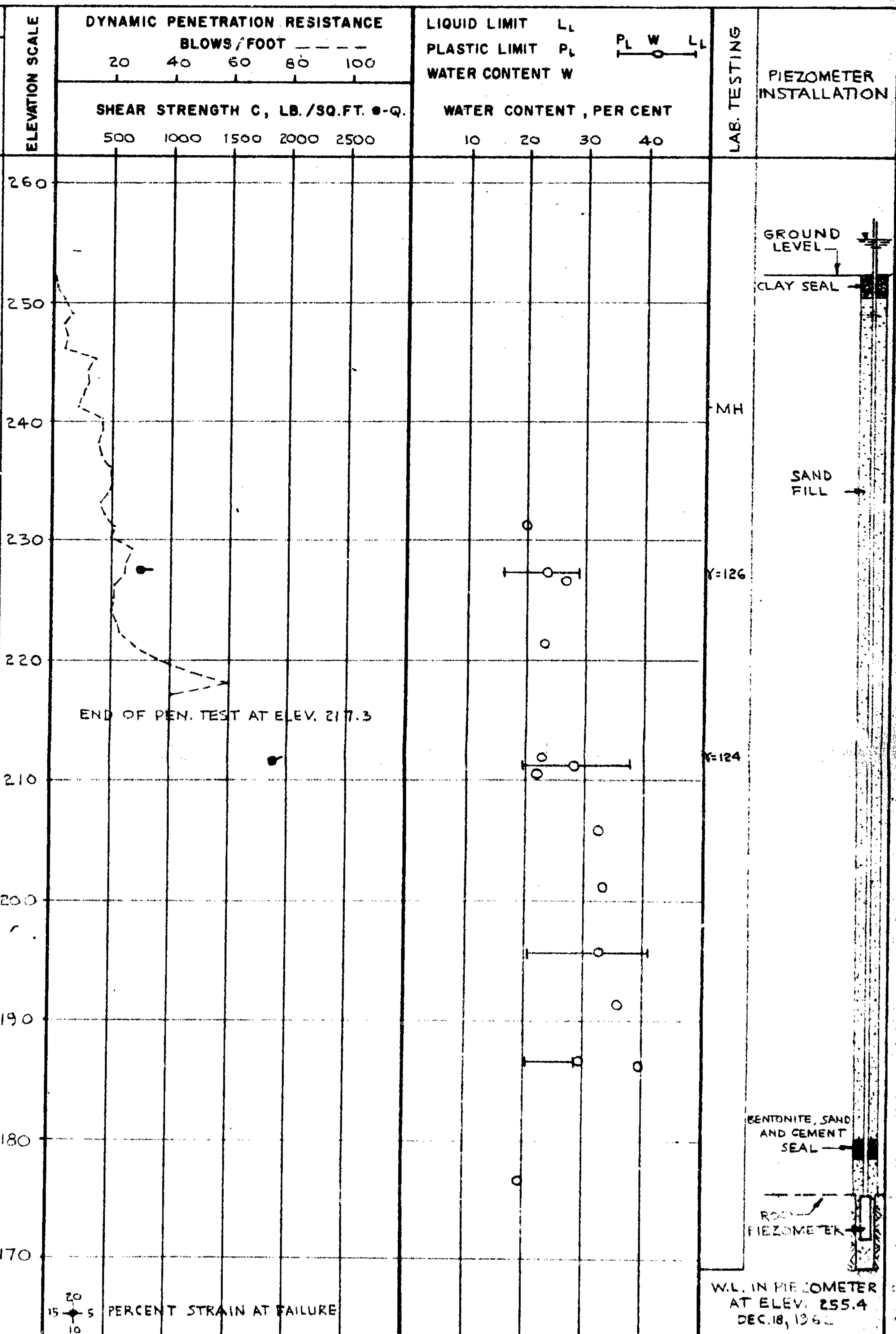
# RECORD OF BOREHOLE 5

LOCATION SEE FIGURE I BORING DATE DEC. 11-12, 1962 DATUM GEODETIC

BOREHOLE TYPE WASH BORING BOREHOLE DIAMETER BX & NX CASING

SAMPLER HAMMER WEIGHT 140 LB. DROP 30 INCHES PEN. TEST HAMMER WEIGHT 140 LB. DROP 30 INCHES

| ELEVN. / DEPTH | DESCRIPTION (SOIL PROFILE) | SAMPLE NUMBER | TYPE | BLOWS / FT. |
|---|---|---|---|---|
| 252.3 | GROUND LEVEL | | | |
| 0.0 | TOPSOIL | | | |
| 1.5 | SOFT MOTTLED BROWN AND GREY **CLAYEY SILT**, SOME SAND | 1 | 2" DO | 6 |
| | | 2 | " | 4 |
| 245.9 / 6.4 | LOOSE GREY **SILTY SAND** SOME ORGANIC MATTER SOME CLAYEY SILT LAYERS | 3 | " | 5 |
| | | 4 | " | 9 |
| | | 5 | " | 10 |
| 232.3 / 20.0 | FIRM TO STIFF GREY **CLAYEY SILT** SOME SILTY CLAY LAYERS BELOW ELEV. 215. FEW HAIR THIN LAYERS OF FINE SAND | 6 | 2" TO | Pm |
| | | 7 | 2" DO | 22 |
| | | 8 | 2" TO | Pm |
| | | 9 | " | Pm |
| | | 10 | " | Pm |
| | | 11 | 2" DO | 15 |
| | | 12 | 2" TO | Pm |
| | | 13 | 2" DO | 13 |
| | | 14 | 2" TO | Pm |
| | | 15 | " | Pm |
| 176.1 / 76.2 | HARD SOUND GREY **ROCK** (PROBABLY CRYSTALLINE LIMESTONE) (BOULDER OR JUT OUT FROM VERTICAL BEDROCK FACE.) | | | |
| 78.0 | PROBABLY **GRAVEL** | 16 | AXT RC | - |
| | | 17 | " | - |
| 169.3 / 83.0 | END OF HOLE | | | |




VERTICAL SCALE 1 INCH TO 10'-0"

GOLDER & ASSOCIATES

DRAWN M.W.

CHECKED [illegible]

PROJECT No. 6365

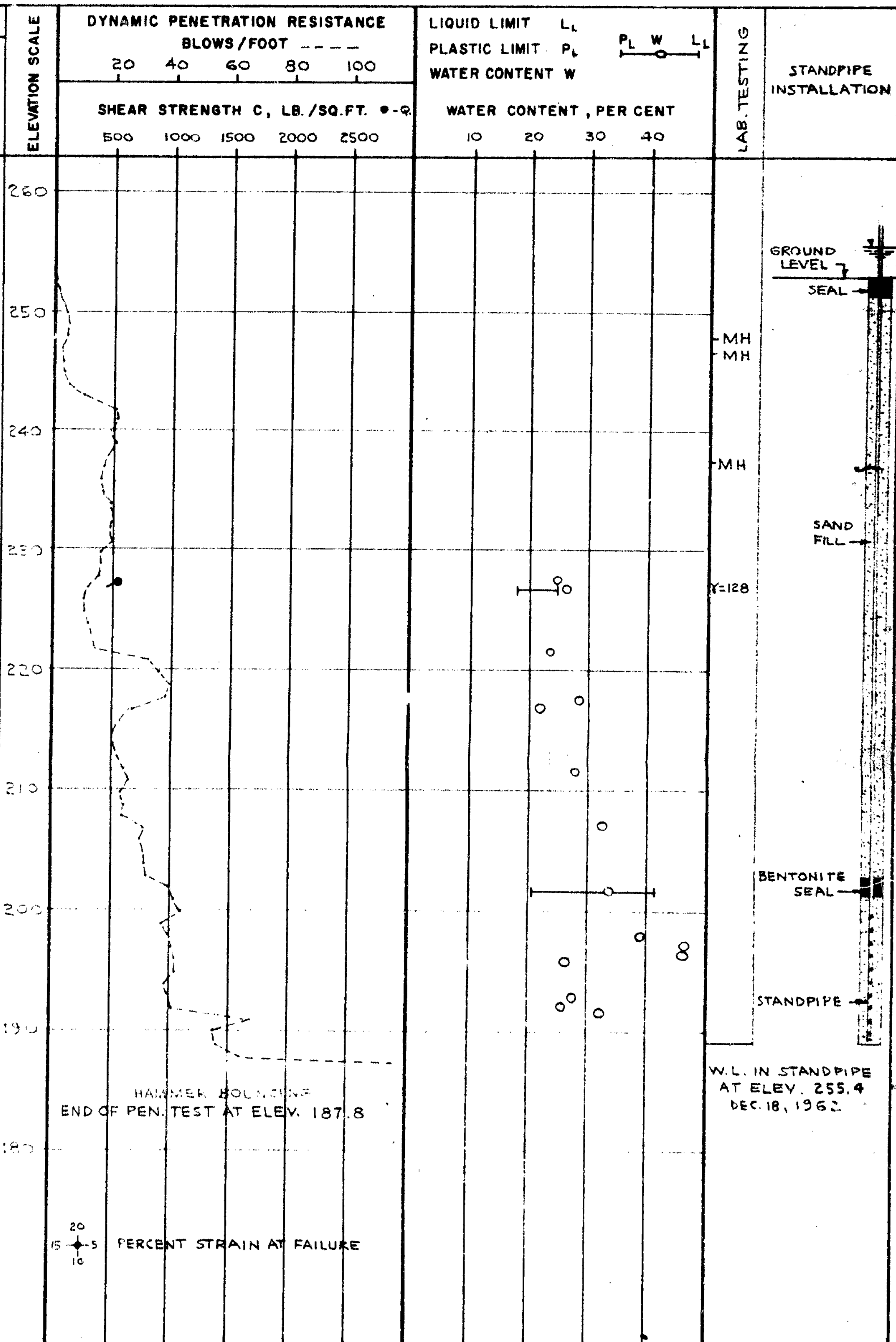
# RECORD OF BOREHOLE 6

LOCATION SEE FIGURE 1 | BORING DATE DEC. 13-14, 1962 | 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

| ELEVN. / DEPTH | SOIL PROFILE – DESCRIPTION | SAMPLE NUMBER | TYPE | BLOWS / FT. |
|---|---|---|---|---|
| 252.9 | GROUND LEVEL | | | |
| 0.0 | **TOPSOIL** | | | |
| 2.3 | VERY LOOSE TO COMPACT MOTTLED BROWN AND GREY TO GREY **SAND**, TRACE SILT OCCASIONAL PIECES SUBANGULAR GRAVEL SOME TWIGS AND ORGANIC MATERIAL | 1 | 2" DO | 6 |
| | | 2 | " | 2 |
| | | 3 | " | 20 |
| | | 4 | " | 11 |
| 234.4 / 18.5 | SOFT TO FIRM GREY **CLAYEY SILT** SOME SILTY CLAY LAYERS BELOW ELEV. 210± . | 5 | " | 8 |
| | | 6 | 2" TO | Pm |
| | | 7 | 2" DO | 7 |
| | | 8 | 2" TO | Pm |
| | | 9 | 2" DO | 9 |
| | | 10 | 2" TO | Pm |
| | | 11 | 2" DO | 8 |
| | | 12 | 2" TO | Pm |
| | | 13 | 2" DO | 8 |
| 189.1 / 63.8 | END OF HOLE. REFUSAL, PROBABLY BOULDER OR BEDROCK | | | |




W.L. IN STANDPIPE AT ELEV. 255.4 DEC. 18, 1962

VERTICAL SCALE
1 INCH TO 10'-0"

GOLDER & ASSOCIATES

DRAWN M.W.
CHECKED M.W.E.

PROJECT No. 6265

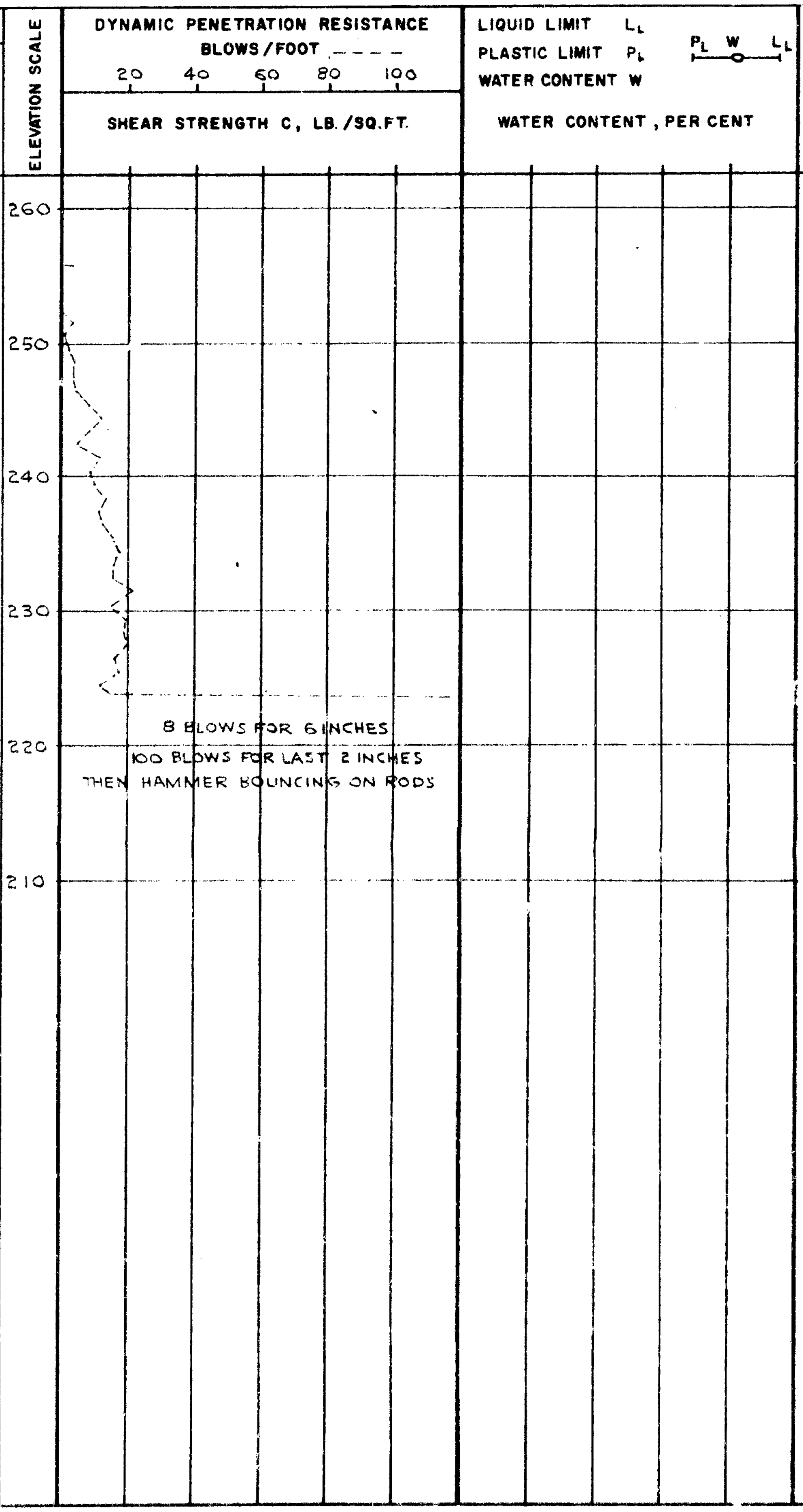
# RECORD OF BOREHOLE 7

LOCATION SEE FIGURE 1 BORING DATE DEC. 13, 1962 DATUM GEODETIC

BOREHOLE TYPE PENETRATION TEST BOREHOLE DIAMETER —

SAMPLER HAMMER WEIGHT — LB. DROP — INCHES PEN. TEST HAMMER WEIGHT 140 LB. DROP 30 INCHES

| ELEVN. / DEPTH | SOIL PROFILE DESCRIPTION | STRAT. PLOT | SAMPLES NUMBER | TYPE | BLOWS / FT. |
|---|---|---|---|---|---|
| 252.5 | GROUND LEVEL | | | | |
| 0.0 | DYNAMIC PENETRATION TEST ONLY - NO SAMPLES TAKEN | | | | |
| 223.8 / 28.7 | END OF PEN. TEST | | | | |
| | PROBABLY BOULDER OR BEDROCK | | | | |




VERTICAL SCALE
1 INCH TO 10'-0"

GOLDER & ASSOCIATES

DRAWN M.W.
CHECKED [illegible]

PROJECT No. 6265

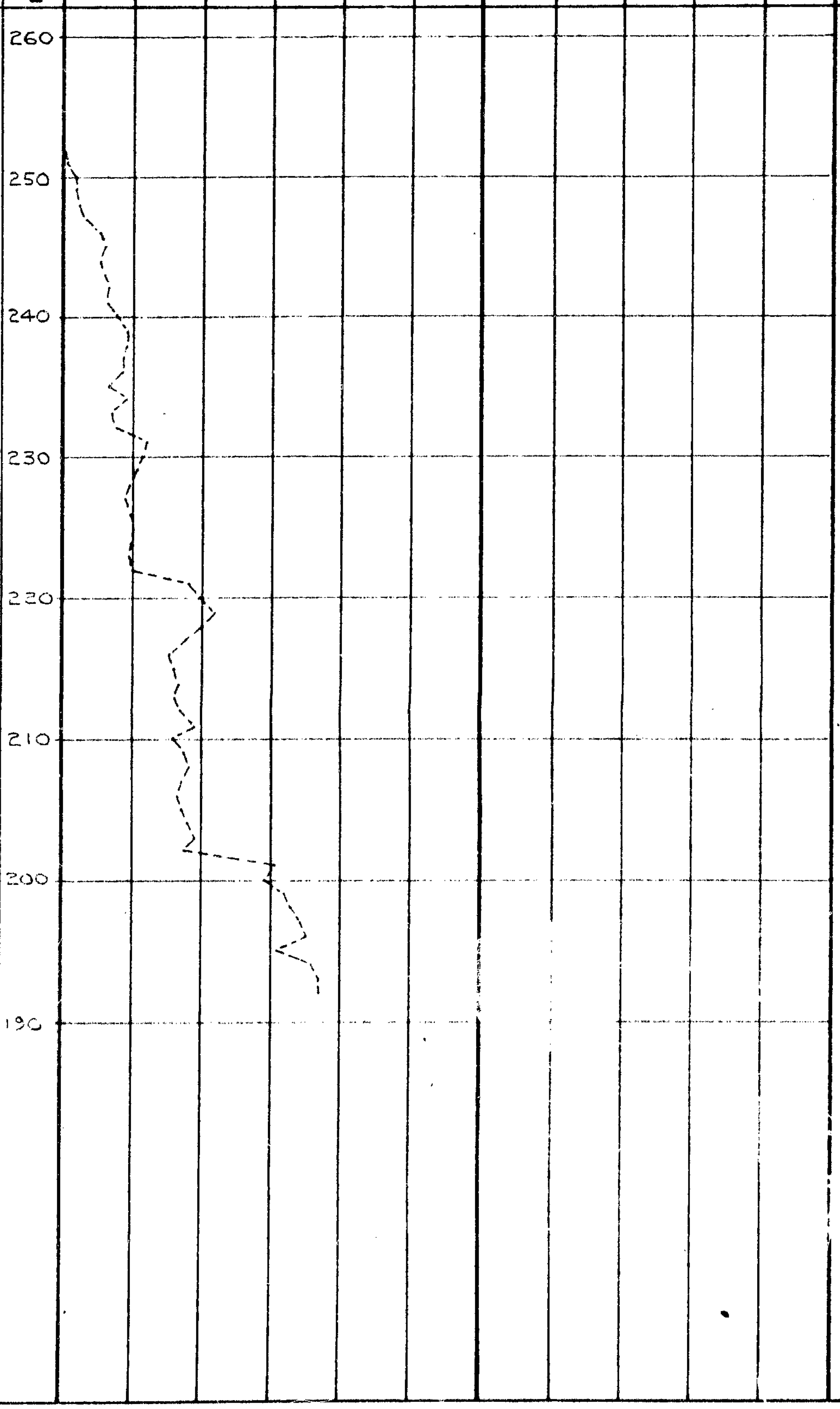
# RECORD OF BOREHOLE 8

**LOCATION** SEE FIGURE 1 **BORING DATE** DEC. 12, 1962 **DATUM** GEODETIC

**BOREHOLE TYPE** PENETRATION TEST **BOREHOLE DIAMETER** —

**SAMPLER HAMMER WEIGHT** — **LB. DROP** — **INCHES** **PEN. TEST HAMMER WEIGHT** 140 **LB. DROP** 30 **INCHES**

| SOIL PROFILE | | | SAMPLES | | | ELEVATION SCALE | DYNAMIC PENETRATION RESISTANCE BLOWS/FOOT ----- (20, 40, 60, 80, 100) / SHEAR STRENGTH C, LB./SQ.FT. | LIQUID LIMIT $L_L$ / PLASTIC LIMIT $P_L$ / WATER CONTENT W / WATER CONTENT, PER CENT |
|---|---|---|---|---|---|---|---|---|
| ELEVN. DEPTH | DESCRIPTION | STRAT. PLOT | NUMBER | TYPE | BLOWS / FT. | | | |
| 252.0<br>0.0 | GROUND LEVEL | | | | | | | |
| | DYNAMIC PENETRATION TEST ONLY- NO SAMPLES TAKEN | | | | | | | |
| 192.0<br>60.0 | END OF PEN. TEST<br>PROBABLY NOT ON BOULDER OR BEDROCK | | | | | | | |




VERTICAL SCALE
1 INCH TO 10'-0"

GOLDER & ASSOCIATES

DRAWN M.W.
CHECKED M.W.

PROJECT No. 6265

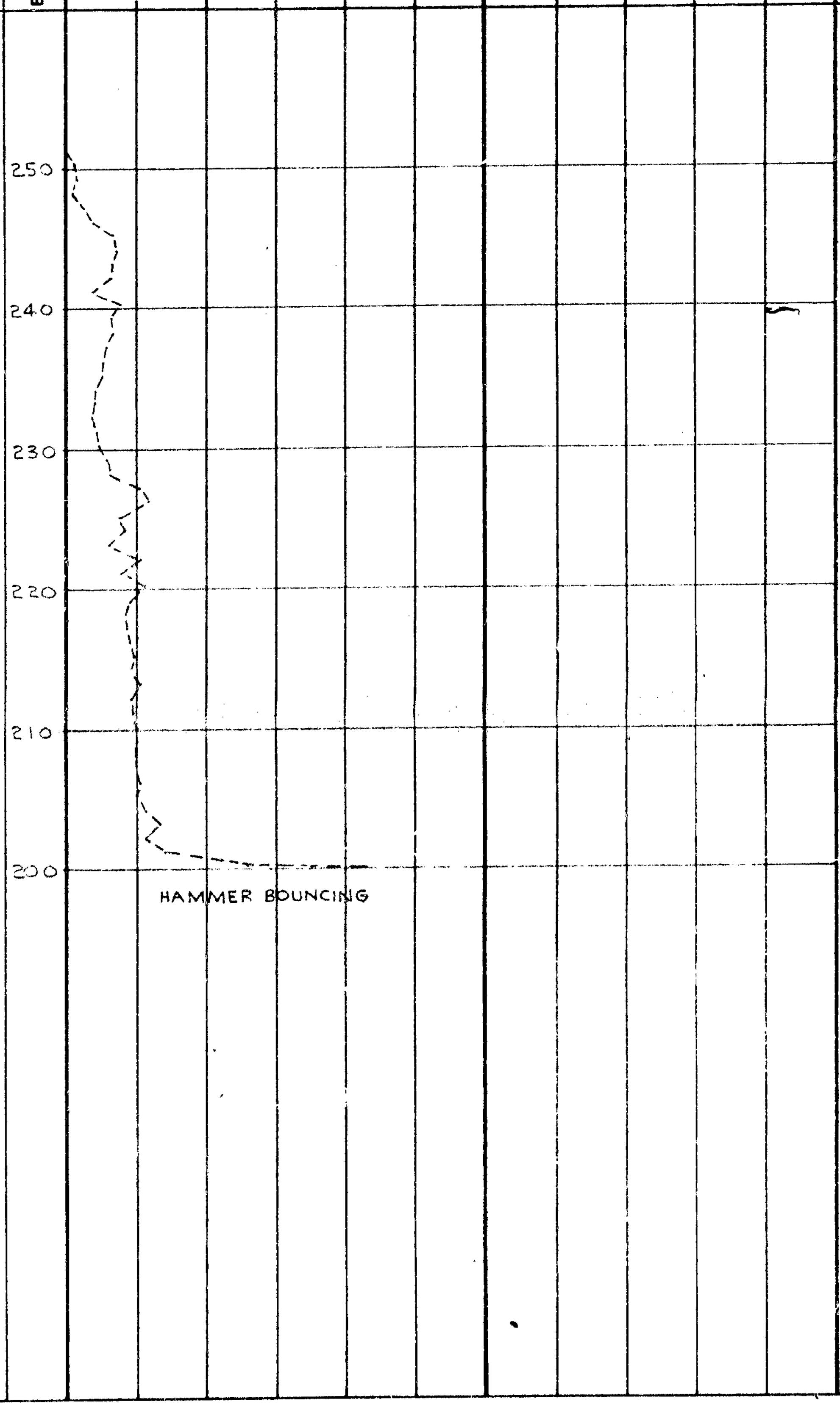
# RECORD OF BOREHOLE 9

LOCATION SEE FIGURE 1  BORING DATE DEC. 13, 1962  DATUM GEODETIC

BOREHOLE TYPE PENETRATION TEST  BOREHOLE DIAMETER —

SAMPLER HAMMER WEIGHT — LB. DROP — INCHES  PEN. TEST HAMMER WEIGHT 140 LB. DROP 30 INCHES

| SOIL PROFILE | | | SAMPLES | | | | DYNAMIC PENETRATION RESISTANCE BLOWS/FOOT - - - - 20 40 60 80 100 / SHEAR STRENGTH C, LB./SQ.FT. | LIQUID LIMIT $L_L$ PLASTIC LIMIT $P_L$ WATER CONTENT W / WATER CONTENT, PER CENT |
|---|---|---|---|---|---|---|---|---|
| ELEVN. / DEPTH | DESCRIPTION | STRAT. PLOT | NUMBER | TYPE | BLOWS / FT. | ELEVATION SCALE | | |
| 251.2 / 0.0 | GROUND LEVEL | | | | | 250 | | |
| | DYNAMIC PENETRATION TEST ONLY - NO SAMPLES TAKEN | | | | | 240, 230, 220, 210 | | |
| 200.2 / 51.0 | END OF PEN. TEST — PROBABLY BOULDER OR BEDROCK | | | | | 200 | HAMMER BOUNCING | |




VERTICAL SCALE
1 INCH TO 10'-0"

GOLDER & ASSOCIATES

DRAWN M.W.
CHECKED [illegible]

PROJECT No. 6265

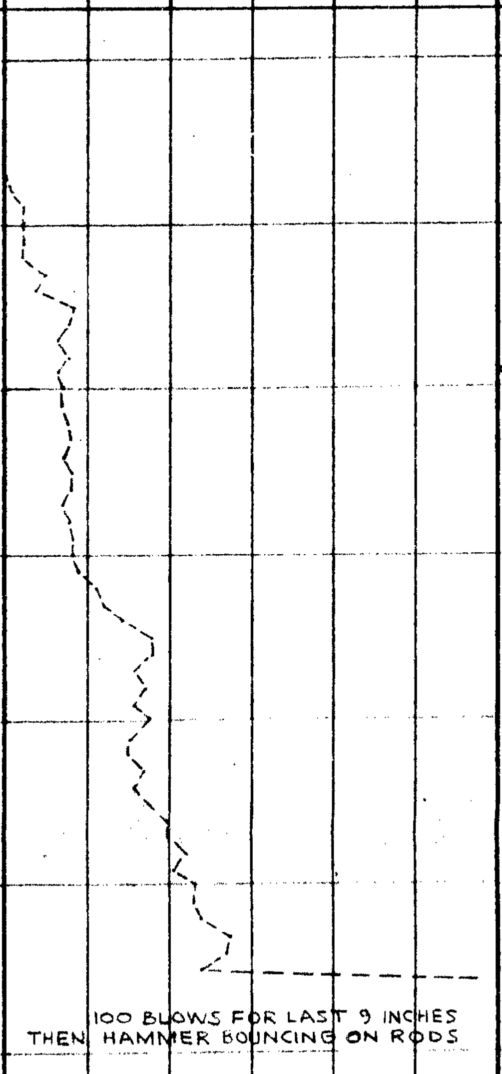
# RECORD OF BOREHOLE 10

LOCATION SEE FIGURE 1 BORING DATE DEC. 12, 1962 DATUM GEODETIC

BOREHOLE TYPE PENETRATION TEST BOREHOLE DIAMETER —

SAMPLER HAMMER WEIGHT — LB. DROP — INCHES PEN. TEST HAMMER WEIGHT 140 LB. DROP 30 INCHES

| SOIL PROFILE | | | SAMPLES | | | ELEVATION SCALE | DYNAMIC PENETRATION RESISTANCE BLOWS/FOOT (20, 40, 60, 80, 100) / SHEAR STRENGTH C, LB./SQ.FT. | LIQUID LIMIT $L_L$, PLASTIC LIMIT $P_L$, WATER CONTENT W / WATER CONTENT, PER CENT |
|---|---|---|---|---|---|---|---|---|
| ELEVN. DEPTH | DESCRIPTION | STRAT. PLOT | NUMBER | TYPE | BLOWS / FT. | | | |
| | | | | | | 260 | | |
| 252.9 / 0.0 | GROUND LEVEL | | | | | 250 | | |
| | | | | | | 240 | | |
| | DYNAMIC PENETRATION TEST ONLY - NO SAMPLES TAKEN | | | | | 230 | | |
| | | | | | | 220 | | |
| | | | | | | 210 | | |
| 204.1 / 48.8 | END OF PEN. TEST / PROBABLY BOULDER OR BEDROCK | | | | | 200 | | |




VERTICAL SCALE
1 INCH TO 10'-0"

GOLDER & ASSOCIATES

DRAWN M.W.
CHECKED [illegible]

PROJECT No. 6265

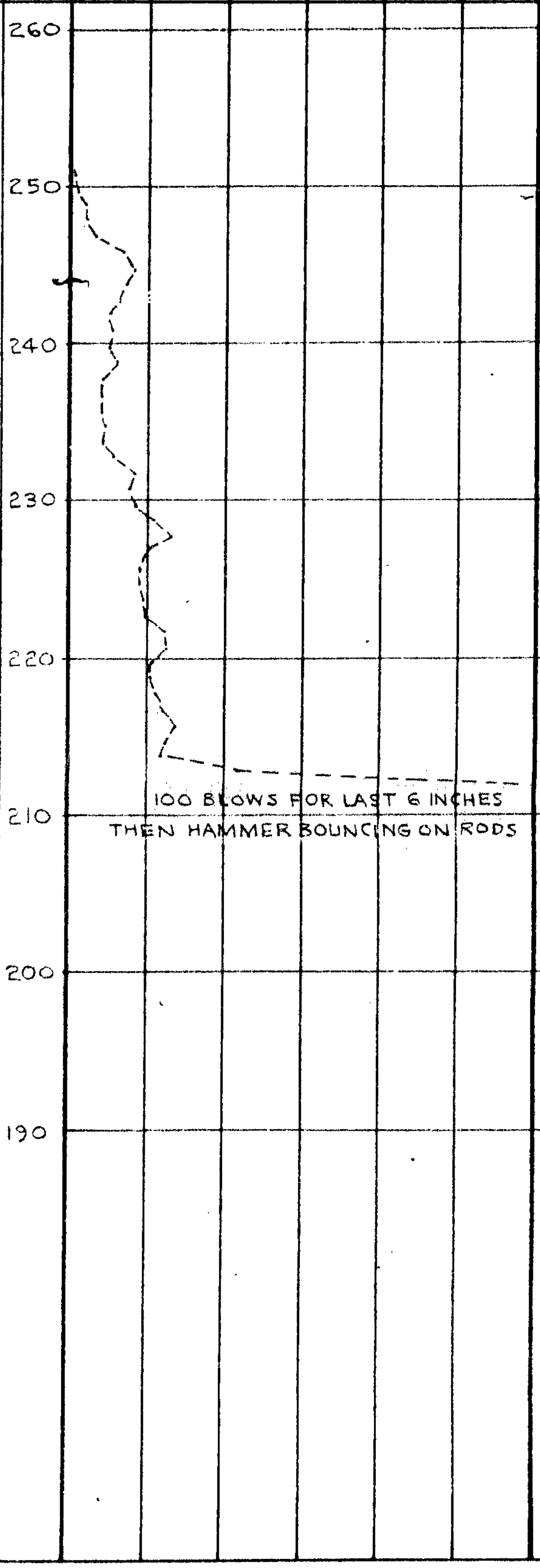
# RECORD OF BOREHOLE 11

LOCATION SEE FIGURE 1 BORING DATE DEC. 12, 1962 DATUM GEODETIC

BOREHOLE TYPE PENETRATION TEST BOREHOLE DIAMETER –

SAMPLER HAMMER WEIGHT – LB. DROP – INCHES PEN. TEST HAMMER WEIGHT 140 LB. DROP 30 INCHES

| SOIL PROFILE | | | SAMPLES | | | ELEVATION SCALE | DYNAMIC PENETRATION RESISTANCE BLOWS/FOOT 20 40 60 80 100 / SHEAR STRENGTH C, LB./SQ.FT. | LIQUID LIMIT $L_L$ PLASTIC LIMIT $P_L$ WATER CONTENT W / WATER CONTENT, PER CENT |
|---|---|---|---|---|---|---|---|---|
| ELEVN. DEPTH | DESCRIPTION | STRAT. PLOT | NUMBER | TYPE | BLOWS/FT. | | | |
| 251.7 | GROUND LEVEL | | | | | | | |
| 0.0 | DYNAMIC PENETRATION TEST ONLY – NO SAMPLES TAKEN | | | | | | | |
| 211.2 / 40.5 | END OF PEN. TEST – PROBABLY BOULDER OR BEDROCK | | | | | | | |




VERTICAL SCALE
1 INCH TO 10'-0"

GOLDER & ASSOCIATES

DRAWN M. W.
CHECKED [illegible]

PROJECT No. 6265

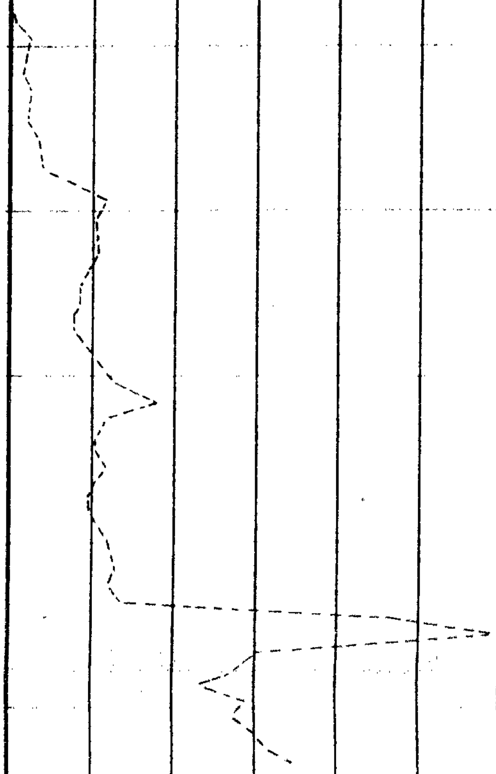
# RECORD OF BOREHOLE 12

LOCATION SEE FIGURE 1 BORING DATE DEC. 7, 1962 DATUM GEODETIC

BOREHOLE TYPE PENETRATION TEST BOREHOLE DIAMETER —

SAMPLER HAMMER WEIGHT — LB. DROP — INCHES PEN. TEST HAMMER WEIGHT 140 LB. DROP 30 INCHES

| SOIL PROFILE | | | SAMPLES | | | ELEVATION SCALE | DYNAMIC PENETRATION RESISTANCE BLOWS/FOOT - - - - - 20 40 60 80 100 / SHEAR STRENGTH C, LB./SQ.FT. | LIQUID LIMIT $L_L$ PLASTIC LIMIT $P_L$ WATER CONTENT W ($P_L$ — W — $L_L$) / WATER CONTENT, PER CENT |
|---|---|---|---|---|---|---|---|---|
| ELEVN. / DEPTH | DESCRIPTION | STRAT. PLOT | NUMBER | TYPE | BLOWS / FT. | | | |
| | | | | | | 260 | | |
| 252.6 / 0.0 | GROUND LEVEL | | | | | | | |
| | | | | | | 250 | | |
| | | | | | | 240 | | |
| | DYNAMIC PENETRATION TEST ONLY - NO SAMPLES TAKEN | | | | | | | |
| | | | | | | 230 | | |
| | | | | | | 220 | | |
| | | | | | | 210 | | |
| 206.6 / 46.0 | END OF PEN. TEST | | | | | | END OF PEN. TEST AT ELEV. 206.6 | |
| | | | | | | 200 | | |

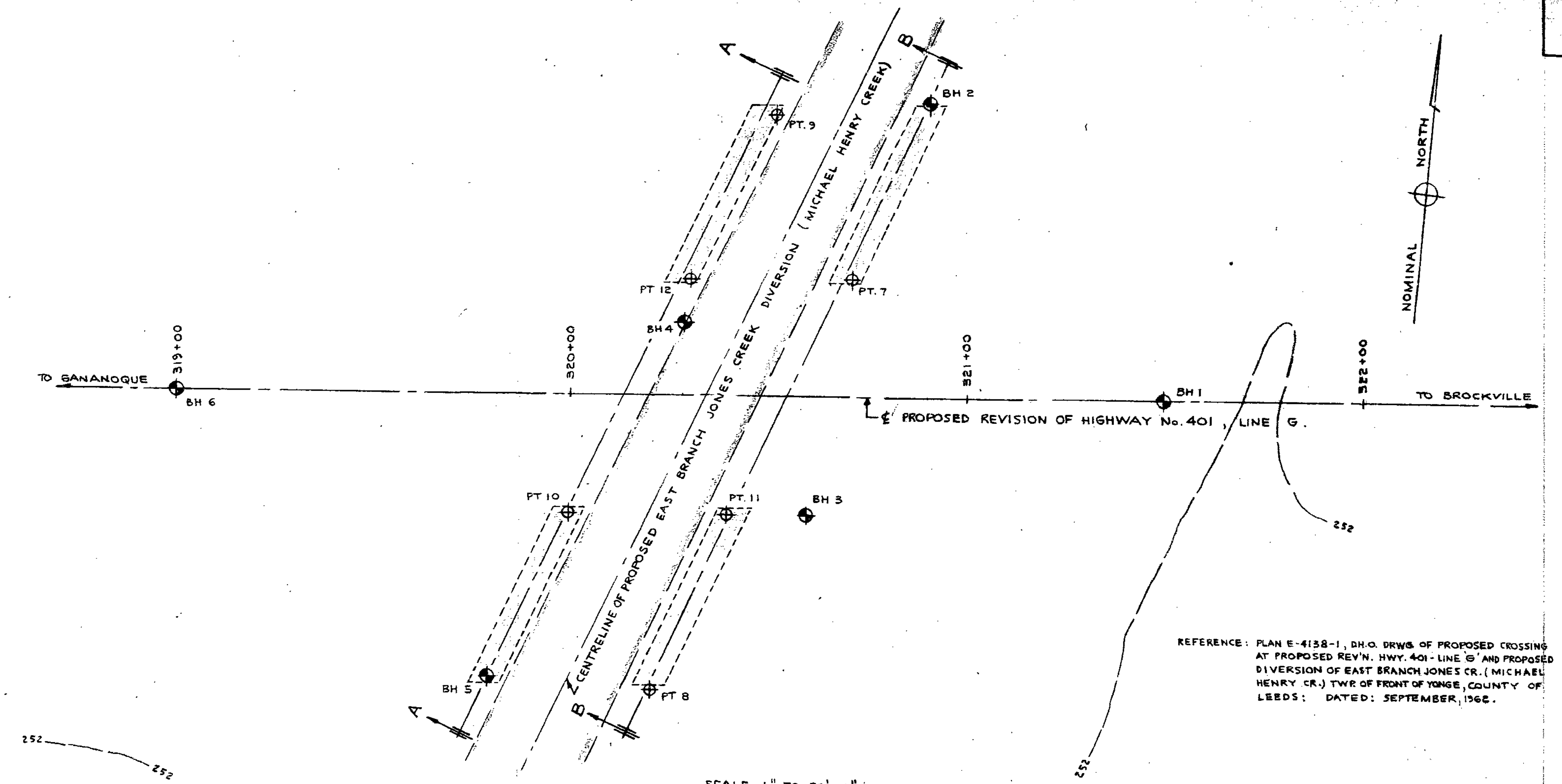


VERTICAL SCALE
1 INCH TO 10'-0"

GOLDER & ASSOCIATES

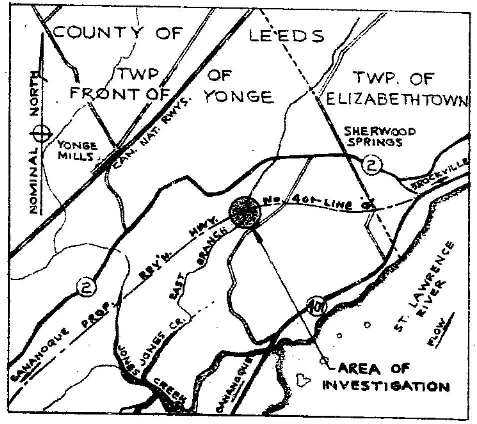
DRAWN M.W.
CHECKED [illegible]

| BORING PLAN | FIGURE 1 |
| --- | --- |




REFERENCE: PLAN E-4138-1, DH.O. DRWG. OF PROPOSED CROSSING AT PROPOSED REV'N. HWY. 401 - LINE 'G' AND PROPOSED DIVERSION OF EAST BRANCH JONES CR. (MICHAEL HENRY CR.) TWP. OF FRONT OF YONGE, COUNTY OF LEEDS: DATED: SEPTEMBER, 1962.

SCALE 1" TO 20'-0"




KEY PLAN
SCALE 1" TO 0.8 MILES

LEGEND

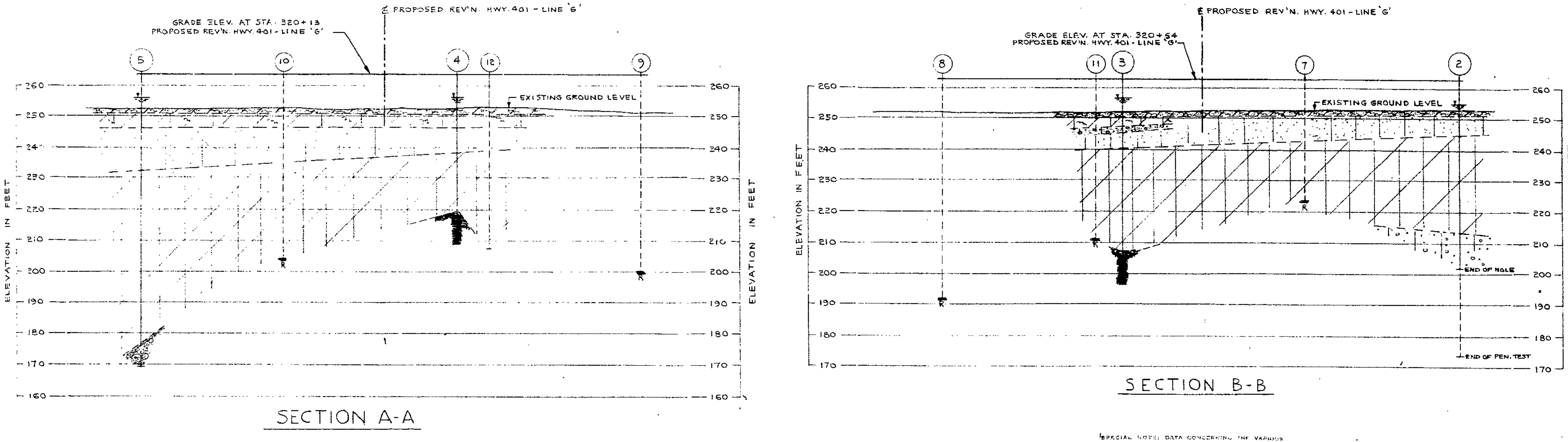
- BOREHOLE IN PLAN
- PENETRATION TEST IN PLAN
- PROPOSED FOOTING LOCATIONS

GOLDER & ASSOCIATES

Made. Chkd. Appd.

# SOIL STRATIGRAPHY
SECTIONS A-A & B-B

FIGURE 2




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.

SCALE 1" TO 20'-0"

## LEGEND

- (2) BOREHOLE IN ELEVATION
- (7) PENETRATION TEST IN ELEVATION
- W.L. IN BOREHOLES, DEC. 18, 1362

## STRATIGRAPHY

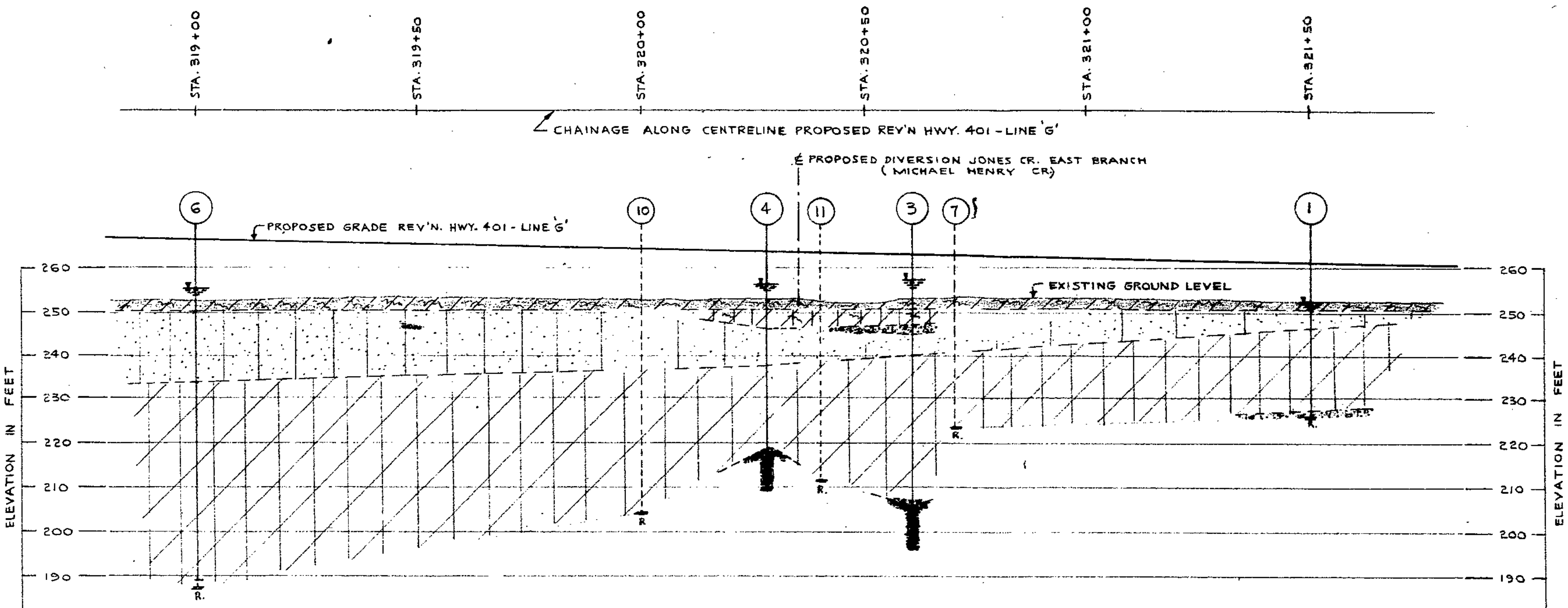
- TOPSOIL
- SOFT TO FIRM MOTTLED GREY AND BROWN CLAYEY SILT, SOME ORGANIC MATTER
- VERY LOOSE SILTY SAND AND GRAVEL
- VERY LOOSE TO COMPACT SILTS AND SANDS, SOME TWIGS
- SOFT TO VERY STIFF GREY CLAYEY SILT, SOME SILTY CLAY LAYERS WITH INCREASING DEPTH
- GRAVEL AND BOULDERS (PROBABLY VERY DENSE)
- COMPACT TO DENSE GREY SILTY SAND AND GRAVEL
- HARD, GENERALLY SOUND, GRANITIC TYPE ROCK (BEDROCK)
- R REFUSAL, BOULDER OR BEDROCK

GOLDER & ASSOCIATES

Made M.W.
Chkd.
Appd.

# SOIL STRATIGRAPHY
LONGITUDINAL SECTION

FIGURE 3




SCHEMATIC SECTION ALONG CENTRELINE OF PROPOSED REVISION OF HIGHWAY 401 - LINE 'G'

SCALE 1" TO 20'-0"

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.

## LEGEND

- (3) BOREHOLE IN ELEVATION
- (7) PENETRATION TEST IN ELEVATION
- W.L. IN BOREHOLES, DEC. 18, 1962

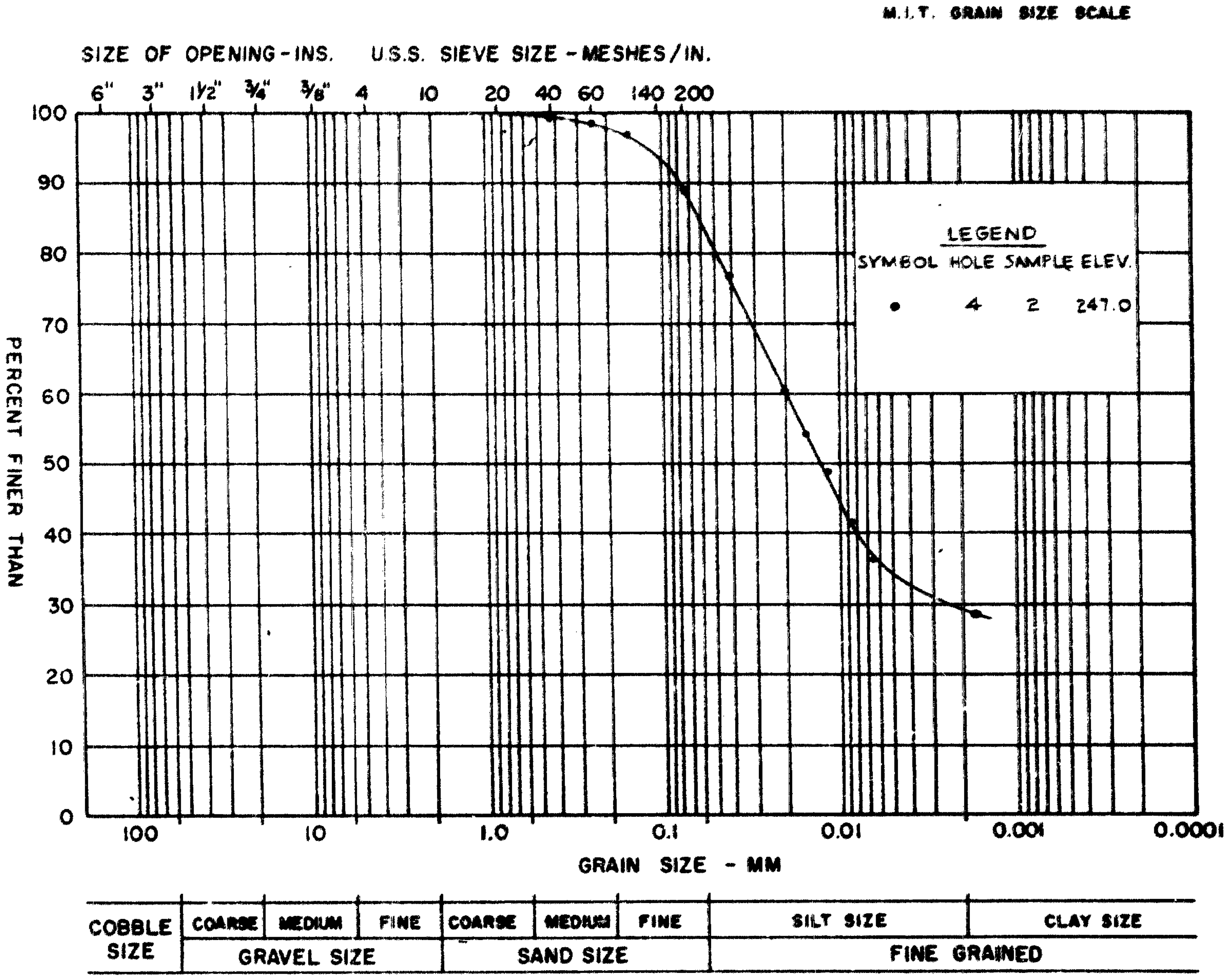
## STRATIGRAPHY

- TOPSOIL
- SOFT TO FIRM MOTTLED GREY AND BROWN CLAYEY SILT, SOME ORGANIC MATTER
- VERY LOOSE SILTY SAND AND GRAVEL
- VERY LOOSE TO COMPACT SILTS AND SANDS, SOME TWIGS
- SOFT TO VERY STIFF GREY CLAYEY SILT, SOME SILTY CLAY LAYERS WITH INCREASING DEPTH
- VERY DENSE SILTY SAND AND GRAVEL
- HARD, GENERALLY SOUND, GRANITIC TYPE ROCK (BEDROCK)
- R — REFUSAL, BOULDER OR BEDROCK

GOLDER & ASSOCIATES

Made [illegible]
Chkd. [illegible]
Appd. [illegible]

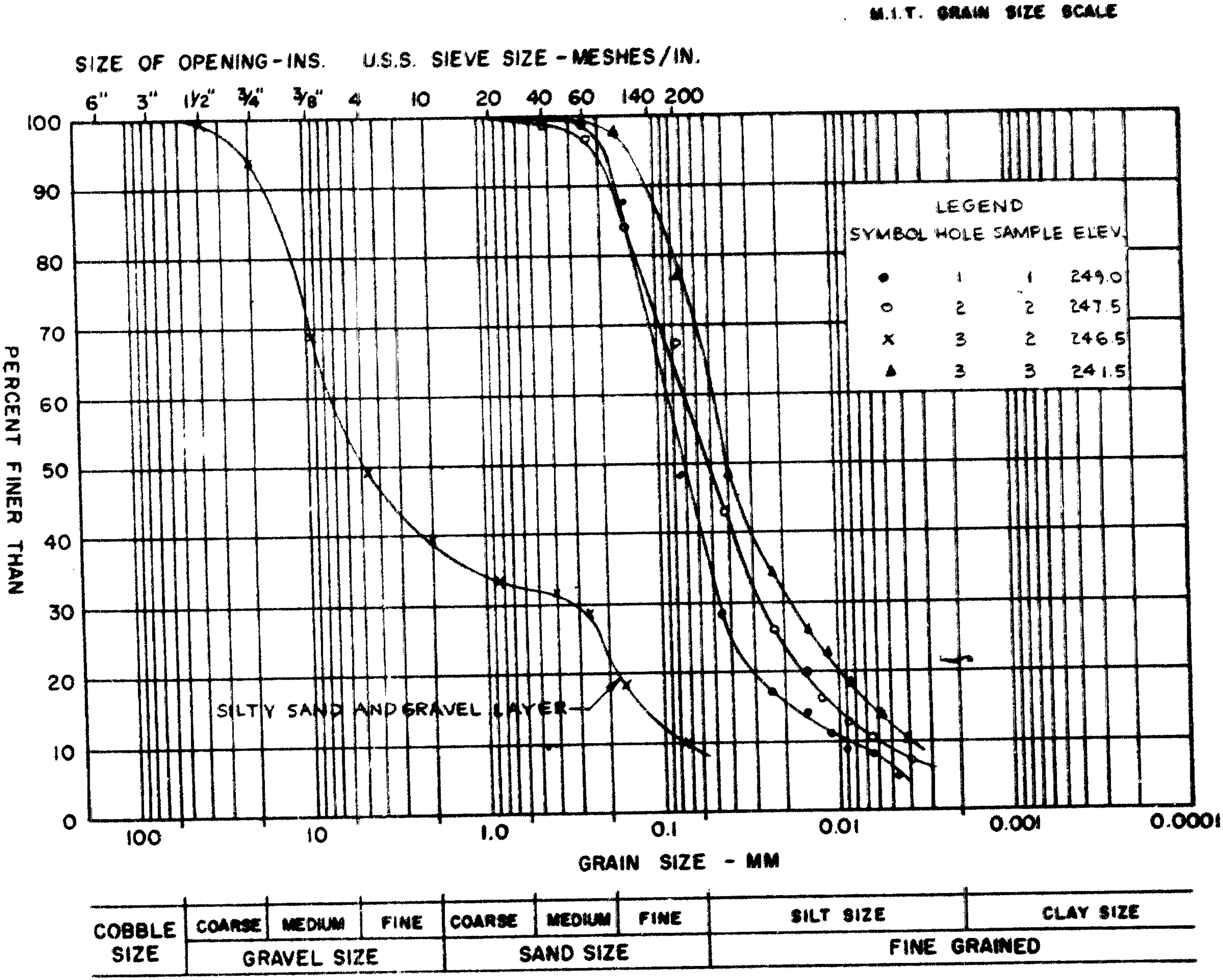
GOLDER & ASSOCIATES




# GRAIN SIZE DISTRIBUTION

MOTTLED GREY & BROWN CLAYEY SILT

FIGURE 4



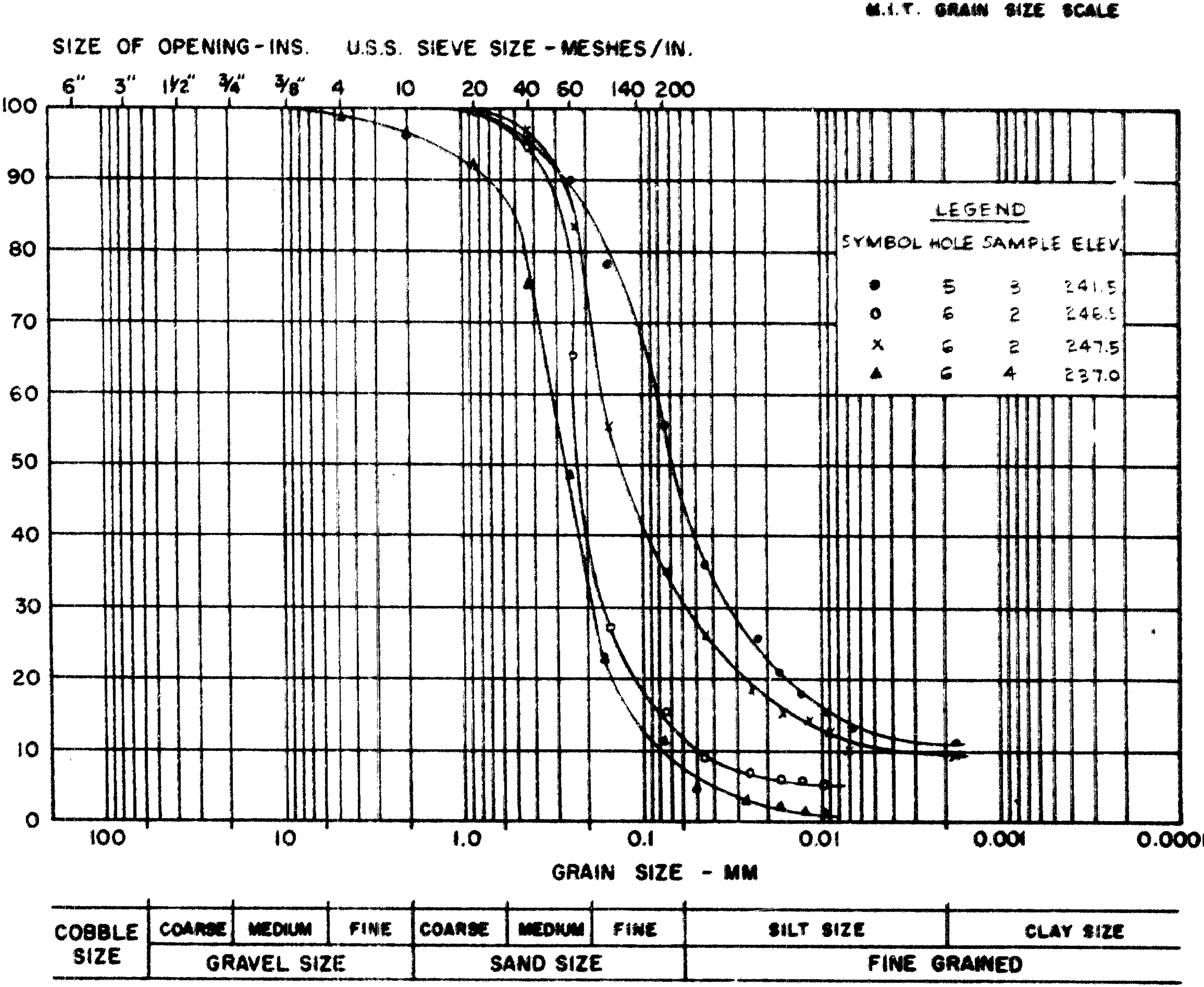

GOLDER & ASSOCIATES

## GRAIN SIZE DISTRIBUTION

VERY LOOSE TO COMPACT SILTS & SANDS

FIGURE 5

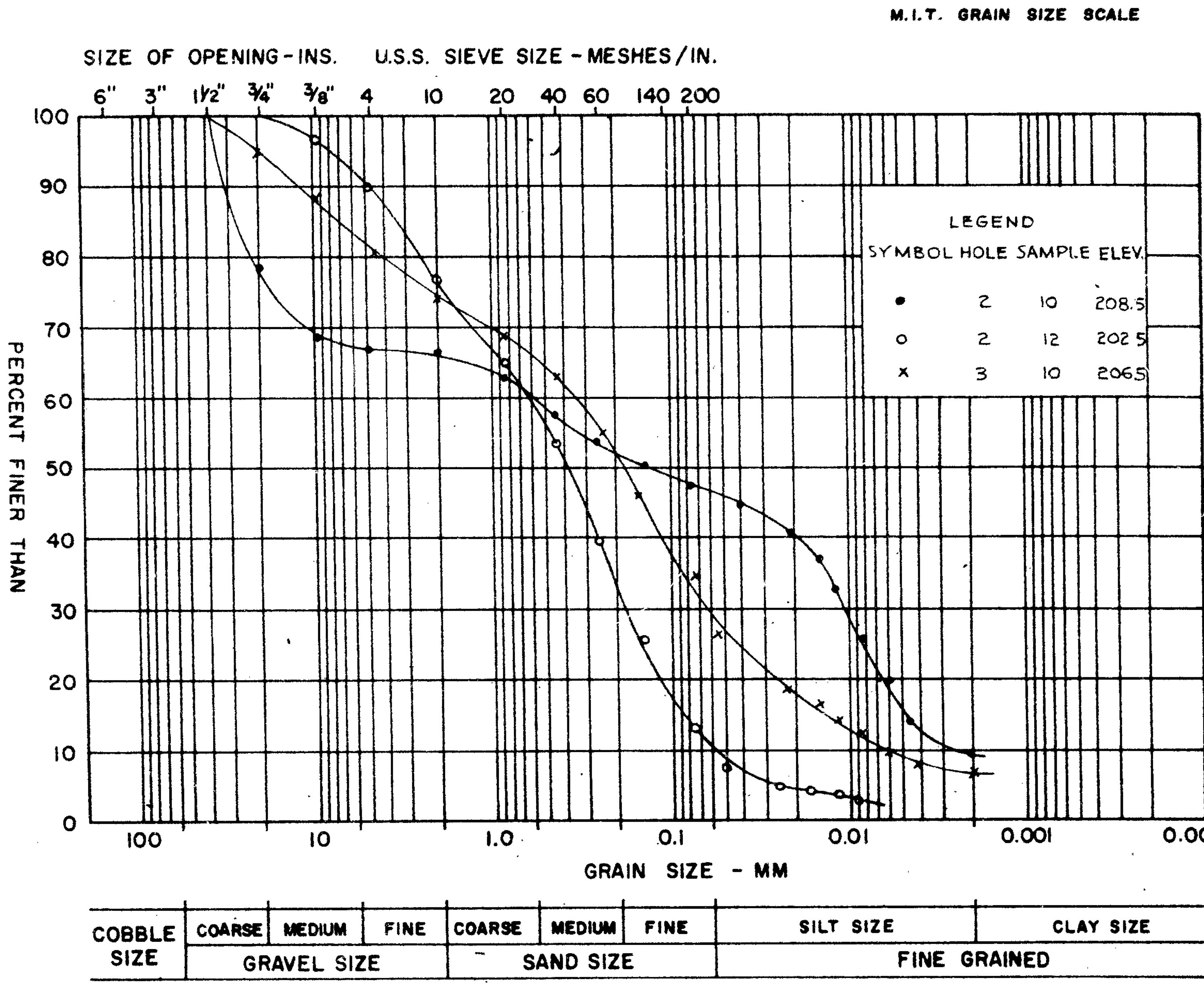
GOLDER & ASSOCIATES




## GRAIN SIZE DISTRIBUTION

VERY LOOSE TO COMPACT SILTS & SANDS

FIGURE 6




GOLDER & ASSOCIATES

GRAIN SIZE DISTRIBUTION
SILTY SAND & GRAVEL

FIGURE 7

# PLASTICITY CHART

## CLAYEY SILT STRATUM

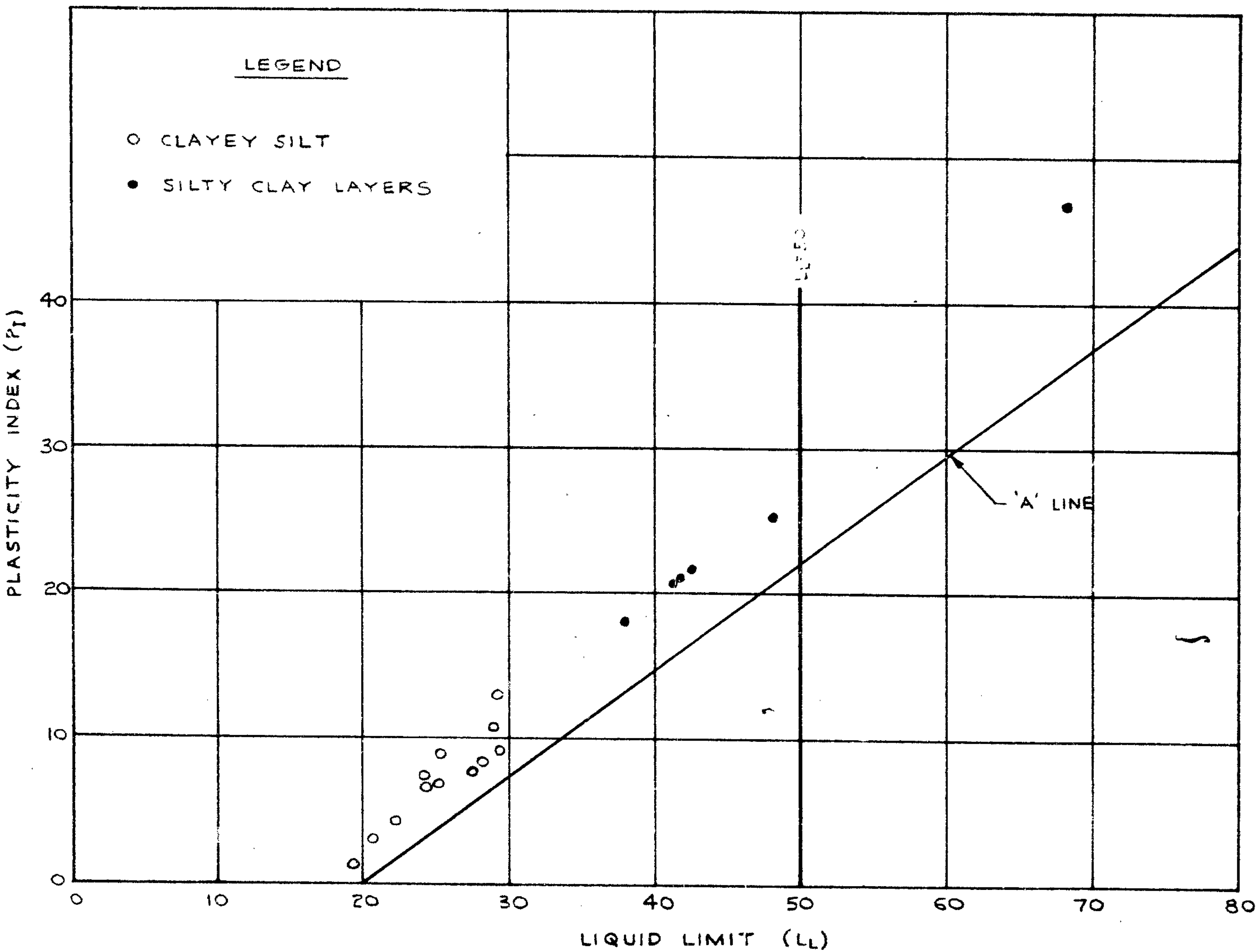


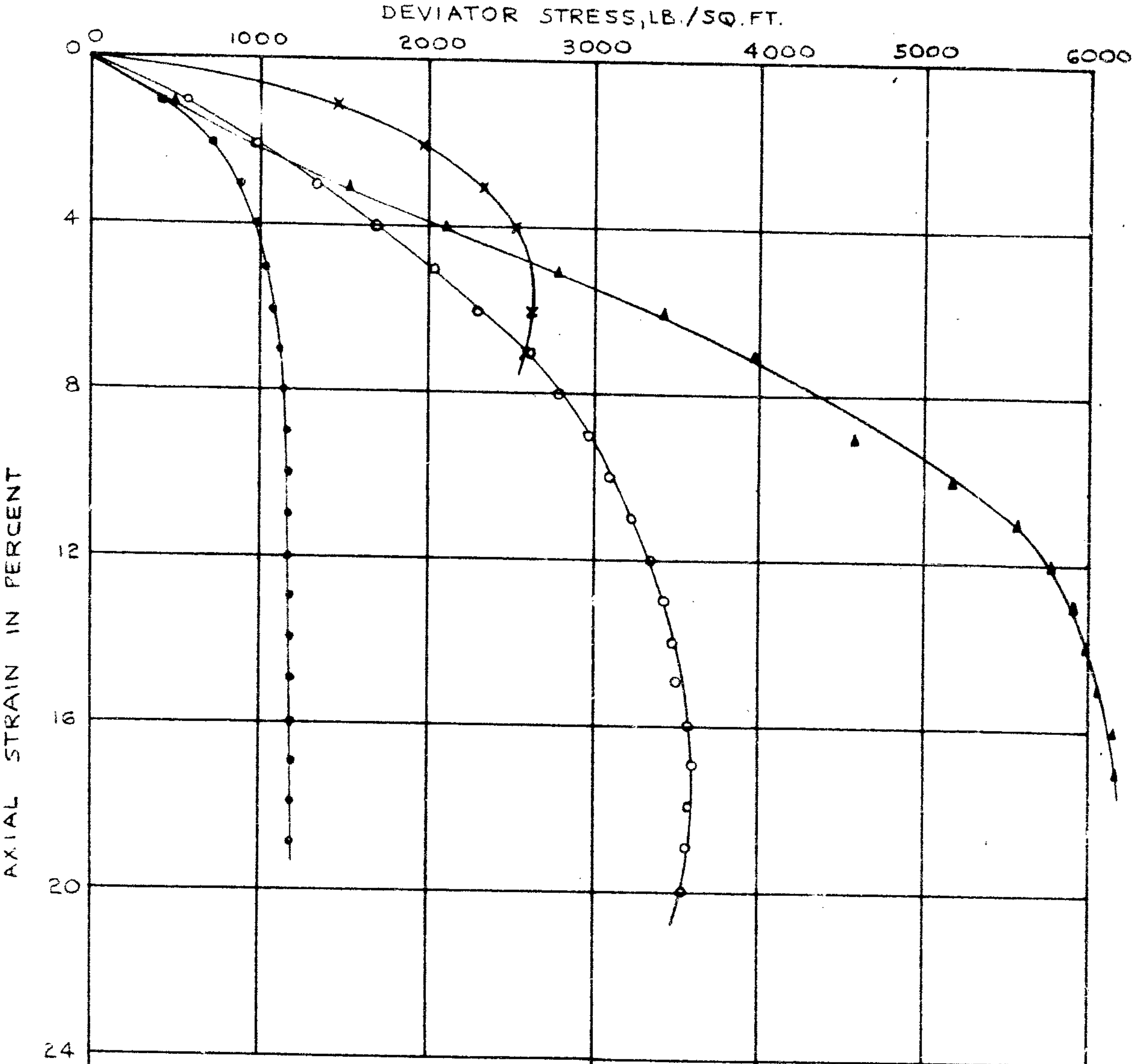

FIGURE 8

GOLDER & ASSOCIATES

# TYPICAL STRESS-STRAIN CURVES

CLAYEY SILT STRATUM

FIGURE 9

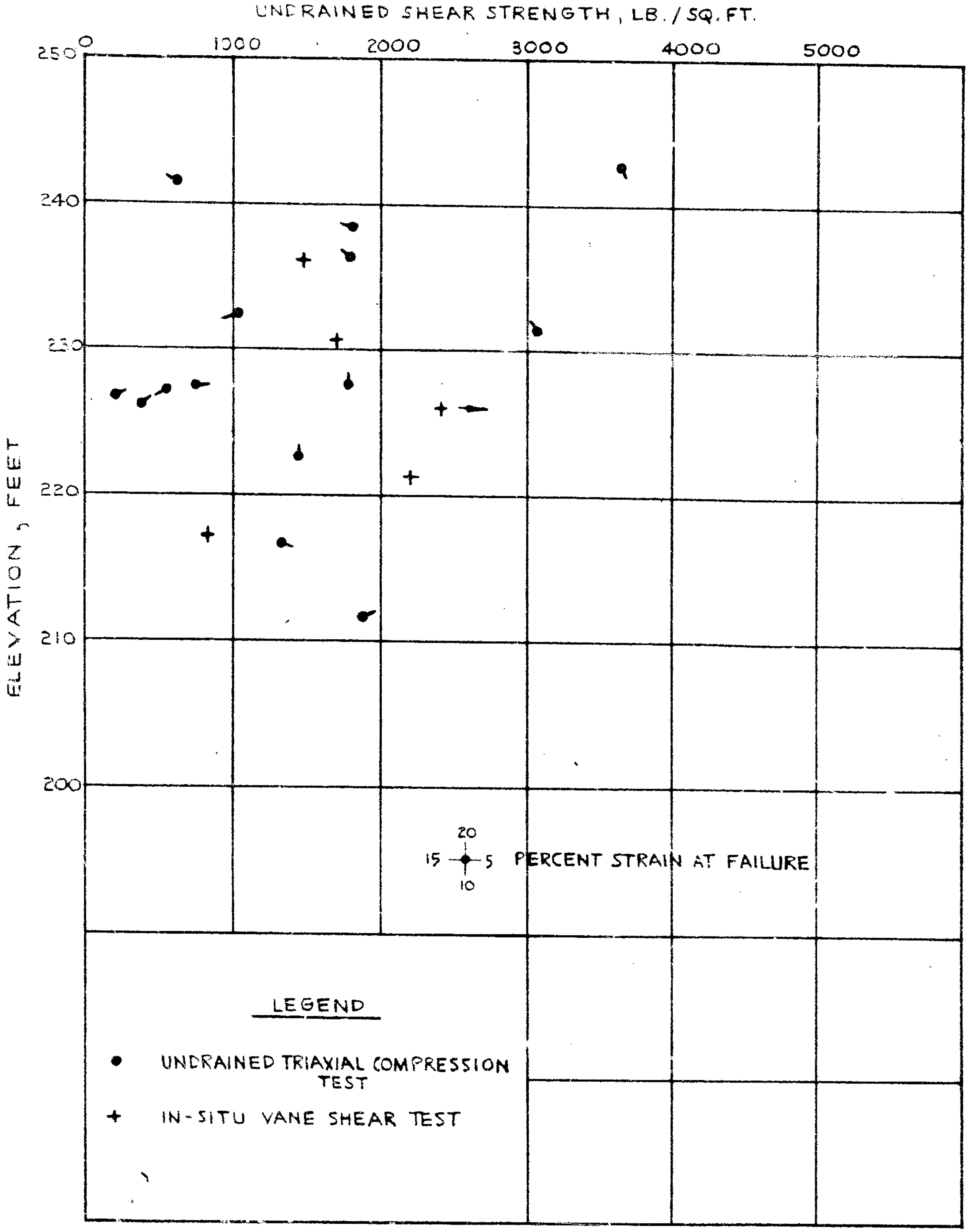



LEGEND

| SYMBOL | HOLE | SAMPLE | ELEVATION |
|---|---|---|---|
| ● | 1 | 4 | 241.5 |
| o | 2 | 4 | 238.5 |
| x | 3 | 8 | 217.0 |
| ▲ | 4 | 5 | 232.0 |

# UNDRAINED SHEAR STRENGTH VS ELEVATION
CLAYEY SILT STRATUM

FIGURE 10

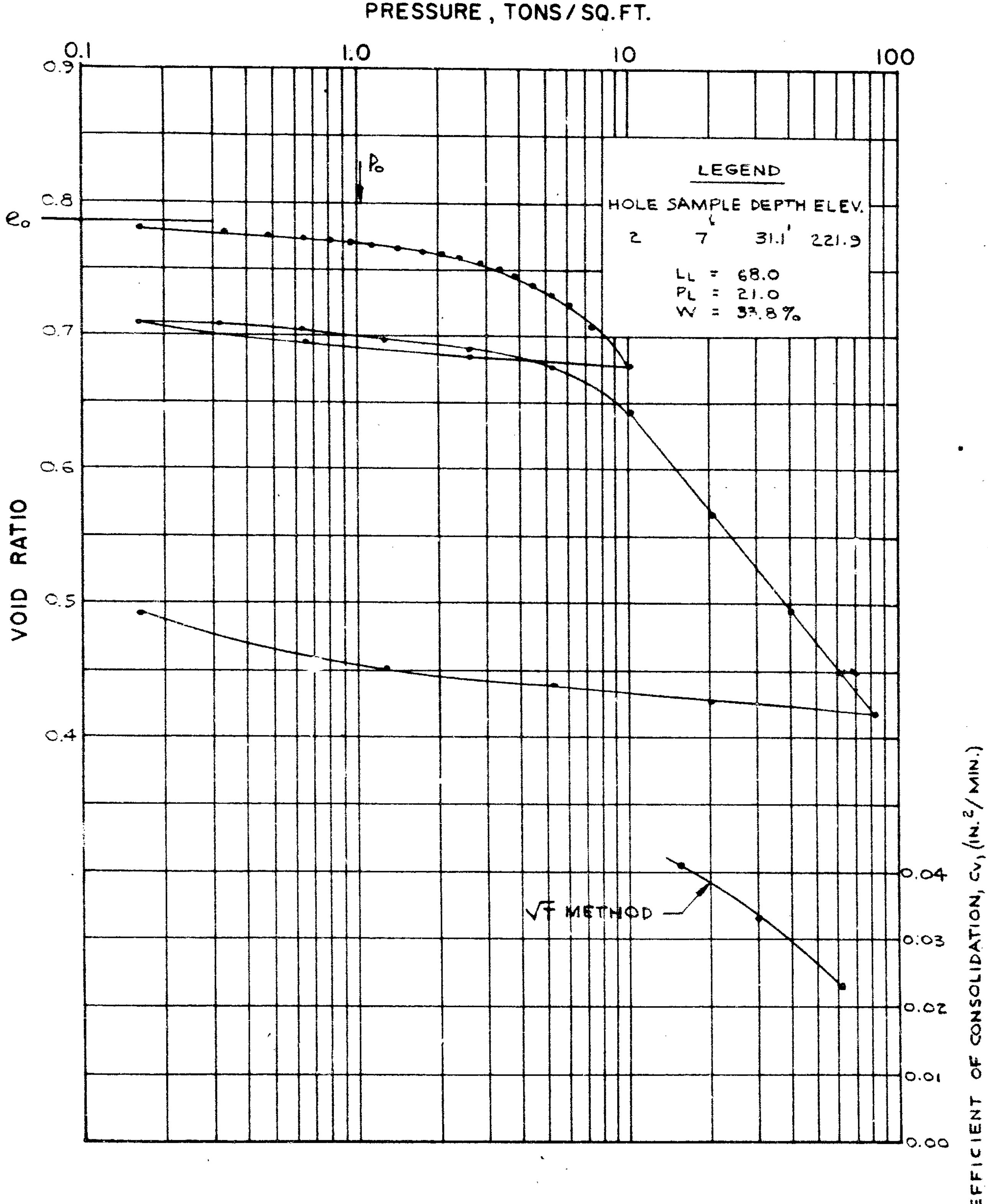



GOLDER & ASSOCIATES

# VOID RATIO - PRESSURE CURVES CONSOLIDATION TEST

FIGURE 11

SILTY CLAY LAYER IN CLAYEY SILT STRATUM




GOLDER & ASSOCIATES