

23-64-174

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REPORT

TO

DE LEUW, CATHER & COMPANY OF CANADA LIMITED

ON

ROUTE BORINGS

PROPOSED STAGE IV INTERCHANGE

OTTAWA QUEENSWAY - BRIDGE 38

W.P. 949-59-3

OTTAWA

ONTARIO

Distribution:

10 copies - De Leuw, Cather & Company of Canada Limited,  
Ottawa, Ontario

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

April, 1964

64008

*Handwritten signature/initials*

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### ABSTRACT

The results of a supplementary soil investigation carried out primarily to determine the extent of fill covering the site at selected locations along the ramps in the proposed Queensway - Bridge 38 Interchange in Ottawa, Ontario, are reported.

It was found that the interchange area to the south of the Queensway centreline and for several hundred feet to the north is covered by up to about 16 feet of heterogeneous fill which is essentially granular in nature. Leda clay fill, obtained from excavation of the Rideau Canal, underlies the site to a depth of about 20 feet some 500 feet north of the Queensway centreline. A surface deposit of peat, organic silt and clay fill, about 7 feet thick, covers the area between the two railway lines in the northern part of the site.

It is recommended that the ramps be constructed in advance of the scheduled completion of the interchange and surcharged to permit the major portion of the settlement to take place before the roadway is put in service.

The stability of the proposed Canal Road embankment to the north of the Queensway is discussed in the report.

## INTRODUCTION

H. Q. Golder & Associates Ltd. has been retained by De Leuw, Cather & Company of Canada Limited, Consulting Engineers, to carry out route borings at selected locations along the ramps in the proposed Queensway - Bridge 38 Interchange in Ottawa, Ontario. The main purpose of this investigation was to determine the thickness and character of the fill covering the site and to provide general information regarding the foundation design of the proposed ramps.

This report supplements and should be read in conjunction with our report 64006, dated March, 1964, to De Leuw, Cather & Company of Canada Limited on Site Investigation, Proposed Canal Road Bridge 38. The results of a preliminary site investigation carried out previously for the Proposed Queensway - Nicholas Street Interchange in this general area are presented in our report 6339, dated December, 1963.

## PROCEDURE

The field work for this investigation was carried out during the periods January 31 to February 7, 1964 and February 24 to February 25, 1964 using mobile power auger and diamond drilling equipment. A total of eleven boreholes with accompanying dynamic penetration tests (numbered 201 to 211,

inclusive) were put down to depths of from 20 to 40 feet below ground surface. Nine of the boreholes (202 to 210, inclusive) were located in the interchange area to the south of the proposed Queensway and the remaining two boreholes were put down along the proposed Canal Road some 500 to 700 feet north of the Queensway.

Detailed logs of each borehole put down in this investigation are given on the Records of Boreholes at the end of the report. The locations of the borings, including those put down during the previous preliminary investigation in the interchange area, are shown on Figure 1.

The samples obtained during this investigation were brought to our laboratory for examination and testing. The results of laboratory testing on samples from borehole 201 are given on the Record of Borehole and on Figure 2.

All elevations in this report were supplied by De Leuw, Cather & Company of Canada Limited, and are referred to Geodetic datum.

#### SITE TOPOGRAPHY AND GEOLOGY

The interchange is to be located between about chainage 440+00 and 455+00 on the proposed Queensway to the

east of the Rideau Canal in Ottawa, Ontario. The layout of the proposed interchange is shown on Figure 1. The Queensway in this locality follows an abandoned railway right of way on an embankment some 5 feet high. The site to the north of the Queensway centreline is occupied by abandoned railway maintenance shops and in local areas by scattered debris and rubbish piles. Two separate railway lines, presently in service, run along the northern portion of the site in an easterly direction some 600 feet to the north of the Queensway at the proposed Canal Road crossing. The ground surface between and to the north of these two lines, which are on embankments, drops off some 15 feet to about elevation 190. To the south of the railway lines the existing ground surface, apart from minor local variations, slopes down across the site from about elevation 205 to 195 in a general south-easterly direction.

From local information and the previous investigations carried out in this area it is known that the site is covered by fill. The fill ranges in composition from a sensitive silty clay obtained from excavation of the Rideau Canal to a heterogeneous mixture of sand and rubbish. The fill is underlain in local areas by a thin layer of geologically recent sand, silt and peat or directly by a stratum of sensitive silty clay to clayey silt. The clay is followed

by silt which in turn overlies glacial till resting on shale bedrock.

#### SOIL CONDITIONS

The soil conditions are divided into three separate areas as set out below.

Area Covered by B.H.'s 202 - 210:- Borings 202 to 210, inclusive, put down along the proposed ramps to the south of the Queensway centreline show that the area is covered by about 4 to 16 feet of heterogeneous fill. There is a trend for the thickness of the fill to increase in an easterly direction towards the proposed location of Bridge 38. The composition of the fill is variable ranging from essentially a granular material, which forms the major portion of the deposit, to a sensitive silty clay. The clayey fill is only some 2 feet thick and is present at the base of the deposit at boreholes 202 to 206, inclusive, in the western portion of the site. The granular fill consists mainly of sand to sandy silt but includes coal, cinders, ashes, pieces of wood, organic matter and garbage in varying proportions. The clayey fill is comprised of silty clay to clayey silt with occasional sand pockets.

Based on the standard penetration resistance values

given on the Records of Boreholes, the heterogeneous granular fill is very loose to loose and the clayey fill generally firm.

The fill to the south of the Queensway is underlain in a few boreholes by a geologically recent deposit of loose to compact silty sand to silt up to about 2 feet in thickness. A stratum of sensitive silty clay underlies the geologically recent deposit or the fill directly. The silty clay stratum, where it was completely penetrated by the borings, ranges from about 30 to 10 feet in thickness in a general easterly direction. The stratum is composed essentially of silty clay but varies to a clayey silt and contains occasional fine sand and silt seams. Based on the in situ vane tests, the results of which are given on the Records of Boreholes, the undrained shear strength ranges between about 1,000 and 2,000 lb/sq.ft. This is in the stiff range of consistency. The sensitivity of the clay, as determined by the field vane measurements, is between about 5 and 20.

The silty clay, in the borings which penetrated it, is underlain by a stratum of generally compact silt with a trace to some clay. From the borings put down to the south of the Queensway during the previous investigations, it is known that the silt is followed by compact to dense sandy



glacial till resting on shale bedrock.

Area Covered by B.H. 201:- The borings put down during the previous preliminary investigation show that an essentially granular fill covers the proposed interchange area for some 400 feet to the north of the Queensway centreline and that beyond this, to the north-west, the site is covered by clay fill. Borehole 201 in this investigation, located along the proposed Canal Road at chainage 146+30, some 500 feet north of the Queensway centreline, shows that about 15 feet of clay fill underlies a 5 foot thick surface cover of loose to compact granular fill. From local information it is known that the clay fill was obtained from excavation of the Rideau Canal. It is a sensitive Leda clay, has a chunky structure and contains occasional small pockets of sand and silt.

The undrained shear strength of the clay fill in borehole 201 was measured by in situ vane tests and by laboratory triaxial compression tests on relatively undisturbed samples. The results obtained, which range from about 500 to 2,000 lb/sq.ft., are given on the Record of Borehole. In general, however, the measured shear strength is of the order of 1,000 lb/sq.ft. The higher values obtained may represent the strength of relatively undisturbed chunks or

blocks of clay and the overall consistency of the clay fill is probably in the firm range.

The clay fill in borehole 201 is underlain by a thin layer of firm clayey silt topsoil, forming the original ground surface, followed by a stratum of compact silty sand with gravel and a trace of clay. This stratum is till-like in composition and is the softened and modified upper portion of the glacial till deposit underlying the site. A grading curve for a sample of the modified till is shown on Figure 2.

Area Covered by B.H. 211:- At borehole 211, located between the two railway lines at chainage 144+60 along the proposed Canal Road, a deposit of very soft dark brown peat and organic silt some 5 feet thick was encountered below ground surface. This deposit is underlain by about 1 foot of soft grey silty clay fill followed by a thin layer of soft dark brown peat. The peat layer is further underlain, at a depth of 7 feet below ground surface, by loose to compact grey sand with a trace of gravel about 7 feet thick. A stratum of till-like material consisting of loose to dense grey silty sand with gravel and a trace of clay underlies the sand. This is the same stratum as encountered in borehole 201 at depth.

## WATER CONDITIONS

Except for a standpipe installation in one borehole, water level readings were obtained in open boreholes in this investigation. Readings were taken during the course of drilling and at periodic intervals following completion of drilling operations. The results of one set of observations are given on the Records of Boreholes.

The readings showed that the groundwater level during February, 1964, did not fluctuate by more than 1 foot, was generally in the fill deposit covering the site, and within about 12 feet from ground surface.

## DISCUSSION

### General

It is understood that the Queensway - Bridge 38 Interchange will consist of a number of approach ramps as shown on Figure 1. Except for the Canal Road embankment, the ramps will in general be on fill up to about 10 feet above ground surface or in cut as much as 3 feet below existing ground surface. The Canal Road approach embankment crossing the Queensway is to be about 20 feet in height above existing ground surface at Bridge 38 and is to remain at about this height for some 500 feet to the north. Beyond this, the embankment is to reach a maximum height of about 35 feet above ground

surface between the two existing railway lines which are to be abandoned prior to construction in 1965.

This report covers the low level ramps in the interchange area and the Canal Road embankment to the north of Bridge 38. The treatment of the Canal Road approach embankment adjacent to Bridge 38 and along the associated retaining wall has been discussed in our report 64006, dated March, 1964, for the Proposed Canal Road Bridge 38.

#### Low Level Ramps

The borings put down in this and previous investigations show that fill, essentially granular in nature, covers the area of the site where low level ramps about 10 feet in height or less are to be constructed. There should be no problem with overall stability of the ramps; however there will be some settlement of the ramps because of the variable and generally loose nature of the fill deposit. For ramps about 10 feet in height it is estimated that the settlement could be of the order of 6 inches or more. Most of the settlement should take place quite rapidly, but as the fill is clayey or contains clayey pockets in local areas, some of the settlement in these areas could continue for a considerable period.

In order to minimize settlement of the approach ramps and provide a smooth roadway surface, either the fill deposit covering the site could be removed and replaced with clean granular material compacted in place or the ramps could be surcharged prior to placement of the pavement surface. As complete removal of the fill would be uneconomical, it is recommended that the ramps be constructed in advance of the scheduled completion of the interchange and surcharged to 150 percent of the final design height. This will permit a substantial portion of the settlement which would be realized under the design height to take place before the roadway surface is paved and put in service. It is suggested that a minimum surcharge of 5 feet be placed, as in areas where the final ramp grade will be at about existing ground surface. Similarly, where the ramps will be in cut, a minimum surcharge of 5 feet should be provided above final ramp grade.

The settlement of the ramp fill and surcharge should be monitored and the surcharge left in place until settlement effectively ceases. Only an approximate estimate can be made of the time required for surcharging and it is suggested that at least six months be allowed. This, however, should be checked by the field measurements.

It is recommended that all topsoil and recent rubbish fill across the site be removed prior to construction of the earthfill ramps.

#### Canal Road Embankment

At borehole 201, some 500 feet north of the Queensway centreline where the height of the Canal Road embankment is to be 20 feet above existing ground surface, about 15 feet of clay fill was encountered beneath a thin surface cover of granular fill. The presence of the clay fill in this portion of the site will result in long term settlement of the roadway embankment and could present an embankment stability problem. It is understood that, due to construction scheduling and the presence of railway tracks to the north which are presently in service, there will be no time available to surcharge the roadway embankment in this area.

The shear strength of the clay fill, as determined by field vane and laboratory compression tests, ranges between about 500 and 2,000 lb/sq.ft. The fill is a sensitive Leda clay obtained from excavation of the Rideau Canal and has undoubtedly been remoulded to some extent during placing. It is therefore possible that there are some local soft zones

within the clay fill where the shear strength could be lower than 500 lb/sq.ft. However, based on the available strength and penetration results, the minimum overall shear strength of the clay fill is considered to be of the order of 500 lb/sq.ft. For this minimum shear strength value in the clay fill, computations indicate that there should be no major instability of an embankment 20 feet high with side slopes no steeper than 2 horizontal to 1 vertical.

The total consolidation settlement under a 20 foot high embankment resting on 15 feet of partially remoulded Leda clay fill could be of the order of 1 foot. Due to the relatively impervious nature of the clay, a period of several years may be required for the majority of the consolidation settlement to take place. In addition to settlement there could be some lateral movement in the embankment and underlying clay fill. As in the ramp areas, the settlement should be monitored in the field to indicate when the major portion of movement has taken place and the final pavement can be laid down.

The Canal Road embankment is to reach a maximum height of about 35 feet above existing ground surface between the two railway embankments some 600 feet to the north of the

Queensway centreline. Borehole 211 at this location disclosed 7 feet of very soft to soft peat, organic silt and clay fill resting on a stratum of sand followed by a sandy till.

Because of their low shear strength and high compressibility, the surface deposits are not competent for the support of the proposed embankment. To provide a suitable foundation, it is recommended that the peat and clay overlying the sand be removed and replaced with granular material, compacted in place, prior to placement of the embankment. The excavation and replacement of the upper compressible deposits should be carried out in the area between the two railways and under the complete width of the roadway embankment. If this is done, the proposed 35 foot high embankment may then be constructed with side slopes no steeper than 2 horizontal to 1 vertical. However, the existing railway embankments some 15 feet in height are possibly underlain by the soft organic deposits; the proposed Canal Road embankment will add some 20 feet of fill to these existing embankments. If the soft deposits are present, they could induce local instability or large differential settlement. Consequently, it is recommended that when the tracks are removed from service, the existence and character of such underlying soft deposits be proved by borings and a decision made if these deposits should also be removed and



replaced.



J. L. Seychuk, P. Eng.



for V. Milligan, P. Eng.

JLS/NG  
64008  
April, 1964

## LIST OF ABBREVIATIONS

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

### I. SAMPLE TYPES

|           |                     |
|-----------|---------------------|
| <i>AS</i> | auger sample        |
| <i>CS</i> | chunk sample        |
| <i>DO</i> | drive open          |
| <i>DS</i> | Denison type sample |
| <i>FS</i> | foil sample         |
| <i>RC</i> | rock core           |
| <i>ST</i> | slotted tube        |
| <i>TO</i> | thin-walled, open   |
| <i>TF</i> | thin-walled, piston |
| <i>WS</i> | wash sample         |

### II. PENETRATION RESISTANCES

**Dynamic Penetration Resistance:** The number of blows by a 140-pound hammer dropped 30 inches required to drive a 2-inch diameter, 60 degree cone one foot, where the cone is attached to 'A' size drill rods and casing is not used.

**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.

|           |  |
|-----------|--|
| <i>WH</i> | sampler advanced by static weight—weight, hammer |
| <i>PH</i> | sampler advanced by pressure—pressure, hydraulic |
| <i>PM</i> | sampler advanced by pressure—pressure, manual    |

### III. SOIL DESCRIPTION

#### (a) *Cohesionless Soils*

| <i>Relative Density</i> | <i>N, blows/ft.</i> |
|-------------------------|---------------------|
| Very loose              | 0 to 4              |
| Loose                   | 4 to 10             |
| Compact                 | 10 to 30            |
| Dense                   | 30 to 50            |
| Very dense              | over 50             |

#### (b) *Cohesive Soils*

| <i>Consistency</i> | <i>c<sub>u</sub>, lb./sq. ft.</i> |
|--------------------|-----------------------------------|
| 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                        |

### IV. SOIL TESTS

|           |  |
|-----------|--|
| <i>C</i>  | consolidation test                                   |
| <i>H</i>  | hydrometer analysis                                  |
| <i>M</i>  | sieve analysis                                       |
| <i>MH</i> | combined analysis, sieve and hydrometer <sup>1</sup> |
| <i>Q</i>  | undrained triaxial <sup>2</sup>                      |
| <i>R</i>  | consolidated undrained triaxial <sup>2</sup>         |
| <i>S</i>  | drained triaxial                                     |
| <i>U</i>  | unconfined compression                               |
| <i>V</i>  | field vane test                                      |

### NOTES:

<sup>1</sup>Combined analyses when 5 to 95 per cent of the material passes the No. 200 sieve.

<sup>2</sup>Undrained triaxial tests in which pore pressures are measured are shown as  $\bar{Q}$  or  $\bar{R}$ .

## LIST OF SYMBOLS

### I. GENERAL

|                           |                                     |
|---------------------------|-------------------------------------|
| $\pi$                     | = 3.1416                            |
| $e$                       | = base of natural logarithms 2.7183 |
| $\log_e a$ or $\ln a$     | natural logarithm of $a$            |
| $\log_{10} a$ or $\log a$ | logarithm of $a$ to base 10         |
| $t$                       | time                                |
| $g$                       | acceleration due to gravity         |
| $V$                       | volume                              |
| $W$                       | weight                              |
| $M$                       | moment                              |
| $F$                       | factor of safety                    |

### II. STRESS AND STRAIN

|                 |  |
|-----------------|--|
| $u$             | pore pressure  |
| $\sigma$        | normal stress  |
| $\sigma'$       | normal effective stress ( $\bar{\sigma}$ is also used) |
| $\tau$          | shear stress   |
| $\epsilon$      | linear strain  |
| $\epsilon_{xy}$ | shear strain   |
| $\nu$           | Poisson's ratio ( $\mu$ is also used)                  |
| $E$             | modulus of linear deformation (Young's modulus)        |
| $G$             | modulus of shear deformation                           |
| $K$             | modulus of compressibility                             |
| $\eta$          | coefficient of viscosity                               |

### III. SOIL PROPERTIES

#### (a) Unit weight

|            |   |
|------------|---|
| $\gamma$   | unit weight of soil (bulk density)                              |
| $\gamma_s$ | unit weight of solid particles                                  |
| $\gamma_w$ | unit weight of water  |
| $\gamma_d$ | unit dry weight of soil (dry density)                           |
| $\gamma'$  | unit weight of submerged soil                                   |
| $G_s$      | specific gravity of solid particles $G_s = \gamma_s / \gamma_w$ |
| $e$        | void ratio  |
| $n$        | porosity  |
| $w$        | water content   |
| $S_r$      | degree of saturation  |

#### (b) Consistency

|           |  |
|-----------|--|
| $w_L$     | liquid limit   |
| $w_P$     | plastic limit  |
| $I_P$     | plasticity index   |
| $w_s$     | shrinkage limit  |
| $I_L$     | liquidity index = $(w - w_P) / I_P$                      |
| $I_C$     | consistency index = $(w_L - w) / I_P$                    |
| $e_{max}$ | void ratio in loosest state                              |
| $e_{min}$ | void ratio in densest state                              |
| $D_r$     | relative density = $(e_{max} - e) / (e_{max} - e_{min})$ |

#### (c) Permeability

|     |                               |
|-----|-------------------------------|
| $h$ | hydraulic head or potential   |
| $q$ | rate of discharge             |
| $v$ | velocity of flow              |
| $i$ | hydraulic gradient            |
| $k$ | coefficient of permeability   |
| $j$ | seepage force per unit volume |

#### (d) Consolidation (one-dimensional)

|       |  |
|-------|--|
| $m_v$ | coefficient of volume change<br>= $-\Delta e / (1+e) \Delta \sigma'$ |
| $C_c$ | compression index = $-\Delta e / \Delta \log_{10} \sigma'$           |
| $c_c$ | coefficient of consolidation   |
| $T_v$ | time factor = $c_v t / d^2$ ( $d$ , drainage path)                   |
| $U$   | degree of consolidation  |

#### (e) Shear strength

|          |   |
|----------|---|
| $\tau_f$ | shear strength                                      |
| $c'$     | effective cohesion                                  |
| $\phi'$  | effective angle of shearing resistance, or friction |
| $c_u$    | apparent cohesion*                                  |
| $\phi_u$ | apparent angle of shearing resistance, or friction  |
| $\mu$    | coefficient of friction                             |
| $S_t$    | sensitivity   |

\*For the case of a saturated cohesive soil,  $\phi_u = 0$  and the undrained shear strength  $\tau_f = c_u$  is taken as half the undrained compressive strength.

# RECORD OF BOREHOLE 201

LOCATION CANAL ROAD, STA. 146+30  
See Figure 1

BORING DATE JAN. 31 - FEB. 3, 1964

DATUM

GEODETIC

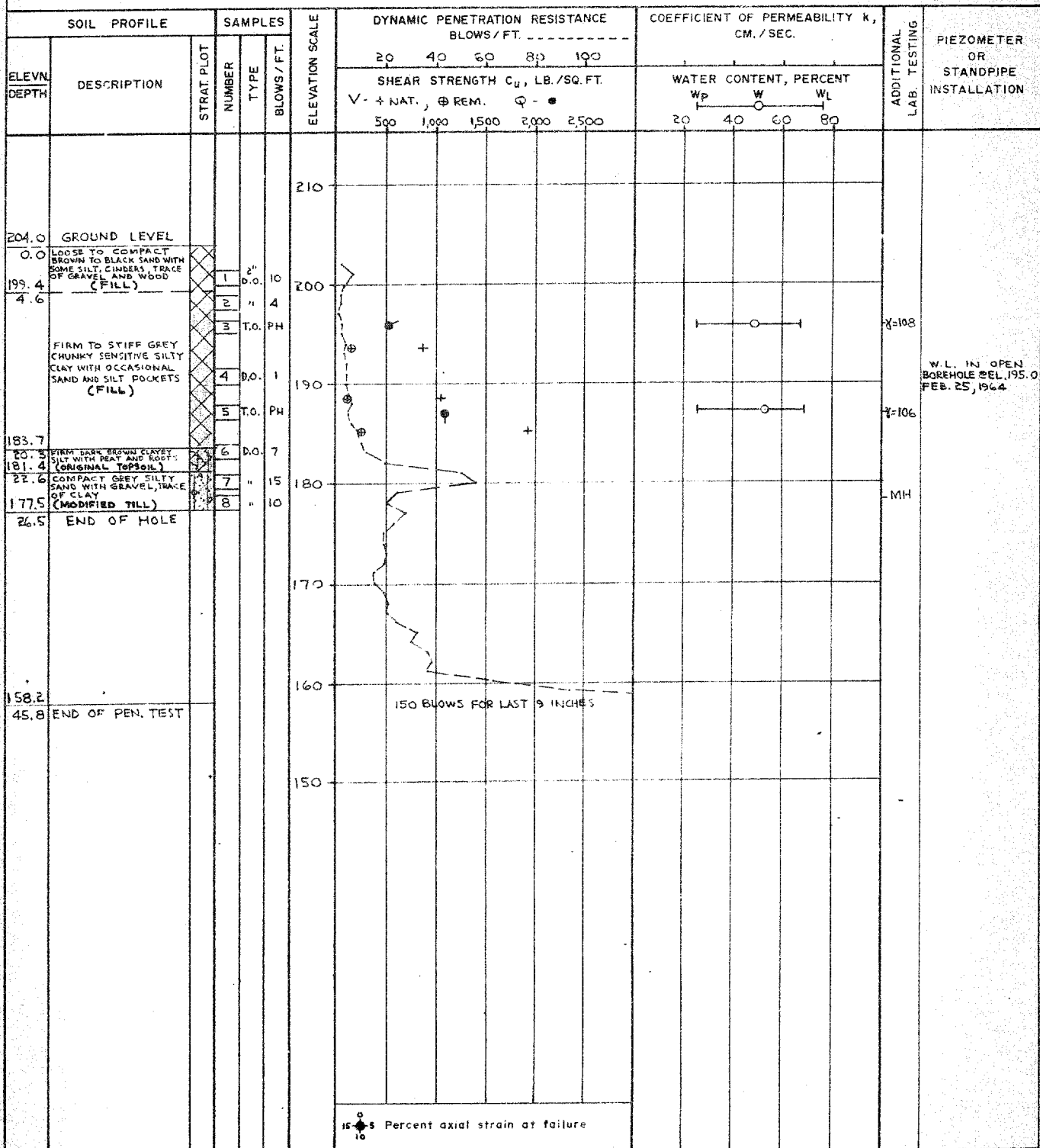
BOREHOLE TYPE POWER AUGER BORING

BOREHOLE DIAMETER

4.5"

SAMPLER HAMMER WEIGHT 140 LB. DROP 30 INCHES

PEN. TEST HAMMER WEIGHT 140 LB. DROP 30 INCHES



VERTICAL SCALE  
1 INCH TO 10'-0"

GOLDER & ASSOCIATES

DRAWN J.A.  
CHECKED M

# RECORD OF BOREHOLE 202

LOCATION RAMP W-5, STA. 644+10  
See Figure 1

BORING DATE FEB. 4, 1964

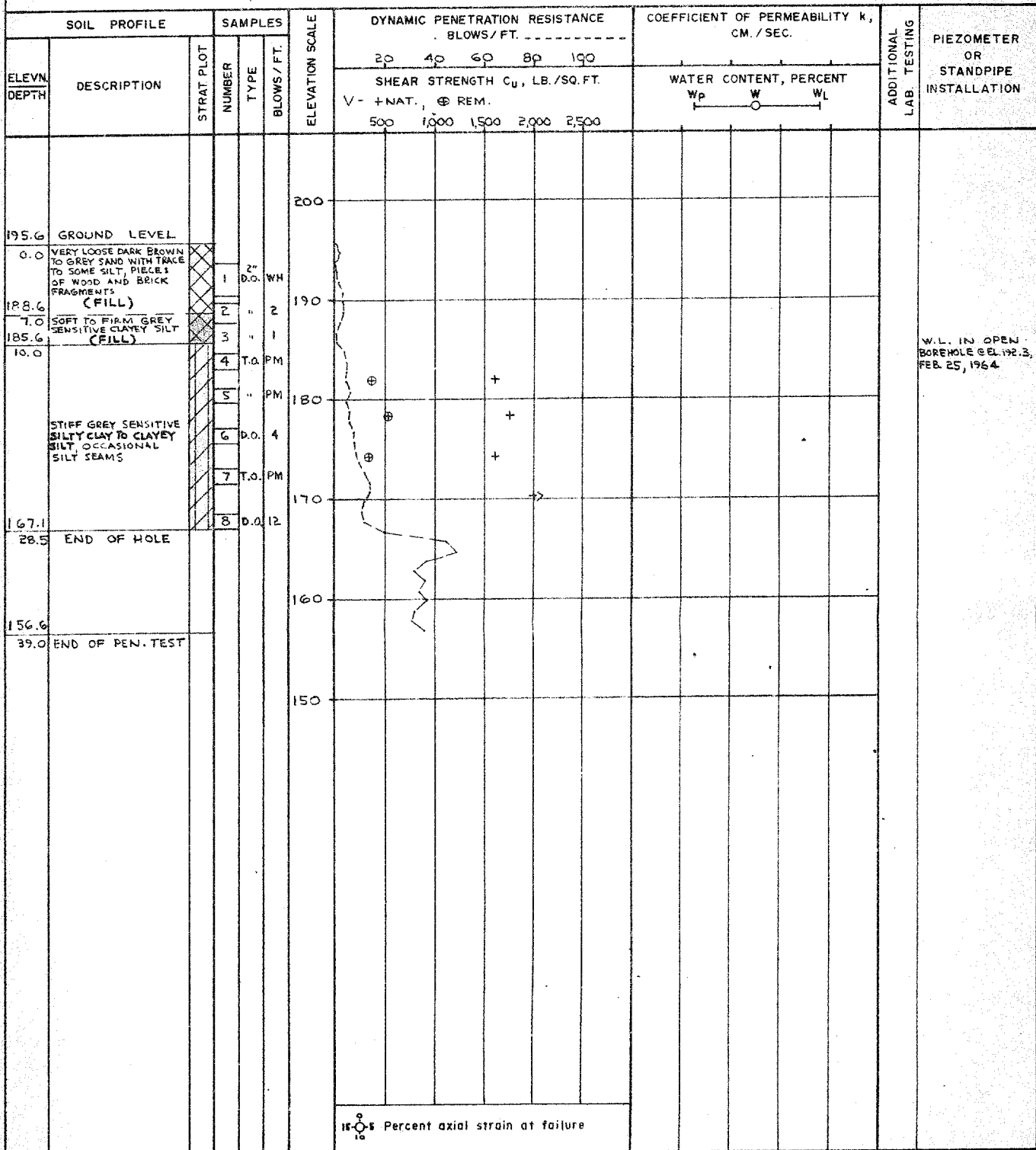
DATUM GEODETIC

BOREHOLE TYPE POWER AUGER BORING

BOREHOLE DIAMETER 4.5"

SAMPLER HAMMER WEIGHT 140 LB. DROP 30 INCHES

PEN. TEST HAMMER WEIGHT 140 LB. DROP 30 INCHES



VERTICAL SCALE  
1 INCH TO 10'-0"

GOLDER & ASSOCIATES

DRAWN J.A.  
CHECKED D.M.

# RECORD OF BOREHOLE 203

LOCATION RAMP W-3, STA. 642+38  
See Figure 1

BORING DATE FEB. 4, 1964

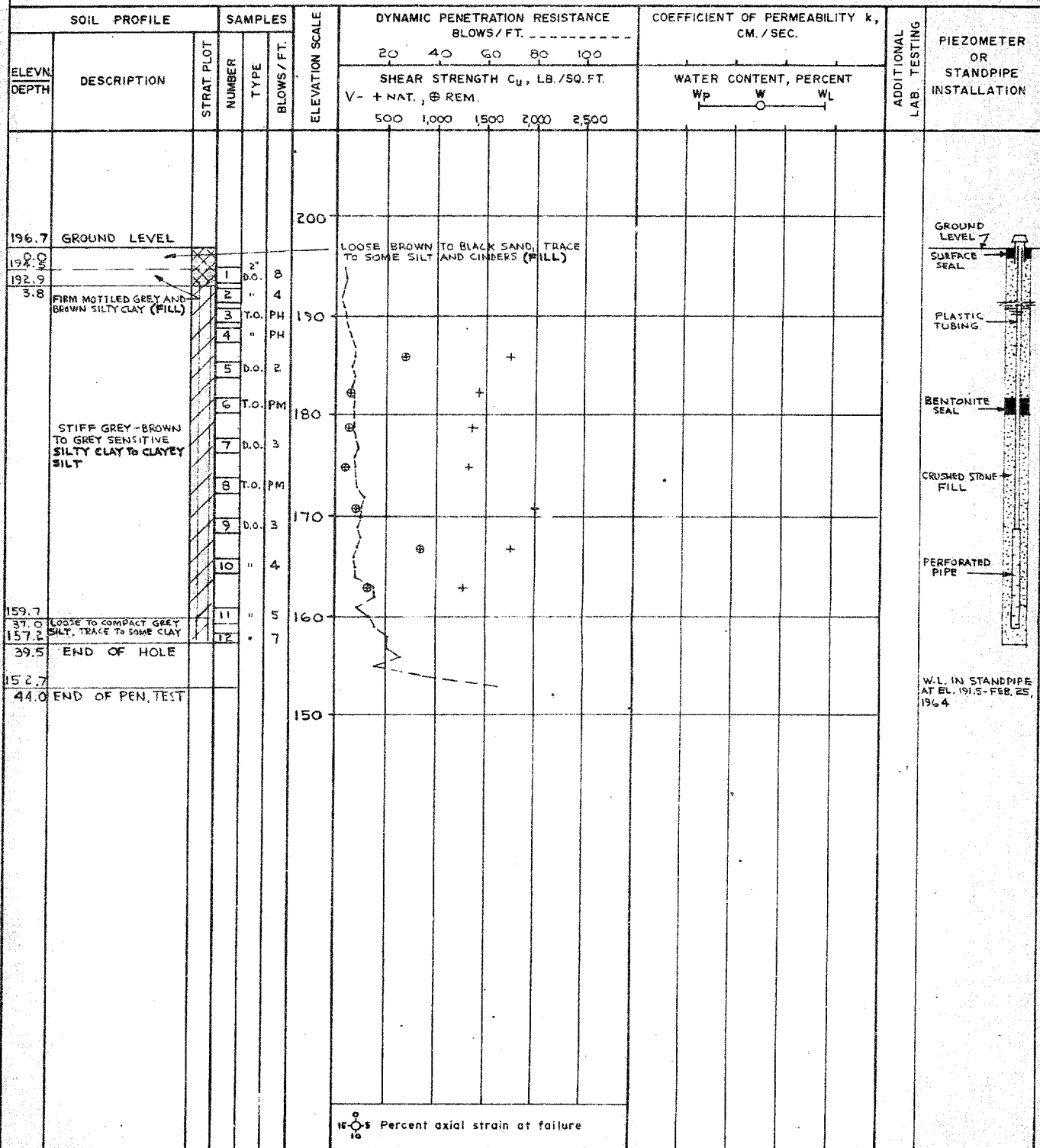
DATUM GEODETIC

BOREHOLE TYPE POWER AUGER BORING

BOREHOLE DIAMETER 4.5"

SAMPLER HAMMER WEIGHT 140 LB. DROP 30 INCHES

PEN. TEST HAMMER WEIGHT 140 LB. DROP 30 INCHES



VERTICAL SCALE  
1 INCH TO 10'-0"

GOLDER & ASSOCIATES

DRAWN J.A.  
CHECKED D.C.

# RECORD OF BOREHOLE 204

LOCATION RAMP W-5, STA. 639+50  
See Figure 1

BORING DATE FEB. 7, 1964

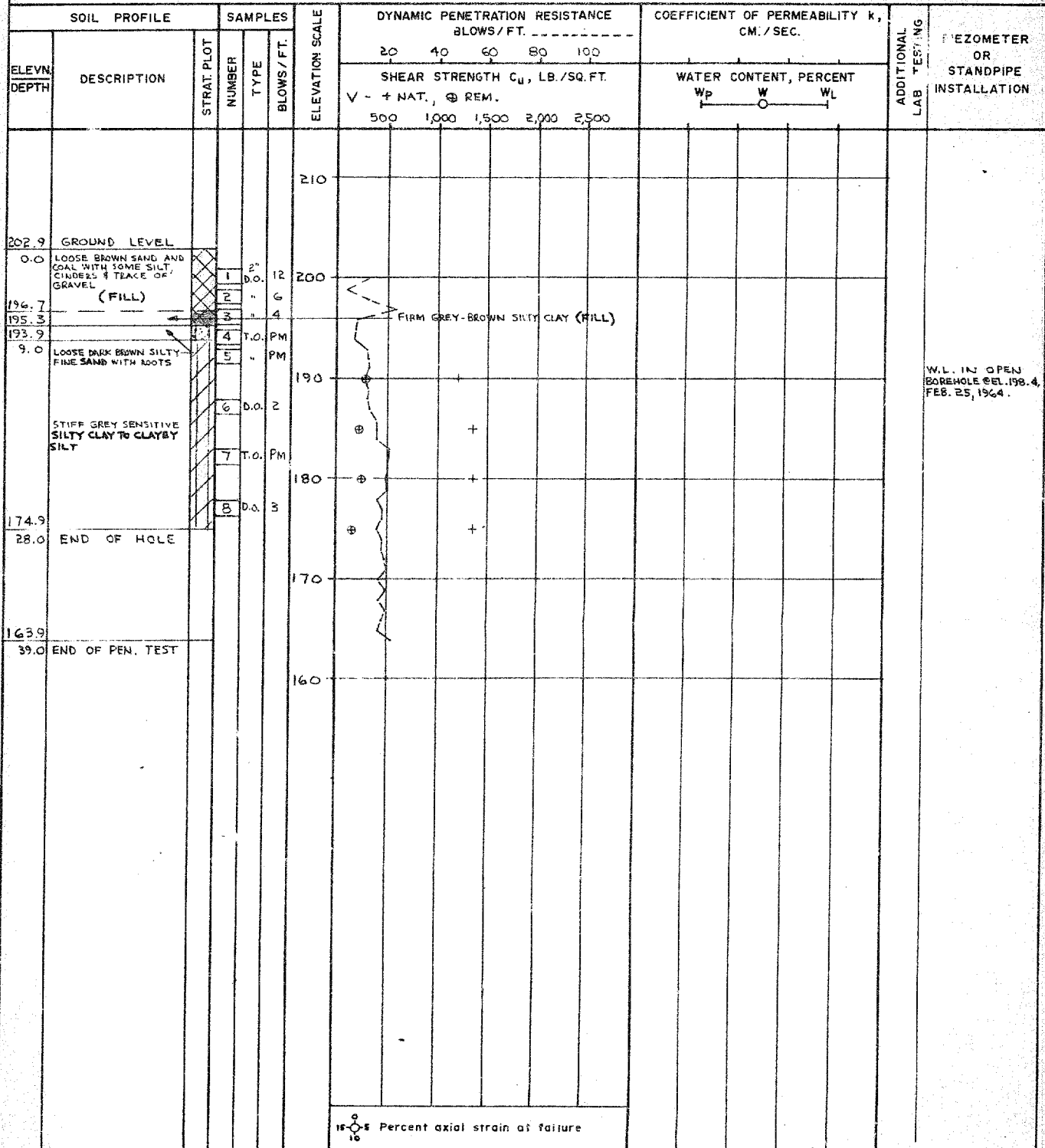
DATUM GEODETIC

BOREHOLE TYPE POWER AUGER BORING

BOREHOLE DIAMETER 4.5"

SAMPLER HAMMER WEIGHT 140 LB. DROP 30 INCHES

PEN. TEST HAMMER WEIGHT 140 LB. DROP 30 INCHES




VERTICAL SCALE  
1 INCH TO 10'-0"

GOLDER & ASSOCIATES

DRAWN J.A.  
CHECKED J.A.

PEN. TEST HAMMER WEIGHT 140LB. DROP 30 INCHES

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



# RECORD OF BOREHOLE 206

LOCATION RAMP W-N, STA. 543+63  
See Figure 1

BORING DATE FEB. 5, 6, 1964

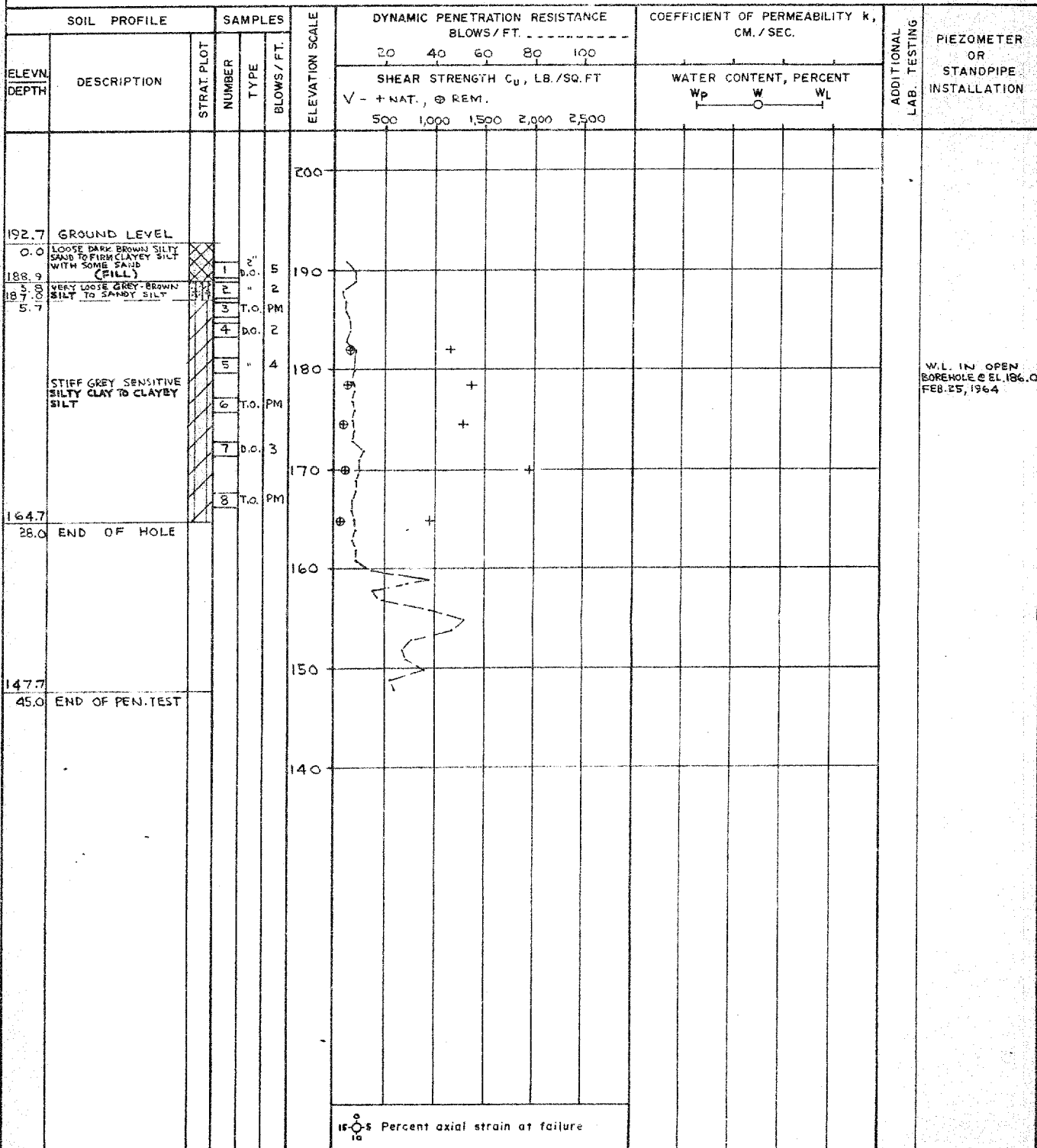
DATUM GEODETIC

BOREHOLE TYPE POWER AUGER BORING

BOREHOLE DIAMETER 4.5"

SAMPLER HAMMER WEIGHT 140 LB. DROP 30 INCHES

PEN. TEST HAMMER WEIGHT 140 LB. DROP 30 INCHES



VERTICAL SCALE  
1 INCH TO 10'-0"

GOLDER & ASSOCIATES

DRAWN J.A.  
CHECKED *mm*

## RECORD OF BOREHOLE 207

LOCATION RAMP N-E, STA. 761+85  
See Figure 1

BORING DATE FEB. 6, 7, 1964

DATUM                      GEODETIC

BOREHOLE TYPE

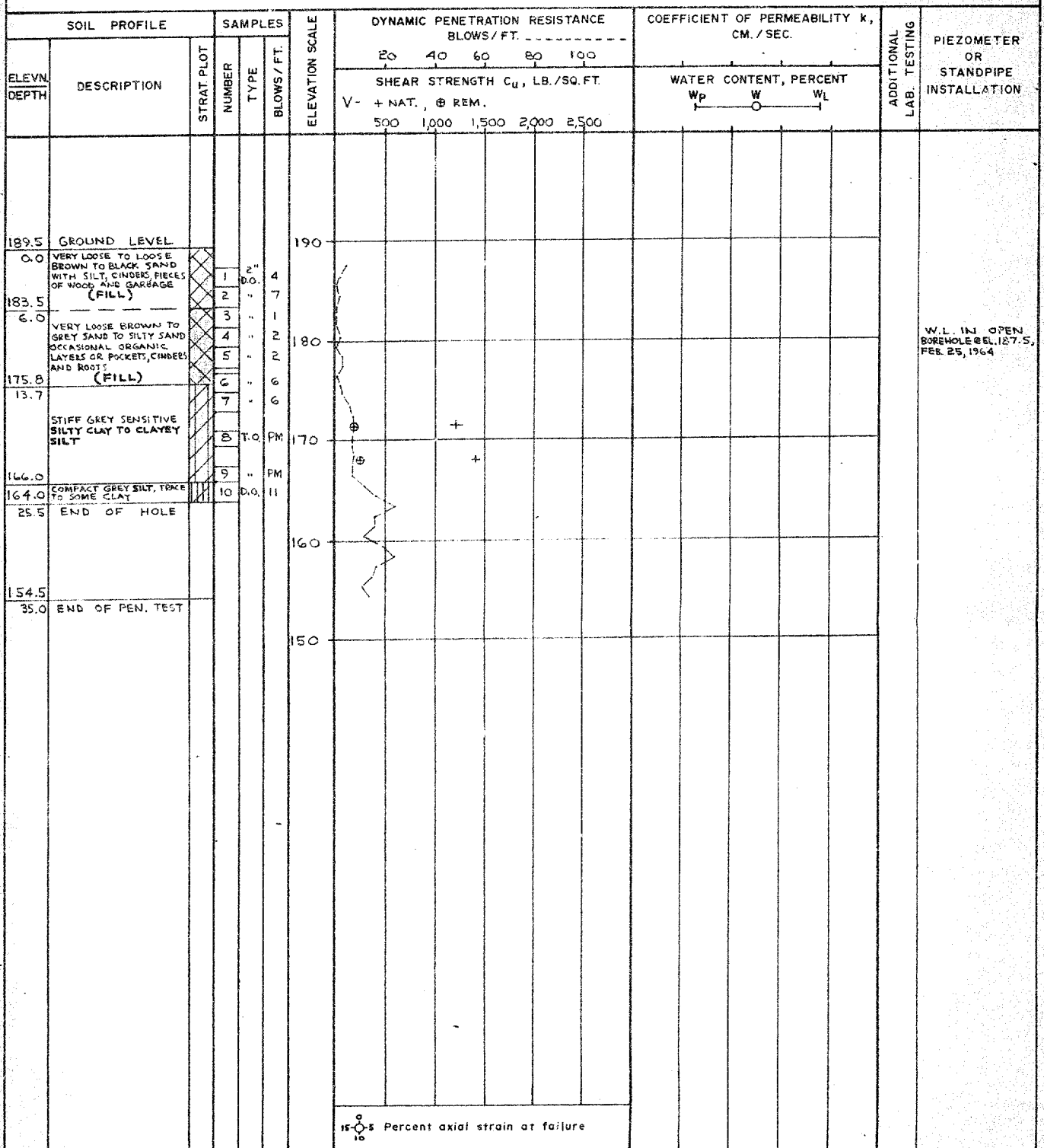
WASH BORING

BOREHOLE DIAMETER

EX CASING

SAMPLER HAMMER WEIGHT 140 LB. DROP 30 INCHES

PEN. TEST HAMMER WEIGHT 140 LB. DROP 30 INCHES



VERTICAL SCALE  
1 INCH TO 10'-0"

**GOLDER & ASSOCIATES**

DRAWN J. A.  
CHECKED [Signature]

# RECORD OF BOREHOLE 208

LOCATION RAMP N-E, STA. 755+80  
See Figure 1

BORING DATE FEB. 5, 1964

DATUM GEODETIC

BOREHOLE TYPE

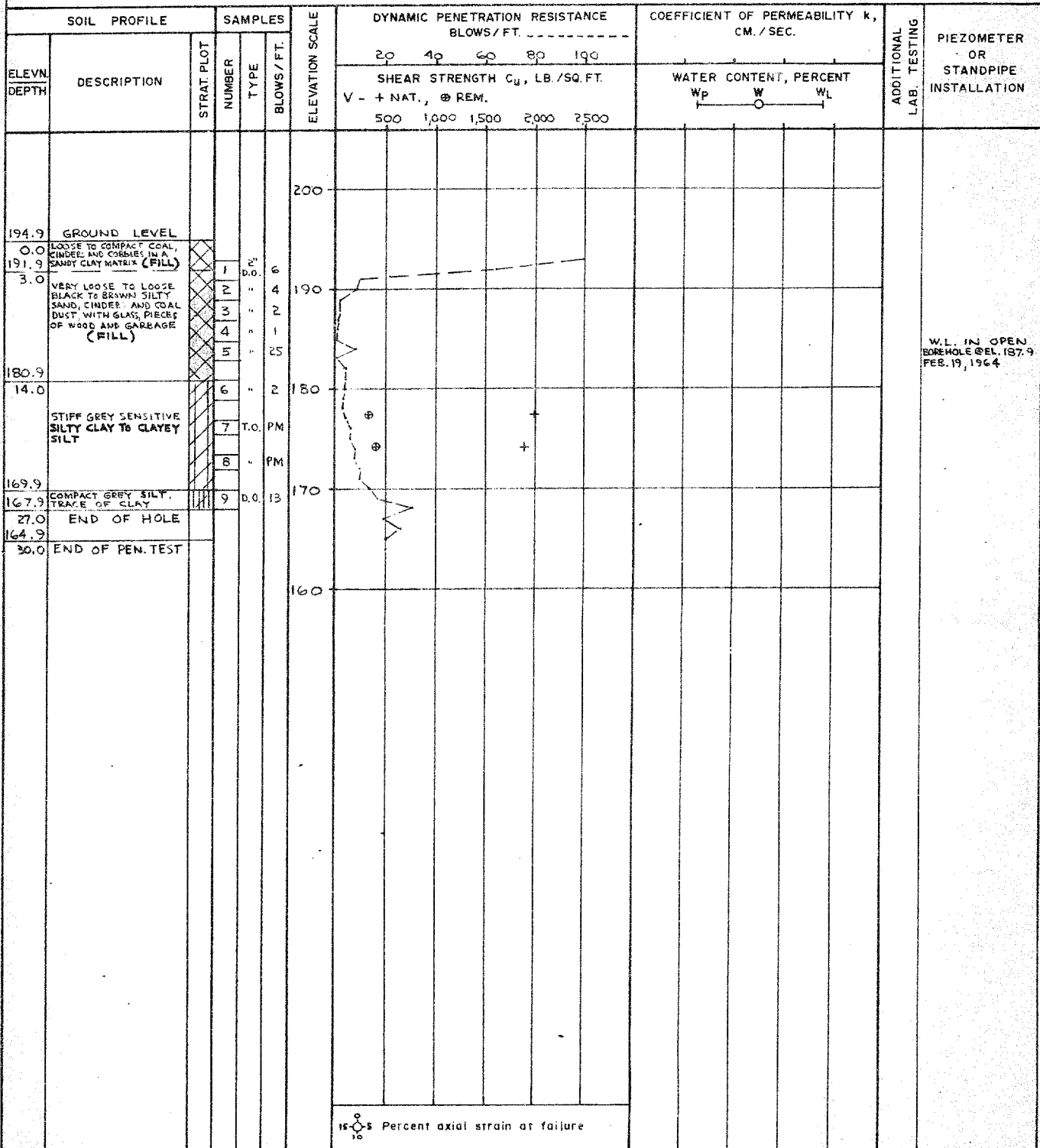
WASH BORING

BOREHOLE DIAMETER

Bx CASING

SAMPLER HAMMER WEIGHT 140 LB. DROP 30 INCHES

PEN. TEST HAMMER WEIGHT 140 LB. DROP 30 INCHES



W.L. IN OPEN  
BOREHOLE @ EL. 187.9  
FEB. 19, 1964

VERTICAL SCALE  
1 INCH TO 10'-0"

GOLDER & ASSOCIATES

DRAWN J.A.  
CHECKED [Signature]

# RECORD OF BOREHOLE 209

LOCATION RAMP N-E, STA. 764+60  
See Figure 1

BORING DATE FEB. 4, 5, 1964

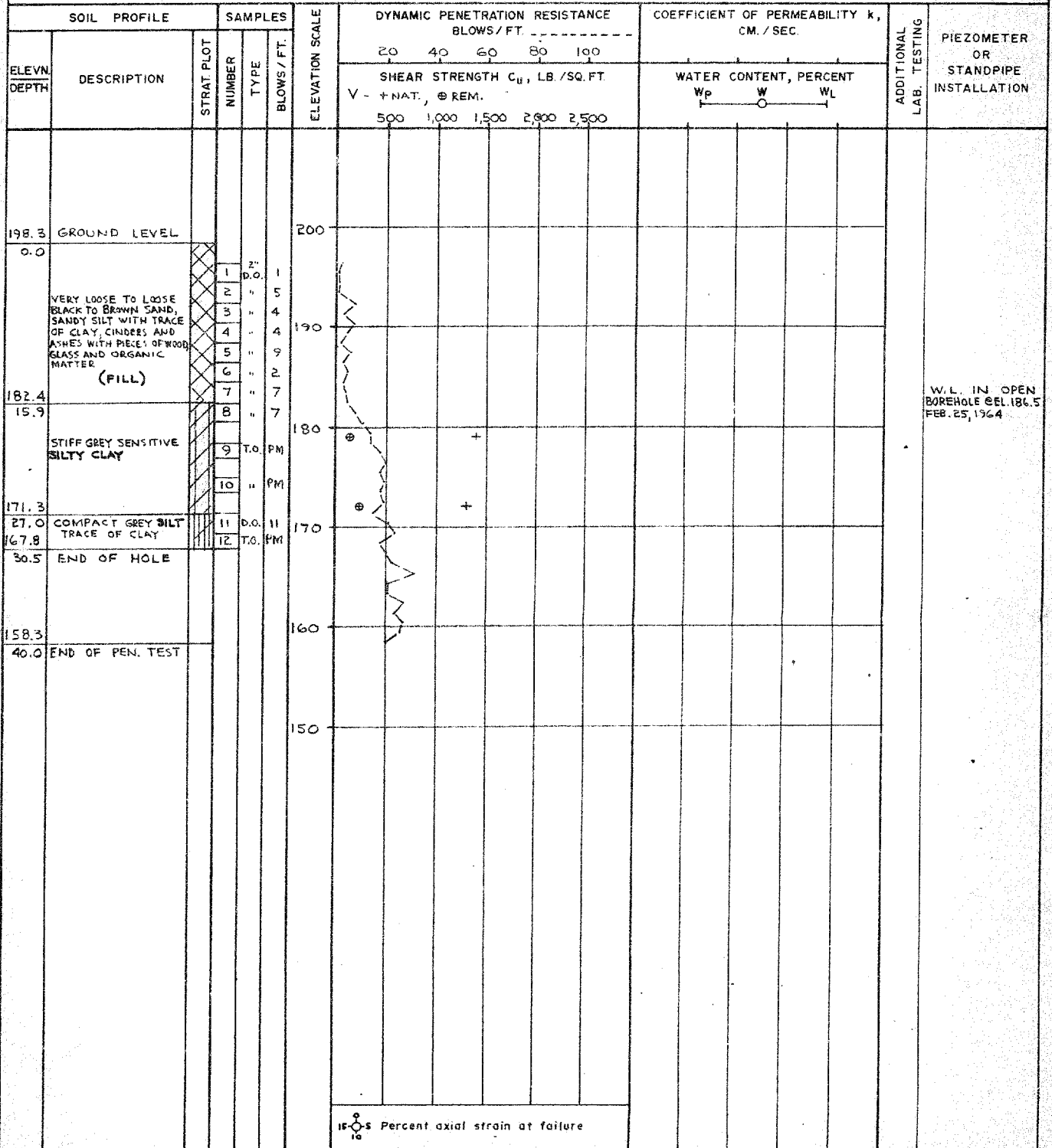
DATUM GEODETIC

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



VERTICAL SCALE  
1 INCH TO 10'-0"

GOLDER & ASSOCIATES

DRAWN J.A.  
CHECKED JY

## RECORD OF BOREHOLE 210

LOCATION RAMP S-E, STA. 867+83  
See Figure 1

BORING DATE FEB. 7, 1964

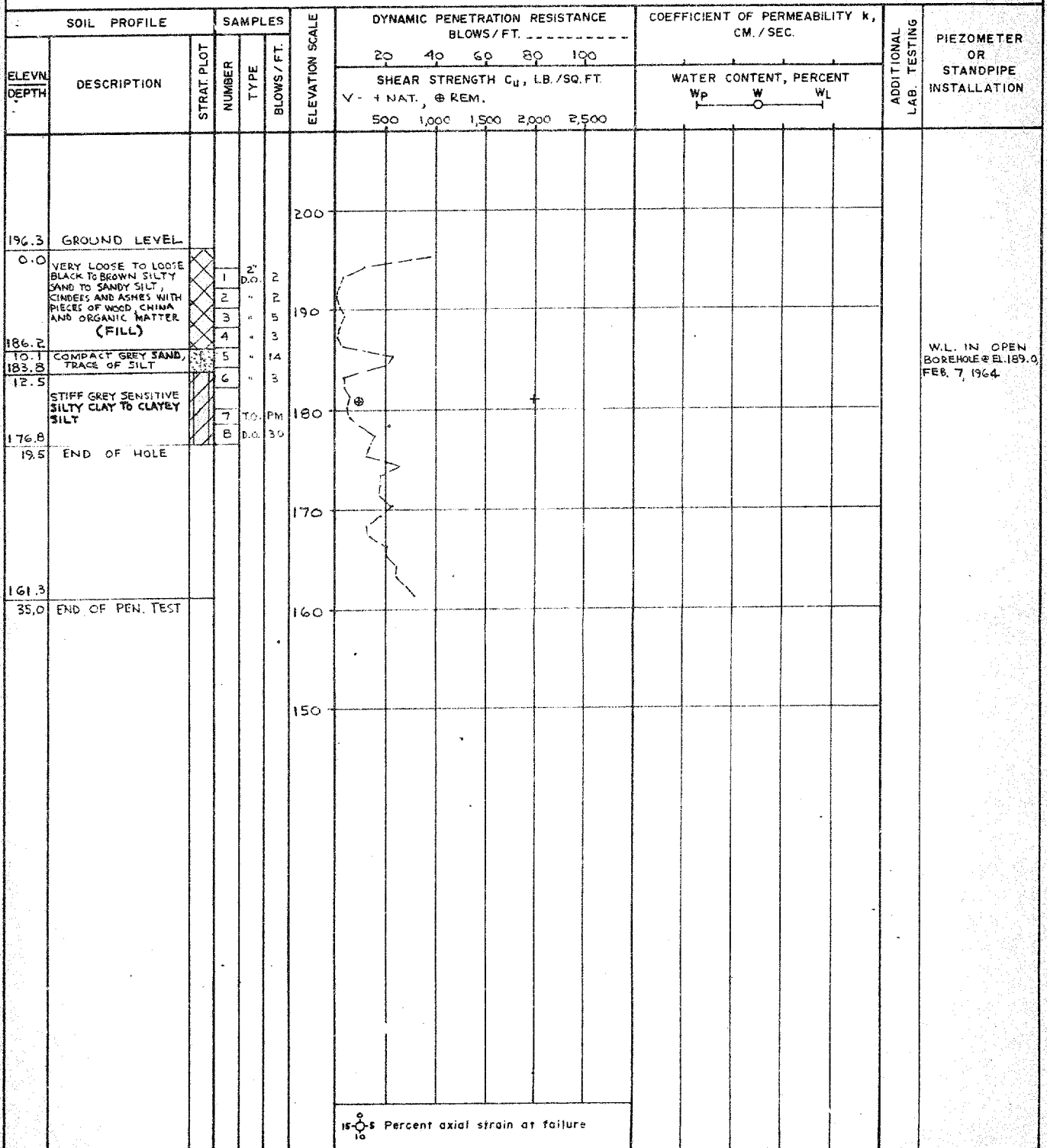
DATUM GEODETIC

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

VERTICAL SCALE  
1 INCH TO 10'-0"

GOLDER &amp; ASSOCIATES

DRAWN *JA*  
CHECKED *JA*

## RECORD OF BOREHOLE 211

LOCATION CANAL ROAD, STA. 144+60  
See Figure 1

BORING DATE FEB. 24-25, 1964

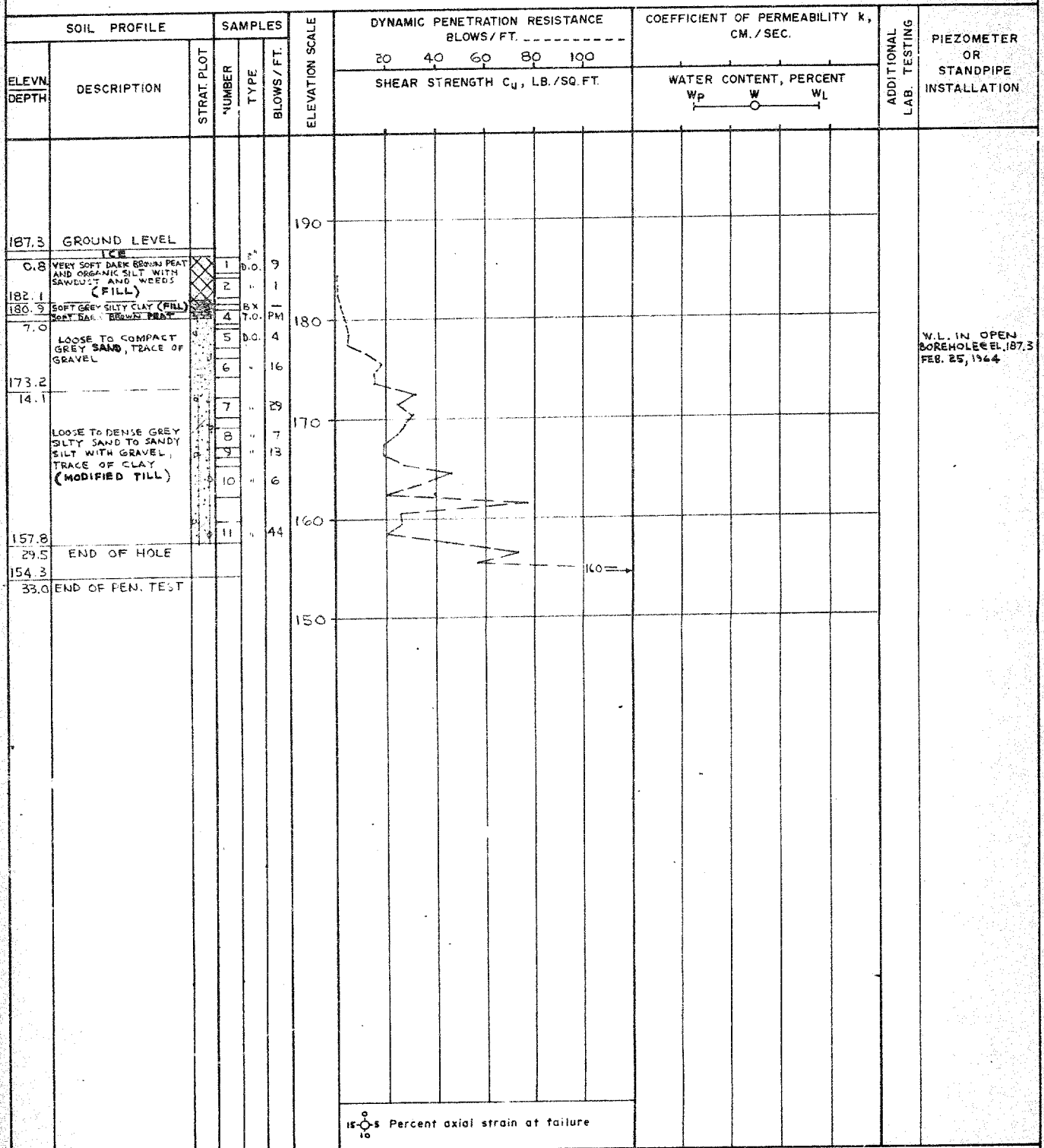
DATUM GEODETIC

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

VERTICAL SCALE  
1 INCH TO 10'-0"

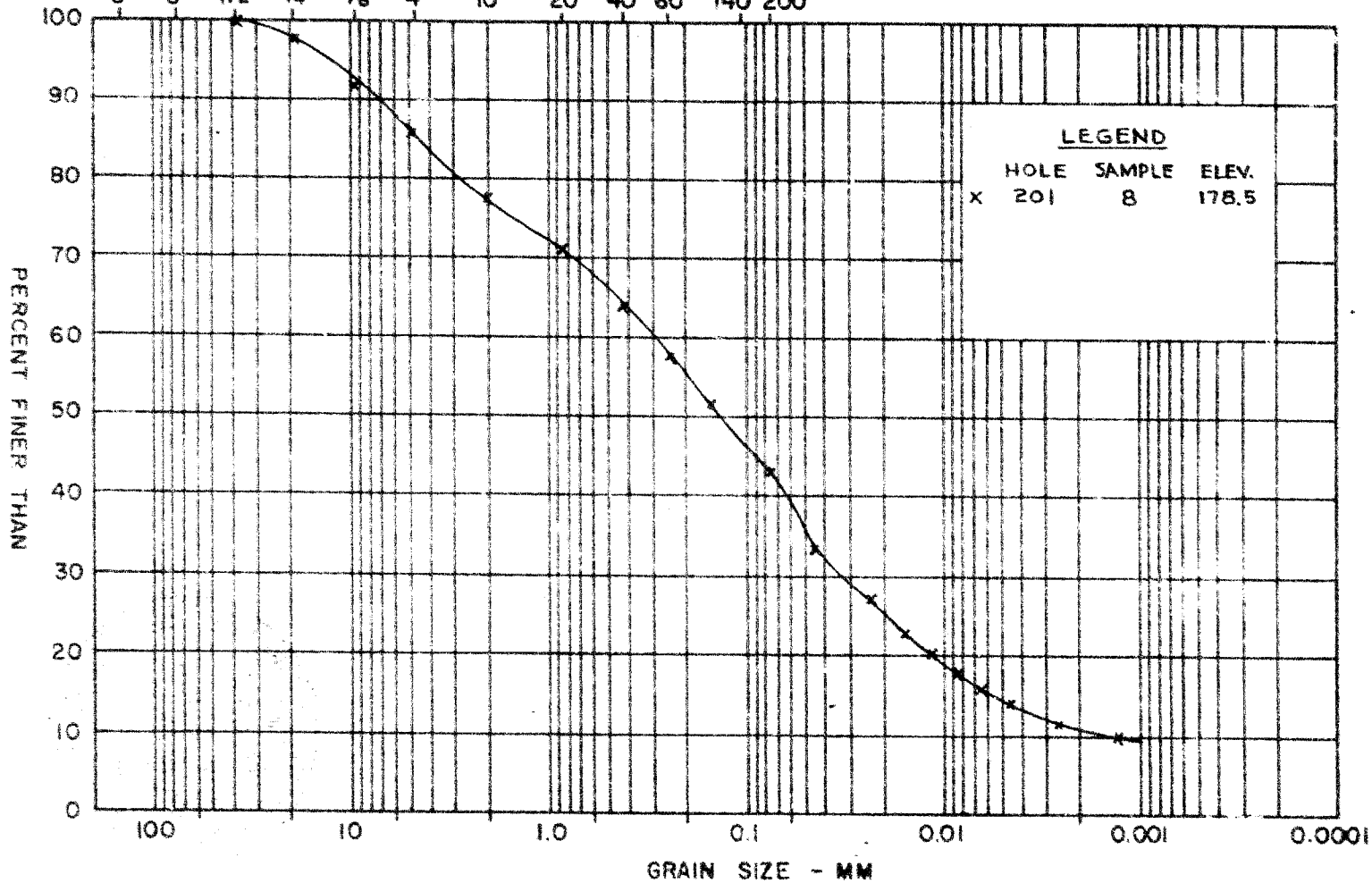
GOLDER &amp; ASSOCIATES

DRAWN J.A.  
CHECKED *dy*

# 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



GOLDER & ASSOCIATES

GRAIN SIZE DISTRIBUTION  
MODIFIED TILL

FIGURE 2

| COBBLE SIZE | COARSE      | MEDIUM | FINE | COARSE    | MEDIUM | FINE | SILT SIZE    | CLAY SIZE |
|-------------|-------------|--------|------|-----------|--------|------|--------------|-----------|
|             | GRAVEL SIZE |        |      | SAND SIZE |        |      | FINE GRAINED |           |

#64-F-225C

W.P. #949-59-03

OTTAWA

QUEENSWAY

BRIDGE #38



