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LOCATION PROP. MACDONALD -
CARTIER BRIDGE,
OTTAWA APPROACH

=====

OVERSIZE DRAWINGS TO BE INCLUDED WITH THIS REPORT. NONE

REMARKS: _____

BA 1490

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

CONSULTING ENGINEERS - MACDONALD-CARTIER BRIDGE

ON

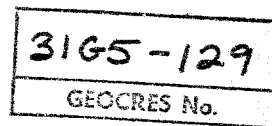
SITE INVESTIGATION

PROPOSED MACDONALD-CARTIER BRIDGE

OTTAWA APPROACH

OTTAWA

ONTARIO



Distribution:

**20 copies - Consulting Engineers - Macdonald-Cartier Bridge,
Ottawa, Ontario.**

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

July, 1962

6135-2

ABSTRACT

The factual results of a site investigation carried out for the Ottawa approach portion to the proposed Macdonald-Cartier Bridge between Ottawa, Ontario and Hull, Quebec, are reported.

It was found that the site is covered by a shallow depth of generally granular overburden resting on bedrock. The overburden on the east bank of the Ottawa River is about 3 feet thick increasing to about 15 feet near the west bank of the Rideau River. Bedrock surface slopes off gradually across the site in a general west to east direction from about elevation 190 at Sussex Street to about elevation 170 at the Rideau River.

A layer of loose to compact sandy fill which reaches a maximum thickness of about 10 feet at the existing railway embankment on the west bank of the Rideau River forms the surface cover over most of the site. The fill between the Rideau River and King Edward Avenue to the west is underlain by a 10 foot thick stratum of loose to compact sandy to clayey silt. To the west of King Edward Avenue up to about Cumberland Street the fill is underlain by about 15 feet of compact sandy gravel grading into compact to dense cobbles and boulders. A thin layer of compact sandy glacial till above the bedrock generally underlies the silt or cobbles and boulders and the fill west of Cumberland Street.

Bedrock across the site is a shaley limestone. The upper portion of the bedrock is slightly weathered and jointed. Below this upper weathered zone the bedrock is generally sound but contains both healed and open fractures.

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INTRODUCTION

H. Q. Golder & Associates Ltd. has been retained by the Consulting Engineers - Macdonald-Cartier Bridge to carry out a site investigation for the Ottawa approach portion to the proposed Macdonald-Cartier Bridge between Ottawa, Ontario and Hull, Quebec. The purpose of this work was to determine and interpret the soil and rock conditions at the site in relation to foundation design for the approach structures.

The results of the stage I and stage II site investigations carried out for the main bridge over the Ottawa River are presented in our reports 6135 dated December, 1961 and 6135-3 dated June, 1962, respectively. This report which covers the factual information obtained from the site investigation for the Ottawa approach portion to the bridge complements and should be read in conjunction with the above reports.

PROCEDURE

The field work for this investigation was carried out during the periods January 16 to February 2, March 7 to March 12 and June 5 to June 7, 1962. A total of 17 boreholes, numbered 30 to 46 inclusive, were put down during the first two periods using a standard machine drillrig. Thirteen of these borings were put down at proposed bridge structure locations and the remaining 4 along the proposed roadway route. Two additional boreholes, numbered 47 and 48, were put down during the latter period of the work at the revised location of the proposed bridge structure near Cumberland and Redpath Streets.

Bedrock was core drilled in BXT size (approx. $1\frac{1}{2}$ inches diameter) in most of the boreholes put down. A porous pot piezometer was installed in one borehole at each of the proposed structure locations to determine the groundwater level.

The locations of all the borings put down in this investigation are shown on Figure 1. Sections of the inferred soil and bedrock stratigraphy are given on Figures 2, 3 and 3A. A detailed log for each boring is given on the Records of Boreholes.

The samples obtained during the investigation were brought to our laboratory for examination and testing. The results of the laboratory testing are plotted on the Records of Boreholes and on Figures 4 to 7, inclusive.

The elevations given in this report are referred to Geodetic datum. All the survey work connected with the investigation was carried out by the Consulting Engineers.

SITE TOPOGRAPHY AND GEOLOGY

The Ontario approach section of the proposed Macdonald-Cartier Bridge over the Ottawa River is situated within the City of Ottawa. The approach begins on the south or west side of the Rideau River and curves westward between Redpath and Boteler Streets to join the bridge proper on the east side of the Ottawa River near the proximity of Sussex Drive and Redpath Street.

At the site the Rideau River is a shallow stream with

bedrock generally outcropping in the stream bed and along its banks. Several bedrock islands dot the channel of the river. The banks of the river rise only a few feet to the general ground surface on either side. About 1500 feet north of the bridge approach the Rideau River plunges over a 50 foot cliff to join the Ottawa River some 2000 feet downstream from the bridge site. At the proposed bridge abutment location on the Ottawa bank, vertical bluffs 45 feet high separate the upland area of the approach section from the flood plain of the Ottawa River.

Over the length of the approach, a distance of about 2000 feet, the ground surface rises gently from an elevation of about 185 on King Edward Avenue near the Rideau River to about 194 on Sussex Drive.

The site is underlain by relatively flat lying beds or laminae of limestone and shale of Ordovician age. The bedrock is overlain, in some places, by a thin veneer of Pleistocene till. As the glaciers retreated, the bedrock and till of the area was inundated by the Champlain Sea which invaded the land. Sediments of gravels, sands, silts and clays were deposited in this marine environment. Within the area of the site the overburden cover which consists of marine deposits and till is shallow and generally less than 15 feet.

A more detailed account of the physiography and geology of this locality is given in our report 6135, dated December, 1961.

SOIL CONDITIONS

The principal soil strata encountered by the borings put down at the site are as follows:

Fill

The approach route which approximately follows an existing railway line is generally covered by a layer of fill up to about 11 feet thick at the Rideau River. The fill is variable in composition across the site but is comprised mainly of dark brown silty sand with some gravel and a trace of organic matter. Occasional cobble sizes and concrete slabs, particularly in the vicinity of station 54+00, are present in the fill. It is understood that the concrete slabs have been dumped on the site.

Based on the standard penetration tests which gave 'N' values ranging between about 3 and 20 blows per foot, together with the results of the dynamic penetration tests, the fill is loose to compact.

Silt

A stratum of grey brown to grey silt underlies the surface layer of fill at the 2 structure locations proposed nearest the Rideau River to the east of King Edward Avenue. The silt is about 8 to 10 feet thick and extends down to about elevations 171 and 176 at the existing railway line and the location to the north-west of this, respectively. The stratum is essentially

comprised of silt but varies in composition from a sand to clayey silt. Grading curves obtained on samples from the stratum are shown on Figures 4 and 5. The stratum is generally horizontally stratified with layers of the order of 1/8 inch thick which represent a minor variance in grain size and colour. Occasional thin layers of sand and silty clay are present in the silt stratum. The results of an Atterberg limit and 2 organic content determinations on samples from the stratum are given on the Records of Boreholes.

Standard penetration tests carried out in the silt gave 'N' values ranging between about 5 and 30 blows per foot with a few values of up to about 50 blows per foot. Based on these results the stratum varies from loose to dense and is generally loose to compact.

Sandy Gravel

At ground surface at the structure location along the main approach route to the west of King Edward Avenue, below the surface cover of fill at the structure location near Redpath and Cumberland Streets and below the fill at about station 50+00 along the main route, is a stratum of sandy gravel. The stratum is grey brown in colour and is about 6 feet thick. It is comprised essentially of gravel with sand and a trace of silt and cobbles. At the structure location near Redpath and Cumberland, the cobble content is greater than at the other locations and the stratum also contains

boulder sizes with depth. The gravel, cobbles and boulders in the stratum are composed of limestone and the individual sizes are generally subangular in shape. Two grain size distribution curves on samples of the sandy gravel are shown on Figure 6.

Standard penetration tests in the stratum gave 'N' values ranging from about 30 to over 100 blows per foot. Most of the higher values were obtained on cobble sizes and thus are not representative of the in situ density of the stratum. The sandy gravel, based on the resistance to drilling together with the 'N' values obtained, ranges from loose to dense and is judged to be generally compact.

Cobbles and Boulders

The sandy gravel at the structure location along the main approach route to the west of King Edward Avenue grades into a stratum of cobbles and boulders which extends down to bedrock. Cobbles and boulders were also encountered overlying the bedrock and beneath the surface cover of concrete slab fill in borehole 33 put down at about station 54+00 along the main route. The stratum is about 10 feet thick and is comprised of grey limestone cobbles and boulders in a matrix of sand and gravel. The boreholes could not be advanced by the normal wash boring method and the casing had to be drilled through the cobbles and boulders stratum. It is estimated based on the performance of the rig during drilling operations

and the core recovered that the maximum boulder size could be about 4 feet. Similarly, it is estimated that the cobbles and boulders vary from a loose to dense state of packing and are generally compact to dense.

Silty Sand with Gravel

Underlying the silt or sandy gravel at the 2 structure locations in the vicinity of the intersection of Redpath, Cumberland and King Edward Avenue and beneath the fill in borehole 37 at about station 51+00 along the north approach route, is a stratum of glacial till resting on bedrock. The stratum is between about 2 and 3 feet thick and is comprised of a well graded composite of particles from the gravel to clay range. Three typical grain size distribution curves on samples of the till are given on Figure 7. The predominance of silt, sand and gravel sizes allows classification as a sandy till, essentially non-plastic.

Standard penetration tests carried out in the stratum gave 'N' values ranging from about 6 to 40 blows per foot. Based on these results together with the dynamic penetration test results, the till varies from loose to very dense and is generally compact to dense.

BEDROCK CONDITIONS

Bedrock underlies the site at about elevation 190 at Sussex Street gradually dropping off to about elevation 170 on the

west bank of the Rideau River. The overburden cover at the above locations is about 3 and 15 feet, respectively. Within the general area of the proposed bridge crossing over the Ottawa River the bedrock may be divided into three zones, referred to as zones A, B and C, which differ in their physical properties. These are described in detail in our report 6135, dated December, 1961. For the Ontario approach portion of the site under consideration, however, only the uppermost A zone is significant; the B and C zones lie buried by more than 150 feet of the A zone bedrock.

The A zone is dominantly limestone, fine to medium grained in size, fossiliferous and dark grey brown in colour. Black shale occurs as thin partings and laminae throughout the rock. From the rock cores examined in this section there is a gradual and distinct change in the composition and character of the bedrock from west to east. On Sussex Drive the shale more commonly occurs as discrete beds varying from a fraction of an inch to 3 inches in thickness. Near King Edward Avenue the individual beds of shale are not as conspicuous and the shale appears to be more uniformly disseminated throughout the limestone. It is best described as an argillaceous limestone. The rock is also characterized by a breccia or intraformational conglomerate interspersed through the section. The conglomerate probably originated when the sea floor was stirred up by some means prior to induration of the sediments, followed by redeposition of the fragments together with muds and calcium carbonate.

In general the bedrock across the site is relatively sound. The upper few feet of the limestone, however, show a slight

degree of weathering often accompanied by jointing and resultant poor core recovery. In addition to the surface jointing, vertical fractures are present in many drill cores. These fractures seldom exist for more than a few feet in any one core. In some instances the fractures are healed with calcite, in others only partly healed and in some they are open.

Occasional thin mud seams or voids were encountered in the bedrock during drilling. These seams or voids represent solution channels which result when percolating water dissolves out the relatively soluble limestone. The solution channels are seldom persistent for more than a few feet along any one bed; in general the water tends to move on top of a bed then drop down a few inches along a joint or fracture to the next lower bed.

WATER CONDITIONS

A porous pot piezometer was installed in one borehole at each of the proposed structure locations to determine the groundwater level. The piezometers were read periodically and the results of the observations are given on the Records of Boreholes.

The readings showed that the groundwater level at the structure locations, to the east of Cumberland Street near the Rideau River, is within the granular overburden and fluctuates with the Rideau River level. On January 24, 1962 the groundwater at these locations was at about elevation 178 and about 10 feet below general ground surface. During the middle of April, 1962 the water level was

at about elevation 183 and in the first part of June had dropped to about elevation 177.

At the Sussex Street structure location the water level on April 11, 1962 was within the bedrock and about 6 feet below ground surface.

JLS/jb
6135-2



J. L. Seychuk, P. Eng.

July, 1962

for 
V. Milligan, P. Eng.

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	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.P. - Thin-walled, Piston
F.S. - Foil 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 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:

<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	Less than 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	Qc - Consolidated Undrained Triaxial
SA - Sieve Analysis	S - Drained Triaxial
CA - 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^u or Q^uc.

SOIL PROPERTIES

γ - Total Unit Weight	K - Coefficient of Permeability
γ_d - Dry Unit Weight	c - Undrained Shear Strength (1/2 Compressive Strength)
γ_b - Submerged Unit Weight	St - Sensitivity
L _L - Liquid Limit	ϕ^* - Effective Angle of Shearing Resistance
P _L - Plastic Limit	c' - Effective Cohesion Intercept
W - Natural Water Content	Cc - Compression Index
G - Specific Gravity	Cv - Coefficient of Consolidation
e - Void Ratio	

RECORD OF BOREHOLE 30

LOCATION SEE FIGURE 1

BORING DATE JAN. 16 - 25, 1962

DATUM

GEODETIC

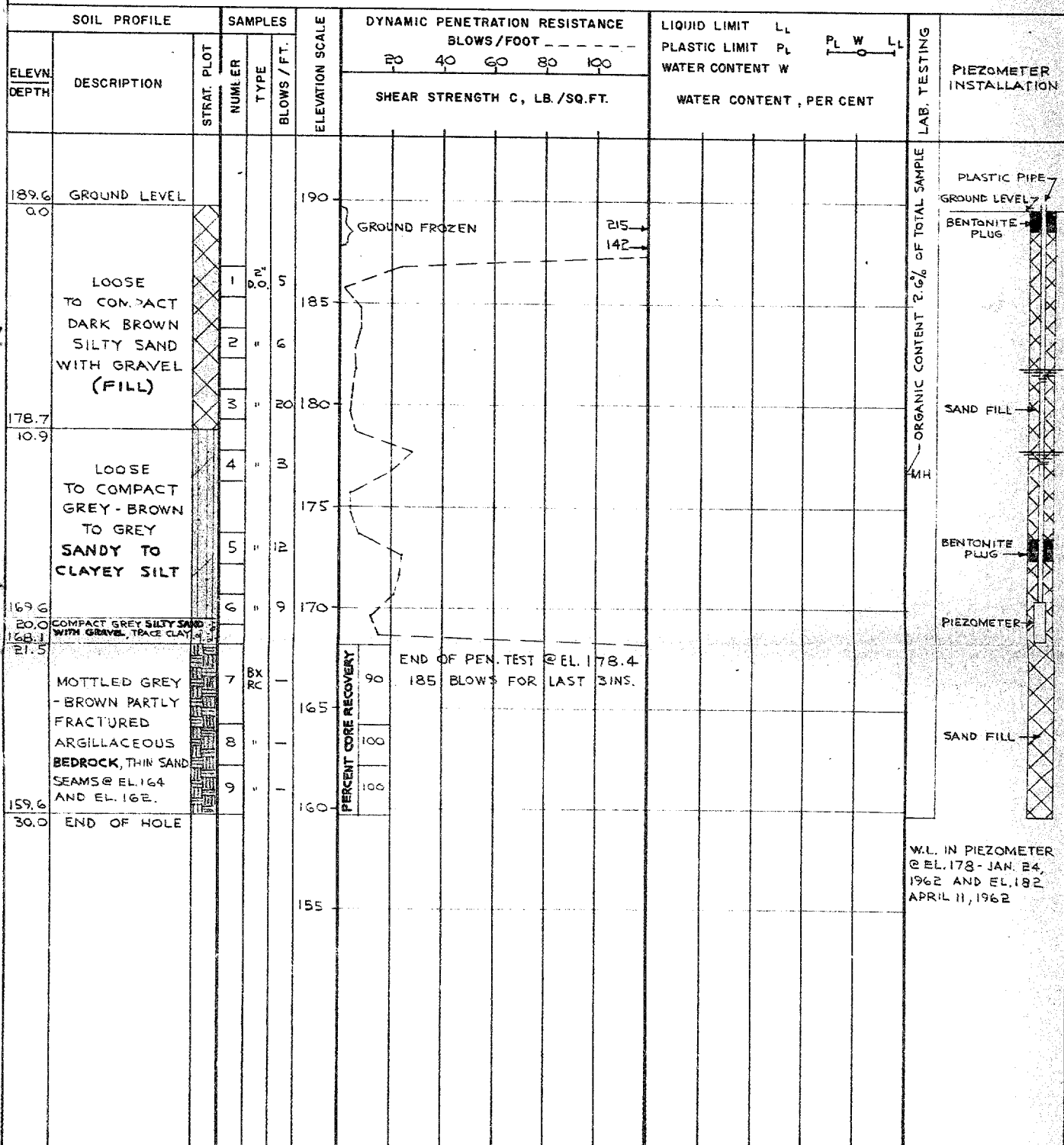
BOREHOLE TYPE POWER AUGER & WASH BORING

BOREHOLE DIAMETER

4.5" & B X CASING

SAMPLER HAMMER WEIGHT 140 LB. DROP 30 INCHES

PEN. TEST HAMMER WEIGHT 140 LB. DROP 30 INCHES

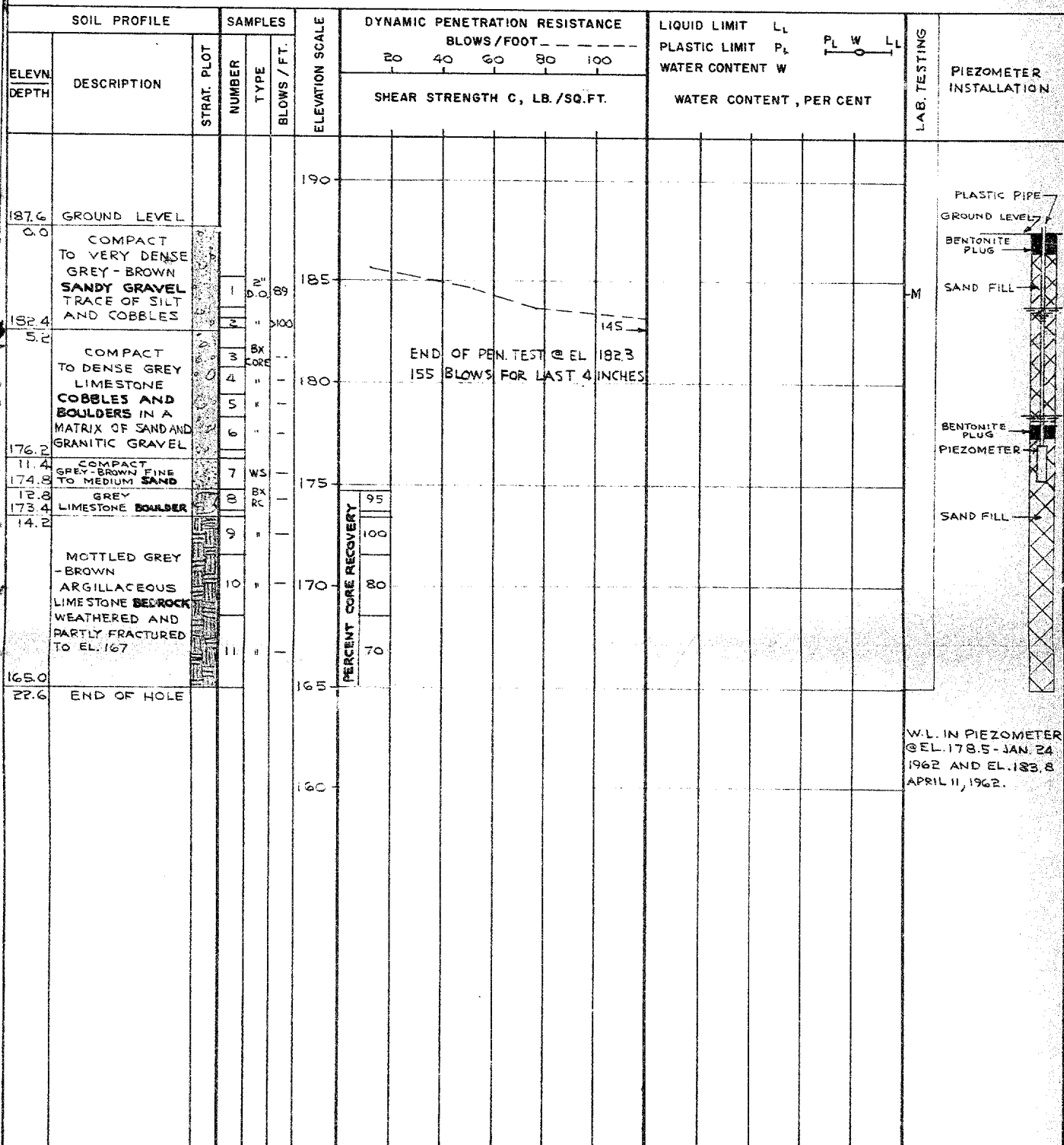

 VERTICAL SCALE
 1 INCH TO 5'-0"

GOLDER & ASSOCIATES

 DRAWN J.A.
 CHECKED *dy*

RECORD OF BOREHOLE 31

LOCATION SEE FIGURE 1 BORING DATE JAN. 18-24, 1962 DATUM GEODETIC
 BOREHOLE TYPE POWER AUGER & WASH BORING BOREHOLE DIAMETER 4.5" & BX CASING
 SAMPLER HAMMER WEIGHT 140 LB. DROP 30 INCHES PEN. TEST HAMMER WEIGHT 140 LB. DROP 30 INCHES



VERTICAL SCALE

1 INCH TO 5'-0"

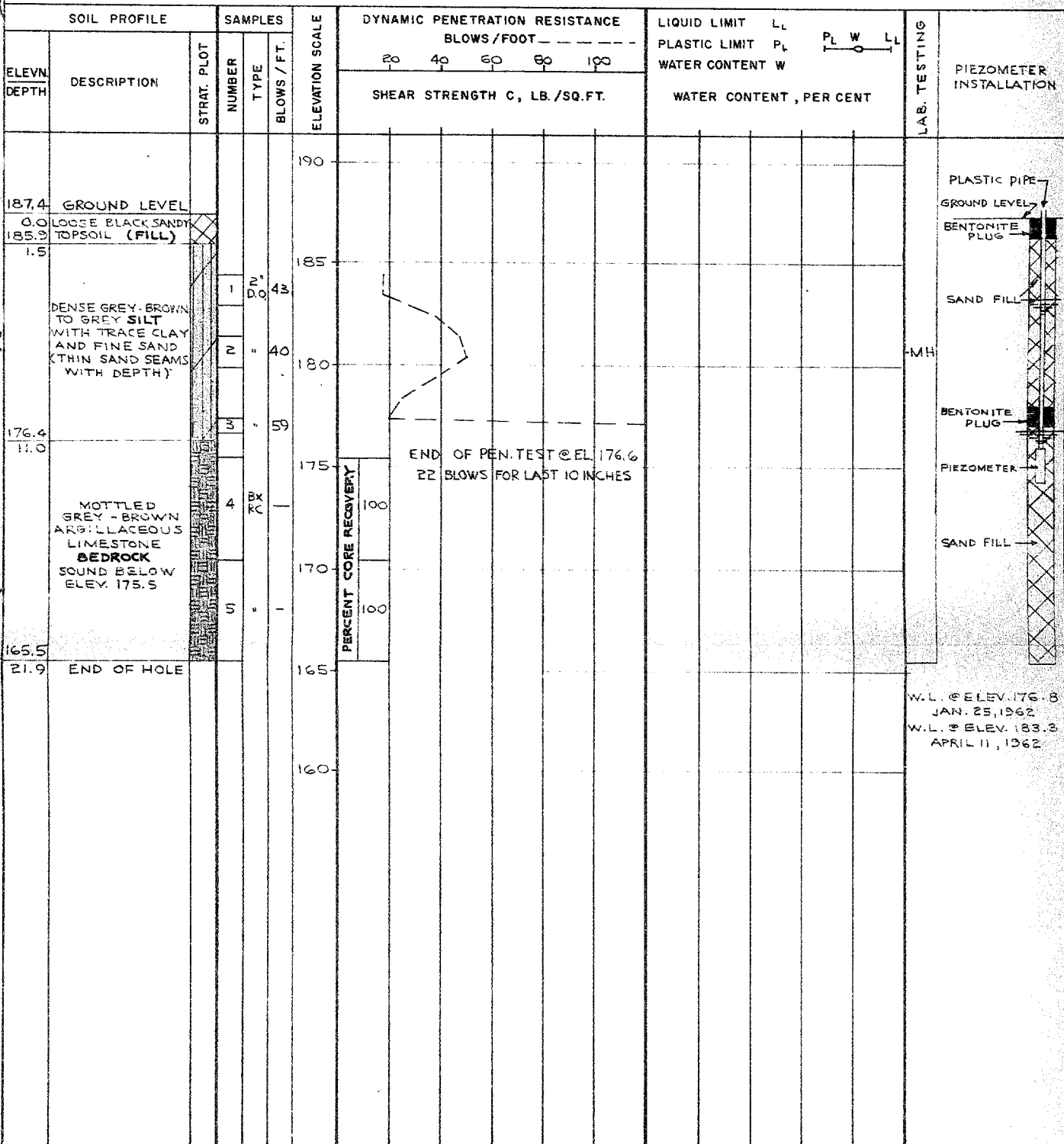
GOLDER & ASSOCIATES

DRAWN J.A.

CHECKED JAY

RECORD OF BOREHOLE 32

LOCATION SEE FIGURE 1 BORING DATE JAN. 18-27, 1962 DATUM GEODETIC
 BOREHOLE TYPE POWER AUGER & WASH BORING BOREHOLE DIAMETER 4.5" & BX CASING
 SAMPLER HAMMER WEIGHT 140 LB. DROP 30 INCHES PEN. TEST HAMMER WEIGHT 140 LB. DROP 30 INCHES



VERTICAL SCALE
1 INCH TO 5'-0"

GOLDER & ASSOCIATES

DRAWN J.A.
CHECKED *oot*

RECORD OF BOREHOLE 33

LOCATION SEE FIGURE 1 BORING DATE JAN. 29-FEB. 1, 1962 DATUM GEODETIC
 BOREHOLE TYPE POWER AUGER & WASH BORING BOREHOLE DIAMETER 4.5" & 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			
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE		BLOWS/FOOT					PLASTIC LIMIT P_L			
						20	40	60	80	100	WATER CONTENT W			
						SHEAR STRENGTH C , LB./SQ.FT.					WATER CONTENT, PER CENT			
188.3	GROUND LEVEL				190									
0.0	CONCRETE SLAB (FILL)													
185.3					185									
3.0														
	LOOSE TO COMPACT GREY LIMESTONE COBBLES AND BOULDERS IN MATRIX OF SAND AND GRAVEL				180									
174.8					175									
13.5														
	MOTTLED GREY-BROWN ARGILLACEOUS LIMESTONE BEDROCK, SLIGHT WEATHERING AND FRACTURING TO ELEV. 171				170									
163.8					165									
24.5	END OF HOLE				160									

VERTICAL SCALE
 1 INCH TO 5'-0"

GOLDER & ASSOCIATES

DRAWN J.A.
 CHECKED *JS*

RECORD OF BOREHOLE 34

LOCATION SEE FIGURE 1 BORING DATE DATUM GEODETIC
 BOREHOLE TYPE POWER AUGER BORING BOREHOLE DIAMETER 4.5"
 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					LIQUID LIMIT L_L PLASTIC LIMIT P_L WATER CONTENT W			WATER CONTENT , PER CENT		
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER		TYPE	BLOWS / FT.						P_L W L_L			
							SHEAR STRENGTH C , LB./SQ.FT.								
						20	40	60	80	100					

AUGERED

END OF PEN. TEST @ EL. 184.6
 79 BLOWS FOR LAST 6 INCHES

VERTICAL SCALE
 1 INCH TO 5'-0"

GOLDER & ASSOCIATES

DRAWN J.A.
 CHECKED *888*

RECORD OF BOREHOLE 35

LOCATION SEE FIGURE 1 BORING DATE JAN. 26-30, 1962 DATUM GEODETIC
 BOREHOLE TYPE POWER AUGER & WASH BORING BOREHOLE DIAMETER 4.5" & 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			LAB. TESTING
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	BLOWS / FT.		BLOWS / FOOT — — — — —					PLASTIC LIMIT P_L			
							20	40	60	80	100	WATER CONTENT W			
SHEAR STRENGTH C , LB./SQ.FT.							WATER CONTENT, PER CENT								
187.6 0.0	GROUND LEVEL					190									
184.3 3.3	LOOSE DARK BROWN SANDY TOPSOIL (FILL)		1	2" DO.	3	185									
	LOOSE TO DENSE GREY-BROWN TO GREY SILT WITH TRACE OF CLAY TO SANDY SILT		2	"	9	180								MH	
			3	"	34									MH	
176.6 11.0		MOTTLED GREY-BROWN FRAGILLACEOUS LIMESTONE BEDROCK, CLAY SEAM AT ELEV. 174 SLIGHT FRACTURING AND WEATHERING TO ELEV. 173		4	BX RC	1									
			5	"	1	175									
			6	"	1										
			7	"	1										
168.1 19.5	END OF HOLE					170									
						165									

PERCENT CORE RECOVERY

75
90
90
100

END OF PEN. TEST @ EL. 176.6

VERTICAL SCALE
1 INCH TO 5'-0"

GOLDER & ASSOCIATES

DRAWN J.A.
CHECKED *JS*

RECORD OF BOREHOLE 36

LOCATION	SEE FIGURE 1	BORING DATE	JAN. 27, 1962	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			

SOIL PROFILE			SAMPLES		ELEVATION SCALE	DYNAMIC PENETRATION RESISTANCE BLOWS/FOOT 20 40 60 80 100	LIQUID LIMIT L_L PLASTIC LIMIT P_L WATER CONTENT W	LAB. TESTING
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE				
187.7	GROUND LEVEL							
0.0	LOOSE DARK BROWN SANDY TOPSOIL (FILL)		1	2.0"	7	133		
184.2	COMPACT TO DENSE GREY - BROWN TO GREY SILT WITH TRACE OF CLAY AND FINE SAND		2	"	10			
3.5			3	"	37			
176.8			4	"	24			
10.9	END OF HOLE REFUSAL ASSUMED BEDROCK					END OF PEN. TEST @ EL. 176.7		

VERTICAL SCALE
1 INCH TO 5'-0"

GOLDER & ASSOCIATES

DRAWN J.A
CHECKED *[Signature]*

RECORD OF BOREHOLE 37

LOCATION SEE FIGURE 1

BORING DATE JAN. 27-31, 1962

DATUM

GEODETIC

BOREHOLE TYPE

POWER AUGER & WASH BORING

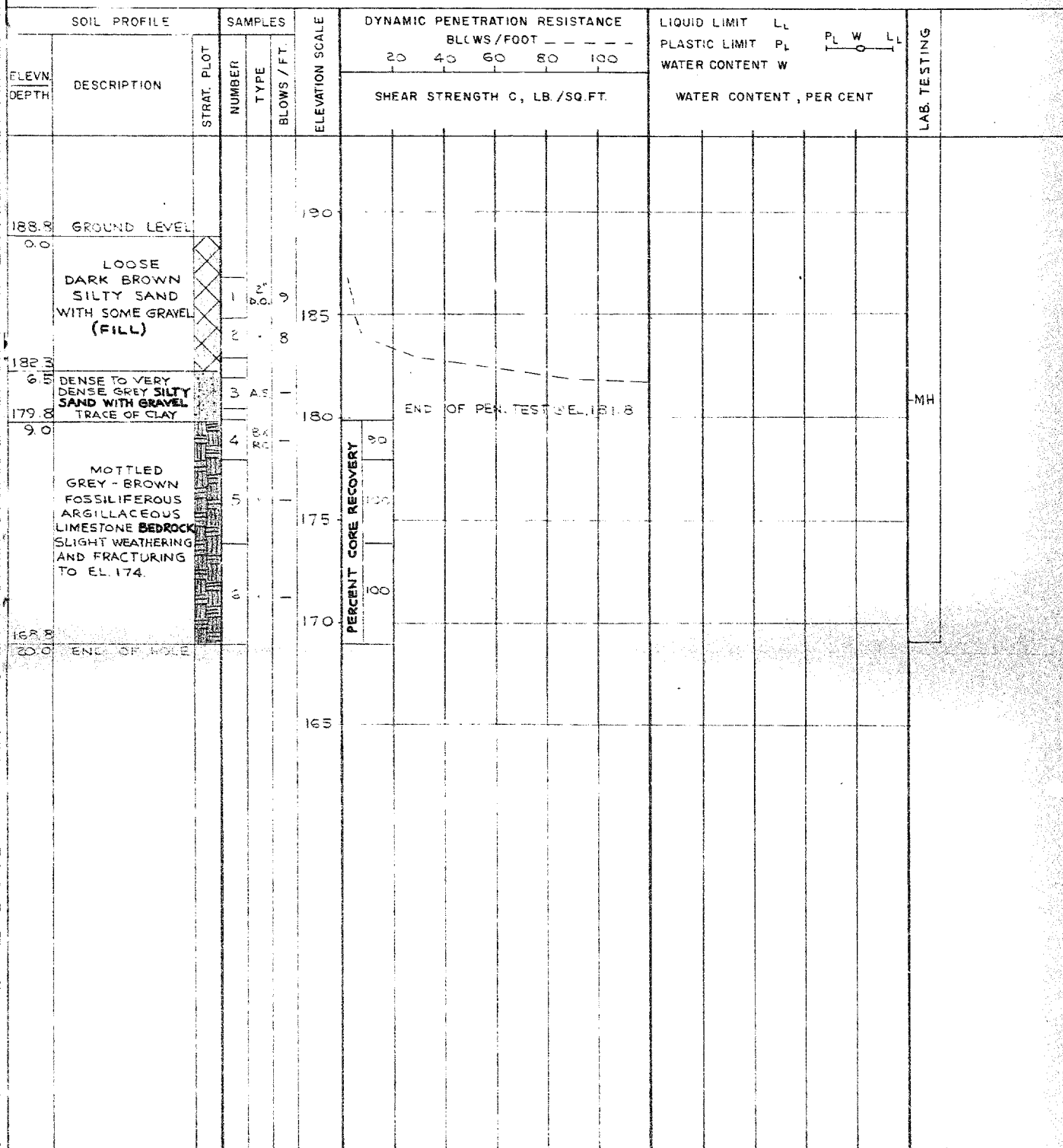
BOREHOLE DIAMETER

4.5" & 8X CASING

SAMPLER HAMMER WEIGHT 140 LB.

DROP 30 INCHES

PEN. TEST HAMMER WEIGHT 140 LB. DROP 30 INCHES



VERTICAL SCALE

1 INCH TO 5'-0"

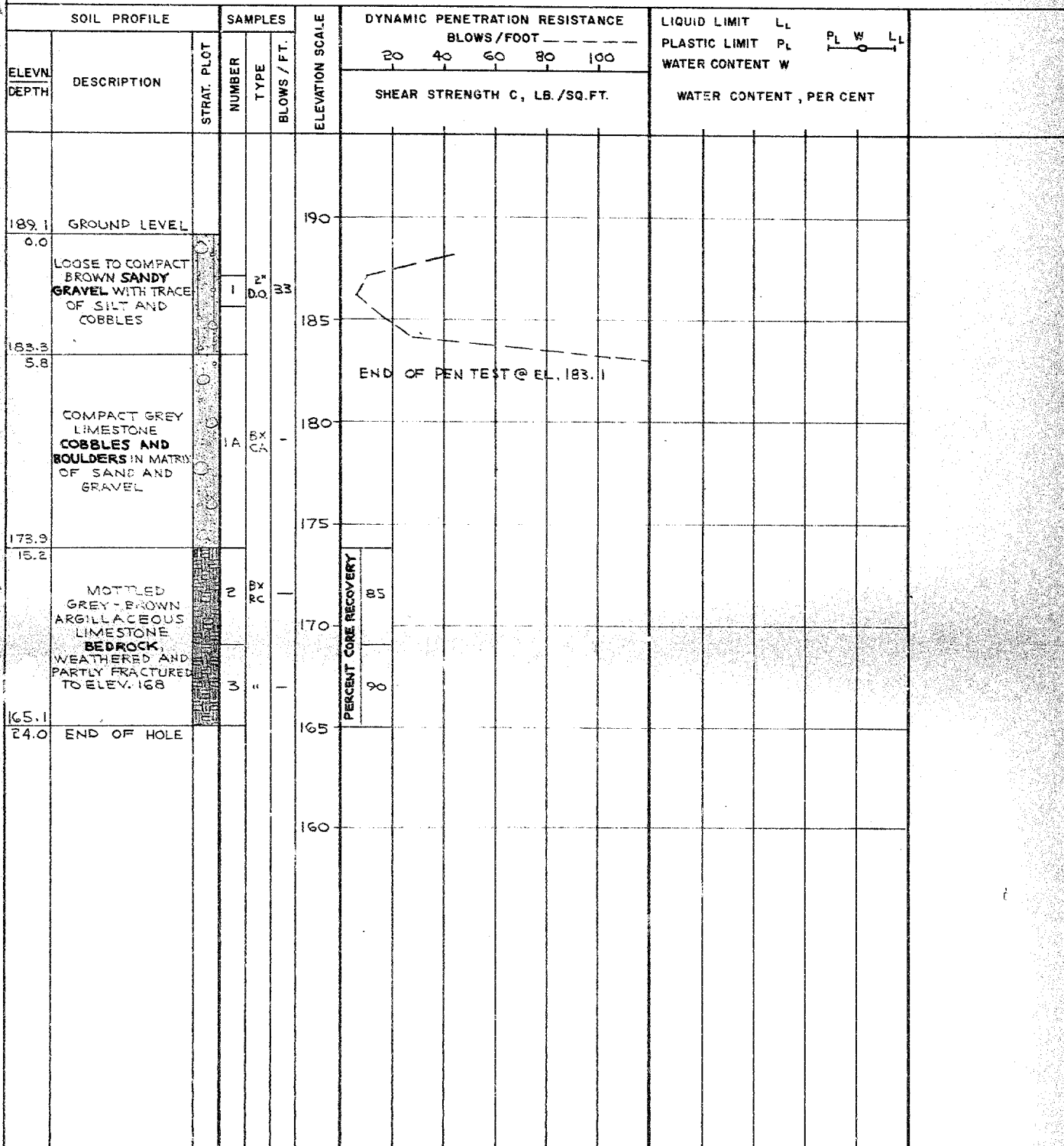
GOLDER & ASSOCIATES

DRAWN M.W.

CHECKED *[Signature]*

RECORD OF BOREHOLE 39

LOCATION SEE FIGURE 1 BORING DATE JAN. 30-FEB. 2, 1962 DATUM GEODETIC
 BOREHOLE TYPE POWER AUGER & WASH BORING BOREHOLE DIAMETER 4.5" 4 BX CASING
 SAMPLER HAMMER WEIGHT 140 LB. DROP 30 INCHES PEN. TEST HAMMER WEIGHT 140 LB. DROP 30 INCHES



VERTICAL SCALE
 1 INCH TO 5'-0"

GOLDER & ASSOCIATES

DRAWN J.A.
 CHECKED JOR

RECORD OF BOREHOLE 40

LOCATION SEE FIGURE 1 BORING DATE JAN. 30, 1962 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

SOIL PROFILE			SAMPLES			ELEVATION SCALE	DYNAMIC PENETRATION RESISTANCE BLOWS/FOOT -----					LIQUID LIMIT L_L PLASTIC LIMIT P_L WATER CONTENT W			LAB. TESTING
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	BLOWS / FT.		SHEAR STRENGTH C , LB./SQ.FT.					WATER CONTENT, PER CENT			
							20	40	60	80	100				
188.5 0.0	GROUND LEVEL														
	COMPACT TO DENSE GREY-BROWN SANDY GRAVEL WITH TRACE OF SILT AND COBBLES		1	N ₆₀	32										
182.5 6.0	END OF HOLE		2	"	40										

END OF PEN. TEST @ EL. 184.3
 15 BLOWS FOR LAST 3 INCHES

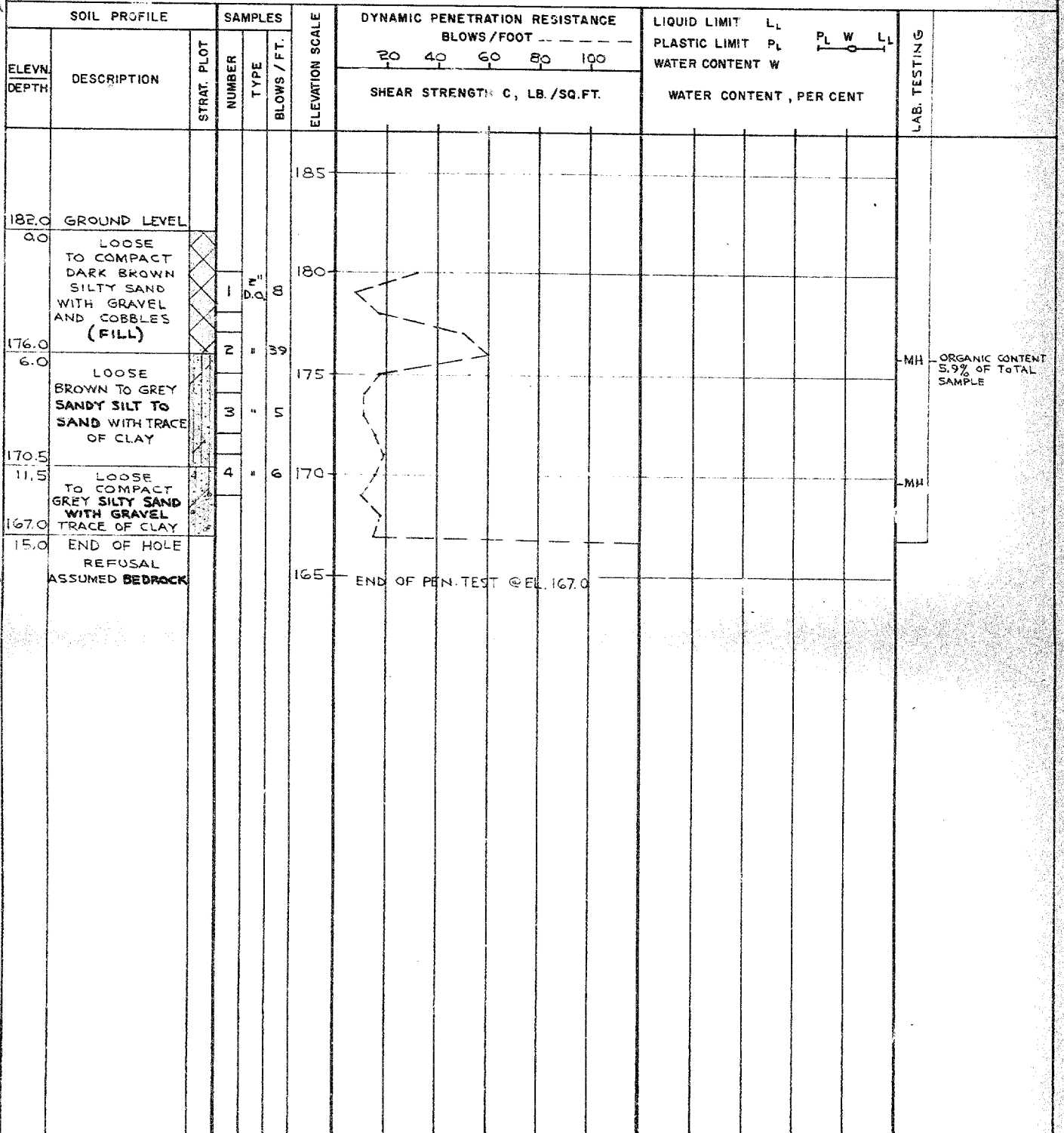
VERTICAL SCALE
 1 INCH TO 5'-0"

GOLDER & ASSOCIATES

DRAWN J.A.
 CHECKED *off*

RECORD OF BOREHOLE 41

LOCATION SEE FIGURE 1 BORING DATE JAN. 30, 1962 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 40 INCHES



MH ORGANIC CONTENT 5.9% OF TOTAL SAMPLE

MH

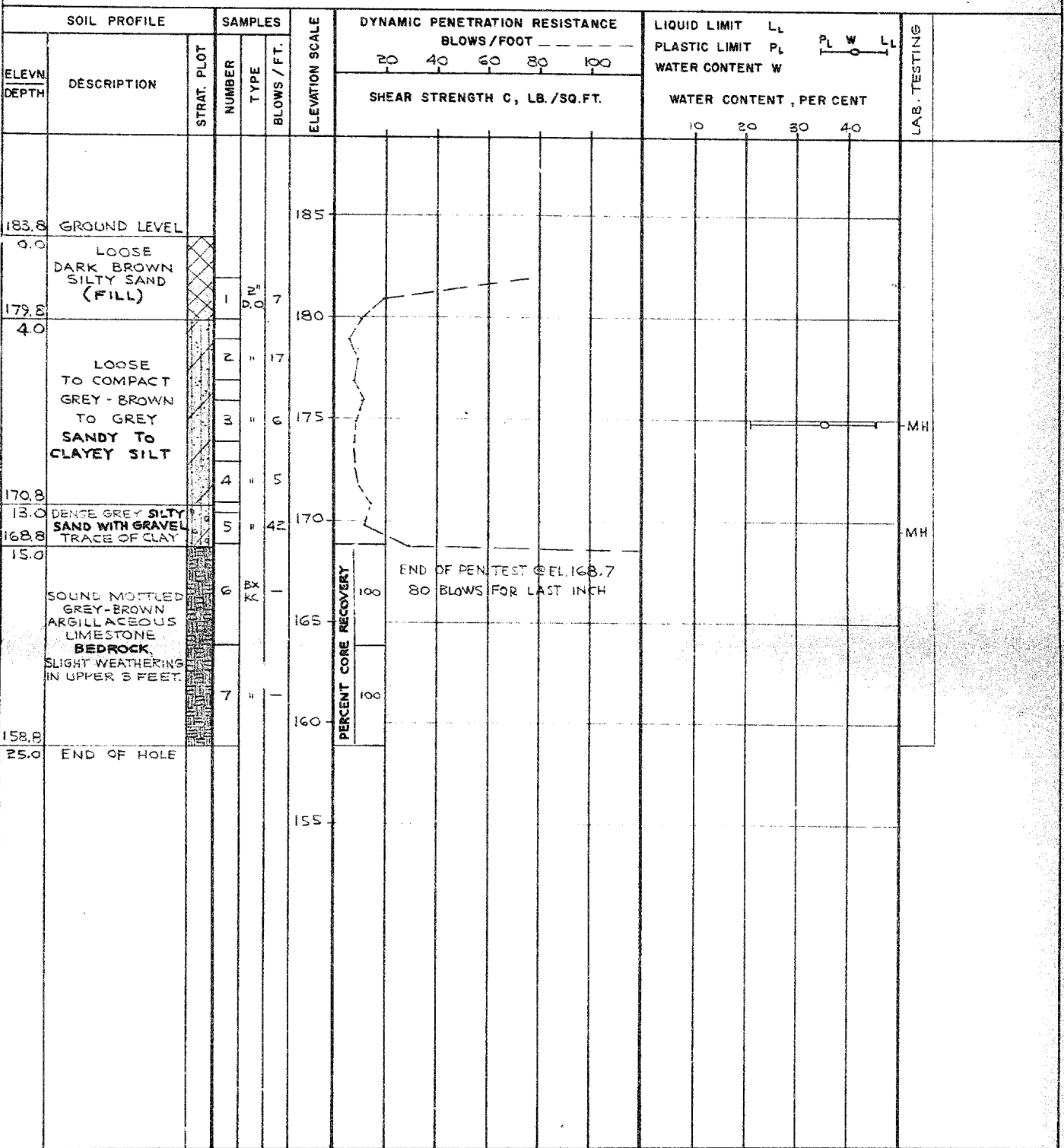
VERTICAL SCALE
1 INCH TO 5'-0"

GOLDER & ASSOCIATES

DRAWN J.A.
CHECKED *JOY*

RECORD OF BOREHOLE 42

LOCATION SEE FIGURE 1 BORING DATE JAN. 30 - FEB. 1, 1962 DATUM GEODETIC
 BOREHOLE TYPE POWER AUGER & WASH BORING BOREHOLE DIAMETER 4.5" & BX CASING
 SAMPLER HAMMER WEIGHT 140 LB. DROP 30 INCHES PEN. TEST HAMMER WEIGHT 140 LB. DROP 30 INCHES



VERTICAL SCALE
1 INCH TO 5'-0"

GOLDER & ASSOCIATES

DRAWN J.A.
CHECKED JAY

RECORD OF BOREHOLE 43

LOCATION SEE FIGURE 1 BORING DATE MARCH 7, 1962 DATUM GEODETIC
 BOREHOLE TYPE WASH BORING BOREHOLE DIAMETER BX CASING
 SAMPLER HAMMER WEIGHT 140 LB. DROP 30 INCHES PEN. TEST HAMMER WEIGHT — LB. DROP — INCHES

SOIL PROFILE			SAMPLES			ELEVATION SCALE	DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT				LIQUID LIMIT L_L PLASTIC LIMIT P_L WATER CONTENT W				ELEVATION SCALE	SHEAR STRENGTH C , LB. / SQ.FT.				WATER CONTENT, PER CENT			
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	BLOWS / FT.																		
193.9	GROUND LEVEL					195																	
0.0	LOOSE TO COMPACT GREY-BROWN SILTY SAND WITH GRAVEL (FILL)																						
191.0																							
2.9			1	BB		190	75																
			2	"			90																
			3	"			90																
			4	"		185	100																
			5	"		180																	
			6	"		175	100																
			7	"		170	100																
			8	"		165																	
						160	100																
						155																	
						150	100																
144.7						145																	
402	END OF HOLE																						

INTERBEDDED
DARK GREY
LIMESTONE AND
BLACK SHALE
BEDROCK
WEATHERED AND
PARTLY FRACTURED
TO ELEV. 187
HEALED VERTICAL
FRACTURES
ELEV. 178 TO 172.

WATER RETURN
NO WATER LOSS DURING
DRILLING IN BEDROCK.

PERCENT CORE RECOVERY

VERTICAL SCALE
1 INCH TO 5'-0"

DRAWN J.A.
CHECKED Jox

RECORD OF BOREHOLE 44

LOCATION SEE FIGURE 1 BORING DATE MARCH 8, 1962 DATUM GEODETIC
 BOREHOLE TYPE WASH BORING BOREHOLE DIAMETER BX CASING
 SAMPLER HAMMER WEIGHT — LB. DROP — INCHES PEN. TEST HAMMER WEIGHT — LB. DROP — INCHES

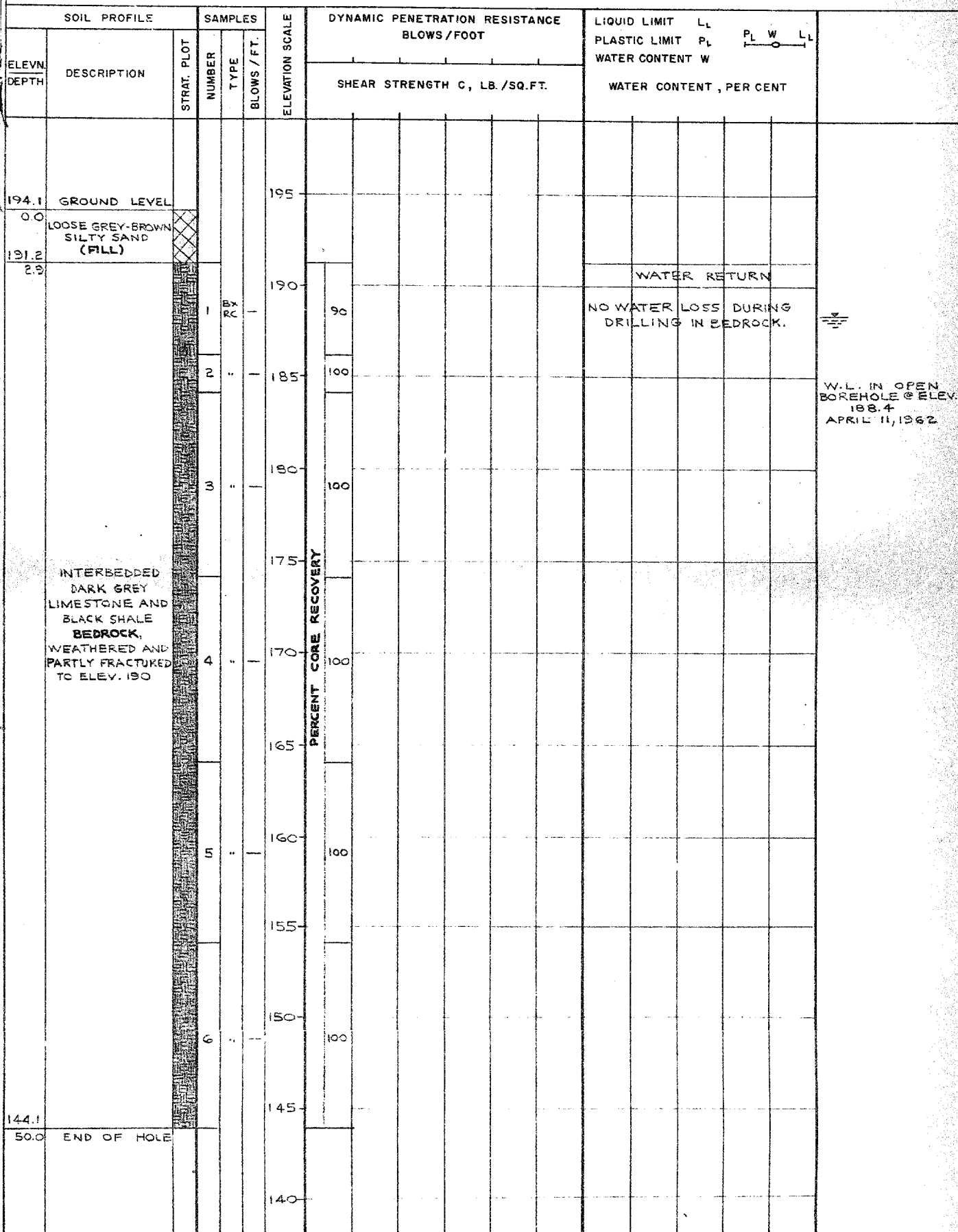
SOIL PROFILE		SAMPLES			ELEVATION SCALE	DYNAMIC PENETRATION RESISTANCE BLOWS/FOOT				LIQUID LIMIT L_L PLASTIC LIMIT P_L $\frac{P_L}{L_L}$ W $\frac{W}{L_L}$ WATER CONTENT W			
ELEV. / DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE		SHEAR STRENGTH C, LB./SQ.FT.				WATER CONTENT, PER CENT			
194.1	GROUND LEVEL				195								
0.0	LOOSE GREY-BROWN SILTY SAND (FILL)												
191.2					190								
2.9													
			1	BY RC		90							
			2	"	185	100							
			3	"	180	100							
			4	"	175	100							
	INTERBEDDED DARK GREY LIMESTONE AND BLACK SHALE BEDROCK, WEATHERED AND PARTLY FRACTURED TO ELEV. 190				170	100							
			5	"	165								
					160	100							
					155								
					150	100							
			6	"	145								
144.1													
50.0	END OF HOLE												

WATER RETURN
 NO WATER LOSS DURING
 DRILLING IN BEDROCK.

W.L. IN OPEN
 BOREHOLE @ ELEV.
 188.4
 APRIL 11, 1962

SAMPLER HAMMER WEIGHT — LB. DROP — INCHES

PEN. TEST HAMMER WEIGHT — LB. DROP — INCHES


 VERTICAL SCALE
 1 INCH TO 5'-0"

GOLDER & ASSOCIATES

 DRAWN J.A.
 CHECKED JAG

SOIL PROFILE			SAMPLES		ELEVATION SCALE	DYNAMIC PENETRATION RESISTANCE BLOWS/FOOT					LIQUID LIMIT L_L PLASTIC LIMIT P_L $\overline{P_L \quad W \quad L_L}$ WATER CONTENT W				
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE		SHEAR STRENGTH C , LB./SQ.FT.					WATER CONTENT, PER CENT				
193.4	GROUND LEVEL				195										
0.0	ROADWAY FILL														
191.8															
1.6	COMPACT GREY-BROWN														
190.4	SAND (FILL)														
3.0															
			1	BY RC	190	95					WATER RETURN				
			2	"	185	100					COMPLETE WATER LOSS DURING DRILLING IN BEDROCK @ EL. 188.9				
			3	"	180	100									
			4	"	175	100									
	INTERBEDDED DARK GREY LIMESTONE AND BLACK SHALE BEDROCK, SLIGHT WEATHERING AND FRACTURING TO ELEV. 184 UNHEALED VERTICAL FRACTURES ELEV. 166.5 TO 164.5 POORLY HEALED VERTICAL FRACTURES ELEV. 149.0 TO 145.0		5	"	170	100									
			6	"	165	100									
			7	"	160	100									
					155										
					150										
					145										
142.9					140										
50.9	END OF HOLE														

 VERTICAL SCALE
 1 INCH TO 5'-0"

GOLDER & ASSOCIATES

 DRAWN J.A.
 CHECKED *888*

RECORD OF BOREHOLE 46

LOCATION SEE FIGURE 1 BORING DATE MARCH 10, 1962 DATUM GEODETIC
 BOREHOLE TYPE WASH BORING BOREHOLE DIAMETER BX CASING
 SAMPLER HAMMER WEIGHT — LB. DROP — INCHES PEN. TEST HAMMER WEIGHT — LB. DROP — INCHES

SOIL PROFILE		SAMPLES		ELEVATION SCALE	DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT				LIQUID LIMIT L_L PLASTIC LIMIT P_L WATER CONTENT W			
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER TYPE		SHEAR STRENGTH C , LB./SQ.FT.				WATER CONTENT, PER CENT			
193.4	GROUND LEVEL			195								
0.0	ROADWAY FILL											
191.9												
1.5	COMPACT GREY-BROWN											
190.0	SAND (FILL)			190								
3.4												
			1	190								
			2	185								
				180								
			3	175								
				170								
			4	165								
				160								
			5	155								
				150								
			6	145								

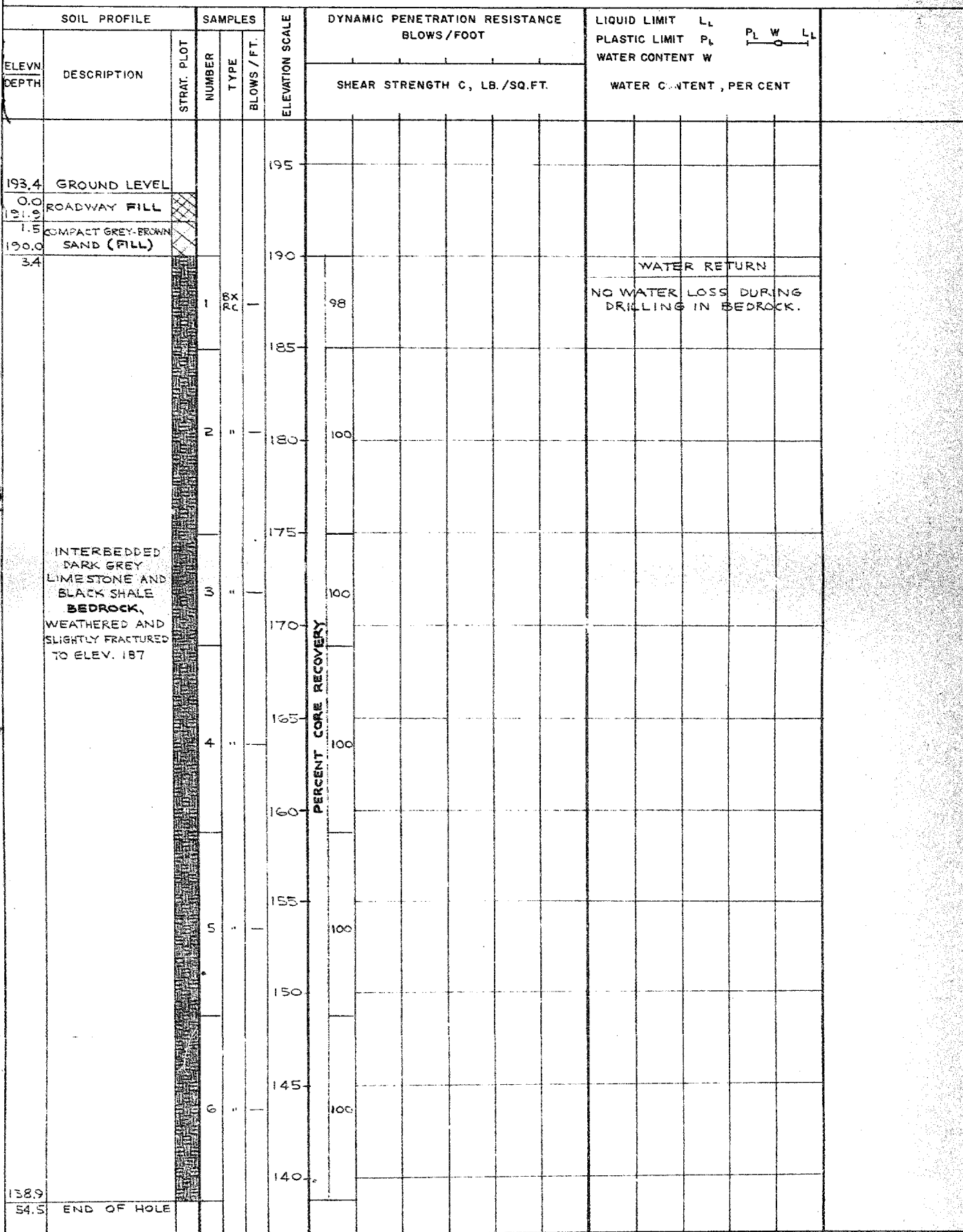
INTERBEDDED
DARK GREY
LIMESTONE AND
BLACK SHALE
BEDROCK,
WEATHERED AND
SLIGHTLY FRACTURED
TO ELEV. 157

PERCENT CORE RECOVERY

WATER RETURN
NO WATER LOSS DURING
DRILLING IN BEDROCK.

SAMPLER HAMMER WEIGHT — LB. DROP — INCHES

PEN. TEST HAMMER WEIGHT — LB. DROP — INCHES

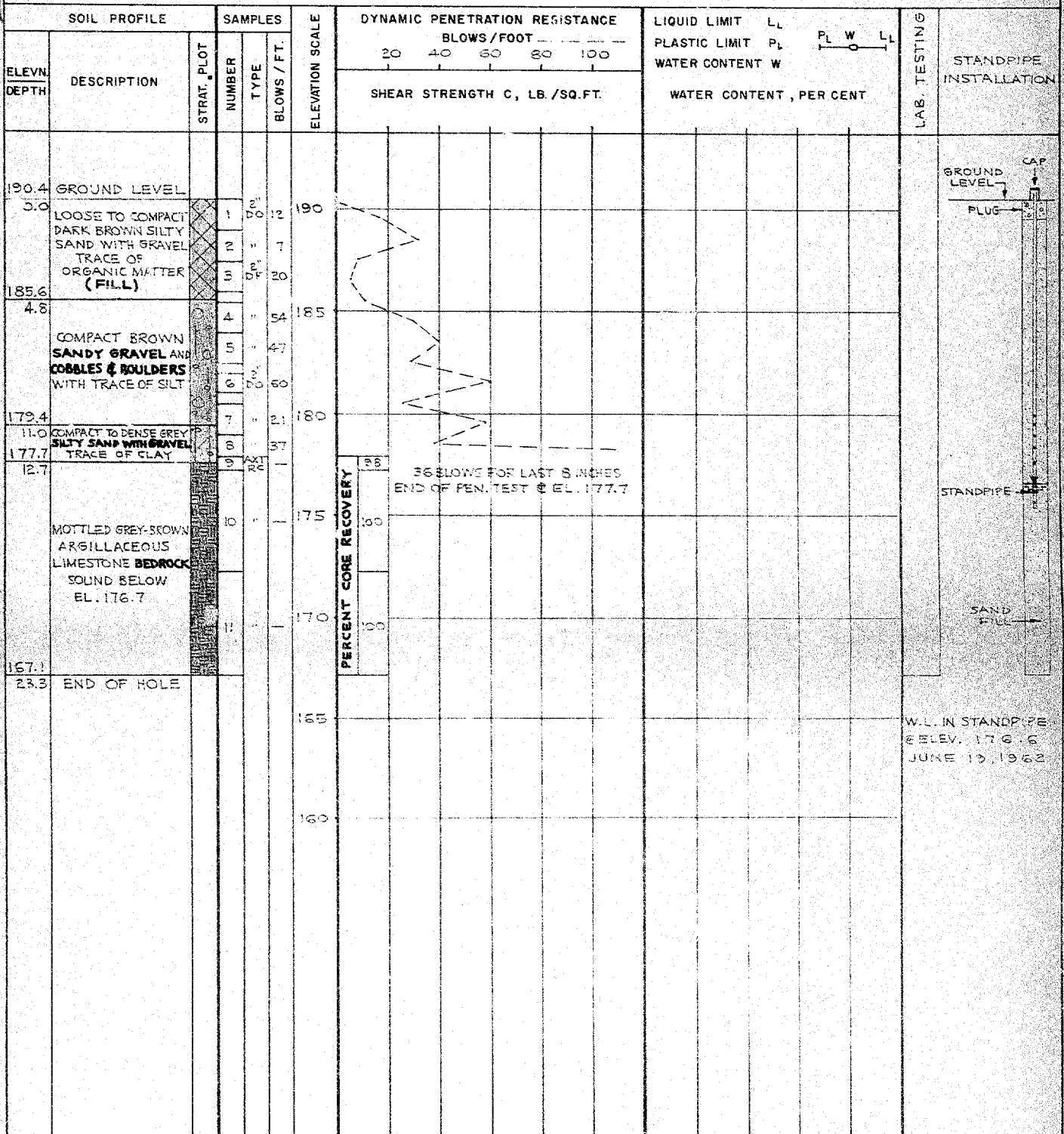

 VERTICAL SCALE
 1 INCH TO 5'-0"

GOLDER & ASSOCIATES

 DRAWN J.A.
 CHECKED *Mr*

RECORD OF BOREHOLE 47

LOCATION SEE FIGURE 1 BORING DATE JUNE 5-6, 1962 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

 VERTICAL SCALE
 1 INCH TO 5'-0"

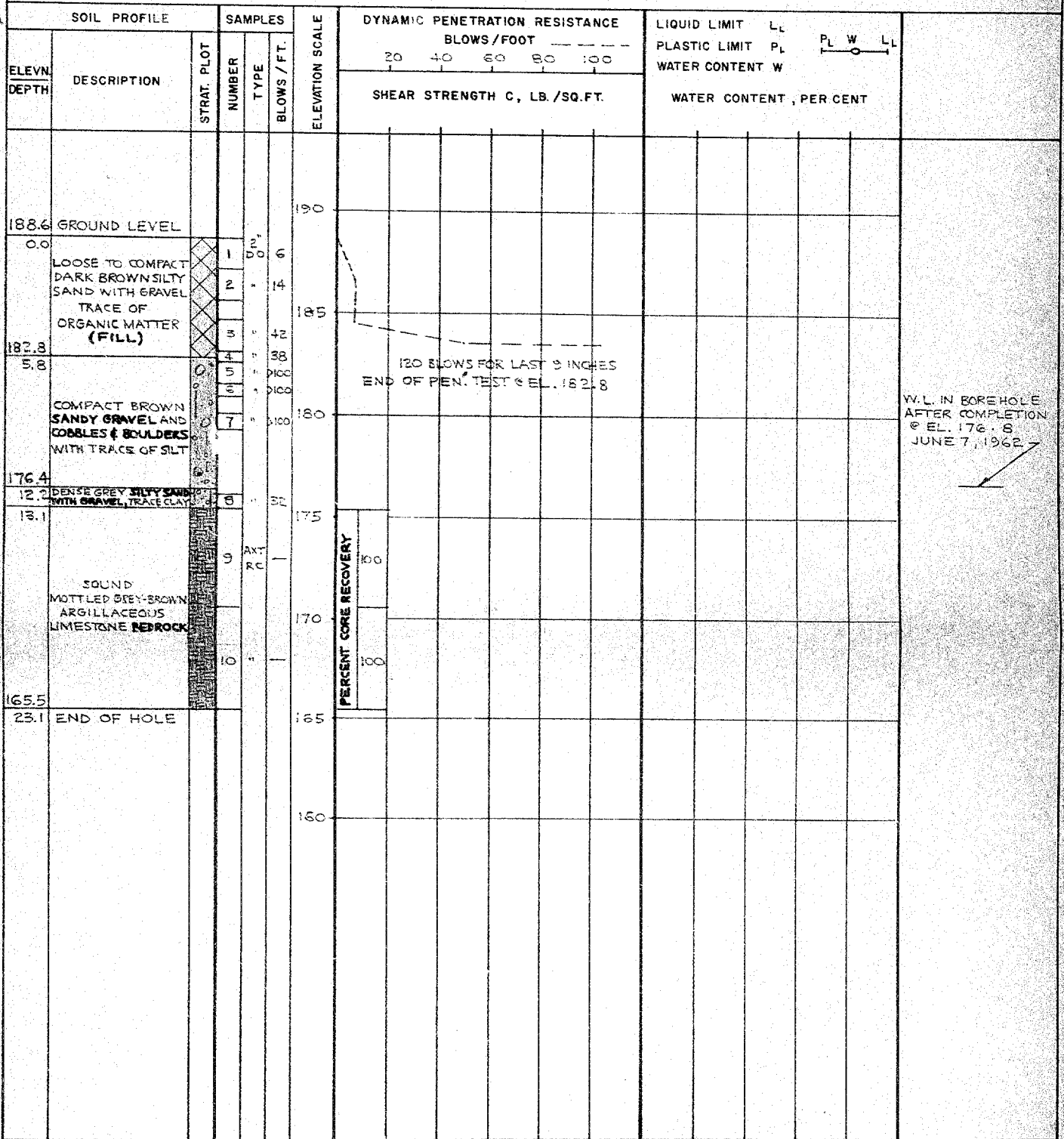
GOLDER & ASSOCIATES

DRAWN M.W.

CHECKED *[Signature]*

RECORD OF BOREHOLE 48

LOCATION SEE FIGURE 1 BORING DATE JUNE 6-7, 1962 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



12,000 E.

12,500 E.

OTTAWA RIVER

EARNSCLIFFE HOUSE

PIER No 4

STA 40+00

MAIN ABUTMENT

LADY GREY DRIVE

SUSSEX STREET

STA 45+00

BH 43

BH 44

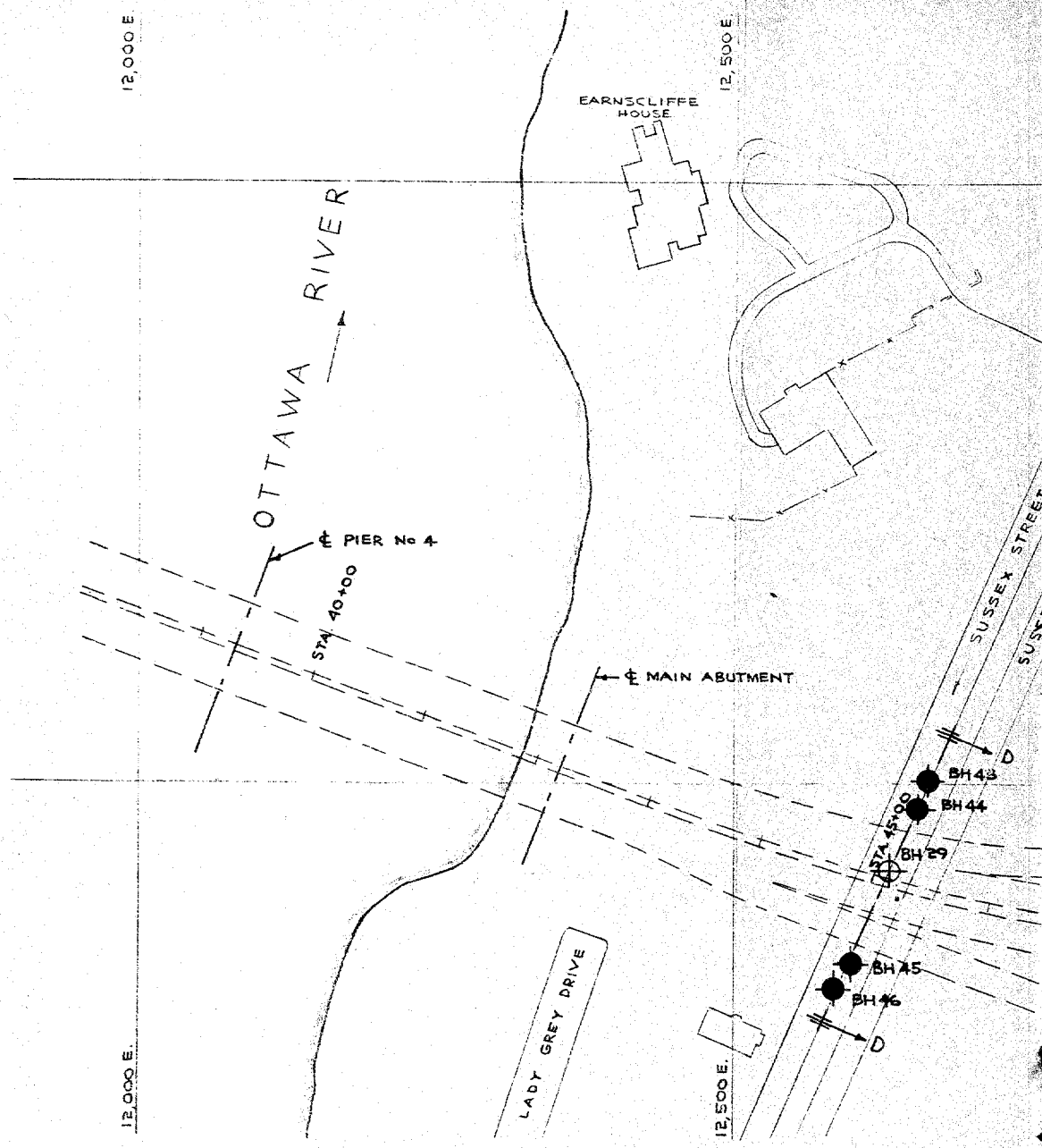
BH 29

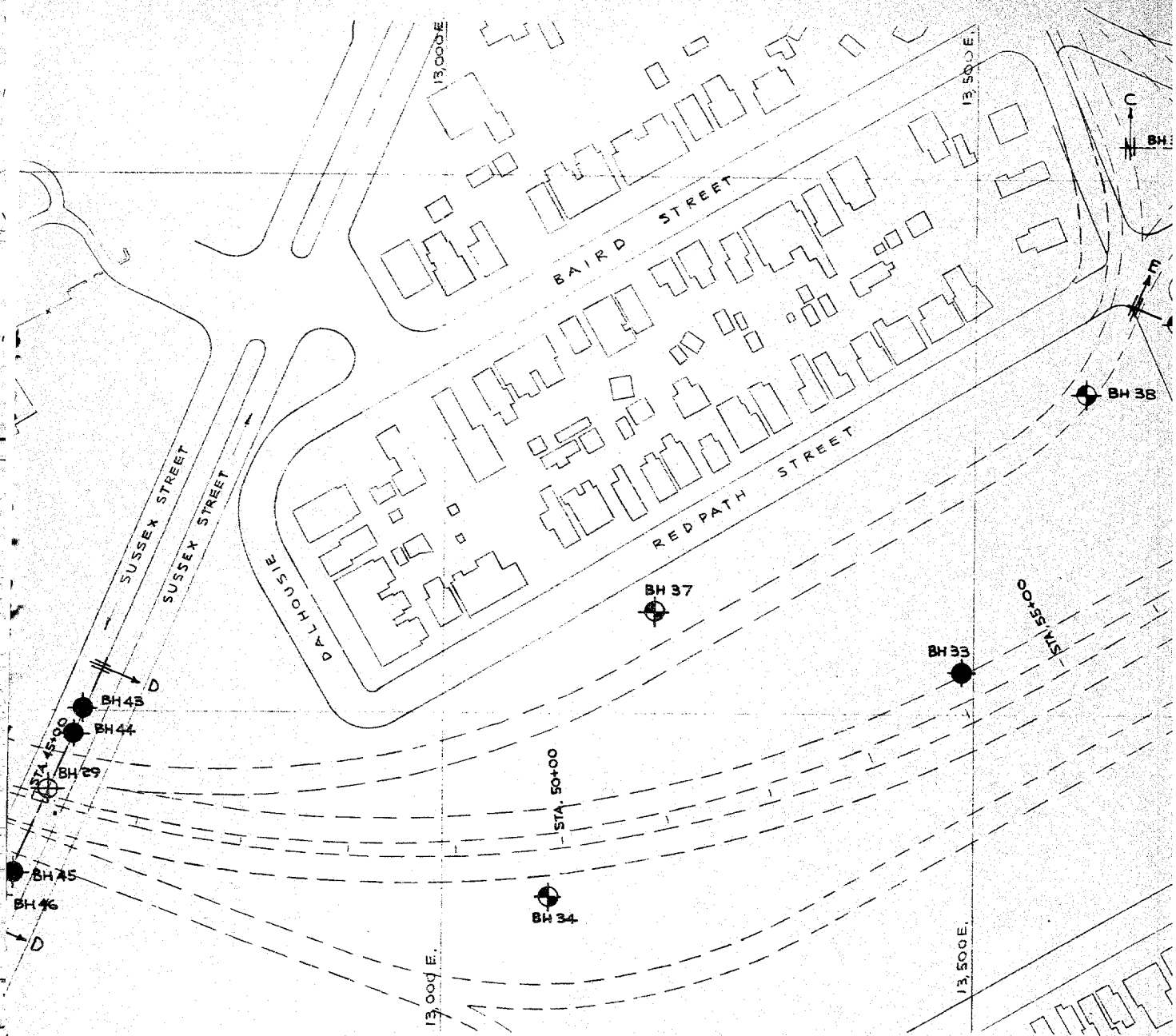
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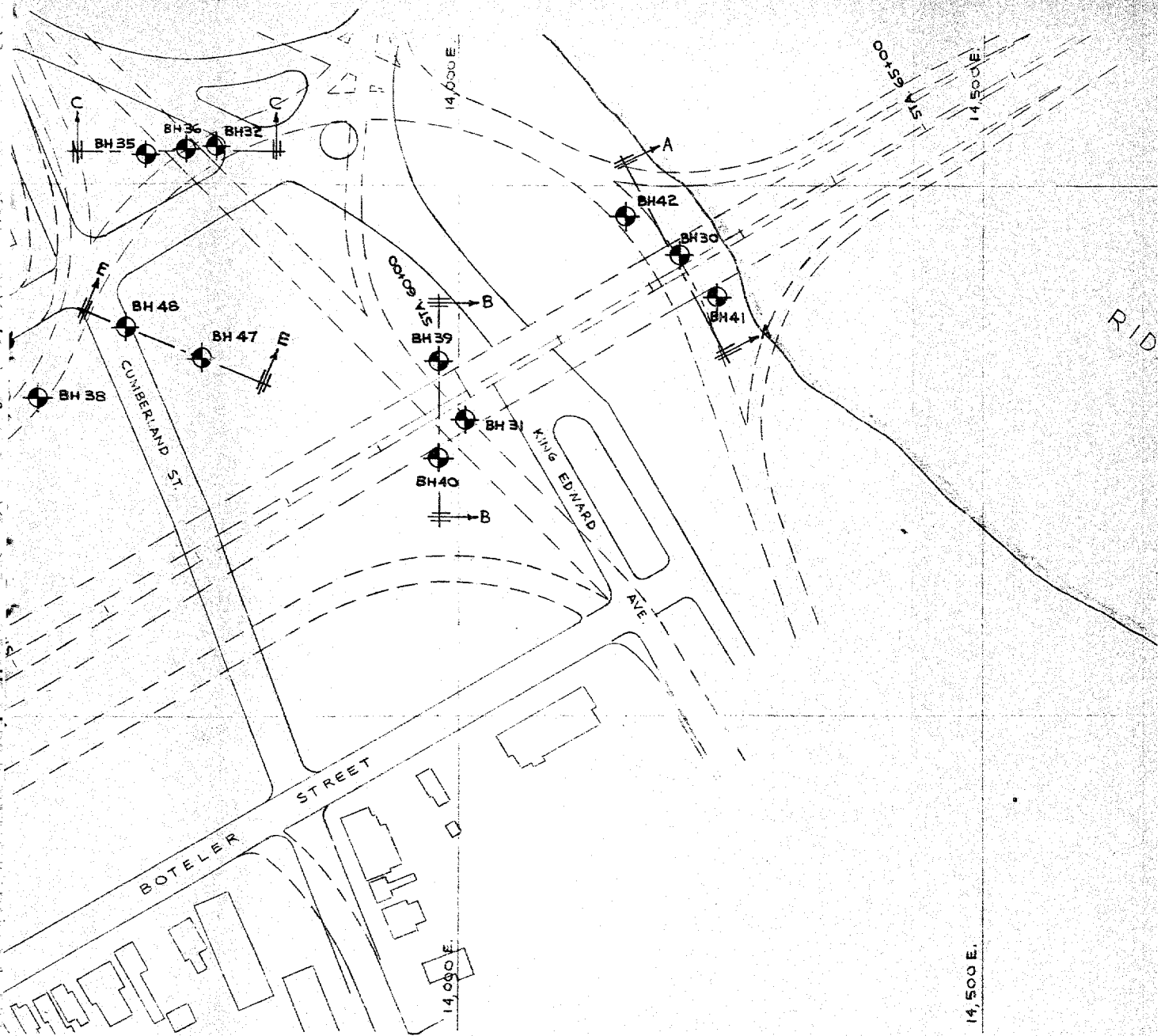
BH 46

12,000 E.

12,500 E.



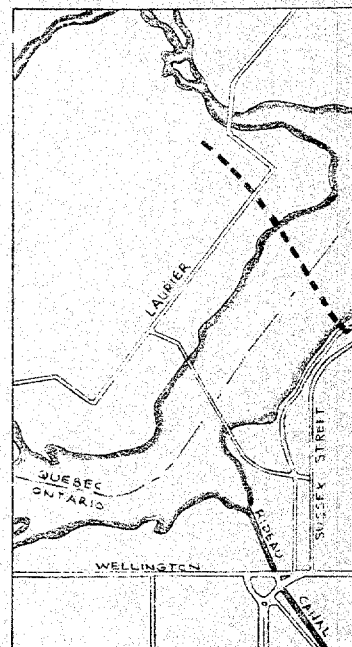
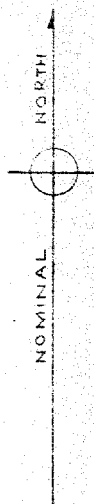




10,600 N.

RIDEAU RIVER

9,500 N.



BOREHOLE WITH F

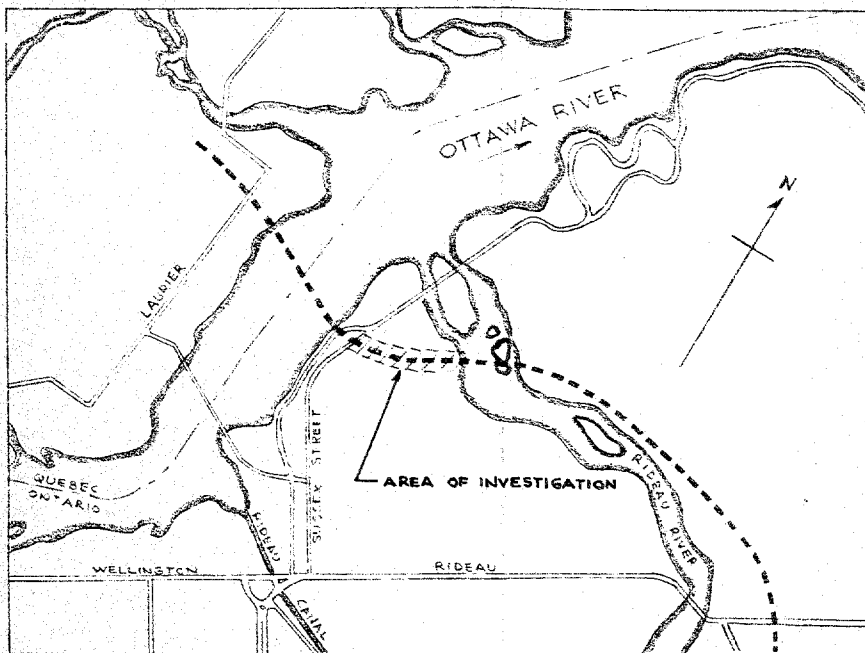


BOREHOLE ONLY II



BOREHOLE FROM P

REFERENCE		C MAC OTTAWA PROPO OTTAWA
DRWG. No.	DESCRIPTION	
SK-C-29	CONSULTING ENGINEERS, MACDONALD-CARTIER BRIDGE, OTTAWA APPROACH DATED JAN. 8, 1962.	



KEY PLAN
SCALE: 1" TO 2200' (APPROX.)

LEGEND

- BOREHOLE WITH PENETRATION TEST IN PLAN
- BOREHOLE ONLY IN PLAN
- BOREHOLE FROM PREVIOUS INVESTIGATION IN PLAN (REPORT No G135) DATED DEC. 1961

31 G5-129
GEOCRE No.

ATION
ERS, MACDONALD-
TAWA APPROACH

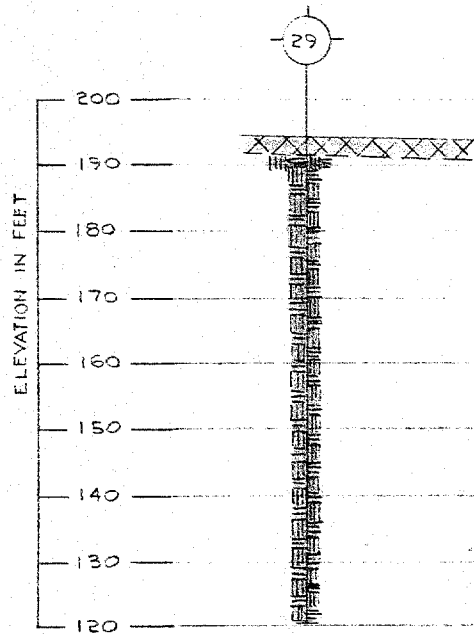
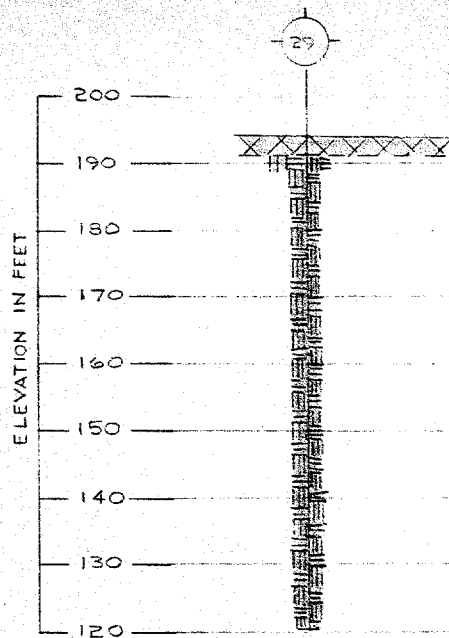
CONSULTING ENGINEERS
MACDONALD-CARTIER BRIDGE
OTTAWA ONTARIO
PROPOSED MACDONALD-CARTIER BRIDGE
OTTAWA APPROACH
OTTAWA ONTARIO
BORING PLAN

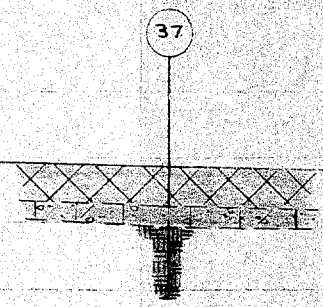
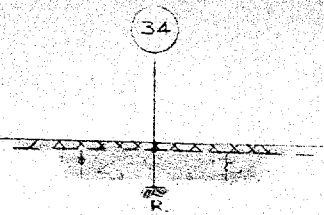
GOLDER & ASSOCIATES
CONSULTING CIVIL ENGINEERS

DATE: MARCH 14, 1962 SCALE: 1" TO 100'

MADE CHKD. APPD.
J.A. [Signature] [Signature]

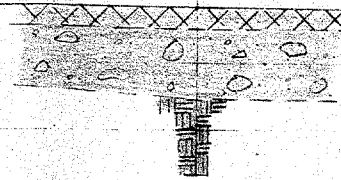
FIGURE 1





SCHEMATIC SECTION ALONG C P

33

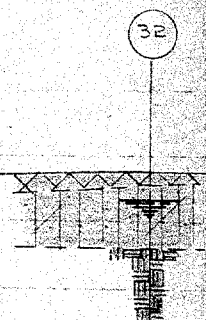
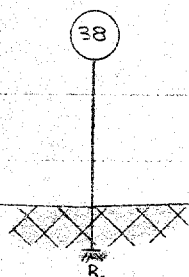


SCHEMATIC SECTION ALONG C PROPOSED MAIN BRIDGE APPROACH



ALONG C PROPOSED NORTH BRIDGE APPROACH

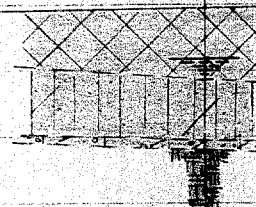
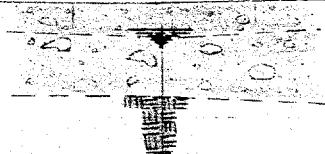
GE APPROACH



20
19
18
17
16
15
14
13
12

31

30



STRATIGRAPHY



LOOSE TO COMPACT BROWN SILTY
SAND WITH GRAVEL (FILL)



LOOSE TO DENSE GREY-BROWN TO
GREY SANDY TO CLAYEY SILT



LOOSE TO VERY DENSE GREY-BROWN SANDY
GRAVEL WITH TRACE OF SILT AND COBBLES



LOOSE TO DENSE GREY LIMESTONE COBBLES AND
BOULDERS IN MATRIX OF SAND AND GRAVEL



LOOSE TO VERY DENSE GREY SILTY SAND WITH
GRAVEL, TRACE OF CLAY



LIMESTONE BEDROCK



REFUSAL - ASSUMED BEDROCK

30

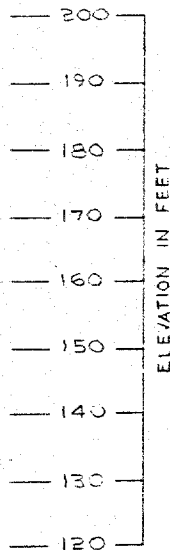
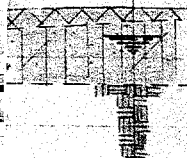
BORE

29

BORE
(PR

WAT

32



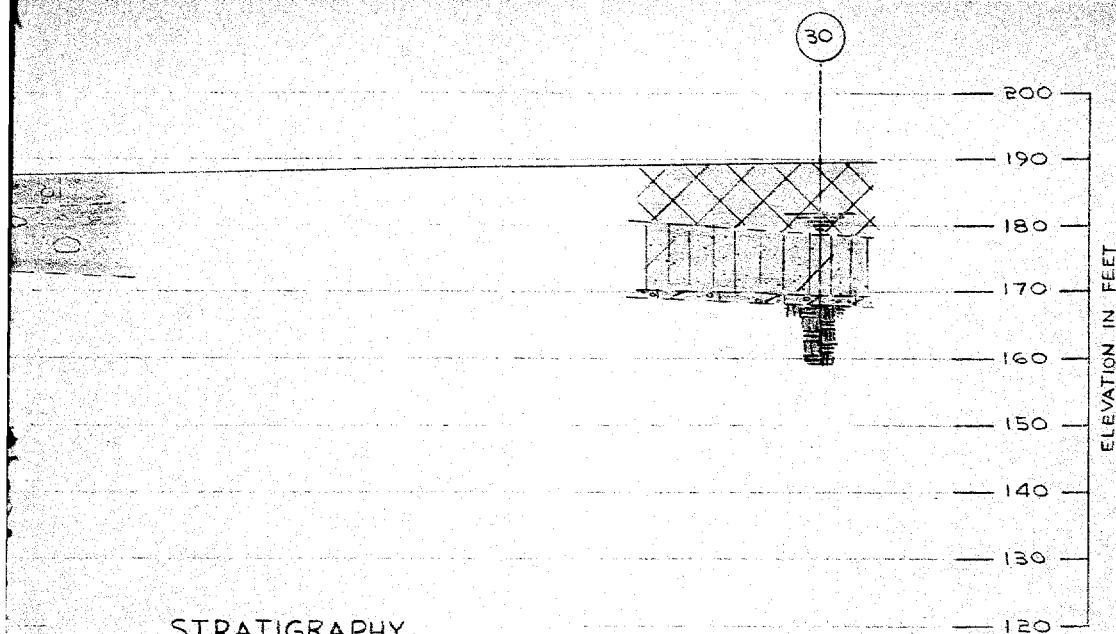
SPECIAL NOTE:
STRATA HAVE BEEN
IDENTIFIED BY
BORING LOGS. THE
BORING LOGS HAVE
EVIDENCE AND SO

CONSULTING ENGINEERS
MACDONALD - CARTIER BRIDGE
OTTAWA ONTARIO
PROPOSED MACDONALD - CARTIER BRIDGE
OTTAWA APPROACH
OTTAWA ONTARIO
SOIL STRATIGRAPHY

GO

DATE

MADE
JA



STRATIGRAPHY



LOOSE TO COMPACT BROWN SILTY
SAND WITH GRAVEL (FILL)



LOOSE TO DENSE GREY-BROWN TO
GREY SILTY TO CLAYEY SILT



LOOSE TO VERY DENSE GREY-BROWN SILTY
GRAVEL WITH TRACE OF SILT AND COBBLES



LOOSE TO DENSE GREY LIMESTONE COBBLES AND
BOULDERS IN MATRIX OF SAND AND GRAVEL



LOOSE TO VERY DENSE GREY SILTY SAND WITH
GRAVEL, TRACE OF CLAY



LIMESTONE BEDROCK



REFUSAL - ASSUMED BEDROCK

LEGEND



BOREHOLE IN ELEVATION
(PRESENT INVESTIGATION)



BOREHOLE IN ELEVATION
(PREVIOUS INVESTIGATION - REPORT 6135)



WATER LEVEL IN BOREHOLE - APRIL 11, 1962

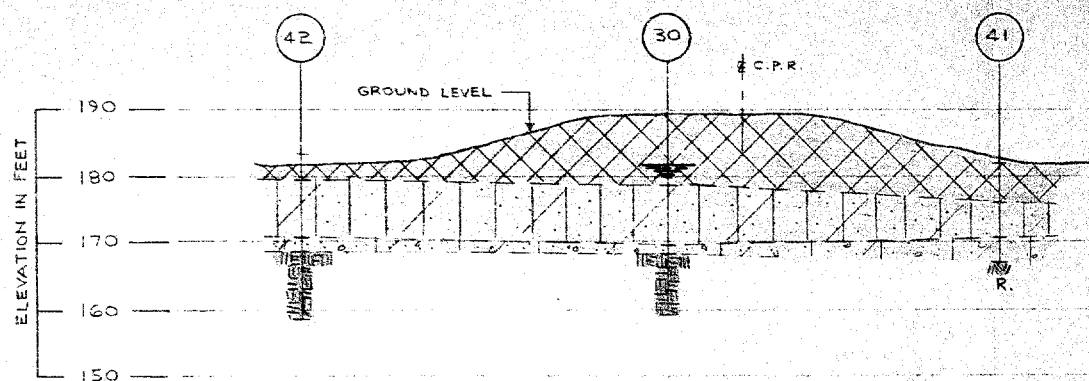
SPECIAL NOTE: DATA CONCERNING THE VARIOUS STRATA HAVE BEEN OBTAINED AT BOREHOLE LOCATIONS ONLY. THE SOIL STRATIGRAPHY BETWEEN BOREHOLES HAS BEEN INFERRED FROM GEOLOGICAL EVIDENCE AND SO MAY VARY FROM THAT SHOWN.

CONSULTING ENGINEERS
MACDONALD - CARTIER BRIDGE
OTTAWA ONTARIO
PROPOSED MACDONALD - CARTIER BRIDGE
OTTAWA APPROACH
OTTAWA ONTARIO
SOIL STRATIGRAPHY

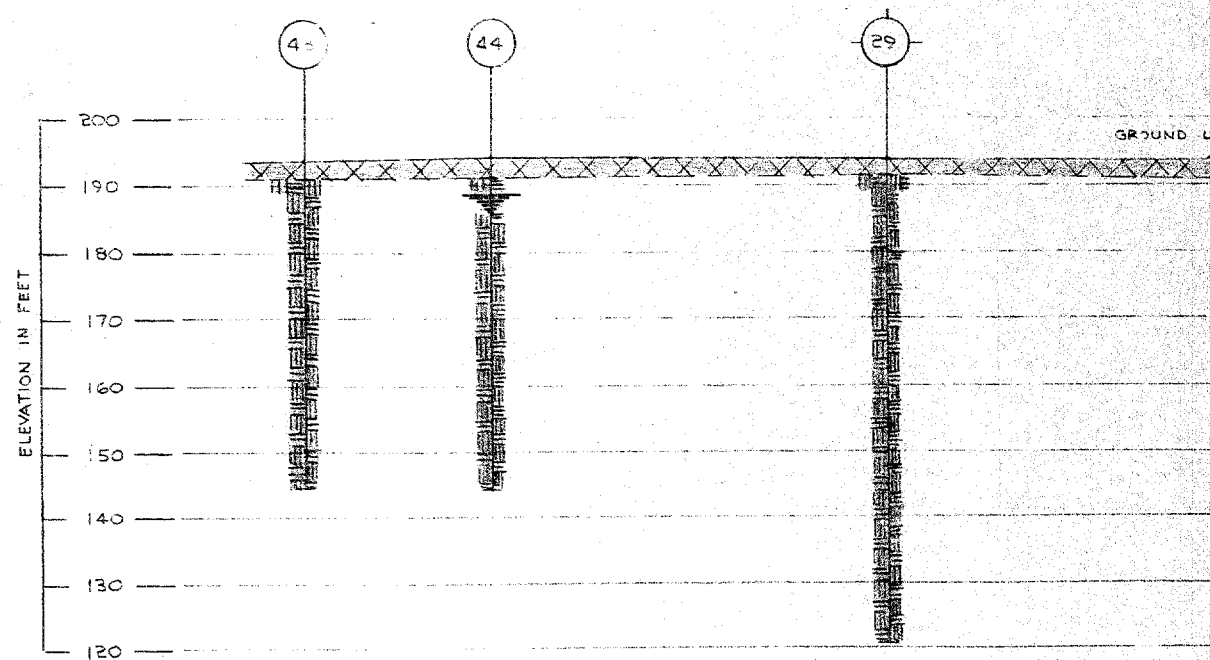
GOLDER & ASSOCIATES
CONSULTING CIVIL ENGINEERS

DATE: APRIL 16, 1962 SCALE: HORIZ. 1" TO 40'
VERT. 1" TO 20'

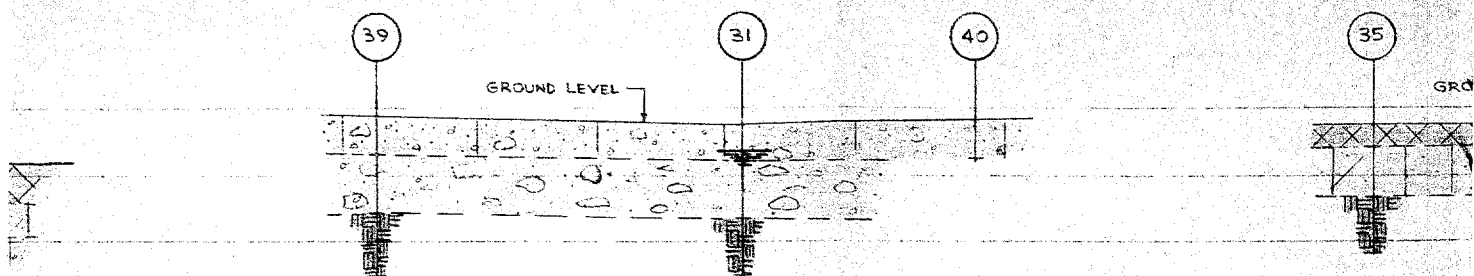
MADE J.A. CHKD. J.M. APPD. J.M. FIGURE 2



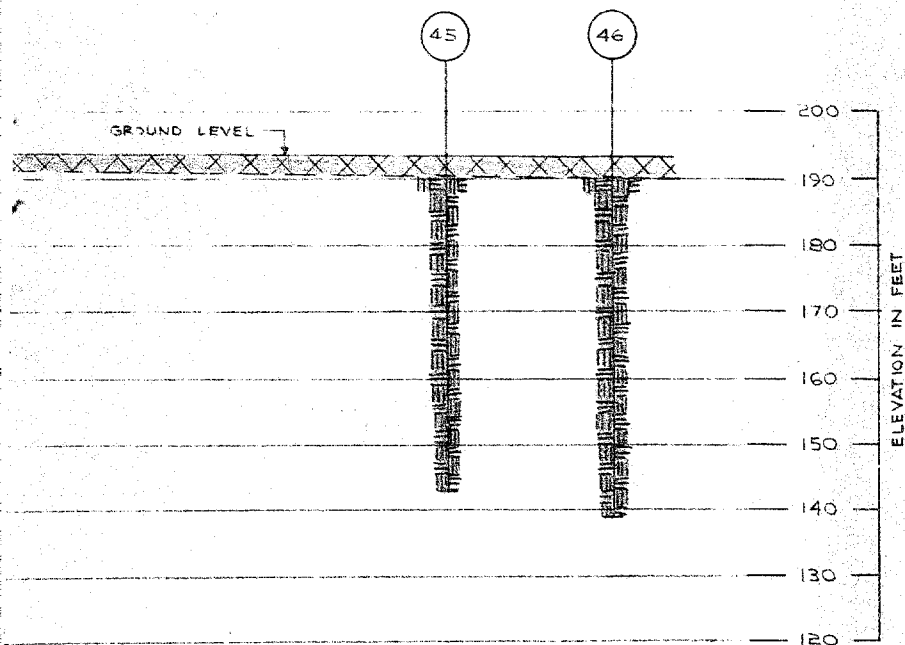
SECTION A-A



SECTION D-D



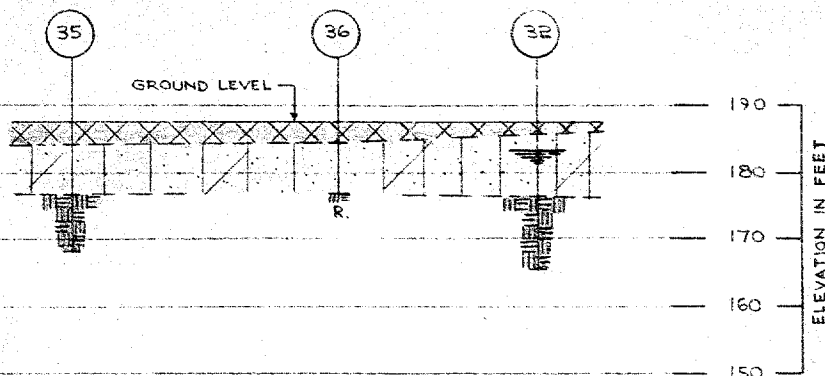
SECTION B-B



NOTE




FOR LOCATION OF SECTIONS
REFER TO FIGURE 1

OTTA
PRG
OTTA










SECTION C-C

LEGEND

- 
 BOREHOLE IN ELEVATION
(PRESENT INVESTIGATION)
- 
 BOREHOLE IN ELEVATION
(PREVIOUS INVESTIGATION - REPORT G135)
- 
 WATER LEVEL IN BOREHOLE - APRIL 11, 1962

STRATIGRAPHY

- 
 LOOSE TO COMPACT BROWN SILTY SAND WITH GRAVEL (FILL)
- 
 LOOSE TO DENSE GREY-BROWN TO GREY SANDY TO CLAYEY SILT
- 
 LOOSE TO VERY DENSE GREY-BROWN SANDY GRAVEL WITH TRACE OF SILT AND COBBLES
- 
 LOOSE TO DENSE GREY LIMESTONE COBBLES AND BOULDERS IN MATRIX OF SAND AND GRAVEL
- 
 LOOSE TO VERY DENSE GREY SILTY SAND WITH GRAVEL, TRACE OF CLAY
- 
 LIMESTONE BEDROCK
- 
 REFUSAL - ASSUMED BEDROCK

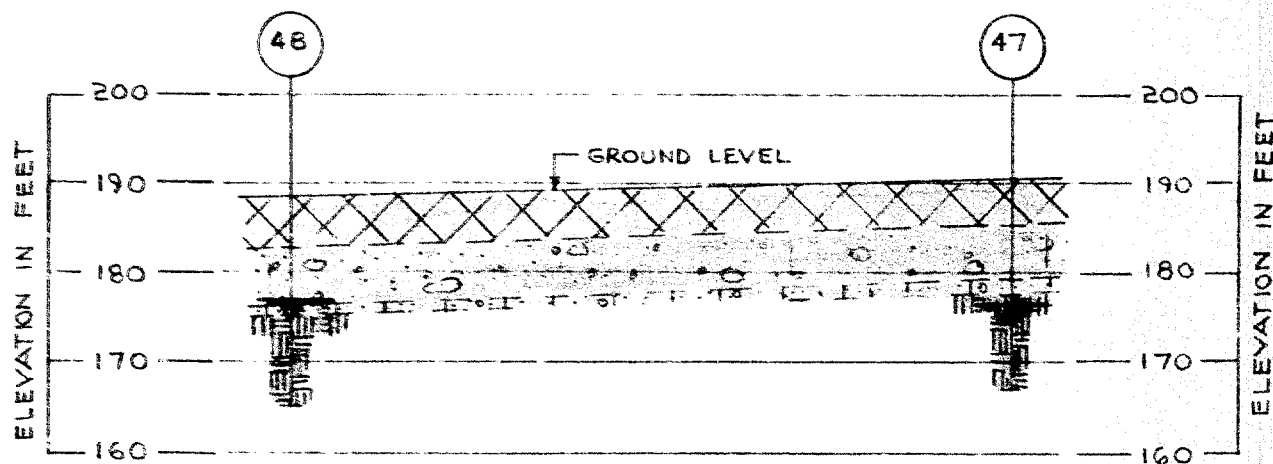
SPECIAL NOTE: DATA CONCERNING THE VARIOUS STRATA HAVE BEEN OBTAINED AT BOREHOLE LOCATIONS ONLY. THE SOIL STRATIGRAPHY BETWEEN BOREHOLES HAS BEEN INFERRED FROM GEOLOGICAL EVIDENCE AND SO MAY VARY FROM THAT SHOWN.

CONSULTING ENGINEERS MACDONALD - CARTIER BRIDGE			GOLDER & ASSOCIATES	
OTTAWA ONTARIO			CONSULTING CIVIL ENGINEERS	
PROPOSED MACDONALD - CARTIER BRIDGE			DATE: APRIL 16, 1962 SCALE: 1" TO 20'-0"	
OTTAWA APPROACH				
SOIL STRATIGRAPHY			FIGURE 3	
MADE J.A.		CHKD. <i>grr</i>	APPD. <i>hly</i>	

SOIL STRATIGRAPHY

ADDITIONAL BOREHOLES

FIGURE 3A



SECTION E-E

SCALE: 1" TO 20'-0"

NOTE:

FOR LOCATION OF SECTION REFER TO FIG. 1

STRATIGRAPHY

LOOSE TO COMPACT DARK BROWN SILTY SAND WITH GRAVEL, TRACE OF ORGANIC MATTER (FILL)



COMPACT BROWN SANDY GRAVEL AND COBBLES AND BOULDERS WITH TRACE OF SILT



COMPACT TO DENSE GREY SILTY SAND WITH GRAVEL, TRACE OF CLAY



LIMESTONE BEDROCK

LEGEND

BOREHOLE IN ELEVATION

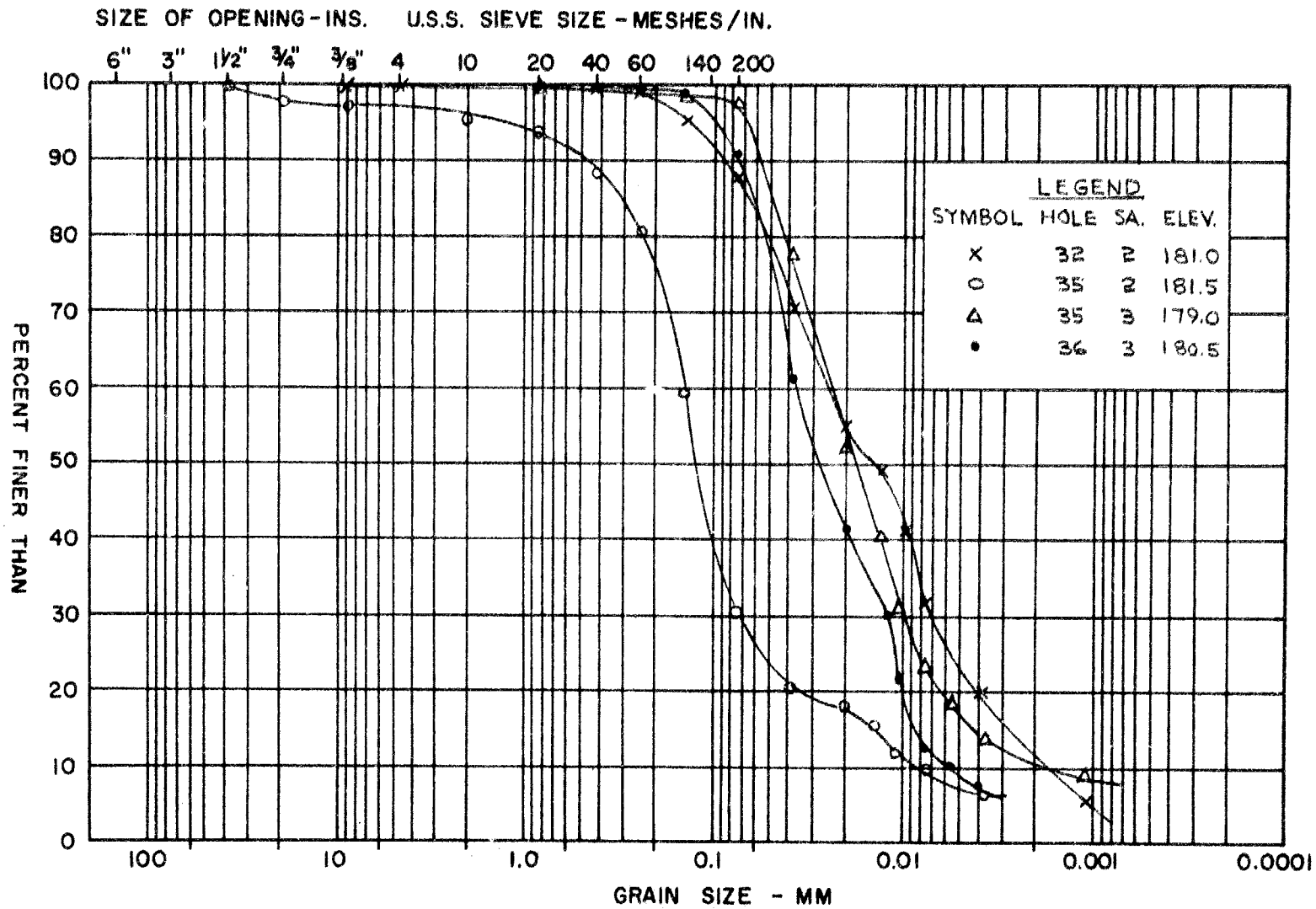


W.L. IN BOREHOLE, JUNE, 1962

GOLDER & ASSOCIATES

3165-129

M.I.T. GRAIN SIZE SCALE



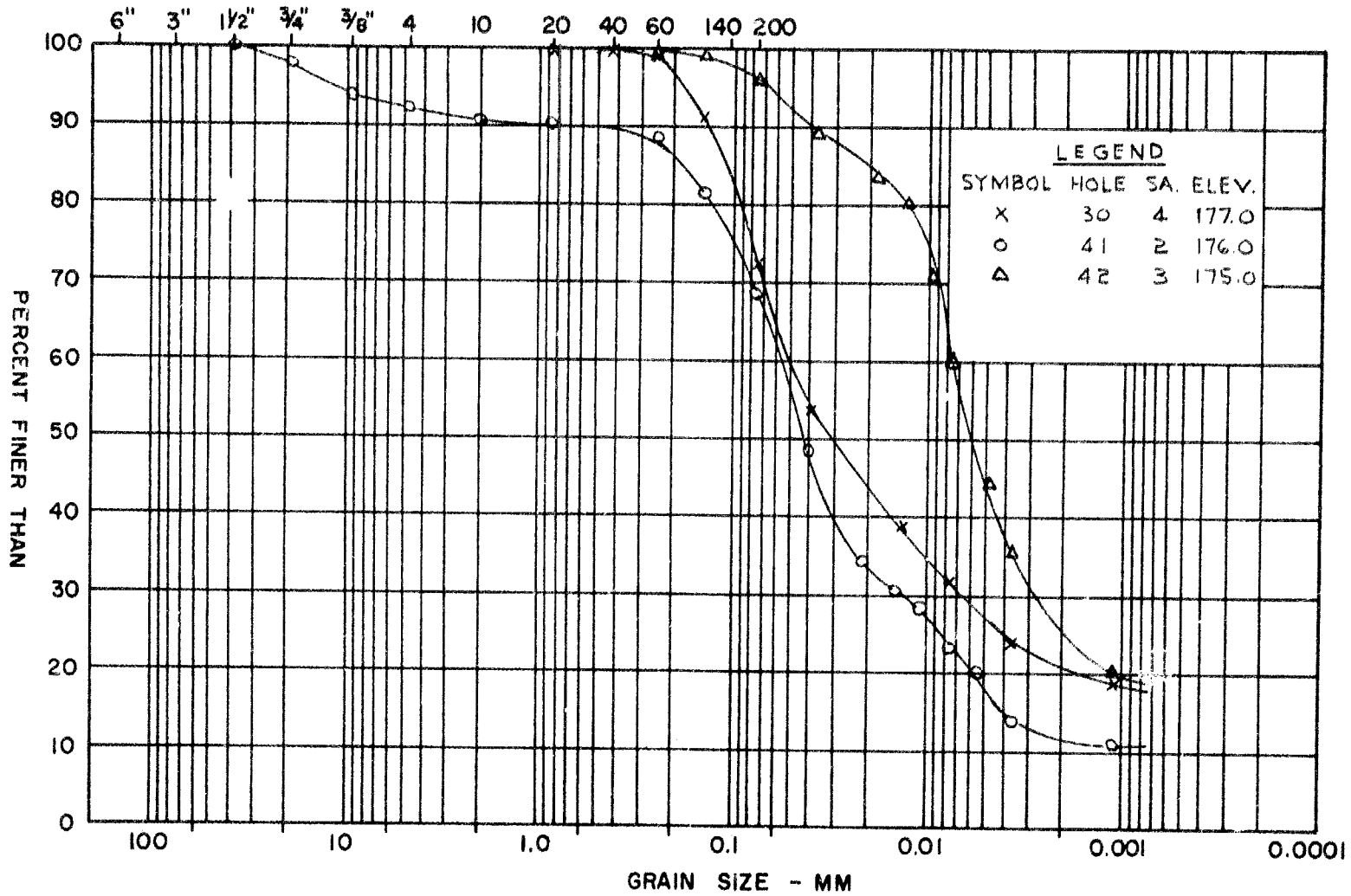
GOLDER & ASSOCIATES

GRAIN SIZE DISTRIBUTION
SANDY TO CLAYEY SILT

FIGURE 4

M.I.T. GRAIN SIZE SCALE

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



GOLDER & ASSOCIATES

GRAIN SIZE DISTRIBUTION
SANDY TO CLAYEY SILT

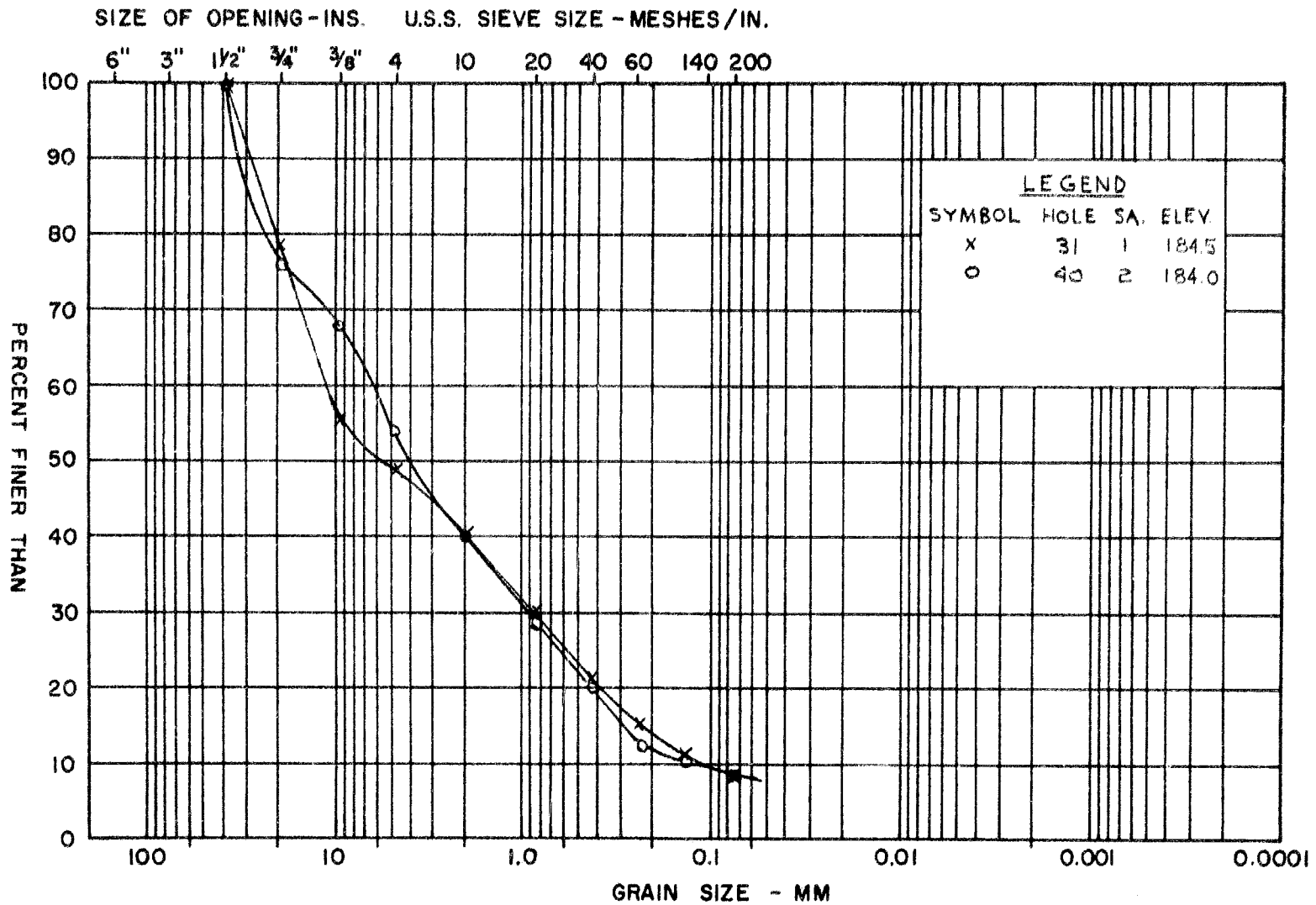
FIGURE 5

M.I.T. GRAIN SIZE SCALE

GRAIN SIZE DISTRIBUTION
SANDY GRAVEL

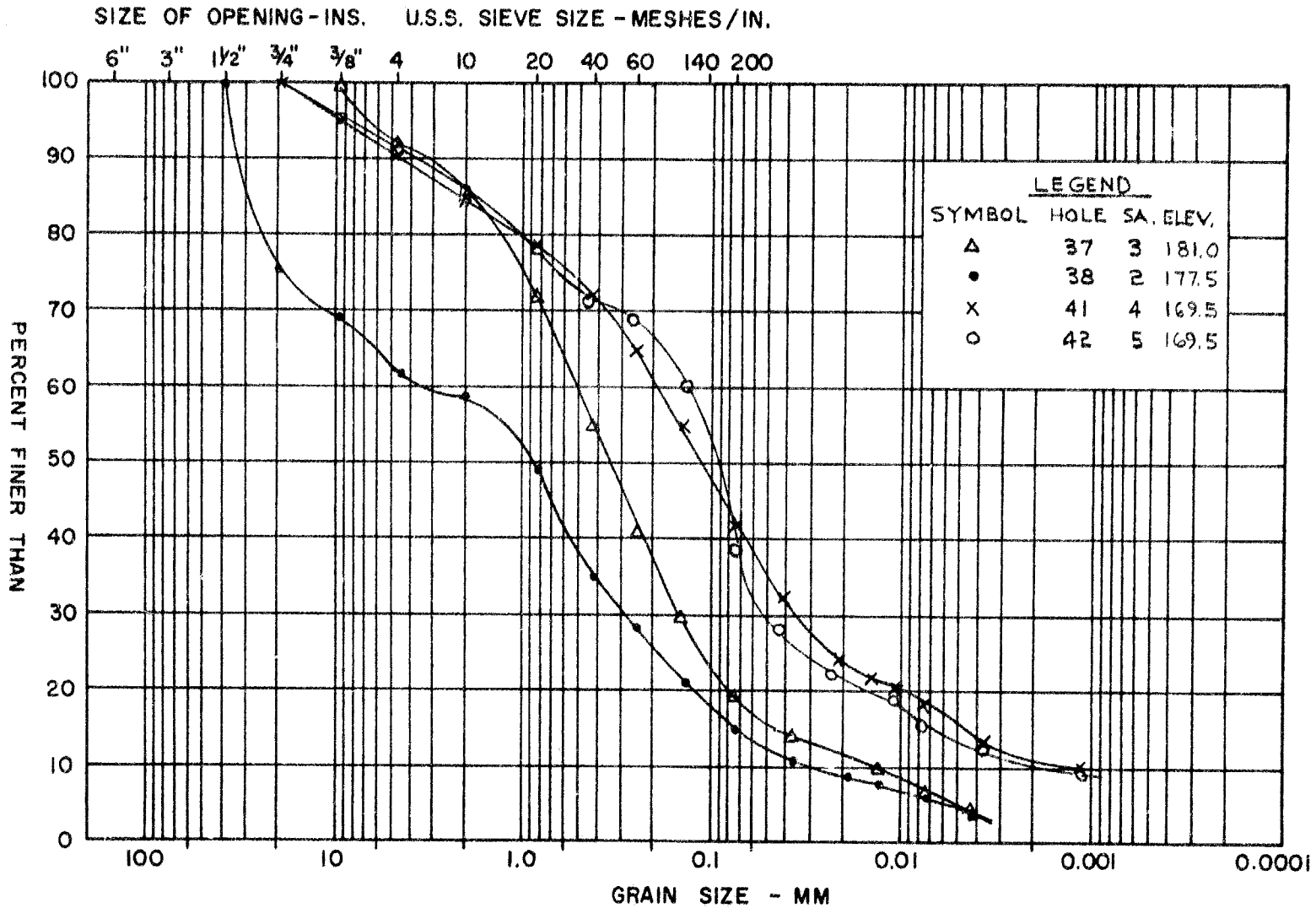
FIGURE 6

GOLDER & ASSOCIATES



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

M.I.T. GRAIN SIZE SCALE



GOLDER & ASSOCIATES

GRAIN SIZE DISTRIBUTION
SILTY SAND AND GRAVEL

FIGURE 7