

#

60-F-285-C

W.P. # 103-59

BROOKDALE AVE.,

INTERCHANGE, CITY

OF CORNWALL,

BRIDGE NO. <sup>#</sup>10

Mr. A. N. Toye,  
Bridge Engineer.  
Materials & Research Section.

May 3, 1960.

FOUNDATION INVESTIGATION -- by  
Racey, MacCallum & Associates,  
Ltd.

Attention: Mr. S. McCombie.

Re: Intersection of Hwy. No. 401 and  
Brookdale Ave., Cornwall, Ontario.  
W.P. 103-59 -- District 9.

In reviewing the above mentioned report, we have found that the stability analyses carried out by the Consultant were not conclusive. We have also found that the interpretation of the shear strength values used in these calculations was not satisfactory. To accurately define the strength vs. depth profile, we have carried out one additional boring at the site; shear strength measurements were performed in the field and the laboratory. The results of these measurements have been summarized graphically and attached to this memo. From this shear strength presentation, it is obvious that too high values have been used in the previous stability investigations and we have, therefore, carried out additional analyses based on the following assumptions:-

Height of fill equals 22 ft.; shear strength of the clay subsoil  $c = 350$  p.s.f. Because of the very limited depth of the upper stiff layer (approx. 7 ft.) the increase of shear strength has been neglected. The embankment slope was taken as 2:1.

Stability calculations have shown that counterbalancing berms are required for the fill height of 22 ft., proposed. The maximum safe height of the fill that can be built without a berm, is 11 ft. The required length of berm is given on the attached graph giving the relationship between the height of fill to the length of berm. The berm slope is also 2:1. The berm will have to be built in a direction parallel to road centre line, as well as at rightangle to centre line. The structure will have to be founded on end-bearing, small displacement type piles, driven to the contact of the limestone bedrock formation.

cont'd. /2 ...

If we can be of further assistance in interpreting the data contained in the attached report, please do not hesitate to contact our Office.

L. G. Soderman,  
PRINCIPAL SOILS & FOUNDATIONS ENGR.

Per:

*d*  
(A. Starnes,  
FOUNDATIONS OFFICE ENGR.)

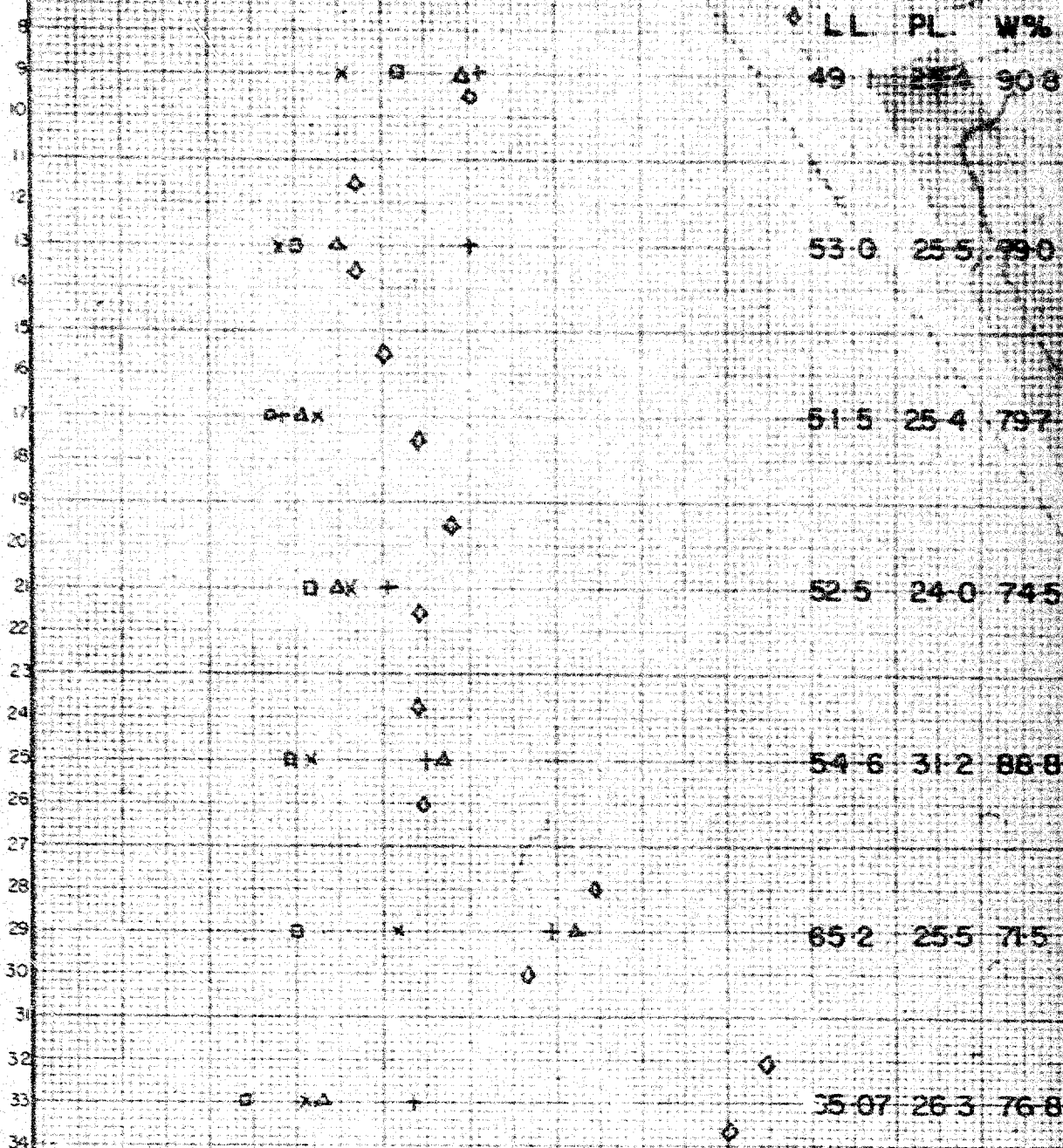
AS/MinF  
Attach.

cc: Messrs. A. M. Tays (2)  
H. A. Tregaskes  
D. G. Ramsay  
J. Ford  
L. E. Walker  
J. B. Grunpian  
A. Watt  
Foundations Office  
Gen. Files. ✓

## SHEAR STRENGTH p.s.f.

100 200 300 400 500 600 700 800

DEPTH BELOW G.L.



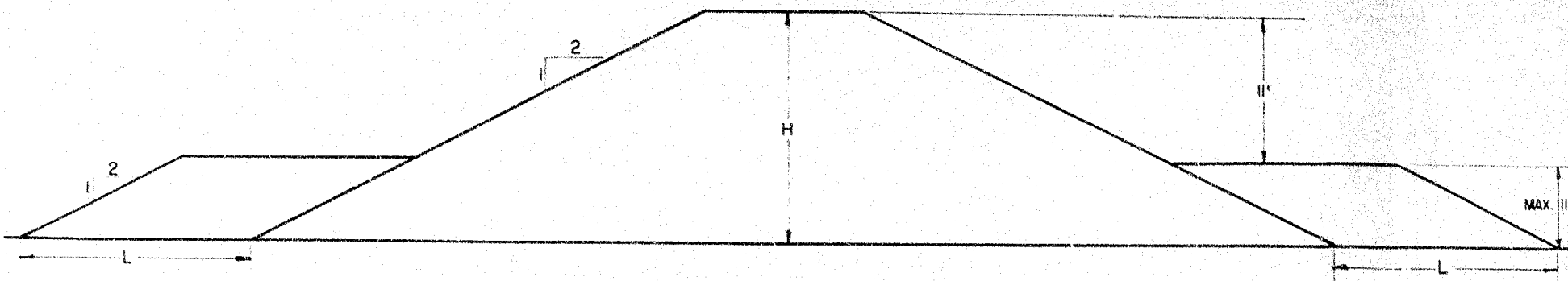
O UNCONFINED

X TRIAXIAL

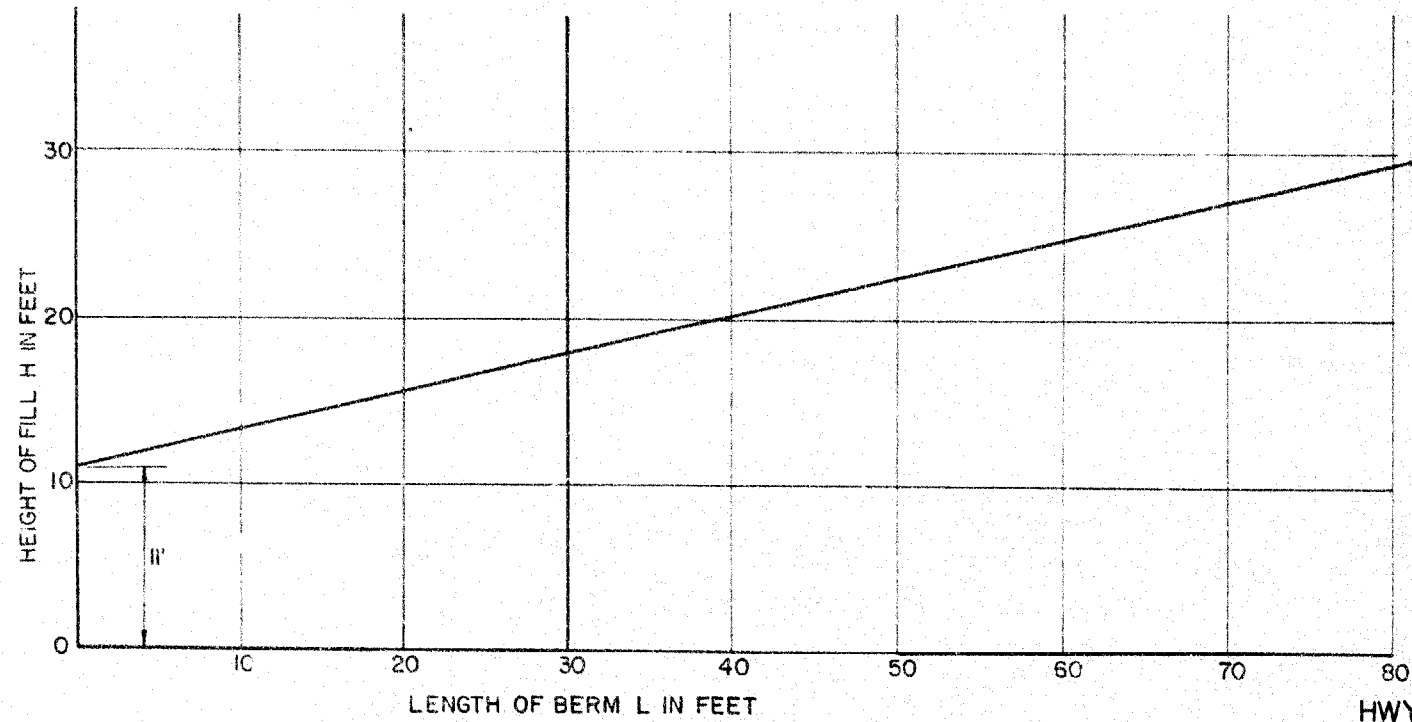
+ LAB VANE

△ " "

◇ FIELD VANE



RECOMMENDED BERM SECTION



HWY. 401 BROOKDALE AVE.

CORNWALL

WP 60F-40

23-62-52  
RACEY, MacCALLUM AND ASSOCIATES  
LIMITED

A COMPANY OWNED, DIRECTED AND OPERATED BY

Consulting Engineers  
AND ASSOCIATED STAFF

MONTREAL  VANCOUVER

DONALD C. MACCALLUM, B.ENG., M.E.I.C., P.ENG.

H. JOHN RACEY, B.Sc., M.E.I.C., P.ENG.

GEORGE L. HOUGHTON, A.M.I.MECH.E., M.E.I.C., P.ENG.

TORONTO

TORONTO DIVISION  
27 CARLTON STREET

Reference: S-500/T-2104  
- Report -

15th March, 1960

Department of Highways for Ontario,  
Materials and Research Section,  
C/o Parliament Buildings,  
TORONTO - Ontario.

Attention: Mr. L. Soderman.

RE: SOIL INVESTIGATION AT INTERSECTION  
OF HWY # 401 AND BROOKDALE AVENUE,  
CORNWALL, ONTARIO.

Dear Sir,

The enclosed report presents the results of our  
soil investigation at the above location.

We hope the report is satisfactory to you; if you  
have any questions about it please do not hesitate to get in  
touch with us.

Thank you for this opportunity of being of service  
to you.

Yours very truly,  
RACEY, MacCALLUM AND ASSOCIATES LIMITED,

J. J. Schoustra, P.Eng.,  
Divisional Soil Engineer.

JJS/YDP

Department of Highways for Ontario,  
Materials and Research Section,  
C/o Parliament Buildings,  
Toronto, Ontario.

SOIL INVESTIGATION AT INTERSECTION  
OF HWY # 401 AND BROOKDALE AVENUE,  
CORNWALL, ONTARIO.

Reference: S-500/T-2104  
- Report -

Racey, MacCallum and Associates  
Limited.

16th March, 1960.

# RACEY, MACCALLUM AND ASSOCIATES LIMITED

A COMPANY OWNED, DIRECTED AND OPERATED BY

Consulting Engineers  
AND ASSOCIATED STAFF

MONTREAL  VANCOUVER

TORONTO

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TORONTO DIVISION  
27 CARLTON STREET

Reference: S-500/T-2104  
- Report -

16th March, 1960

## SOIL INVESTIGATION AT INTERSECTION OF HWY # 401 AND BROOKDALE AVENUE, CORNWALL, ONTARIO.

### INTRODUCTION :

The field investigation to determine the sub-soil conditions at the site was carried out from 21st January, 1960 to 3rd February, 1960, and consisted of four boreholes and five cone-penetration tests. On arrival at the laboratory the soil samples obtained from the field were subjected to various tests to determine its strength and settlement characteristics.

The following paragraphs present a detailed description of the field and laboratory results, together with recommendations regarding a suitable type of foundation for the proposed overpass and the sub-soil conditions.

### SITE GEOLOGY :

The region where the site under investigation is located is known as the St. Lawrence - Ottawa lowlands. This till plain was buried under the sediments of the new extinct Champlain Sea which covered this area after the recession of the last glacier. With the removal of the glacier load and the disappearance of the sea, these sedimentary deposits of siltish clay were gradually exposed and are now commonly known as "Leda" clays.

### SCOPE OF FIELD INVESTIGATION :

The field work consisted of a boring with adjacent cone penetration tests at locations No 1, 2, 3 and 4, and a cone penetration test at location No 5. The locations of the boreholes and cone tests are shown on Enclosure No 1, which also shows the soil profile along Brookdale Avenue, Cornwall. The results are plotted on data sheets - Enclosures No 2, 3, 4, 5 and 6.



Reference: S-500/T-2104  
- Report - Continued.

16th March, 1960

The whole site was covered with snow which at places was more than 2 feet deep. Elevations shown are however at actual ground level.

Borings were carried out using a standard diamond-drilling rig equipped for sampling with a 2-inch outside diameter split spoon and 2 inch inside diameter thin walled Shelby tubes. Boreholes were advanced by driving BX casing and washing, with samples being taken at regular intervals. In addition to the sampling, several vane-torsional tests were carried out at various depths to obtain the in-situ soil shear strength both in the undisturbed and re-moulded state. In the underlying bedrock an AX-core bit was used to recover bedrock cores.

Adjacent to each borehole a 60-degree point angle cone was driven to obtain a continuous record of soil density. The driving energy was a 140 lb hammer at a 30 inches drop. The same driving energy was also used for obtaining split-spoon samples. The results of the borings and cone tests can be seen on Enclosures No 2 to 6.

Artesian water was encountered in all the boreholes. These boreholes were subsequently plugged before leaving the site.

#### SUB-SOIL CONDITIONS :

The soil profile along the proposed centre-line of the overpass - shown on Enclosure No 1 - indicates generally uniform sub-soil conditions over the site. It consists of approximately 36 to 40 feet of soft to very soft, silty clay (for grain size analysis see Enclosure No 11), overlying approximately 10 feet of dense to very dense clayey sandy till interspersed with gravel and some boulders. Limestone bedrock underlies all this.

Artesian water was found in all boreholes at approximately the interface of the bedrock and the overlying boulder till. The maximum hydrostatic pressure head encountered was approximately 3 feet above ground level (Elevation 197.0 feet), and the minimum was 6 inches (Elevation 194.6 feet).

Accurate determination of the ground water table could not be made, due to the fact that wash water was used in advancing the borings. However, other evidence such as change in colouring

Reference: S-500/1-210,  
- Report - Continued.

16th March, 1960

and moisture of the clay samples would seem to indicate that the lowest ground water table usually exists in the upper few feet of the silty-clay stratum.

LABORATORY WORK :

Laboratory tests were carried out to determine the strength characteristics of the sub-soil and establish correlation with the in-situ vane tests. The results of the unconfined compression and triaxial tests done in this connection are shown on Enclosures No 7 to No 10, and also on Enclosures No 2 to No 5.

To help establish classification and determine soil composition, Atterberg Limit tests and a wet sieving analysis were carried out. The results of the Atterberg tests are shown on Enclosures No 2 to 5, and of the wet sieving analysis on Enclosure No 11.

A Consolidation test was also undertaken to find out the settlement characteristics, the results of which are plotted as an 'e-log p' curve on Enclosure No 12.

DISCUSSION OF RESULTS :

The silty clay exhibits a fairly high shear strength in the upper 10 feet reaching a high of above 1200 psf. Below this depth the strength is relatively uniform and of the order of approximately 450 psf. However, there is a slight gain in strength nearer the bottom of the silty clay stratum. The values obtained by the Unconfined Compression Tests are generally somewhat lower but only by 10% or so, when compared with the in-situ vane values. A triaxial test carried out on a sample obtained from a depth of 30 feet and cell pressures of 30, 40 and 50 psi gave similar results. This small discrepancy between the laboratory tests and field values is probably due to the following factors, or possibly due to a combination of some or all of them.

- i. A general disturbance of the soil caused by sampling and preparation procedures.
- ii. The removal of the in situ stress after sampling.
- iii. The samples being not quite uniform.

Reference: S-500/T-2104;  
- Report - Continued.

16th March, 1960

From the above foregoing considerations it would seem reasonable to accept the in-situ vane values.

Re-moulded shear strengths as indicated by the in-situ vane tests indicate the silty clay to be somewhat sensitive.

The results of the consolidation tests indicate that the clay has been pre-consolidated : approximately 2000 to 2200 psf, but this is equal to the pressure of the overburden as the test was conducted on a sample from a depth of nearly 16 feet. This would indicate the soil to be a normally consolidated soil and, as such, no advantage can be taken of any previous geological pre- or over-consolidation pressures.

EMBANKMENT STABILITY :

It was decided to make stability analyses for both the embankment and abutment fill assuming a base failure in each case. The following assumptions were assumed in making the calculations :

- a. Embankment height approximately 22 feet.
- b. Embankment average crest width 35 feet with side slopes of 1 in  $1\frac{1}{2}$ .
- c. Unit weight of fill 120 pcf.
- d. Clay stratum depth approximately 36 feet.
- e. Zero angle of friction ( $\phi = 0$ ).
- f. Cohesive strength (C) of 1200 psf for top 3 feet, and average of 450 psf below that.
- g. Water table at ground surface.

The results of the analyses are shown on Enclosure No 13 and No 14. The factor of safety for the embankment fill was found to be 1.06, and for the abutment fill to be 1.02. Greater stability could be obtained by increasing the side slopes from 1 to  $1\frac{1}{2}$  to 1 to 2 or better.

Stability analyses assuming the failure taking place inside the clay stratum itself rather than at the full depth of the

Reference: S-500/T-2104  
- Report - Continued.

16th March, 1960

layer were also undertaken. The results showed a quite rapid increase in the factor of safety when smaller slip circles were used.

#### EMBANKMENT SETTLEMENT :

Settlement calculations based on the results of the consolidation test and the assumptions noted above indicate that the settlement under the centre of the embankment fill will be approximately 4 feet, and nearly 5 inches under the edge of the fill. These values are in all probability somewhat greater than actual, due to sample disturbance as noted elsewhere. The settlement will be 50% and 90% complete in approximately 8 months and 3 years respectively.

In view of the above, it is suggested that care be taken and a careful watch kept during filling operations. It is further suggested that the fill be put down in well compacted layers and the settlement watched.

#### FOUNDATIONS :

The nature of the material excludes any possibility of spread footings from being considered. Steel H piles driven to refusal or some other kind of hollow or cast-in-place piles would seem advisable. Some trouble may be encountered in driving through the somewhat bouldery till lying above the bedrock. It is suggested that recourse be taken to well known pile bearing formulae in determining the capacities of the pile, dependent upon the pile being used.

It is to be noted that in designing the piles account will have to be taken of lateral pressures resulting from the embankment fill and acting on the piles. This should also help increase the safety factor of the fill.

In view of the high sensitivity of the clay and the amount of fill to be placed, it is recommended that the piles be driven into the ground before any fill is placed. The clay should very nearly recover its original strength in approximately a month's time - which in all probability will be the length of time needed to place approximately 22 feet of fill.

Reference: S-500/T-2104  
- Report - Continued.

16th March, 1960

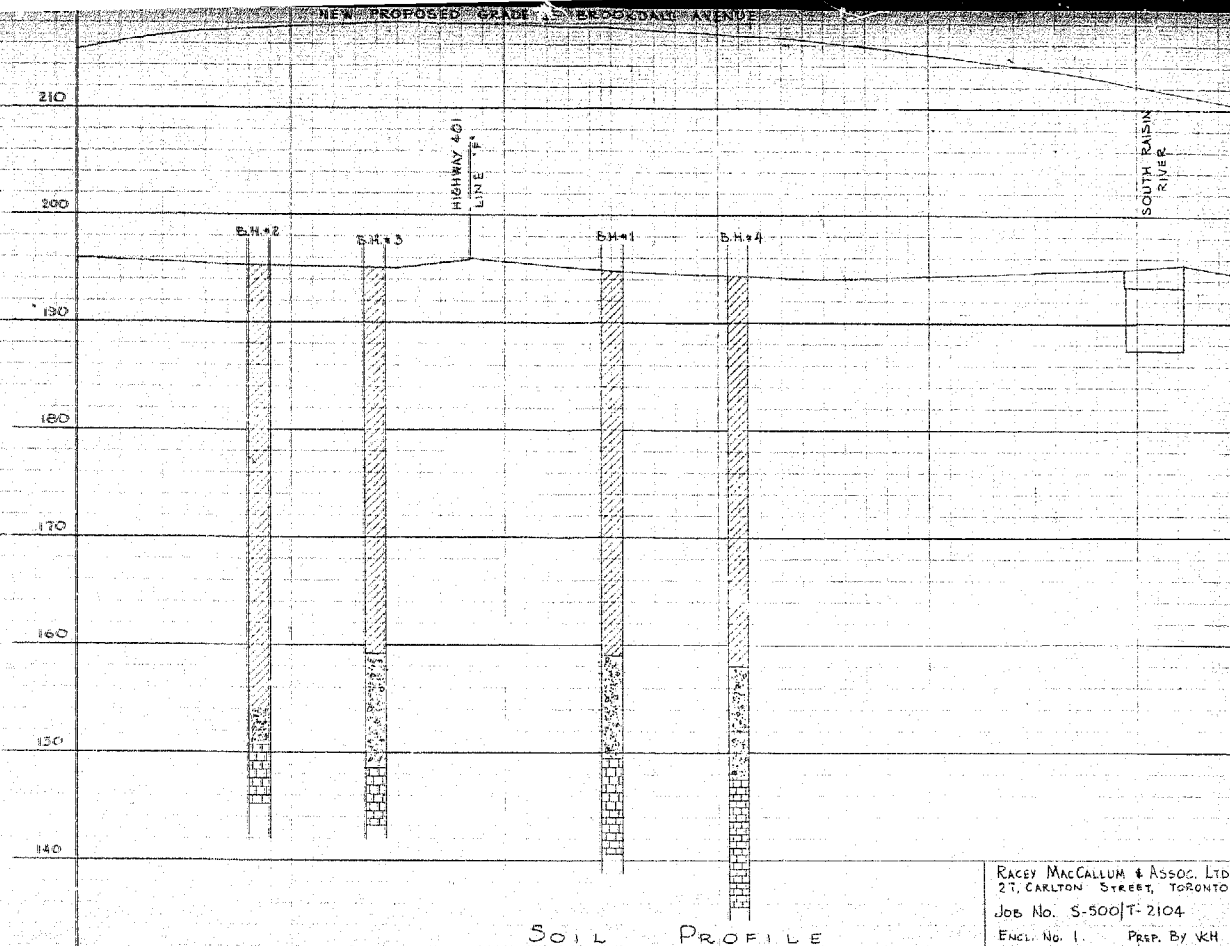
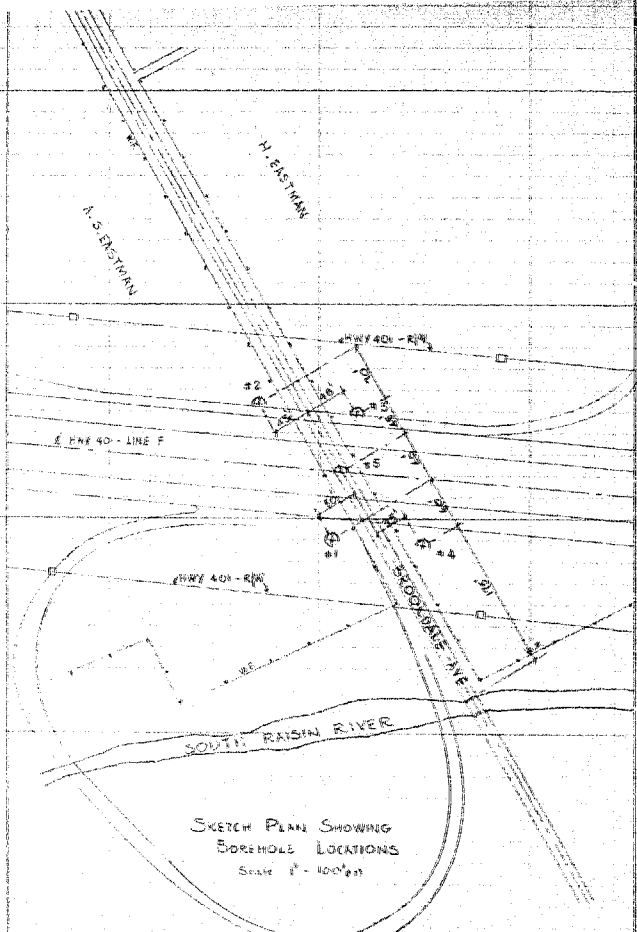
CONCLUSIONS AND RECOMMENDATIONS :

The following conclusions and recommendations seem warranted as a result of the foregoing considerations :

1. The overburden consists of a 36 to 40 foot layer of siltish clay overlying 4 to 6 feet of sandy till. The underlying bedrock is mainly limestone.
2. Artesian water under varying pressure heads was encountered in all the boreholes.
3. Steel H or cast-in-place piles would seem advisable for the foundations of the proposed overpass.
4. The piles should be driven before the placing of embankment fill.
5. The settlement under the embankment fill will be approximately 4 feet at the centre and nearly 5 inches at the edge. A careful watch should be kept during the fill operations.
6. The safety factor against a slip-circle failure is roughly 1.06 under the road embankment, and 1.02 under the abutment fill.

*V. K. Handa*  
V. K. Handa, P.Eng.,  
Project Engineer.

VKH/YDP



RACEY MACCALLUM & ASSOC. LTD.  
27, CARLTON STREET, TORONTO  
JOB No. S-500/T-2104  
ENCL. No. 1 PREP. BY K.H.

**Foundation Engineering Division**

### LEGEND

### Consistency

**Natural moisture and  
Liquidity Index (LI)**

**Liquid limit**

**Plastic** 塑料

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9

### Sampling Method

2<sup>nd</sup> Dia. split tube

2<sup>nd</sup> Shelby tube

DEPTH FEET	CONSISTENCY		SAMPLE	NATURAL UNIT WT. P.C.F.	REMARKS	
	MOISTURE CONTENT, % DRY WEIGHT					
0	20	40	60	80	100	
	</					

**RACEY MacCALLUM AND ASSOCIATES LTD.**

Foundation Engineering Division

Engineering Data Sheet for Borehole: 1

Project: SOIL INVEST. CROSSING 401 & BROOKDALE AVE.  
 Location: CORNWALL - ONTARIO.  
 Hole Location: See Enclosure No 1.  
 Hole Elevation and Datum: 194.0 feet  
 Field Supervisor: V.H. Prep.: V.H.  
 Driller: J.C. Checked: Date:

**LEGEND**

Shear Strength (C)

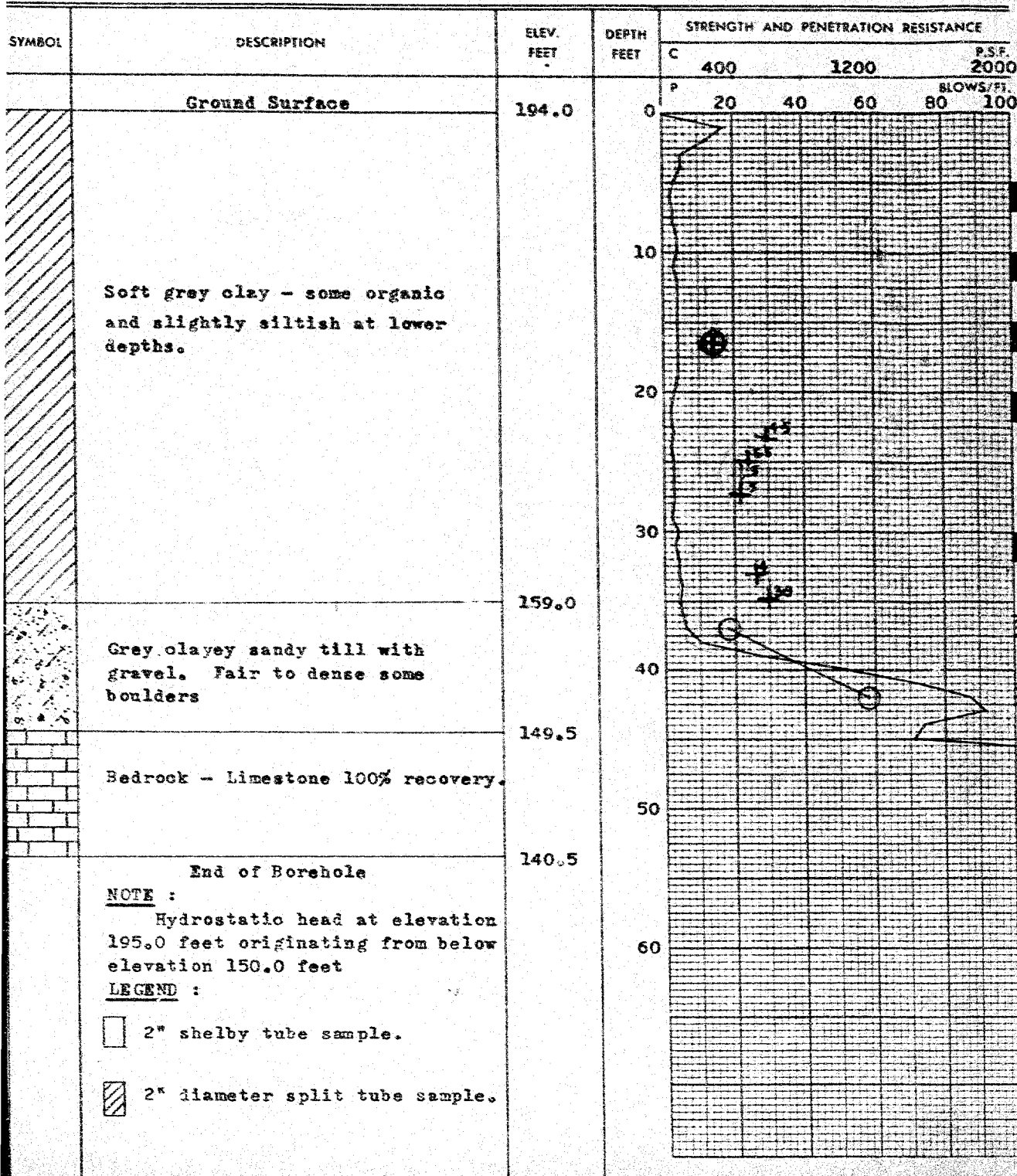
 Unconfined compression  
 Vane test and sensitivity (S)

Penetration Resistance (P)

2" Split tube

2" Dia. Cone

Casing





**RACEY MacCALLUM AND ASSOCIATES LTD.**

Foundation Engineering Division

Engineering Data Sheet for Borehole: 2

Project: SOIL INVEST. CROSSING 401 & BROOKDALE AVE.  
 Location: CORNWALL - ONTARIO.  
 Hole Location: See Enclosure No 1.  
 Hole Elevation and Datum: 194.2 feet.  
 Field Supervisor: V.H. Prep.: V.H.  
 Driller: J.C. Checked: Date:

**LEGEND**

Shear Strength (C)

Unconfined compression

Vane test and sensitivity (S)

Penetration Resistance (P)

2" Split tube

2" Dia. Cone

Casing

4.5



SYMBOL	DESCRIPTION	ELEV. FEET	DEPTH FEET	STRENGTH AND PENETRATION RESISTANCE					
				C	400	600	1200	P.S.F. 2000	
	Ground Surface	194.2		P	20	40	60	80	100
	Medium stiff to very soft grey clay, some varving.								
	Grey fine to medium coarse dense clayey till, some gravel.	154.2							
		150.7							
	Bedrock - Limestone 100 % recovery.	145.2							
	End of Borehole								
	NOTE : Hydrostatic head at elevation 197.0 feet originating from elevation 150.0 feet.								
	LEGEND :								
	2" shelby tube sample.								
	2" diameter split tube sample.								

**RACEY MacCALLUM AND ASSOCIATES LTD.**

Foundation Engineering Division

Engineering Data Sheet for Borehole: 2

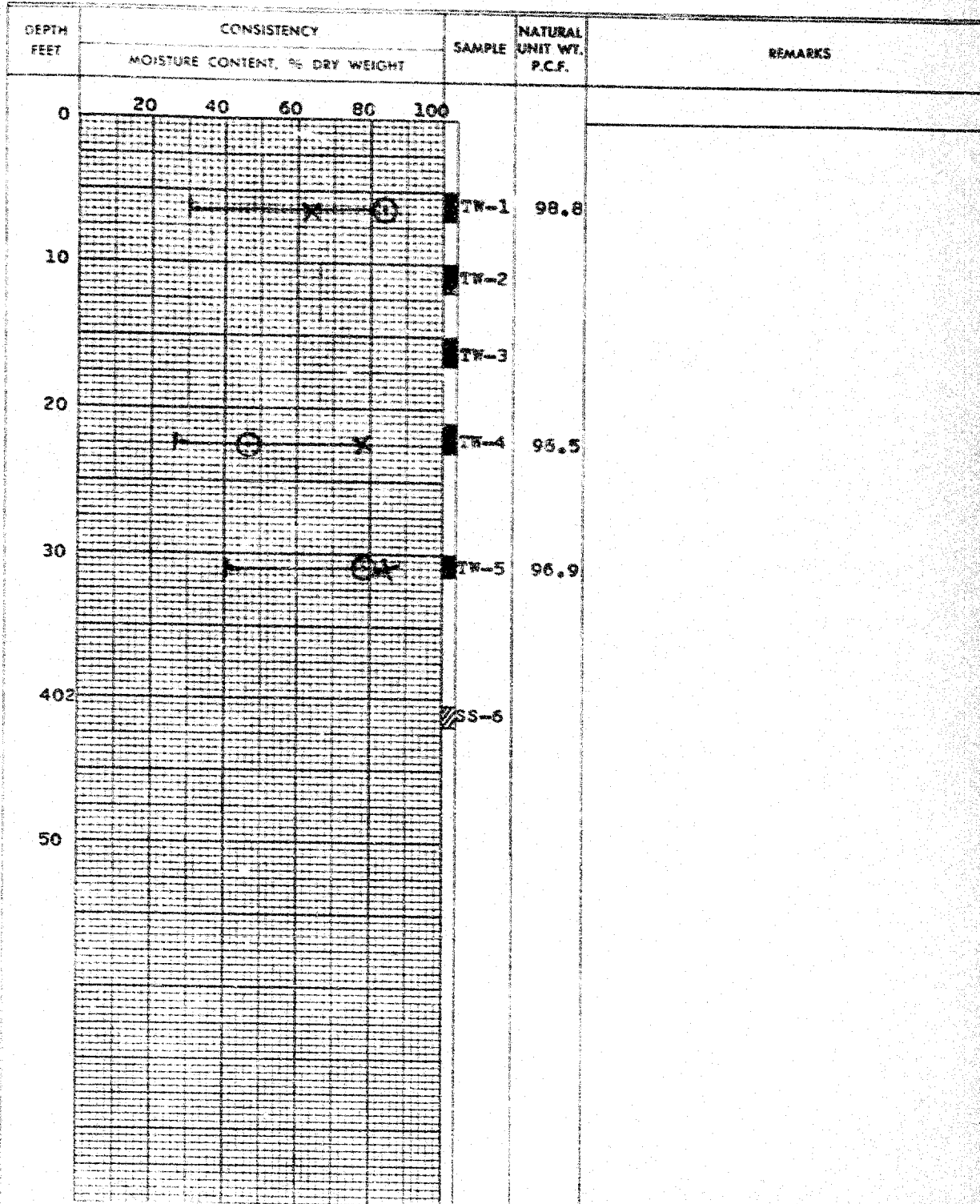
**LEGEND****Consistency**

Natural moisture and  
Liquidity Index (LI)  
Liquid limit  
Plastic limit

**Sampling Method**

2" Dia. split tube

2" Shelby tube



**RACEY MacCALLUM AND ASSOCIATES LTD.**

Foundation Engineering Division

Engineering Data Sheet for Borehole: 3

Project: SOIL INVEST. CROSSING 401 & BROOKDALE AVE.  
 Location: CORNWALL - ONTARIO.  
 Hole Location: See Enclosure No 1.  
 Hole Elevation and Datum: 194.1 feet  
 Field Supervisor: V.H. Prep.: V.H.  
 Driller: J.C. Checked: \_\_\_\_\_ Date: \_\_\_\_\_

**LEGEND**

Shear Strength (C)

Unconfined compression

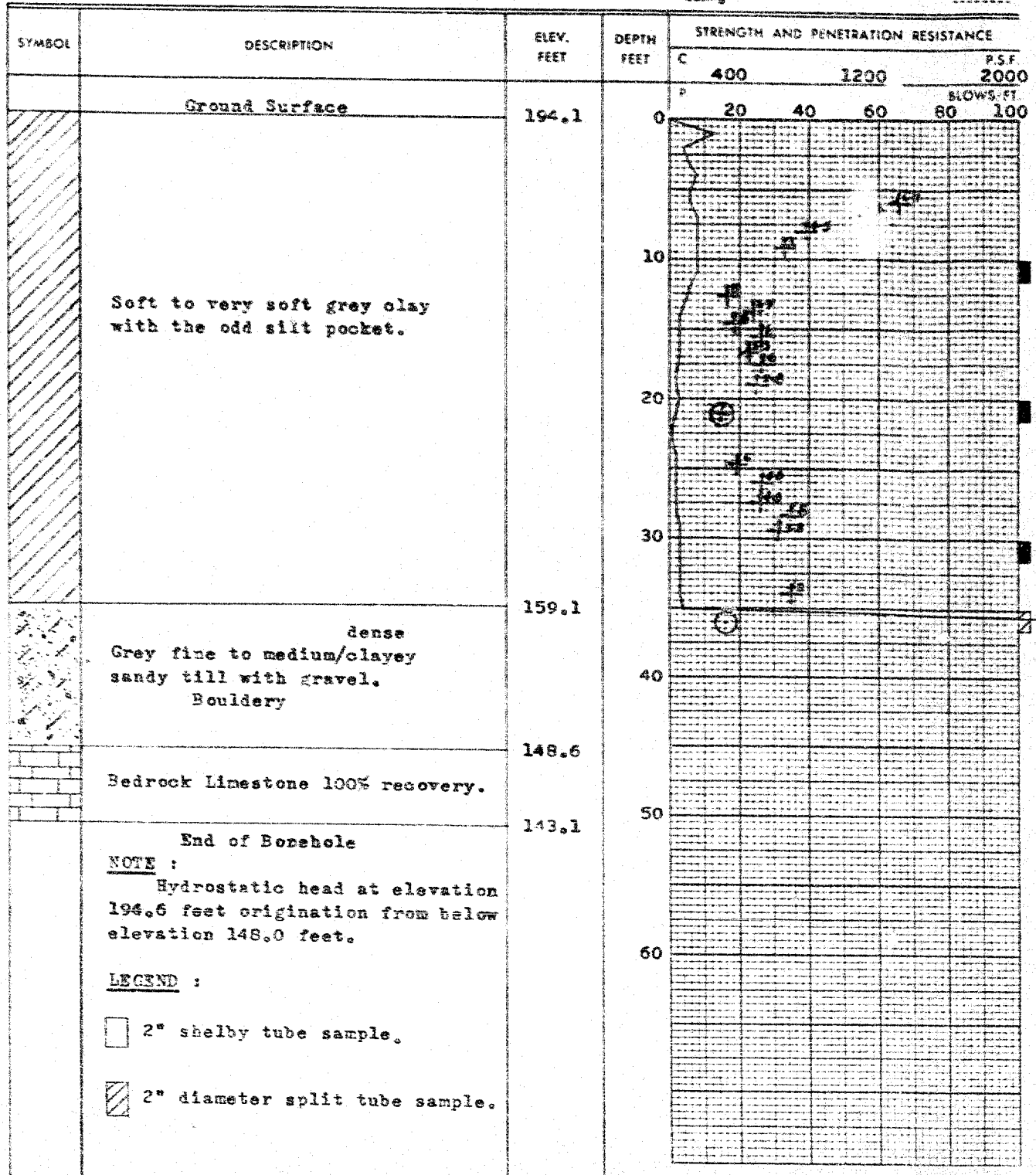
Vane test and sensitivity (S)

Penetration Resistance (P)

2" Split tube

2" Dia. Cone

Casing

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43

**RACEY MacCALLUM AND ASSOCIATES LTD.**

Foundation Engineering Division

Engineering Data Sheet for Borehole: 3

**LEGEND**

Consistency

Natural moisture and  
Liquidity Index (LI)Liquid limit  
Plastic limit

X LI

-O-

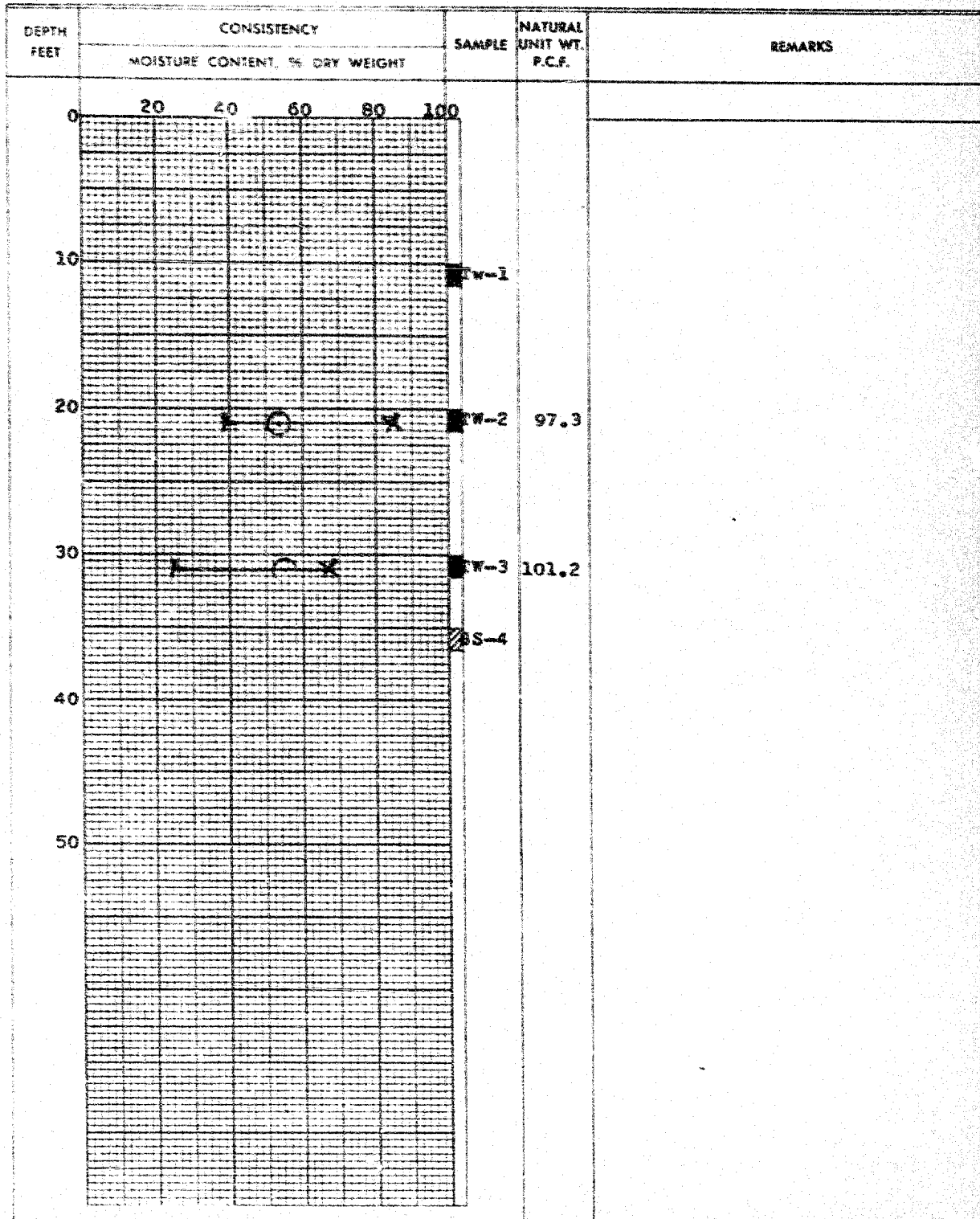
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Sampling Method

2" Dia. split tube



2" Shelby tube



**RACEY MacCALLUM AND ASSOCIATES LTD.**

Foundation Engineering Division

Engineering Data Sheet for Borehole: 4

Project: SOIL INVEST. CROSSING 401 & BROOKDALE AVE.  
 Location: CORNWALL - ONTARIO.  
 Hole Location: See Enclosure No 1.  
 Hole Elevation and Datum: 193.0 feet  
 Field Supervisor: V.H. Prep.: V.H.  
 Driller: J.C. Checked: Date:

**LEGEND**

Shear Strength (C)

Unconfined compression

Vane test and sensitivity (S)

Penetration Resistance (P)

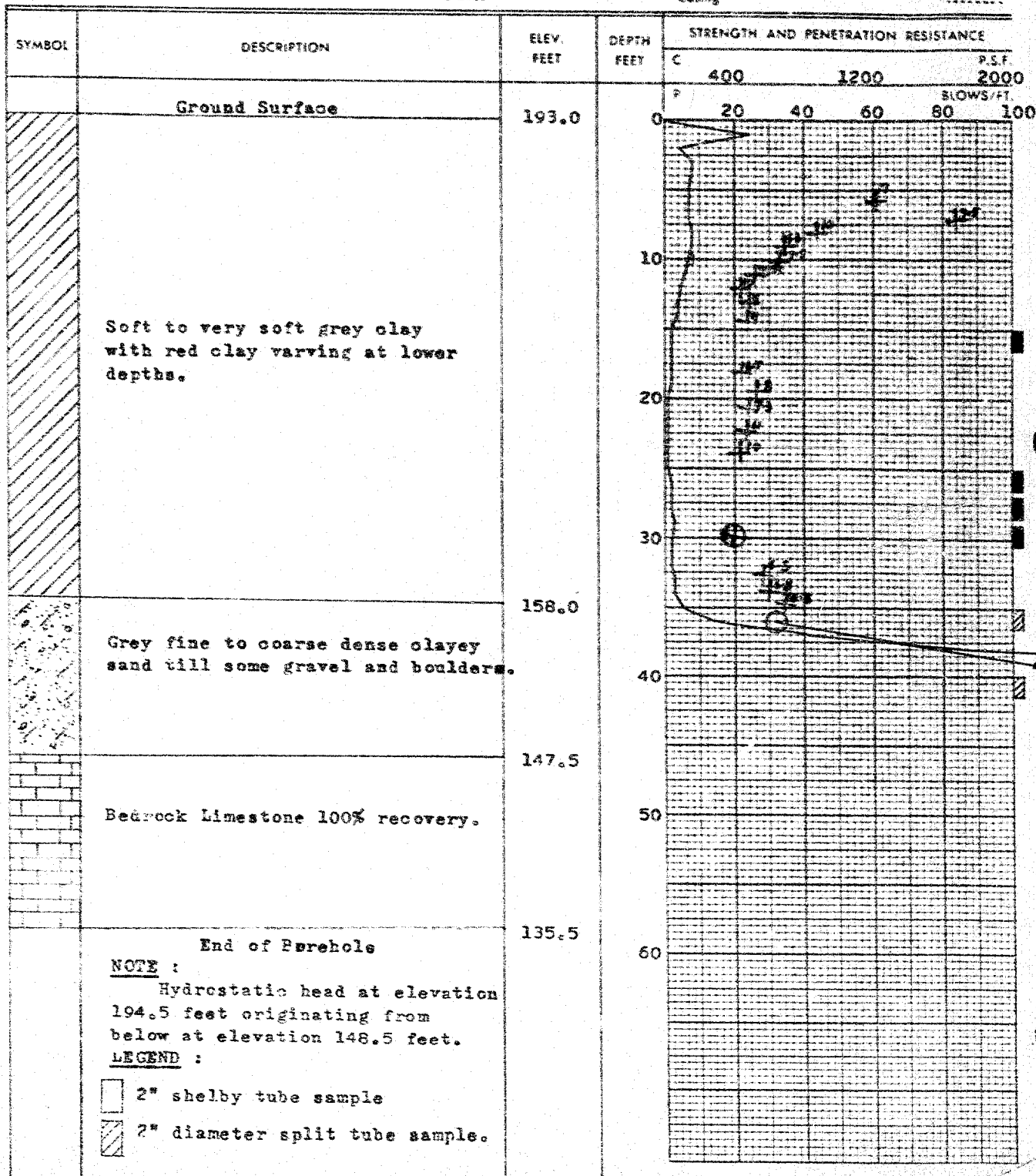
2" Split tube

2" Dia. Cone

Casing

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**RACEY MacCALLUM AND ASSOCIATES LTD.**

Engineering Data Sheet for Borehole: 4

### LEGEND

### Consistency

## Natural moisture and Equilibrium Index 183

**Lead time**

**Pliginskij** **Wladimir**

### Sampling Method

2" Dia. split tube

2011 2012 2013 2014

DEPTH FEET	CONSISTENCY				SAMPLE	NATURAL UNIT WT. P.C.F.	REMARKS
	MOISTURE CONTENT, % DRY WEIGHT						
	20	40	60	80	100		
0							
10							
20							
25							
26							
27							
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29							
30							
31							
32							
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**RACEY MacCALLUM AND ASSOCIATES LTD.**

Foundation Engineering Division

Engineering Data Sheet for Borehole: 5

Project: SOIL INVEST. CROSSING 401 &amp; BROOKTALE AVE.

Location: CORNWALL - ONTARIO.

Hole Location: See Enclosure No 1.

Hole Elevation and Datum: 194.5 feet

Field Supervisor: V.H. Prep.: V.H.

Driller: J.C. Checked:

Date:

**LEGEND**

Shear Strength (C)

Unconfined compression

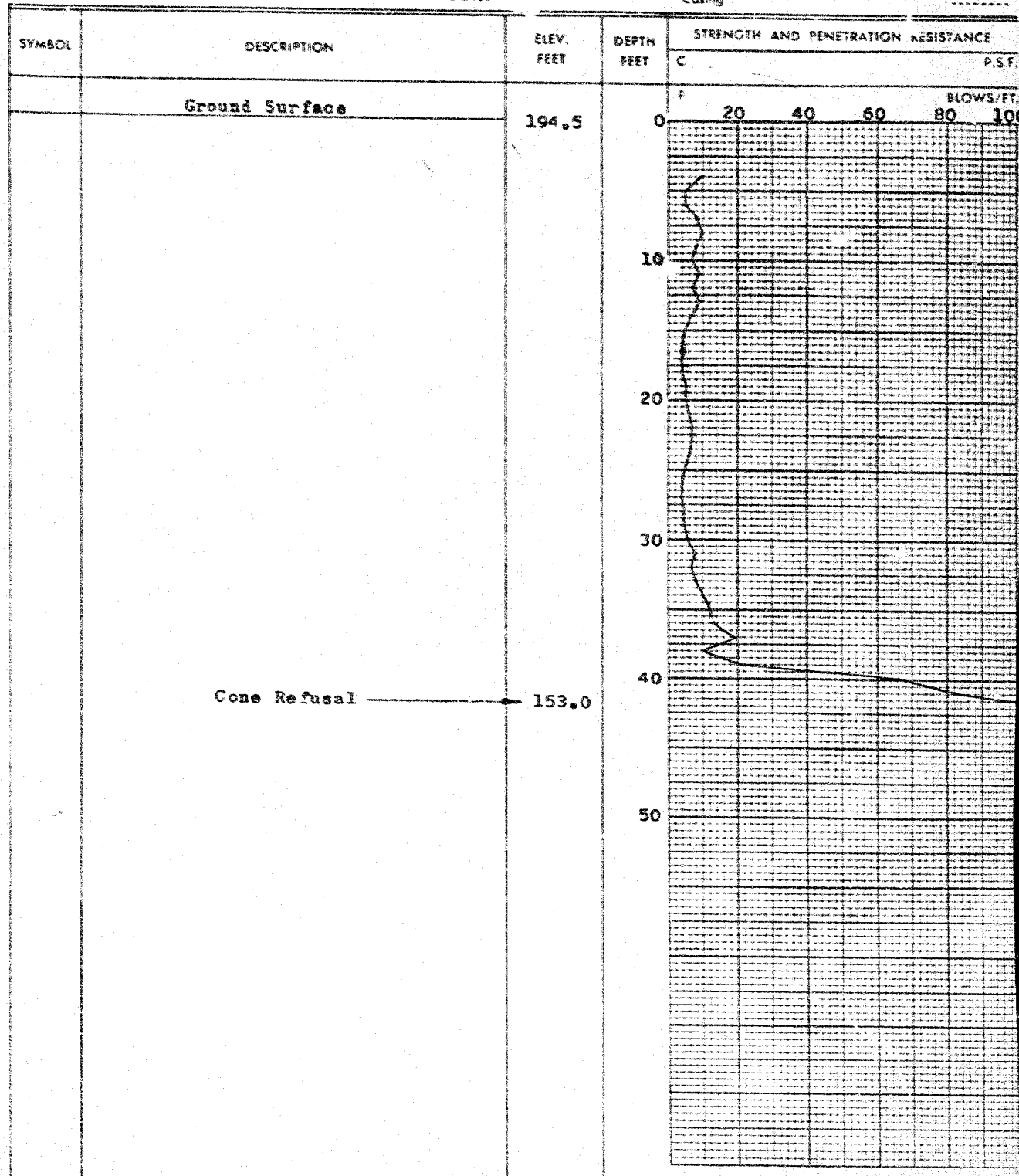
Vane test and sensitivity (S)

Penetration Resistance (P)

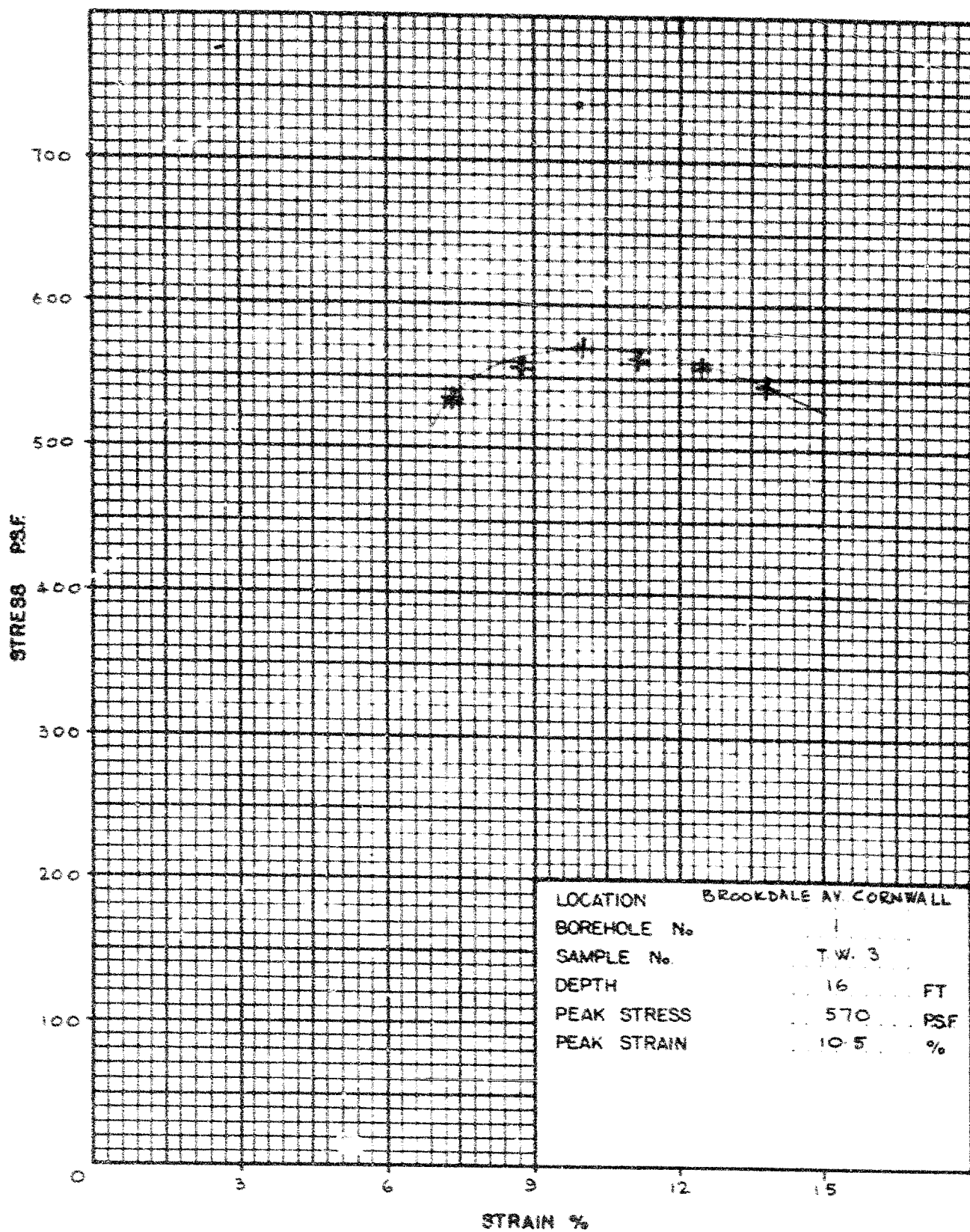
2" Split tube

2" Dia. Cone

Casing



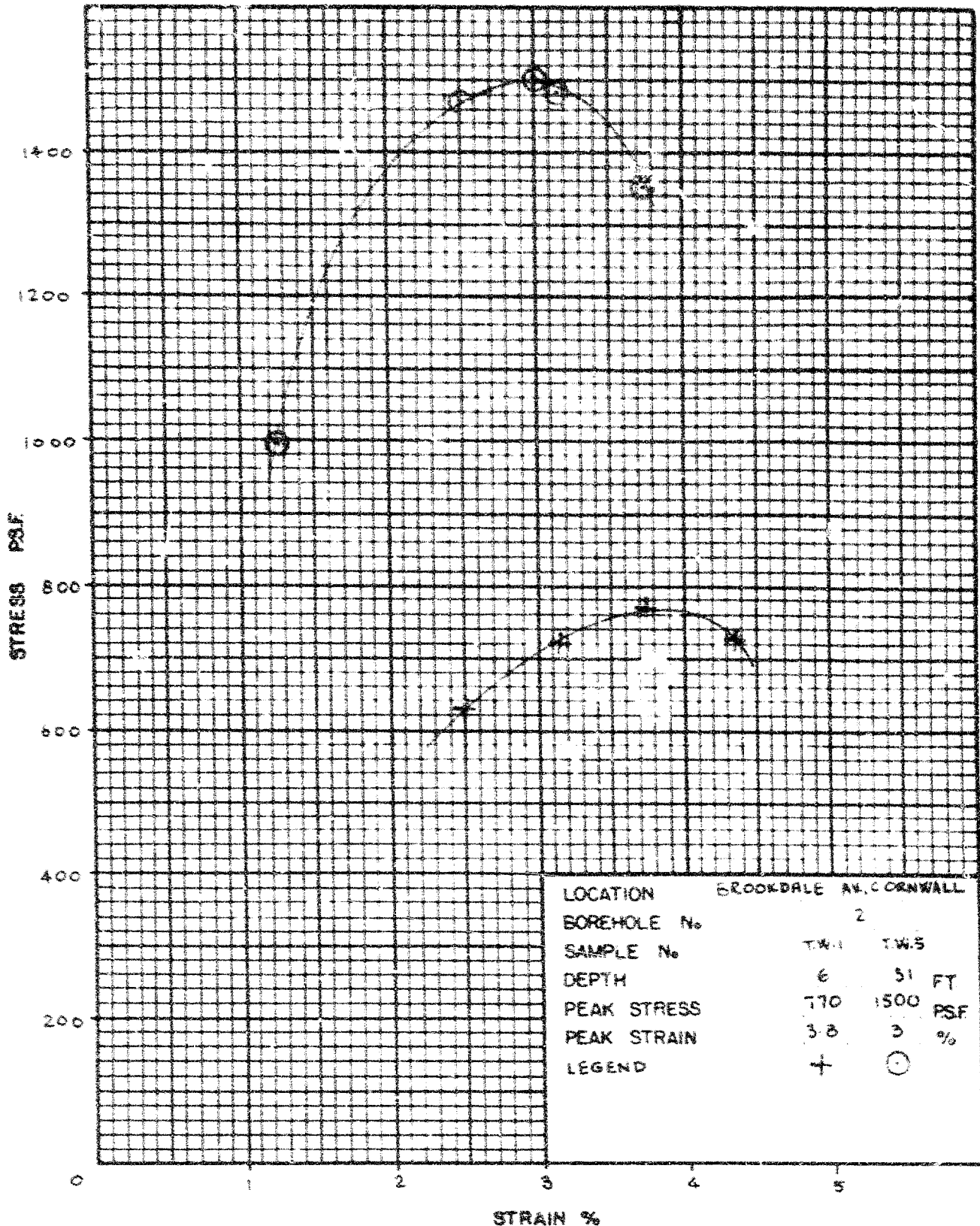
## UNCONFINED COMPRESSION TEST





Prep. By V.H.

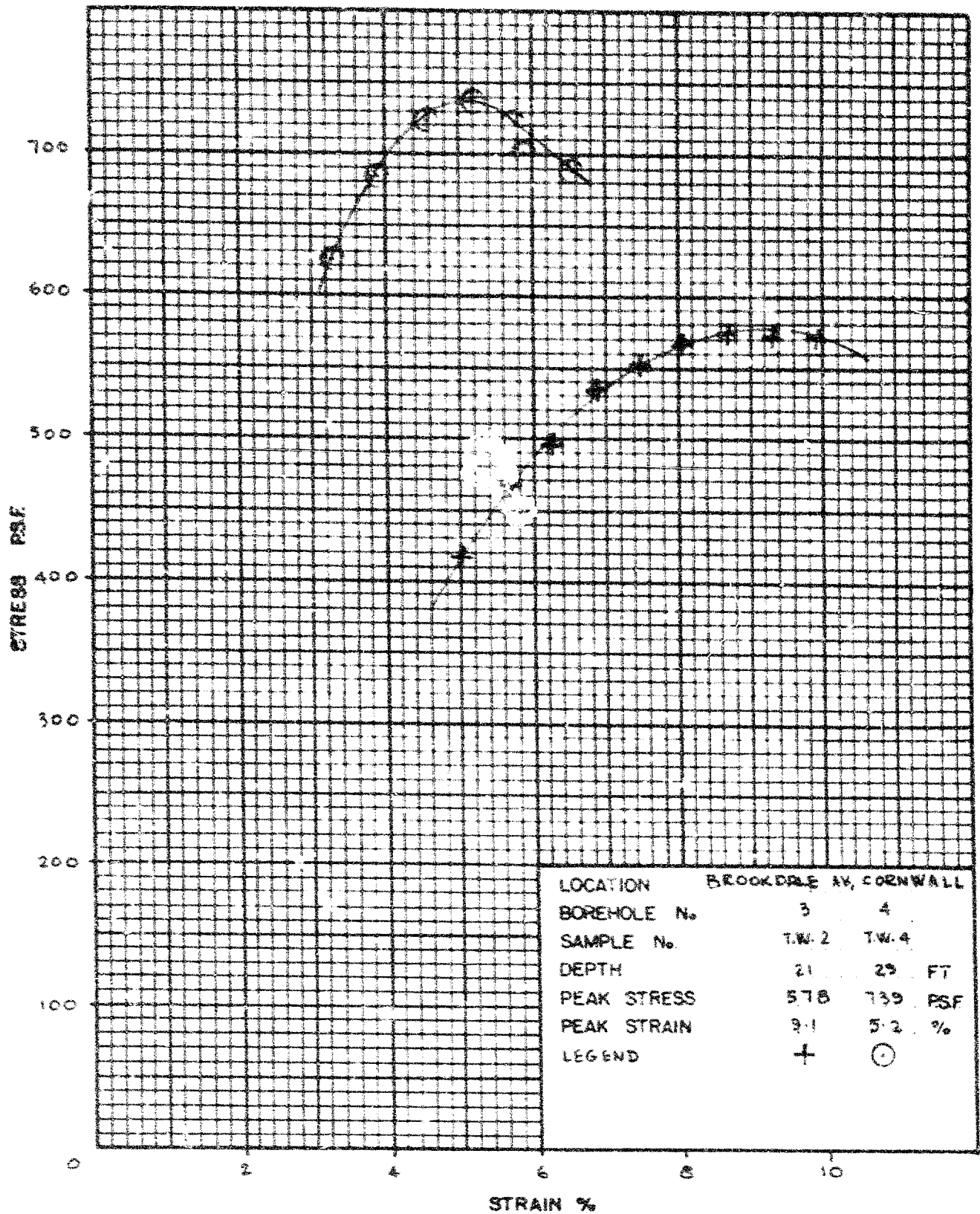
# UNCONFINED COMPRESSION TEST



LOCATION	BROOKDALE AV. CORNWALL		
BOREHOLE No.	2		
SAMPLE No.	TW.1	TW.5	
DEPTH	6	51	FT
PEAK STRESS	770	1500	PSF
PEAK STRAIN	3.8	3	%
LEGEND	+	O	

Prep. By V.M.

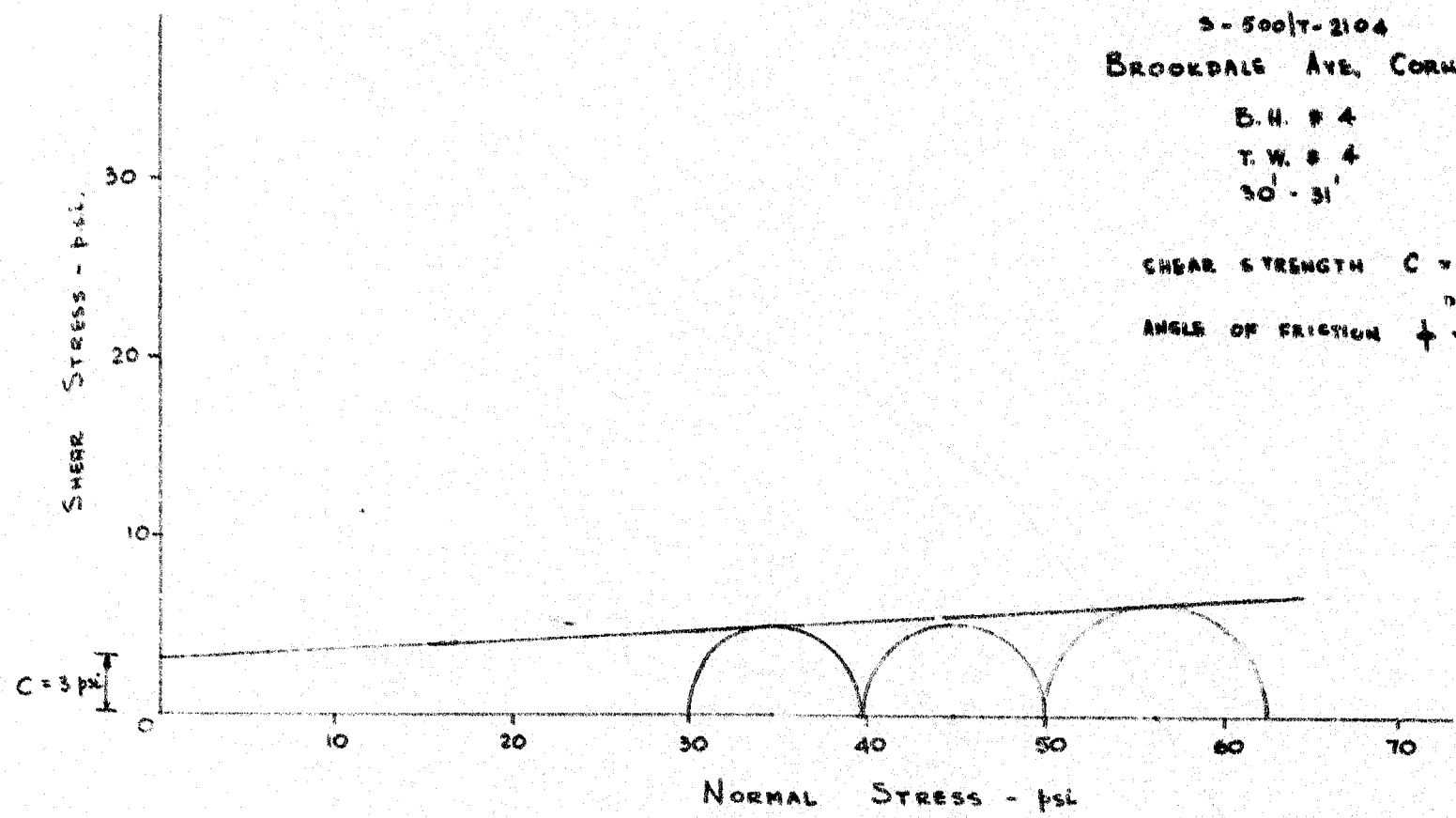
## UNCONFINED COMPRESSION TEST



LOCATION	BROOKDALE AV, CORNWALL		
BOREHOLE No.	3	4	
SAMPLE No.	T.W. 2	T.W. 4	
DEPTH	21	29	FT
PEAK STRESS	578	739	PSF
PEAK STRAIN	9.1	5.2	%
LEGEND	+	○	

S-550/T-2104  
BROOKDALE AVE, CORNWALL, ONT.  
B.H. # 4  
T.W. # 4  
30' - 31'

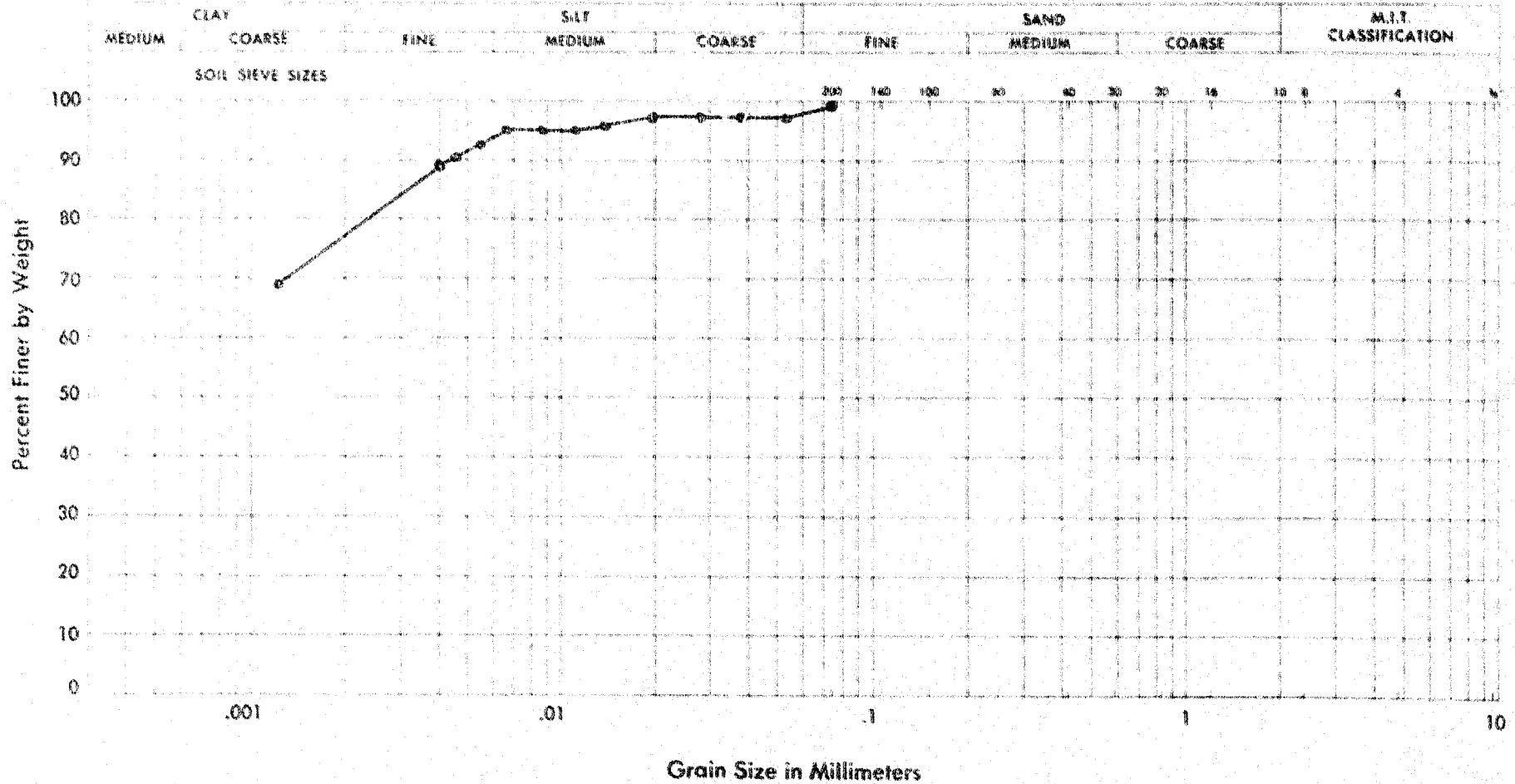
SHEAR STRENGTH  $C = 3 \text{ psi}$   
" 432 pcf  
ANGLE OF FRICTION  $\phi = 4^\circ$



TRIAXIAL TEST

# RACEY MacCALLUM AND ASSOCIATES LTD.

## GRAIN SIZE DISTRIBUTION

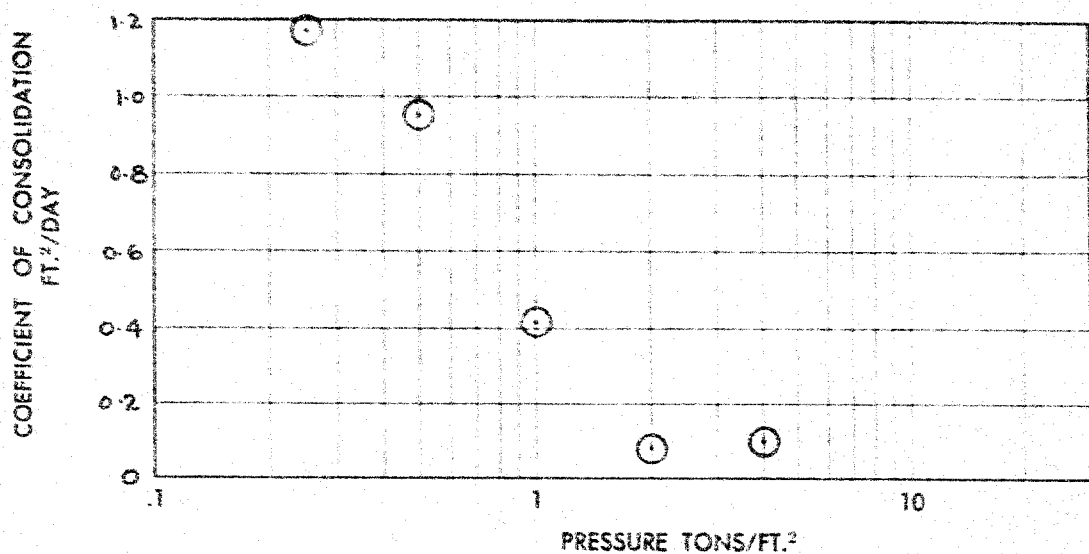
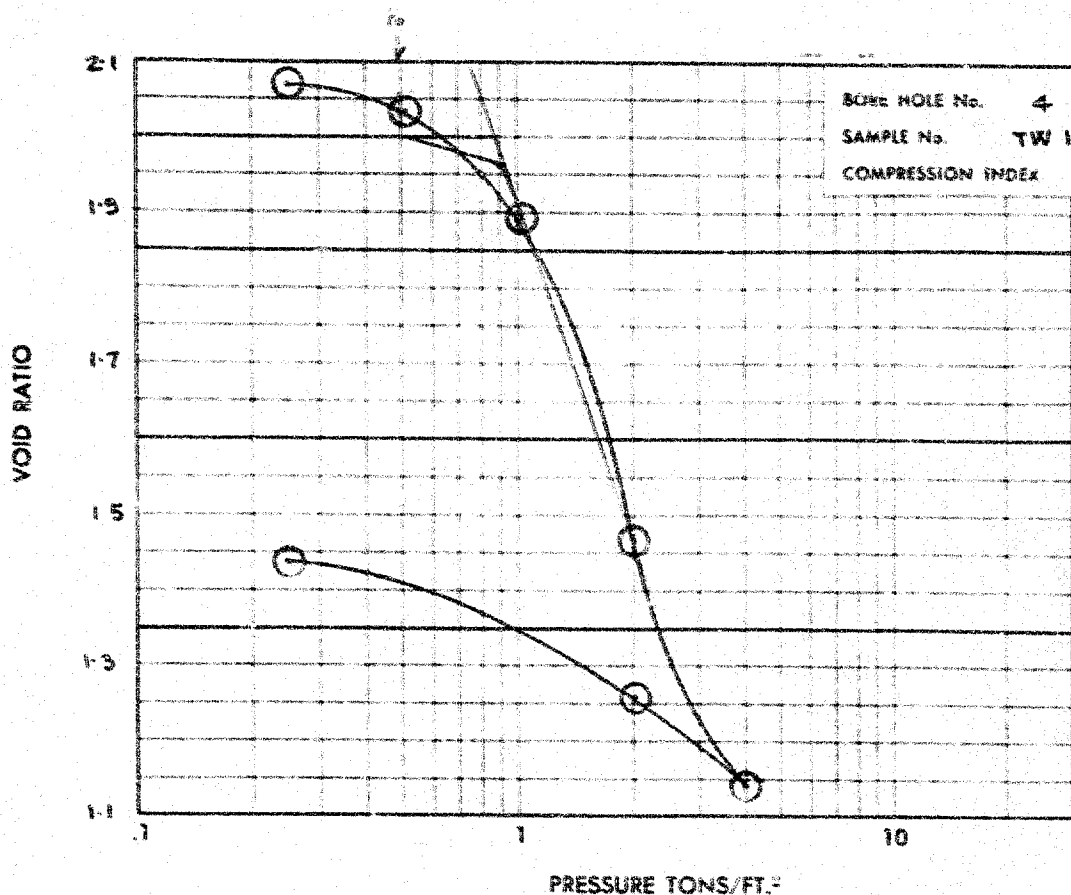


Project BROOKDALE AVE. CORNWALL, ONT.

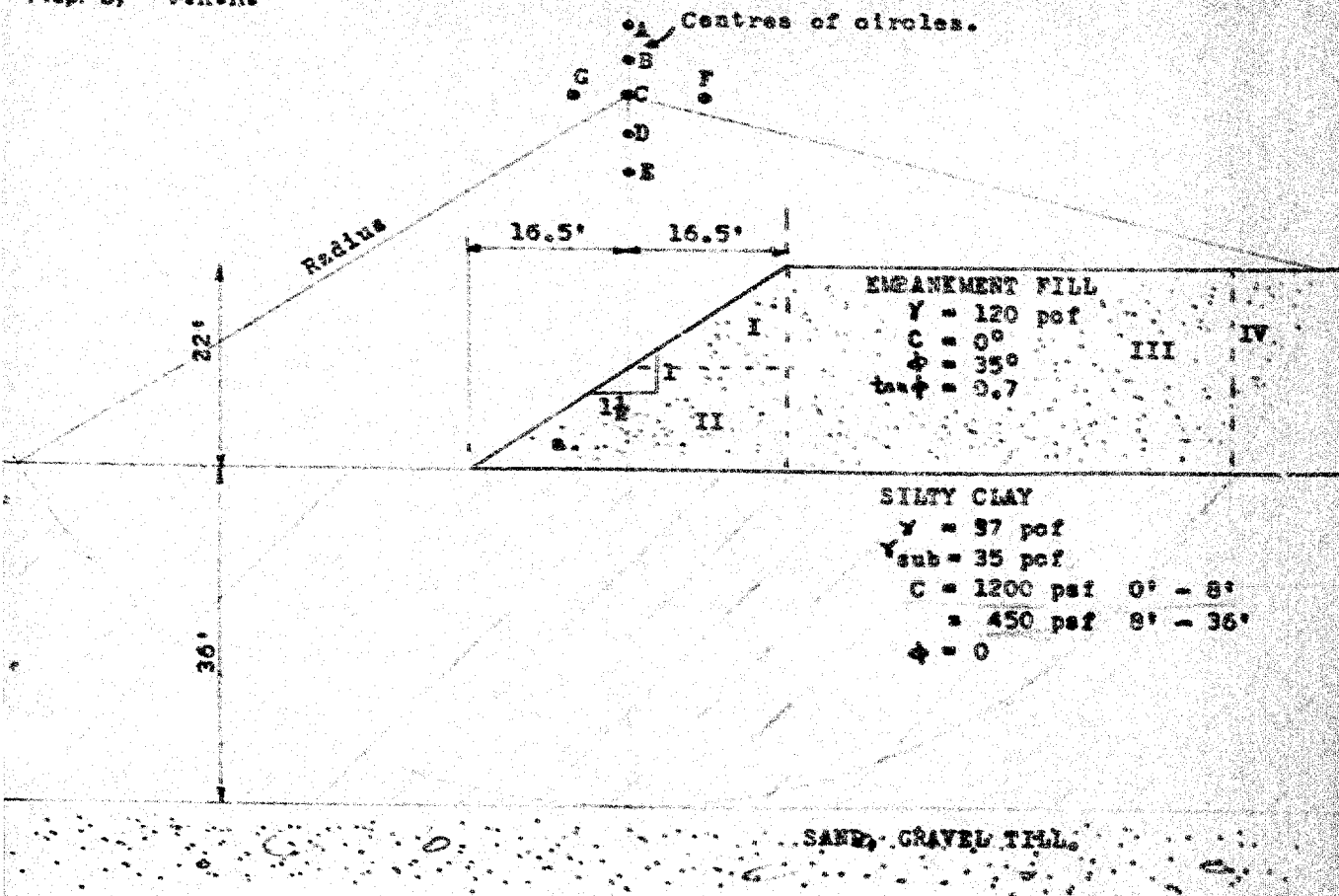
Order No. S-500/T-2104

Legend ○ HYDROMETER ANALYSIS  
B.H. # 2 - SAMPLE T.W.5

# RACEY MacCALLUM AND ASSOCIATES LTD. CONSOLIDATION TEST



Prep. By V.K.H.



**EXAMPLE :**

Sol. for Point C :  
Disturbing Mom.

Resisting Mom.

I. $8.25 \times 11 \times 120 \times 11$	120,000	a. $8.25 \times 11 \times 120 \times 5.5$	= 60,000
II. $16.5 \times 11 \times 120 \times 8.25$	180,000	IV. $0.7 \times 5.06 \times 76$	= 270,000
III. $48 \times 22 \times 120 \times 40.5$	5,150,000	Arc. $20 \times 1200 \times 76$	= 1,830,000
IV. $11 \times 76 \times 1,000$	836,000	$134 \times 450 \times 76$	= 4,580,000
	<u>6,286,000</u>		<u>6,740,000</u>

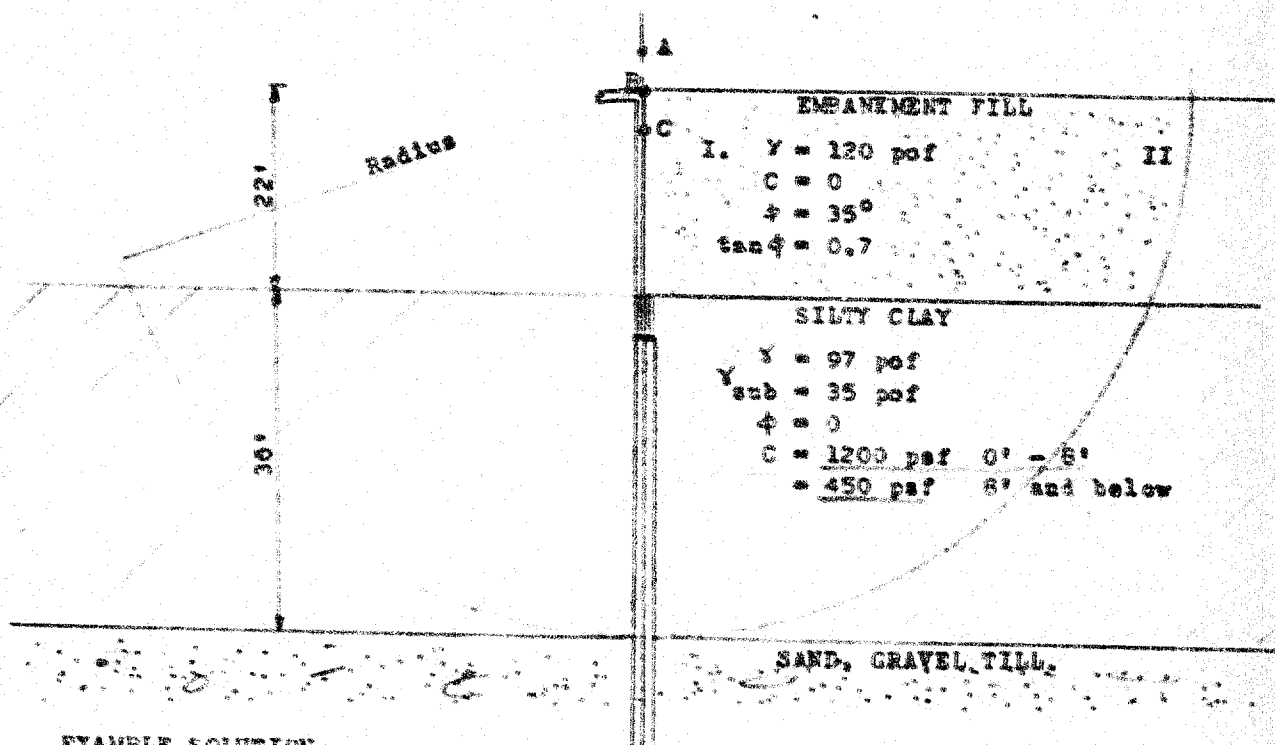
F.S. = 1.065

TRIAL SOLUTION.

<u>Radius.</u>	<u>Distance from <math>\phi</math> of slope.</u>	<u>Safety Factor.</u>
A 84'	0	1.11
B 80'	0	1.07
C 76'	0	1.065
D 72'	0	1.07
E 68'	0	1.11
F 76'	7' inwards	1.15
G 76'	7' outwards	1.165

\*Approx. critical circle.

Prep. By V.K.H.

ABUTMENT STABILITY.EXAMPLE SOLUTION.I  $54 \times 22 \times 120 \times 22$ 

3,650,000 ft.lbs.

II  $7,500 \times 58$ 

435,000

4,285,000 ft.lbs.RESISTING MOMENTS.II.  $0.7 \times 3.0 \times 58 = 122,000$ Arc.  $17.2 \times 1200 \times 58 = 1,190,000$  $120.2 \times 450 \times 58 = 3,140,000$ 4,452,000

F.S. = 1.02

TRIAL SOLUTIONS.

	<u>Radius.</u>	<u>Distance from <math>\frac{1}{4}</math> Abutment.</u>	<u>Safety Factor.</u>
A	62'	0	1.04
B*	58'	0	1.02
C	54'	0	1.14

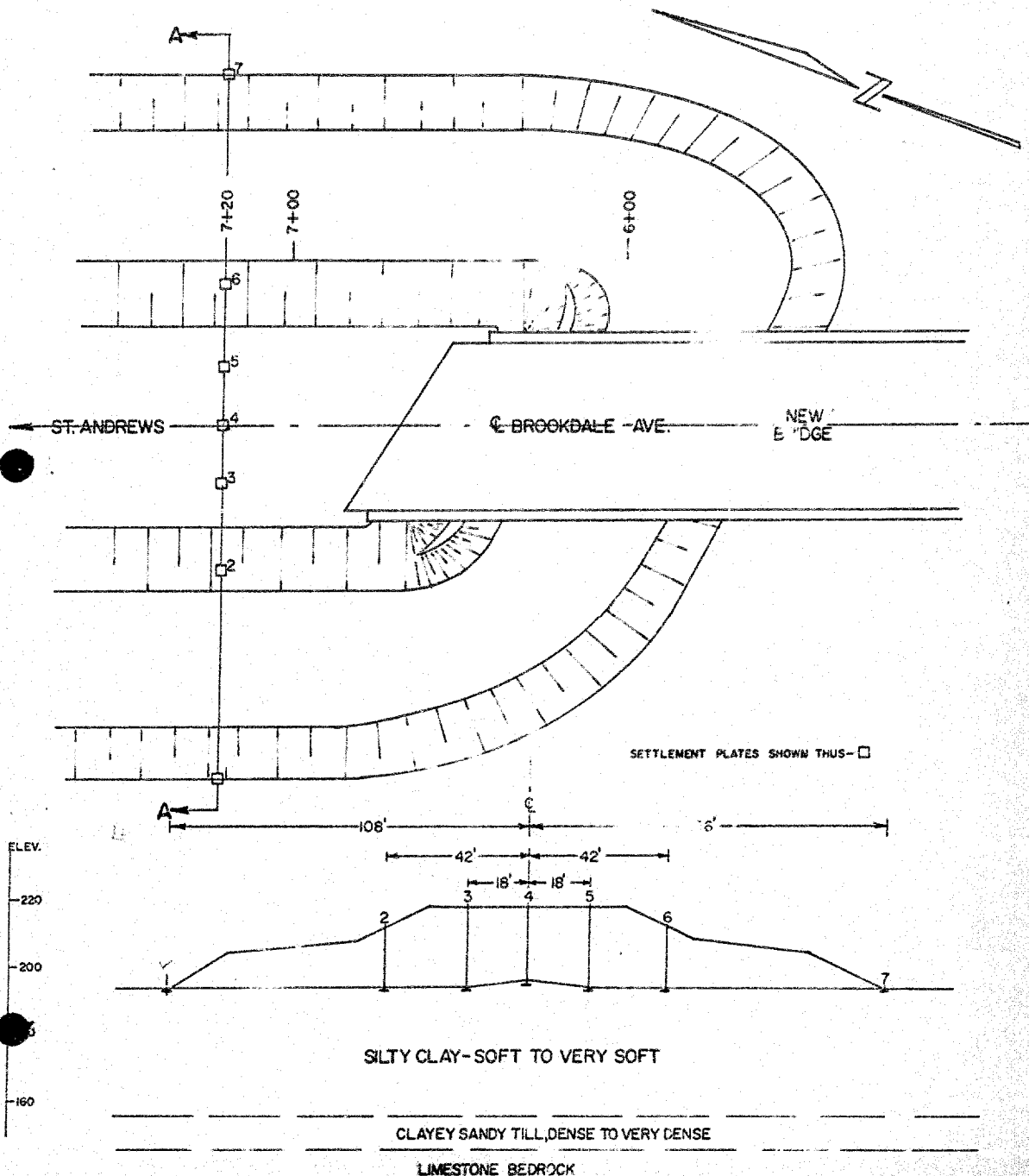
\* Approx. critical circle.

# TOWNSHIP OF CORNWALL BRIDGE No 10

## INSTRUMENTATION OF APPROACH

### 7 SETTLEMENT PLATES

62-F-84



#### SECTION A-A (STA. 7+20)

NOTE: PLATES INSTALLED

JUNE 28, 1962

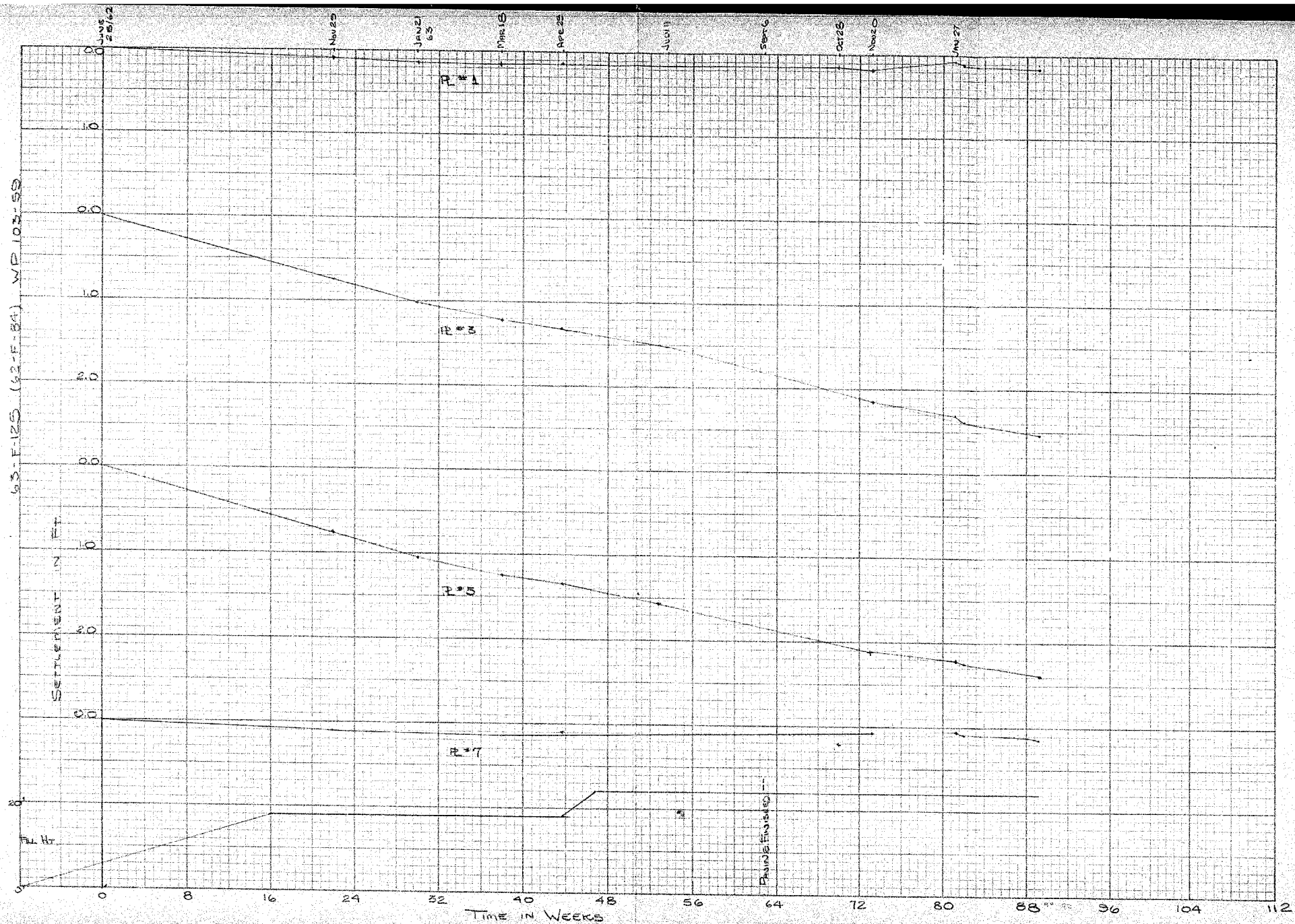
FILL STARTED

JULY 2/62

FILL COMPLETED

MAY 27/63

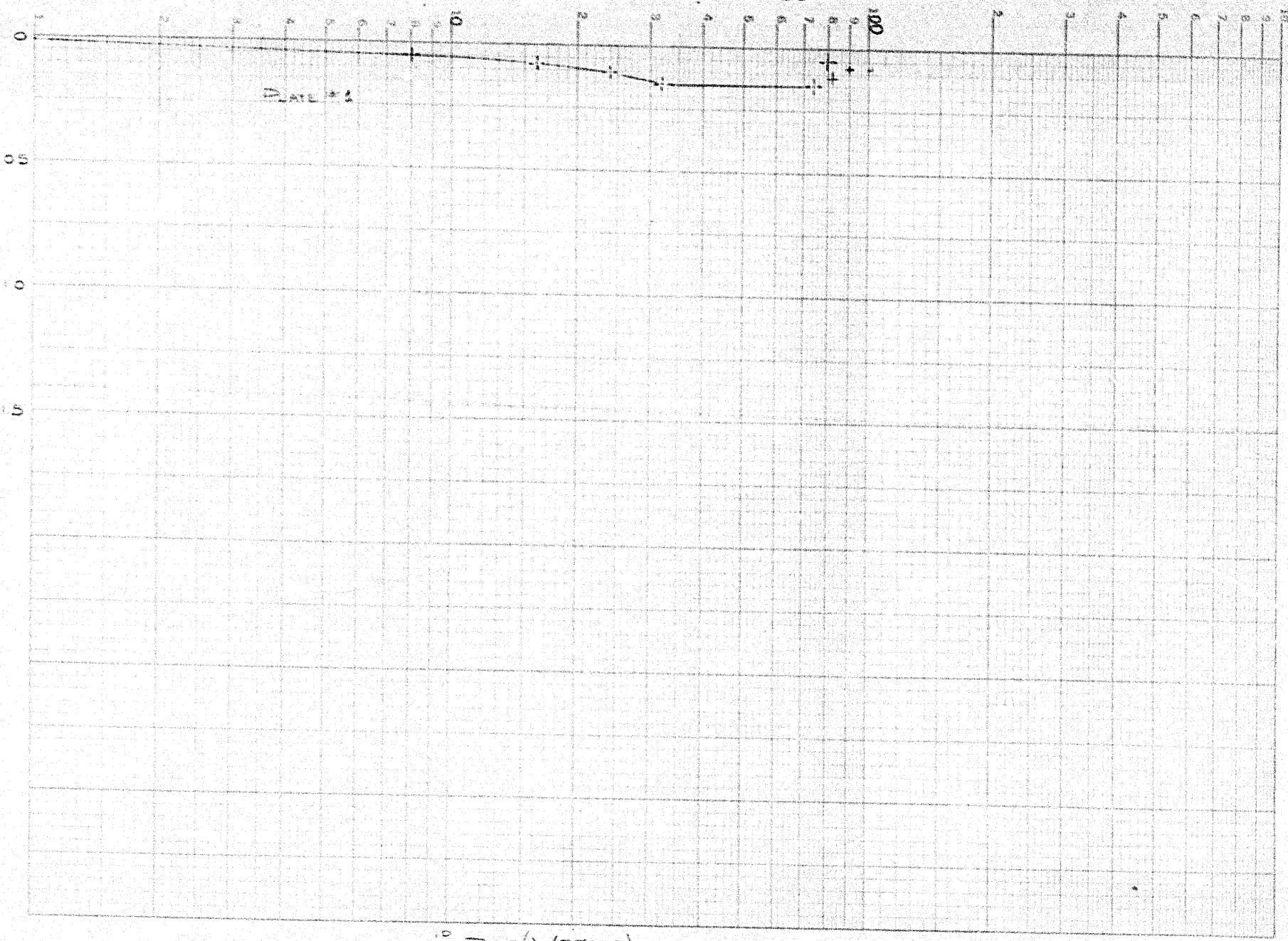




63-F-125

$\Delta H (ft)$

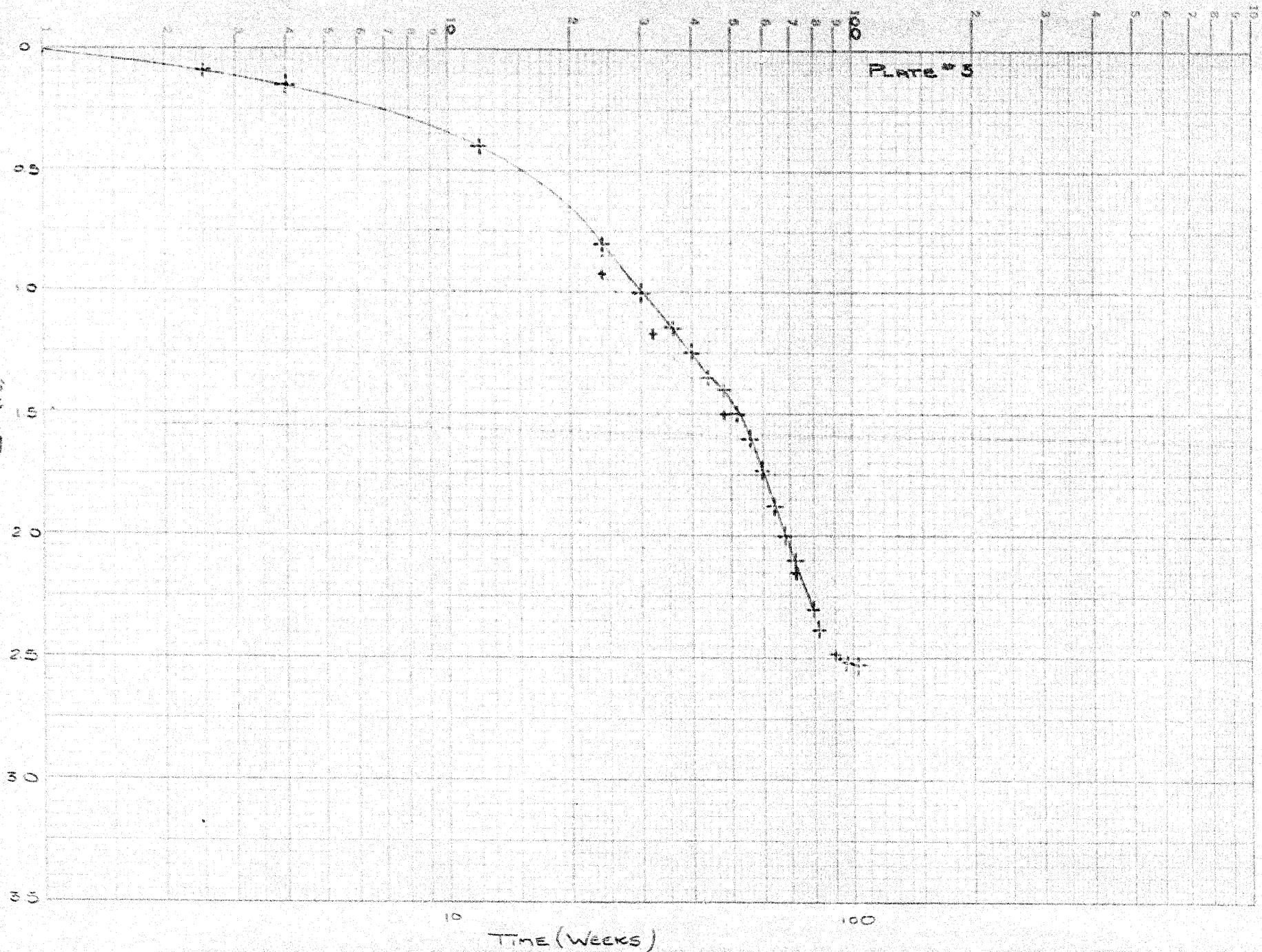
TIME (WEEKS)



63-F-125

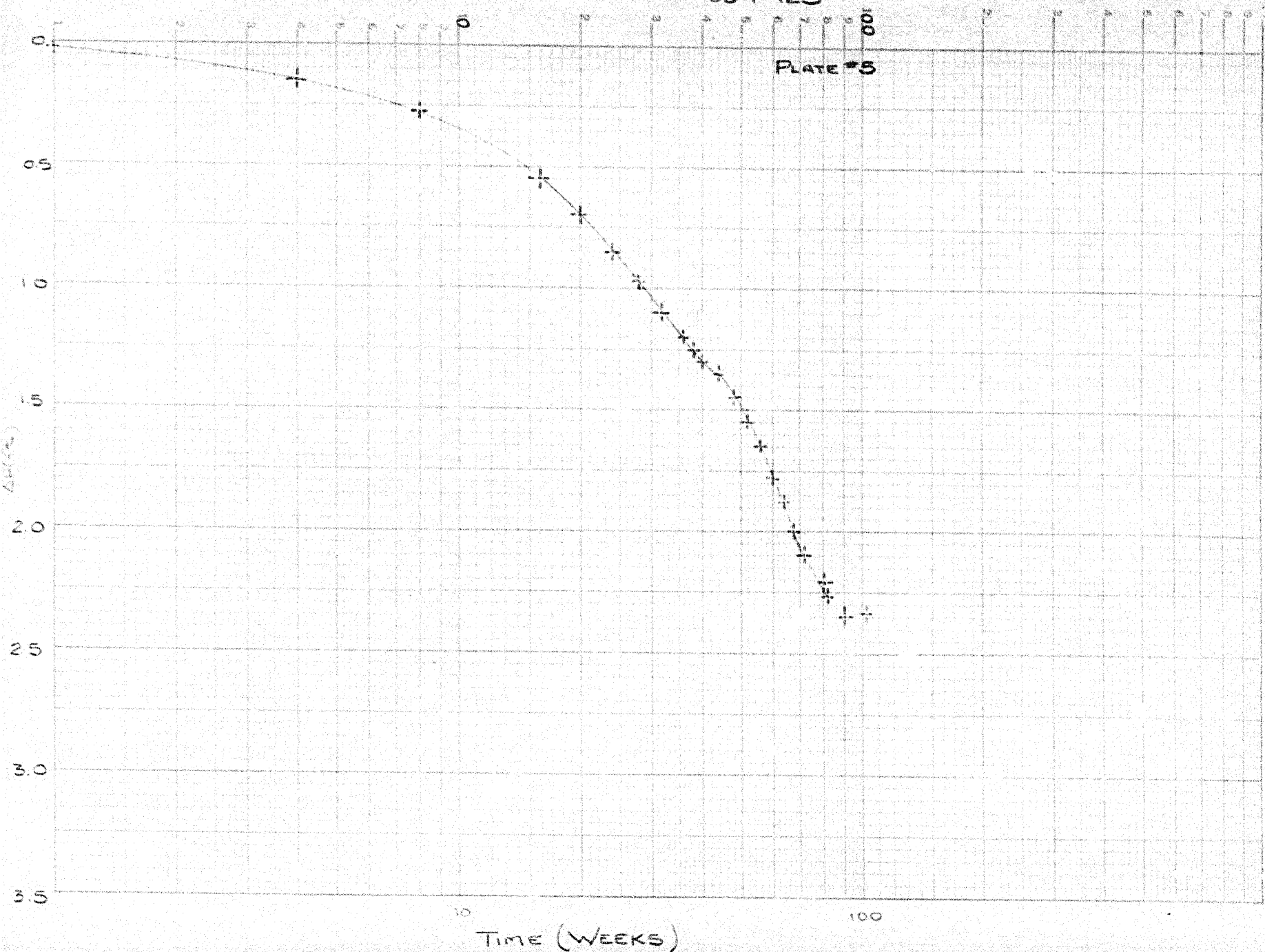
PLATE #3

$\Delta H(t)$



63-F-125

PLATE #5



63-F-125

LINE #7

TIME (WEEKS)

100

Mr. S. R. Davis,  
Bridge Planning Engr.,  
Bridge Division.

Foundation Section,  
Materials & Research Div.,  
Room 107, Lab. Bldg.

February 28, 1964

Brookdale Avenue Underpass - District No. 9,  
Cont. No. 61-97 (W.P. 103-59, W.J. 63-7-125)

As you will recall, the Foundation Section started an investigation at the above-mentioned site late last year soon after you advised us that definite signs of movement at the abutments were taking place. The purpose of the investigation was to establish, if possible, the reasons for the observed movements and to recommend remedial measures.

The results of our investigation are, for the time being, inconclusive and we are therefore not in a position to make any specific comments. However, it appears to us that no further movements of the abutments have taken place, although the rocker bearings have been further inclined and are presently in a very bad shape. This further movement of the rocker bearings was caused by the contraction of the bridge beams due to temperature changes.

Because of the excessive rocker bearing movements, pins in the bearings are badly bent and could be easily sheared off if further deformations take place. It is our recommendation that measures to avoid this from happening, be undertaken as soon as possible.

We intend to continue with our investigation and observations and will advise you should there be any conclusive findings.

AGS/XdeF

cc: Foundations Office  
Gen. Files

*A. G. Sternac*  
A. G. Sternac,  
PRINCIPAL FOUNDATION ENGINEER

TO: MR. A. G. STERMAC,  
PRINCIPAL FOUNDATION ENGR.,  
FOUNDATION SECTION  
MATERIALS & RESEARCH DIVISION

FROM: MR. L. E. WALKER  
DISTRICT ENGINEER  
OTTAWA

ATTN: MR. K. G. SELBY  
SENIOR FOUNDATION ENGINEER

DATE: OCTOBER 30, 1963

SUBJECT: BROOKDALE AVE. UNDERPASS  
HWY 401 - W.P. 103-52 - CONTRACT 62-52

CONCERNING YOUR MEMORANDUM OF OCTOBER 23, 1963  
IN CONNECTION WITH THE ABOVE MENTIONED STRUCTURE, THE  
FOLLOWING INFORMATION HAS BEEN COLLECTED.

1. WITHIN 200 FT. OF THE ABUTMENTS, THERE WASN'T ANY  
FILL PLACED IN 1961. ON JULY 2, 1962 CONTRACTOR STARTED  
PLACING FILL AND BERMS, AND FINISHED FOR SEASON ON  
OCTOBER 19, 1962. FILL AT THIS STAGE WAS 18 FT. HIGH, OR  
2 FT. BELOW EARTH GRADE. FILL WAS COMPLETED IN 1963,  
FROM MAY 7 TO MAY 27.
2. AN 11 FT. PILE OF TOP SOIL WAS PLACED ON THE EAST  
SIDE OF THE NORTH RAMP APPROXIMATELY 250 FT. FROM  
THE BRIDGE FROM SEPT. 2 TO SEPT. 30, 1961. THIS PILE  
WAS REMOVED AROUND SEPT 2, 1963. THERE WAS  
APPROXIMATELY 4600 CU. YDS. IN THIS STOCK PILE.
3. GRANULAR BACKFILL WAS PLACED AT THE BRIDGE  
ABUTMENTS DURING OCTOBER 1962 AND MAY 1963.  
TWELVE INS. OF SAND CUSHION AND 6 INS. OF GRANULAR  
WERE PLACED FROM JULY 11, THROUGH JULY 13, 1963. THREE  
AND A HALF INS. OF HL 6 WERE PLACED FROM JULY 31,  
THROUGH AUG 3, 1963, AND ONE AND A HALF INS. OF  
HL 1 WERE PLACED SEPT 6, 1963.
4. RECORDS OF CONCRETE PLACEMENT ARE BEING  
SHIPPED FROM OTTAWA.
5. PILE DRIVING RECORDS ARE BEING SHIPPED FROM OTTAWA.
6. THE BRIDGE ABUTMENT HAS FALLEN APPROXIMATELY  
THREE QUARTERS OF AN IN. AWAY FROM THE BRIDGE DECK  
AS OF SEPT 15, 1963. THE FILL HAS SETTLED APPROXIMATELY  
1 IN. SINCE THE PAVING WAS PLACED. AS A RESULT THE  
ASPHALT AND THE CURB AND GUTTER HAVE CRACKED. THERE  
HAS BEEN NO OTHER VISUAL MOVEMENT OTHER THAN  
NORMAL WORKING CONDITIONS.



Mr. L. E. Walker,  
District Engineer,  
Ottawa, Ontario.

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

Attn: Mr. G. A. Metcalfe,  
Construction Engr.

October 23, 1963

Brookdale Ave. Underpass,  
Hwy. 401 -- W.P. 103-52

We have been informed by the Bridge Office that movements of the abutments have been observed recently at the above-mentioned structure.

In order to determine the cause of these movements and the appropriate remedial measures, it is essential for us to obtain certain information regarding construction operations which is as follows:

- (1) Height of fill placed and where placed, 200 ft. each side of the abutments in the various stages of construction, with dates.
- (2) Record of any topsoil heaps placed within 200 ft. of the abutments - where placed, quantity, when placed, and when removed.
- (3) Granular base and paving operations on the approaches, with related dates, and quantities.
- (4) Complete records of when concrete was placed in various parts of the structure.
- (5) Complete records of all pile driving for the structure.
- (6) Details of any observations which might have been made by your field staff of any structural movements.

We would appreciate it if you would supply us with this information as soon as possible, as the Bridge Office are of the opinion that the situation may become critical.

*K. G. Selby*

RGS/MSef

cc: Mr. E. R. Davis

Foundations Office  
Gen. Files

K. G. Selby,  
SENIOR FOUNDATION ENGINEER  
For:  
A. G. Stermac,  
PRINCIPAL FOUNDATION ENGINEER



The following information was given by Mr. Stewart Campbell, Project Supervisor of the above-mentioned job:

- (1) Pile driving was carried out under contract 62-52. All driving records will be shipped from Ottawa to our Office today.
- (2) Details of structural movements: Bridge abutments falling away from bridge deck approx.  $3/4$  inch. (Started, as far as we know, Sept. 15, 1963.) Fill has settled approx. 1 inch since paving operation from July 31 to August 3, 1963. Asphalt has cracked along with the curb and gutter on top of abutment - no other visual movements were observed.
- (3) Asphalt: Base Course started July 31, 1963 - completed August 3, 1963. (3" thick).  
Top Course started August 5, 1963 - completed August 6, 1963. ( $1\frac{1}{4}$ " thick).
- (4) Granular: Placed during July 11 - 13, 1963. (12" base course plus 6" top course).
- (5) Height of Fill within 200 ft. No fill placed in 1961 - started placing fill July 2, 1962 along with the berm - continued until October 19, 1962. - continuous operation - material sandy, bouldery till. Fill was then within 2 ft. of finished earth grade (18 ft. completed) - berms completed - berms were 13 ft. high at the highest point (berms constructed for fills exceeding 11 ft. in height.)  
In 1963, started to complete the fill - work started May 7, 1963 and completed May 27, 1963.  
Granular backfill was placed at bridge during the month of October, 1962 (mostly completed) and finished during May, 1963.
- (6) Details of Stockpile: Approx. 250 ft. East from the bridge North abutment, 11-ft. stockpile was in place. This was placed on Sept. 2, to 30, 1961 before grading operations started. The stockpile was removed Sept. 2, 1963. Approx. 4000 cu. yds.
- (7) Complete records of concrete pouring by various parts of the structure, will be mailed as soon as possible.

M. Devata  
Sr. Foundation Engineer

Mr. K. Luczka

August 24, 1962

Bridge Const. Liaison Eng.

Re: Hwy. 401, Cont. 62-52

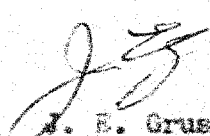
M. & R. Division, Kingston

Brookdale Road Interchange

As requested, the structure site at Brookdale Avenue and Hwy. 401 was reviewed yesterday to determine the allowable bearing values for the falsework.

The 401 grade is built approximately to earth subgrade. I understand from Mr. S. Campbell, project supervisor for the grading contract, that the old road was removed in its entirety and the adjacent area stripped so as to provide uniform subsoil conditions. The present earth subgrade has a few localized soft, wet areas as a result of adverse weather conditions.

The allowable loading is difficult to estimate because of the great changes which result with an increase in the field moisture content. However I would suggest that a loading of 3,000 - 4,000 p.s.f. be used with the 4,000 p.s.f. being preferable. The contractor should attempt to keep a uniform loading on all the mud sills.

  
J. E. Gruspier  
Regional Soils Engineer

JEG:cdm

c.c. L.B. Walker (2)  
T. Sternac ✓  
G.A. Wong

File

*The report was reviewed and  
up to 3,000 p.s.f. was recommended  
in the discussion with K. Luczka.*

*AL Sternac*

Department of Highways

COPY

For the information of

Mr. A. G. Stermac,  
Principal Foundation Eng.,  
Room 107, Lab. Bldg.

Bridge Division,  
November 27, 1961.

*Murphy*

MEMORANDUM TO:

Mr. G. Metcalfe,  
Construction Engineer,  
Department of Highways,  
530 Tremblay Road,  
OTTAWA, Ontario.

RE: W.P. 101-59  
Hwy. #401 at Brookdale Ave.  
Contract No. 61-97 62-52

Would you kindly advise Mr. A. G. Stermac of the Foundations Section when you expect the Contractor to begin placing the approach fills to the structure at this location so that he might arrange to instrument them.

JBC/ea  
cc. A. G. Stermac

J. E. Curtis,  
Bridge Location Engineer.

60-7-38  
We have to arrange for instrumentation. Made  
arrangements with him last week on Nov 20/61

W.P. 103-59.

W.J. 62-F-84.

July 18, 1962.

- INSTRUMENTATION OF APPROACHES -

An instrumentation programme at the above-mentioned site has been initiated. A Foundation Report was prepared by Racey, MacCallum, and settlements of up to 4' have been computed. Future fill height on the north approach will be in the order of 18'.

Seven settlement plates were installed on the north approach at Sta. 7+20, Brookdale Ave., on June 29, 1962. When the fill is completed, steel pipes will be drilled down to contact the plates. At present, the indications are that the fill will be completed sometime in the fall of 1962.

K. G. Selby,  
SR. FOUNDATION ENGINEER.

Mr. S. McCombie,  
Bridge Planning Engr.  
Materials & Research Section.

September 2, 1960.  
REVIEW OF DESIGN - by  
Foundation Section.

Attention: Mr. J. B. Curtis.

Re: W.P. 103-59,  
Cornwall Twp. Bridge No. 10,  
at Brookdale Ave. & Hwy. 401.

We have reviewed the design of Bridge No. 10 at Brookdale Ave. & Hwy. 401, as submitted by the Consultants, Proctor & Redfern. The only comments we have to make, concern the construction procedure, and they are as follows:-

Suggested Construction Procedure:

- 1) Driving of piles for three piers.
- 2) Construction of footings for the piers and refilling of excavation up to elevation 196.0'.
- 3) Building of berms and approach fills up to elevation 204.0'.
- 4) Driving of piles for abutments.
- 5) Construction of abutments and refilling of excavation - i.e., building of small berms in front of abutments.
- 6) Building of approach embankments.

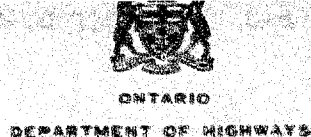
We believe that the above recommendations will prove adequate for your future work in connection with this project. Should there be further queries, however, please feel free to contact the Foundations Office.

AS/MdeF  
cc: Foundations Office (2)  
Gen. Files.

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

  
(A. Sternac,  
FOUNDATIONS OFFICE ENGR.)

**OVER** OFFICE LOCATION -  
DOWNSVIEW AVE..  
KEELE ST. - HIGHWAY 401  
TORONTO, ONTARIO.



POSTAL ADDRESS -  
DEPARTMENT OF HIGHWAYS  
PARLIAMENT BUILDINGS,  
TORONTO 2, ONTARIO.

Bridge Division,  
August 30th, 1960.

**MEMORANDUM TO:**

Mr. L.G. Soderman,  
Princ. Soils & Found. Engineer,  
Materials & Research Branch,  
Downsview, Ontario.

RE: W.P. 103-59,  
Cornwall Twp. Br. # 10,  
@ Brookdale Ave. & Hwy. 401.

Enclosed find one copy of the second preliminary for the above structure. The first design was rejected by your section for slope stability problems.

We believe the designer has closely followed all the recommendations of the report but would appreciate any comments you wish to make.

JBC:jk

J.B. Curtis,  
For; S. McCombie,  
Bridge Planning Engineer.

*No comments. Design O.K.  
August 31st, 1960*

*Atkinson*

# SUGGESTED CONSTRUCTION PROCEDURE

- 1) Driving of piles for three piers
- 2) Construction of ~~footings~~ for the piers and refilling of excavation up to elev. 196.0
- 3) Building of berms & approach fills up to elevation 204.0
- 4) Driving of piles for abutments
- 5) Construction of abutments & refilling of excavation i.e. building of back berm in front of abutment
- 6) Building of approach embankments

Enclosed find one copy of the report preliminary for the above structure. The first design was rejected by your section for slope stability problems. We believe the designer has closely followed all the recommendations of the report but would appreciate any comments you wish to make.

J. B. Smith,  
for J. B. Smith,  
Bridge Planning Engineer.

1961:10



Mr. A. M. Toye,  
Bridge Engineer.  
Materials & Research Section.

May 3, 1960.

FOUNDATION INVESTIGATION -- by  
Racey, MacCallum & Associates,  
Inc.

Attention: Mr. S. McCombie.

Re: Intersection of Hwy. No. 401 and  
Brookdale Ave., Cornwall, Ontario.  
W.P. 103-99 -- District 9.

In reviewing the above mentioned report, we have found that the stability analyses carried out by the Consultant were not conclusive. We have also found that the interpretation of the shear strength values used in these calculations was not satisfactory. To accurately define the strength vs. depth profile, we have carried out one additional boring at the site; shear strength measurements were performed in the field and the laboratory. The results of these measurements have been summarized graphically and attached to this memo. From this shear strength presentation, it is obvious that too high values have been used in the previous stability investigations and we have, therefore, carried out additional analyses based on the following assumptions:-

Height of fill equals 22 ft.; shear strength of the clay subsoil  $c = 350$  p.s.f. Because of the very limited depth of the upper stiff layer (approx. 7 ft.) the increase of shear strength has been neglected. The embankment slope was taken as 2:1.

Stability calculations have shown that counterbalancing berms are required for the fill height of 22 ft., proposed. The maximum safe height of the fill that can be built without a berm, is 11 ft. The required length of berm is given on the attached graph giving the relationship between the height of fill to the length of berm. The berm slope is also 2:1. The berm will have to be built in a direction parallel to road centre line, as well as at rightangle to centre line. The structure will have to be founded on end-bearing, small displacement type piles, driven to the contact of the limestone bedrock formation.

cont'd. /2 ...



If we can be of further assistance in interpreting the data contained in the attached report, please do not hesitate to contact our Office.

L. G. Goderman,  
PRINCIPAL COILS & FOUNDATIONS ENGR.

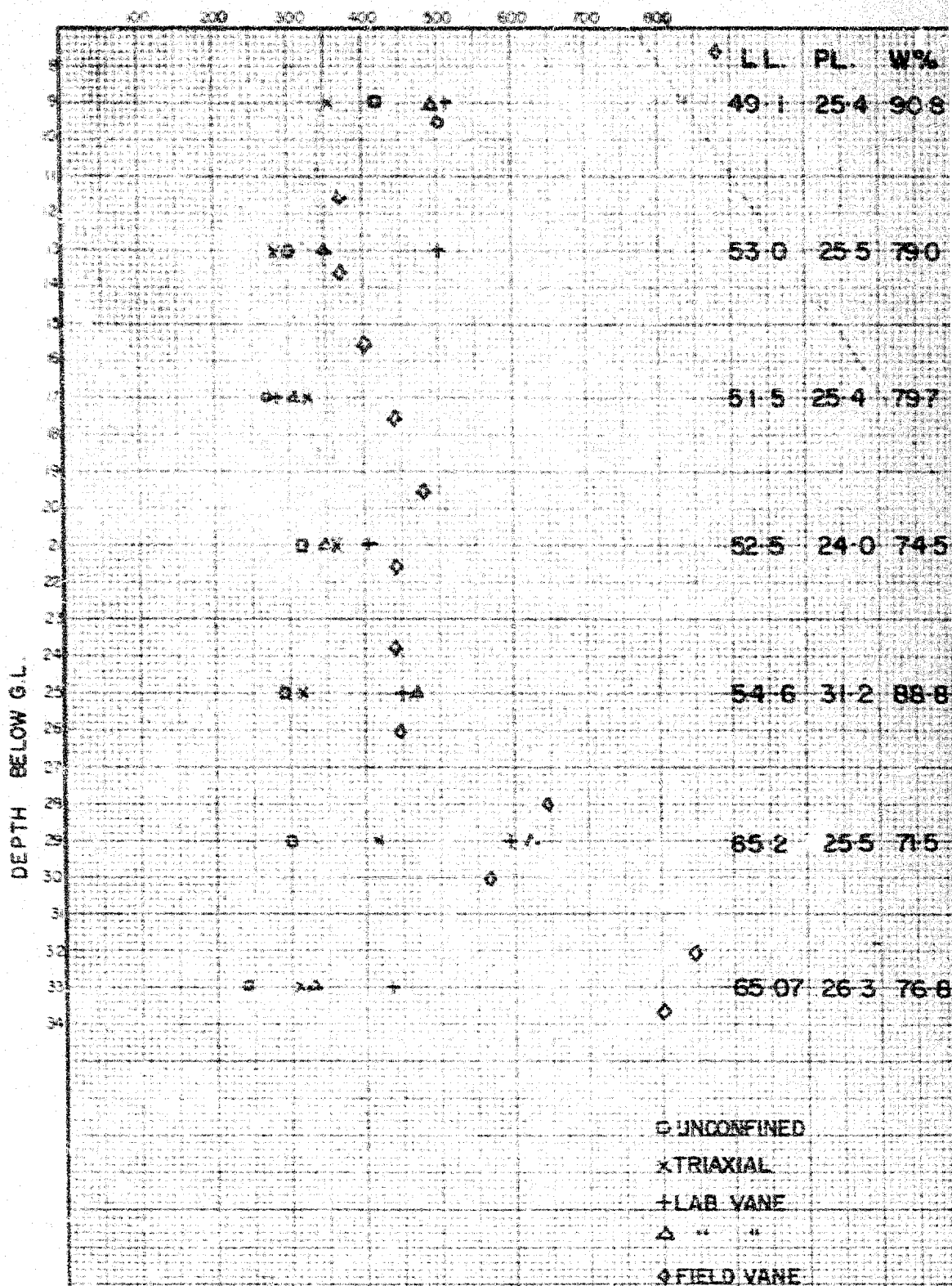
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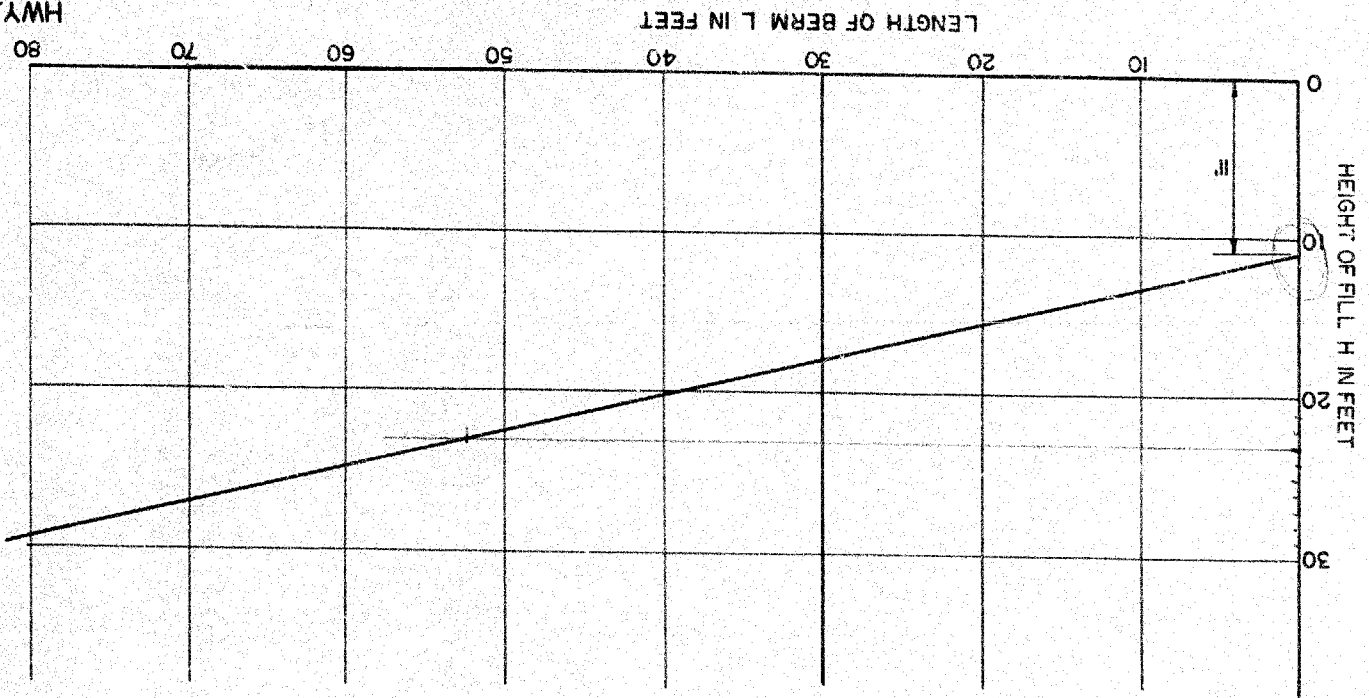
✓  
(A. Sterns,  
FOUNDATIONS OFFICE ENGR.)

AS/Mer  
Attach.

cc: Messrs. A. M. Toye (2)  
H. A. Tregaskes  
D. G. Ramsay  
J. Ford  
L. E. Walker  
J. E. Gruspler  
A. Watt  
Foundations Office ✓  
Gen. Files.

# SHEAR STRENGTH p.s.f.





RECOMMENDED BERM SECTION

