

Memo to Mr. A. M. Toye, Date March 2, 1960.  
Bridge Engineer. Subject FOUNDATION INVESTIGATION -- by  
From Materials & Research Section. Racey, MacCallum & Associates,  
Ltd.

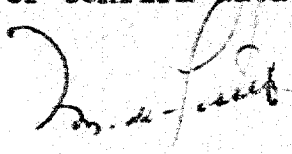
Attention: Mr. S. McCombie.

Re: Proposed Crossing of County Suburban Road 19  
for Highway 401, Con. III & IV, Lot 15,  
Twp. of Cornwall, Ontario, Dist. 9 - W.P.79-459.

Due to the fact that we have not had an opportunity to review the above-mentioned report, we are passing it along to you, without our usual comments, rather than hold up the Design group.

However, upon review by the designers, we would be pleased to answer any queries, or confirm data contained in the Consultants' report.

LGS/MdeF  
Attach.

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

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

BA 1005

RACEY, MacCALLUM AND ASSOCIATES  
LIMITED

A COMPANY OWNED, DIRECTED AND OPERATED BY

Consulting Engineers  
AND ASSOCIATED STAFF

MONTREAL  VANCOUVER

TORONTO

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 DIVISION  
27 CARLTON STREET

Reference: S-500/T-2036  
- Report -

16th February, 1960

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

Attention: Mr. L. G. Soderman.

RE: FOUNDATION INVESTIGATION FOR  
PROPOSED CROSSING OF COUNTY SUBURBAN ROAD 19  
FOR HIGHWAY 401, CON. III & IV, LOT 15  
TOWNSHIP OF CORNWALL, ONTARIO,  
DISTRICT NO. 9, W.P. 79-452.

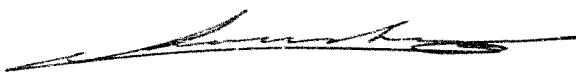
Dear Sirs,

The enclosed report presents the results of our  
foundation 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.

FOUNDATION INVESTIGATION FOR  
PROPOSED CROSSING OF COUNTY SUPERBAN ROAD #19  
FOR HIGHWAY 401, CON. III & IV, LOT 15,  
TOWNSHIP OF CORNWALL, ONTARIO,  
DISTRICT NO. 9, W.P. 79-159.

Reference: S-500/T-2036  
- Report -

Racey, MacCallum and Associates  
Limited.

16th February, 1960

# RACEY, MACCALLUM AND ASSOCIATES LIMITED

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TORONTO DIVISION  
27 CARLTON STREET

REFERENCE: S-500/T-2036  
REPORT

Toronto 2, Ontario  
February 16, 1960

## FOUNDATION INVESTIGATION FOR PROPOSED CROSSING OF COUNTY SUBURBAN ROAD 19 FOR HIGHWAY 401, CON. III & IV, LOT 15 TOWNSHIP OF CORNWALL, ONTARIO DISTRICT NO. 9, W.P. 79-959

### INTRODUCTION

The field investigation to determine the sub-soil conditions on the site was carried out from 28th December, 1959 to 18th January, 1960.

This report presents a detailed description of the field investigation and subsequent results, together with recommendations regarding a suitable type of foundation for the proposed crossing.

### PRELIMINARY GEOLOGICAL STUDY

The area under investigation is part of the St. Lawrence-Ottawa lowland. This till plain which is extremely stoney is overlaid by sediment deposits from the Champlain Sea which covered this area after the recession of the last glacier.

Since the site itself is on the slopes of a ridge or drumlin, these sedimentary deposits of silty clay are not deep and are of the order of 5 to 6 feet.

### FIELD INVESTIGATION

The field work consisted of one boring with adjacent cone penetration test at locations No. 1, 2, 4, 5, 7 and 8, and cone penetration tests at locations No. 3 and 6. The locations of the boreholes and cone tests, along with the Soil Profile of the site are shown on Enclosure I, and the results on Enclosures 2, 3, 4, 5, 6, 7, 8 and 9.

Adverse weather conditions (icing) delayed the drilling until 30th December, 1959 and considerably slowed down operations when

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February 16, 1960

FIELD INVESTIGATION (continued)

work did proceed. It also prevented any drilling for another two days.

Borings were carried out using a standard diamond drilling rig. Boreholes were advanced by driving BX casing with split spoon samples and penetration readings being taken at regular intervals. The driving energy for both the split spoon and cone penetrations was a 140 lb. hammer at a 30 inch drop.

Once a bouldery condition was reached, the borehole was continued by running an AX shoe bit and casing until bedrock was reached, at which time an AX core bit was used to recover the bedrock cores. The use of the AX core bit and AX casing to advance and keep the hole open made sampling very difficult. Sampling was also limited by the size of gravel and boulders.

SUB-SOIL CONDITIONS

The sub-soil condition is generally uniform over the site. It consists of a five to six foot layer of medium stiff to stiff silty clay overlying approximately 12 to 18 feet of fine to medium dense sand and gravel and medium dense sand till, interspersed with boulders.

The underlying bedrock is mainly limestone, beginning at Elevation 161.0 feet approximately (Borehole No. 8) and gradually sloping southwards towards Borehole No. 1 at Elevation 171.0 feet (approximately).

Artesian water under a hydrostatic pressure of 2 feet was encountered in Borehole No. 5, originating from below Elevation 185.0 feet in the dense sandy gravelly till. The flow had dwindled to a rare trickle in two days at which time the flow stopped completely. The hole eventually froze up that evening, but was plugged before leaving the site.

LABORATORY WORK

Unconfined Compression Tests made on two clay samples from Boreholes 1 and 2 indicated an average shear strength of 1700 lb./sq.ft. Atterberg Limits were determined for four different samples from boreholes 1, 2, 4 and 5. The results show a wide variation for the Liquid Limit as can be seen from the relevant data sheets and the brief summary below

Natural Moisture Content	- 47-48%
Liquid Limit	- 59-89%
Plastic Limit	- 35-40%

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DISCUSSION OF RESULTS

(a) Foundations

The sub-soil profile indicates that the overburden material is quite uniform, made up mainly of sands and gravels. This would preclude the possibility of any stability problems being encountered.

As far as foundations for the proposed overpass are concerned, piles would seem to be most practical due to the relatively loose nature of the granular material and the fact that bedrock is met at quite shallow depths. Steep H piles driven to refusal at bedrock or some other kind of hollow, or cast-in-place piles would be eminently desirable. In view of the boundary nature of the soil it is not possible to predict their bearing capacity. It is suggested that recourse be taken to well known pile bearing formulas in determining these capacities, dependent upon the pile being used.

Should, however, spread footings be considered, then the following bearing pressures are suggested:

<u>Elevation</u>	<u>Approx. depth below Ground Level (ft.)</u>	<u>Bearing Pressure</u>
192	10	5000 lb. psf
191	11	5500 lb. psf
190	12	7000 lb. psf
189	13	7500 lb. psf
188	14	8000 lb. psf

These pressures are based upon differential settlement being less than 3/4-inch.

However, the cost of excavating to this depth is likely to make this type of footing uneconomical.

(b) Embankment

It was decided to make a stability analysis of the abutment fill in case failure occurred by slipping of the clay layer. The angle of internal friction for the clay layer was assumed to be zero. The values for C and  $\gamma$  were obtained from the laboratory results. This can be seen from Enclosure 10, which presents the results of the analysis. Failure was assumed to take place at the top of the abutment. The factor of safety was found to be 2.16.

In view of the stiff nature of the clay layer and the high strengths obtained in the laboratory, it would appear that this clay

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February 16, 1960

DISCUSSION OF RESULTS (continued)

(b) Embankment (continued)

has been pre-consolidated at some time or other by desiccation or other means. The likelihood thus of any appreciable settlement taking place is not very great.

CONCLUSIONS AND RECOMMENDATIONS

Summarising the foregoing results and considerations, the following conclusions and recommendations seem warranted:

1. The overburden is quite shallow and consists of approximately 5 feet of silty clay overlying 15 to 20 feet of sand and gravel and sand till. The bedrock is mainly limestone.
2. Artesian water was encountered in one borehole, but the flow petered out in approximately two days.
3. No problems concerning approach fill stability are expected.
4. As the overburden consists mainly of some stiff silty clay and relatively loose granular stoney material, an ordinary footing foundation is likely to be uneconomical. The most practical type would be an H pile driven to refusal at bedrock.
5. The possibility of any settlement occurring is unlikely.

*V.K. Handa*

---

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

VKH/m

**RACEY MacCALLUM AND ASSOCIATES LTD.**

Foundation Engineering Division

Engineering Data Sheet for Borehole: No 1

Project: **FOUNDN. INVEST. PROPOSED CROSSING, COUNTY RD./HWY#101**Location: **CORNWALL, ONTARIO.**Hole Location: **See Enclosure No 1.**Hole Elevation and Datum: **198.00 feet.**Field Supervisor: **V.H. Prep.: V.H.**Driller: **L.G. Checked:**

Date:

**LEGEND**

Shear Strength (C)

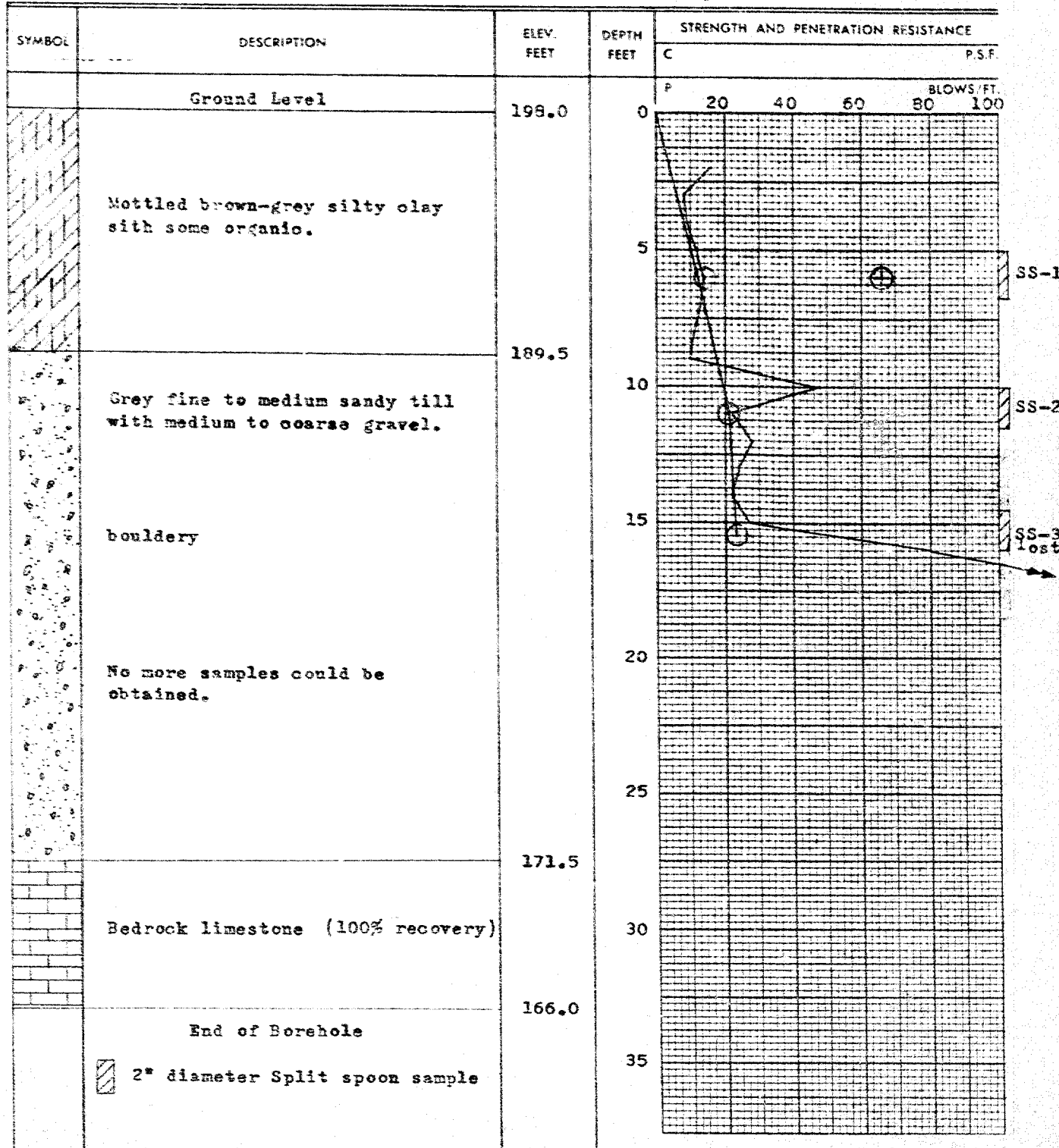
Unconfined compression  
Vane test and sensitivity (S)

Penetration Resistance (P)

2" Split tube

2" Dia. Cone

Casing



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Foundation Engineering Division

Engineering Data Sheet for Borehole: No 1

**LEGEND****Consistency**

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



x LI

**Sampling Method**

2" Dia. split tube



2" Shelby tube



DEPTH FEET	CONSISTENCY					SAMPLE	NATURAL UNIT WT. P.C.F.	REMARKS
	MOISTURE CONTENT, % DRY WEIGHT							
0	20	40	60	80	100			
5						SS-1	110.6	
10						SS-2		
15						SS-3		
						lost		
20								
25								
30								
35								

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Engineering Data Sheet for Borehole: No 2.

Project: **FOUNDN. INVEST. PROPOSED CROSSING, COUNTY RD. /**  
 Location: **CORNWALL, ONTARIO. HWY#101, W.P. 79-59**  
 Hole Location: **See Enclosure No 1.**  
 Hole Elevation and Datum: **199.0 feet.**  
 Field Supervisor: **V.H. Prep.: V.H.**  
 Driller: **L.G. Checked:** Date:

**LEGEND**

Shear Strength (C)

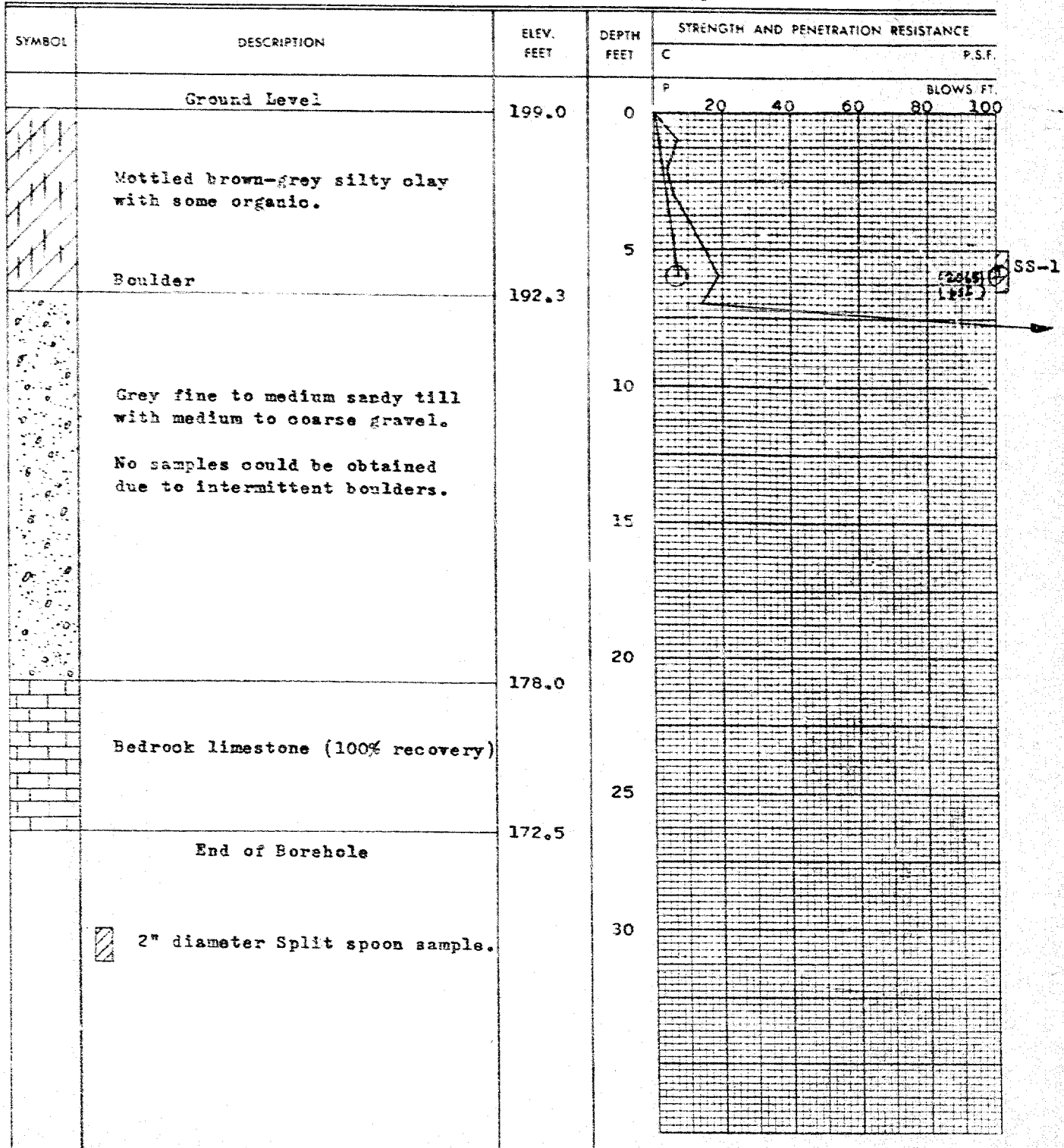
 Unconfined compression  
 Vane test and sensitivity (S)

Penetration Resistance (P)

2" Split tube

2" Dia. Cone

Casing



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Foundation Engineering Division

Engineering Data Sheet for Borehole: No 2.

**LEGEND****Consistency**

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

→ —→ —→  
X LI  
— G  
— P

**Sampling Method**

2" Dia. split tube

2" Shelby tube



DEPTH FEET	CONSISTENCY					SAMPLE	NATURAL UNIT WT. P.C.F.	REMARKS
	MOISTURE CONTENT, % DRY WEIGHT							
	20	40	60	80	100			
0								
5								
			X			3S-1	110.2	
10								
15								
20								
25								
30								



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Foundation Engineering Division

Engineering Data Sheet for Borehole: 4

Project: FOUNDN. INVEST. PROPOSED CROSSING, COUNTY RD./HWY #401

Location: CORNWALL, ONTARIO.

W.P. 79-59

Hole Location: See Enclosure No 1.

Hole Elevation and Datum: 202.0 feet

Field Supervisor: J.W. Prep.: V.H.

Driller: M.G. Checked:

Date:

**LEGEND**

Shear Strength (C)

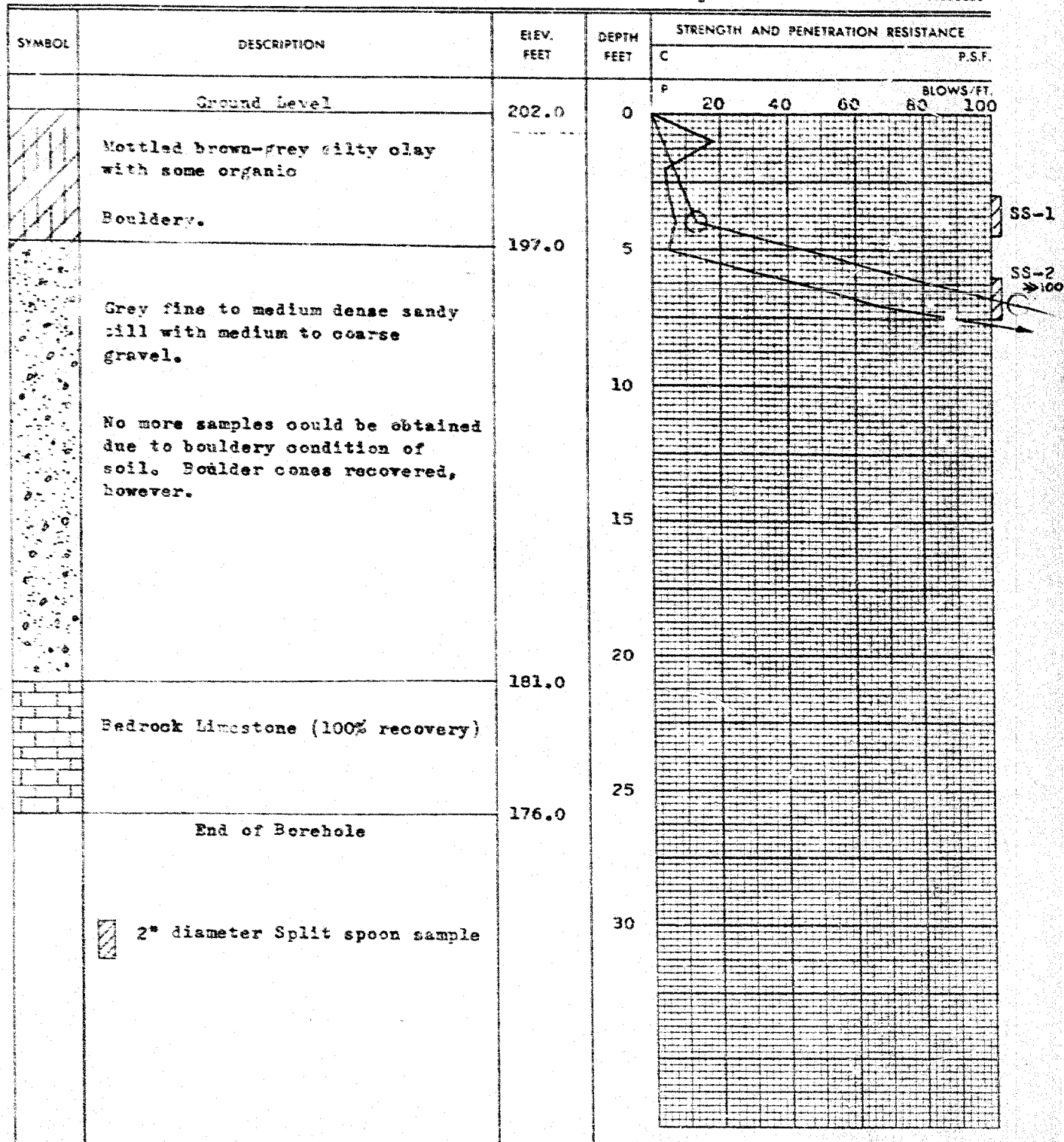
Unconfined compression  
Vane test and sensitivity (S)

Penetration Resistance (P)

2" Split tube

2" Dia. Cone

Casing

⊕  
+3⊕  
⊕

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Foundation Engineering Division

Engineering Data Sheet for Borehole: No 4.

**LEGEND**Consistency

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

Sampling Method

2" Dia. split tube

2" Shelby tube



DEPTH FEET	CONSISTENCY					SAMPLE	NATURAL UNIT WT. P.C.F.	REMARKS
	MOISTURE CONTENT, % DRY WEIGHT							
0	20	40	60	80	100			
5						SS-1		
						SS-2		
10								
15								
20								
25								
30								

**RACEY MacCALLUM AND ASSOCIATES LTD.**

Foundation Engineering Division

Engineering Data Sheet for Borehole: 5

Project: **FOUNDN. INVEST. PROPOSED CROSSING, COUNTY RD./HWY#401**Location: **CORNWALL, ONTARIO.**

W.P.79-59

Hole Location: **See Enclosure No 1.**Hole Elevation and Datum: **201.5 feet.**Field Supervisor: **V.H. Prep: V.H.**Driller: **M.G. Checked:**

Date:

**LEGEND**

Shear Strength (C)

Unconfined compression  
Vane test and sensitivity (S)

Penetration Resistance (P)

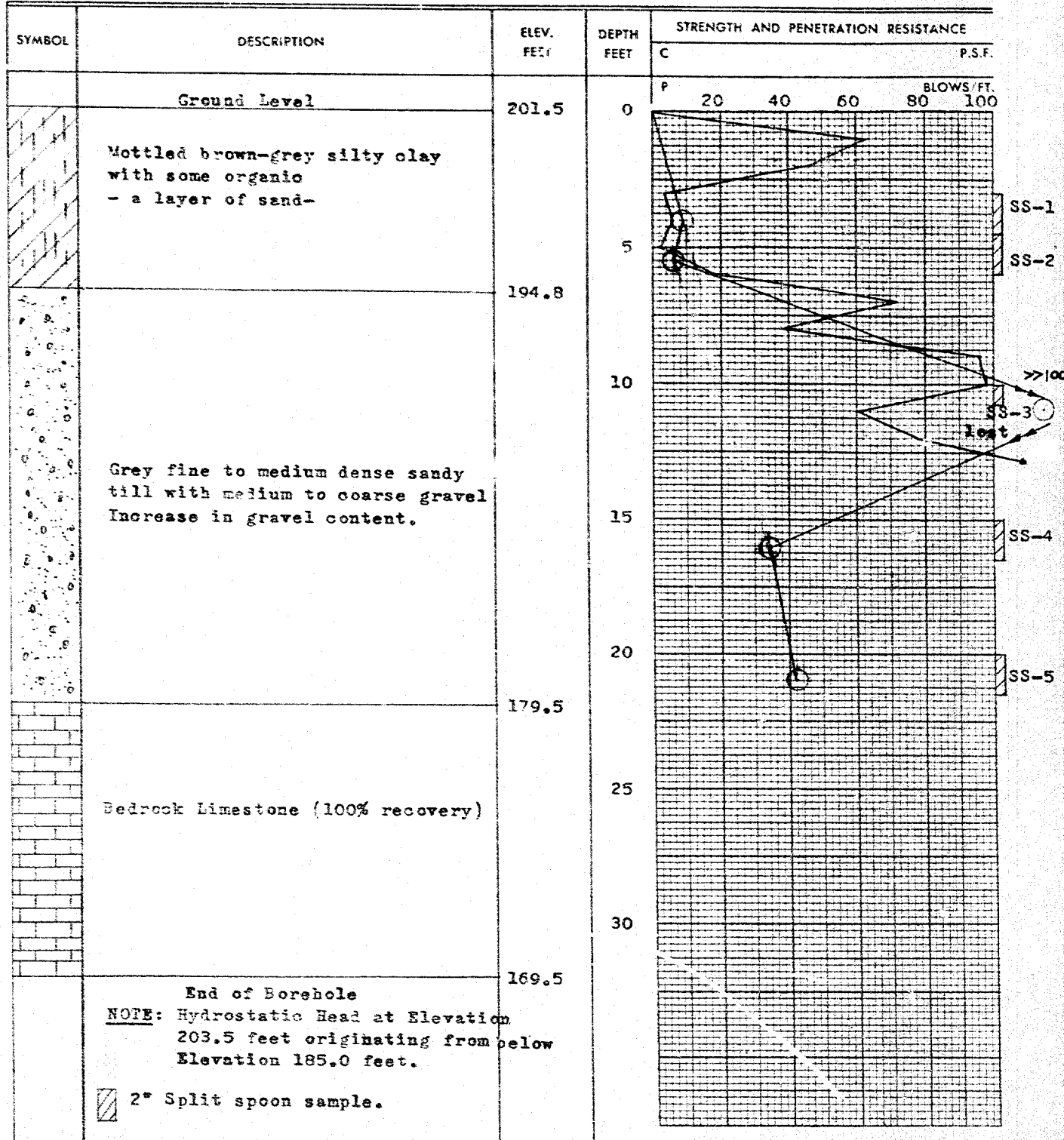
2" Split tube

2" Dia. Cone

Casing

⊕  
+3⊕  
⊕

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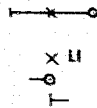
**RACEY MacCALLUM AND ASSOCIATES LTD.**

Foundation Engineering Division

Engineering Data Sheet for Borehole: No 5.

**LEGEND****Consistency**

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

**Sampling Method**

2" Dia. split tube

2" Shelby tube



DEPTH FEET	CONSISTENCY					SAMPLE	NATURAL UNIT WT. P.C.F.	REMARKS
	MOISTURE CONTENT, % DRY WEIGHT							
	20	40	60	80	100			
0								
5						SS-1		
						SS-2		
10						SS-3		
						lost		
15						SS-4		
20						SS-5		
25								



**RACEY MacCALLUM AND ASSOCIATES LTD.**

Foundation Engineering Division

Engineering Data Sheet for Borehole: 7

Project: FOUNDN. INVEST. PROPOSED CROSSING, COUNTY RD./HWY#401

Location: CORNWALL, ONTARIO.

W.P. 79-59

Hole Location: See Enclosure no 1.

Hole Elevation and Datum: 202.6 feet.

Field Supervisor: J.W. Prep.: V.H.

Driller: M.G. Checked:

Date:

**LEGEND**

Shear Strength (C)

Unconfined compression

Vane test and sensitivity (S)

Penetration Resistance (P)

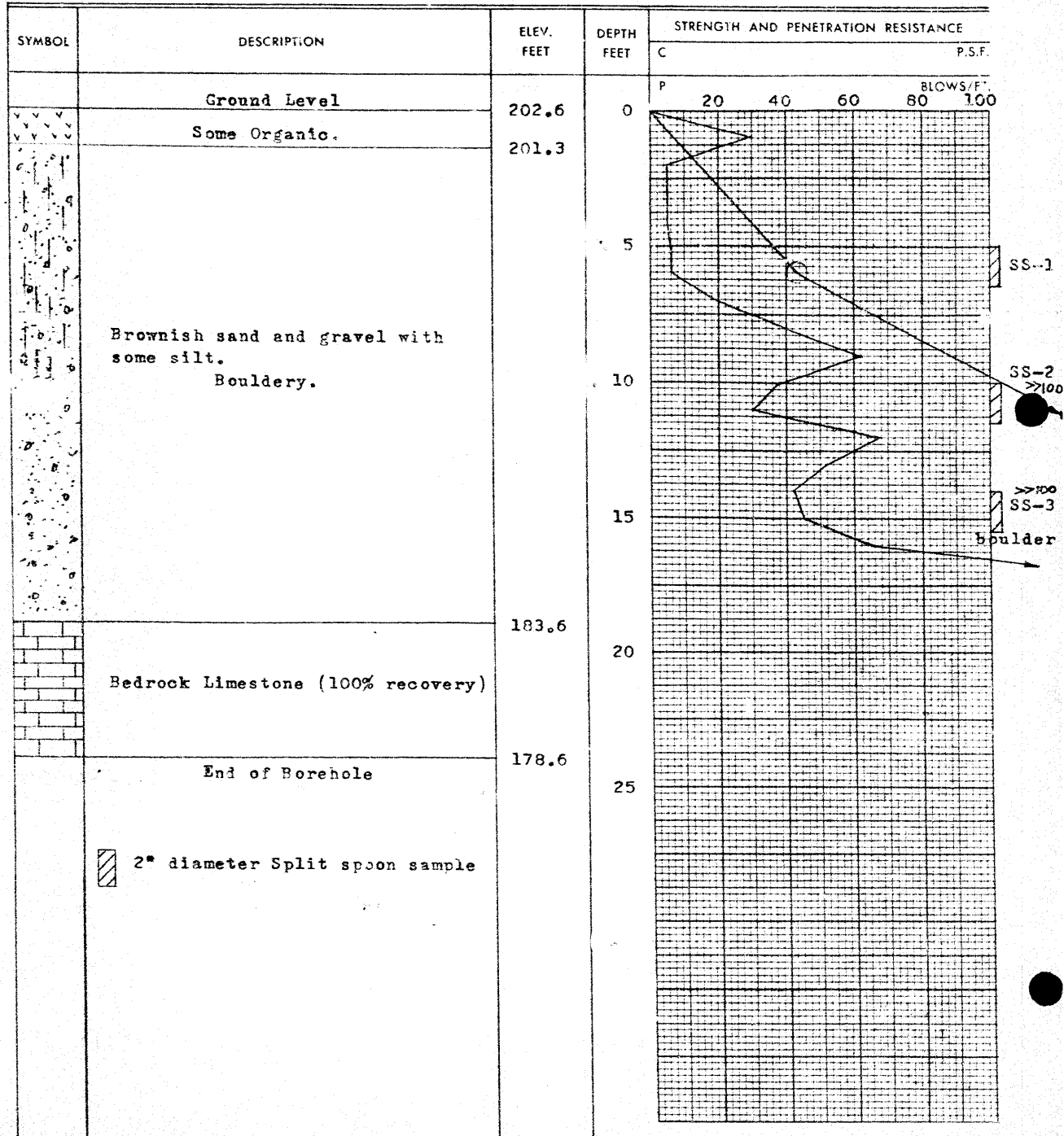
2" Split tube

2" Dia. Cone

Casing

⊕  
+5

⊕ ⊕



**RACEY MacCALLUM AND ASSOCIATES LTD.**

Foundation Engineering Division

Engineering Data Sheet for Borehole: No 8.

Project: FOUNDN. INVEST. PROPOSED CROSSING, COUNTY RD./HWY #101

Location: CORNWALL, ONTARIO

W.P. 79-59

Hole Location: See Enclosure No 1.

Hole Elevation and Datum: 204.5 feet

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

Driller: L.G. Checked:

Date:

**LEGEND**

Shear Strength (C)

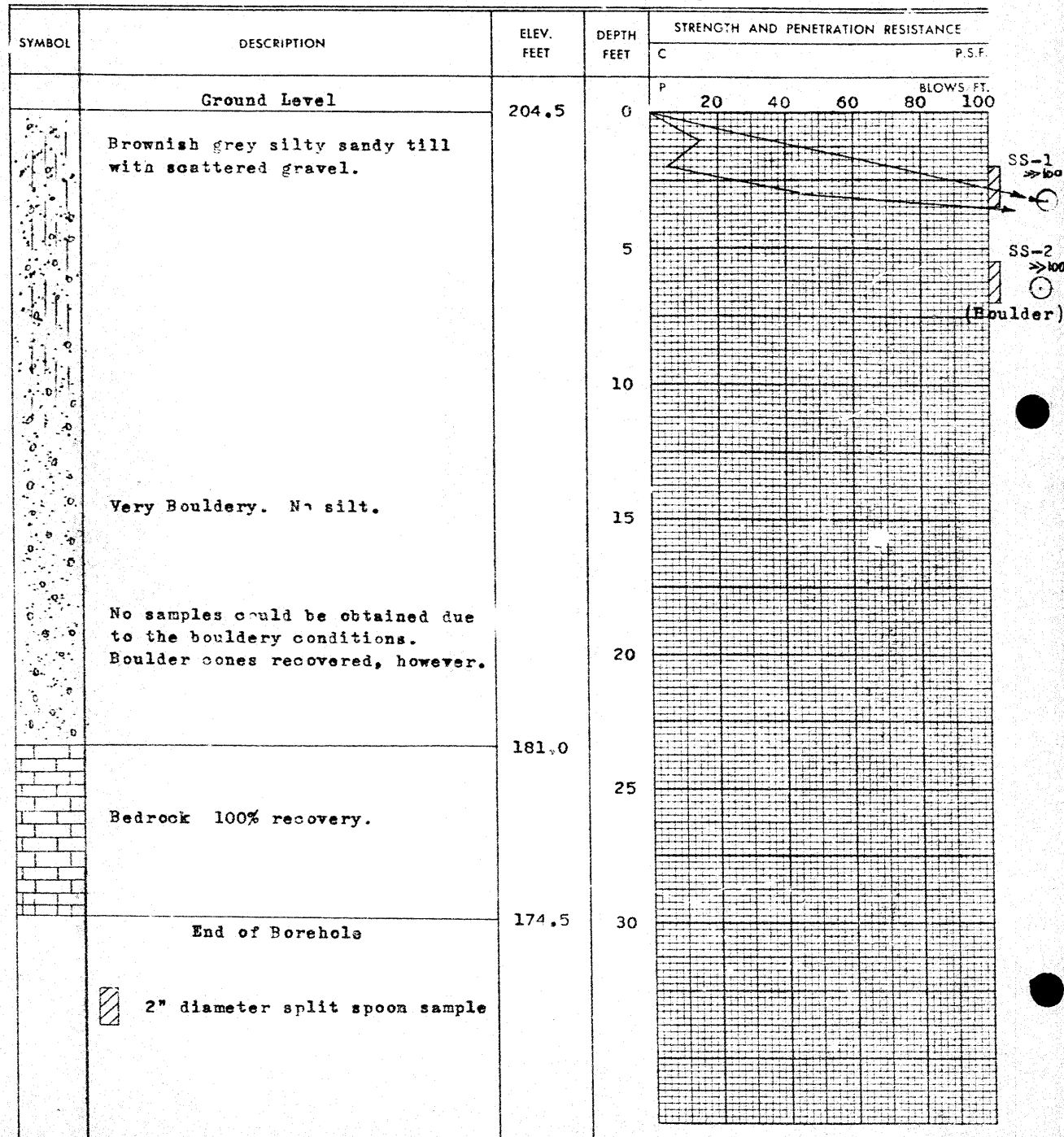
Unconfined compression  
Vane test and sensitivity (S)

Penetration Resistance (P)

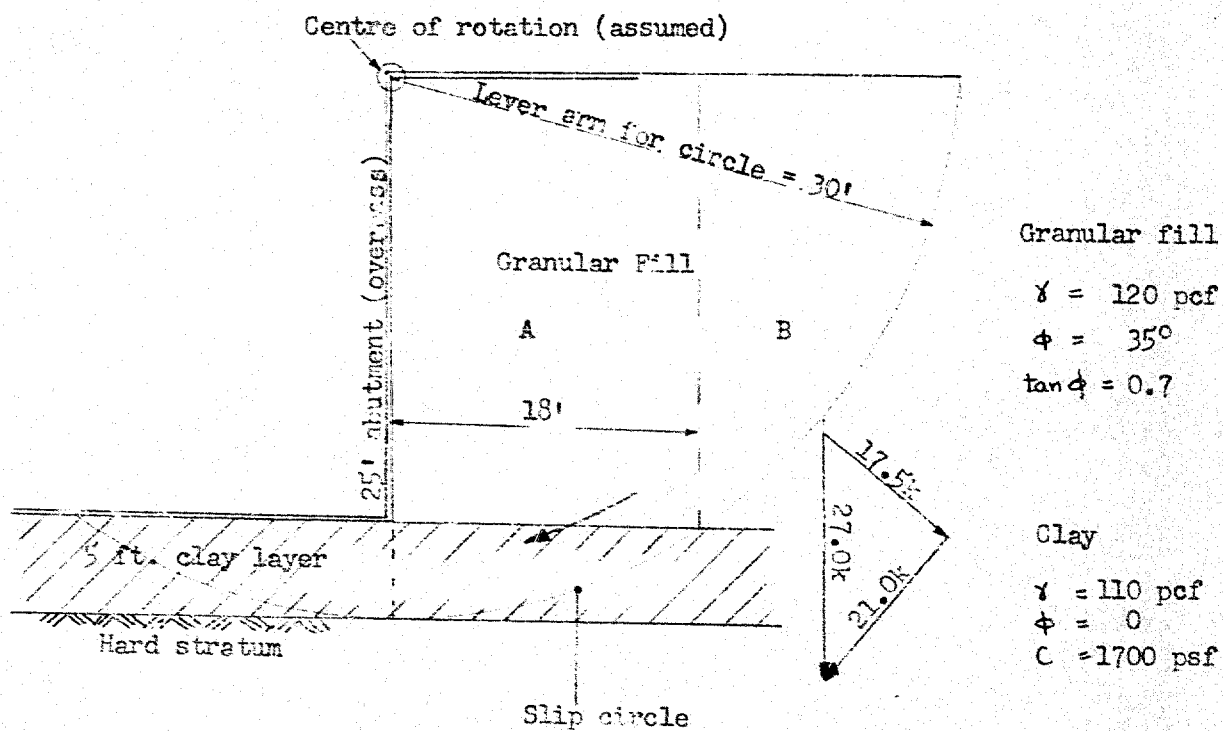
2" Split tube

2" Dia. Cone

Casing

⊕  
+5

Prep. By V.K.H.



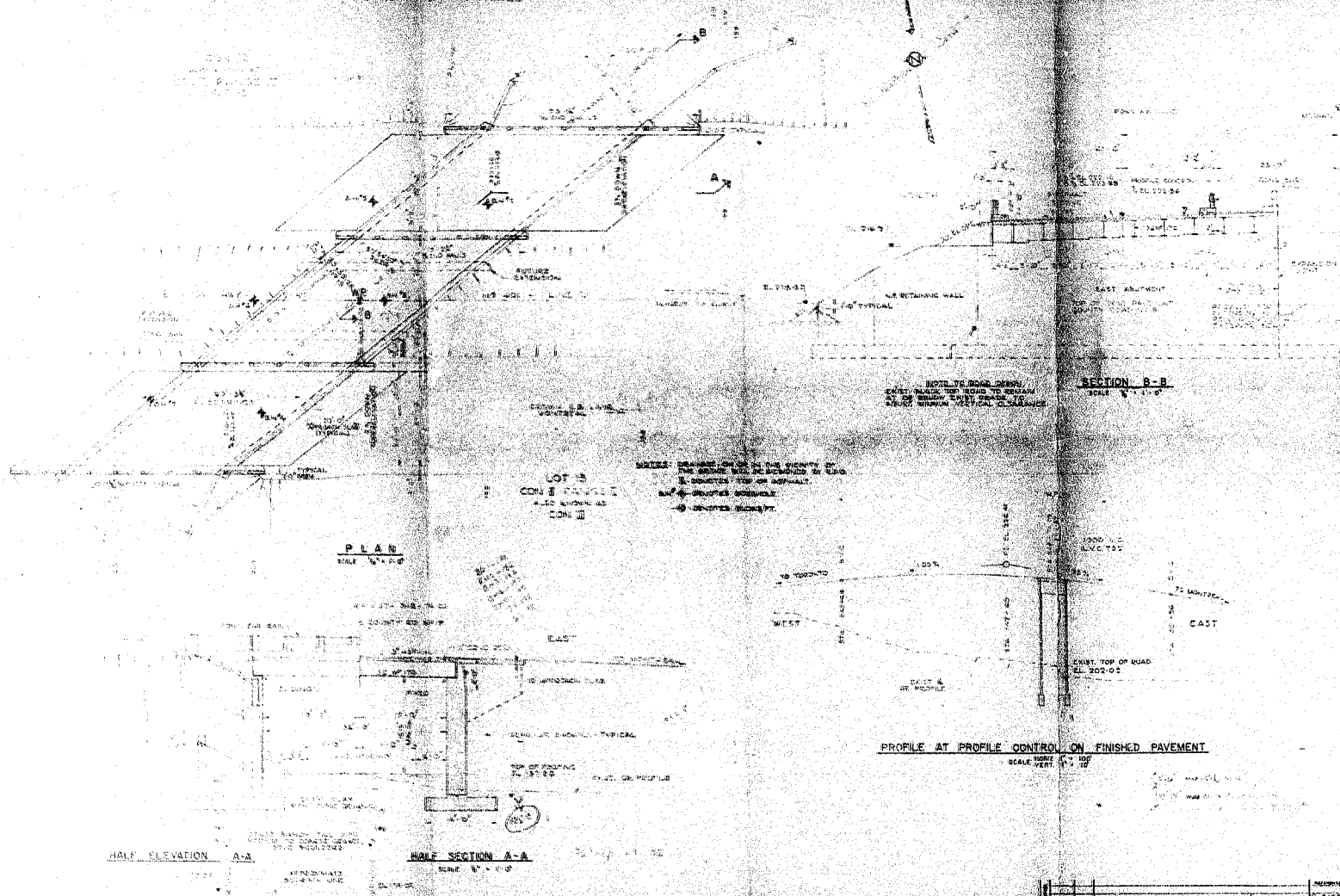
## Disturbing moments

A	$18 \times 25 \times 120 \times 9$	486000 lb.ft.
B	$21,000 \times 30$	630000 lb.ft.
		<u>1116000 lb.ft.</u>

## Resisting moments

	$0.7 \times 17,500 \times 30$	364000
Arc	$10 \times 1700 \times 30$	204000
		<u>240400</u>

$$F.S. = \frac{2404000}{1116000} = 2.16$$



- KEY PLAN**  
SCALE 1" = 100'
- GENERAL NOTES**
1. THE BRIDGE SHALL BE CONSTRUCTED IN ACCORDANCE WITH THE SPECIFICATIONS FOR BRIDGES AND STRUCTURES OF THE DISTRICT ENGINEER.
  2. THE BRIDGE SHALL BE CONSTRUCTED IN ACCORDANCE WITH THE SPECIFICATIONS FOR BRIDGES AND STRUCTURES OF THE DISTRICT ENGINEER.
  3. THE BRIDGE SHALL BE CONSTRUCTED IN ACCORDANCE WITH THE SPECIFICATIONS FOR BRIDGES AND STRUCTURES OF THE DISTRICT ENGINEER.
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  10. THE BRIDGE SHALL BE CONSTRUCTED IN ACCORDANCE WITH THE SPECIFICATIONS FOR BRIDGES AND STRUCTURES OF THE DISTRICT ENGINEER.

**PRELIMINARY**

W.P. 79-55  
D.W. 11-A-1955/7

PROCTOR & REDFERN  
CONSULTING ENGINEERS  
TORONTO  
DEPARTMENT OF HIGHWAYS, ONTARIO  
BRIDGE OFFICE, TORONTO

CORNWALL TOWNSHIP  
BRIDGE N° 9

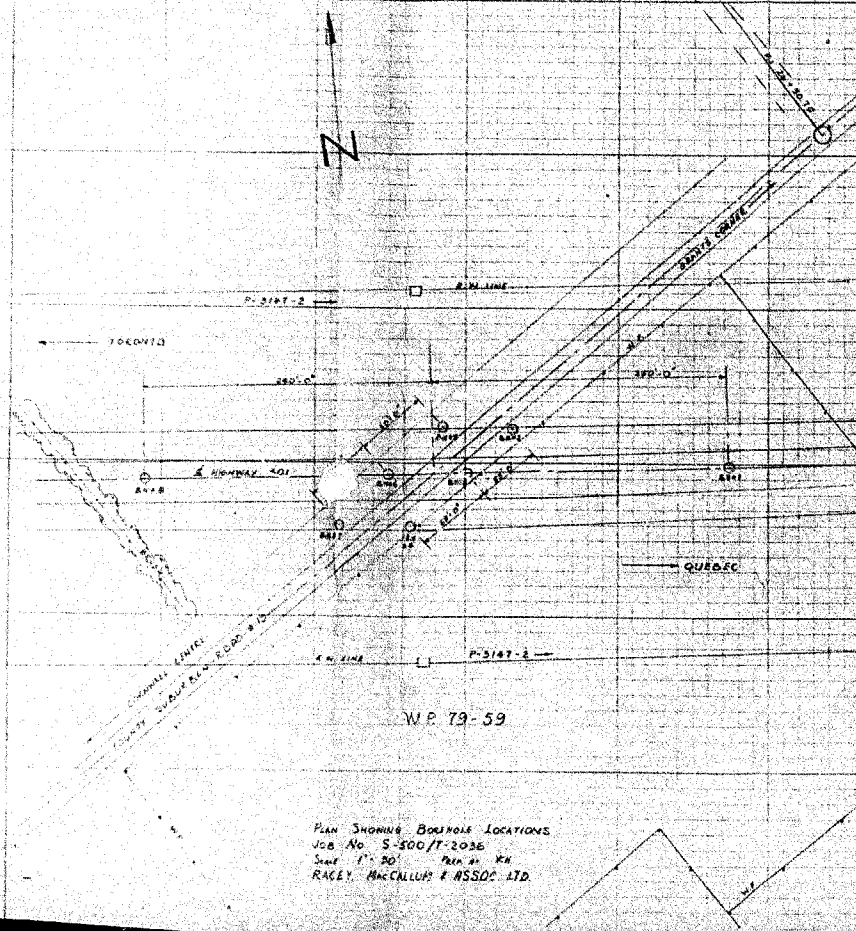
THE HIGHWAY NO. 401  
CO. 578400  
TWO CORNWALLS  
L.V. 18  
S.M. 18

GENERAL ARRANGEMENT

APPROVALS

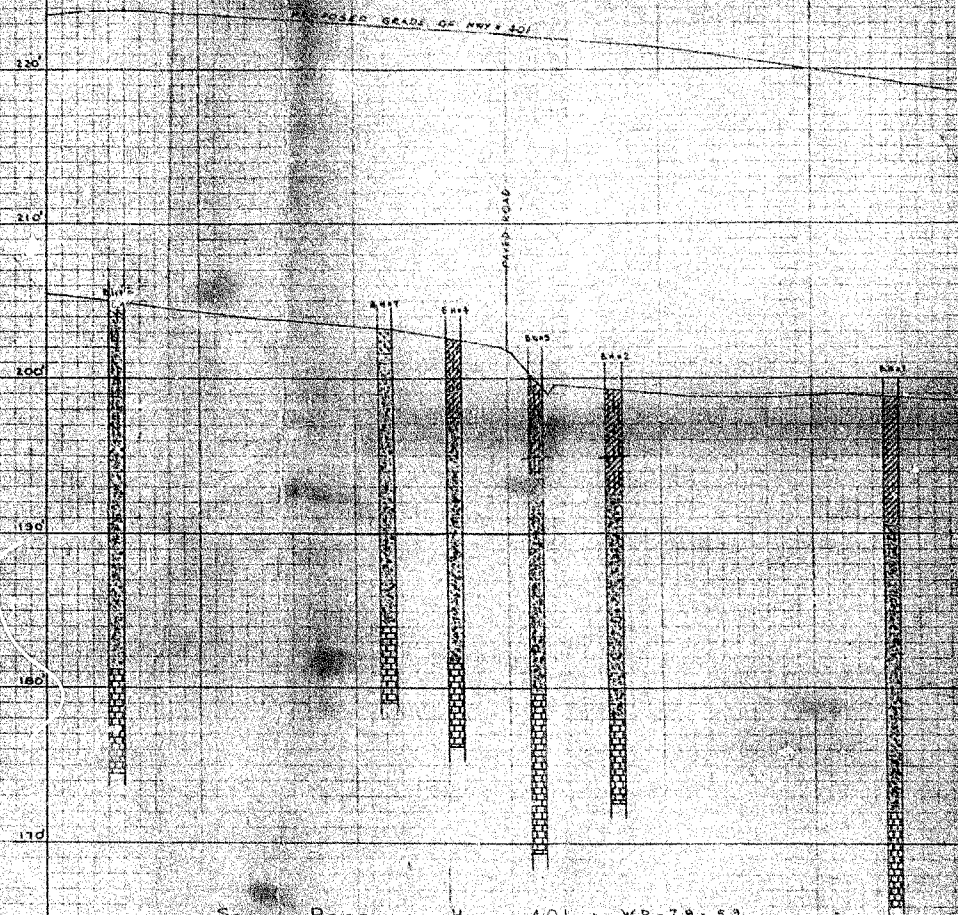
APR 5 1960

DESIGNED BY: J.M. W.T. W.T.  
CHECKED BY: J.M. W.T. W.T.  
APPROVED BY: J.M. W.T. W.T.



WP 79-59

PLAN SHOWING BOREHOLE LOCATIONS  
 JOB No. S-300/T-2036  
 Scale 1" = 20' Plan # KH  
 RACEY, MACCALLUM & ASSOC. LTD.



SOIL PROFILE HWY 401 - WP-79-59

RACEY, MACCALLUM & ASSOC. LTD.  
 JOB No. S-300/T-2036  
 Scale 1" = 20' Plan # KH

#60-F-295-C

#W.P. 79-59

HWY. <sup>#</sup>401,

CORNWALL TWP.

