

58-F-302C

W.P. 930-57

T.C.H. BRIDGE

EAST BRANCH OF

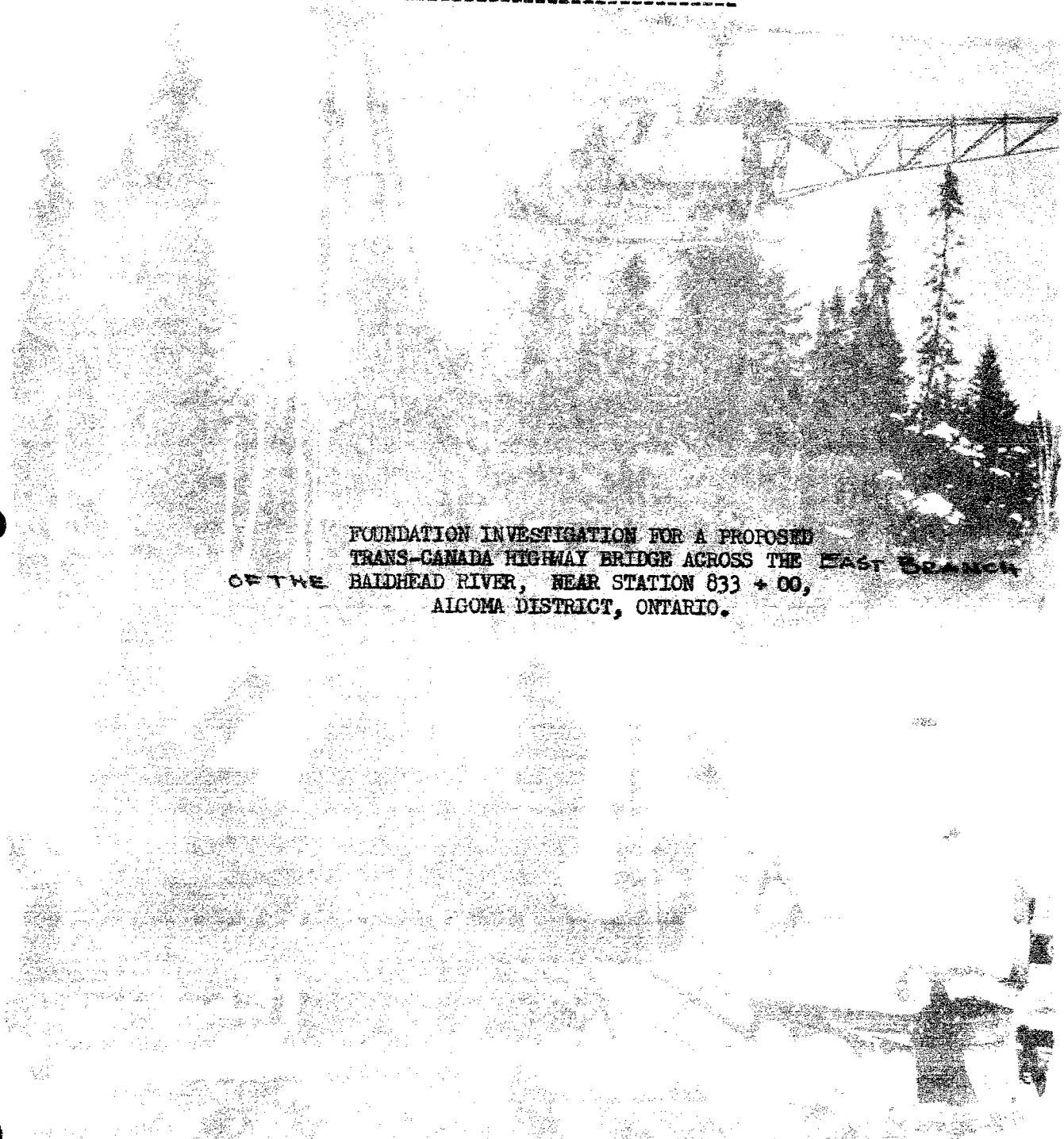
BALDHEAD RIVER

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58-F-302 C

M P 334 27

Messrs. Proctor and Redfern,
11, Jordan Street,
Toronto 1.



FOUNDATION INVESTIGATION FOR A PROPOSED
TRANS-CANADA HIGHWAY BRIDGE ACROSS THE EAST BRANCH
OF THE BALDHEAD RIVER, NEAR STATION 833 + 00,
ALGOMA DISTRICT, ONTARIO.

Reference: S-500-S-538/T-1073

Racey, MacCallum and Associates
Limited

21 March, 1958

Reference: S-500-S-538/T-1073

21 March, 1958

FOUNDATION INVESTIGATION FOR A PROPOSED
TRANS-CANADA HIGHWAY BRIDGE ACROSS THE
BALDHEAD RIVER, NEAR STATION 833 + 00,
AIGOMA DISTRICT, ONTARIO.

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GENERAL :

Because of the inaccessibility of both the sites at which drilling was to be carried out on the Baldhead River, it was decided by the consulting engineer and Department of Highways of Ontario supervisory personnel that a helicopter would be the most convenient way of transporting the drill, and its associated equipment and operators into the sites. The base camp for men and equipment was the Coldwater Construction Camp at the present effective terminal of the trans-Canada highway at Coldwater River, some 10 miles to the south of the proposed drilling areas; the personnel were flown into the site from this Camp each morning and returned to it at night. Without such a facility in the weather conditions which were encountered the work which was carried out would have been impossible.

The men involved on jobs S-500-S-538/T-1073 and T-1074 consisted of the following :

	<u>Name</u>	<u>Affiliation</u>
Supervisor :	P. J. Finn - Soil Technician	Racey, MacCallum and Associates
Surveyor :	Mr. R. Van Dusen	Proctor and Redfern, Consulting Engineers.
Driller :	Mr. R. Constantineau	F. E. Johnston Drilling Company, Ottawa, Ontario.
Driller's helper :	Mr. A. St. Amour	F. E. Johnston Drilling Company, Ottawa, Ontario.
Helicopter pilot :	Mr. T. Cook	Dominion Helicopters, King, Ontario.
Flight engineer :	Mr. D. Cassidy	Dominion Helicopters, King, Ontario.

The helicopter was rented from Dominion Helicopters, King, Ontario, for the duration of the field investigation.

FIELD OPERATIONS :

Mr. P. J. Finn and Mr. R. Van Dusen travelled from Toronto to the Coldwater Construction Camp site, arriving on the afternoon of

12 February, 1958. The helicopter and the crew arrived shortly afterwards and arrangements were made with Mr. Finn for the purchase of aviation gasoline, which had to be supplied from Sault Ste. Marie. Later in the day, the drill crew arrived from Ottawa and were quartered in the Construction Camp.

The next morning, 13 February, 1958, the ferry operations began. Mr. Finn and Mr. Dusen first of all flew into the site on the south branch of the Baldhead River, near Station 833 + 00, approximately 10 miles north of the Coldwater Camp, in order to select suitable "drop areas" for the drill and the equipment. Meanwhile, at the Construction Camp, the truck transporting the drill was unloaded and the drill dismantled since the helicopter could not take the complete rig in one flight. It was necessary to take apart the drilling equipment into approximately 500-lb or less packages. On returning from the preliminary reconnaissance, Mr. Van Dusen undertook the supervision of the preparatory work required at the drill site, involving the cutting of logs on which to place the incoming equipment to prevent the heavier parts from sinking in the $3\frac{1}{2}$ feet of snow which covered the area; he was later joined by Mr. St. Amour to assist in the heavy work. Mr. Finn took charge of the work of loading the drilling equipment on to the helicopter at the Construction Camp.

When the drill had been broken down into suitable parts the work of ferrying it into the site was begun. Initially some difficulty was encountered since the weight of the various drill parts was not known and a certain amount of trial and error was necessary in order to find the most efficient loading procedure. However, after this first experience, no further difficulties were met with in the course of the remainder of the operation. The operation was eventually refined to a high state of efficiency as a turn-around time of 24 minutes was sufficient to load a piece of equipment, carry it to the site, unload it and return to the Construction Camp again. Such an operation involved 20 minutes flight time, 10 minutes in each direction.

In the first week's drilling at the first site, the drilling operations were carried out under extremely severe weather conditions in the deep snow with temperatures at about -30° F. during the day. During the second and subsequent weeks the weather moderated somewhat to temperatures of -20° F. and occasionally reached temperatures as high as 25° F. Because the weather conditions were so difficult, a considerable amount of trouble developed as the various water lines which were required to advance the boreholes froze, in spite of the precautions which were taken. The hose persisted in freezing at pipe connections, and the copper gas line to the pressure pump broke frequently owing to the extremely low temperatures and vibration. The latter problem was cured by the acquisition of a flexible gas line.

During the drilling operation the driller and the helper attended to the immediate task of advancing the drill hole, while Mr. Van Dusen occupied himself in supplying the coil heating equipment with a supply of wood and performing the survey work necessary to locate the other boreholes. Mr. Finn supervised the entire operation and took charge of the obtaining of samples and maintaining a log of the soils encountered in the drill hole. He took charge of the soil samples as they were obtained and ensured that they did not freeze by placing the

- 3 -

sample jars close to the coil heater and protecting them from the wind by placing a wall of logs around them.

Towards the end of the drilling operations it was found that advantage could be taken of the return flights of the helicopter by beginning to start ferrying equipment and supplies back to the base camp before completion of the final drill hole. In this way, the maximum use of flying time could be achieved with a consequent saving in the number of round trips that were required.

Work at the first drill site, on the south branch of the Baldhead River (Station 833 + 00), proved to be very difficult owing to numerous boulders encountered in the top 10 feet of soil. In order to get through this layer of boulders it was necessary to do a considerable amount of time-consuming drilling inside the BX casing with AX core barrel. The operation had been begun by driving BX casing with a driving shoe attached, which did not prove to be a successful procedure, due in part to the flexibility of BX casing; when boulders were encountered the casing would buckle under the repeated blows of the hammer and it became almost impossible to drive a vertical hole without rendering the casing useless for normal drilling operations after the boulder layer had been penetrated. Eventually 3-inch pipe was used and this proved to be both a practical and an efficient solution.

Borehole No 4 of this investigation was completed on 26 February, 1958, and the following day was occupied in flying the drill to the new site on the north branch of the river at Station 165 + 00 approximately. Drilling was commenced at the new site on 1 March, 1958, one day's delay being necessitated because of bad weather on 28 February, 1958.

SOIL PROFILE :

The site plan, Enclosure No 2, shows the location of the boreholes and cone penetration tests actually carried out at Station 833 + 00. It was originally intended to carry out four boreholes and penetration cone tests at the bridge site, but drilling conditions proved so difficult that it was felt desirable to cut down the amount of work performed.

A cone penetration test was attempted at Location 1, shown on Enclosure No 2, but it was found possible to drive the cone test only to a depth of about 3 feet. At each of several sites the numerous boulders in the underlying soil prevented the driving of the cone further than this depth without severe damage to the point. However, it was found possible to advance a borehole at Location No 1, and the soil strata encountered are shown in the Engineering Data sheet, Enclosure No 3.

The drill was then moved to Location 2, where it proved possible to carry out both the cone penetration test and a borehole, with the results shown on Enclosure No 4. Apart from the difference in depth to bedrock, the results seem to be quite similar for both boreholes. Consequently it was felt advisable to carry out only a cone penetration test at Location 3, and accordingly cone penetration test No 3 was driven.

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Refusal was encountered in this hole at a much shallower depth than was the case in either of the first two boreholes, and a further cone penetration test at the location shown on Enclosure No 2 as 3A was performed. This gave results substantially identical to those obtained with the cone test No 3. At this stage it was decided to carry on and drive a penetration cone at Location 4 in the diagram; it proved impossible to penetrate the dense boulder layer at this location. Consequently a borehole, No 3, was also attempted but it, too, proved almost impossible and succeeded only in penetrating to a depth of 3 feet, where the hole was terminated in case of damage to the equipment. Since an examination of the site conditions seemed to indicate that those existing at location No 2 on the north bank of the river were poorer than those on the south bank of the river, it was decided to attempt a further borehole at the location shown as Borehole No 4 on the diagram. The results obtained from Borehole No 4 are shown on the Engineering Data sheet, Enclosure No 7, and substantiate those of the cone penetration tests 3 and 3A. In order to check the elevation of bedrock, which apparently changed between locations No 2 and No 3, it was decided to carry out a further cone penetration test, No 3B, on the centre line of the road. The results of this cone test are shown on Enclosure No 6, and indicate that a uniform gradient of the bedrock apparently exists from cone No 3 location down to location of Borehole No 2.

The soil conditions appear to be quite similar at all three completed boreholes, with a surface layer of approximately 10 feet of coarse sand, gravel and boulders underlain by a 15 foot layer of loose to medium dense coarse sand containing some fine gravel. Underneath this latter layer is a zone of loose to medium dense silty fine to medium sand, which varies in thickness in the different boreholes. In Borehole No 1 this material has a thickness of approximately 20 feet, while in Borehole No 2 only 5 - 10 feet of fine material is encountered, and approximately 10 feet in Borehole No 4. Below this, again, is a grey medium dense fine to coarse sand containing some gravel in all three boreholes immediately overlying bedrock, which consists of a granite. A similar pattern of density is apparent in all of the boreholes, with extremely dense material at the surface which probably represents that portion of the soil profile which is disturbed by periodic floods of the river and has, therefore, been moved and compacted to a high degree. The layer immediately underneath this, of thickness 15 to 20 feet, appears to be in a very loose to medium dense condition and does not constitute a reliable bearing material for foundations. Below a depth of 40 feet in Borehole No 1, the soil begins to become more dense again and this density increases until bedrock is reached. In Borehole No 2 a gradual increase in density occurs from a depth of 25 feet down to about 35 feet, but the density once again falls off as bedrock is approached. In this borehole the material between a depth of 9 feet and a depth of 25 feet is in an extremely loose condition. In Borehole No 4 the soil appears to be in a loose to medium dense state from a depth of 10 feet down to a depth of 25 feet in the medium sand immediately overlying bedrock. The soil encountered in all boreholes is a grey material and all the fragments appear to be angular, indicating that they have not been subject to a great deal of movement or attrition.

As mentioned earlier, the 9 - 10 foot thick layer of boulders and gravel at the surface of the profile seems to be the portion of the

profile which is subject to movement during periodic floods on the river, and may not therefore be considered to be a safe foundation for a bridge structure. Under normal conditions the water table is, of course, very near the surface in all the holes encountered, although at the time the investigation was carried out the top 3 or 4 feet of gravel were frozen.

FOUNDATIONS :

The 10 foot thick top layer of boulders and gravel is not considered to be a suitable foundation for bridge abutments in spite of its density, since it is felt that the material will be subject to scour in future spring floods. In the event that scour did take place the underlying material is not in a dense enough situation to support the bridge. It is recommended, therefore, that piles be used at this site for the establishment of a foundation.

Steel H-piles should be used, but in order to avoid the difficulties attendant upon driving through the coarse sand, gravel and boulders in the top layer of soil, an excavation should be carried out to about a depth of 5 or 6 feet before driving is attempted. The length of piles which will be required will vary somewhat, depending upon location.

The indications are that, in Borehole No 1, it would be necessary to drive piles to bedrock at Elevation 940 approximately, while in Borehole No 2 on the other side of the river the piles can probably be driven to Elevation 942 approximately. It is possible that the last 10 or 15 feet of driving in this hole may be quite hard. Borehole No 4 indicates that a much shorter length of pile will be required, and that the limit of penetration will be reached at approximately Elevation 956. No unusual difficulty should be encountered in driving piles at this location. The maximum allowable loads for H-piles can be used in these circumstances, since the piles will in each case probably rest upon sound, hard bedrock.

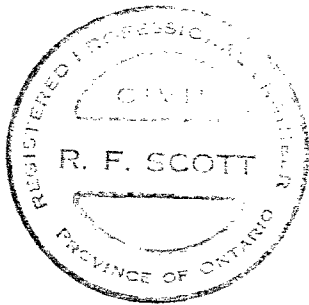
Because of the extremely permeable nature of the top layers of soil, it may be anticipated that drainage of any foundation excavation is going to constitute a difficult problem. It is felt that the most desirable solution would be to surround the excavation by means of sheet piling, driven to a depth of approximately 30 feet. It will probably be desirable to leave this piling in place after construction, in order to constitute protection against scour for the abutments. Drainage of the excavation would probably be best undertaken by means of well points, in order to keep the level of water low and minimise the chance of upheaval due to the upward flow of water into the bottom of the excavation. There is a possibility of the river changing its course during storm periods, or flooding the low lying ground around the bridge site, and some allowance should be made for this in the design of the approach embankments on each side.

CONCLUSIONS :

1. The conditions at the site, with the exception of the depths to bedrock, appear to be relatively uniform with a layer of 10 feet of boulders, sand and gravel overlying less dense granular materials.

CONCLUSIONS (Continued) :

2. It is not recommended that the foundation be placed on the boulder surface layer owing to the possibility of scour taking place.
3. It is recommended that steel H-piles be used at this location, driven to bedrock. Maximum allowable pile loads can be used.
4. Drainage difficulties may be expected, and it is recommended that steel sheet piling be driven around the excavation and drained by means of well points.
5. It is recommended that the sheet piling be left in place after construction is completed to act as a protection against scour.



Ronald F. Scott.

Ronald F. Scott, P.Eng.,
Divisional Soil Engineer.

RFS/YDP

Prep. By R.F.S.

Baldhead
River

Coldwater River



ALGOMA
DISTRICT

LAKE
SUPERIOR

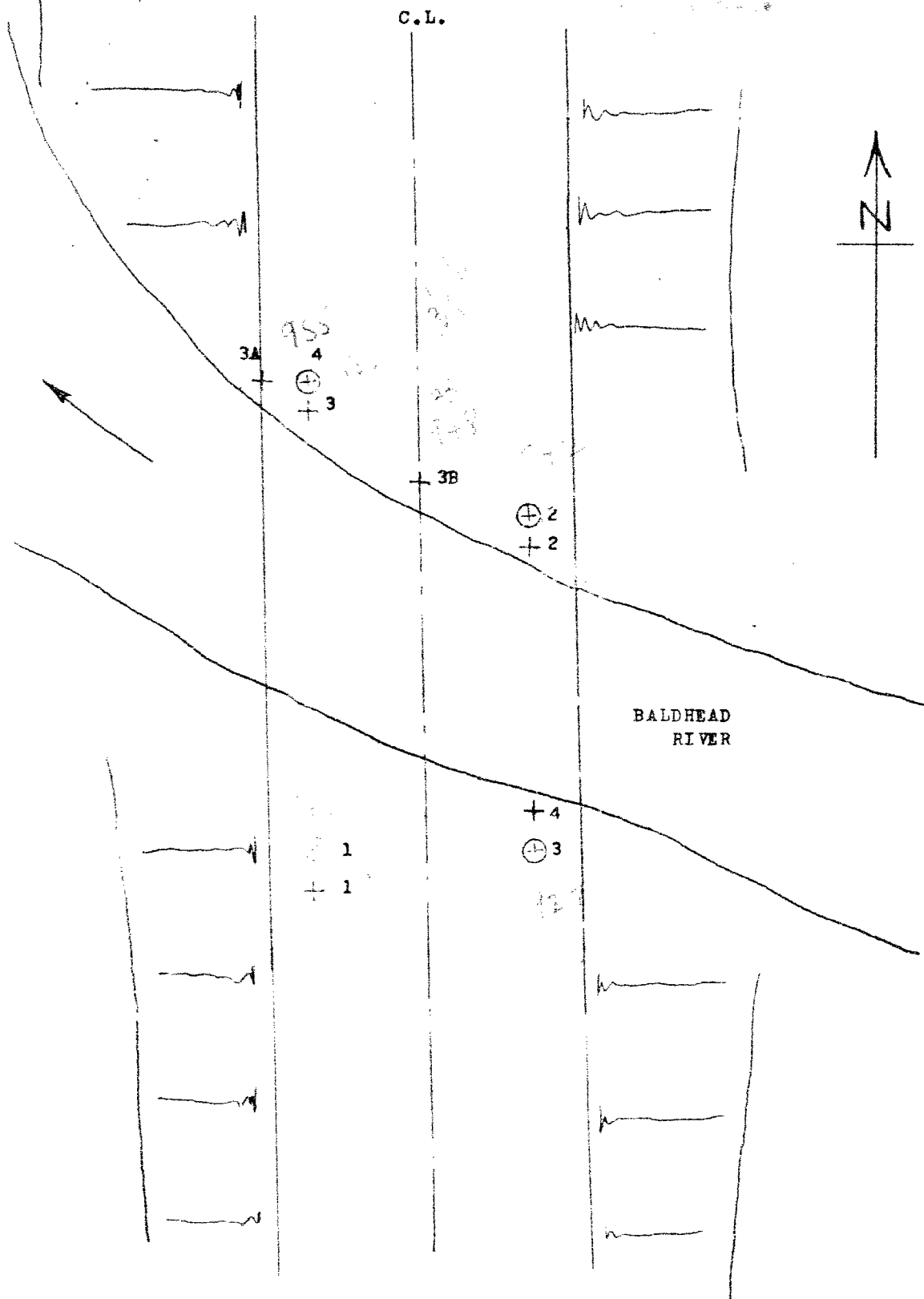
LOCATION PLAN
BALDHEAD RIVER

SCALE: 1 inch = 8 miles

Sault Ste. Marie

Prep. By R.F.S.

HJ 7-1171



⊕ BOREHOLE
+ CONE PENETRATION TEST

Racey, MacCallum & Associates Ltd.

SITE PLAN
BALDHEAD RIVER BRIDGE,
NEAR STATION 833 + 00
SCALE : 1 inch = 20 feet.

RACEY MacCALLUM AND ASSOCIATES LTD.

Foundation Engineering Division

Engineering Data Sheet for Borehole: 1

Project: BRIDGE ON TRANS-CANADA HIGHWAY; APPROX. STA 532+00

Location: BALDHEAD RIVER, See Enclosure No 1

Hole Location: See Enclosure No 2

Hole Elevation and Datum: 989.2

Field Supervisor: P.F. Prep.: R.P.S.

Driller: P.C. Checked:

Date: 13. 3. 1980

LEGEND

Shear Strength (C)

Unconfined compression

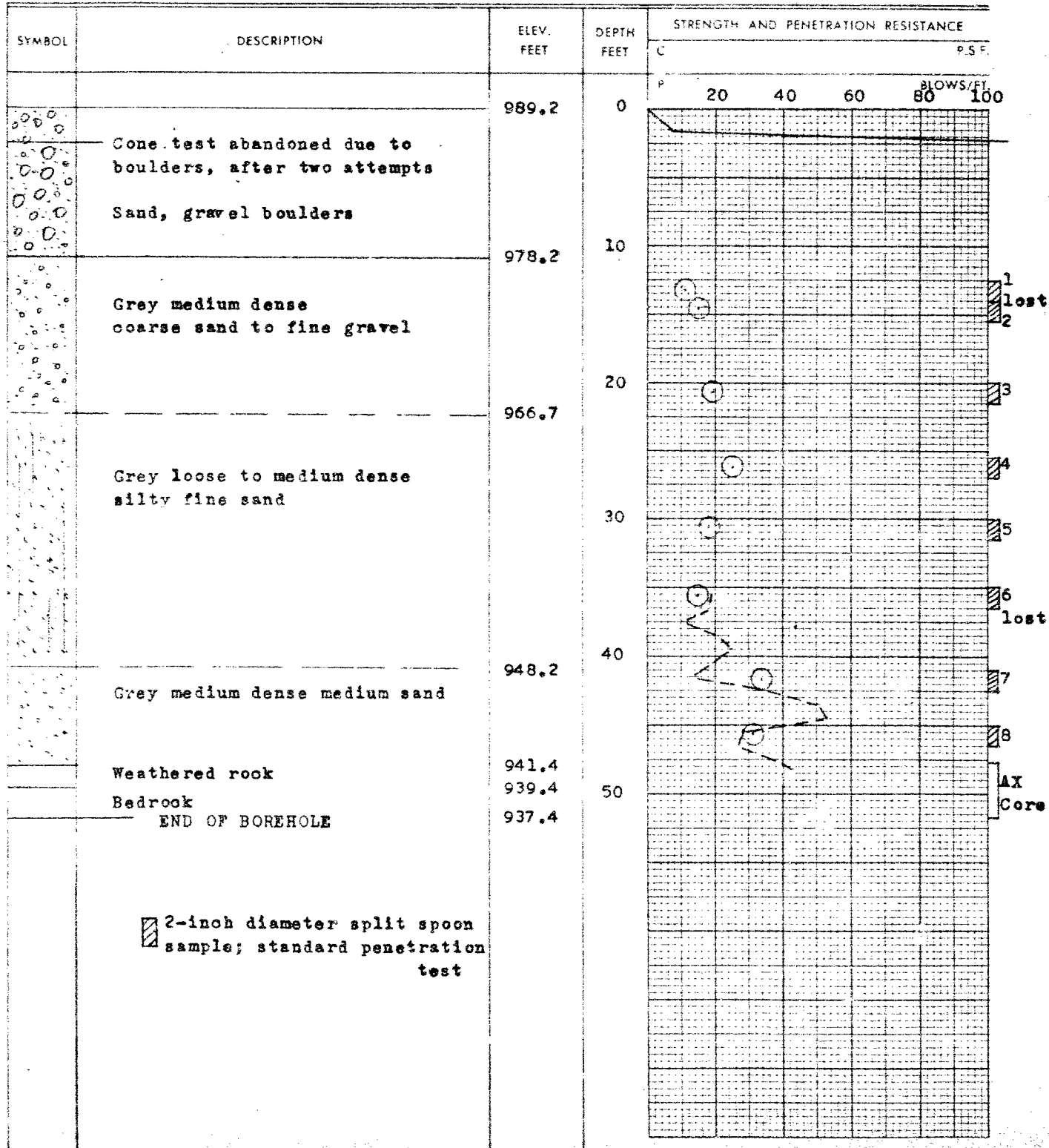
Vane test and sensitivity (S)

Penetration Resistance (P)

2" Split tube

2" Dia. Cone

Casing



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Foundation Engineering Division

Engineering Data Sheet for Borehole: 2

Project: BRIDGE ON ST. LAWRENCE CANADA HIGHWAY; APPROX. STA 135+00

Location: BALTIMORE RIVER, See Enclosure No 1

Hole Location: See Enclosure No 2

Hole Elevation and Datum: 987.1

Field Supervisor: P.F. Prep: E.F.S.

Driller: R.C. Checked:

Date: 13. 3. '58

LEGEND

Shear Strength (C)

Unconfined compression

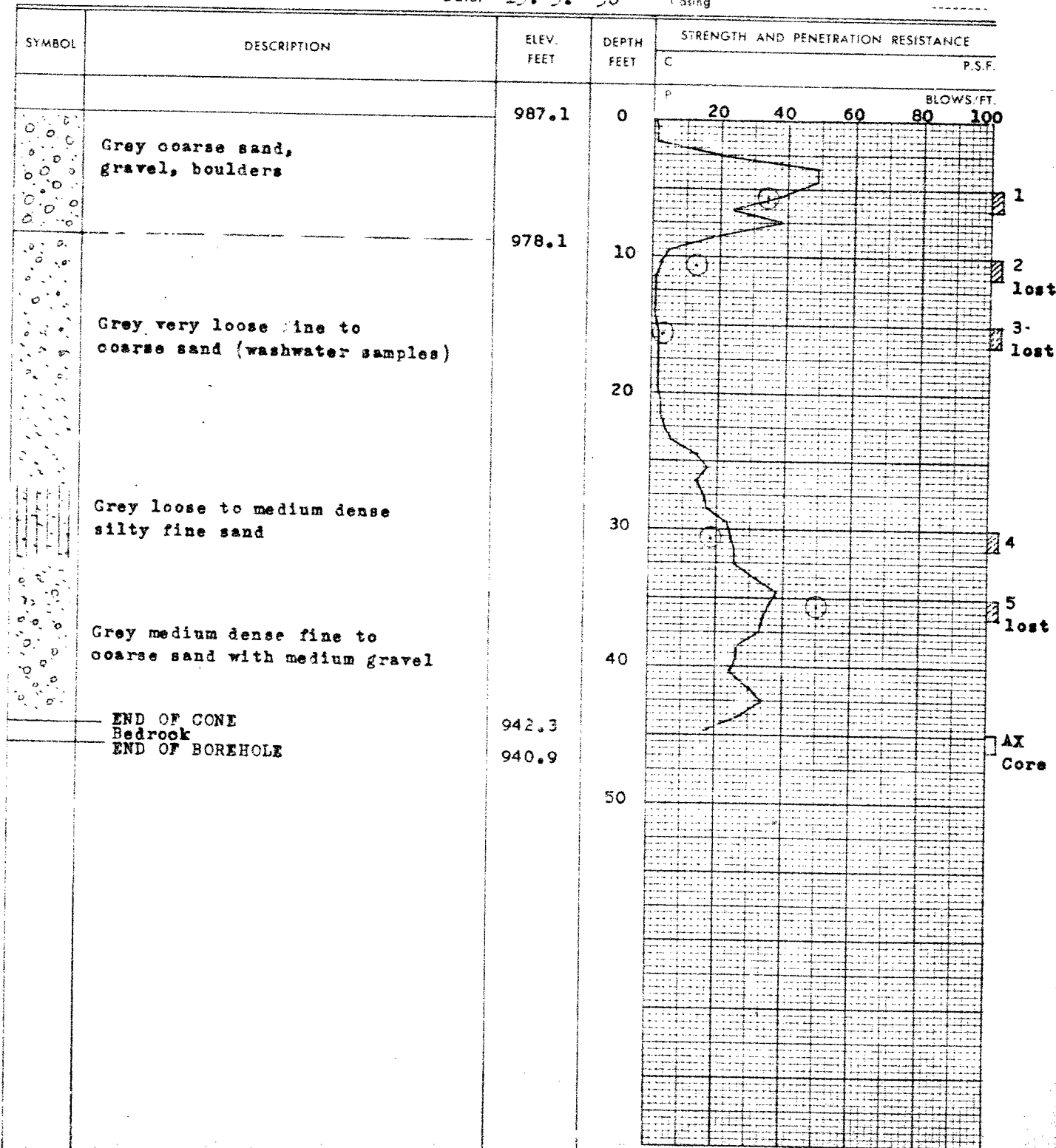
Vane test and sensitivity (S)

Penetration Resistance (P)

2" Split tube

2" Dia. Cone

Casing

⊕
+s

RACEY MacCALLUM AND ASSOCIATES LTD.

Foundation Engineering Division

Engineering Data Sheet for **Cones 3 and 3A**Project: **BRIDGE ON TRANS-CANADA HIGHWAY; APPROX. STA 833+00**Location: **BALDHEAD RIVER, See Enclosure No 1**Hole Location: **See Enclosure No 2**Hole Elevation and Datum: **987.0**Field Supervisor: **P.F.** Prep.: **R.F.S.**Driller: **R.C.** Checked:Date: **13. 3. '58****LEGEND**

Shear Strength (C)

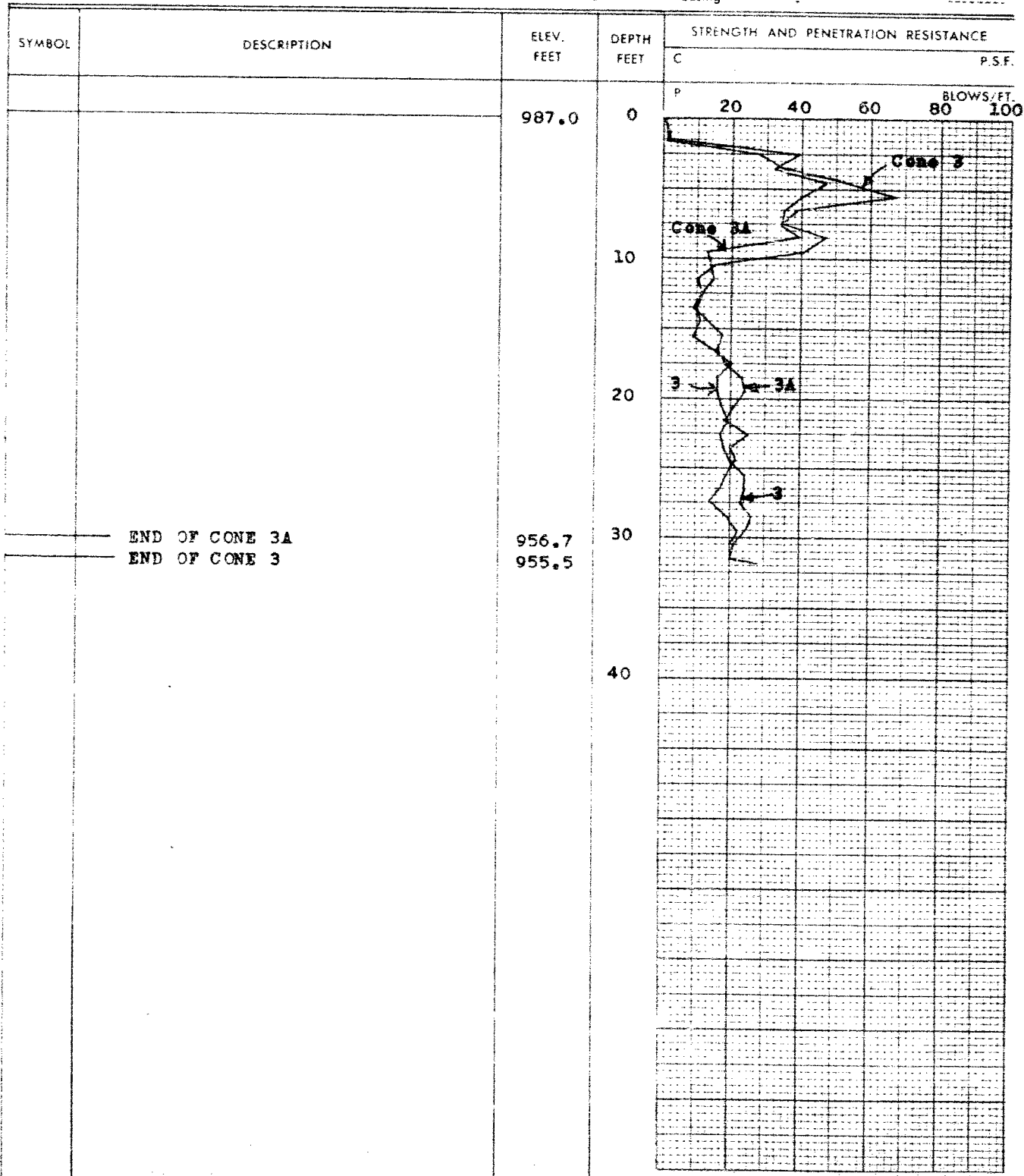
Unconfined compression
Vane test and sensitivity (S)

Penetration Resistance (P)

2" Split tube

2" Dia. Cone

Casing

⊕
+s⊕
⊕

RACEY MacCALLUM AND ASSOCIATES LTD.

Foundation Engineering Division

Cone 3B

Engineering Data Sheet for ~~Borehole~~

Project: BRIDGE ON TRANS-CANADA HIGHWAY; APPROX. STA 833+00

Location: BALDHEAD RIVER, See Enclosure No 1

Hole Location: See Enclosure No 2

Hole Elevation and Datum: 987.0

Field Supervisor: P.F. Prep.: R.F.S.

Driller: R.C. Checked:

Date: 13. 3. '58

LEGEND

Shear Strength (C)

Unconfined compression

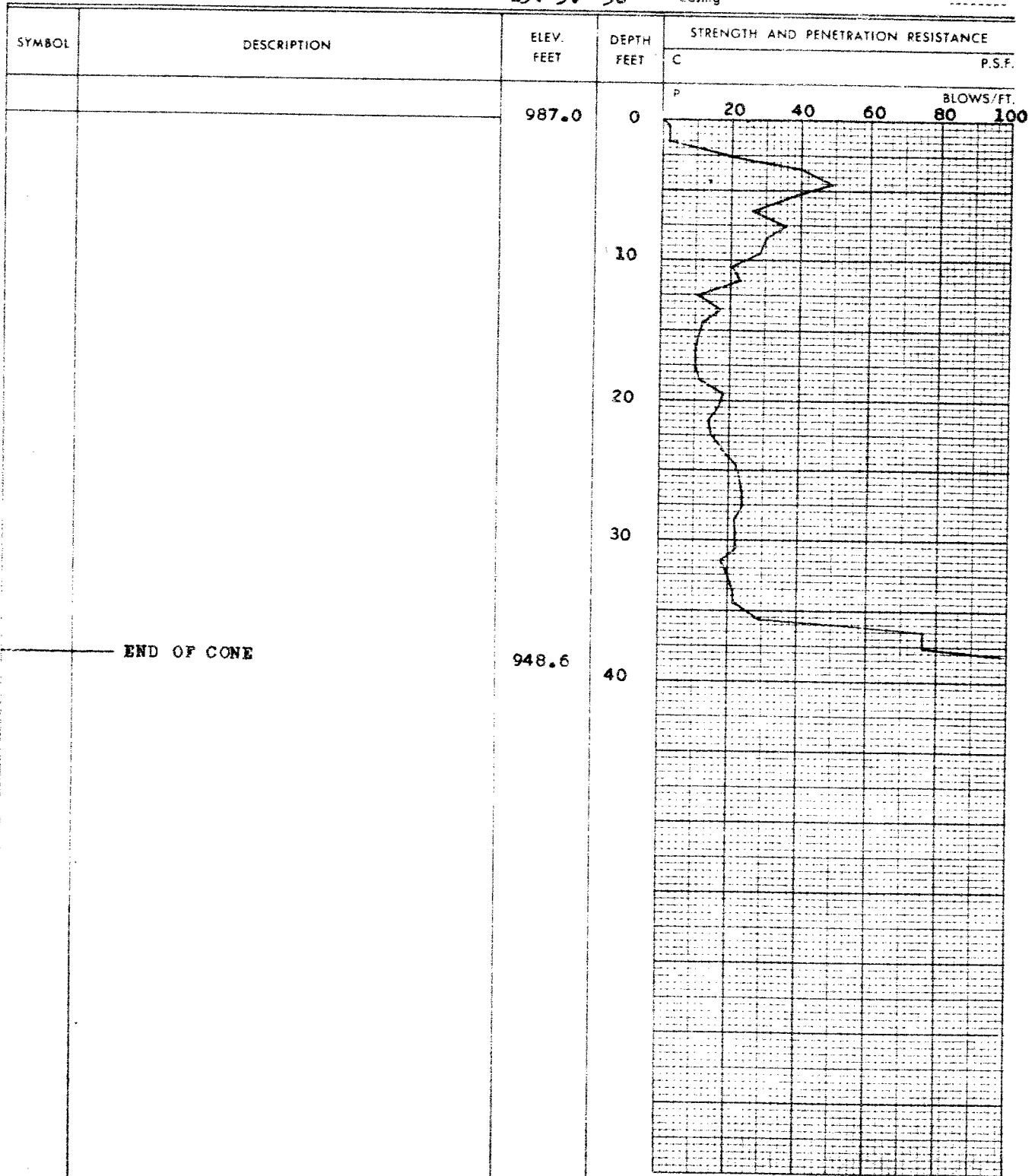
Vane test and sensitivity (S)

Penetration Resistance (P)

2" Split tube

2" Dia. Cone

Casing

⊕
4.3⊕ ⊕
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RACEY MacCALLUM AND ASSOCIATES LTD.

Foundation Engineering Division

Engineering Data Sheet for Borehole: 4

Project: BRIDGE ON TRANS-CANADA HIGHWAY; APPROX. STA 833+00

Location: BALDHEAD RIVER, See Enclosure No 1

Hole Location: See Enclosure No 2

Borehole Elevation and Datum: 987.0

Field Supervisor: P.F. Prep.: R.F.S.

Driller: R.C. Checked:

Date: 13. 3. '58

LEGEND

Shear Strength (C)

Unconfined compression

Vane test and sensitivity (S)

Penetration Resistance (P)

2" Split tube

2" Dia. Cone

Casing

⊕
+3

⊕ ⊕

