

#58-F-203C

Hwy #50

PALGRAVE

BRIDGE

REPLACEMENT

The Department of Highways of Ontario
Bridge Office
280 Davenport Road,
Toronto - Ontario

28 F 203 C

RE: SUBSOIL INVESTIGATION FOR THE
PROPOSED BRIDGE REPLACEMENT AT THE
NORTH END OF PALGRAVE ON HWY NO.50
ONTARIO

Reference 105/795

Dominion Soil Investigation Ltd.

December 25th, 1958.

Report No. 105/F95

December 23rd, 1958

SUBSOIL INVESTIGATION FOR
THE PROPOSED PALGRAVE BRIDGE
REPLACEMENT ON HWY No. 50 ONTARIO

PURPOSE OF THE INVESTIGATION AND SCOPE OF THE REPORT

1. The investigation was undertaken to determine the foundation conditions at the above mentioned site. This report covers a description of the field work undertaken, the subsoil conditions encountered and a suggested method of support for the structure.

LOCATION OF THE SITE AND BOREHOLES

2. The proposed Palgrave bridge replacement is at the north end of Palgrave on Hwy. No. 50. A sketch plan showing the site is shown on Enclosure No.1. The locations of the test boreholes are shown on Enclosure No.2. Enclosure 2a shows a soil profile along the centreline of the proposed structure.

FIELD INVESTIGATION AND DESCRIPTION OF THE SUBSOIL

3. Field work commenced on December 8th 1958 and was completed on December 19th. Some delay in starting the project was caused by the weather conditions. Before December 8th the ice in the Humber River was too thick for a raft but not thick enough to support the drill and equipment. Subsequent to December 8th the ice became thick enough to support the drill, but some difficulty was experienced pulling casing; and at two

borehole locations the ice was cracking badly by the time all the casing was removed. This limited the depth to which it was possible to take the boreholes.

Three boreholes and three cone penetration tests were carried out.

It was observed that the depth of the water was some 4 ft greater than that shown on the Department location plan at boreholes 2, 3 and 4.

A party from the Materials Testing division who were taking water and suck soundings along the proposed centreline found similar results.

The subsoil conditions are uniform and consist of up to 3 ft of very soft suck overlaying medium dense, fine or very fine gray sand. The penetration resistance of this fine sand increases slightly with depth and is medium dense - dense below a depth of 50 - 60 ft or elevation 837 - 847 ft. The penetration profiles for the boreholes and cone tests are shown on Enclosures 3 - 6 inclusive.

DISCUSSION OF THE RESULTS

4. The fine sand encountered has a standard penetration resistance of 20 to 30 blows/ft and has a safe allowable bearing capacity for spread footings of 2 tons per sq. ft. with allowable settlements of the order of 1 inch. However dewatering such a fine sand would probably be difficult and expensive. Some form of pile foundation would therefore probably be more economic.

The bearing capacity of piles in a sand is not easily arrived at by analysis, and empirical estimates are usually used.

One such empirical formula given by G.G. Meyerhoff*

$$\text{is } Q_u = \frac{4NA}{F.S.} + \text{skin friction provided that } \frac{\text{embedded pile length}}{\text{pile diameter}}$$

where Q_A is the allowable bearing capacity in tons

N is the standard penetration resistance at the pile tip

A is the pile tip area

$F.S$ is the factor of safety

Skin friction is usually assumed to accomodate less than 10% of the allowable load. It is felt that in a very fine sand such as encountered here the friction component is of considerably greater significance.

However ignoring the frictional component of the allowable bearing capacity and assuming the piles have a total length of more than 50 ft below existing water level then N may be taken to be 25. If it is further assumed that the pile tip area is 0.75 sq. ft. and $FS = 3$

$$\text{then } Q_A = \frac{4 \times 25 \times 3}{3 \times 4} \text{ tons} = 25 \text{ tons}$$

Wood piles with a safe load of 20 - 25 could therefore be used provided the pile cap is placed below water level.

The standard penetration resistance remains fairly constant and it is therefore not anticipated that absolute refusal will be reached particularly with the first few piles of any group. Meyerhoff's formula suggests that an arbitrary depth of penetration may be selected dependent upon the standard penetration resistance and the pile dimensions. If such an arbitrary depth of penetration is selected and the piles are assumed to be end bearing then concrete piles could be used.

The support which H piles could be expected to give cannot be determined by means of Meyerhoff empirical equation. It may however be assumed that the end bearing properties of H piles in medium dense fine sand are not as good as those of comparable sized wood or concrete piles.

The values for end bearing derived from the Meyerhoff expression compare well with the tabulated values given by Dunham in "Foundations of Structures" and suggest that an allowable bearing capacity of 20 tons per ft diameter pile is reasonable.

Though it seems preferable to consider the pile action to be end bearing a check on the probable bearing capacity assuming skin friction has been made. Using the tabulated values given in "Foundations of Structures" for wet confined fine sand an allowable skin friction of 400 p.s.f. may be assumed.

Taking the embedded pile length to be 40 ft and the pile diameter to be 1 ft then the allowable load per pile is

$$\frac{40 \times \pi \times 1 \times 400}{2000} \text{ tons or approximately 25 tons.}$$

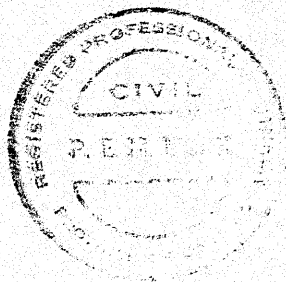
The value of allowable skin friction used above has some allowance for the effect of using the piles in small groups.

CONCLUSIONS

5. a. The subsoil conditions are uniform and consist of saturated medium dense fine to very fine gray sand.
- b. The standard penetration resistance of the sand is 20 blows per ft increasing to about 30 blows per ft below a depth of 50 - 60 ft below existing river level.
- c. 50 ft piles of 1 ft diameter of either wood or concrete should be capable of supporting an allowable load of 20 tons per pile. It is thought that 8 piles would have to be driven to a depth of 60 ft to achieve the same bearing capacity due to their smaller cross sectional area when considered for end bearing and their smaller soil displacement when considered in a group for frictional support.

- d. The total settlement using pile foundations should be less than 1 in.
- e. The placement of spread footings would be difficult due to the problems of dewatering the fine sand.
- f. The approach embankments should be stable and it is thought that the soft muck can be removed by displacement if the embankment is placed as an advancing V. The Materials Testing Division have more detailed information on the extent of the muck along the centreline of the proposed structure.

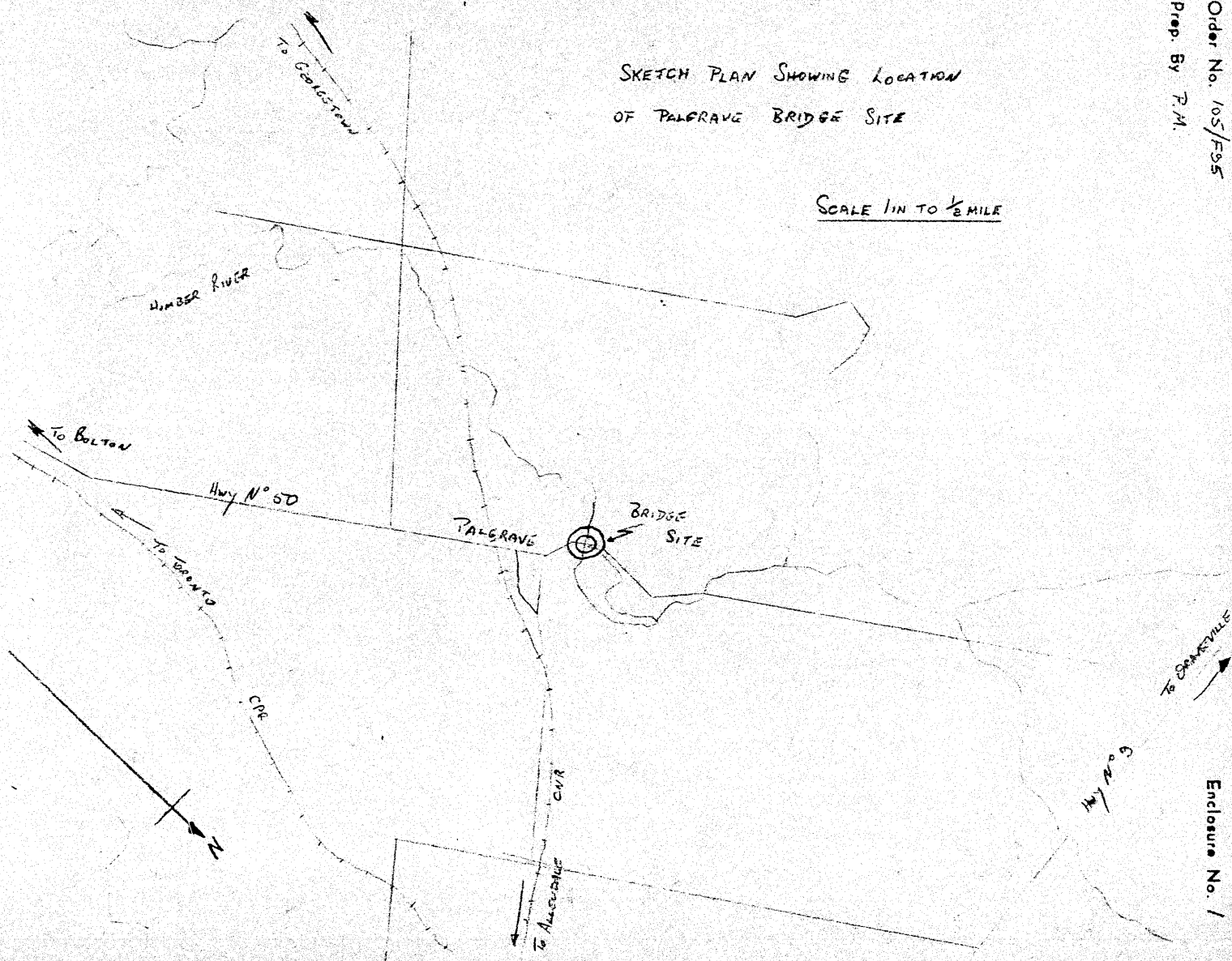
P.E.M. Monk, P.Eng.



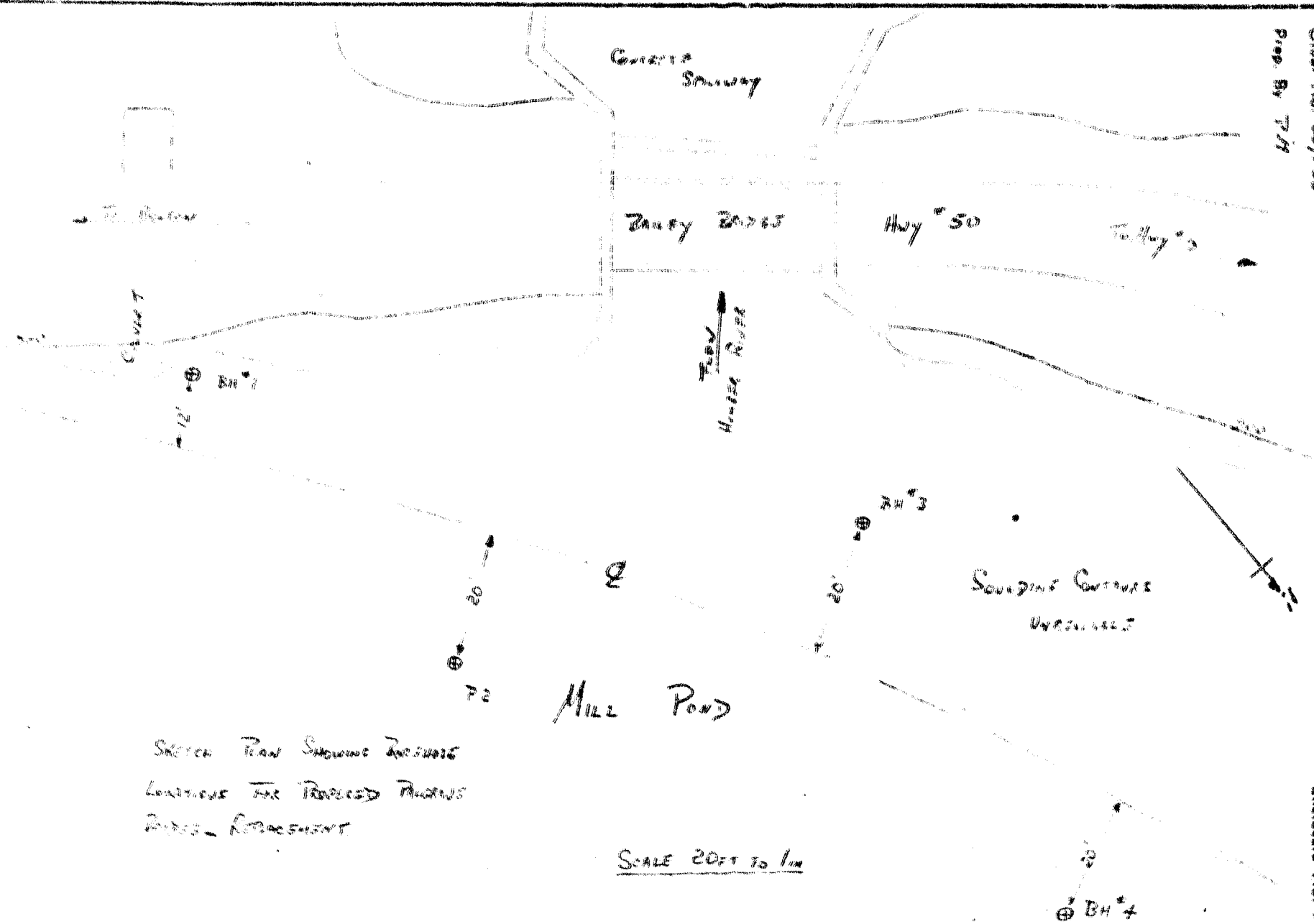
- * "Penetration Tests and Bearing Capacity of Cohesionless Soils"
G.G. Meyerhoff. Proceedings of the American Society of
Civil Engineers January 1956.

SKETCH PLAN SHOWING LOCATION
OF PALGRAVE BRIDGE SITE

SCALE 1 IN TO $\frac{1}{2}$ MILE



Domestic Soil Investigation Ltd.



SKETCH PLAN SHOWING LOCATIONS
LOCATIONS FOR PROPOSED BOREHOLE
BOTH REPRESENT.

SCALE 20 FT TO 1 IN

Dominion Soil Investigation Ltd.

2000

100

22

Highway

E.H.

4.H.

Revised Chart

Chart No. 22

Chart No. 22



Chart

Chart No. 22

Chart No. 22

Chart No. 22

Chart No. 22

Chart No. 22

Chart No. 22

SOIL PROFILE AT SITE
OF PROPOSED BRIDGE
BRIDGE ON Hwy 50

SCALE 20 FT TO 1 IN

890
890
880
870
860
850
840
830
820
810

Water

Loose Sand

Loose Sand

Loose Sand

END OF HOLE

Water

Loose Sand

Loose Sand

Loose Sand

END OF HOLE

END OF CUE TEST

Dominion Soil Investigation Ltd.

Engineering Data Sheet for Borehole: I

Date: 18/12/58

Project: Proposed Palgrave Bridge

Location: N. end Palgrave Hwy No 50

Hole Location: See Enclosure No 2

Hole Elevation and Datum: 897 Geo.

Field Supervisor: Prep.: P.M.

Driller: H.P. Checked:

LEGEND

Shear Strength (C)

Unconfined compression
Vane test and sensitivity (S)

Penetration Resistance (P)

2" Split tube

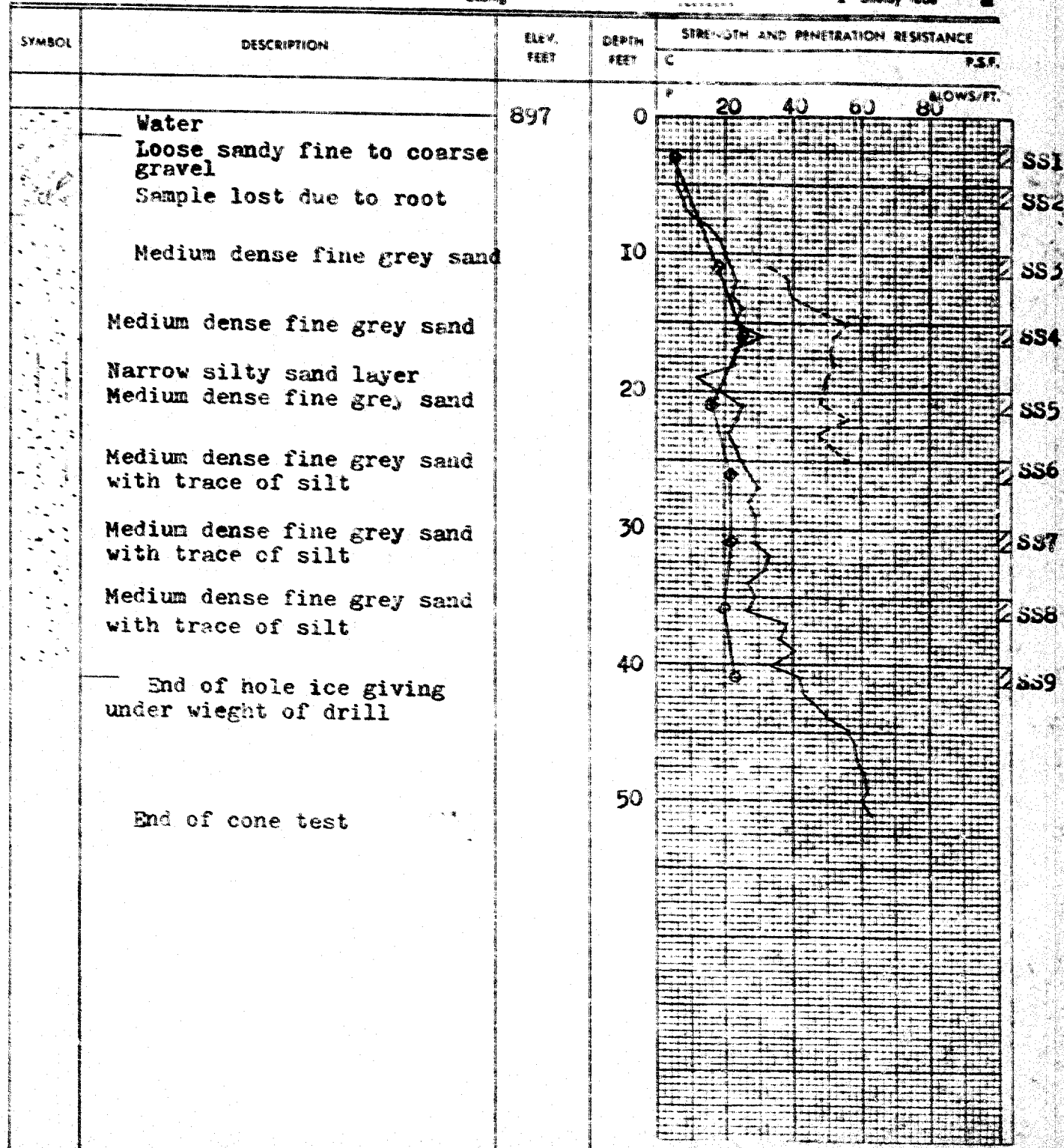
2" Dia. Cone

Coring

Sampling Method

2" Dia. split tube

2" Shelby tube



Dominion Soil Investigation Ltd.

Engineering Data Sheet for Borehole P 2

Date: 22/12/58

Project: Proposed Palgrave Bridge
 Location: N end Palgrave Hwy No 50
 Hole location: See Enclosure No 2
 Hole Elevation and Datum: 897 Geo.
 Field Supervisor: P.M. Prep: P.M.
 Driller: H.P. Checked:

LEGEND

Shear Strength (C)

Unconfined compression
 Vane test and sensitivity (S)

Penetration Resistance (P)

2" Split tube

2" Dia. Cone

Casing

Sampling Method

2" Dia. split tube

2" Shelby tube

SYMBOL	DESCRIPTION	ELEV FEET	DEPTH FEET	STRENGTH AND PENETRATION RESISTANCE			
				C	S	P	Blows/ft
		897	0	20	40	60	80
			10				
			20				
			30				
			40				
			50				
			60				
			70				

END OF CASE TEST

Dominion Soil Investigations Ltd.

Engineering Data Sheet for Borehole: 3

Date: 13/12/70

Project: Proposed Palgrave Bridge
Location: N. end Palgrave Hwy No 50

Hole location: See Enclosure No 2

Hole Elevation and Datum: 897

Field Supervisor: F.M. Prep: F.M.

Driller: H.P. Checked:

Ugindo

shear strength (C)

Unconsolidated compression

Wave test and penetration (S)

Penetration Resistance (P)

2" 100 g.p.s.

2" 100 lb. cone

Coring

Sampling Method

2" dia. split tube

2" Shelby tube

SYMBOL	DESCRIPTION	ELEV. FEET	DEPTH FEET	STRENGTH AND PENETRATION RESISTANCE			
				C	P	DATA	PSF
		897	0	20	40	60	80
	Water						
	Very soft muck		10				
	Loose fine to coarse slightly organic sand						
	Medium dense fine grey sand		20				881
	Medium dense fine to medium with some coarse sand						882
	Medium dense fine with some medium sand		30				883
	Medium dense fine grey sand						884
	Medium dense fine grey sand		40				885
	Medium dense fine grey sand						886
	Medium dense fine grey sand		50				887

Dominion Soil Investigation Ltd.Engineering Data Sheet for Boreholes: 4Date: 19/12/58

Project: Proposed Palgrave Bridge
 Location: N. end Palgrave Hwy No 50
 Hole Location: See Enclosure No 2
 Hole Elevation and Datum: 897 Geo.
 Field Supervisor: P.M. Prep: P.M.
 Driller: H.F. Checked:

LEGENDShear Strength CUnconfined compression
Wave test and sensitivity (S)Penetration Resistance R2" Split tube2" Dia. ConeCoringSampling Method2" Dia. split tube2 Shelby tube