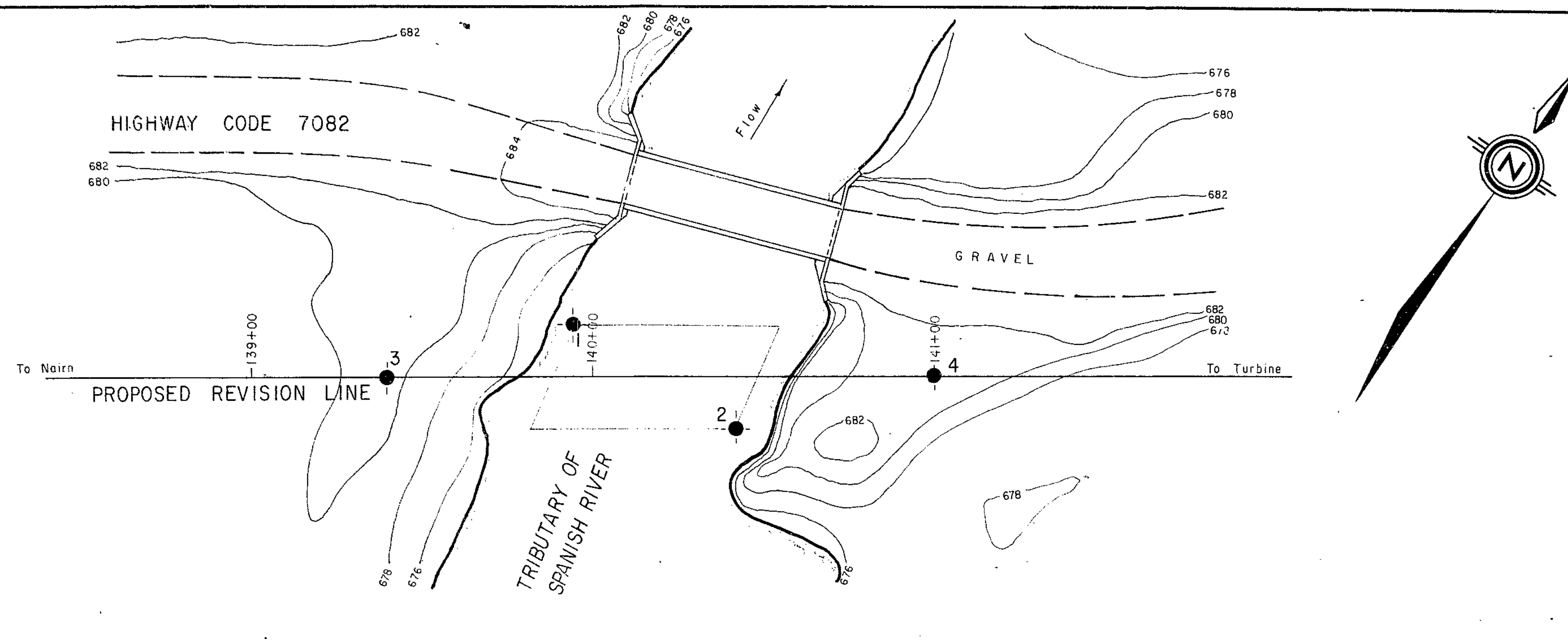
#69-F-209 C

W.P. 86-68-02

H.W.Y. #662, REV'N. LINE.

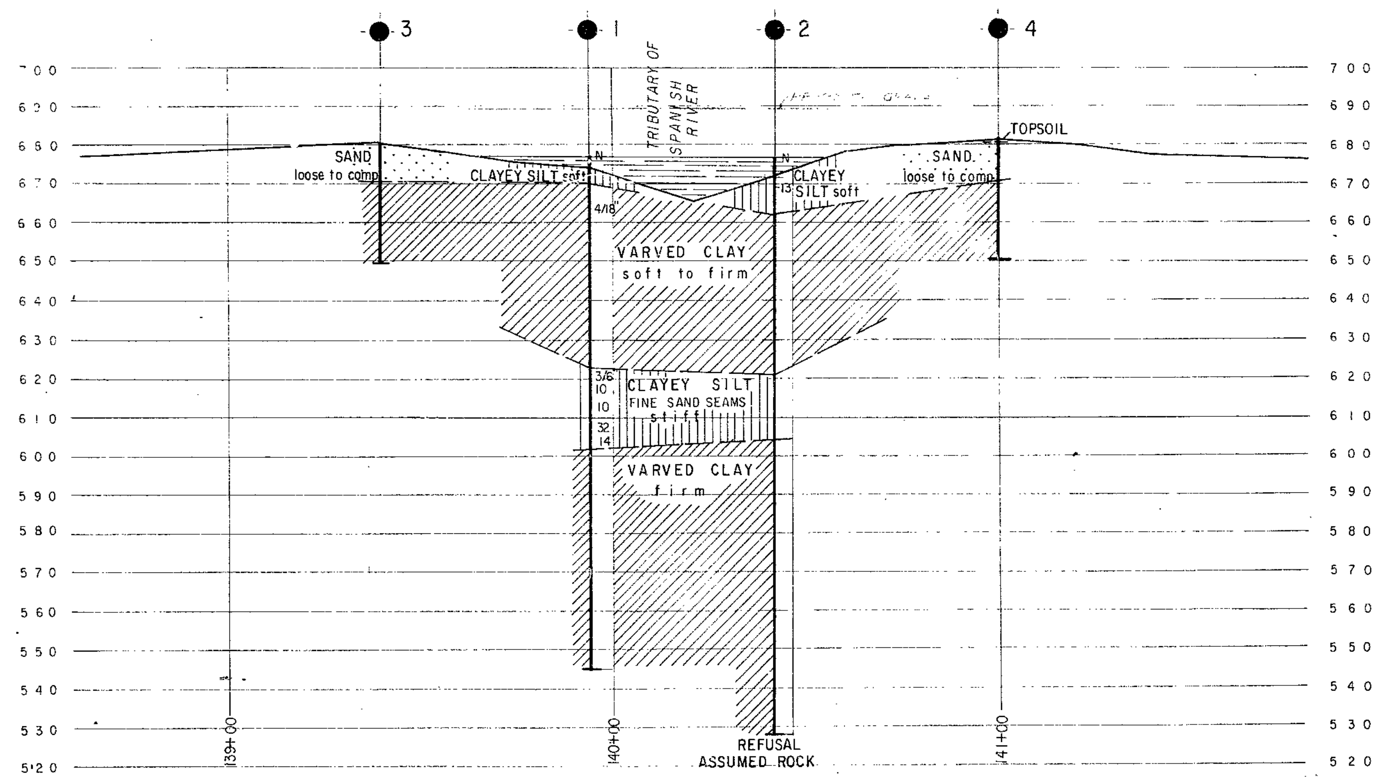
TRIBUTARY OF

SPANISH RIVER.



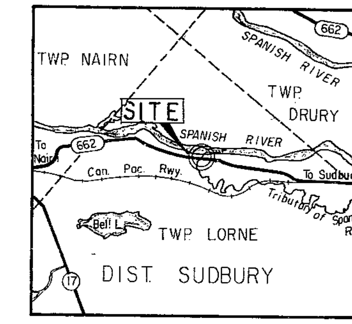
PLAN

SCALE 20 10 0 20 40 60 FT.



℄ PROFILE

SCALE 20 10 0 20 40 60 FT.



KEY PLAN

SCALE IN MILES 1 ½ 0 1 2

LEGEND

- Bore Hole
- Cone Penetration Hole
- Bore & Cone Penetration Hole
- Water Levels established at time of field investigation. NOV. 1969

W.L. TRIBUTARY OF SPANISH RIVER
ELEV. 677·2 NOV. 7 1969

NO.	ELEVATION	STATION	OFFSET
1	677·2	139+94	15' Lt
2	677·2	140+42	15' Rt.
3	680 5	139+40	℄
4	681 2	141+00	℄

- NOTE -

The boundaries between soil strata have been established only at Bore Hole locations. Between Bore Holes the boundaries are assumed from geological evidence and may be subject to considerable error.

REVISIONS		
DATE	BY	DESCRIPTION

WILLIAM TROW ASSOCIATES LIMITED

DEPARTMENT OF HIGHWAYS - ONTARIO
MATERIALS & TESTING OFFICE - FOUNDATION SECTION

TRIBUTARY OF SPANISH RIVER

KING'S HIGHWAY NO. 662 REV'N LINE DIST. NO. 17
DIST. SUDBURY
TWP. LORNE LOT 11 CON. 6

BORE HOLE LOCATIONS & SOIL STRATA

SUBM'D. H. K.	CHECKED	W.P. NO. 86-68-02	DRAWING NO. T - 371
DRAWN E. F. K.	CHECKED	JOB NO.	
DATE NOV. 1969		SITE NO.	BRIDGE DRAWING NO.
APPROVED PRINCIPAL FOUNDATION ENGINEER		CONT. NO.	

PRINT RECORD

NO.	FOR	DATE

cc: Gen. Files

WP-86-68-2

DEPARTMENT OF HIGHWAYS ONTARIO

MEMORANDUM

To: Mr. B. R. Davis
Bridge Engineer,
Bridge Office,
Admin. Bldg.

Attention: Mr. S. McCombie

Our File Ref.

From: Foundation Section,
Materials & Testing Office,
Room 107, Lab. Bldg.

Date: November 12, 1969

NOV 12 1969

In reply to

Subject: Re: FOUNDATION INVESTIGATION REPORT --
By: William Trow Associates Ltd.
Proposed Relocation of Bridge --
Hwy. 662, Rev'n. Line and Spanish River
W.P. 86-68-02 -- District 17 (Sudbury)

Attached please find the above mentioned report prepared and submitted by the Consultant, W. A. Trow Associates Ltd.

We have reviewed the report and feel that it contains sufficient information for you to proceed with the design.

Should you wish to discuss the report, or any part thereof, please feel free to call on this Office.

AGStermac

A. G. Stermac
PRINCIPAL FOUNDATION ENGINEER

AGS/MdeF
Attach.

cc: Messrs. B. R. Davis (2)
H. A. Tregaskes
D. W. Farren
H. McArthur
T. A. Sharpe
J. C. McAllister
E. R. Saint
B. A. Singh
Foundations Files
Gen. Files

90 Milvan Drive
Weston 486, Ontario
749-1290

Soil Mechanics
Consultants

W. A. Trow
MSc. MEIC. P. Eng.

K. Peaker
PhD. MEIC. P. Eng.

William Trow Associates Ltd.

Project: J 5499/T 371

November 10th, 1969.

Mr. A. Rutka, P.Eng.,
Materials and Testing Engineer,
Department of Highways of Ontario,
Materials and Testing Division,
MacDonald Cartier Freeway and Keele Street,
Downsview, Ontario.

Attention: Mr. A.G. Stermac, P.Eng.
Principal Foundation Engineer

Foundation Investigation
Proposed Relocation of Bridge
Hwy. 662, Rev'n North Line and Spanish River
Project WP 86-68-02

Dear Sirs,

Enclosed herewith is our report on foundation conditions at this river crossing.

The site is underlain by great depths of soft varved clay. The most practical foundation solution, in our opinion, is to support the abutments on friction timber piles. The estimated working capacity of a 40 ft. long timber pile of 1 ft. average diameter is 15 tons.

If you have any queries concerning the information contained in this report, we shall be pleased to discuss them with you.

Yours very truly,

WILLIAM TROW ASSOCIATES LIMITED

W. Trow

W.A. Trow, P.Eng.

WAT/ec
Enc.
Dist: Dept. of Highways of Ontario (11)

FOUNDATION INVESTIGATION
PROPOSED RELOCATION OF BRIDGE
HWY. 662, REV'N NORTH LINE AND SPANISH RIVER
PROJECT WP 86-68-02

69-F-209C

Prepared for

DEPARTMENT OF HIGHWAYS OF ONTARIO

WILLIAM TROW ASSOCIATES LIMITED
Toronto, Hamilton, Sudbury

Project: J 5499/T 371
November 10th, 1969

90 Milvan Drive,
Weston 486, Ontario.
749-1290

TABLE OF CONTENTS

TEXT

DRAWINGS

FOUNDATION INVESTIGATION
PROPOSED RELOCATION OF BRIDGE
HWY. 662, REV'N NORTH LINE AND SPANISH RIVER
PROJECT WP 86-68-02

SUMMARY

Deep borings for the above bridge indicated that the site is underlain by a thick deposit of soft to firm varved clay which continues with only minor variation to a depth of 147 ft. where refusal on assumed bedrock is encountered. Since the clay is too weak for economic footing design and since bedrock is at such great depth, the only practical means for supporting the bridge abutments is by means of timber piles. The estimated working capacity of a 40 ft. long 12 inch diameter timber pile is 15 tons. It is recommended that the approach embankments be kept as low as possible and preferably at or below El. 684 ft. to keep settlements within reasonable limits.

PROJECT

It is proposed to replace the existing simple steel truss bridge spanning this tributary of the Spanish River by a slightly skewed bridge located on a realignment of Hwy. 662 located about 50 ft. upstream. Consideration is also being given to the raising of road grade to El. 689.5 ft. or about 10 ft. above present levels.

SITE

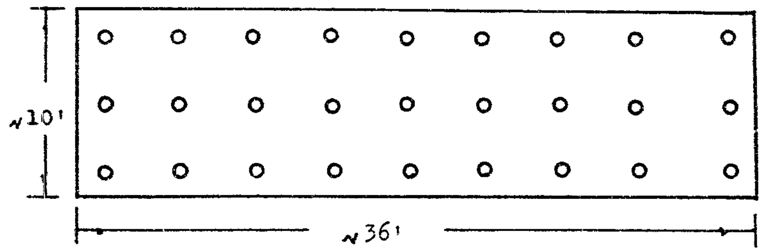
This bridge is located just upstream of the location where this tributary empties into the Spanish River. River flow is in a northerly direction and it was very sluggish at the time of the fieldwork. The water level in the Spanish River is controlled by a dam located about 1/4 mile downstream. The water reaches a maximum depth of about 12 ft. at this location. The terrain in this area is flat and poorly drained, a situation resulting from the fact that the land was covered by a large glacial lake after the Wisconsin ice retreated about 9500 years ago. The tributary creek drains a swampy area to the south.

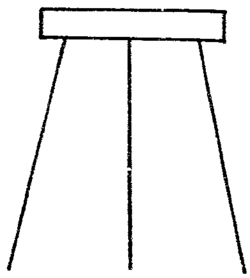
FIELDWORK AND SOIL

Two deep borings in excess of 120 ft. were made at the bridge site and one additional shallow boring was made along each approach to the bridge. The locations of the holes, and the interpreted subsoil stratigraphy, are shown on the enclosed drawing. It is seen that the predominating soil, down to refusal at 147 ft. depth, is a soft to firm varved clay of medium plasticity. The undrained shear strength of this soil within the first 50 ft. of depth increases gradually from about 420 psf, 15 ft. below river level, to 650 psf, 46 ft. below river level.

FOUNDATIONS

In view of the weak condition of the varved clay, the problems associated with working below river level, and the great depth to bedrock, the most practical means for supporting the abutments of the bridge is timber piles. The estimated working capacity of a timber pile of 1 ft. average diameter and driven 40 ft. into clay is 15 tons. This capacity incorporates a factor of safety of two assuming that the soil strength soon returns to its present values, which is the usual experience with timber piles in soft clay. In order to minimize the possibility of an overlapping of the loads of adjacent piles, it is suggested that they be driven in three rows with the two outside rows battered as indicated in the sketch below. The batter piles will also serve to carry the earth pressure and traffic forces exerted on the abutments. It is recommended that a pile load test be made to confirm the working capacity of 15 tons.





In order to obtain a firm base and provide a form for the pile cap and at the same time obtain some scour protection, it is suggested that the abutment locations be covered by about 2 ft. of class B pit-run gravel after the piles have been driven and that light sheeting be driven around the abutment to a depth of about 12 ft. below river bed level.

EMBANKMENTS

The preliminary plans for this project indicate a road grade to approximate El. 689.5 ft. This is about 9 ft. above ground level along the approaches to the bridge and about 17 ft. above river bed level at the abutments.

Embankment failure at this site may be anticipated when the pressure of the fill approaches about 2500 psf, i.e. approximately 5 times the undrained shear strength of the clay. This pressure is equivalent to a fill height of about 19 ft. In addition, considerable settlement can be anticipated because of the very compressible nature and great depth of the clay. Even if the surcharge pressure is kept to about 1500 psf adjacent to the bridge, the equivalent fill to El. 687 ft. approximately, the settlement due to consolidation of the first 40 ft. of soil will be appreciable. This estimated movement is computed approximately from the following expression.

$$S = M_v \, \Delta p \, \Delta h = 6 \text{ inches very approximately}$$

where: M_v = .019 square feet per kip is the approximate average modulus of compressibility within the pressure range applicable

Δp = 0.7 ksf is the approximate average embankment pressure added in the first 40 ft. of soil adjacent to the abutments

Δh = 40 ft.

Although the actual settlement will probably be somewhat less than this and since the pile-supported bridge will also tend to move down under the influence of the fill load, thereby minimizing differential settlement between the bridge and the fill, it is recommended that a lower road grade be considered and preferably a level close to the existing highway grade. A lower road grade will, or course, eliminate any possibility of embankment instability and it will reduce the magnitude of the fill pressure on the abutments.

WILLIAM TROW ASSOCIATES LIMITED

W. Trow

W.A. Trow, P.Eng.

WAT/ec
Enc.
Dist: Mr. A. Rutka, P.Eng.,
Materials and Testing Engineer,
Department of Highways of Ontario,
Materials and Testing Division,
MacDonald Cartier Freeway and Keele Street,
Downsview, Ontario.
Attn: Mr. A.G. Stermac, P.Eng.
Principal Foundation Engineer

BOREHOLE LOG

JOB No. J 5499/T 371 BOREHOLE No. 1 DRAWING No. 1

PROJECT Proposed Relaxation of Bridge,
LOCATION Hwy. 662, Rev'n North Line and
Spanish River,
Project WP 36-68-02.
HOLE LOCATION AND DATUM SEE DRAWING No. 1

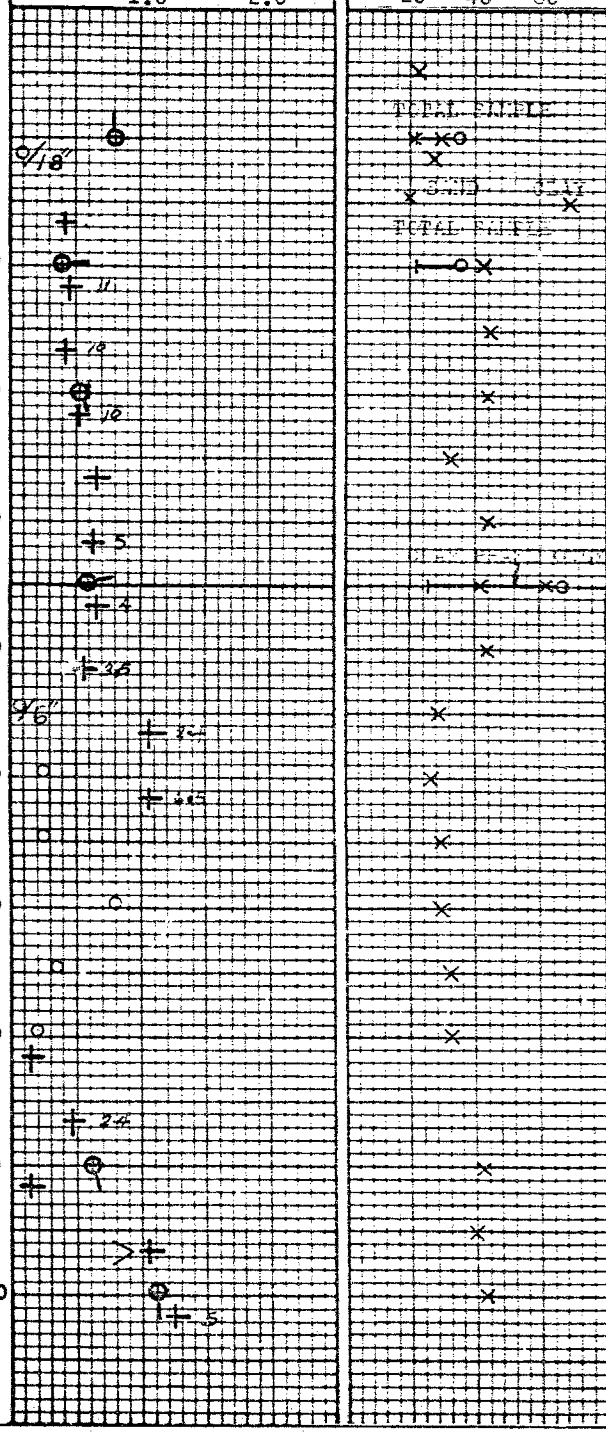
2" O.D. SPLIT TUBE
2" I.D. SHELBY TUBE
2" DIA. CONE
PUSHED P
VANE TEST AND SENSITIVITY (S) +S

NATURAL MOISTURE ×
PLASTIC AND LIQUID LIMIT
UNDRAINED TRIAXIAL AT OVERBURDEN PRESSURE
% STRAIN AT FAILURE

SOIL DESCRIPTION	ELEV. FEET	DEPTH FT.	NATURAL UNIT WEIGHT P.C.F.
	677.2		
WATER	675		
CLAYEY SILT-soft, grey to dark grey, organic stained, some sand seams.	670		
VARVED CLAY-soft; becoming firm below 30 ft. depth; grey to dark grey, some sand and silt intrusions.		10	119.5
		20	111
		30	111
		40	
			111
	623	50	
CLAYEY SILT-stiff, grey, pockets of silt, some fine sand seams.		60	
		70	
	602		
VARVED CLAY-firm, grey.		80	
		90	111
		100	111

PENETRATION RESISTANCE 350 FT. LB. BLOWS FT. 20 40 60 80
SHEAR STRENGTH K.S.F. 1.0 2.0

NATURAL MOISTURE CONTENT AND ATTERBERG LIMITS % DRY WEIGHT 20 40 60



William Trow Associates Ltd.

BOREHOLE LOG

JOB No. J 5499/T 371 | BOREHOLE No. 1 | DRAWING No. 1A

PROJECT Proposed Relaxation of Bridge,

LOCATION Hwy. 662, Rev'n North Line and Spanish River,

Project WP 86-68-02.

HOLE LOCATION AND DATUM SEE DRAWING No. 1

2" O.D. SPLIT TUBE

2" I.D. SHELBY TUBE

2" DIA. CONE

PUSHED P

VANE TEST AND SENSITIVITY (S) +S

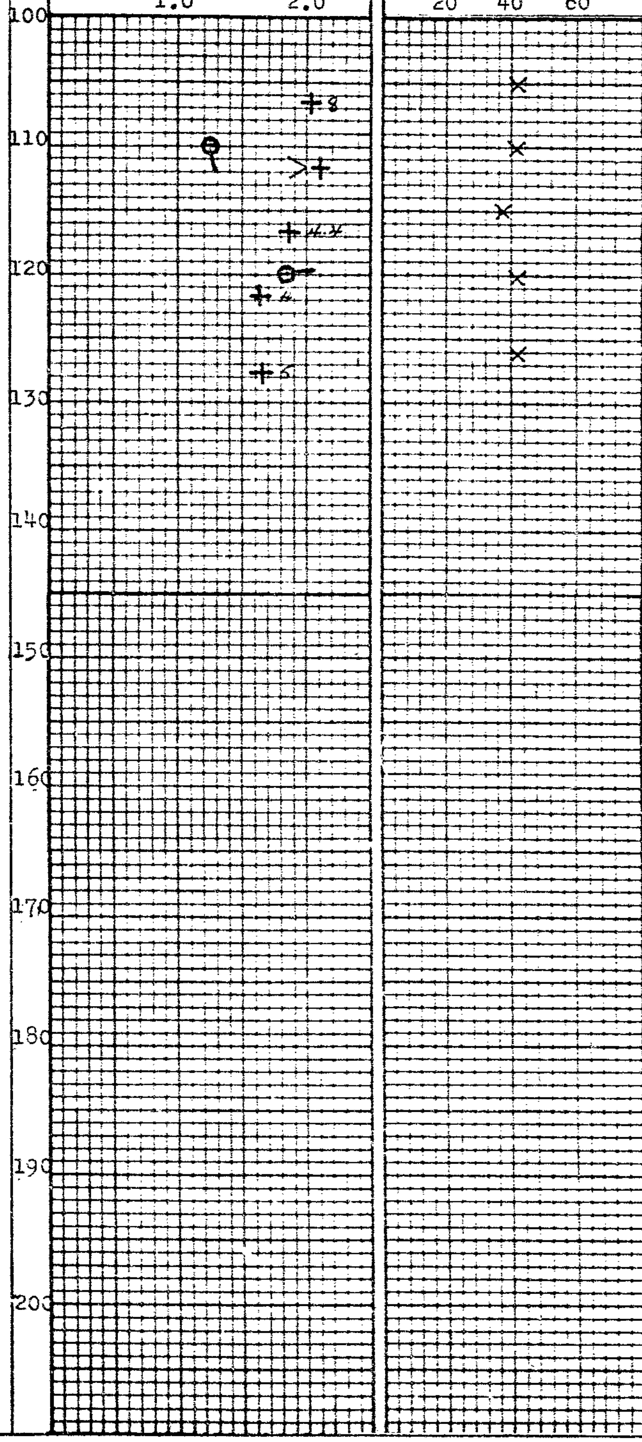
NATURAL MOISTURE X

PLASTIC AND LIQUID LIMIT

UNDRAINED TRIAXIAL AT OVERBURDEN PRESSURE

% STRAIN AT FAILURE

GWL	SYMBOL	SOIL DESCRIPTION	ELEV. FEET	DEPTH FT.	PENETRATION RESISTANCE 350 FT. LB. BLOWS FT. 20 40 60 80 / SHEAR STRENGTH K.S.F. 1.0 2.0	NATURAL MOISTURE CONTENT AND ATTERBERG LIMITS % DRY WEIGHT 20 40 60	NATURAL UNIT WEIGHT P.C.F.
		VARVED CLAY-firm, grey					110.0
							111.2
							113.0
							111.2
							113.0
		END OF BOREHOLE					



NOTES:

1) Hole cased to full depth with NX casing.

William Trow Associates Ltd.

BOREHOLE LOG

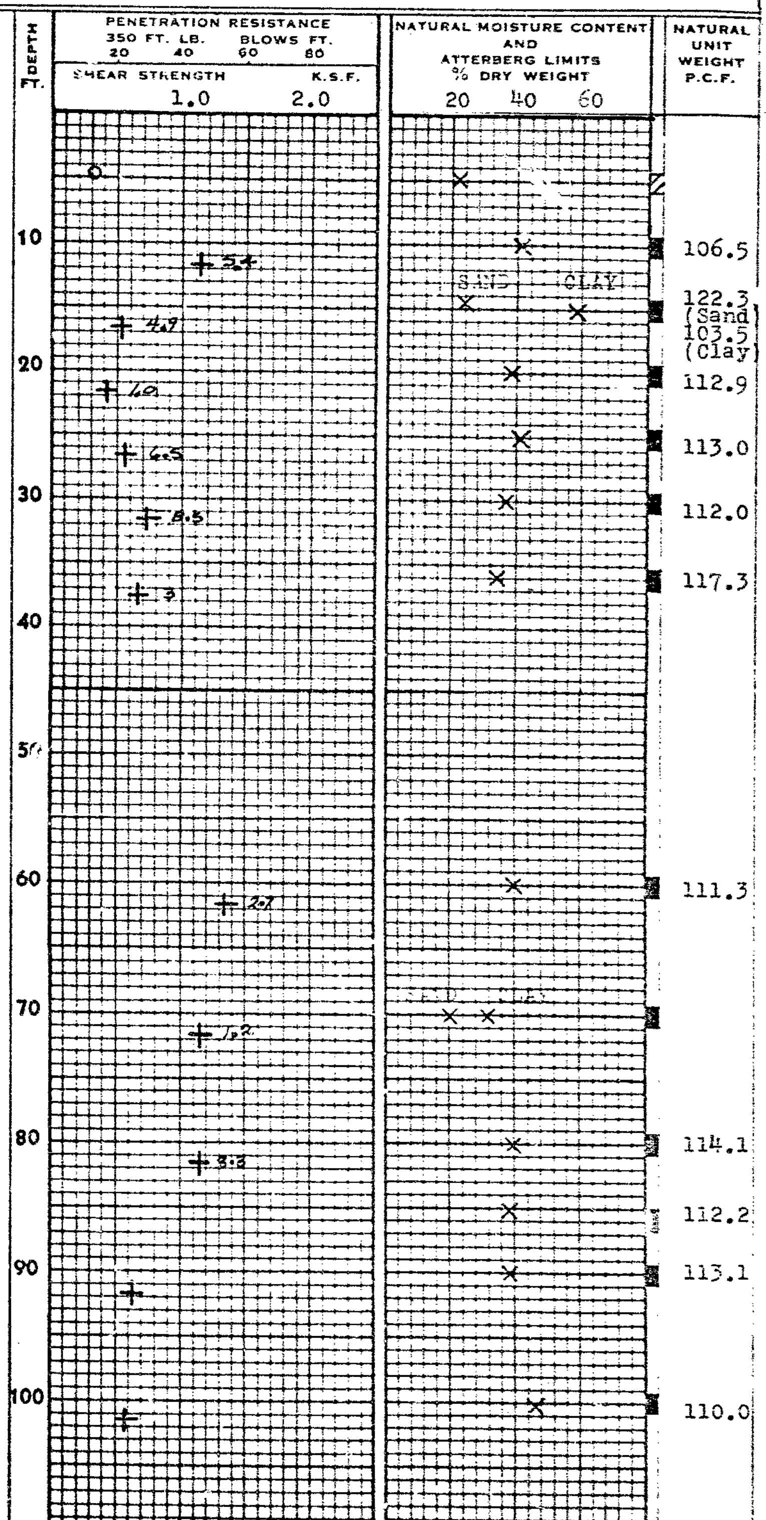
JOB No. J 5499/T 371 BOREHOLE No. 2 DRAWING No. 2

PROJECT Proposed Relaxation of Bridge,
LOCATION Hwy. 662, Rev'n North Line and
Spanish River,
Project WP 86-68-02.
HOLE LOCATION AND DATUM SEE DRAWING No. 1

2" O.D. SPLIT TUBE
2" I.D. SHELBY TUBE
2" DIA. CONE
PUSHED P
VANE TEST AND SENSITIVITY (S) + S

NATURAL MOISTURE ×
PLASTIC AND LIQUID LIMIT
UNDRAINED TRIAXIAL AT OVERBURDEN PRESSURE 0 15 5 10
% STRAIN AT FAILURE

GWL	SYMBOL	SOIL DESCRIPTION	ELEV. FEET
			677.2
		WATER	672.7
		CLAYEY SILT-soft, grey; inclusions of decomposed wood and occasional sand seams noted, organic stained.	662
		VARVED CLAY-soft to firm, grey to dark grey; varved with fat clay phase (0.1") and silty clay phase (0.2") and occasionally with lean clay phase (0.1"). Odd, thin, fine silty sand intrusions noted; alternate phases of varved clay became thicker below about 30 ft. depth.	621
		CLAYEY SILT-stiff, grey with pockets and layers of silt, fine sand seams.	604
		VARVED CLAY-firm, grey. Washed ahead below 100 ft. depth to refusal and assumed rock at 148.3 ft. depth.	



William Trow Associates Ltd.

BOREHOLE LOG

JOB No. J 5499/T 371 **BOREHOLE No.** 3 **DRAWING No.** 3

PROJECT: Proposed Relaxation of Bridge,
LOCATION: Hwy. 662, Rev'n North Line and Spanish River,
Project WP 86-68-02.
HOLE LOCATION AND DATUM SEE DRAWING No. 1

Legend	
2" O.D. SPLIT TUBE	
2" I.D. SHELBY TUBE	
2" DIA. CONE	
PUSHED	P
VANE TEST AND SENSITIVITY (S)	+ S
AS	Auger Sample
NATURAL MOISTURE	X
PLASTIC AND LIQUID LIMIT	
UNDRAINED TRIAXIAL AT OVERBURDEN PRESSURE	0, 5, 10, 15
% STRAIN AT FAILURE	

G W L	SYMBOL	SOIL DESCRIPTION	ELEV. FEET	DEPTH FT.	PENETRATION RESISTANCE 350 FT. LB. BLOWS FT. 20 40 60 80 / SHEAR STRENGTH K.S.F. 1.0 2.0	NATURAL MOISTURE CONTENT AND ATTERBERG LIMITS % DRY WEIGHT	NATURAL UNIT WEIGHT P.C.F.
			680.5				
		6 inches TOPSOIL SILTY FINE SAND-loose to compact, brown; moist to wet below 3.0 ft. depth.			+2.0		AS
			670.5	10	+3.8		AS
		VARVED CLAY-firm to soft, grey, occasional thin wet sand seam.			→		AS
				20	+4.3		AS
					+4.0		
		END OF BOREHOLE	649.5	30	+2.2		AS

NOTES:

1) Borehole advanced uncased by power auger on Nov. 3, 1969.
2) Hole open to 3.6 ft. depth and water standing at 3.4 ft. depth on completion.

Depth scale: 10, 20, 30, 40, 50, 60, 70, 80, 90, 100

William Trow Associates Ltd.

BOREHOLE LOG

JOB No. J 5499/T 371 | BOREHOLE No. 4 | DRAWING No. 4

PROJECT Proposed Relaxation of Bridge,
LOCATION Hwy. 662, Rev'n North Line and
Spanish River,
Project WP 86-68-02.
HOLE LOCATION AND DATUM SEE DRAWING No. 1

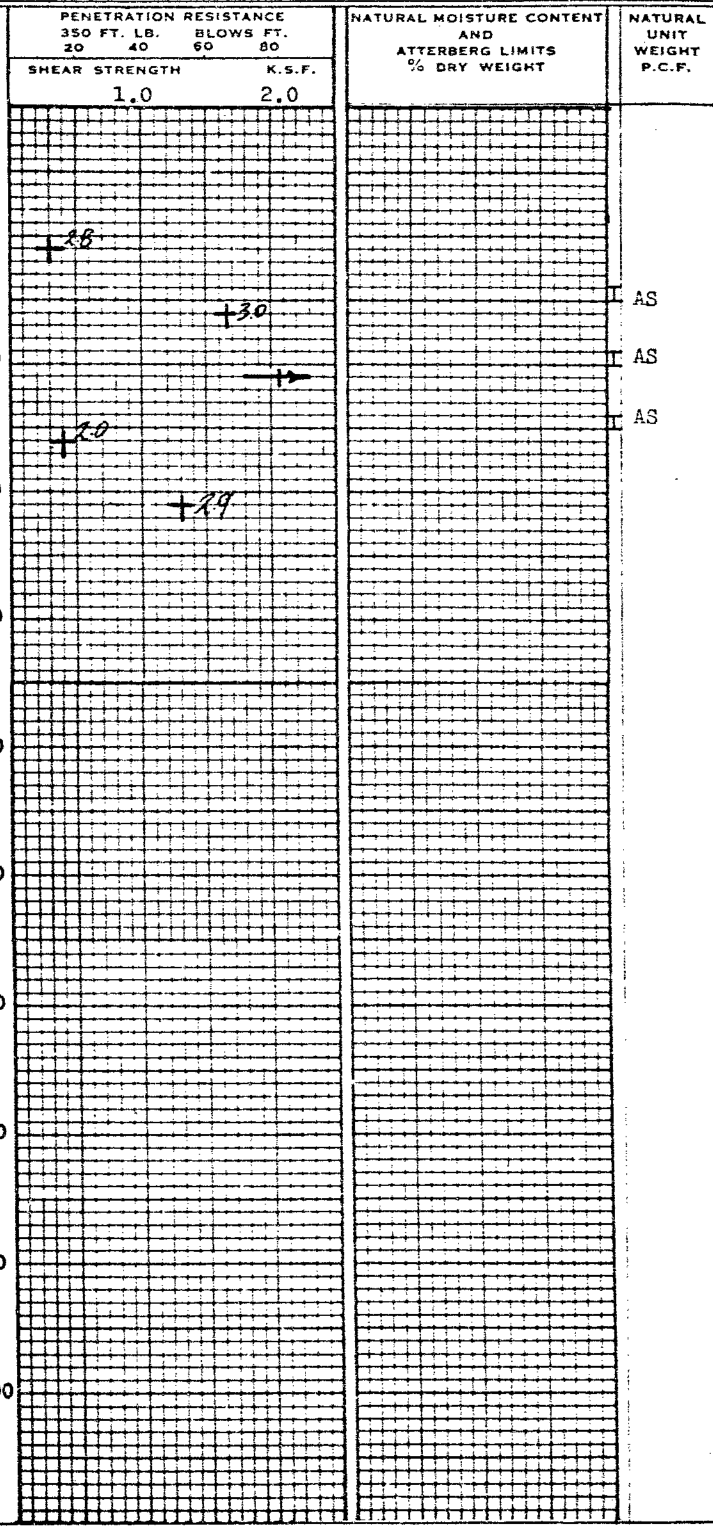
2" O.D. SPLIT TUBE
2" I.D. SHELBY TUBE
2" DIA. CONE
PUSHED P
VANE TEST AND SENSITIVITY (S) +S
AS Auger Sample

NATURAL MOISTURE ×
PLASTIC AND LIQUID LIMIT
UNDRAINED TRIAXIAL AT OVERBURDEN PRESSURE
% STRAIN AT FAILURE

G W L	SYMBOL	SOIL DESCRIPTION	ELEV. FEET	DEPTH FT.
			681.2	
		6 inches TOPSOIL SILTY FINE SAND-loose to compact, brown; moist to wet below 3.0 ft. depth.		
		VARVED CLAY-firm to soft, grey with occasional thin sand and silt seams. N.B. :Borehole caving at 12.0 ft. and 15.0 ft. depth during augering.	671	10
				20
		END OF BOREHOLE	650.2	30

NOTES:

1) Borehole advanced uncased by power auger on Nov. 3, 1969.
2) Hole open to 4.0 ft. depth and water standing at 3.7 ft. depth on completion.

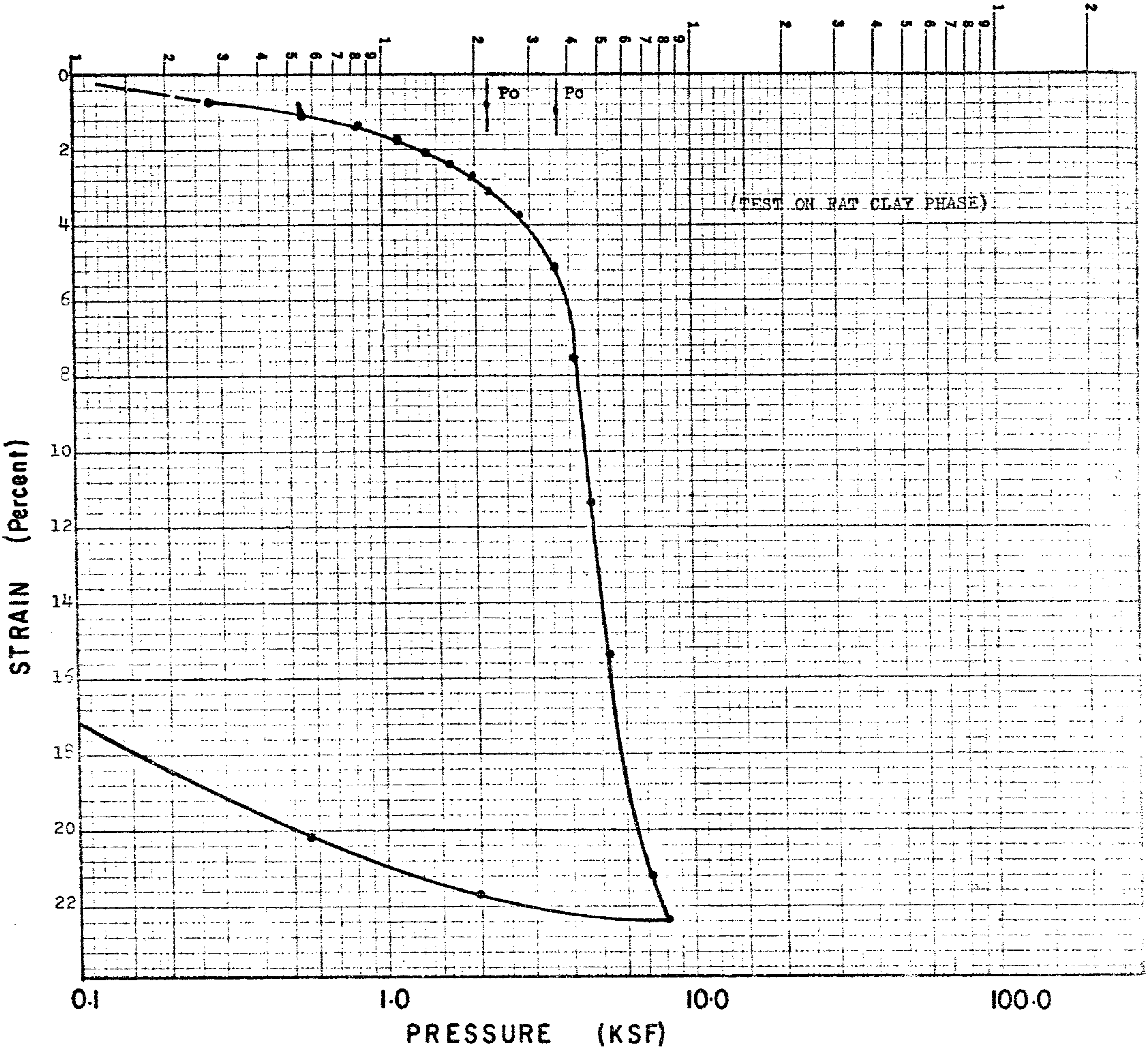


William Trow Associates Ltd.

PROJ. J 5499/T-371

DWG. Nº 5

WILLIAM TROW ASSOCIATES LIMITED
CONSOLIDATION TEST RESULTS



Borehole Nº 1/TW10

Depth 43 ft.

Moisture Content 63 %

Liquid Limit 67 %

Plastic Limit 26 %

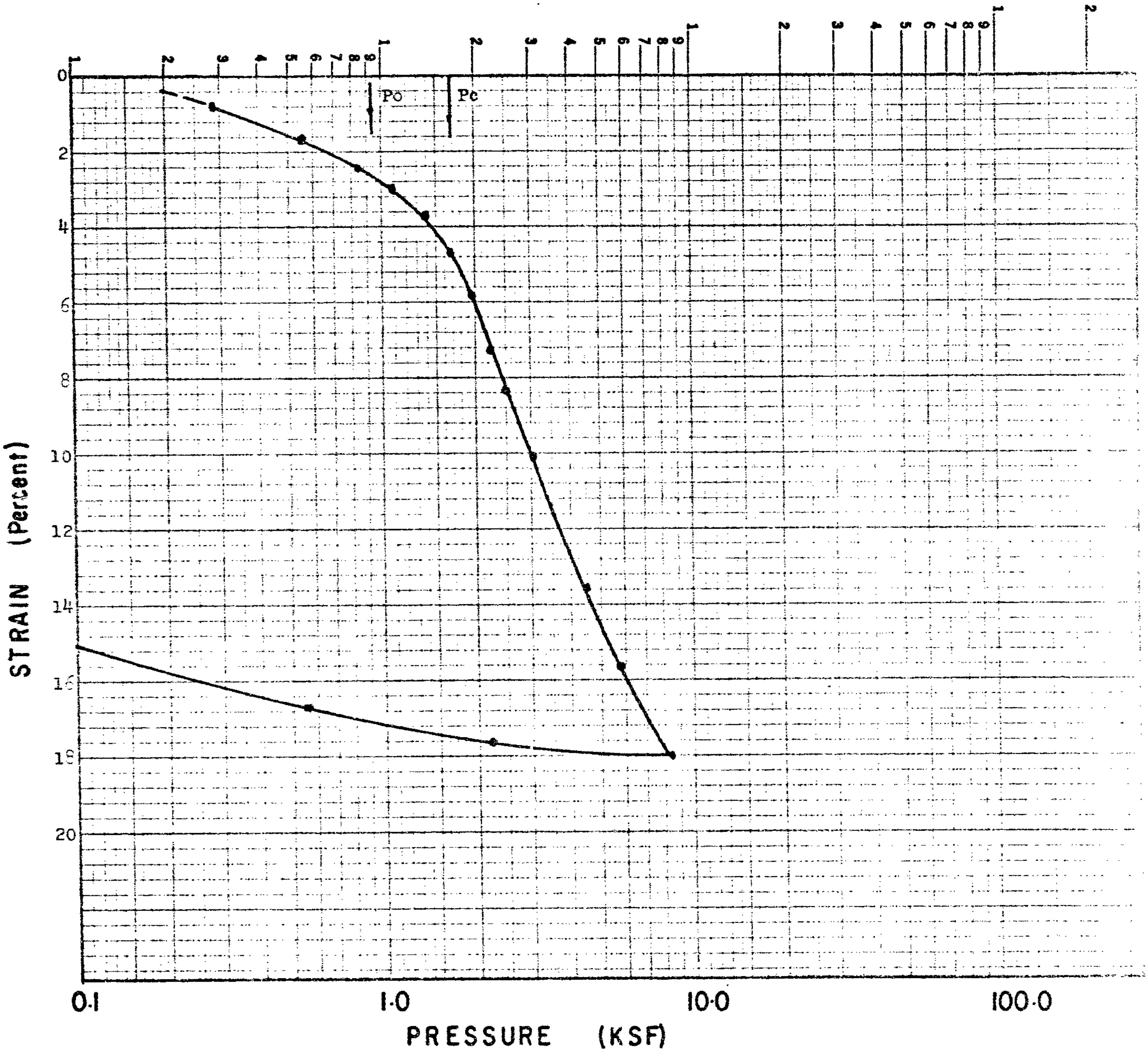
Sample Description

1 to 3 ksf = .013 sq. ft./kip.

$$Mv \quad \frac{\Delta \text{ strain}}{\Delta \text{ pressure}}$$

PROJ. J 5499/T-371 DWG. Nº 6

WILLIAM TROW ASSOCIATES LIMITED
CONSOLIDATION TEST RESULTS



Borehole Nº 1/TW5

Depth 19 ft.

Moisture Content 43 %

Liquid Limit 36 %

Plastic Limit 22 %

Sample Description

0.5 to 1.5 ksf = .025 sq. ft./kip.

$$M_v \; \frac{\Delta \text{ strain}}{\Delta \text{ pressure}}$$