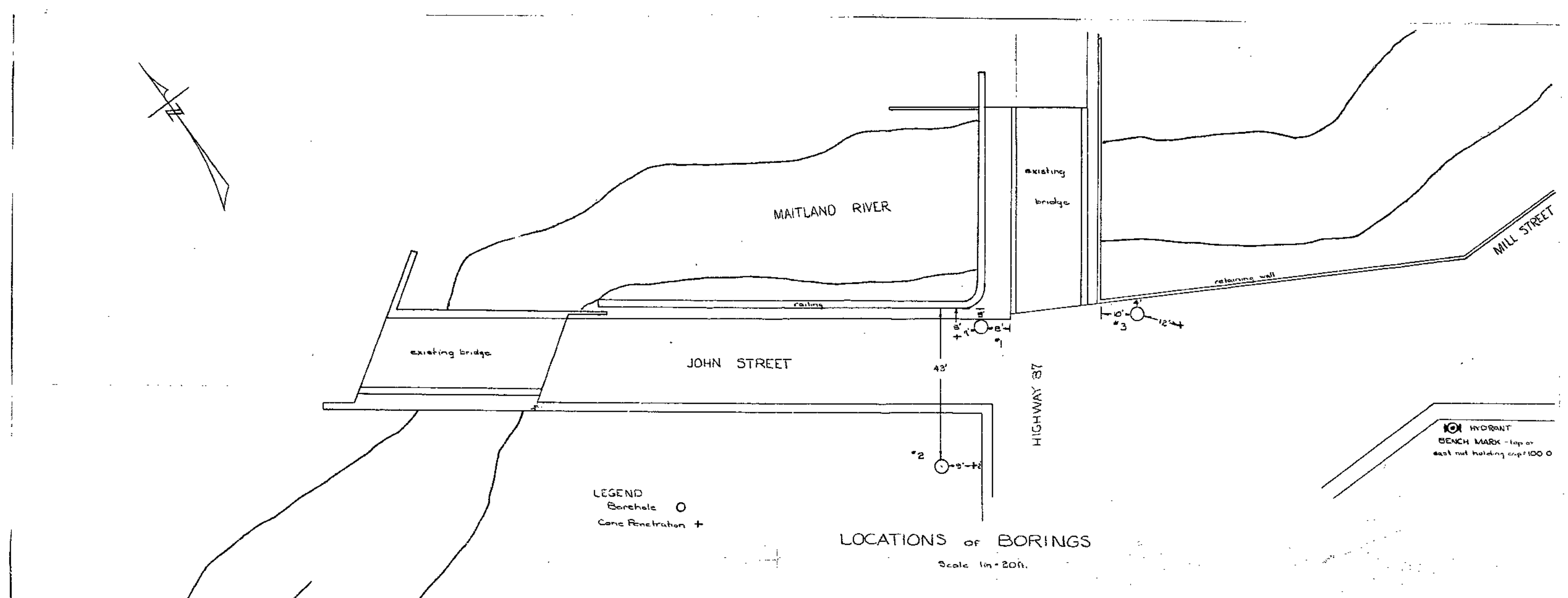
59-F-261C

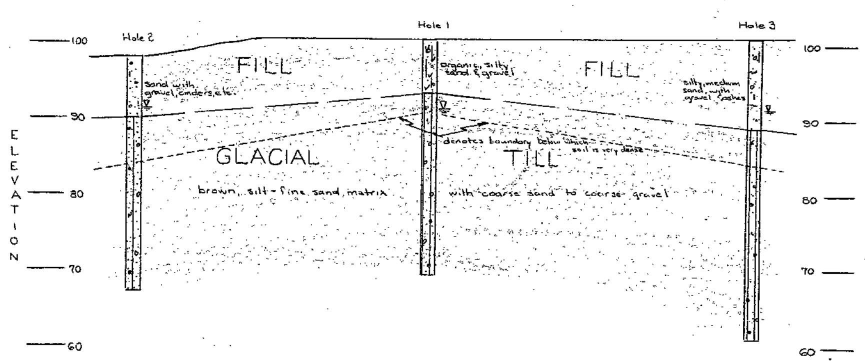
Hwy. # 87

Maitland River



LOCATIONS OF BORINGS

Scale 1in = 20ft.



ESTIMATED SUBSOIL STRATIGRAPHY

PROFILE PROJECTED BETWEEN BORINGS

Scales Hor. 1in = 10ft.
Vert. 1in = 10ft.

WILLIAM A. TROW AND ASSOCIATES

SITE INVESTIGATIONS
AND
SOIL MECHANICS CONSULTATION

W. A. TROW, M.A.S.C., M.E.I.C., P.ENG.

884 WILSON AVE.
DOWNSVIEW, ONT.
ST. 8-5921

Project: J 403

August 14, 1959.

59-F-261C

Mr. A. Rutka,
Dept. of Highways of Ontario,
Materials and Research Branch,
Parliament Buildings,
Toronto 5, Ont.

Attention: Mr. L. G. Soderman, P.Eng.,
Principal Soils and Foundation
Engineer

Foundation Investigation
New Maitland River Bridge
Highway No. 87 - Harriston, Ontario

Dear Sirs:

The enclosed report describes the soil conditions underlying the proposed bridge relocation noted above.

No foundation problem appears to exist at this location, since the soil, below an 8 foot thick stratum of loose fill, consists of an extremely dense glacial deposit of sandy silt with gravel. The permissible bearing value for this material is at least equal to 8000 p.s.f. According to field measurements in the borings, this pressure can be applied at a depth of about 18 feet below ground surface or about 8 feet below the existing river bed. However, the results of a probing in this river bed suggests that scouring has taken place to a depth of 10 feet and therefore a foundation depth 10 feet below river bed level has been recommended.

Considerable water will be encountered during excavation if the north abutment is placed in the river as presently proposed. However, this difficulty can be avoided,in large part, if the bridge site is moved a few feet to the south. A discussion of excavation methods has been given in the report.

We hope that the contents of this report provide you with sufficient information for proceeding with the design and construction of this project. Please contact us if any comments require amplification or if additional queries come to mind.

Yours very truly,

W. Trow

WAT/lt
Encl.

William A. Trow (P. Eng.)

DEPARTMENT OF HIGHWAYS OF ONTARIO
MATERIALS AND RESEARCH BRANCH
PARLIAMENT BUILDINGS, TORONTO, ONTARIO.

FOUNDATION INVESTIGATION
NEW MAITLAND RIVER BRIDGE
HIGHWAY NO. 87 - HARRISTON, ONTARIO

Project: J403 August 14, 1959.

William A. Trow and Associates

TABLE OF CONTENTS

ENCLOSURES

FOUNDATION INVESTIGATION
NEW MAITLAND RIVER BRIDGE
HIGHWAY NO. 87 - HARRISTON, ONTARIO

This report describes the soils investigation carried out at the site of a proposed bridge which is to replace two existing structures over the Maitland River on Highway 87, at Harriston, Ont. The results of this investigation are presented together with a discussion of the foundation conditions that exist. Recommendations concerning the safe bearing capacity for the bridge footings and excavation requirements for these footings have been given.

Description of Site

The Maitland River winds along a narrow, shallow ravine through the south part of the Town of Harriston. The seven foot deep ravine cuts through relatively flat terrain at the bridge location.

Drawing No. 1 illustrates the general layout of the existing roads and bridges at the crossing site. Two bridges presently span the river in this vicinity. Highway 87 is carried by a reinforced concrete plate-deck and girder structure, while John Street passes over a through-arch bridge of reinforced concrete. Both bridge structures are in an advanced state of disrepair, with much spalled concrete exposing the steel reinforcing. Portions of the guard railing have either been broken or fallen off.

The normal surface of the river is at an elevation some 7 feet below the underside of the bridges. Maximum high water level reported by a number of townspeople occurred after Hurricane "Hazel" in 1954. The river at that time reached an approximate level of one foot below the bridge and flooded the lower-lying areas adjacent to the site.

A seven foot high concrete retaining wall parallels John Street over a considerable distance as shown in the drawing. This wall also is in poor condition with large areas of spalled concrete and a number of large vertical cracks.

Photos showing the existing bridges and a portion of the retaining wall are presented with the drawings.

It is proposed that the river be diverted, causing it to pass through the existing John Street and Highway 87 intersection. One bridge structure to carry Highway 87 will be constructed at this point. The existing river course will be filled and John Street will pass over this fill to intersect Highway 87 north of the new bridge, at the approximate location of the existing highway bridge.

As presently proposed, one abutment of the new bridge will be located immediately north of the south abutment of the existing bridge. This will place it in the existing river bed. The other new abutment will be located some 50 feet to the south. The two new abutments will approximately parallel Mill Street.

Field Work

Three borings were put down at the locations shown in Dwg. 1. Standard diamond drilling equipment was used. The 2-7/8 inch casing was drilled to the required sampling depths and washed or drilled clean.

A standard 2-inch outside diameter split spoon was used to obtain samples of the soil. The sampler was driven under an energy of 350 ft.lbs. per hammer blow. The number of hammer blows required to drive the spoon from 6 inches to 18 inches penetration into the undisturbed soil ahead of the boring is recorded as the penetration resistance of the soil at this depth.

On withdrawal, the sampler was dismantled, the soil classified and then retained in moisture proof containers.

A dynamic cone penetration test was performed adjacent to each hole. This test consists of driving a 2-inch diameter 60° cone into the ground with hammer blows of 350 ft.lbs. energy. The number of blows per foot of penetration are recorded and serve to supplement the penetration values recorded during sampling.

A log for each boring has been prepared showing sampling intervals, soil types encountered and penetration resistance values. The logs are presented as Dwgs. 2, 3 and 4.

Water levels in the borings during their advance and on completion were recorded. The stable water level at each location is shown on the logs.

One probing was carried out in the river bed near the bridge on Highway 87. The results of this test are presented in Dwg. 5.

Soil Types Encountered

The natural ground of the area is evidently a granular glacial deposit with a density varying from medium dense near the surface to very dense after a very few feet of penetration below the ground. Classification of this material is "a sandy silt containing coarse sand and gravel sizes". The results of a mechanical sieve analysis on four samples of this glacial till are presented in Dwg. 6. An hydrometer analysis was carried out on one of these samples and is also reported in Dwg. 6.

Overlying the glacial till is a loose deposit of sand and gravel containing foreign matter such as wood, ashes, glass, etc. This is evidently fill material placed after construction of the existing bridges. Dwg. 1 contains a subsoil profile projected between borings. The depth, below which the soil is very dense, is shown as a dotted line across the profile.

The water table of the area investigated can be considered to be at river elevation.

The probe put down in the river showed loose material extending to a depth of 10 feet. The soil becomes dense at 12 feet.

Foundation Considerations

In general, the foundation conditions at this site are quite satisfactory for the direct support of abutment footing loads. According to the results of the three borings, very dense granular glacial till exists at depths ranging from 9 to 18 feet below the existing road surface or at a maximum of about 8 feet below the surface of the river. The safe bearing value to apply on this dense soil is at least equal to 8000 p.s.f. Settlement should be immediate with load application and should not exceed one inch under this pressure.

Although a depth of 8 feet below the river surface is indicated from the borehole results, this foundation level may not provide sufficient protection against river scour. This opinion is based upon the results of the probing made in the existing river bed. In three attempts to determine the probable depth of re-sorted river bed deposits, two encountered refusal, at shallow depth, on boulders, and the third test was taken to a depth of 12 feet, through 10 feet of loose to medium dense granular material. It was concluded from this test that river scour, at some time, has penetrated to a depth of 10 feet. Therefore footings for the new bridge must be carried down to this level, or to approximate elevation 81 feet. This will involve footing excavations 10 feet below the present river surface.

According to present design proposals, part of the north abutment of the proposed bridge replacement will be located in the bed of the existing stream. The excavation for this abutment footing must pass through about 10 feet of loose permeable granular deposits before competent glacial till is encountered. A considerable flow of water into the footing trench can be anticipated while this is being done.

Three alternatives appear to be available for dealing with this problem. One of these is to carry out the excavation work and placement of concrete underwater. By this method, there should be no danger of a "quick sand" condition developing in the footing bed because the water level at all times will be in balance. Some uncertainty will exist concerning concrete placement conditions and numerous probings will be required to ensure that no significant depth of loose soil has sloughed into the excavation. Some loose material, up to a thickness of about 2 inches, can be tolerated provided that a 6 inch layer of coarse gravel is placed on it prior to the installation of concrete. The excavation for this proposal can be sheeted or left unsupported. In the latter circumstance, a much larger volume of soil must be removed in order to ensure that the slopes of the cut lie well beyond the footing bed. Because of space limitations, some type of sheeted excavation would appear to be preferable.

Another alternative, which will permit the dewatering of the excavation and examination of the footing bed prior to the placement of concrete, involves the use of interlocking steel sheet piling. This piling should be driven around the perimeter of the excavation to a depth at least 5 feet below final excavation level, or about 15 feet below the surface of the river; this requirement is to avoid a "quick" condition of the dense fine-grained silty sand glacial till when the excavation is dewatered. Wherever possible, the piling should be driven without resorting to jetting methods, so that a tight seal with the natural soil will be obtained.

If all the piles are advanced at approximately the same time, there should be less danger of separation at the interlocks than if each pile is driven to the required depth well ahead of adjacent piles. If it is necessary to jet the piles into this dense till, a permeable channel may develop immediately adjacent to them. As a consequence, a piping condition may develop along the inside perimeter of the sheeting as the water in the excavation is pumped out. It should be possible to prevent the removal of fines from the soil in this circumstance by placing a filter consisting of a 6 inch layer of concrete sand and then a layer of medium gravel over any unstable area.

A third alternative, which would circumvent the problems of placing the abutment footing through loose river bed material, would be to move the bridge site a few feet farther south. If the north abutments of the new bridge were to be placed south of the existing retaining wall, approximately in the line of borings 1 and 3, excavation work would be almost entirely in the medium dense to dense till. Either the existing concrete wall or a shallow cut-off clay seal would prevent water from entering through the one-to-two feet of loose material found below the water table at the Hole 3 location.

In regard to this last proposal, accepted excavation practice in sandy silt soils, such as the till material underlying this site, calls for the installation of a well-point system to lower the ground water prior to excavation. This requirement is necessary in order to maintain this fine grained soil in a stable state as the digging operations proceed below the water table. The results of the mechanical analyses tests on representative till samples from this site are shown in Dwg. 6, together with the grading limits of soils in which successful well-point installations have been made. Three of the four samples tested show an appreciable silt content and exhibit similar gradations. Sample No.3 of Hole 1 contained a large amount of gravel sizes. The sandy silt that surrounds the pieces of gravel in this latter case appears very similar to the soil of the other samples. It is felt, therefore, that the drainage characteristics of soil typified by sample 3 of Hole 1 will correspond to the soil of the other samples. The information in Dwg. 6 therefore suggests that a vacuum well-point system will be necessary to lower the ground water effectively.

The foregoing remarks are based entirely upon the grain size of this glacial till. In this discussion of excavation problems, consideration should be given also to the high relative density of the till. Because the sandy silt is very dense, its permeability must be lower than would be indicated by the grading curves. It is possible, therefore, that the excavations for both abutment footings can be taken to a depth of 10 feet below river bed level without difficulty from ground water, provided that they are located well back from the existing river. Some shoring of the trench may be required however, and it may be necessary to direct seeping water to a sump where pumping can be carried out. Should any instability of the bottom of the excavation become evident during digging, a vacuum well-point system would have to be installed. The trench should be filled with water while the necessary installation arrangements are being made. Since this work can be done at any time, it would appear that an initial attempt to excavate without well-points would be warranted.

Should well-points be found necessary, 8-inch diameter holes should be drilled around the perimeter of the excavation at 2½-foot centres to a depth of at least 5 feet below the proposed footing elevations. A perforated well-point should be placed in each hole and surrounded with a filter of concrete sand carried close to the top surface of the till. Water under very low pressure should be pumped through the well-point screen as the sand filter is placed, and the well-point should be moved up and down slightly in order to assist the movement of the sand into the hole.

A clay or bentonite slurry should be placed in the hole over this sand in order to provide a seal against air leaks. This seal should be about 3 feet thick. Once a vacuum is created in the system, the water table should be lowered sufficiently in a period of about two weeks, or less. The lowering of the water table should be recorded in at least two observation wells left open to the atmosphere.

Excavation of the new south abutment can be carried out by any of the methods indicated above. Less water should be anticipated at this location.

Summary of Comments and Conclusions

1) Very dense sandy silt with gravel till will be the foundation soil for the proposed bridge structure. A safe bearing value of 8000 p.s.f. is recommended for spread footings.

2) Deep footing excavations will be required to prevent undermining by river scour. A minimum footing elevation of 10 feet below proposed river bed elevation is recommended.

3) Steel sheet piling driven 5 feet below footing level appears to be the most positive means of enclosing the excavation area. Economics may warrant the consideration of other less positive but probably equally satisfactory solutions to the control of ground water. These proposals are discussed in the report.

4) If the north abutment is placed in the existing river as presently proposed, considerable water, flowing from the loose granular material below river bed level, will be encountered. If the bridge site is moved a few feet farther south, this water problem can be avoided to a considerable degree.

5) The granular fill material, overlying the till and comprising the first 8 feet of soil at the site, exists in a relatively loose condition and is essentially above the water table. This material can be removed without difficulty.

REGISTERED PROFESSIONAL ENGINEER
D. H. SHIELDS
PROVINCE OF ONTARIO

Donald H. Shields (P. Eng.)

DHS/lt
August 14, 1959.
J 403

PROJECT NO. J 403

DRAWING NO. 2

WILLIAM A. TROW & ASSOCIATES

SITE INVESTIGATIONS AND SOIL MECHANICS CONSULTATION

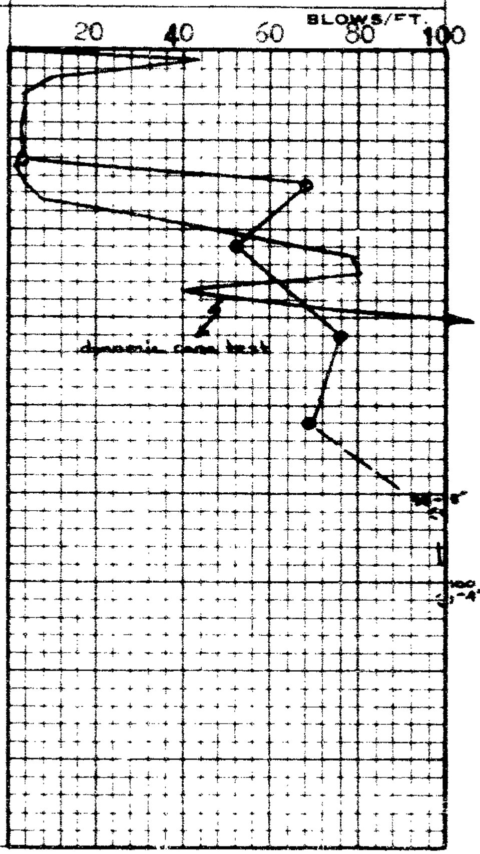
LEGEND
- 2" DIA. SPLIT TUBE
- 2" SHELBY TUBE
- 2" SPLIT TUBE
- 2" DIA. CONE
- CASING
- 2" SHELBY
- 1/2 UNCONFINED COMPRESSION (Qu)
- VANE TEST (C) AND SENSITIVITY (S)
- NATURAL MOISTURE AND LIQUIDITY INDEX
- LIQUID LIMIT
- PLASTIC LIMIT

PROJECT Bridge Replacement
LOCATION Hwy. 87, Harriston, Ont.
HOLE LOCATION See Dwg. 1
HOLE ELEVATION AND DATUM 100.7 – from most easterly nut on cap of nearby hydrant – 100.0

BOREHOLE NO. 1
FIELD SUPERVISOR
DRILLER
PREP.

SYMBOL	DESCRIPTION	ELEV. FEET	DEPTH FEET	SAMPLE	NATURAL UNIT WT. P.C.F.
		100.7	0		
	Fill: silty, organic sand and gravel.			1	No recov.
	Glacial Till – brown silt-fine sand matrix surrounding coarse sand to coarse sand to coarse gravel – very dense. (W.T. [illegible])	93.7	10	2, 3	
			20	4, 5	
			30	6, 7	
	End of hole	69.4	40		

STRENGTH AND PENETRATION RESISTANCE — P.S.F. — BLOWS/FT.



CONSISTENCY — MOIST. CONTENT – % DRY WT.

NOTES: 1) [illegible] casing drilled to sampling depth.
2) Water level after 14 hrs., hole caved to 1[illegible]' = [illegible].4'
3) Hole caved and dry to [illegible]', 12 hrs. after completion.
4) 2 in. diam. cone and [illegible]" diam. split spoon driven with 140 lb. hammer dropping 30 ins.

PROJECT NO J 403

DRAWING NO. 3

WILLIAM A. TROW & ASSOCIATES

SITE INVESTIGATIONS AND SOIL MECHANICS CONSULTATION

LEGEND

- 2" DIA. SPLIT TUBE
- 2" SHELBY TUBE
- 2" SPLIT TUBE
- 2" DIA. CONE
- CASING
- 2" SHELBY
- 1/2 UNCONFINED COMPRESSION (Qu)
- VANE TEST (C) AND SENSITIVITY (S)
- NATURAL MOISTURE AND LIQUIDITY INDEX
- LIQUID LIMIT
- PLASTIC LIMIT

PROJECT Bridge Replacement

LOCATION Hwy. 87 Harriston Ont.

HOLE LOCATION See plan

HOLE ELEVATION AND DATUM 98.1 - from most easterly nut on cap of nearby hydrant - 100.0

BOREHOLE NO. 2

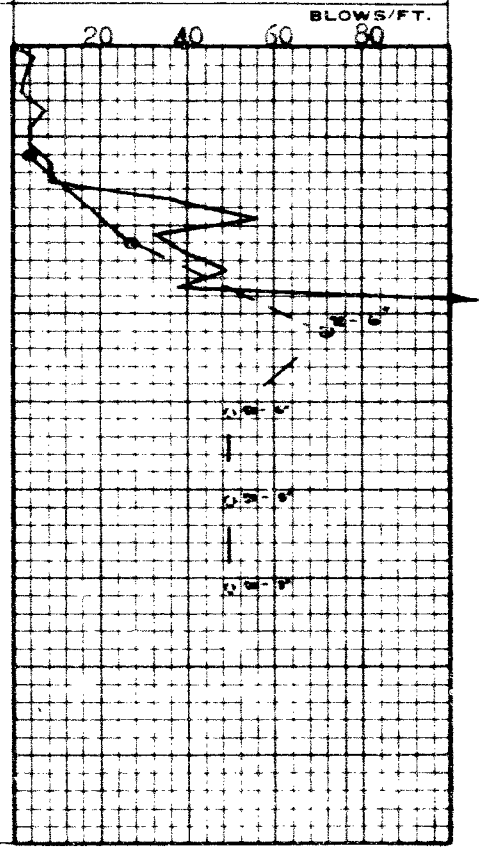
FIELD SUPERVISOR

DRILLER

PREP.

SYMBOL	DESCRIPTION	ELEV. FEET	DEPTH FEET	SAMPLE
		98.1	0	
	Fill - brown sand with gravel, cinders and tile pieces. W.T. ▽ 91.2			1
	Glacial Till - brown silt-fine sand matrix surrounding coarse sand to coarse gravel. -very dense below 14 ft.	90	10	2
				3
			20	4
				5
	End of hole	67.3	30	6
			40	

STRENGTH AND PENETRATION RESISTANCE — P.S.F. — BLOWS/FT.



CONSISTENCY — MOIST. CONTENT - % DRY WT.

NATURAL UNIT WT. P.C.F.

NOTES: 1) BX casing drilled to sampling depth.
2) Water level recorded in uncased hole 15 hrs. after completion = 6.9'
3) 2 in. diam. cone and 2 in. diam. split spoon driven with 140 lb. hammer dropping 30 ins.

PROJECT NO. J 403

DRAWING NO. 4

WILLIAM A. TROW & ASSOCIATES

SITE INVESTIGATIONS AND SOIL MECHANICS CONSULTATION

LEGEND

- 2" DIA. SPLIT TUBE
- 2" SHELBY TUBE
- 2" SPLIT TUBE
- 2" DIA. CONE
- CASING
- 2" SHELBY
- 1/2 UNCONFINED COMPRESSION (Qu)
- VANE TEST (C) AND SENSITIVITY (S)
- NATURAL MOISTURE AND LIQUIDITY INDEX
- LIQUID LIMIT
- PLASTIC LIMIT

PROJECT Bridge Replacement

LOCATION Hwy. 87, Harriston, Ont.

HOLE LOCATION See Plan

HOLE ELEVATION AND DATUM 100.9 from most easterly nut on cap of nearby hydrant - 100.0

BOREHOLE NO. 3

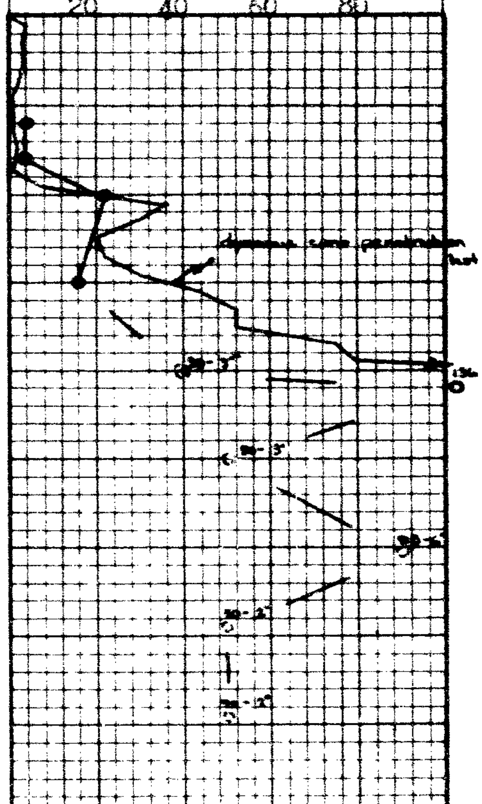
FIELD SUPERVISOR

DRILLER

PREP.

SYMBOL	DESCRIPTION	ELEV. FEET	DEPTH FEET
		100.9	0
	Fill - silty, mainly medium sand with gravel, silty, grey to brown with ashes. W.L.		10
	Glacial Till - brown, silt-fine sand matrix surrounding coarse sand to coarse gravel - very dense below 17 feet.	89	20, 30
	End of hole	61.1	40

STRENGTH AND PENETRATION RESISTANCE — P.S.F. — BLOWS/FT. 20 40 60 80



CONSISTENCY — MOIST. CONTENT - % DRY WT.

SAMPLE		NATURAL UNIT WT. P.C.F.
1	No recov.	
2	"	
3		
4		
5	No recov.	
6		
7		
8	No recov.	
9	No pene.	
10	No recov.	
11	"	
12	No pene.	
13	No recov.	

NOTES: 1) BX casing drilled to required sampling depth.
2) Water level recorded in uncased hole after 2 days, = 9.4 ft.
3) 2 in. diam. cone and 2 in. diam. split spoon driven with 140 lb. hammer dropping 30 ins.

PROJECT NO. J 403

DRAWING NO. 5

WILLIAM A. TROW & ASSOCIATES

SITE INVESTIGATIONS AND SOIL MECHANICS CONSULTATION

PROJECT: Bridge Replacement

LOCATION: Hwy. 87 Harriston, Ont.

HOLE LOCATION: See plan

HOLE ELEVATION AND DATUM: 90.5

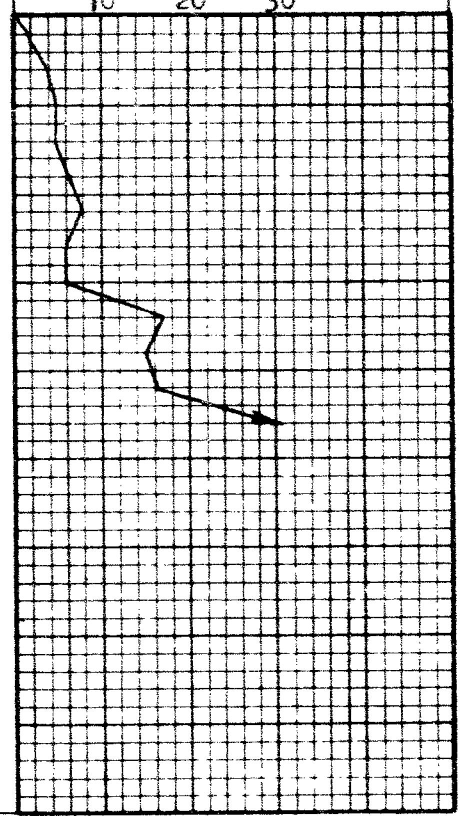
BOREHOLE NO.: Probing A

FIELD SUPERVISOR:

DRILLER:

PREP.:

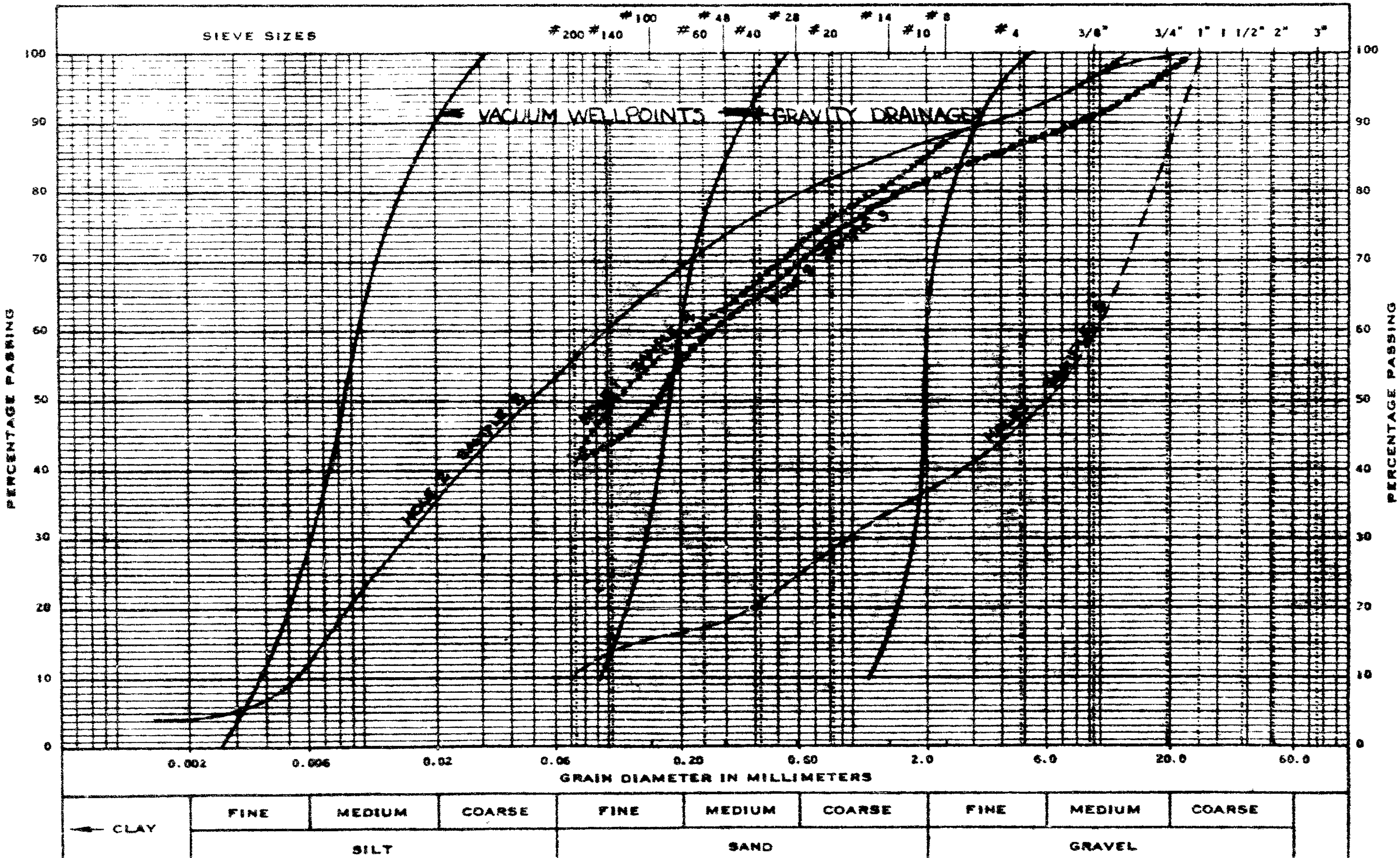
LEGEND
- 2" DIA. SPLIT TUBE
- 2" SHELBY TUBE
- 2" SPLIT TUBE
- 2" DIA. CONE
- CASING
- 2" SHELBY
- 1/2 UNCONFINED COMPRESSION (Qu)
- VANE TEST (C) AND SENSITIVITY (S)
- NATURAL MOISTURE AND LIQUIDITY INDEX
- LIQUID LIMIT
- PLASTIC LIMIT

SYMBOL	DESCRIPTION	ELEV. FEET	DEPTH FEET	STRENGTH AND PENETRATION RESISTANCE P.S.F. / BLOWS/FT. (10, 20, 30)	CONSISTENCY / MOIST. CONTENT - % DRY WT.	SAMPLE	NATURAL UNIT WT. P.C.F.
		90.5	0				
	- 1½ inch rod driven from river bed under existing Hwy. 87 bridge. - recorded blows per foot are number of equivalent 350 ft. lb. energy hammer blows.		10 20				

Project: J 403

Dwg. No. 6

MECHANICAL ANALYSIS

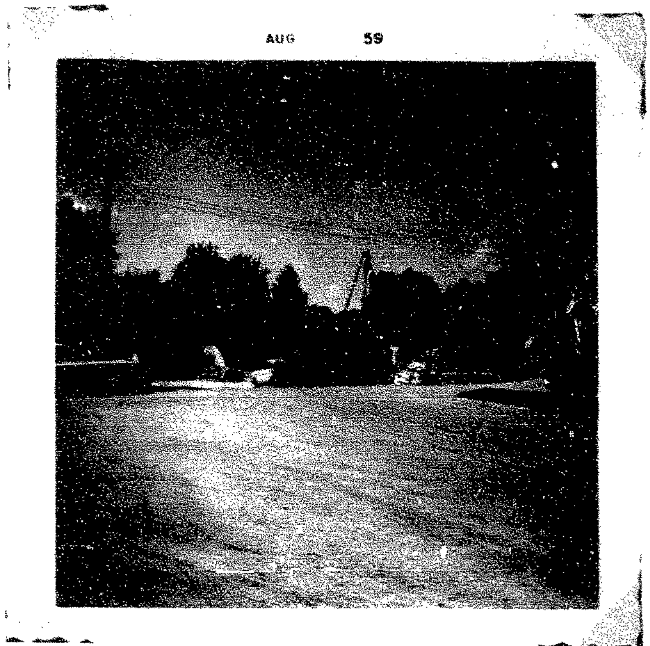


MODIFIED M.I.T. CLASSIFICATION

Delineating limits of soil - dewatering methods from Fig. 14-14 "Soil Mechanics, Foundations and Earth Structures" - Tschebotarioff

Samples of Till from Harriston

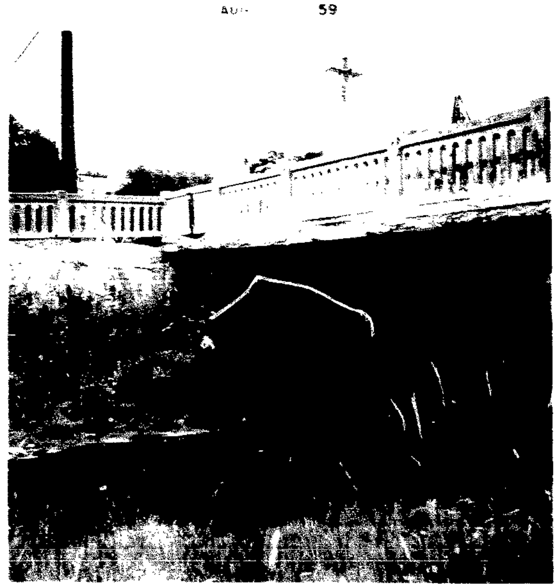
WILLIAM A. TROW AND ASSOCIATES



New Bridge to be located in centre of photograph.
Existing Hwy. 87 bridge to right; John St. bridge in background.

East side of Hwy. 87 bridge, looking towards south abutment.

New Bridge to be located in centre of photograph.
Existing Hwy. [illegible] bridge to right; John St. bridge in background.



East side of Hwy. [illegible] bridge, looking towards south abutment.

West abutment of John St. Bridge, looking North.
Note scour under north wing wall.

North corner of east abutment of John St. Bridge.
Retaining wall extends to Hwy. 87 Bridge on left.

West abutment of John St. Bridge, looking North.
Note scour under north wing wall.

North corner of east abutment of John St. Bridge.
Retaining wall extends to Hwy. 87 Bridge on left.