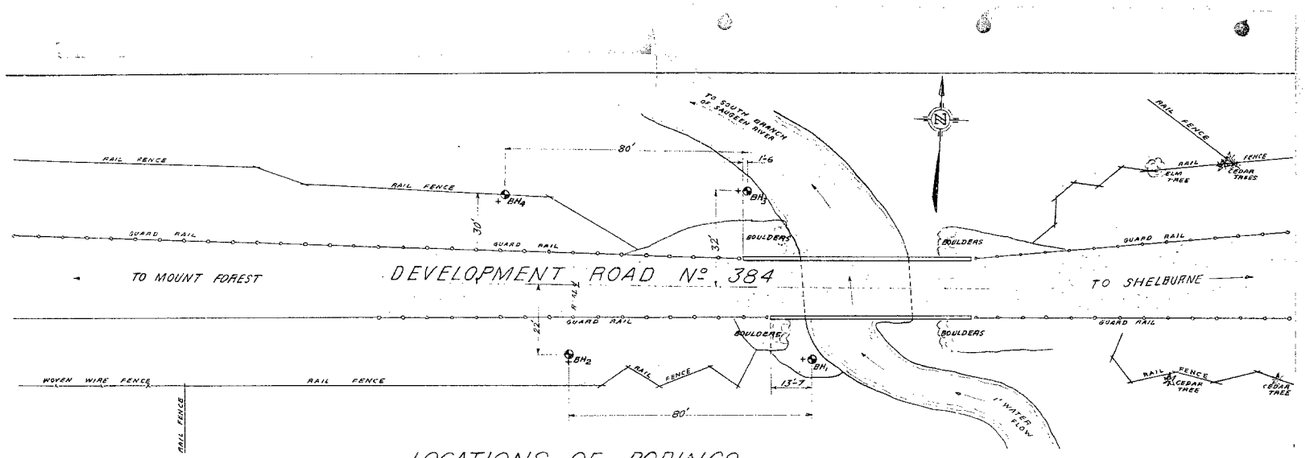
59-F-257C

W.P. 729-56

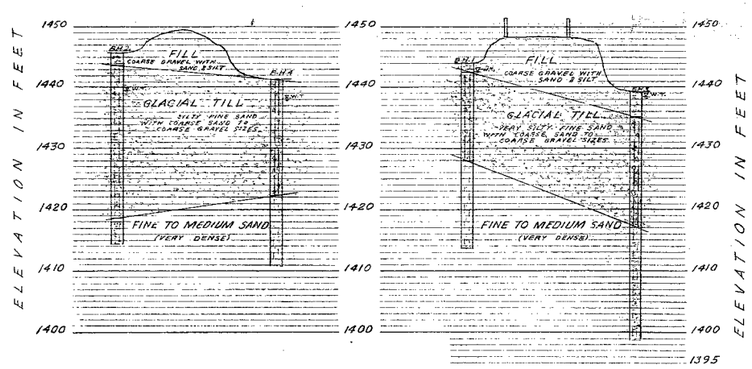
HWY. # 89

SAUGEEN RIVER BRANCH



LOCATIONS OF BORINGS

SCALE 1IN=20FT



HOLES Nº 2 & 4 HOLES Nº 1 & 3

ESTIMATED SOIL PROFILES

HORIZONTAL 1IN=20FT VERTICAL 1IN=10FT

LEGEND

- ● BORE HOLE
- + CONE HOLE

BRIDGE SITE

4 MI APPROX. EAST OF MOUNT FOREST

ON DEVELOPMENT ROAD 384

William A Trow & Associates

Site Investigation & Soil Mechanics

Consultants

August 13 1959

ONTARIO

DEPARTMENT OF HIGHWAYS

Memo to Mr. A. M. Toye,

Bridge Engineer.

From Materials & Research Section.

Date September 3, 1959.

Subject Re: Saugeen River Branch - Approx. 4 Mi. East of Mt. Forest, W.P. 729B-56, Dist.#5, Dev. Rd. #384.

PRESENT Hwy #89

Attention: Mr. S. McCombie.

The foundation report submitted by W. A. Trow & Associates, concerning the above site, has been reviewed by the Foundation Section. Our review of this report has resulted in the following comments:-

(1) The spread footings should be placed at elevation 1429' with an allowable load of 4 tons/sq. ft. as indicated in the report, unless hydrology information indicates otherwise. If the hydrology report states that the footings may be placed above this elevation, the footings may be placed at 1431' provided that all loose pockets of material under the footings are removed. An allowable bearing capacity of 4 tons/sq. ft. can be used at this elevation (1431'). Due to the soil type encountered, refusal depth for steel 'H' piles is difficult to determine. If, for any reason, steel 'H' piles must be driven, the Foundation Section should be contacted before design is undertaken.

(2) Open excavation and underwater placing of concrete may prove difficult and should be avoided if possible. An alternative method of placing footings, would be to drive sheet piles, as recommended by the Consultant. Little difficulty should be encountered in driving these piles provided that the upper layer of bouldery fill is removed prior to driving operations. Care should be taken that the sheet piles are a minimum of 5 ft. below foundation level. The well-point method of dewatering as suggested by the Consultant, is a second alternative but, due to the cost involved and the vacuum system required, this may prove uneconomical.

If any further information regarding the contents of this report is required, please contact our office.

L. G. Soderman,
PRINCIPAL SOILS & FOUNDATIONS ENGR.
per:

K. Peaker.

(K. Peaker,
Foundation Field Supervising Engr.)

cc: Messrs. A. M. Toye
H. A. Tregaskes
D. G. Ramsay
A. Gater
E. J. Orr
P. F. Weber
Fdn. Section
Gen. Files

ONTARIO

DEPARTMENT OF HIGHWAYS

Memo to Mr. A. M. Toye, Bridge Engineer.

From Materials & Research Section, (Foundations Office).

Date March 29, 1961.

Subject Re: Cont. 61-40, Smith-Saugeen River Bridge, Dev. Rd. 384, Dist. 5.

PRESENT HWY# 89

Attention: Mr. A. E. McKim, Bridge Control Engr.

In reply to your memo, dated March 27/61, we would like to make the following comments:-

In the recommendations for the above mentioned bridge, spread footings with a safe bearing load of 4.0 T/sq.ft., were suggested. Because of some reasons not presently known to us, the designer has chosen steel 'H' piles (14-BP-73) for the support of the piers and abutments. On Drawing No. D-4452-1, these piles are shown, but no tip elevations are given.

The soil through which these piles should be driven is very dense, as illustrated by the refusal to driving of the dynamic cone between elevations 1428 and 1433. The recorded 'N' values below these elevations are mostly in excess of 100 blows. A glacial till forms the upper layer down to approximately elevations 1413 to 1422. Below, a layer of very dense fine to medium sand of undetermined depth is encountered.

The problem with piles in such materials, is how to drive - i.e., how to get them down to the required depth.

Because of the very flat grain size distribution curve of the till material, it is questionable whether jetting would be of any help. Driving piles without any additional help, could lead to buckling and damaging of the piles.

It would appear that pre-drilling would be the best solution in this particular case. Displacement piles would be more suitable because they would fit much better into the pre-drilled boreholes, and there would be no open spaces left that would undoubtedly have to be filled up upon completion of driving.

cont'd. /2 ...

OVER

It is believed that the boreholes within the till stratum would not cave in, and the whole operation could be completed satisfactorily. The boring should be carried down to about 3 - 4 feet above the desired tip elevation and the pile then driven for these 3 - 4 feet. If the design would call for a considerable pile length within the sand layer and the borings would be caving-in in this material, jetting could be resorted to and no problem is anticipated in getting the pile to the desired elevation. Here again, jetting should be stopped at a distance of a few feet above the required tip elevation and the pile driven for this distance without the help of jetting.

The above suggested construction procedure will probably have to be adjusted according to the experience gathered during the progress of the work.

L. G. Soderman,
PRINCIPAL FOUNDATION ENGR.
Per:

A G Stermac

(A. G. Stermac,
SUPERVISING FOUNDATION ENGR.)

AGS/MdeF

cc: Foundations Office
Gen. Files.

The pile driving can be stopped if within the last 2 ft 5 blows/in penetration with no driving energy of using the diesel hammer developing not less than 22000 ft lb (fire equivalent steam)

BA 937

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 406

August 14, 1959.

59-F-257C

W.P. 729 -56
CONTRACT 61-40
59-F-257C

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

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

Foundation Investigation
Proposed Replacement Bridge
Development Road No. 384, 4 Miles East of Mt. Forest
PRESENT HWY # 89

Dear Sirs:

Enclosed herewith is our report on the soil conditions encountered at the site noted above.

Dense sandy silt with gravel and cobbles underlies the proposed site for this bridge, which will be about 80 feet to the west of the existing structure. Simple abutment footings can be used for bridge support and the recommended safe bearing value is 8000 p.s.f. This pressure can be applied at or below a depth of 9 feet below the existing creek surface.

Although the possibility of river bed scour to this depth appears remote, some rip rap protection should be provided in the form of stones up to about 18 inches in diameter. The banks of approach fill immediately adjoining the abutments should receive similar protection.

The excavations for the abutments will be made in soil that could become unstable as digging operations proceed below the water table. Suggested alternatives for dealing with this problem have been given.

We hope that the information enclosed herein is sufficient for your design purposes. If we can be of assistance in amplifying any statements or in answering other queries that come to mind, please do not hesitate to contact us.

Yours very truly,

W. Trow

William A. Trow (P. Eng.)

WAT/lt
Encl.

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

FOUNDATION INVESTIGATION
PROPOSED REPLACEMENT BRIDGE
DEVELOPMENT ROAD NO.384, 4 MILES EAST OF MT.FOREST
PRESENT HWY # 89

Project: J 406 August 14, 1959.

William A. Trow and Associates

TABLE OF CONTENTS

ENCLOSURES

FOUNDATION INVESTIGATION
PROPOSED REPLACEMENT BRIDGE
DEVELOPMENT ROAD NO.384, 4 MILES EAST OF MT.FOREST

This report covers the soils investigation carried out to determine the foundation conditions existing at the site of a proposed replacement of a bridge located about 4 miles east of Mt. Forest, on Development Road 384. The results of the investigation are presented and recommendations are made regarding the safe bearing value for spread footings. Problems associated with excavation for the bridge abutments are discussed in detail.

Description of Site

A small creek winds along the bottom of a valley which is about 20 feet deep and 300 feet wide at the proposed bridge location. The existing bridge is a reinforced concrete plate-deck and girder structure with a clear opening 36 feet wide and about 8 feet high. The concrete of this structure is badly deteriorated and the guard rails have been damaged. The south west bank of the river has been paved with concrete and field stone in order to control erosion, but this protective course has been undermined.

It is proposed that the new bridge will be constructed approximately 80 feet west of the old structure and that the stream will be diverted to this location. The stream flow is in a northerly direction at the existing bridge crossing and its bed is boulder strewn. The water is about one to two feet deep at this location. According to local residents, the maximum water level increase is about 5 feet.

Field Work

Four borings were put down at this site to depths ranging from 25 to 40 feet in the locations shown on Dwg. No.1. Standard diamond drilling equipment was used. BX casing 2-7/8 inches in diameter was drilled to the required sampling depth and washed or drilled clean. A 2 inch O.D. split spoon sampler was driven ahead of the casing with 350 ft.lb. hammer blows. The number of hammer blows required to drive the sampler from 6 inches to 18 inches penetration into the undisturbed soil ahead of the boring was recorded as the penetration resistance of the soil at that depth. On withdrawal, the sampler was dismantled, the soil classified and retained in moisture proof containers. Drawings 2 to 5 are the logs for the borings showing sampling depths, soil types encountered, penetration resistance values and water table measurement.

Before each boring was made, a dynamic penetration test was carried out adjacent to it. This test consists of driving a 2 inch diameter 60° cone into the ground with hammer blows of 350 ft.lbs. The number of blows per foot of penetration is recorded in the log of the corresponding borehole. The dynamic penetration test supplements the standard penetration resistance results obtained by sampling.

Soil Types Encountered

Up to 4 feet of gravel and boulders, which appear to be fill, are found overlying the natural soils at this site. A glacial drift deposit of silt-fine sand, containing coarse sand to coarse gravel, lies below and it extends down to elevations ranging from 1417 to 1424 feet, or some 16 to 26 feet below the ground surface. This glacial till deposit is variable in density, but is proven to be very dense below a minimum elevation of 1429 feet.

A deposit of very dense fine to medium sand with silt at some levels underlies the till. The extent of this deposit was not proven beyond elevation 1399 feet.

Ground water level in the area investigated corresponds essentially with the elevation of the river.

Mechanical sieve and hydrometer analyses were performed on two typical till samples. The results of these tests are presented in Dwg. 6.

Foundation Considerations

The creek over which the new structure will pass normally flows about 7 feet below the underside of the existing structure in a slow moving stream about one to two feet deep. According to local residents, the water has reached a maximum flood stage of approximately 2 feet below the underside of the bridge. This represents a rise of about 5 feet in creek level. The footings for the abutments of the proposed bridge must be carried deep enough to prevent undermining during any future flood.

Very dense soil was encountered below elevation 1429. This material has a safe bearing value of at least 8000 p.s.f. and therefore represents a most competent foundation medium. Elevation 1429 is approximately 9 feet below normal water level. Footings placed at this depth should be adequately protected against undermining by scour during flood periods. Based on the stones which are strewn in the present creek bed, the maximum size of rip rap for this purpose should be at least 18 inches. In view of the well-graded nature of the natural soil, no intermediate gravel filter should be required between the coarse rip rap and the ground.

Various construction methods are practised when placing footings below the level of a river which passes within a few feet of the proposed excavations. Mechanical analyses of the soil in which the excavations will be carried out (see Dwg. 6) show the material at this site to be very well graded, and to contain an appreciable amount of silt. However, because of the preponderance of sand and gravel sizes, water should be expected to enter an open excavation fairly rapidly. It should be appreciated that the natural grading for this soil should lie to the right of the curves shown in Dwg. 6; gravel greater than about $1\frac{1}{4}$ inches was excluded from the split spoon used for sampling purposes.

Since the amount of water that can be expected to enter a footing trench is fairly large, sub-aqueous excavation and placement of concrete would seem to have definite advantages. No problems associated with unwatering or protection of the sides of the excavation would be encountered. As long as the water level inside the excavation is at the same relative elevation as the ground water during and after digging operations, little sloughing of the sides of the hole or instability of the base should be experienced. The soil should stand on moderately steep slopes, at least as steep as 35° to the horizontal, thereby keeping the excavation to a reasonable size. Care would have to be exercised to ensure that no soft slough material remains in the bottom when concrete is placed. Probings in the bottom of the trench should disclose the presence of any soft material which could then be removed. Since it would be difficult to remove the last few inches of softened soil, a coarse gravel pad some 6 inches thick should be placed prior to placing the formwork. This gravel pad would allow up to 2 or 3 inches of slough material to enter its voids and produce a competent bearing pad.

Either tremie or Prepakt concrete could be used to construct the portion of the abutments below water. The excavation void around the abutment footing should be filled with a 2 to 3 foot thick layer of gravel and then large boulders or concrete rubble from demolition of the existing bridge should be placed on top. These measures will provide additional scour protection.

Since underwater excavations and concrete placement require a great deal of inspection and control, it may be advisable to dewater the excavation and place concrete in the dry. One method of doing this is to drive interlocking steel sheet piling around the perimeter of the excavation and to a depth of at least 5 feet below the proposed footing elevation. Each pile should be driven only a few feet ahead of the others at any given time in order to minimize separation of interlocks. Jetting is not recommended since this forms voids between the soil and piling through which water can enter the excavation and cause piping problems.

The sheet pile enclosure can be dewatered either during or subsequent to excavation. The specified 5 foot penetration of the piles below footing elevation should reduce the hydraulic gradient in the soil sufficiently to prevent any instability of the bottom of the pit.

An alternate means of construction would be to lower the ground water before excavation work commences. A comparison of the gradings of the soil to be excavated, with the grading limits for successfull well-point installations, is presented in Dwg. 6. Since the soil is quite dense and well graded and its silt content is variable, a vacuum well-point system may be necessary to dewater and stabilize the footing trench. The well points should be located at least 5 feet below excavation level and 5 feet apart. This spacing can be halved if pumping experience warrants. Holes 8 inches in diameter should be provided for each unit.

A small amount of water should be pumped through the well-point after it is inserted and concrete sand dumped into the annular space. The well-point should be worked up and down slightly to facilitate the installation of the sand filter. A slurry of clay or bentonite should be placed around the first 3 feet of pipe below ground level in order to form a seal. Subsequent excavation in the dewatered zone could be carried out with steeply sloping sides.

Conclusions

The observations and comments of the foregoing section can be summarized briefly as follows:

1) Very dense sand silt and gravel till exists at a depth of 9 feet below creek level, at the proposed bridge location. This glacial till deposit has a safe bearing capacity of at least 8000 p.s.f. for spread footings.

2) With foundations at a depth of 9 feet, undermining of the structure during peak flood should be prevented. Rip rap protection should be provided around the abutments and adjoining approach fill.

3) Excavation for the abutment foundations can be carried out either underwater or in the dry. Interlocking steel sheet piles or a well-point system are required for this latter method.

D.H. Shields

Donald H. Shields (P. Eng.)

DHS/lt
Encl.
August 14, 1959.
J 406

REGISTERED PROFESSIONAL ENGINEER
CIVIL
D. H. SHIELDS
PROVINCE OF ONTARIO

PROJECT NO. J 406

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 County Road Bridge (Devel.Rd.304)
LOCATION 4.2 miles East of Mt. Forest
HOLE LOCATION See Dwg. #1
HOLE ELEVATION AND DATUM 1439.9 Geodetic Datum

BOREHOLE NO. 1
FIELD SUPERVISOR
DRILLER
PREP.

SYMBOL	DESCRIPTION	ELEV. FEET	DEPTH FEET	STRENGTH AND PENETRATION RESISTANCE P.S.F. / BLOWS/FT.	CONSISTENCY / MOIST. CONTENT - % DRY WT.	SAMPLE	NATURAL UNIT WT. P.C.F.
		1439.9	0	20 40 60 80			
	Grouted gravel & boulders(fill)	38.3 1438					
	Glacial Till - sandy silt containing coarse sand to coarse gravel		10			1 2	
	- very dense below 7 feet.	1424				3 4	No penetration
	Brown silty fine sand changing to grey at 21 feet, very dense.		20			5 6	
	End of hole	1413.7				7	
	NOTES: BX casing drilled to required sampling depths. Water level recorded in uncased hole after 24 hrs. 2 in.diameter sampler and cone driven with 140 lb. hammer dropping 30 inches.		30 40				

PROJECT NO. J 406

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 County Road Bridge (Devel. Rd. 384)

LOCATION 4.2 miles East of Mt. Forest

HOLE LOCATION See Dwg. 1

HOLE ELEVATION AND DATUM 1445.6 Geodetic datum

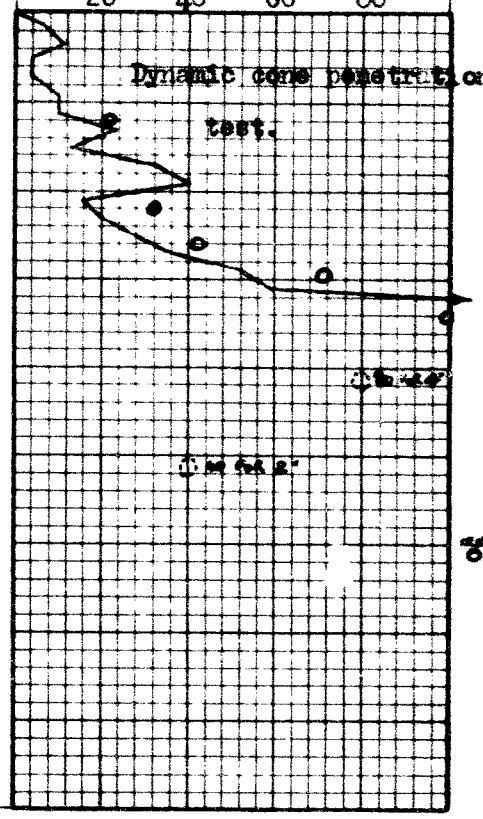
BOREHOLE NO. 2

FIELD SUPERVISOR

DRILLER

PREP.

SYMBOL	DESCRIPTION	ELEV. FEET	DEPTH FEET	STRENGTH AND PENETRATION RESISTANCE P.S.F.	CONSISTENCY MOIST. CONTENT - % DRY WT.	SAMPLE	NATURAL UNIT WT. P.C.F.
		1445.6	0				
	Possible gravel fill	1443.6					
	Glacial Till - brown sandy silt containing coarse sand to coarse gravel sizes, grey below 17½ ft.	39.4	10			1	
	Very dense below 16 ft.					2	No recov.
						3	No recov.
						4	
						5	
			20			6	
		1418.6				7	
	Grey fine to medium sand, very dense.		30			8	
	End of hole	1414.1					
	NOTES: BX casing drilled to required sampling depth. Water level recorded after 24 hours in uncased hole. 140 lb. hammer dropping 30 ins. used to drive 2" diam. sampler and cone.		40				



PROJECT NO. J 406

DRAWING NO. 4

WILLIAM A. TROW & ASSOCIATES

SITE INVESTIGATIONS AND SOIL MECHANICS CONSULTATION

PROJECT County Road Bridge (Devel.Rd 384)

LOCATION 4.2 mi. East of Mt. Forest.

HOLE LOCATION See plan

HOLE ELEVATION AND DATUM 1439.2 Geodetic datum

BOREHOLE NO. 3

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.	CONSISTENCY MOIST. CONTENT- % DRY WT.	SAMPLE	NATURAL UNIT WT. P.C.F.
		1439.2	0	20 40 60 80 BLOWS/FT.			
	Gravel and Boulders (Fill?)	38.5					
	Glacial Till: brown sandy silt with coarse sand to coarse gravel. Many boulders from 13 ft. to 22 ft. Very dense below 9 ft.	1435	10	Dynamic Cone Penetration Test		1 2 3 4 5	No pene. No pene.
			20	Rock		6	No recov.
	Grey, fine to medium sand - silty on occasion and few coarse sand sizes. Very dense. Hole filled in; no sampling possible below 35 ft.	1417.2	30			7 8 9	
	End of hole	1398.9	40				

NOTES: BX casing drilled to sampling depth. Water level recorded in uncased hole after 4 hrs. 2" diameter sampler and cone driven with 140 lb. hammer dropping 30 ins.

PROJECT NO. J 406

DRAWING NO. 5

WILLIAM A. TROW & ASSOCIATES

SITE INVESTIGATIONS AND SOIL MECHANICS CONSULTATION

PROJECT County Road Bridge (Tem.Rd. 384)

LOCATION 4.[illegible] mi. east of Mt. Forest.

HOLE LOCATION See plan

HOLE ELEVATION AND DATUM 1441.4 Geodetic datum

BOREHOLE NO. 4

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
		1441.4	0
	Glacial till: brown sandy silt with coarse sand to coarse gravel, changes to grey below 13 feet.	1438.2	
	Very dense below 12 feet.		10
	Grey, medium sand becoming fine at end of hole.	1422.4	20
	Very dense		
	End of hole	1410.8	30
	BX casing drilled to sampling depth. Water level recorded in uncased hole after 24 hrs. 140 lb. hammer dropping 30 ins. used to drive 2" diameter sampler and cone.		40

STRENGTH AND PENETRATION RESISTANCE

P.S.F.

BLOWS/FT. 20 40 60 80

Dynamic Cone Pene. Test

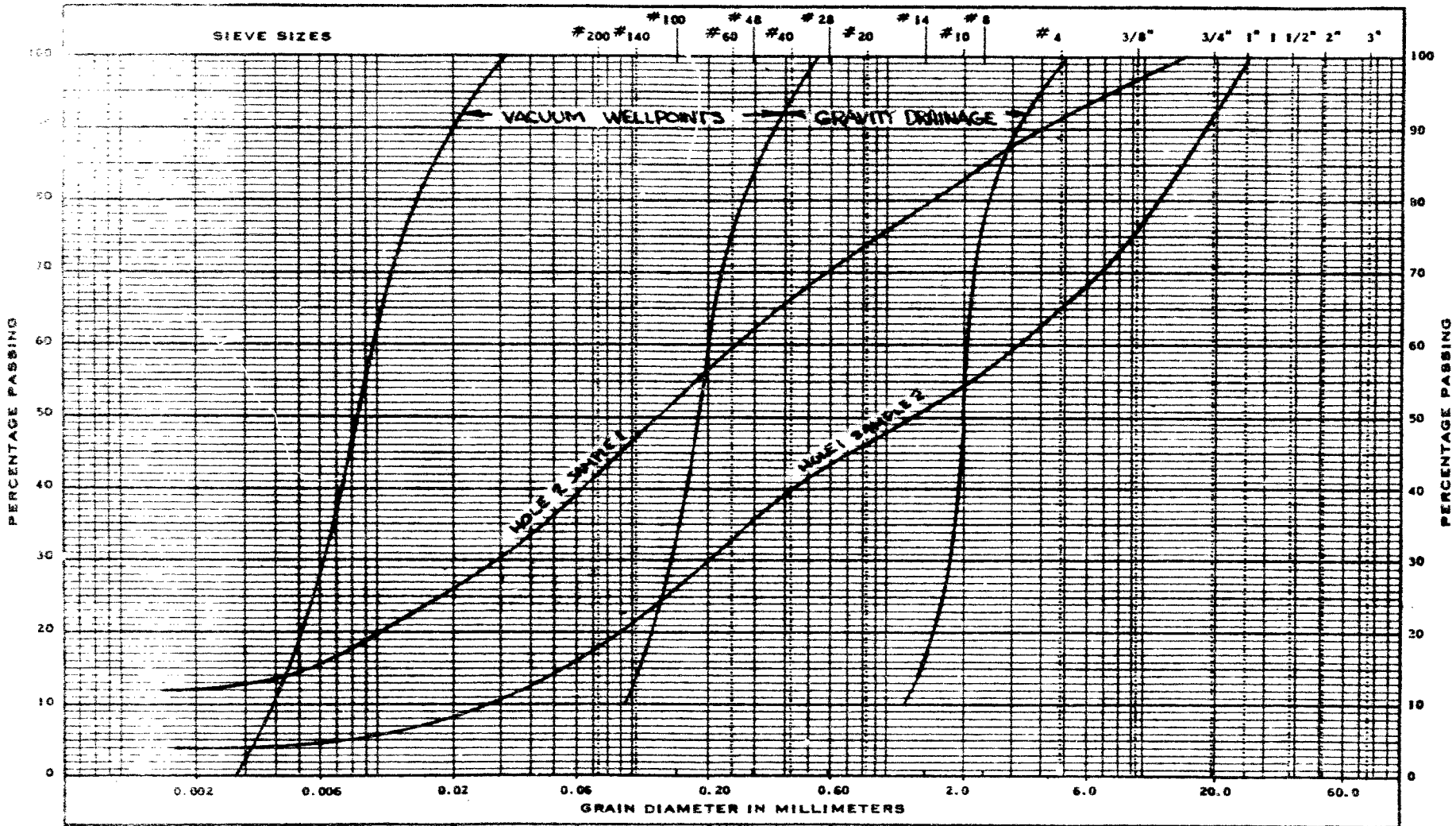
CONSISTENCY

MOIST. CONTENT - % DRY WT.

SAMPLE	NATURAL UNIT WT. P.C.F.
1	
2	No recov.
3	"
4	
5	
6	
7	

Project: J 406 Dwg. No. 6

MECHANICAL ANALYSIS



MODIFIED M.I.T. CLASSIFICATION

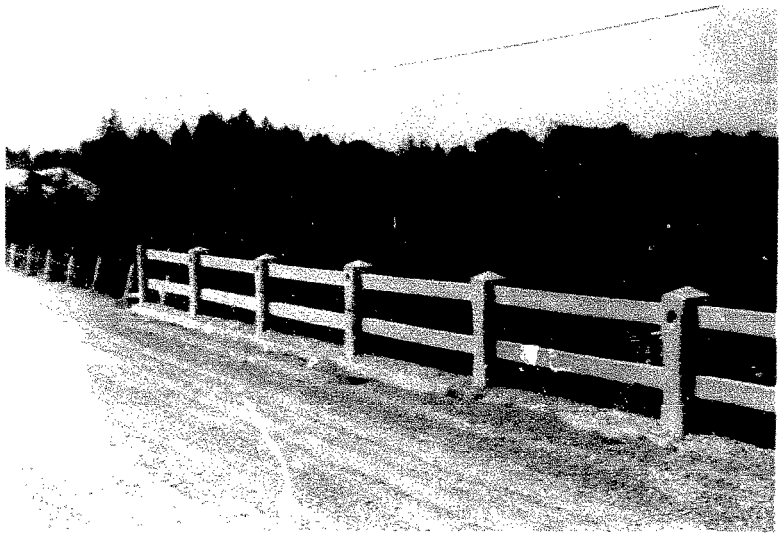
Delineating limits of Soil Dewatering Methods, from Fig. 14 – 14 – "Soil Mechanics Foundations and Earth Structures" Tschebotarioff

Grain Size Distribution for samples of Till from Bridge Site 4 mi. east of Mt. Forest

WILLIAM A. TROW AND ASSOCIATES

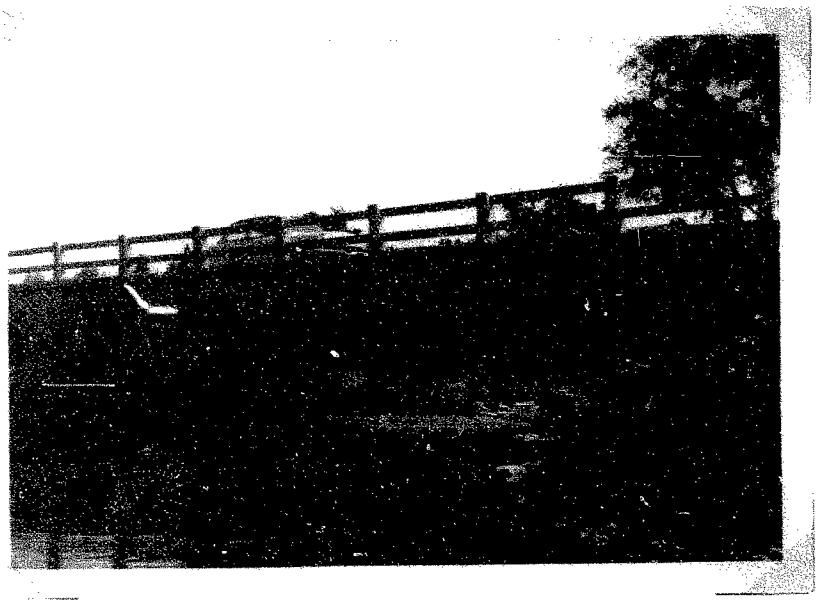
Looking north down valley.

Looking south up valley.

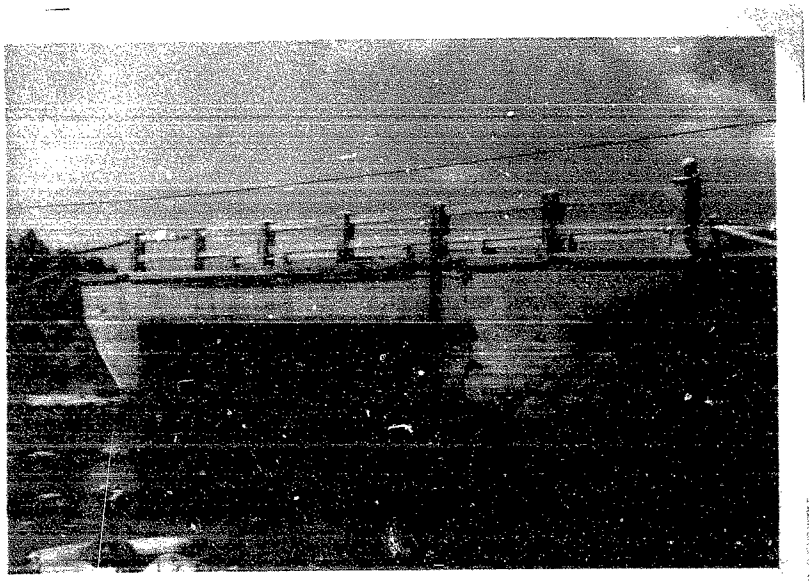


Looking North Bank Valley.

Looking South Bank Valley.



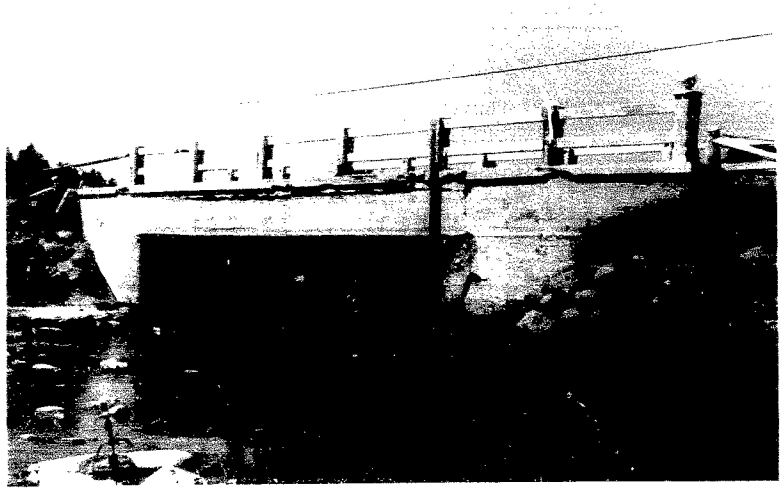
Looking south from north side of bridge.
Hole 3 location on right.



Looking north from south side of bridge.
Hole 1 location on left.

J406

Looking south [illegible] on north side of bridge.
Hole 3 location on right.



Looking north from south side of bridge.
Hole 4 location on left.

Looking west. Drill set up on Hole 4.

Looking east. Hole 2 location in foreground.

J406

Looking west, Drill set up on Hole 4.

Looking east. Hole 1 location in foreground.