#61-F-230M

DARGEL

BRIDGE

BLENHEIM TWP

BA 1323

WILLIAM A. TROW AND ASSOCIATES LTD.

SITE INVESTIGATIONS
LABORATORY TESTING
SOIL MECHANICS CONSULTATION

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

1850 JANE ST.,
WESTON, ONT.
CH. 1-4644

REC'D Nov 2/61
READ BY
COPY TO

Project: J750

October 31, 1961

C.C. Parker & Associates Ltd.,
Consulting Professional Engineers,
795 Main Street West,
Hamilton, Ontario

Attention: Mr. D.C. Cramm, P.Eng.

Re: Foundation Conditions
Dargel Bridge
Township of Blenheim

Dear Sirs:

We have completed an investigation of foundation conditions at the existing Dargel bridge crossing of the Nith River. The field work consisted of 3 borings taken to a maximum depth of 46 feet below the level of this stream.

We have found that the soil to this level consists of strata of gravel, sand and silt which exist in a dense to very dense condition below an approximate depth of 10 feet from the river surface. The borings were terminated in an extremely dense deposit of silty sand glacial till which begins 36 feet below the stream on the south side of the bridge and which was encountered 5 and 11 feet lower down under the centre and north side of the bridge respectively. According to well drilling records, bedrock lies at least 150 feet below the surface in this area.

River scour is estimated to extend to relative El 79 feet or 8 feet below the water surface. Abutment and pier footings should be taken at least to this depth at which level a safe net bearing value of 4000 psf can be applied. However, in view of the excavation difficulties associated with construction this far below the water table, the use of a pile foundation would appear to be preferable.

Timber piles should be expected to reach refusal in a stratum of dense sand at depths below the river surface ranging from 15 feet near the centre of the bridge to 20 and 23 feet at the south and north ends respectively. A safe bearing load of 20 tons can be developed at these depths. The pile driving energy used on the timber piles should not exceed 8750 ft.lbs. per blow and refusal in this sand should be defined as 8 blows per inch of penetration. All piles must be driven at least to relative elevation 74 feet, however, even if jetting must be resorted to.

Cylindrical steel piles, if used, probably will penetrate down to or close to the very dense till deposit described above. The driving energy in this denser material should be in the order of 15,000 ft.lbs. per blow and the refusal resistance should be taken as 12 to 15 blows per inch. Sheet piling or heavy rip rap should be placed around the piers and abutments in order to provide protection against river erosion.

In view of the granular nature of the ground and the relatively low heights of additional fill required in the bridge approaches, no embankment stability problem is envisaged. Some stripping of surface topsoil adjacent to the edges of the existing embankments appears to be desirable however.

The field observations and test information which form the basis for these recommendations are presented in the sections that follow.

Site Description

The Nith River at this crossing flows in a westerly direction through a relatively broad flat flood plain. The present river channel is cut into this flood plain for a depth of about 10½ feet. The river bed under the existing bridge is strewn with coarse gravel and boulders. The depth of water ranges from 2½ to 3½ feet and the river is about 120 feet wide. It is understood that flood level is at approximate El 98 feet which represents a rise of 11 feet above present levels.

The existing truss bridge was built in 1878 and is a single span structure about 125 feet wide. The abutments are badly deteriorated, as indicated on the accompanying photographs and the north abutment is undermined. Twelve by twelve inch timbers have been inserted under this footing.

The land to the south of the bridge is flat, but the ground rises beyond a distance of about 500 feet to the north.

Field Investigation Methods

The three borings of this investigation were performed using conventional wet sampling methods. All holes were cased with 2½ inch I.D. BX pipe to full depth.

Samples were taken at 5 foot intervals of depth for the most part, although the sampling intervals were increased in the lower levels of holes 2 and 3 in order to expedite the field program. Because the borings were penetrating through fine sand well below the water table, the casing was always kept full of water. This was done in order to avoid the introduction of an unbalanced hydrostatic head in the sand which could cause it to become disturbed and loose.

Cone penetration tests were performed adjacent to holes 1 and 2 in order to provide a check on the split spoon driving records. The energy used in driving the cone and split spoon was equal to 350 ft.lbs. per blow.

Hole No. 3 was performed from the bridge deck. The elevations of all holes were referred to the bench mark established on the four foot stump located at the south end of the bridge.

Subsoil Description

The type of soil encountered at each test location is described in the borehole logs, Dwgs. 2 to 4, and summarized in the estimated subsoil profile shown in Dwg. 1. Therefore no detailed description will be given here.

Slightly organic loose sandy silt and sand, which is the flood plain alluvium of this river, was encountered to approximate elevation 86 feet in holes 1 and 2 adjacent to the abutments. Coarser sand and gravel in a denser state extends below this to depths ranging from El 81 feet to 79 feet. This deposit is believed to represent the coarser material left after river scouring has taken place.

Dense fine silty sand is the predominating soil type below these materials. It contains scattered thin seams of clay and silt. Refusal to timber piles is anticipated in this sand at depths where the penetration resistance measurements exceed about 32 blows per foot.

This sand is underlain at approximate El 50 feet by dense silt and then, a few feet farther down by extremely dense silty sand glacial till. Because of the very high density of this material, advancement of the borings was very difficult and the holes were terminated after a maximum penetration of 5 feet. Diamond drilling would have boen required for greater penetration. In view of the dense state of the overlying soil, this expensive operation did not appear to be warranted.

Discussion of Foundation Requirements

The conclusions and recommendations for the proposed structure are indicated in the opening paragraphs of this report and no purpose is served by repeating them here. The establishment of a satisfactory base for the support of the bridge appears to be the only Soil Mechanics problem at this site.

In order to provide protection against scour, the abutment footings should be taken at least to the maximum indicated depth of river erosion which, from the results of hole 3, appears to be about 8 feet below the present river surface. The fine sand at this depth is sufficiently dense to support a net bearing pressure of 4000 psf safely. However, excavation work to this level will involve the usual dewatering problems encountered when digging well below the water table in fine sand.

Because of this fact, the use of timber piles for the support of the bridge has been recommended. On the basis of the field penetration measurements, this type of pile should encounter refusal at the relatively shallow depths indicated at the first of the report. In order to avoid damage to them, the driving energy should be limited to 6750 ft.lbs. of energy and refusal should be taken as 8 blows per inch. It is important that the piles be driven at least to El 74 feet or about 5 feet below the indicated scour level, even though hard driving may be encountered above this depth. The results of hole 2 indicate that resistance to driving on the north side of the bridge will be high below El 78 feet.

The piles should be cut off below low water level which has been given as El 86 feet. The river banks and bed adjacent to the piers and abutments should be protected with a layer of well graded rip rap about 18 inches thick. Alternatively sheet piling can be driven to protect the tops of the piles during periods of high scour activity in the river.

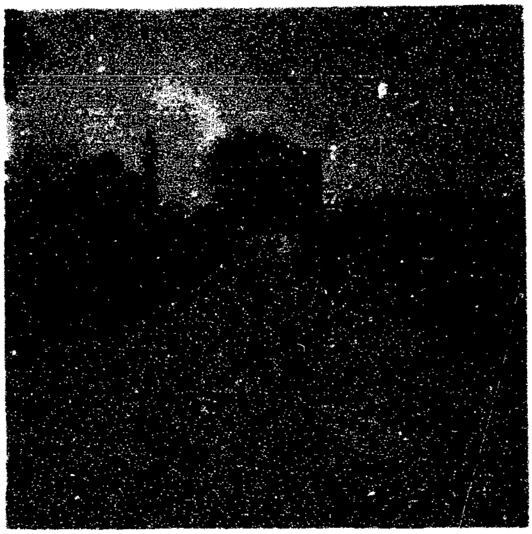
Since the soil underlying this site is predominantly of a granular nature, and since the additional approach fill heights are not great, no embankment stability problem is envisaged.

We hope that the information contained in this report is of assistance to you in the design of this structure. Please contact us if you have any queries on this subject.

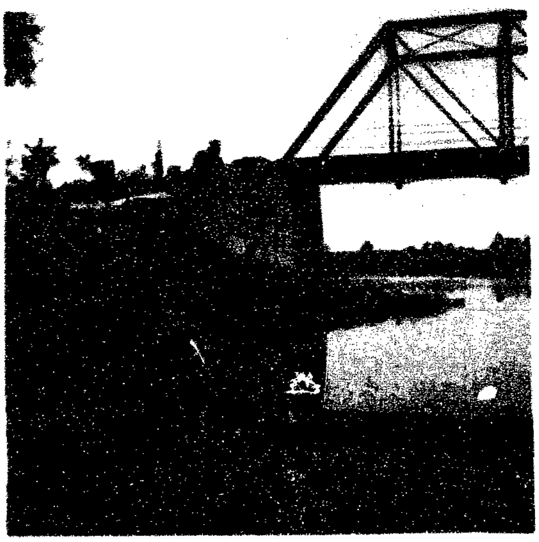
Yours very truly,

William A. Trow, P.Eng.

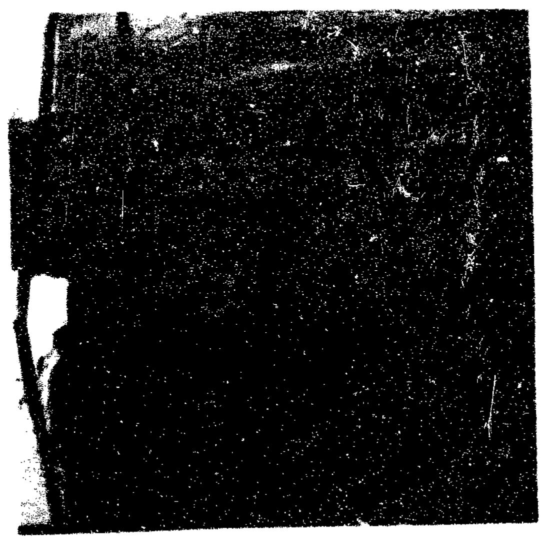
WAT/gc
Enc.



View of Bridge from South approach
Drill on Hole 1

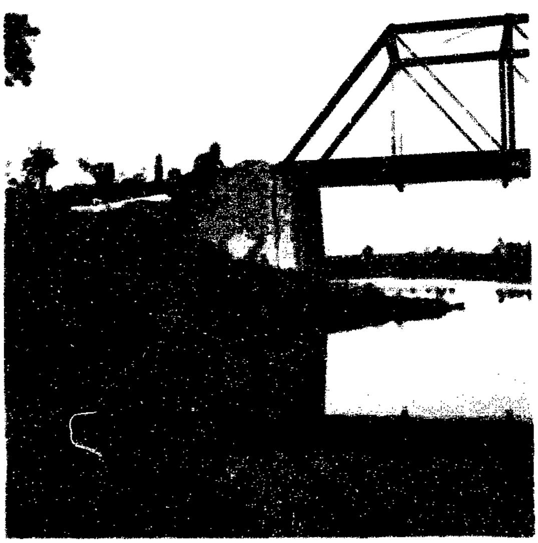


View from West
showing crack
in North abutment

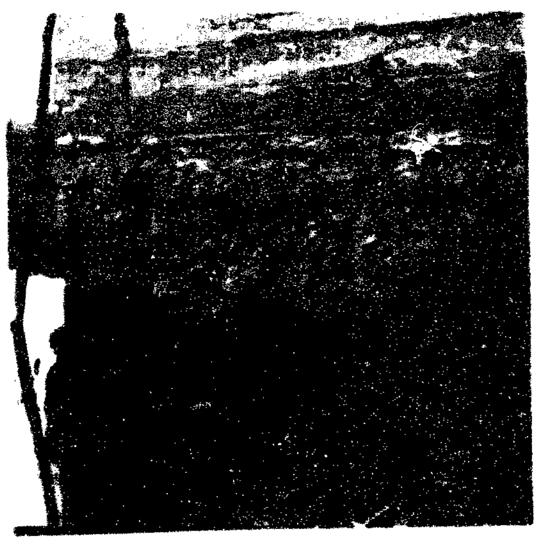


View showing undercutting
and deterioration of
East side of North abutment

View of Bridge from South approach
Drill on Hole 1



View from West
showing crack
in North abutment



View showing undercutting
and deterioration of
East side of North abutment

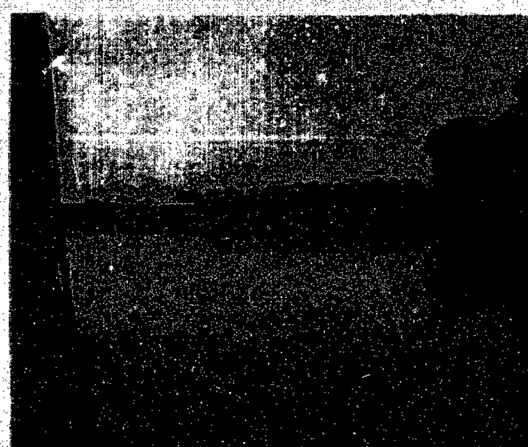
View looking East showing
erosion of North bank of the river

View looking upstream
showing South bank
West of bridge

View from North abutment
showing upstream flood plain
on South bank of creek

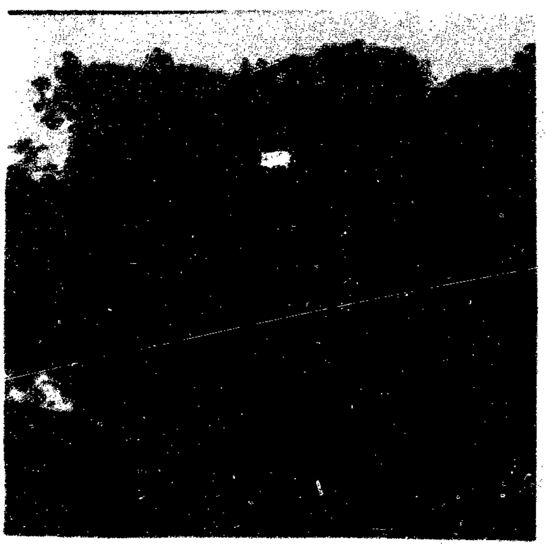
View looking East showing
erosion of North bank of the river

View looking upstream
showing South bank
West of bridge



View from North abutment
showing upstream flood plain
on South bank of creek

Vie. of Bridge from the Southeast
looking downstream

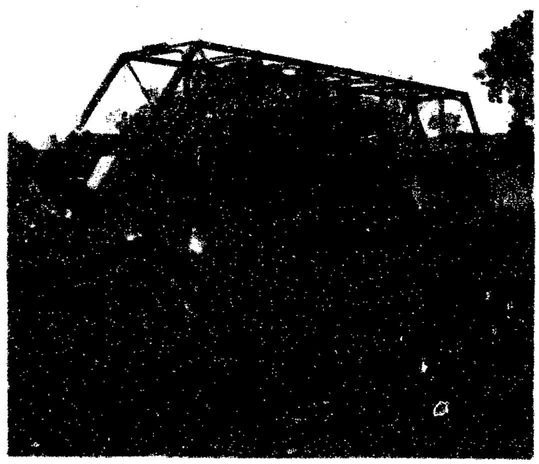


View of Bridge
from Northeast corner

View of Bridge
from Southeast corner

View of Bridge from the Southeast
looking downstream

View of Bridge
from Northeast corner



View of Bridge
from Southeast corner

WILLIAM A. TROW & ASSOCIATES LTD.

SITE INVESTIGATIONS — SOIL MECHANICS CONSULTATION

DRAWING No 2

PROJECT No J750

LEGEND

PENETRATION RESISTANCE
- 2" O.D. SPLIT TUBE
- 3" I.D. SHELBY TUBE
- 2" DIA. CONE

SHEAR STRENGTH
- UNDRAINED TRIAXIAL AT OVERBURDEN PRESSURE ⊕
- UNCONFINED COMPRESSION ⊗
- VANE TEST AND SENSITIVITY (S) +S

NATURAL MOISTURE CONTENT AND LIQUIDITY INDEX X^{LI}

ATTERBERG LIMITS
- LIQUID LIMIT
- PLASTIC LIMIT

SAMPLE TYPE
- 2" O.D. SPLIT TUBE
- 2" I.D. SHELBY TUBE
- 3" O.D. SHELBY TUBE

BOREHOLE No 1

PROJECT Dargel Bridge, Twp. of Blenheim

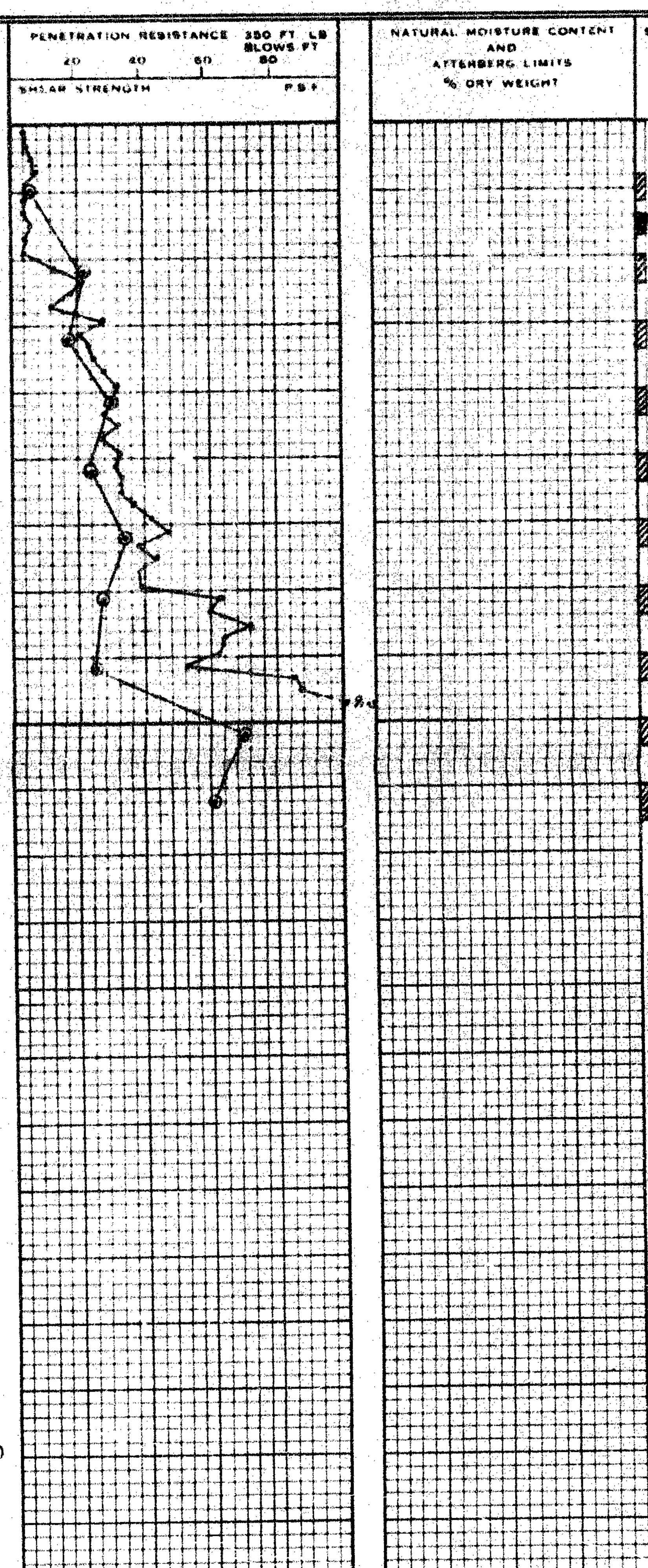
LOCATION East of Drumbo, Ont.

HOLE LOCATION See Dwg. 1.

HOLE ELEVATION 96.30 ft.

DATUM See Dwg. 1.

SYMBOL	SOIL DESCRIPTION	ELEV FEET	DEPTH FEET	SAMPLE TYPE AND No	NATURAL UNIT WEIGHT P.C.F.
	Ground Surface	96.3	0		
	SILT-brown, sandy, some organics, wood pcs. shell fragments; stiff clayey silt layer with wood particles 6½ - 7 ft.	89.3		SS1	
	SAND-grey, brown, silty fine to med. with some coarse layers containing shell fragments; layer black organic sand at 9½ ft.	86.9	10	TW2	Levered
	SAND & GRAVEL-coarse, brown sand, fine to coarse gravel, with silt binder.	85.8 80.8		SS3 SS4	
	SAND-fine, greyish-brown, little silty & siltier with depth. Few scattered silty clay seams to 35 ft. Scattered thin clayey silt seams to 40 ft. Few thin silt seams 35 - 45 ft.		20 30 40	SS5 SS6 SS7 SS8 SS9	
	GLACIAL TILL-fine to coarse gravel sizes med. coarse sand, grey silt binders, very dense.	51.3		SS10	
	End of Hole	44.3	50	SS11	Bounce



Depth scale: 0, 10, 20, 30, 40, 50, 60, 70, 80, 90, 100, 110

Notes:
1) Boring cased with BX pipe to full depth.
2) With hole at 45 ft., water level change from El 86.3 to 86.9 ft. overnight.
3) Cone driven 10 ft. south of hole.

WILLIAM A. TROW & ASSOCIATES LTD.

SITE INVESTIGATIONS — SOIL MECHANICS CONSULTATION

DRAWING No. 3
PROJECT No. J750

LEGEND

PENETRATION RESISTANCE
- 2" O.D. SPLIT TUBE
- 3" I.D. SHELBY TUBE
- 2" DIA. CONE

SHEAR STRENGTH
- UNDRAINED TRIAXIAL AT OVERBURDEN PRESSURE
- UNCONFINED COMPRESSION
- VANE TEST AND SENSITIVITY (S)

NATURAL MOISTURE CONTENT AND LIQUIDITY INDEX

ATTERBERG LIMITS
- LIQUID LIMIT
- PLASTIC LIMIT

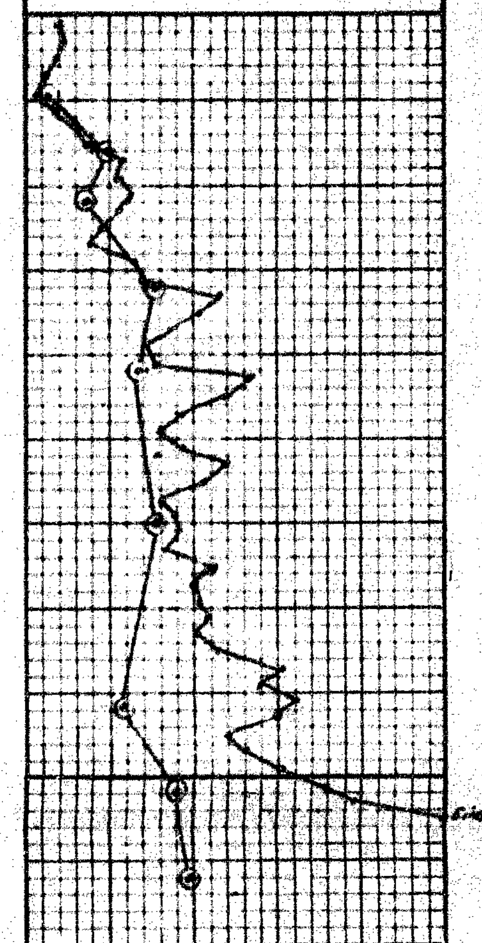
SAMPLE TYPE
- 2" O.D. SPLIT TUBE
- 2" I.D. SHELBY TUBE
- 3" O.D. SHELBY TUBE

BOREHOLE No.: 2
PROJECT: Dargel Bridge, Twp. of Blenheim
LOCATION: East of Drumbo, Ont.
HOLE LOCATION: See Dwg. 1.
HOLE ELEVATION: 94.1 ft.
DATUM: See Dwg. 1.

Soil Description	Elev. Feet	Depth Feet	Sample Type and No.	Natural Unit Weight P.C.F.
Ground Surface	94.1	0		
SANDY SILT-brown, organic, few fine gravel sizes.	90.2			
SAND-brown & grey, stratified, some organics.	87.6		SS1	
GRAVEL-fine to coarse, med. to coarse brown sand; slightly silty, some organics.	81.1	10	SS2, SS3	
SILT-cohesive, brown, coarse, few silty clay seams & fine sand seams.	77.1		SS4	
GRAVEL-fine to coarse with coarse brown sand, shell fragments	74.1	20		
SAND-brown, fine little silty. Scattered thin clay seams. Many 4 to 6 inch silty sand seams.	47.7		SS5, SS6, SS7, SS8	
SILT-greyish brown, cohesive with some fine silty sand seams. GLACIAL TILL CONTACT AT 54.3 ft. End of Hole	39.8	50	SS9, SS10	Bounce

Notes: 1) As hole 1.
2) Cone driven 7 ft. north of hole.

PENETRATION RESISTANCE 350 FT. LB. BLOWS/FT. 20 40 60 80 — SHEAR STRENGTH P.S.F.



NATURAL MOISTURE CONTENT AND ATTERBERG LIMITS % DRY WEIGHT

DEPTH FEET: 0, 10, 20, 30, 40, 50, 60, 70, 80, 90, 100, 110

WILLIAM A. TROW & ASSOCIATES LTD.

SITE INVESTIGATIONS   SOIL MECHANICS CONSULTATION

DRAWING NO. 4

PROJECT NO. J750

LEGEND

PENETRATION RESISTANCE
- 2" O.D. SPLIT TUBE —o—o—o—
- 2" I.D. SHELBY TUBE —+—+—+—
- 2" DIA. CONE ————

SHEAR STRENGTH
- UNDRAINED TRIAXIAL AT OVERBURDEN PRESSURE ⊕
- UNCONFINED COMPRESSION ⊗
- VANE TEST AND SENSITIVITY (S) +S

NATURAL MOISTURE CONTENT AND LIQUIDITY INDEX X LI

ATTERBERG LIMITS
- LIQUID LIMIT —o
- PLASTIC LIMIT ⊢

SAMPLE TYPE
- 2" O.D. SPLIT TUBE
- 2" I.D. SHELBY TUBE
- 3" O.D. SHELBY TUBE

BOREHOLE No. 3

PROJECT Dargel Bridge, Twp. of Blenheim

LOCATION East of Drumbo, Ont.

HOLE LOCATION See Dwg. 1.

HOLE ELEVATION 104 ft.

DATUM See Dwg. 1.

SYMBOL	SOIL DESCRIPTION	ELEV FEET	DEPTH FEET	SAMPLE TYPE AND No.	NATURAL UNIT WEIGHT P.C.F.
	Bridge Deck	104.0	0		
▽		86.9			
	WATER	83.5			
	GRAVEL-fine to coarse, med. coarse sand, little silty	78.9			
	SAND-brown, fine with silty seams and some fine clayey silt seams.			SS1, SS2, SS3, SS4	
	SILT-brown, saturated.	51.0			
	GLACIAL TILL	46.0		SS5	
	End of Hole	45.3			

Notes: As in Hole 1.

PENETRATION RESISTANCE 350 FT. LB BLOWS/FT: 20 40 60 80

SHEAR STRENGTH P.S.F.

NATURAL MOISTURE CONTENT AND ATTERBERG LIMITS % DRY WEIGHT