

#66-F- 276 M

BRIDGE # 17

LOT 9, CON. IV/V

METCALFE TWP.

3A 2308

DOMINION SOIL INVESTIGATION LIMITED

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264 WELLINGTON STREET,  
LONDON ONTARIO

SOIL INVESTIGATION

for

BRIDGE NO 17

LOT 9, CONCESSION IV & V

TOWNSHIP OF METCALFE

by

DOMINION SOIL INVESTIGATION LIMITED  
369 Queens Avenue  
LONDON ONTARIO

Reference No. 6-1-L9  
February 28th, 1966.

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SUMMARY

The two borings showed the following ground succession:-  
compact clayey silt Fill (5'-0" to 9'-0"); very stiff  
silty clay till (21'-6" maximum penetrated).

It is recommended that the structure be supported on spread footings at or below El. 86 using a maximum allowable soil pressure of 5000 pounds per square foot. The estimated total settlement is less than 1-inch.

No unusual construction problems are anticipated.

## I INTRODUCTION

Verbal authorization was received from A. M. Sprist and Associates, consulting engineers, to carry out a soil investigation at a site in the Township of Metcalfe where it is proposed to replace an existing road bridge with a new structure.

The existing steel-beam structure is located on Lot 9, Concessions IV and V of the Township where the road crosses a tributary of the east branch of the Sydenham River.

It is understood that the proposed structure will have about a 30 foot span, and that the longitudinal and transverse centre lines will be the same as the existing bridge.

The purpose of this investigation was to reveal the subsurface conditions at the site and to determine the relevant soil properties for the design and construction of the new foundations.

## II FIELD WORK

The field work, consisting of 2 boreholes, was carried out on February 15 and 16, 1966, at the locations shown on Enclosure 2. The holes were advanced by washboring methods, and were lined with Bx casing.

Standard Penetration Tests using a 2-inch outside diameter split-spoon sampler were performed at frequent intervals of depth, using a driving force of a 140 lb. hammer falling freely through 30-inches. The tube is first driven an initial 6-inches to allow for the presence of disturbed material at the bottom of the borehole. The number of standard blows required to drive the sampler a further 12-inches was recorded as the standard penetration resistance (or 'N' value). This test determines the relative density of granular strata and gives an indication of the consistency of cohesive strata. It also enables samples to be obtained for classification purposes.

Insitu vane shear tests, using a 4-inch long by 2-inch diameter 4-bladed vane, were performed in cohesive strata to determine the undrained shear strength of the soil.

Cont'd over....

Dynamic cone penetration tests were performed adjacent to each borehole location to obtain an indication of soil density changes with depth.

The results of the field tests are presented on the Geotechnical Data Sheets, Enclosures 3 and 4. Elevations were referred to a site benchmark which was established by the client (Nail in tree, 41 feet south of Sta. 0+37W, El. 100 feet).

### III LABORATORY TESTS

A series of laboratory tests were performed on samples of the silty clay stratum in which spread footings will bear, if such a design is used.

Atterberg Limit and moisture content tests were carried out on 2 samples as a means of classification and as a guide to the probable behaviour of the soil. These gave values of Liquid Limit of 32%; Plastic Limit of 15% and Plasticity Index of 17% indicating that the soil is a clay of low plasticity and compressibility. The Liquidity Indices which relate the natural moisture content of the clay to the Atterberg Limits ranged were 0.24 and 0.18, confirming the 'very stiff' consistency obtained from the visual and tactile examination.

The results of the Atterberg Limit and moisture content tests are plotted graphically on the Geotechnical Data Sheet for each borehole.

### IV SUBSURFACE CONDITIONS

Detailed descriptions of the strata encountered in each borehole are given on the Geotechnical Data Sheets, comprising Enclosures 3 and 4, and a general picture of the soil stratigraphy is given in the form of a Sub-surface Profile on Enclosure 2.

The boreholes revealed the following general ground succession:-

	<u>Thickness</u>	
	BH.1	BH.2
(a) Road Ballast.	1'-0"	1'-0"
(b) Compact brown clayey silt. (Fill). This material is associated with the construction of the approaches to the existing bridge.	5'-0"	9'-0"

Cont'd over....

- (c) Brown/grey silty clay containing traces of gravel. The consistency of this stratum is described as 'very stiff' as indicated by standard penetration test results ranging from 15 to 23 blows per foot. penetrated 20'-6" 21'-6"

V GROUNDWATER CONDITIONS

The groundwater in the two boreholes reached equilibrium at an average El. 94.5 which was 1.1/2 feet above the water level in the adjacent creek at the time of the investigation.

VI DISCUSSION

The bed of the creek extends to El. 89.9, therefore allowing for frost protection it is recommended that footings should bear at or below El. 86. The footing depth should be decided after a hydrological study has been made to determine the maximum depth of scour. This level lies within the stratum of very stiff silty clay till and on the basis of the borehole results a maximum net soil pressure of 5000 pounds per square foot is appropriate for the design of footings. Furthermore the footings will have a factor of safety of 3 against shear failure of the underlying soil.

It is estimated that total settlement will not exceed 1-inch and in view of the similar conditions encountered in the two boreholes, no appreciable differential settlement is anticipated.

The adhesion between the footings and the silty clay till may be taken as 2000 p.s.f. and the factor of safety against horizontal sliding of the abutments should be at least 1.5.

The very stiff cohesive soil will present no unusual construction problems. The volume of seepage will be small and should be collected in sumps dug below the footing level and removed by pumping.

Yours very truly,

DOMINION SOIL INVESTIGATION LIMITED

*C.J.W. Atkinson*

C.J.W. Atkinson, M.Sc., P.Eng.,  
Branch Manager



CJWA:jms

Enclosures



# LIST OF SYMBOLS, ABBREVIATIONS AND NOMENCLATURE.

## SOIL COMPONENTS AND GROUND WATER CONDITIONS.

BOULDER	COBBLE	GRAVEL		SAND			SILT	CLAY	ORGANICS	BEDROCK	GROUND WATER LEVEL	DEPTH OF CAVE-IN
		COARSE	FINE	COARSE	MEDIUM	FINE						
Ø	> 8"	3"	¾"	4.76mm	2.0	0.42	0.074	0.002	>	NO SIZE LIMIT		
U.S. Standard Sieve Size :				No. 4	No. 10	No. 40	No. 200					

## SAMPLE TYPES.

AS Auger sample	RC Rock core	TP Piston, thin walled tube sample
CS Sample from casing	% Recovery	TW Open, thin walled tube sample
ChS Chunk sample	SS Split spoon sample	WS Wash sample

SAMPLER ADVANCED BY static weight : w  
 " pressure : p  
 " tapping : t

OBSERVATIONS  
 MADE WHILE  
 CORING

Steady pressure  
 No pressure  
 Intermittent pressure

Washwater returns  
 Washwater lost

## PENETRATION RESISTANCES.

**DYNAMIC PENETRATION RESISTANCE** : to drive a 2" Ø, 60° cone attached to the end of the drilling rods into the ground, expressed in blows per foot.

**STANDARD PENETRATION RESISTANCE, -N-** : to drive a 2" outside dia, split spoon sampler 1 foot into the ground, expressed in blows per foot.

**EXTRAPOLATED -N- VALUE**

The energy for the penetration resistances is supplied by a 140 lb. hammer falling 30 inches

SYMBOL :



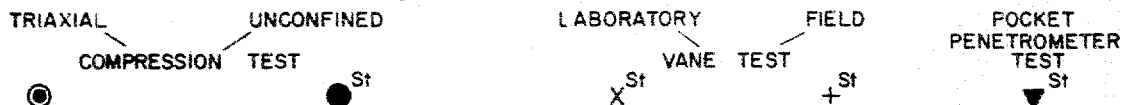
322

## SOIL PROPERTIES.

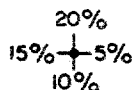
W % Water content	δ <sup>*</sup> Natural bulk density (unit weight)	k Coeff. of permeability
LL % Liquid limit	e Void ratio	C Shear strength in terms of total stress
PL % Plastic limit	RD Relative density	φ Angle of int. friction in terms of effective stress
PI % Plasticity index	C <sub>v</sub> Coeff. of consolidation	C' Cohesion
LI Liquidity index	m <sub>v</sub> Coeff. of volume compressibility	φ' Angle of int. friction

## UNDRAINED SHEAR STRENGTH.

— DERIVED FROM —



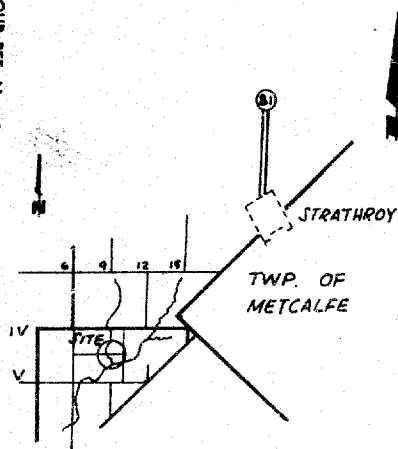
Strain at failure is represented by direction of stem



$$St : \text{sensitivity} = \frac{\text{shear strength in undisturbed state}}{\text{shear strength in remoulded state}}$$

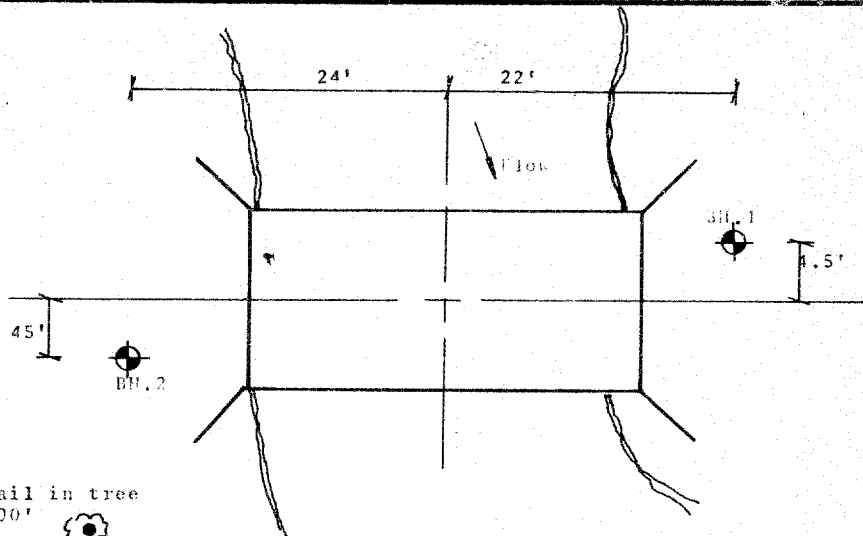
## SOIL DESCRIPTION.

COHESIONLESS SOILS :	RD :	COHESIVE SOILS :	C lbs/sq ft
Very loose	0 - 15 %	Very soft	less than 250
Loose	15 - 35 %	Soft	250 - 500
Compact	35 - 65 %	Firm	500 - 1000
Dense	65 - 85 %	Stiff	1000 - 2000
Very dense	85 - 100 %	Very stiff	2000 - 4000
		Hard	over 4000



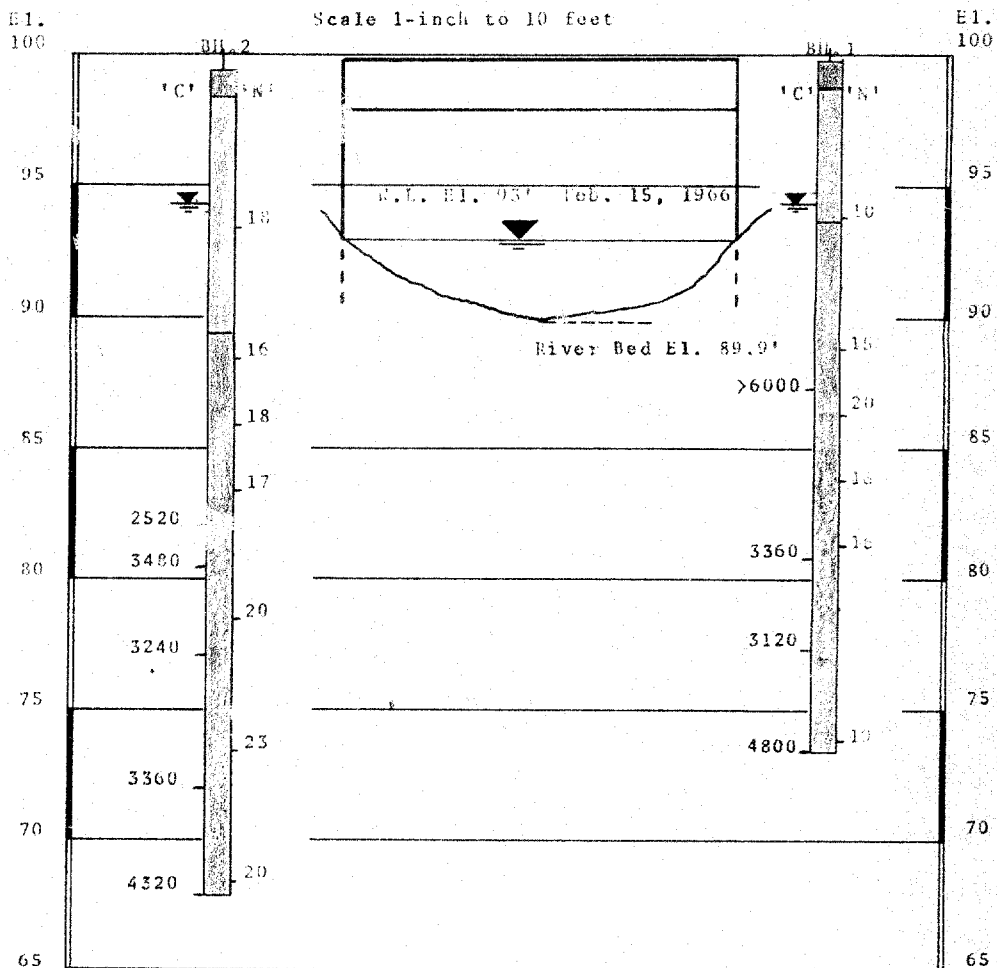
KEYPLAN

BM. Nail in tree  
E1. 100'



LOCATION OF BOREHOLES

Scale 1-inch to 10 feet



SUBSURFACE PROFILE

Vert. Scale 1-inch to 5 feet.

# GEOTECHNICAL DATA SHEET FOR BOREHOLE 1. ....

OUR REFERENCE NO. 6-1-19

CLIENT: A. J. Spriet & Associates

PROJECT: Bridge No. 17

LOCATION: Jct. of Vereville, County of Middlesex, Ont. DATE: February 18, 1966

DATUM ELEVATION 100' (See Enclosure 2)

METHOD OF BORING: Washboring

DIAMETER OF BOREHOLE 1.5 (3-inch)

ENCLOSURE NO. 3

ELEVATION ft.	DEPTH ft.	STRATIFICATION DESCRIPTION	STRATIFICATION SYMBOL	SAMPLES			PENETRATION RESISTANCE blows per foot					CONSISTENCY water content %				REMARKS
				NUMBER	TYPE	N- or Advance- ment of Sampler	20	40	60	80	100	PL	W	LI		
							SHEAR STRENGTH 1000 lbs./sq ft					10	20	30	40	
							1	2	3	4	5	6	7	8	9	
99.8	0.0	Ground Surface														
	1.0	Ballast	▲													
		Compact brown clayey silt, (Fill)	⊗				1	SS	10							
95	6.0	Stiff to very stiff silty clay traces Brown/Grey of gravel, laminated structure. (Glacial Till)	⊗				2	SS	15							
90			⊗				3	SS	20							
85			⊗				4	SS	16							
			⊗				5	SS	16							
80			⊗				6	TW								
75			⊗				7	SS	19							
26.5		End of Borehole														
70																

H. L.  
El. 94.5  
Feb. 15, '66



B. L.  
El. 94.5  
Feb. 15, '66

# GEOTECHNICAL DATA SHEET FOR BOREHOLE .2 . . . .

OUR REFERENCE NO. 6-1-19

CLIENT: A. N. Spry & Associates

PROJECT: Bridge No. 17

LOCATION: Twp. of Actonville, County of Middlesex, Ont.

DATUM ELEVATION: 100' (See Enclosure 2)

METHOD OF BORING Wash Boring

DIAMETER OF BOREHOLE 8x (3-inch)

ENCLOSURE NO. 4

DATE: February 15, 1966

ELEVATION ft.	DEPTH ft.	STRATIFICATION DESCRIPTION	STRATIFICATION SYMBOL	SAMPLES			PENETRATION RESISTANCE Blows per foot					CONSISTENCY water content %				REMARKS
				NUMBER	TYPE	Advancement of Sampler	20	40	60	80	100	PL	W	LI		
							SHEAR STRENGTH 1000 lbs/sq ft									
							1	2	3	4	5	10	20	30	40	
99.4	0.0	Ground Surface														
	1.0	Ballast														
		Compact brown clayey silt (Till)														
95				1	SS	10										
	0.0	wood		2	SS	16										
		Very stiff brown grey silty clay traces of gravel, laminated structure (Glacial Till)		3	SS	18										
85				4	SS	17										
				5	TW											
80				6	SS	20										
				7	SS	23										
75				8	SS	20										
70																
81.5		End of Borehole														
65																

Pl. L.  
81.54.4  
Feb 15, '66