

67 - F - 264 M

BRIDGE # 23

LOT 14 , CONS 12/13

METCALFE TWP.

B.A. 2556
Site 19-393

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264 WELLINGTON STREET
LONDON ONTARIO

67-1-100 M

Report on
SOIL INVESTIGATION
for
BRIDGE NO 23
LOT 14, CONCESSIONS 12 & 13
TOWNSHIP OF METCALFE

by
DOMINION SOIL INVESTIGATION LIMITED
369 Queer Avenue
LONDON ONTARIO

Reference No. 7-2-L4
February 28th, 1967.

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SUMMARY

The two boreholes revealed the following general ground succession:- stiff silty clay fill (9'-0" thick); overlying very stiff to hard silty clay (maximum penetrated 17'-0").

It is recommended that the structure be supported on spread footing foundations at or below El. 85, using a maximum net soil pressure of 5000 p.s.f. Total settlement is estimated to be less than 1-inch.

No unusual construction problems are anticipated.

I INTRODUCTION

Verbal authorization was received from A. M. Spriet & Associates Limited, Consulting Engineers, on February 7, 1967, 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 concrete structure is located on Lot 14, Concessions 12 and 13 of the Township where the road crosses a creek which eventually flows into the Sydenham River.

It is understood that the proposed structure is a concrete rigid frame with about a 35 foot span and that the longitudinal and transverse centre lines will be the same as the existing bridge. The requirements of the project were discussed with Mr. A. M. Spriet, P. Eng., who supplied the foregoing information.

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 THE GEOLOGY OF THE SITE

The site lies in the physiographic region known as the Ekfrid Clay Plain, which lies west and south of the Caradoc Sand Plain. The soil profile generally consists of pale greyish-brown clay, which is strongly calcareous due largely to limestone from the Norfolk formation. Occasionally knolls or low smooth ridges

of sand and gravel are superimposed on the clay

III FIELD WORK

The field work, consisting of 2 boreholes, was carried out on February 8 and 9, 1967, at the locations shown on Enclosure 2. The boreholes were advanced to the sampling depths by washboring methods and were lined with Bx size casing.

Standard penetration tests were carried out at frequent intervals of depth, as detailed on Appendix 'A' and the results are recorded on the Geotechnical Data Sheets as 'N' values.

Dynamic cone penetration tests were performed adjacent to each borehole to obtain an indication of soil density changes with depth. The same source of energy was used to drive the cone as was used for the standard penetration test.

Elevations were referred to a benchmark which was established at the time the field work was carried out (Spike in hydro pole, indicated on Enclosure 2, El. 100 feet).

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 Subsurface Profile on Enclosure 2.

The boreholes revealed the following general ground succession:-

	<u>Thickness</u>
(a) Silty clay Fill, associated with the construction of the approaches to the existing bridge.	9' - 0"
(b) Brown/grey silty clay. The upper zone of the clay stratum is brown in colour and with increasing depth the colour becomes grey. The consistency of the clay is described as 'very stiff' to 'hard' as indicated by 'N' values ranging from 18 to 46 blows per foot.	Maximum penetrated 17' - 6"

V 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 of the clay as a means of classification and as a guide to the probable behaviour of the soil. These gave values of Liquid Limit of 37% and 41%; Plastic Limit of 17% and 18%; and Plasticity Index of 19 and 24, indicating that the soil is a clay of medium plasticity and compressibility. The Liquidity Indices which relate the natural moisture content of the clay to the Atterberg Limits ranged between 0.15 and 0.25 confirming the 'very stiff' consistency obtained from the visual and tactile examination.

An unconfined compression test was carried out on one sample in an attempt to evaluate the shear strength of the clay. The test gave a result of 2380 pounds per square foot again confirming the 'very stiff' consistency.

The results of the Atterberg Limit, moisture content and unconfined compression tests are plotted on the Geotechnical Data Sheets for each borehole.

VI GROUNDWATER CONDITIONS

The average water level observed in the boreholes after completion of the field work, was El. 93.5 which was about 2 feet above the ice level in the adjacent creek at the time the field work was carried out.

VII DISCUSSION AND RECOMMENDATIONS

The natural subsoil below El. 91 consists of very stiff to hard silty clay which will be suitable for the use of spread footing foundations.

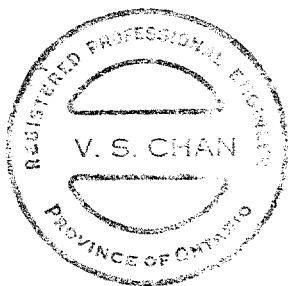
The bed of the creek extends to El. 90.3, therefore allowing 4 feet of soil cover for frost protection, it is recommended that the footings should bear at or below El. 86. The footing depth should be decided after a hydrological study has been made to determine the maximum depth of scour.

The proposed footing level lies within the stratum of very stiff to hard silty clay 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. A safety factor of 3 against general shear failure of the underlying soil is incorporated in the recommended soil pressure.

It is estimated that total settlement of footings mobilizing the above soil pressure 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 may be taken as 1500 p.s.f. and the factor of safety against horizontal sliding of the abutments should be at least 1.5.

The very stiff silty clay stratum will present no unusual construction problems. The volume of seepage into excavations will be very small and should be collected in sumps dug below the footing grade and removed by pumping.



Yours very truly,

DOMINION SOIL INVESTIGATION LIMITED

Victor S. Chan, P. Eng.,
Project Engineer

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

VSC:jms

APPENDIX A

STANDARD PENETRATION TESTS

In order to determine the relative density of non-cohesive soils, such as sands and gravels, the standard penetration test has been adopted. The test also gives an indication of the consistency of cohesive soils.

A two-inch external diameter thick-walled sample tube is driven into the ground at the bottom of the borehole by means of a 140 lb. hammer falling freely through 30 in. The tube is first driven an initial 6 in. to allow for the presence of disturbed material at the bottom of the borehole. The number of standard blows (N) required to drive the sampler a further 12 in. is recorded. The sample tube used is one originally developed by the Raymond Concrete Pile Company in the United States, where a sufficient number of tests have been made in conjunction with field investigations to show that the results, although essentially empirical, may be applied to foundation design.




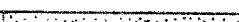






For sands:

Values of N	Density
Less than 10	Loose
Between 10 and 30	Compact
Between 30 and 50	Dense
Greater than 50	Very dense

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"	3/4"	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

SAN	ER	ADVANCED BY	static weight	w	OBSERVATIONS	Steady pressure	Washwater returns
"	"	pressure	p	MADE WHILE	No pressure		
"	"	tapping	t	CORING	Intermittent pressure		Washwater lost

PENETRATION RESISTANCES.

DYNAMIC PENETRATION RESISTANCE: to drive a 2" ϕ , 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:



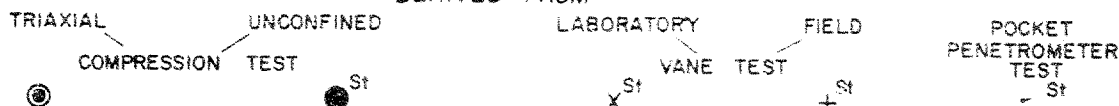
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SOIL PROPERTIES.

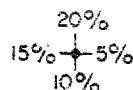
W % Water content	γ Natural bulk density (unit weight)	k Coeff. of permeability
LL % Liquid limit	e Void ratio	C Shear strength in terms of total stress
PL % Plastic limit	RD Relative density	ϕ Angle of int. friction in terms of total stress
PI % Plasticity index	C_v Coeff. of consolidation	C' Cohesion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

UNDRAINED SHEAR STRENGTH.

- DERIVED FROM -



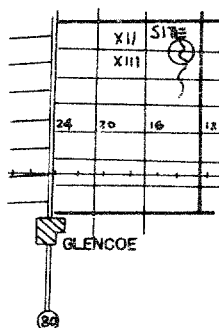
Strain at failure is represented by direction of stem



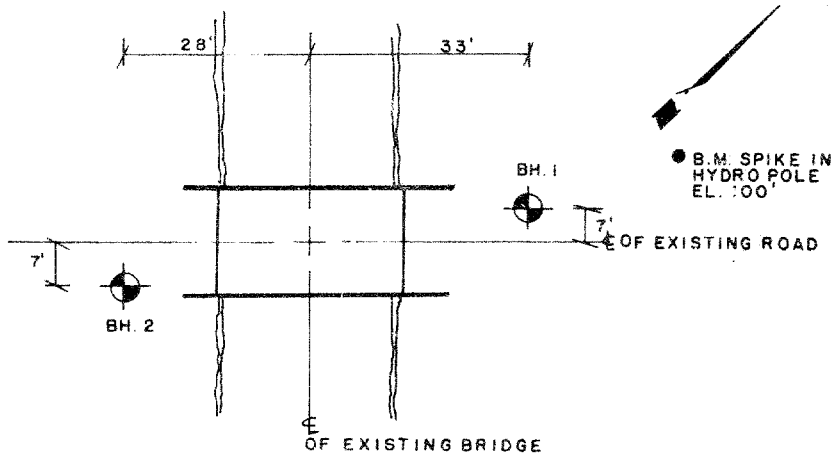
$$St : \text{sensitivity} = \frac{\text{shear strength in undisturbed state}}{\text{shear strength in remoulded state}}$$

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

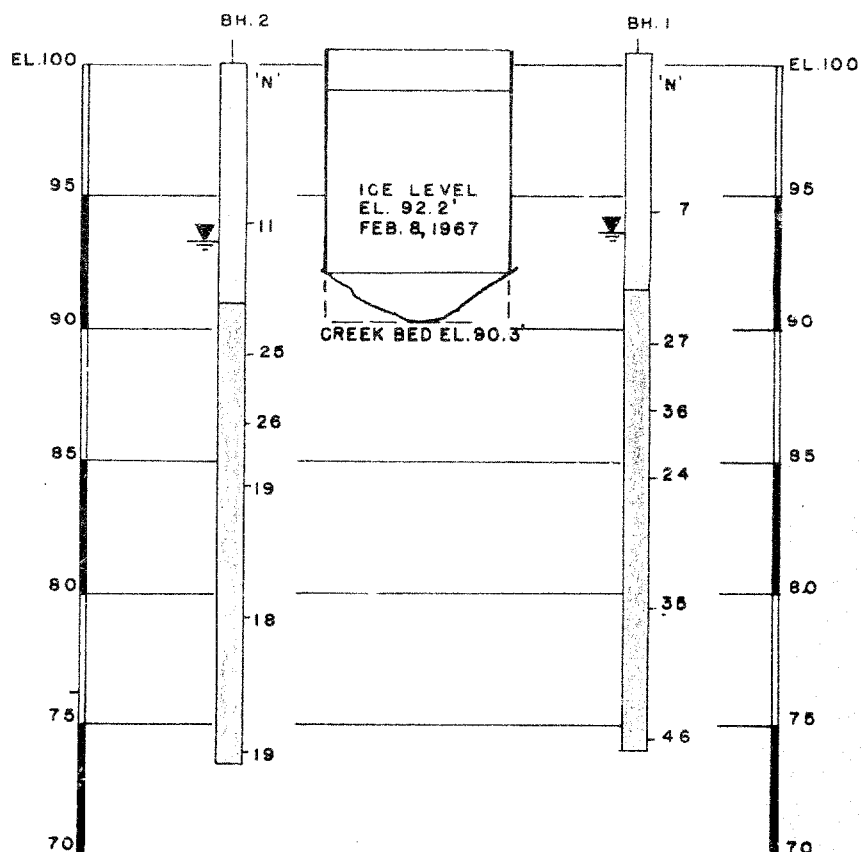
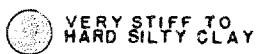


KEY PLAN



LOCATION OF BOREHOLES
SCALE 1" = 20'

LEGEND



SUBSURFACE PROFILE
VERT SCALE 1" = 5'

GEOTECHNICAL DATA SHEET FOR BOREHOLE 11111

OUR REFERENCE NO. 7-2-L4

CLIENT A. M. Spry & Associates

PROJECT Proposed Bridge

LOCATION Lot 14, Concs. 12 & 13, Twp. of Metcalfe

DATUM ELEVATION 10 (See enclosure 2)

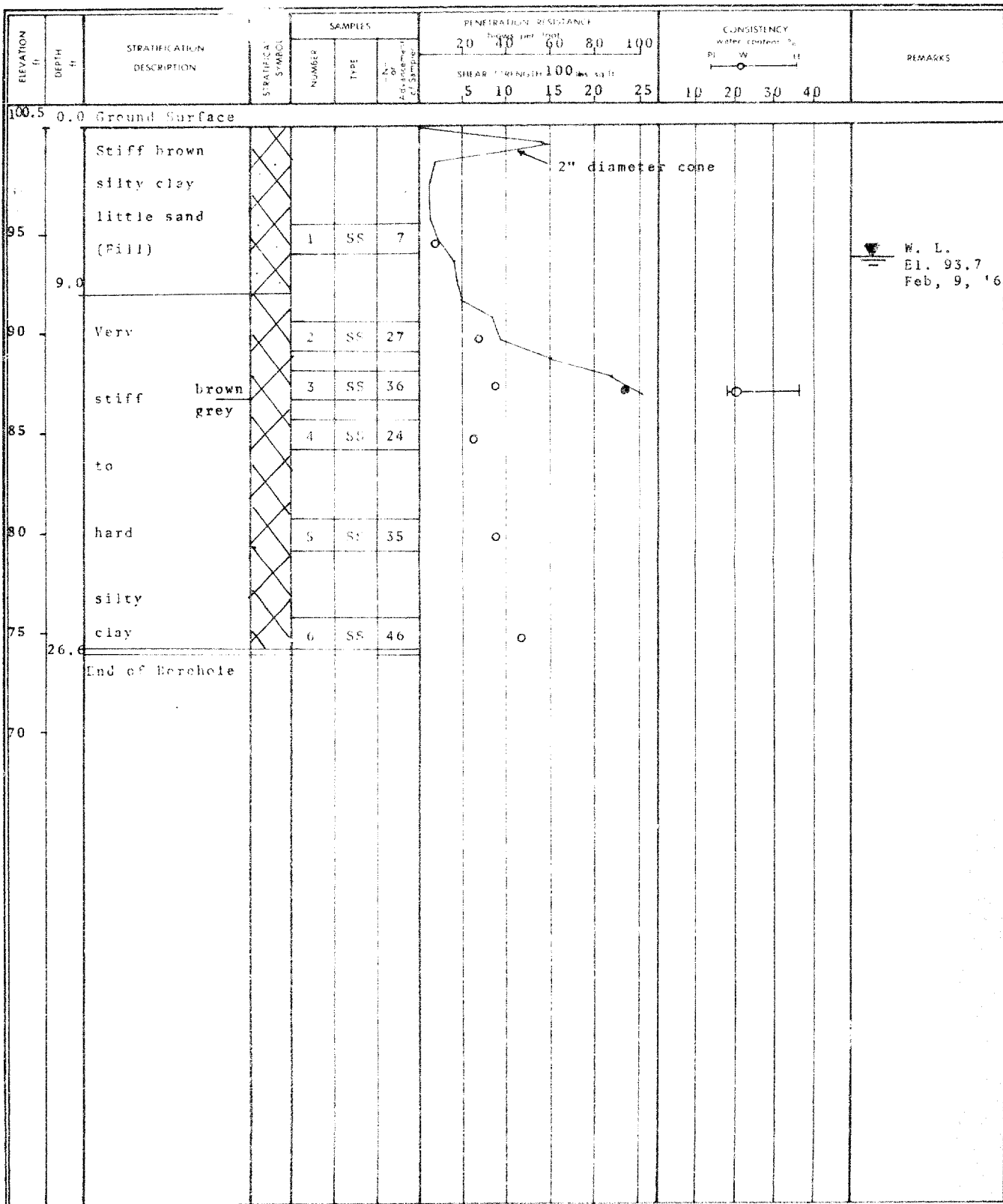
METHOD OF BORING Washboring

DIAMETER OF BOREHOLE 8x (3-inch)

DATE February 8, 1967

ENCLOSURE NO.

3



GEOTECHNICAL DATA SHEET FOR BOREHOLE 2.

OUR REFERENCE NO. 7-2-L4

CLIENT A. M. Spriet & Associates
PROJECT Proposed Bridge
LOCATION Lot 14, Concs. 12 & 13, Twp. of Metcalfe
DATUM ELEVATION 100 feet (See enclosure 2)

METHOD OF BORING Washboring
DIAMETER OF BOREHOLE Bx (3-inch)
DATE February 9, 1967

ENCLOSURE NO. 4

