GEOCRES No.
40516-75

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MONTEITH INGRAM LIMITED
CONSULTING ENGINEERS
PETROLIA ONTARIO

STR SITE No 14-46

Report on

SOIL INVESTIGATION

for

PERCH CREEK BRIDGE

LOT 9/10 SIDEROAD

TOWNSHIP OF SARNIA

Geocres # 40516-75
WO 2006-11009

by

DOMINION SOIL INVESTIGATION LIMITED
369 Queens Avenue,
LONDON 14 ONTARIO

Our Reference: 9-9-L8
January 5th, 1970.

C O N T E N T S

E N C L O S U R E S

SUMMARY

The natural soil profile consists of a stiff to very stiff silty clay stratum which extends to a depth of at least 60 feet below the creek bed.

It is recommended that the proposed structure be supported on spread footing foundations at least 4 feet below the creek bed level, and allowable soil pressures are given in the report with corresponding footing elevations. Total consolidation settlement of the structure is estimated to be about 1-inch.

No unusual construction problems are anticipated.

I INTRODUCTION

In accordance with instructions from Monteith Ingram Limited, Consulting Engineers, a soil investigation has been carried out in the Township of Sarnia, where it is proposed to replace an existing road bridge with a new structure.

The existing structure is located on the Lot 9/10 Sideroad, about 2½ miles north of Highway No. 7, where the road crosses Perch Creek.

It is understood that the proposed structure is a single span bridge, and that it will be centred on the existing structure. The requirements of the project were discussed with Mr. G. W. Ingram P.Eng., who supplied the foregoing information.

The purpose of the 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 PHYSIOGRAPHY

The site is located to the northeast of the City of Sarnia in the physiographic region known as the St. Clair Clay Plain. The topography has little surface relief and the soils are typically clay deposits of glacial lakes Warren and Whittlesey. These lakes covered the area in successive periods during the recession of the Wisconsin glacier. The upper layers of clay generally shows some degree of over-consolidation as a result of desication and weathering.

III FIELD WORK

The field work, consisting of two boreholes and two dynamic cone penetration tests, was carried out on September 24 and 25, 1969, at the locations shown on Enclosure 1. The boreholes were advanced by wash-boring methods and were lined with Bx size casing.

Standard penetration tests were performed at frequent intervals of depth to obtain disturbed samples, which were subjected to classification tests in the laboratory.

'Undisturbed' samples were obtained in 2-inch diameter thin-walled Shelby tubes, which were later extruded in the laboratory and subjected to shear and compression tests.

Insitu vane shear tests were performed in the cohesive subsoil to determine the undrained shear strength profile. The procedure followed in this test is outlined in Appendix 'A'.

The dynamic cone penetration tests were performed adjacent to the borehole locations to obtain an indication of soil density and strata changes with depth.

The results of the field tests are presented on the borehole log sheets, comprising Enclosures 2 and 3. Elevations were referred to the centre of the deck of the existing bridge, which was taken as Geodetic El. 592.46.

IV SUBSURFACE CONDITIONS

Detailed descriptions of the strata, which were encountered in each borehole, are given on the borehole logs comprising Enclosures 2 and 3, and a general picture of the soil stratigraphy is presented in the form of a Subsurface Profile on Enclosure 1. The following notes are intended only to amplify this data:-

Both boreholes encountered fill deposits which are associated with the construction of the approaches to the existing bridge. The natural subsoil consists of silty clay containing a trace of gravel. This material is of glacial origin and is commonly referred to as Glacial Till. Both boreholes were terminated in this stratum at depths of 42½ and 75 feet respectively.

Due to the clay content the till should be regarded as being a plastic and cohesive material, and the consistency is described as 'stiff' to 'very stiff' based on insitu vane shear strengths ranging from 1500 p.s.f. to 4500 p.s.f., and also indicated by 'N' values ranging from 7 to 61 blows per foot. The

upper part of the silty clay stratum shows signs of over-consolidation, however below El. 565 the shear strength of the silty clay is generally uniform.

V GROUNDWATER CONDITIONS

The groundwater levels in boreholes 1 and 2 were observed at El. 576.4 and El. 575 respectively, and the level of the water in the adjacent creek was at El. 580.6 at the time the field work was carried out.

VI LABORATORY TESTING

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 several samples to determine the consistency limits. These gave values of Liquid Limit of 25% and 26%, Plastic Limit of 13%, and Plasticity Index of 12% and 13%, 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 were 0.17 and 0.23 confirming the 'stiff' consistency obtained from visual and tactile examination. The results of the Atterberg Limit and moisture content tests are plotted graphically on the borehole logs for each borehole at the depths to which they refer.

One consolidation test was performed to determine the compressibility characteristics of the soil and to enable settlement calculations to be made. The results of this test are presented in the form of a void ratio-log effective pressure curve on Enclosure 4.

VII DISCUSSION AND RECOMMENDATIONS

The present level of the creek bed is at approximately El. 576 therefore it is recommended that the footing grade be established at least 4 feet below this level to provide sufficient protection against frost action. Also due to the reduction of the shear strength with depth, the allowable soil pressure will depend on the choice of footing elevation, and on the basis of the

borehole results the following maximum allowable soil pressures may be used for the design:-

Footing Elevation Feet	Maximum Allowable Soil Pressure p.s.f.
572	5200
571	4900
570	4600
569	4300
568 and below	4000

The above soil pressures incorporate a factor of safety of 3 against shear failure of the underlying soil.

The long-term consolidation settlement which will occur below an 8 foot wide footing carrying a dead load of 3000 p.s.f. is calculated to be about 2-inches, without applying Skempton and Bjerrum's lateral strain correction. Using a value of 0.4 for pore pressure coefficient A, the value of settlement is reduced to 1.0 inches.

The adhesion between the footings and the underlying silty clay subsoil may be taken as 2000 p.s.f., and the factor of safety against horizontal sliding of

the abutments must be at least 1.5.

The stiff cohesive till should cause no unusual construction problems. Seepage should be collected in sumps dug below the footing grade and removed by pumping. The volume of seepage will be small.

The footings should be back-filled with well-drained granular material, in accordance with the requirements of the Department of Highways, to prevent failure due to an out-of-balance hydrostatic pressure behind the abutment.

Yours very truly,

DOMINION SOIL INVESTIGATION LIMITED

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

CJWA/jmc

APPENDIX 'A'

INSITU VANE SHEAR TEST

In soft to stiff clays, and particularly sensitive clay soils such as frequently occur in alluvial deposits, it is difficult to obtain reasonable undisturbed samples for the determination of the undrained shear strength. In order to overcome this difficulty, the vane test was developed as an in-situ method of measuring the shear strength.

The apparatus consists of a 4-inch long by 2-inch wide rectangular 4-bladed rotating vane attached to a thin rod, which is pushed into the undisturbed soil below the bottom of the bore-hole to the depth at which the test is to be made.

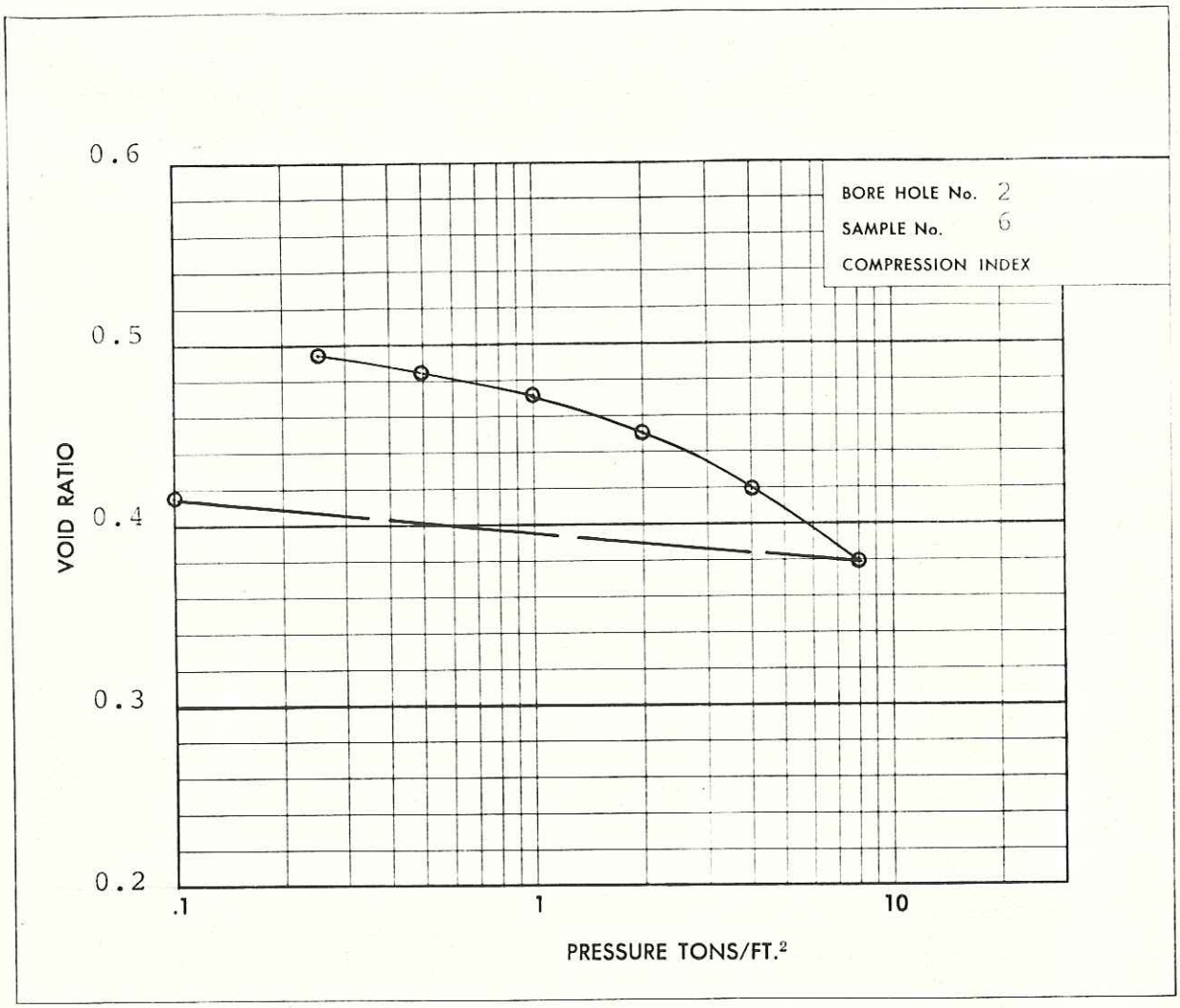
A torque is then applied to the vane and the maximum torque when failure occurs is recorded. The vane is then rotated 10 times to remould the soil and after one minute the torque test is repeated. The shear strength of the soil can then be calculated from the torque and the dimensions of the vane, and the sensitivity of the material estimated from the ratio of the original torque to the final torque after remoulding.

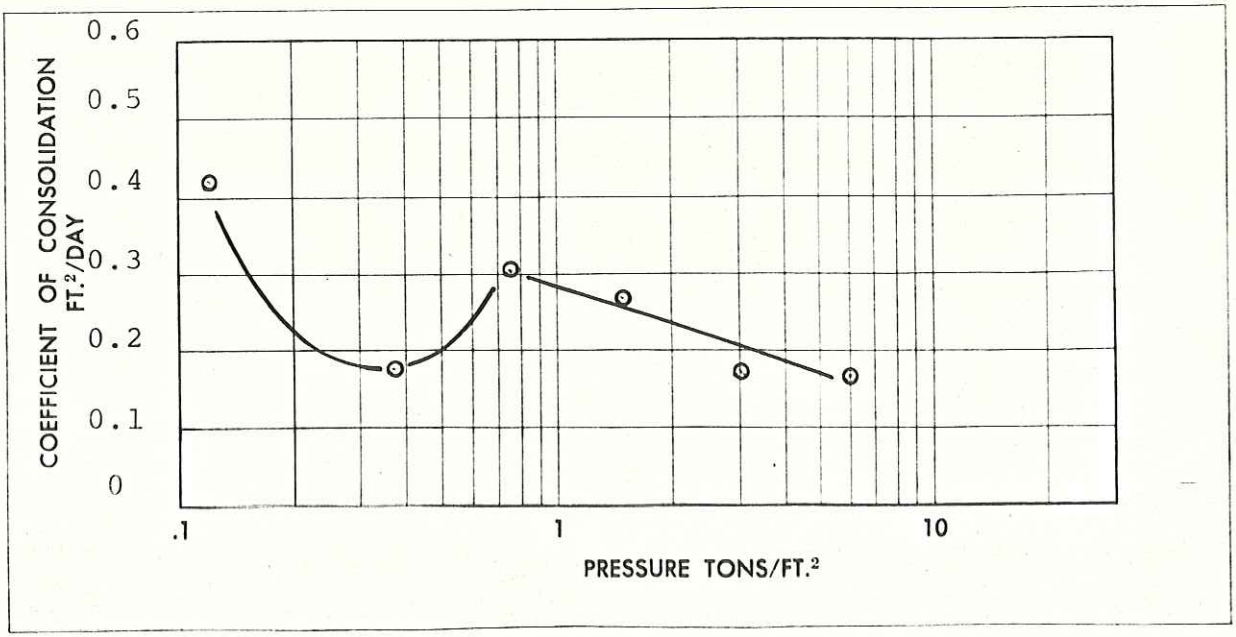
Order No. 9-9-L8

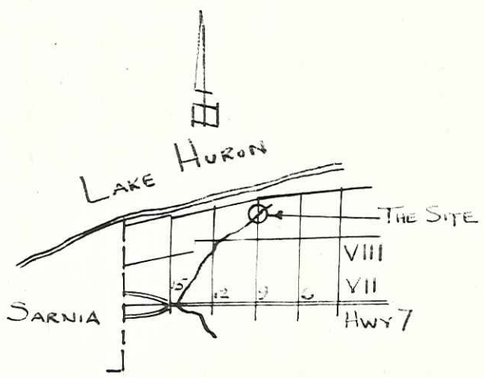
Enclosure No. 4

Dominion Soil Investigation Ltd.

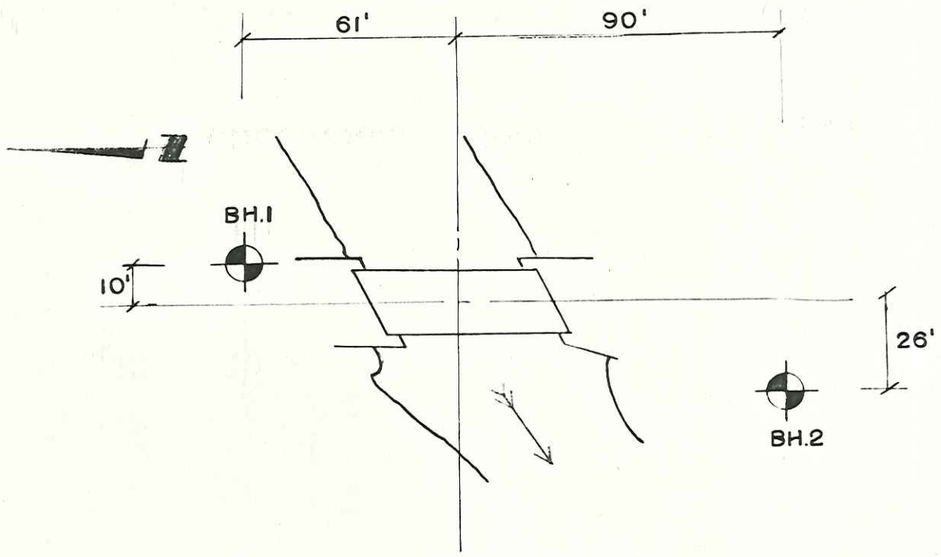
CONSOLIDATION TEST







KEYPLAN

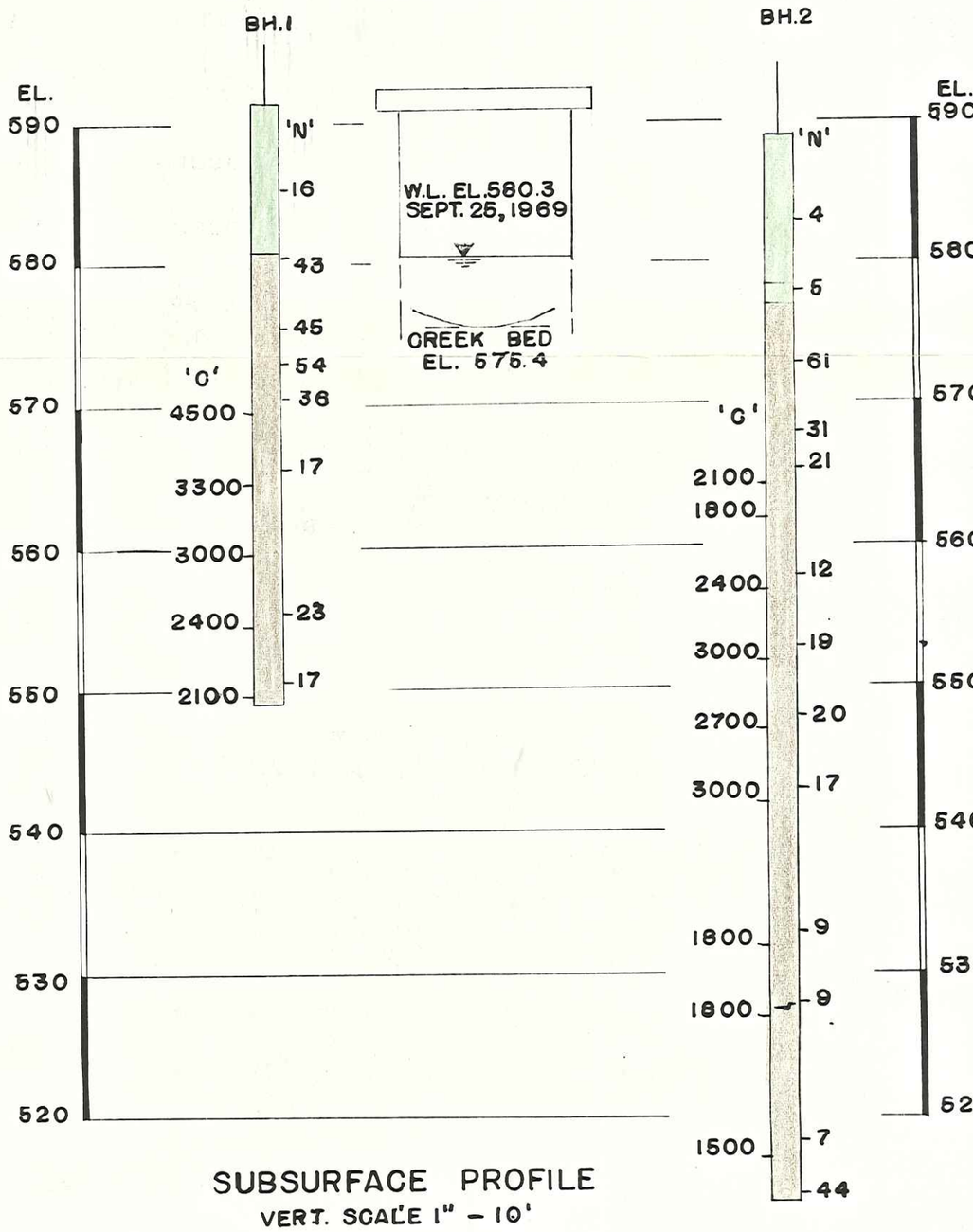


LOCATION OF BOREHOLES
SCALE 1" – 40'

LEGEND

FILL

STIFF TO VERY STIFF SILTY CLAY, TILL



SUBSURFACE PROFILE
VERT. SCALE 1" – 10'

LOG OF BOREHOLE ....1.....

Our Reference Nº 9-9-L8

Enclosure Nº 2

CLIENT: Monteith Ingram Eng. Ltd.,
PROJECT: Proposed Bridge,
LOCATION: 9/10 Sideroad, Township of Sarnia
DATUM ELEVATION: provided by client

DRILLING DATA
Method: Washboring
Diameter: Bx (3-inch)
Date: September 24, 1969

ELEVATION Ft.	DEPTH Ft.	DESCRIPTION	SYMBOL	GROUND WATER	SAMPLES NUMBER	TYPE	'N' Blows / Foot	REMARKS
591.4	0.0	Ground Surface						
	0.5	Topsoil						
590		Brown clayey silt (Fill)						
585					1	SS	16	
	10.5				2	SS	43	
580		brown grey Very stiff silty clay, with a trace of gravel (Glacial Till)						
575					3	SS	45	
					4	SS	54	
570					5	SS	36	
565					6	SS	17	
					7	TW		
560								
555					8	SS	23	
550					9	SS	17	
	42.5	End of Borehole						

PENETRATION RESISTANCE Blows / Foot: 20 40 60 80 100

UNDRAINED SHEAR STRENGTH 100 lbs/sq.ft.: + FIELD VANE TEST; ● COMPRESSION TEST: 10 20 30 40 50

WATER CONTENT %: PLASTIC LIMIT W_P — NATURAL W — LIQUID LIMIT W_L: 10 20 30 40 50

2-inch diameter cone

St=3.8

St=3.7

St=3.3

St=2.7

St=2.3

VERTICAL SCALE: 1 inch to 5 feet

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MADE: JJ CHECKED: CA

SUBSURFACE PROFILE				SAMPLES			PENETRATION RESISTANCE Blows / Foot	WATER CONTENT %	
ELEVATION Ft.	DEPTH Ft	DESCRIPTION	SYMBOL	NUMBER	TYPE	'N' Blows / Foot	20 40 60 80 100	PLASTIC LIMIT W_p	NATURAL W / LIQUID LIMIT W_L
			GROUND WATER				UNDRAINED SHEAR STRENGTH + FIELD VANE TEST ● COMPRESSION TEST 100 lbs/sq.ft. 10 20 30 40 50	10 20 30 40 50	REMARKS
590.0	0.0	Ground Surface							
		Brown silty fine sand (Fill)		1	SS	4	2-inch diameter cone		
585									
580	10.5	Silty clay Fill		2	SS	5			
	12.0	Stiff to very stiff brown silty clay, with a trace of gravel (Glacial Till)		3	SS	61			
575				4	SS	31			
570		Grey		5	SS	21	St=1.8		
				6	TW		St=1.8		
565				7	SS	12	St=2.0		
560				8	SS	19	St=2.0		
555				9	SS	20	St=3.0		
550				10	SS	17	St=3.0		
545				11	TW		St=2.0		
540				12	SS	9	St=3.0		
535				13	SS	9	St=3.0		
530				14	SS	7	St=2.5		
525				15	SS	44			
520									
515	75.0	End of Borehole							

VERTICAL SCALE: 1 inch to 5 feet

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