

DOCUMENT MICROFILMING IDENTIFICATION

GEOCRES No. 40 P13 - 11

W.P. No. _____

CONT. No. _____

W. O. No. _____

STR. SITE No. 2 - 287

HWY. No. _____

LOCATION PROP. BR., GOUGH ST.,
VILLAGE of LUCKNOW

=====

OVERSIZE DRAWINGS TO BE INCLUDED WITH THIS REPORT.

NONE

REMARKS: _____

D. H. 2

DOMINION SOIL INVESTIGATION LIMITED

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FOUNDATION ENGINEERS

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SAULT STE. MARIE
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London, Ont.
November 3, 1965.

Our Ref: 5-10-L2

STRUCTURE SITE No. 2-287

B. M. Ross and Assoc. Ltd.,
Consulting Engineers,
41 West Street,
GODERICH, Ontario.

40 P13-11
GEOCREP No.

Re: Soil Investigation for Proposed Bridge
Gough Street, Village of Lucknow, Ont.

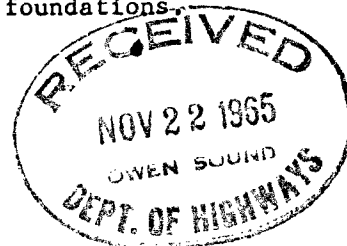
Dear Sirs:

Verbal authorization was received from the office of Mr. B. M. Ross to carry out a soil investigation at a site in the village of Lucknow where it is proposed to replace an existing road bridge with a new structure.

The existing steel-beam structure is located on Gough Street where the road crosses the Nine Mile River.

It is understood that the proposed structure is a rigid-frame with about a 30 foot span, and the longitudinal and transverse centre lines will be the same as the existing bridge. The requirements of the project were discussed with Mr. K. G. Dunn, 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.



PROCEDURE

The field work, consisting of 2 boreholes, was carried out on October 12th and 13th, 1965, at the locations shown on Enclosure No. 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.

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

Falling head permeability tests were performed in the field in granular strata as a means of classification and as a guide to the dewatering characteristics of the soil.

The results of the field tests are presented on the Geotechnical Data Sheet, Enclosure No. 3. Elevations were referred to a Geodetic bench mark El. 882.51 feet (S.I.B. at intersection of Ludgard St. and Stauffer St.)

SUBSURFACE CONDITIONS

Detailed descriptions of the strata encountered in each borehole are given on the Geotechnical Data Sheet, comprising Enclosure No. 3, and a general picture of the soil stratigraphy is given in the form of a Subsurface Profile on Enclosure No. 2.

Underlying relatively thin layers of topsoil or fill, both boreholes encountered a stratum of sand and gravel which extends down to El. 870 \pm . At borehole No. 1 location the soil consists of sand and gravel in equal proportions and also contains a trace of silt. At Borehole No. 2 location the soil consists of clean sand and gravel in equal proportion down to El. 875, and the lower part of the stratum appears to be predominantly gravel. The relative density ranges from compact to very dense as estimated from Standard Penetration Test results ranging from 21 to 53 blows per foot.

Between El. 870 and El. 860 the soil consists of silt or fine sand strata occasionally containing small amounts of gravel. The relative densities of the strata range from "compact" to "dense" as estimated from Standard Penetration Test results ranging from 26 to 46 blows per foot.

Below El. 860, the boreholes were terminated in a very dense silt stratum which is presumably the material of which the moraine is composed, while the overlying strata appear to be fluvial deposits. "N" values of greater than 100 blows per foot were recorded in this stratum.

GROUND WATER CONDITIONS

The water level in the river at the time the field work was carried out was at El. 876.8.

From observations of the water levels and cave-ins recorded in the boreholes after completion of the field work the average ground water table would appear to be at about El. 877.4.

FOUNDATIONS

Spread Footings

The subsoil consists of compact to very dense granular fluvial deposits extending down to El. 860 \pm , overlying very dense glacial deposits, therefore the strata are inherently capable of supporting spread footings.

The bed of the river extends to El. 875.0 and allowing for scour it is recommended that footings should bear at or below El. 871. 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 dense sand and gravel 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 at least 3 against shear failure of the underlying soil. A footing elevation below El. 870 would lie in the fine sand and silt strata and would demand more care to prevent disturbance of the soil beneath the footings during excavation.

It is estimated that total settlement will not exceed 1-inch and differential settlement between abutments should not exceed 3/4 inch.

The coefficient of friction between the footings and the underlying soil may be taken as 0.35 and the factor of safety against horizontal sliding of the abutments should be at least 1.5.

A major problem in the prevailing soil conditions will be to control the groundwater and it is most important that proper dewatering procedures should be used. There would be a tendency for the bottom of an unprotected excavation to heave or "boil" when the water level is lowered. The development of this condition must be prevented; otherwise, excessive settlement and a weakening of the subgrade are likely to result. Because of the successive reduction in permeability of the strata with depth, the most suitable method would be to carry out the excavation inside a sheet pile enclosure. The piles should be driven to such a depth that the distance from the pile tips to the footing grade is equal to the distance from the footing grade to the prevailing water table. The water level can then be lowered by pumping inside the excavation from sumps dug below the footing grade level. The piling may also be left in place to confine the soil below the footings and to provide scour protection.

Piles

The use of driven end-bearing piles may have advantages in economy of design and/or time of construction which will ultimately result in a lower cost for the structure. The length of the piles will be relatively short, therefore, the use of timber piles is recommended. Timber piles of nominal 12-inch diameter designed for a working load of 20 tons would be expected to find a satisfactory set between El. 857 and El. 859. Jetting may be required to penetrate the sand and gravel strata above El. 870.

We trust that this report contains all of the information that you require; however, if we can be of any further assistance, please do not hesitate to call on us.

Yours very truly,

DOMINION SOIL INVESTIGATION LIMITED,

C. J. W. Atkinson
per L.H.K.

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

CJWA/is

E n c l o s u r e s

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
CS Sample from casing
Ch's Chunk sample

RC Rock core
% Recovery
SS Split spoon sample

TP Piston, thin walled tube sample
TW Open, thin walled tube 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.

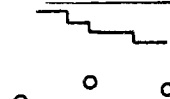
DYNAMIC PENETRATION RESISTANCE : to drive a 2" ϕ , 60° cone attached to the end of the drilling rods into the ground, expressed in blows per foot.

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
LL% Liquid limit
PL% Plastic limit
PI% Plasticity index
LI Liquidity index

γ^* Natural bulk density (unit weight)
e Void ratio
RD Relative density
C_v Coeff. of consolidation
m_v Coeff of volume compressibility

k Coeff. of permeability
C Shear strength — in terms of total stress
 ϕ Angle of int. friction
C' Cohesion — in terms of effective stress
 ϕ' Angle of int. friction

UNDRAINED SHEAR STRENGTH.

— DERIVED FROM —

TRIAXIAL COMPRESSION TEST
UNCONFINED TEST

LABORATORY VANE TEST
FIELD TEST

POCKET PENETROMETER TEST

Strain at failure is represented by direction of stem
20%
15% + 5%
10%

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

SOIL DESCRIPTION.

COHESIONLESS SOILS :

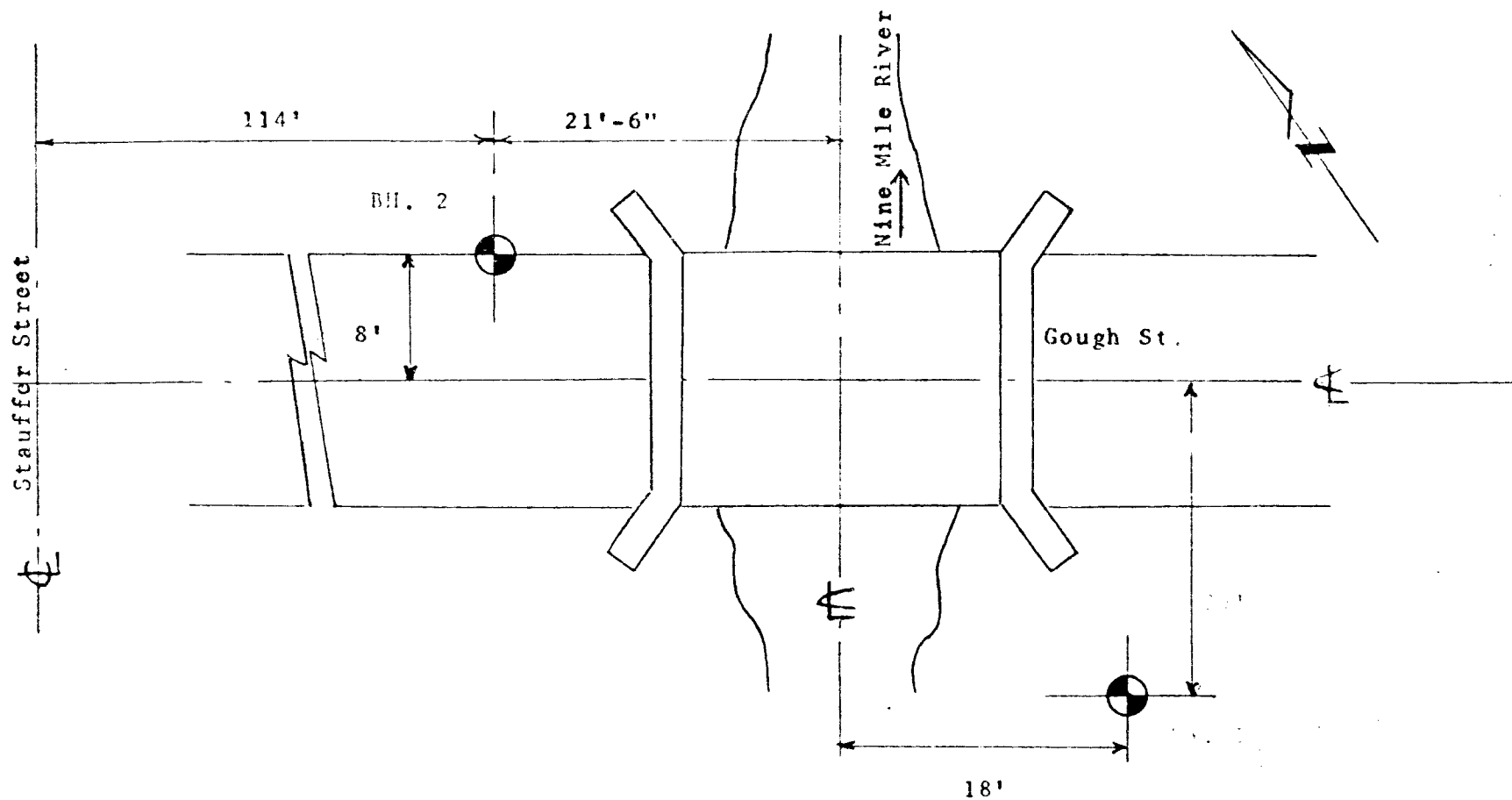
Very loose 0 - 15 %
Loose 15 - 35 %
Compact 35 - 65 %
Dense 65 - 85 %
Very dense 85 - 100 %

RD :

COHESIVE SOILS :

Very soft less than 250
Soft 250 - 500
Firm 500 - 1000
Stiff 1000 - 2000
Very stiff 2000 - 4000
Hard over 4000

C lbs/sq.ft.

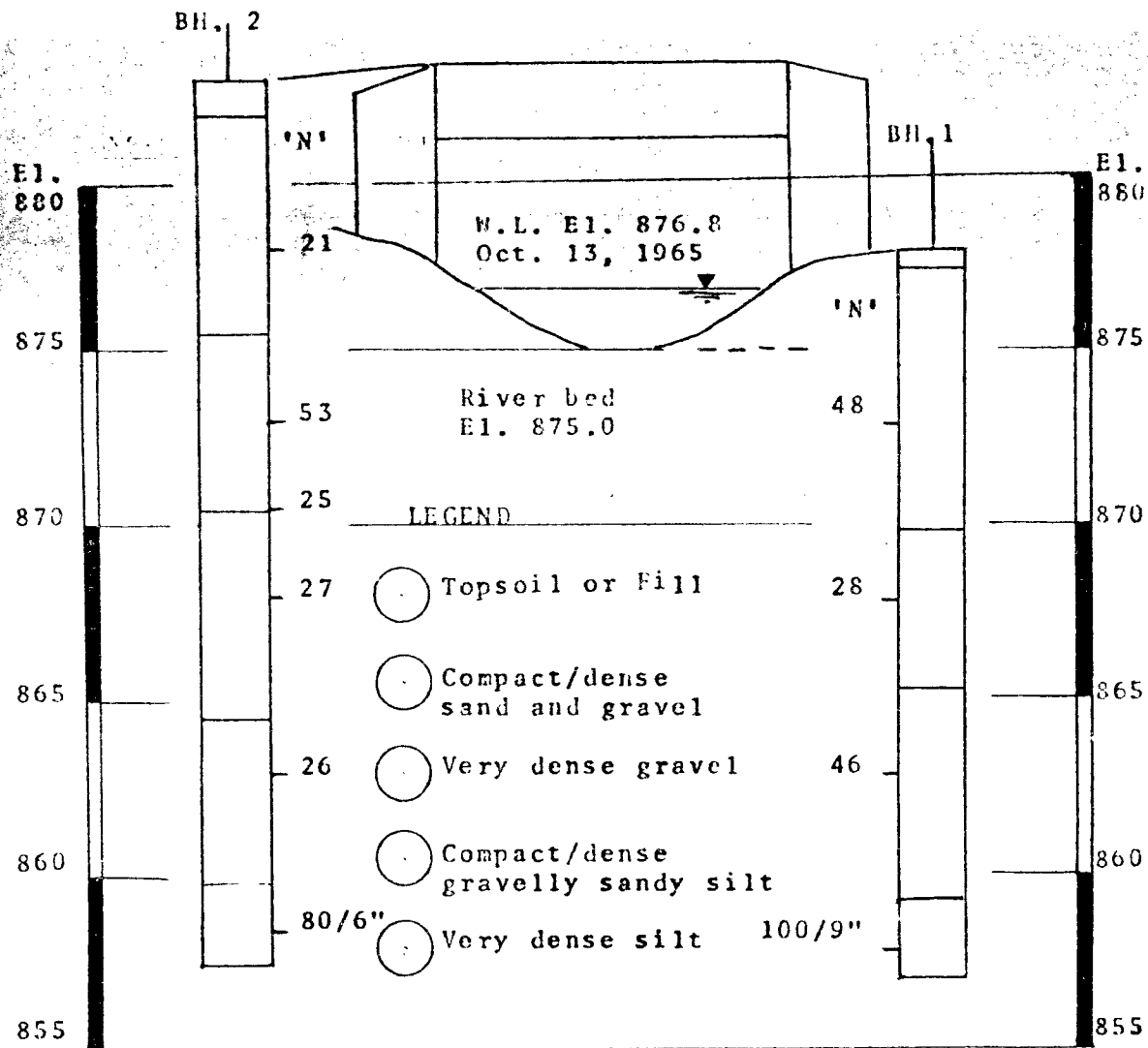


LOCATION OF BOREHOLES

Scale 1-inch to 10 feet

BH. 2

'N' denotes
Standard
Penetration
Test results
in blows/foot.



SUBSURFACE PROFILE

Scale 1-inch to 5 feet

OUR REFERENCE NO 5-10-12

METHOD OF BORING Washboring
DIAMETER OF BOREHOLE Bx (3-inch)
DATE October 12 & 13, 1961

ENCLOSURE NO 3

ELEVATION ft.	DEPTH ft.	STRATIFICATION DESCRIPTION	STRATIFICATION SYMBOL	SAMPLES			PENETRATION RESISTANCE blows per foot					CONSISTENCY water content %		REMARKS
				NUMBER	TYPE	N ₆₀ or Advancement of Sampler	20	40	60	80	100	Pl	W	

877.9	0.0	Ground Surface					Borehole 1								
	0.5	Topsoil													W.L. El. 877.1
875		Dense brown slightly silty sand and gravel.		1	SS	48									Cave-in El. 873.1
870	8.0	Compact grey silty fine sand.		2	SS	28									K values: 6×10^{-4} cm/sec
865	12.5	Dense grey fine sandy silt, trace of fine gravel.		3	SS	46									1×10^{-4} cm/sec
860	18.5	Very dense grey slightly clayey silt.		4	SS	100/9"									
	20.8	End of Borehole													

883.0	0.0	Ground Surface					Borehole 2								
	1.0	Silt. Fill.													
880		Compact brown fine to medium sand with fine to medium gravel.		1	SS	21									Cave-in El. 877.7
875	7.5	Very dense gravel		2	SS	53									K values: 1×10^{-1} cm/sec
870	12.5	Compact grey gravelly sandy silt.		3	SS	25									8×10^{-3} cm/sec
				4	WS										3×10^{-1} cm/sec
				5	SS	27									
865	18.5	Compact grey silt with fine sand layers.		6	SS	26									1×10^{-3} cm/sec
860	23.0	Very dense grey silt.		7	SS	80/6"									
	25.5	End of Borehole													
855															