

# 67 - F - 260 M

STARRITT BRIDGE

CON. 6/7 , LOT 32

WEST MISSOURI TWP.

BA 2735  
site 19-85

H. Q. GOLDER & ASSOCIATES LTD.

SOIL AND FOUNDATION ENGINEERS

HEAD OFFICE - TORONTO, ONTARIO

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LONDON, ONTARIO  
471-0600

67-F-2WM

November 17, 1967.

R. C. Dunn & Associates Ltd.,  
747 Hyde Park Road,  
LONDON, Ontario.

con 687 Lot 32

ATTENTION: Mr. N. W. Warner, P. Eng.

RE: Subsurface Investigation,  
Starritt Bridge, West Nissouri  
Twp., Middlesex County, Ontario

Dear Sirs:

This letter reports the results of a subsurface investigation carried out at the site of the proposed reconstruction of Starritt Bridge, located between Concession VI and VII at Lot 32 in the Township of West Nissouri, Middlesex County, Ontario. It is proposed to replace the existing structure with a reinforced concrete culvert.

Two boreholes were put down on October 23rd, 1967 at the locations shown on Figure 1, using a trailer mounted power auger. Standard penetration tests were carried out in both boreholes and the samples obtained brought to our London laboratory for detailed examination and representative testing. The ground-water level was observed in both boreholes during drilling and in a perforated standpipe installed in Borehole 2 on the completion of drilling.

The soil conditions encountered in the boreholes are shown in detail on the Record of Borehole sheets attached to this letter and an inferred soil stratigraphy across the site is shown with the Site Plan as Figure 1. The results of the laboratory testing are shown on the Records of Boreholes and on Figure 2.

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The elevations given in this letter are referred to a bench mark located as a red paint mark on the top of the northeast corner of the wingwall on the existing bridge. The elevation of this bench mark was given as 90.27 referred to a local datum.

The site is located within the physiographic region known as the Stratford Till Plain. The north branch of Gregory Creek over which the structure will be built flows west to join the Thames River through rolling agricultural land.

The borings put down at the side of the existing road show that there is about 5 to 7 feet of firm brown to dark brown clayey silt fill behind the existing abutments. Below the fill there was a very stiff to hard grey clayey silt till overlain by 1.5 to 2.5 feet of loose grey sand that varies from fine to coarse and can contain clay and organic material. The till forms the major underlying stratum at the site and has a natural water content of about 12 per cent with liquid and plastic limits of about 20 and 12 respectively. A typical grain size distribution curve for the till is shown as Figure 2. The ground-water level was measured about two weeks after completion of drilling to be at Elevation 85.0.

The proposed structure may be founded on spread footings in the till at Elevation 79 or deeper with a maximum allowable bearing pressure of 3 tons per square foot. If the foundations are lowered to Elevation 77, the design bearing pressure may be increased to 4 tons per square foot.

There should be only minor ground-water problems during construction, providing the creek is properly diverted. Any seepage into the excavations can be easily handled with small sump pumps.

We trust that this letter provides sufficient information for the foundation design of the proposed

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structure. If there is any point that requires further explanation, please call our office.

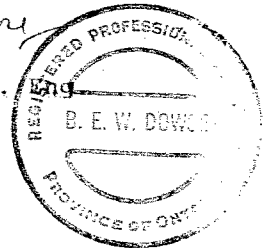
Yours truly,

H. Q. GOLDER & ASSOCIATES LTD.,

*Brian E. W. Dowse*

Brian E. W. Dowse, P. Eng.

BEWD:cmn  
67582  
Nov, 1967



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CONDITION OF ORIGINAL DOCUMENT

## LIST OF ABBREVIATIONS

The abbreviations commonly employed on each "Record of Borehole," on the figures and in the text of the report, are as follows:

### I. SAMPLE TYPES

*AS* auger sample  
*CS* chunk sample  
*DO* drive open  
*DS* Denison type sample  
*FS* foil sample  
*RC* rock core  
*ST* slotted tube  
*TO* thin-walled, open  
*TP* thin-walled, piston  
*WS* wash sample

### II. PENETRATION RESISTANCES

**Dynamic Penetration Resistance:** The number of blows by a 140-pound hammer dropped 30 inches required to drive a 2-inch diameter, 60 degree cone one foot, where the cone is attached to 'A' size drill rods and casing is not used.

**Standard Penetration Resistance, *N*:** The number of blows by a 140-pound hammer dropped 30 inches required to drive a 2-inch drive open sampler one foot.

*WH* sampler advanced by static weight—weight, hammer  
*PH* sampler advanced by pressure—pressure, hydraulic  
*PM* sampler advanced by pressure—pressure, manual

### III. SOIL DESCRIPTION

#### (a) *Cohesionless Soils*

<i>Relative Density</i>	<i>N, blows/ft.</i>
Very loose	0 to 4
Loose	4 to 10
Compact	10 to 30
Dense	30 to 50
Very dense	over 50

#### (b) *Cohesive Soils*

<i>Consistency</i>	<i>c<sub>u</sub>, lb./sq. ft.</i>
Very soft	Less than 250
Soft	250 to 500
Firm	500 to 1,000
Stiff	1,000 to 2,000
Very stiff	2,000 to 4,000
Hard	over 4,000

### IV. SOIL TESTS

*C* consolidation test  
*H* hydrometer analysis  
*M* sieve analysis  
*MH* combined analysis, sieve and hydrometer<sup>1</sup>  
*Q* undrained triaxial<sup>2</sup>  
*R* consolidated undrained triaxial<sup>2</sup>  
*S* drained triaxial  
*U* unconfined compression  
*V* field vane test

#### NOTES:

<sup>1</sup>Combined analyses when 5 to 95 per cent of the material passes the No. 200 sieve.

<sup>2</sup>Undrained triaxial tests in which pore pressures are measured are shown as  $\bar{Q}$  or  $\bar{R}$ .

## LIST OF SYMBOLS

### I. GENERAL

$\pi$	$= 3.1416$
$e$	$=$ base of natural logarithms 2.7183
$\log_e a$ or $\ln a$	natural logarithm of $a$
$\log_{10} a$ or $\log a$	logarithm of $a$ to base 10
$t$	time
$g$	acceleration due to gravity
$V$	volume
$W$	weight
$M$	moment
$F$	factor of safety

### II. STRESS AND STRAIN

$u$	pore pressure
$\sigma$	normal stress
$\sigma'$	normal effective stress ( $\bar{\sigma}$ is also used)
$\tau$	shear stress
$\epsilon$	linear strain
$\epsilon_{xy}$	shear strain
$\nu$	Poisson's ratio ( $\mu$ is also used)
$E$	modulus of linear deformation (Young's modulus)
$G$	modulus of shear deformation
$K$	modulus of compressibility
$\eta$	coefficient of viscosity

### III. SOIL PROPERTIES

#### (a) Unit weight

$\gamma$	unit weight of soil (bulk density)
$\gamma_s$	unit weight of solid particles
$\gamma_w$	unit weight of water
$\gamma_d$	unit dry weight of soil (dry density)
$\gamma'$	unit weight of submerged soil
$G_s$	specific gravity of solid particles $G_s = \gamma_s / \gamma_w$
$e$	void ratio
$n$	porosity
$w$	water content
$S_r$	degree of saturation

#### (b) Consistency

$w_L$	liquid limit
$w_P$	plastic limit
$I_P$	plasticity index
$w_S$	shrinkage limit
$I_L$	liquidity index $= (w - w_P) / I_P$
$I_C$	consistency index $= (w_L - w) / I_P$
$e_{max}$	void ratio in loosest state
$e_{min}$	void ratio in densest state
$D_r$	relative density $= (e_{max} - e) / (e_{max} - e_{min})$

#### (c) Permeability

$h$	hydraulic head or potential
$q$	rate of discharge
$v$	velocity of flow
$i$	hydraulic gradient
$k$	coefficient of permeability
$j$	seepage force per unit volume

#### (d) Consolidation (one-dimensional)

$m_v$	coefficient of volume change $= -\Delta e / (1+e) \Delta \sigma'$
$C_c$	compression index $= -\Delta e / \Delta \log_{10} \sigma'$
$c_v$	coefficient of consolidation
$T_v$	time factor $= c_v / d^2$ ( $d$ , drainage path)
$U$	degree of consolidation

#### (e) Shear strength

$\tau_f$	shear strength
$c'$	effective cohesion
$\phi'$	effective angle of shearing resistance, or friction
$c_u$	apparent cohesion*
$\phi_u$	apparent angle of shearing resistance, or friction
$\mu$	coefficient of friction
$S_i$	sensitivity

\*For the case of a saturated cohesive soil,  $\phi_u = 0$  and the undrained shear strength  $\tau_f = c_u$  is taken as half the undrained compressive strength.

PEN. TEST HAMMER WEIGHT - LB. DROP - INCHES

15-0-5 Percent axial strain at failure

CHECKED

EFFECTS IN NEGATIVE DUE TO  
CONDITION OF ORIGINAL DOCUMENT

## RECORD OF BOREHOLE 2

LOCATION

See Figure 1

BORING DATE

OCT 24, 1967

DATUM

1967

BOREHOLE TYPE

OPEN END


BOREHOLE DIAMETER

4.5"

SAMPLER HAMMER WEIGHT 40 LB. DROP 25 INCHES

PEN. TEST HAMMER WEIGHT - LB. DROP - INCHES

SOIL PROFILE			SAMPLES			ELEVATION SCALE	DYNAMIC PENETRATION RESISTANCE BLOWS / FT. -----					COEFFICIENT OF PERMEABILITY k, CM. / SEC.					ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
ELEVATION DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	BLOWS / FT.		SHEAR STRENGTH $C_u$ , LB. / SQ. FT.					WATER CONTENT, PERCENT <div style="display: flex; justify-content: space-between; width: 100%;"> <span>W<sub>p</sub></span> <span>W</span> <span>W<sub>L</sub></span> </div> <div style="display: flex; justify-content: space-between; width: 100%;"> <span>10</span> <span>20</span> <span>30</span> <span>40</span> </div>						
60.6	SPONGE FILL		1	1	7													
60.0	FINE BROWN TO DARK BROWN CLAYEY SILT WITH SOME SAND AND GRAVEL AND SOME SAND ZONES (FILL)		2	1	9													
52.1			3	1	7													
7.5	DENSE TO MEDIUM TO COARSE SAND		4	1	33													
79.3			5	1	70													
10.0			6	1	74													
	HARD GREY CLAYEY SILT TILL WITH OCCASIONAL SAND AND GRAVEL		7	1	100													
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 15% Percent axial strain at failure
VERTICAL SCALE  
1 INCH TO 50'

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DRAWN 1/1  
CHECKED 1/1

PROTECTIVE PIPE

PIEZOMETER

STANDPIPE

INSTALLATION

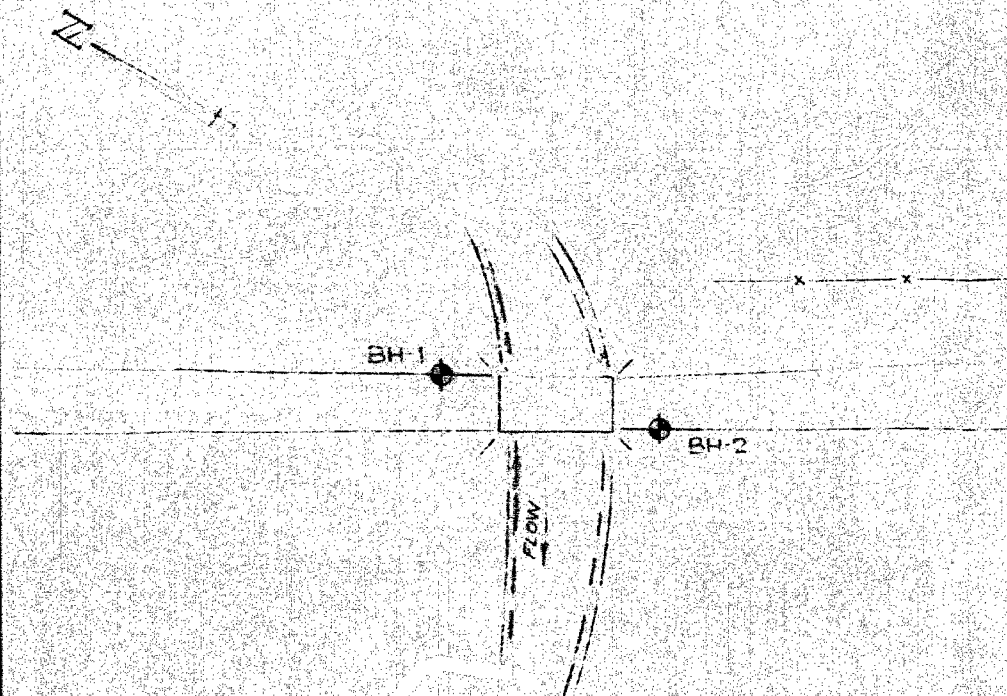
WATER LEVEL IN

STANDPIPE AT

ELEVATION 84.6

NOV 8, 1967

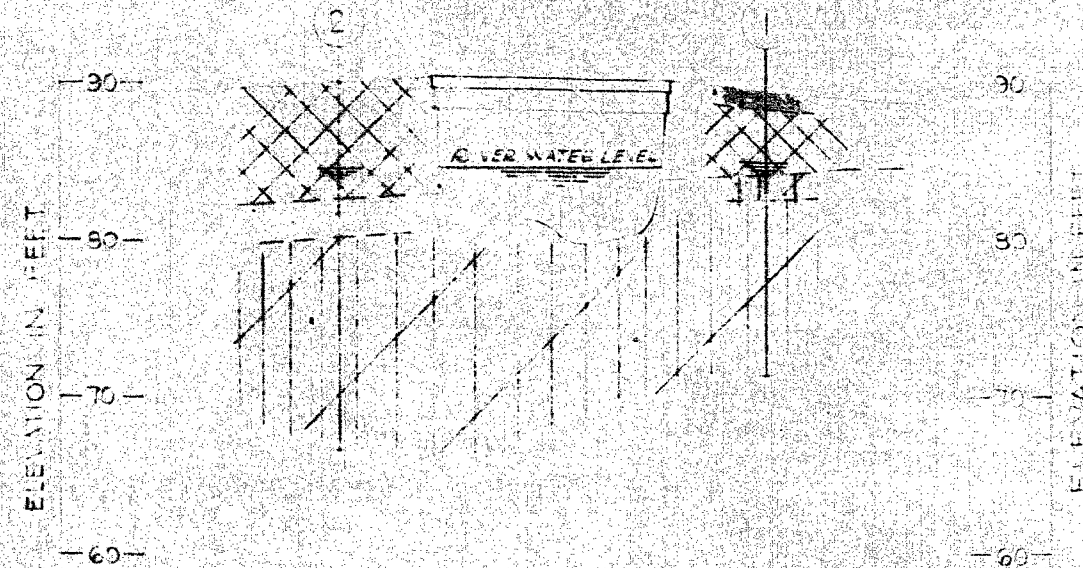




SCALE: 1" TO 40'

REFERENCE

TOWNSHIP OF WEST NISSEAU  
 R. C. DUNN AND ASSOCIATES  
 STABLETT BOULGE  
 LOCATED ON ROAD BETWEEN CON.  
 VI AND VII LOT 32 TOWNSHIP OF  
 WEST NISSEAU

SECTION ALONG CENTRELINE OF ROAD

HORIZONTAL - 1" TO 20'  
 VERTICAL - 1" TO 10'

STRATIGRAPHY

- LOOSE SAND AND GRAVEL (ROADBASE)
- FIRM BROWN TO DARK BROWN CLAYEY SILT  
SOME SAND AND GRAVEL (FILL)
- DENSE GREY MEDIUM TO COARSE SAND
- LOOSE GREY SILTY FINE SAND, TRACE OF  
CLAY AND SLIGHTLY ORGANIC.
- COMPACT TO HARD GREY CLAYEY SILT TILL  
WITH OCCASIONAL SAND AND GRAVEL

LEGEND

- BOREHOLE IN PLAN
- BOREHOLE IN SECTION
- WATER LEVEL IN BOREHOLE  
NOV 8, 1967

SPECIAL NOTE: DATA CONCERNING THE VARIOUS STRATA HAVE BEEN OBTAINED AT BOREHOLE LOCATIONS ONLY. THE SOIL STRATIGRAPHY BETWEEN BOREHOLES HAS BEEN INFERRED FROM GEOLOGICAL EVIDENCE AND SO MAY VARY FROM THAT SHOWN.

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 CONDITION OF ORIGINAL DOCUMENT

Drawn NOV. 9, 1967

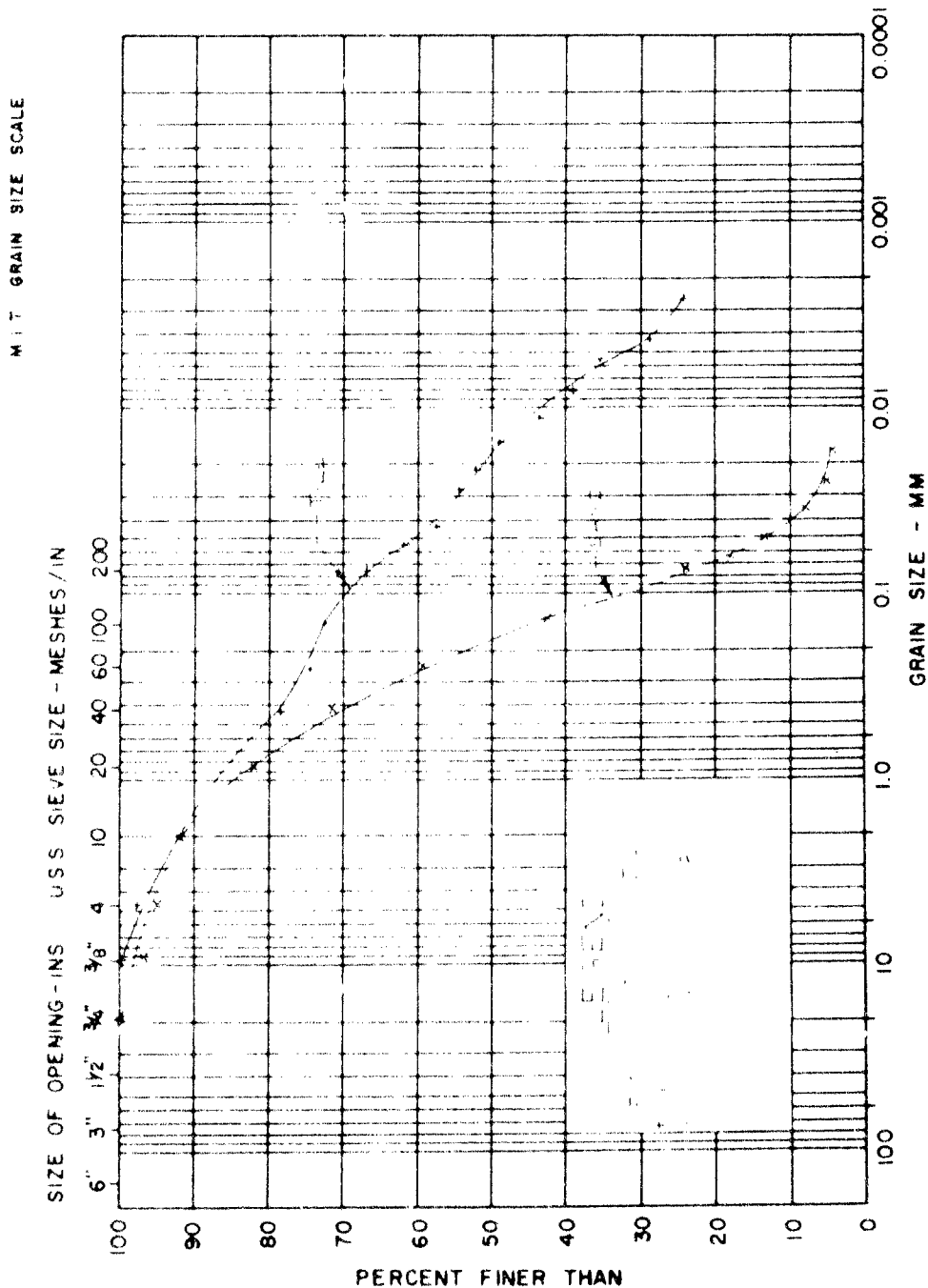
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Made   
 Chkd   
 Appd

# GRAIN SIZE DISTRIBUTION

FIGURE

PROJECT No.



COBBLE SIZE	COARSE	MEDIUM	FINE	SAND SIZE			SILT SIZE		CLAY SIZE	
	GRAVEL SIZE			COARSE	MEDIUM	FINE	FINE GRAINED		FINE GRAINED	

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