

A. M. SPRIET AND ASSOCIATES LIMITED  
CONSULTING ENGINEERS  
264 WELLINGTON STREET  
LONDON ONTARIO

BA 2243

STAMPED FILE NO. 20-104

Report on  
SOIL INVESTIGATION  
for  
ROAD BRIDGE  
LOT 4, CONCESSIONS 7 AND 8  
TOWNSHIP OF N WALSHINGHAM

by

DOMINION SOIL INVESTIGATION LIMITED  
369 Queens Avenue  
LONDON ONTARIO  
Reference No. 5-10-L5  
November 11th, 1965

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## ENCLOSURES

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SUMMARY

The natural soil profile consists of loose sandy silt (8'-0" to 8'-6" thick); soft organic silt (4'-6" to 6'-6" thick); loose to dense silt and silty fine sand (10'-0" to 10'-6" thick); and very stiff silty clay (12'-6" maximum penetrated).

It is recommended that the structure be supported on a piled foundation and several types of piles are considered.

## I INTRODUCTION

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

The existing steel-beam structure is located on Lot 4 Concessions 7 and 8 of the Township where the road crosses Venison Creek.

It is understood that the creek will be relocated and the transverse centre line of the proposed structure, will be about 140 feet to the east of the centre line of the existing bridge. The requirements of the project were discussed with Mr. A. J. DeVos, P. Eng., who supplied the foregoing information.

The purpose of this investigation was to reveal the sub-surface 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 November 4 and 5, 1965, at the locations shown on Enclosure 2. The holes were advanced by wash boring 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<sub>60</sub> 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.

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 indicated by the client (Spike in hydro pole on north side of road, 100 feet east of existing bridge, El. 100 feet).

### III 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) Road Ballast	1'-0" to 1'-6"
(b) Brown sandy silt. The relative density of this stratum is described as 'loose' as estimated from standard penetration test results ranging from 2 to 4 blows per foot.	8'-0" to 8'-6"
(c) Grey organic silt. This stratum contains decomposed roots and wood fibres and exhibits some cohesion. The consistency described is soft as indicated from standard penetration test results ranging from 0 to 2 blows per foot.	4'-6" to 6'-6"
(d) Grey silt, sandy silt and silty fine sand. This stratum is inorganic and non-plastic. The relative density is generally described as 'loose' as estimated from standard penetration test results ranging from 3 to 11 blows per foot. However, the lower part of this stratum at borehole 1 location is in a very dense condition as estimated from a standard penetration test value of 64 blows per foot.	10'-0" to 10'-6"

- (e) Grey silty clay. penetrated  
 This is a cohesive 12'-6" in borehole 2.  
 plastic material and  
 based on visual and  
 tactile examination  
 the moisture content  
 is slightly above  
 the plastic limit of  
 the soil. There is no  
 significant change in  
 shear strength through-  
 out the depth investigated  
 and the consistency is  
 described as 'very stiff'  
 as indicated by standard  
 penetration test results  
 ranging from 19 to 31  
 blows per foot.

#### IV LABORATORY TESTS

A series of laboratory tests was performed on samples of the silty clay stratum.

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 26% and 27%; Plastic Limit of 17% and 18%; and Plasticity Index of 8% and 10% 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 consistency Limits were 0.25 and 0.30 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.

#### V GROUNDWATER CONDITIONS

The water level in the creek at the time the field work was carried out was at El. 93.6.

The ground water in the boreholes reached equilibrium at an average level of El. 95.7, about 2 feet higher than the level of the creek at the time of the investigation.

#### VI DISCUSSION

The soil profile consists of loose or soft highly compressible deposits extending down to El. 75±, therefore the most economical type of support for the bridge footings will probably be a piled foundation. It will be

appropriate for the piles to penetrate into the very stiff clay stratum, with the resulting working load being mobilized partly by end-bearing and partly by friction along the side of the pile.

In the prevailing conditions relatively short driven piles, penetrating 5 to 10 feet into the clay stratum will be the most economical because of the difficulties which would be encountered in driving piles to a considerable depth in the very stiff clay stratum. In the following paragraphs several types of pile are considered.

#### (a) Timber Piles

Timber piles would be expected to achieve a suitable set between El. 68 and El. 65, however at borehole 1 location difficulty may be encountered in penetrating the dense silt layer at El. 75 and provision should be made to jet the piles through this layer. The ultimate bearing capacity of a pile is estimated from the sum of the end-bearing and skin-friction components. For a pile with a 10-inch diameter tip the end-bearing component will be 8 tons, independent of the depth to which the pile is driven into the clay stratum, and the skin friction component will be 2 tons per foot of penetration of the pile into the clay stratum. As an example, the ultimate bearing capacity of a pile driven 6 feet into the clay stratum will be made up of the 8 tons end-bearing component plus the 12 tons attributed to skin friction, resulting in a 20 ton ultimate capacity.

A factor of safety of 2 is usually applied in the design of piles, therefore the allowable working load for such a pile would be 10 tons.

It is estimated that consolidation settlement of a structure supported on a timber pile foundation will be less than 1/2 inch.

#### (b) Precast Concrete Piles

As in the case of the timber pile, the ultimate bearing capacity of a precast concrete pile would consist of an end-bearing and a skin-friction component. The following ultimate load values have been calculated for 9-inch, 12-inch and 15-inch square sections:-

Section	Ultimate bearing capacity	
	End-bearing	Skin-friction/foot penetration into clay stratum.
	tons	(tons)
9-inch square	7.5	2
12-inch square	13.5	2.7

15-inch square

20

3.4

A factor of safety not less than 2 should be applied to the foregoing figures in calculating the working load.

(c) Concrete filled steel-tube Piles

A 12-inch diameter steel tube pile will develop an end-bearing capacity of 10 tons and a skin friction resistance of 2 tons per foot penetration of the pile into the clay stratum. These ultimate values are not significantly greater than those for the timber pile, therefore this type of pile has no apparent advantages and would be more costly.

The Franki-type displacement caisson with an expanded base would probably be more economical than a steel pile. Safe working load of 30 to 35 tons per pile could be achieved with 30-inch diameter bulbs formed between El. 65 and El. 70. It would be necessary to encase that part of the shaft passing through the soft and loose deposits in a permanent thin-walled steel shell.

The foregoing estimates of length and bearing capacity of piles are only theoretical predictions, therefore in practice, the piles should be driven to a satisfactory set in accordance with an accepted dynamic pile driving formula such as the Hiley formula, irrespective of the elevation at which such a set is achieved provided that it is below elevation 75. It is recommended that at least one pile loading test be carried out.

In conclusion, the use of a timber pile foundation will probably be the least expensive, although choice of design may depend on other factors such as availability of material, speed of construction etc.

Dewatering of the excavations for the pile caps can probably be done by pumping from filtered sumps. If the side slopes of the excavation prove to be unstable timber sheeting should be driven to provide lateral support.

Yours very truly,

DOMINION SOIL INVESTIGATION LIMITED

*C.W. Atkinson*

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



CJWA:jms



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	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 :



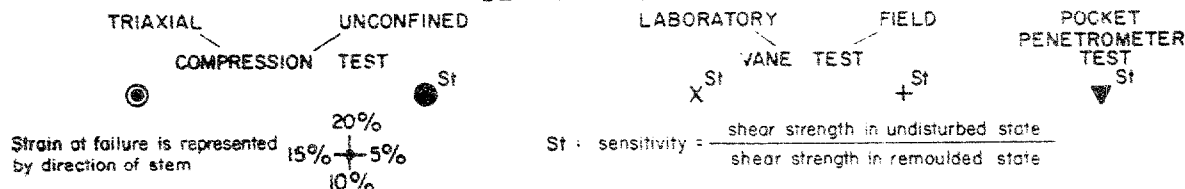
322

## SOIL PROPERTIES.

W %	Water content	γ <sub>n</sub>	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 <sub>i</sub>	Cohesion
LI	Liquidity index	m <sub>v</sub>	Coeff. of volume compressibility	φ'	Angle of int friction

## UNDRAINED SHEAR STRENGTH.

— DERIVED FROM —



## SOIL DESCRIPTION.

### COHESIONLESS SOILS :

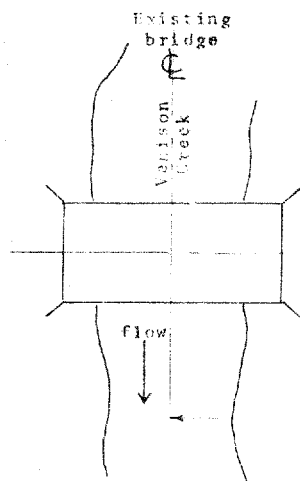
Very loose	0 - 15 %
Loose	15 - 35 %
Compct	35 - 65 %
Dense	65 - 85 %
Very dense	85 - 100 %

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



Township of N. Walsingham

Road Allowance

Conc 8

Conc 7

Proposed

BH.1

4'

BH.2

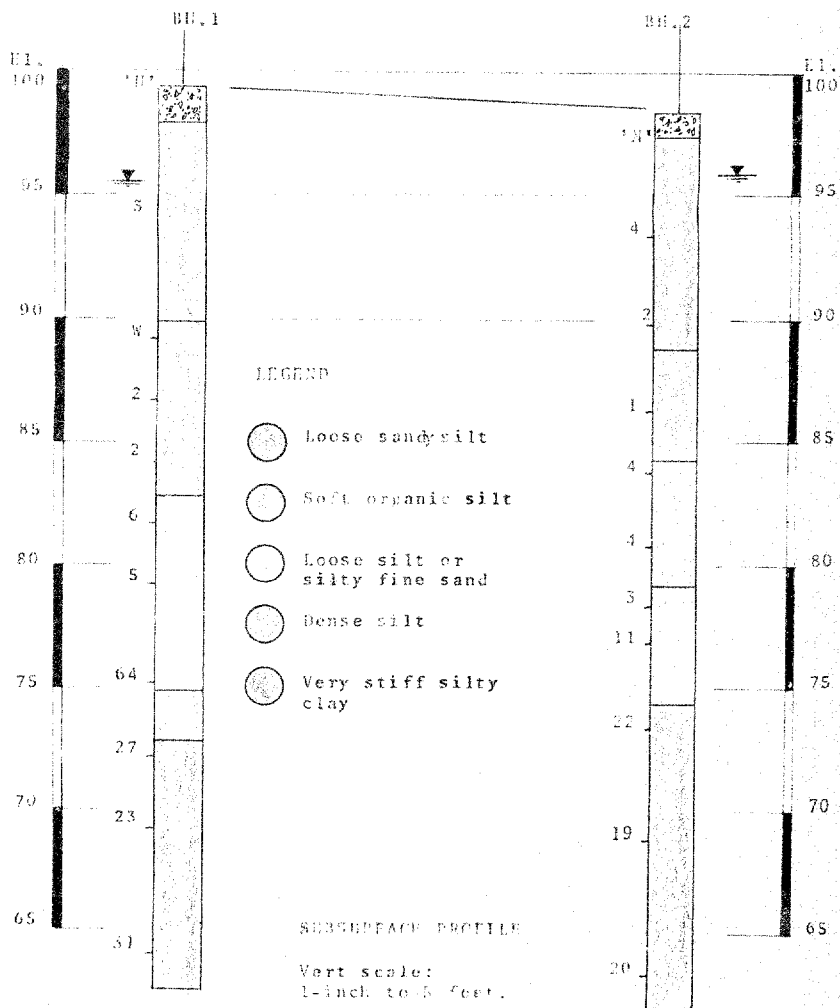
8'

140'

20'

# LOCATION OF BOREHOLES

Scale 1-inch to 20 feet



# GEOTECHNICAL DATA SHEET FOR BOREHOLE 11111

OUR REFERENCE NO: 5-10-13

CLIENT: A. V. Spry and Associates  
PROJECT: Pond Bridge  
LOCATION: W. Walsingham Township  
DATUM ELEVATION: 100 Feet

METHOD OF BORING: Washboring  
DIAMETER OF BOREHOLE: 1 1/2 (3-inch)  
DATE: November 4, 1965

ENCLOSURE NO: 3

ELEVATION ft	DEPTH ft	STRATIFICATION DESCRIPTION	STRATIFICATION SYMBOL	SAMPLES			PENETRATION RESISTANCE blows per foot					CONSISTENCY Water content %				REMARKS
				NUMBER	TYPE	N <sub>60</sub> or adj. value of sample	20	40	60	80	100	PL	WL	SH	LL	
89.1	0.0	Ground Surface														
		Road Ballast														
85	1.3	Loose brown sandy silt.		1	SS	3										
80	9.5	Soft grey organic silt		2	SS	10										
				3	SS	2										
85	16.0	Loose grey sandy silt, trace of organics		4	SS	5										
80				5	SS	6										
				6	SS	5										
75	24.5	House grey silt.		7	SS	64										
70	26.5	Very stiff grey silty clay.		8	SS	27										
				9	SS	23										
65	36.5			10	SS	34										
60		End of Borehole														

W. L.  
Fl. 95.5  
Nov. 4,  
1965.

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

OUR REFERENCE NO. 5-10-15

CLIENT A. M. Spriet and Associates  
PROJECT Road Bridge  
LOCATION N. Walsingham Township  
DATUM ELEVATION 100 feet

METHOD OF BORING Washboring  
DIAMETER OF BOREHOLE 1 1/2 (3-inch)  
DATE November 5, 1965

ENCLOSURE NO. 4

ELEVATION ft	DEPTH ft	STRATIFICATION DESCRIPTION	STRATIFICATION SYMBOL	SAMPLES			PENETRATION RESISTANCE blows per foot				CONSISTENCY water content %				REMARKS
				NUMBER	TYPE	NO. OF SUBSAMPLING	20	40	60	80	100	PL	W	LI	
98.4	0.0	Ground Surface													
	1.0	Road Ballast													
95		Loose brown sandy silt.		1	SS	4									
90	9.5	Soft grey organic silt		2	SS	2									
85	14.0	Loose grey silt		3	SS	1									
80	19.2	Loose grey silty fine sand.		4	SS	4									
75	24.0	Very stiff grey silty clay		5	SS	4									
70				6	SS	3									
65				7	SS	11									
60	36.5	End of Borehole		8	SS	22									
				9	SS	19									
				10	SS	20									

W. L.  
11.95.9  
Nov 5,  
1965.

Mr. K. L. Kleinstaiber,  
Municipal Bridge Liaison Engr.,  
Bridge Division.

Foundation Section,  
Materials & Testing Div.,  
Room 107, Lab. Bldg.

Attn: Mr. G. C. E. Burkhardt,  
Mun. Bridge Checking Engr.

February 17, 1966

Your Memo -- Feb. 9/66

Township of North Walsingham,  
Venison Creek Bridge,  
Lot 4, Con. VII/VIII,  
County of Norfolk,  
Structure Site No. 20-104,  
Your File Ref. BA 2243 -  
Soils Report by Dominion Soil  
Investigation Ltd.

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With reference to your memo of February 9, 1966, in regard to the above-mentioned structure, we herewith submit our comments for your consideration:

We are in full agreement with the chosen design based on the recommendation contained in the Foundation Report (No. 3-10-L5). However, we would not agree with the consultant's recommendation that jetting be used in order to penetrate the piles through the dense silt layer overlying the silty clay in B.H. 1. If refusal is met, piles should be stopped because no benefit could be derived from penetrating this layer to have the piles end in the underlying inferior deposit.

In view of the properties of the subsoil at the proposed new culvert location, it appears to us that dispensing with the piles could create some very undesirable consequences, such as differential settlements which could cause the structure to break.

AGS/KlaF

*A. G. Stermac*  
A. G. Stermac,  
PRINCIPAL FOUNDATION ENGINEER

cc: Foundations Office ✓  
Gen. Files

## MEMORANDUM

To: A. Stermac, P. Eng.,  
Principal Foundation Engineer,  
Room 107, Lab. Bldg.

From: Bridge Division,  
Downsview, Ontario.

Date: February 9, 1966.

Our File Ref.


In Reply To

Subject: Township of North Walsingham,  
Venison Creek Bridge,  
Lot 4, Con. VII/VIII,  
County of Norfolk,  
Structure Site No. 20-104.

Enclosed please find one copy of the Foundation Report, by Dominion Soil Investigation Limited, and one copy of the Plans for above mentioned structure.

We would appreciate it very much, if you could give us your comments to the report on or before February 18th, 1966. We also would like to know, if piles are necessary for a box type structure at this site and at the proposed elevation.

GCEB/im  
Encl.

  
G. C. E. Burkhardt, P. Eng.,  
Municipal Bridge Checking Engineer.

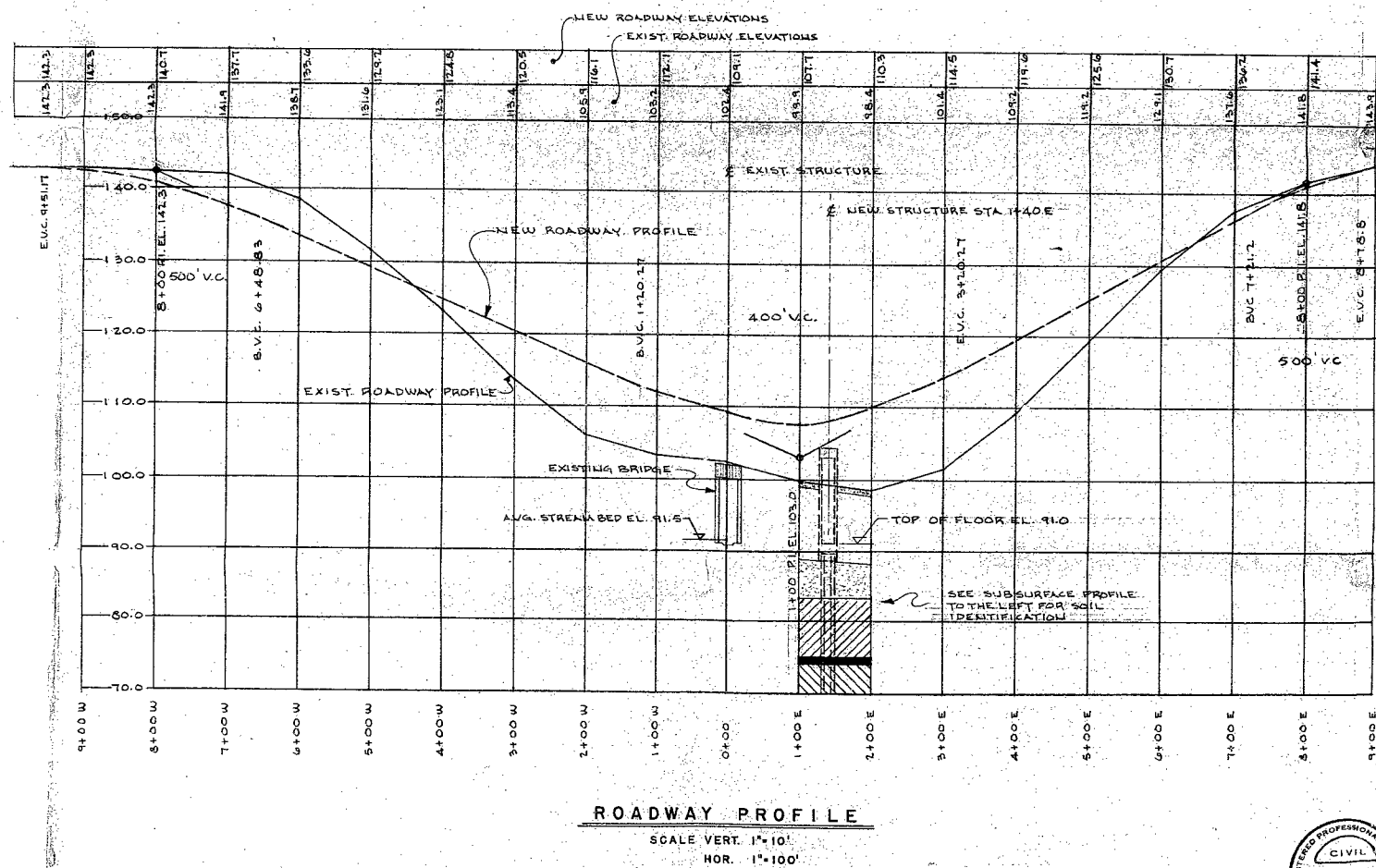
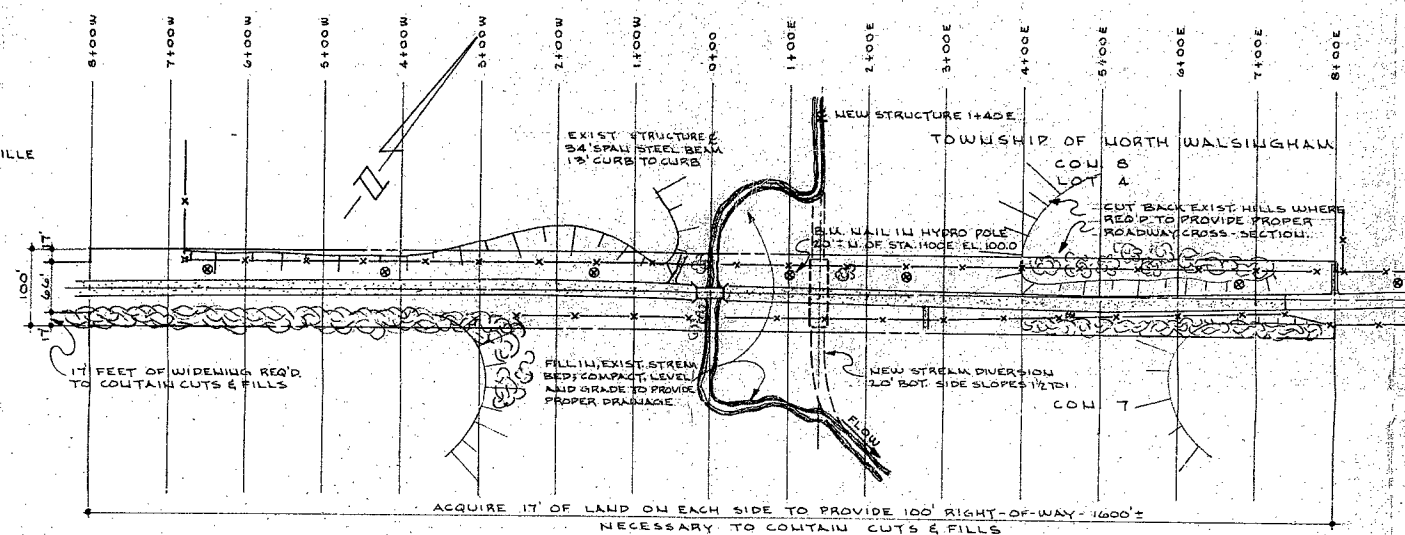
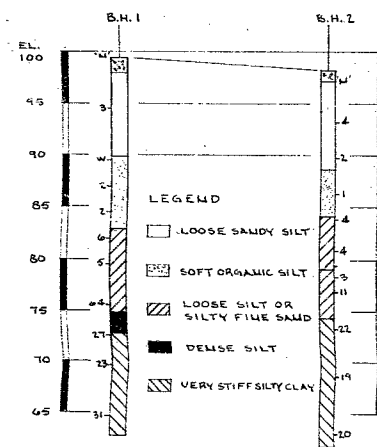
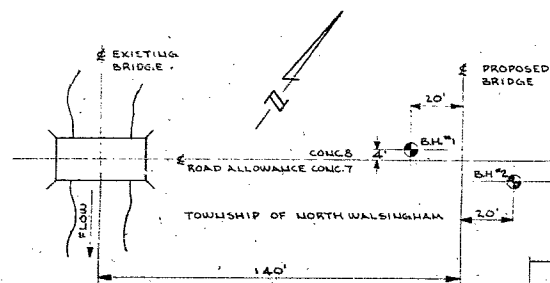
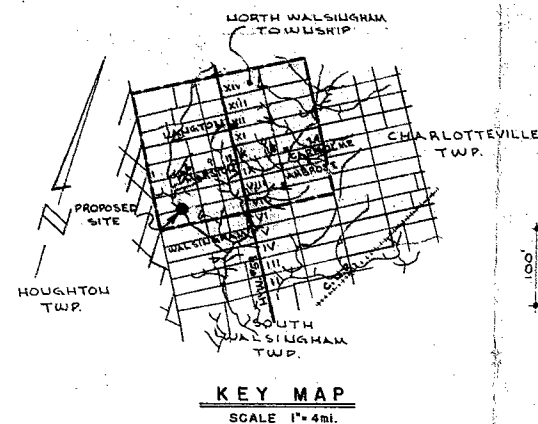
#65-F-285 M

ROAD BRIDGE

LOT #4 CONS. 708

N. WALSINGHAM  
TWP.





#### GENERAL NOTES

- Structure designed for H20-S16 loading.
- Work on the structure must not be commenced until monuments to fix control points have been erected and checked by the engineer.
- Structure to be built in accordance with D.H.D. Form No. 9 (Revised).
- The structure shall be supported on timber piles. Design load is 20 tons. The soil report by Dominion Soils Investigation Ltd., may be seen in the Engineers' office. The Engineer does not guarantee the accuracy of this report.
- Footings excavation to be finished to the next dimensions and the concrete shall be poured against undisturbed material if applicable.
- No concrete shall be placed in the footings before the character of the soil and excavation for footings has been approved by the engineer.
- Concrete Mix:
  - Minimum strength at 28 days 3000 psi.
  - All concrete except in footings shall include an approved air entraining agent.
  - Maximum size of aggregate shall be 2" in deck slab, curb and guardrail; 1 1/2" in footings and 1" elsewhere or as specified.
  - Concrete Mix 1-2-3-5.
- All exposed edges to be chamfered 1" unless otherwise noted. All acute angles shall be filletted as noted.
- No concrete to be poured before materials, mix, formwork, falsework, and reinforcing have been checked by the Engineer.
- Deck falsework shall not be struck until all backfill has been placed and compacted behind the abutments, to the satisfaction of the Engineer.
- Backfill behind abutments to be brought up simultaneously at both ends.
- Construction joints not shown on plans must be approved by the Engineer.
- Reinforcing steel to be Hi-Bond. Clear cover unless otherwise noted; 3" in footings and all surfaces in contact with earth or water; 1 1/2" in bottom of decks; 2" elsewhere.
- Backfill for the roadway shall be approved fill material. The top 18 inches shall be 12" Granular "B" material and 6" Granular "A" material.

#### DATA

- Special Features: No scouring, banks stable, No ice problem.
- This 20' span Concrete Box culvert replaces an existing 34' span steel beam structure, roadway width 13'.
- Existing Structures:
  - 2 1/2 miles upstream - 18' x 12' Concrete Box Culvert.
  - 1 mile downstream - 20' x 12' Concrete Box Culvert.
- Ditch gradient will not be lowered.
- Temporary detour will be required. Contractor will build and maintain it.
- Data obtained from local residents reflect highest water elevation in the area of this construction to be 99.5' and the lowest water elevation to be 91.5'.
- Design Speed: 4.5 M.P.H.
- A.D.T. 100+
- Stopping Sight Distance: 275'

#### STRUCTURE DATA

- Net span length and type of bridge: 20' SPAN CONCRETE BOX CULVERT
- Roadway width on bridge: 13'
- Skew Angle: NONE
- Length and type of piling: 68'-10" TIP DIA. WOODEN PILES  
@ 23' LONG - 27.44 LIN. FT.
- Approx. Weight of Reinforcement: 19.71 TONS
- Approx. Volume of Concrete: 407 CU. YD.
- Approx. volume of approach fill within 100' each side of structure: 2717 CU. YD.
- Drainage Area: APPROX. 2.5 SQ. MI.

Field Investigation Made DEC. 6 1965

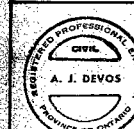
By: A. J. DEVOS, P. ENG.  
(Survey Engineer)

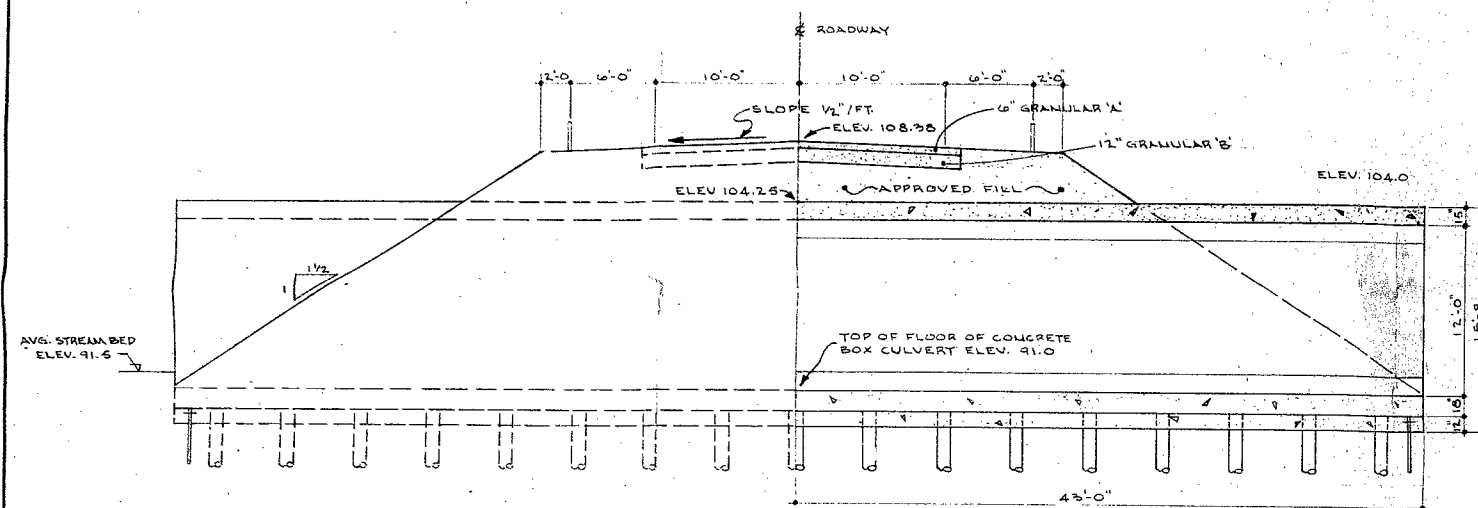
#### BRIDGE CONCESSION 788 LOT 4

OWNER - TOWNSHIP MUNICIPAL DISTRICT NO. 2  
TOWNSHIP - N. WALSHINGHAM CONCESSIONS 7 & 8  
COUNTY - NORFOLK LOT 4

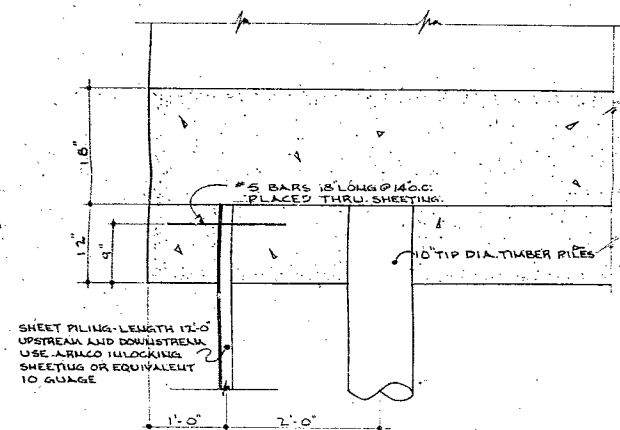
#### SITE PLAN

SCALE: AS SHOWN APPROVED BY: JOB NO. 8583 DRAWN BY: E.W.  
DATE: 17-1-66 REVISIONS:  
GEORGE EMERICK  
RD. SUPT.  
A. M. SPRIET & ASSOCIATES LTD.  
CONSULTING ENGINEERS  
DRAWING NUMBER: 1

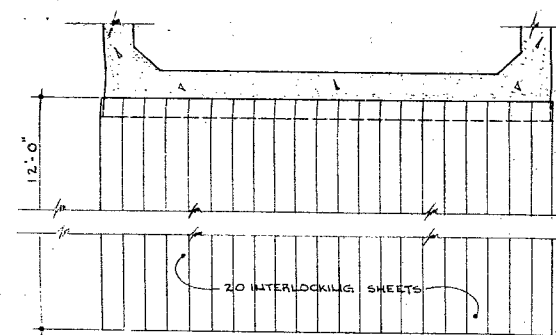




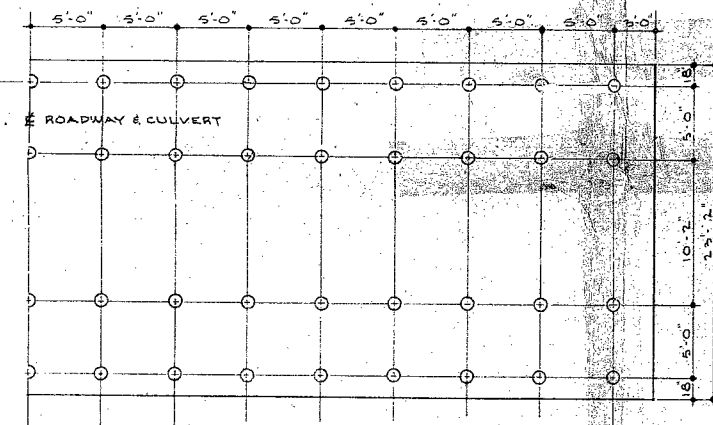
HALF ELEVATION HALF SECTION  
SCALE 3/16" = 1'-0"



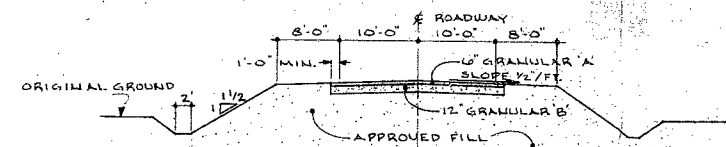
SHEET PILING DETAIL  
SCALE 1" = 1'-0"



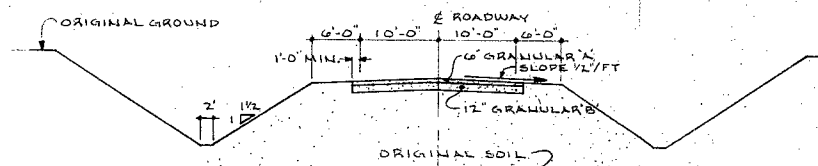
SECTION SHOWING CURTAIN WALL  
SCALE 1/4" = 1'-0"



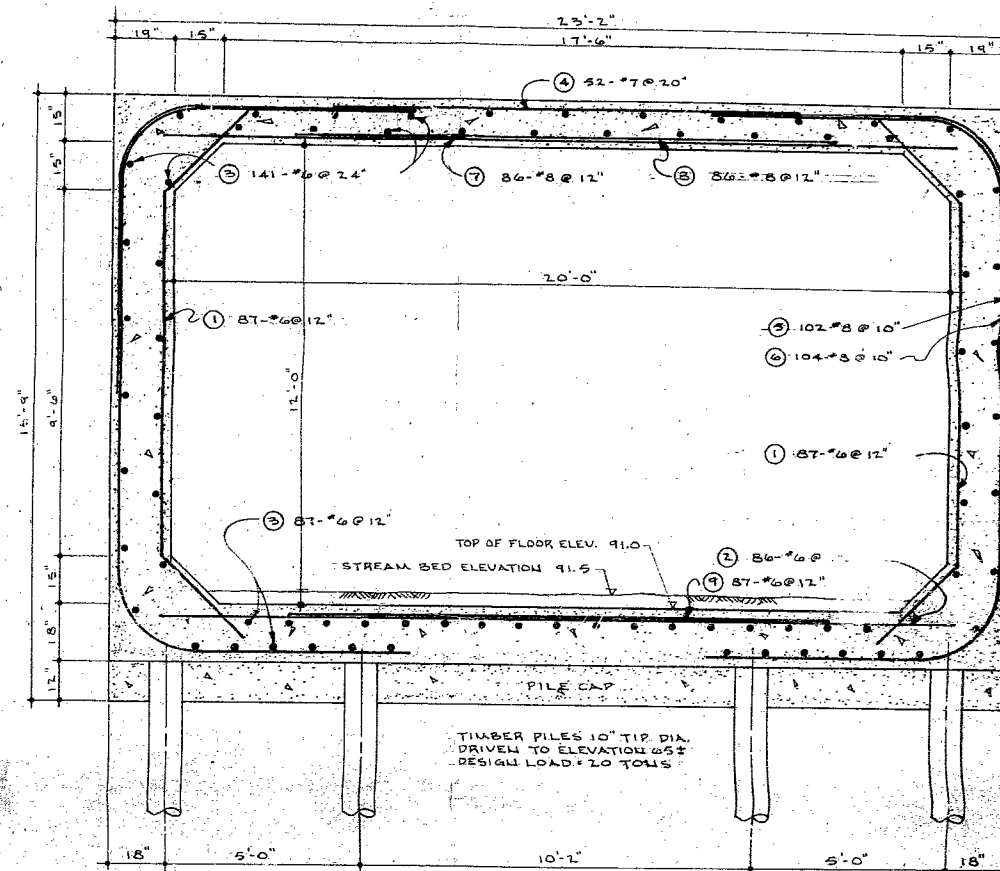
HALF PILING PLAN  
SCALE 3/16" = 1'-0"



ROADWAY FILL SECTION  
SCALE 1" = 10'

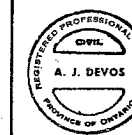


ROADWAY CUT SECTION  
SCALE 1" = 10'



SECTION SCALE 1/2" = 1'-0"

MARK	LOAD	SIZE	LENGTH	SPACE	SHAPE
1	174	#6	15'-6"	12" O.C.	BAR (1)
2	86	#6	20'-6"	12" O.C.	BAR (2)
3	228	#6	29'-10"	VARIES	BAR (3)
4	52	#7	12'-0"	20" O.C.	BAR (4)
5	102	#8	14'-2"	10" O.C.	BAR (5)
6	104	#8	27'-6"	10" O.C.	BAR (6)
7	86	#8	20'-6"	12" O.C.	BAR (7)
8	86	#8	14'-0"	12" O.C.	BAR (8)
9	86	#6	14'-0"	12" O.C.	BAR (9)



BRIDGE CONCESSION 788 LOT 4			
TOWNSHIP OF NORTH WALSHAM			
SCALE: AS SHOWN	APPROVED BY:	JOB NO.	DATE BY E.E.W.
	A. J. DEVOS	8563	REVIEWED
DATE: 17-1-1966			
PLAN, SECT. & ELEV.			
A. M. SPRIET & ASSOCIATES LTD.			
CONSULTING ENGINEERS			
DRAWING NUMBER 2			