

DEPARTMENT OF HIGHWAYS ONTARIO

MEMORANDUM

To: Mr. B. R. Davis,
Bridge Engineer,
Bridge Division.
Attention: Mr. S. McCombie

FROM: Foundation Section,
Materials and Testing Div.,
Room 107, Lab. Bldg.

DATE: March 25, 1966

OUR FILE REF.

IN REPLY TO

APR - 5 1966

SUBJECT:

FOUNDATION INVESTIGATION REPORT

On

The Site of the Proposed Crossing
Lynn River and Hwy. No. 24, Town
of Simcoe, District No. 2 (London)

W.J. 66-F-12 -- W.F. 251-62

Attached, we are forwarding to you, our detailed foundation investigation report on the subsoil conditions existing at the above structure site.

We believe that you will find the factual data and recommendations contained therein, adequate for your design requirements. Should additional information be required, please feel free to contact our Office.

AGS/WdeP
Attach.

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

cc: Messrs. B. R. Davis (2)
H. A. Tregaskes
D. W. Farren
A. Gater
H. C. Dernier
J. Roy
A. Watt

Foundations Office
Gen. Files

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FOUNDATION INVESTIGATION REPORT
On
The Site of the Proposed Crossing
Lynn River and Hwy. No. 24, Town
of Simcoe, District No. 2 (London).
N.J. 66-F-12 -- W.P. 251-62

1. INTRODUCTION:

In a memo dated January 11, 1966, the Bridge Location Section requested a foundation investigation at the site of the proposed Lynn River and Hwy. 24 crossing. The supervision of the field investigation as well as the laboratory tests, were undertaken by this Section. Presented in this report are the results of the above investigation, together with recommendations regarding the foundations.

2. DESCRIPTION OF THE SITE:

The crossing of Lynn River and Hwy. 24 is located at the north side of the Town of Simcoe, some 700 - 800 ft. north of the crossing of Hwy. 3 and Hwy. 24. The existing bridge is a 39-ft. long, single-span truss bridge, some 30 ft. wide.

Physiographically, the area is known as the "Norfolk Sand Plain". The sands and silts of this region were deposited as a delta in glacial lakes Whittlesey and Warren. Most of the moraines are partially or entirely buried by these sands, the depth of which is usually around 30 ft.

3. FIELD INVESTIGATION PROCEDURE:

Four boreholes and 2 cone penetration tests were carried out during the field investigation, using a conventional diamond drill rig adapted for soil sampling purposes. Soil samples were recovered by means of split-spoon samplers, and the Standard Penetration "N" values were recorded. A driving energy of 350 ft. lbs.

3. FIELD INVESTIGATION PROCEDURE: (cont'd.) ...

was utilized for the standard and cone penetration tests.

Locations and elevations of the boreholes may be seen on Drawing No. 66-F-12A, appended to this report.

4. SUBSOIL CONDITIONS:

4.1) General:

Soil samples were visually examined and identified upon recovery. In the laboratory, standard tests were performed on representative samples in order to determine the natural moisture contents, plasticity and grain size characteristics of the soils.

The test results are plotted on the borelogs under Appendix I. The soil profile and cross sections are shown on Drawing No. 66-F-12A.

A brief discussion of the subsoils follows:

4.2) Silty Sand:

At each borehole location below a 1.5 ft. thick layer of organic topsoil, a silty sand deposit was encountered, extending to a depth of 20.5 - 28.5 ft. (El. 669-672 ft.). The relative densities of the stratum vary from loose to very dense, the "N" values ranging from 3 to 73 blows/ft. Some gravel was observed in certain locations, but the predominant grain sizes of the layer were sand (above 50%) and silt.

4.3) Silt to Clayey Silt:

The silty sand was underlain by a silt to clayey silt deposit of cohesive nature, extending to the bottom of the boreholes, (El. 645 - 631.5 ft.). The consistency of the grey-coloured layer was found to be very stiff to hard, as indicated by the Penetration "N" values of 23 to 91 blows/ft. There is a noticeable trend of increasing hardness with depth. The deposit exhibited slight plasticity, having plastic limits from 16.4 to 17.9%, and liquid limits between 20.1 and 29.7%. The liquidity indices were found

cont'd. /3

4. SUBSOIL CONDITIONS: (cont'd.) ...

to be higher than 1.0 in most cases; however, this does not seem to be reflected in the consistency of the soil which is generally hard. The grain size distributions of the samples revealed roughly 80% silt size particles, the remainder being in the clay range.

5. GROUND WATER CONDITIONS:

Free ground water level was observed in each borehole at around El. 687.5 ft., which is the same as the elevation of the prevailing water level of the Lynn River. Due to the high permeability of the silty sand subsoil, it is assumed that any rise of the river water will induce an equivalent rise in the ground water as well.

6. DISCUSSION AND RECOMMENDATIONS:

It is proposed to construct a new bridge at the crossing of Hwy. 24 and Lynn River. The span of the proposed bridge is designed to be 40 ft., the width being 62 ft., with a 30° skew. The strength of the upper subsoil layers does not appear to be adequate to support the structure economically on spread footings; consequently, piled foundations are recommended. It is felt that large displacement steel piles driven down to El. 640 - 650 ft., would be adequate for this purpose. In the case of 12 $\frac{3}{4}$ " diam. steel tube piles driven to the above elevation, it is estimated that a design load of approx. 50 T/pile can be achieved. It is recommended, however, that the working load on the piles be checked during pile driving, according to the Hiley formula (D.H.O. Standards DD 1218 and 1219).

The elevation of the pile caps will be governed by the depths of frost penetration. The excavations for the pile caps are likely to be below ground water level. Dewatering for the excavations will be necessary, since the silty sand soils are susceptible to

cont'd. /4

6. DISCUSSION AND RECOMMENDATIONS: (cont'd.) ...

"boiling" under unbalanced hydrostatic conditions. Dewatering may be achieved by employing a wellpoint system, or by excavating inside a cofferdam of interlocking sheet piles. In the latter case, piles should be driven to a depth below the bottom of the excavation equal to or larger than the distance between the ground water level and the bottom of the excavation in order to prevent "boiling".

No stability problem is foreseen for the approaches, since the proposed grade is the same as the present one. If open spill-through type abutments are to be used, the end slopes should be protected against scour.

7. SUMMARY:

The foundation investigation for the proposed new bridge at the crossing of Hwy. 24 and Lynn River is reported.

Subsoil was found to consist of silty sand and silt to clayey silt deposits.

Due to the subsoil conditions, piled foundations are recommended for the proposed structure. In the case of 12 $\frac{3}{4}$ in. diam. steel tube piles driven to El. 640 - 650 ft., a design load of approx. 50 T/pile is recommended. Pile driving should be checked in the field by means of the Hiley formula.

Dewatering will likely be necessary for the excavations as described under Section 6.

No stability problems for the approaches is anticipated.

cont'd. /5

8. MISCELLANEOUS:

The field work, performed during the period February 2 to 7, 1966, was supervised by Mr. W. W. Kulmatickas, Project Foundation Engineer.

Equipment used was owned and operated by Johnston Drilling Co. Ltd.

This report was prepared by Mr. A. K. Barsvary, Project Foundation Engineer.

The general supervision was undertaken by Mr. K. G. Selby, Senior Foundation Engineer.

March 1966

APPENDIX I

FOUNDATION SECTION

CHECKED BY K.G.S.

[illegible]

MATERIALS & TESTING DIVISION

FOUNDATION SECTION

ORIGINATED BY W.W.K.

COMPILED BY W.W.K.

CHECKED BY K.G.S.

[illegible]

DEPARTMENT OF HIGHWAYS - ONTARIO

RECORD OF BOREHOLE NO. 3

FOUNDATION SECTION

MATERIALS & TESTING DIVISION

JOB 66-F-12 LOCATION Hwy. #24 & Lynn River, Ch 6/20 43'-0" Lt. ORIGINATED BY W.W.K.
W.P. 251-62 BORING DATE Feb. 4 to 7, 1966. COMPILED BY W.W.K.
DATUM 696.9 BOREHOLE TYPE Washboring BX Casing. CHECKED BY K.G.S. dk

SOIL PROFILE		SAMPLES			DYNAMIC PENETRATION RESISTANCE		LIQUID LIMIT — WL PLASTIC LIMIT — WP WATER CONTENT — W		BULK DENSITY P.C.F.	REMARKS
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	BLOWS / FOOT	ELEV. SCALE	20 40 60 80 100	WP W WL		
696.9	Groundlevel									
695.4	Black org. topsoil.									
1.5										
	Silty sand.		1	SS	25	690				Gr4%Sa28% Si56%Cl 12%
	Compact to loose.		2	SS	7					W.L. Elev. ▼ 687.5
	Brown.					680				Observed in Casing.
			3	SS	8					
672.9										
24.0						670				
	Silt to clayey silt.		4	SS	26					Si80% Cl 20%
	Very stiff to hard.					660				
	Grey.		5	SS	51					
						650				
645.4			6	SS	91					
51.5	End of borehole.					640				

DEPARTMENT OF HIGHWAYS - ONTARIO

MATERIALS & TESTING DIVISION

RECORD OF BOREHOLE NO. 4

FOUNDATION SECTION

JOB 66-F-12 LOCATION Hwy. #24 & Lynn River Ch 7+31 40'-0" Lt. ORIGINATED BY W.W.K.
 W.P. 251-62 BORING DATE Feb. 7, 1966. COMPILED BY W.W.K.
 DATUM 696.2 BOREHOLE TYPE Washboring BX Casing. CHECKED BY K.G.S. *AK*

SOIL PROFILE			SAMPLES			ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE				LIQUID LIMIT — WL			BULK DENSITY	REMARKS
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	BLOWS / FOOT		BLOWS / FOOT				PLASTIC LIMIT — WP				
						SHEAR STRENGTH P.S.F.				WATER CONTENT — W					
											WP	W	WL		
											WATER CONTENT %			P.C.F.	
											10	20	30		
696.2	Groundlevel														
695.7	Black org. topsoil														
1.5															
	Silty sand.		1	SS	14	690									W.L. Elev.
	Loose to compact.		2	SS	3										687.6
	Brown.		3	SS	12	680									Observed in Casing.
			4	SS	14	670									
669.0															
27.2															
	Silt to clayey silt.		5	SS	58	660									Si 83% Cl 17%
	Hard.														
	Grey.		6	SS	59	650									
639.7															
56.5	End of borehole.		7	SS	63	640									
						630									

W.L. Elev.

687.6

Observed in Casing.

Si 83%
Cl 17%

ABBREVIATIONS USED IN THIS REPORT

PENETRATION RESISTANCE

STANDARD PENETRATION RESISTANCE 'N' - THE NUMBER OF BLOWS REQUIRED TO ADVANCE A STANDARD SPLIT SPOON SAMPLER 12 INCHES INTO THE SUBSOIL, DRIVEN BY MEANS OF A 140 POUND HAMMER FALLING FREELY A DISTANCE OF 30 INCHES.

DYNAMIC PENETRATION RESISTANCE - THE NUMBER OF BLOWS REQUIRED TO ADVANCE A 2 INCH, 60 DEGREE CONE, FITTED TO THE END OF DRILL RODS, 12 INCHES INTO THE SUBSOIL, THE DRIVING ENERGY BEING 350 FOOT POUNDS PER BLOW.

DESCRIPTION OF SOIL

THE CONSISTENCY OF COHESIVE SOILS AND THE RELATIVE DENSITY OR DENSENESS OF COHESIONLESS SOILS ARE DESCRIBED IN THE FOLLOWING TERMS:-

<u>CONSISTENCY</u>	<u>'N' BLOWS/FT.</u>	<u>c LB./SQ. FT.</u>	<u>DENSENESS</u>	<u>'N' BLOWS/FT.</u>
VERY SOFT	0 - 2	0 - 250	VERY LOOSE	0 - 4
SOFT	2 - 4	250 - 500	LOOSE	4 - 10
FIRM	4 - 8	500 - 1000	COMPACT	10 - 30
STIFF	8 - 15	1000 - 2000	DENSE	30 - 50
VERY STIFF	15 - 30	2000 - 4000	VERY DENSE	> 50
HARD	> 30	> 4000		

TYPE OF SAMPLE

S.S.	SPLIT SPOON	T.W.	THINWALL OPEN
W.S.	WASHED SAMPLE	T.P.	THINWALL PISTON
S.B.	SCRAPER BUCKET SAMPLE	O.S.	OESTERBERG SAMPLE
A.S.	AUGER SAMPLE	F.S.	FOIL SAMPLE
C.S.	CHUNK SAMPLE	R.C.	ROCK CORE
S.T.	SLOTTED TUBE SAMPLE		
	P.H. SAMPLE ADVANCED HYDRAULICALLY		
	P.M. SAMPLE ADVANCED MANUALLY		

SOIL TESTS

Q _u	UNCONFINED COMPRESSION	L.V.	LABORATORY VANE
Q	UNDRAINED TRIAXIAL	F.V.	FIELD VANE
Q _{cu}	CONSOLIDATED UNDRAINED TRIAXIAL	C	CONSOLIDATION
Q _d	DRAINED TRIAXIAL	S	SENSITIVITY

ABBREVIATIONS USED IN THIS REPORT

SOIL PROPERTIES

γ	UNIT WEIGHT OF SOIL (BULK DENSITY)
γ_s	UNIT WEIGHT OF SOLID PARTICLES
γ_w	UNIT WEIGHT OF WATER
γ_d	UNIT DRY WEIGHT OF SOIL (DRY DENSITY)
γ'	UNIT WEIGHT OF SUBMERGED SOIL
G	SPECIFIC GRAVITY OF SOLID PARTICLES $G = \frac{\gamma_s}{\gamma_w}$
e	VOID RATIO
n	POROSITY
w	WATER CONTENT
S_r	DEGREE OF SATURATION
w_L	LIQUID LIMIT
w_p	PLASTIC LIMIT
I_p	PLASTICITY INDEX
s	SHRINKAGE LIMIT
I_L	LIQUIDITY INDEX = $\frac{w - w_p}{I_p}$
I_C	CONSISTENCY INDEX = $\frac{w_L - w}{I_p}$
e_{max}	VOID RATIO IN LOOSEST STATE
e_{min}	VOID RATIO IN DENSEST STATE
I_D	DENSITY INDEX = $\frac{e_{max} - e}{e_{max} - e_{min}}$
	RELATIVE DENSITY D_r IS ALSO USED
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
m_v	COEFFICIENT OF VOLUME CHANGE = $\frac{-\Delta e}{(1+e)\Delta\sigma'}$
C_v	COEFFICIENT OF CONSOLIDATION
C_c	COMPRESSION INDEX = $\frac{\Delta e}{\Delta \log_{10} \sigma'}$
T_v	TIME FACTOR = $\frac{C_v t}{d^2}$ (d, DRAINAGE PATH)
U	DEGREE OF CONSOLIDATION
τ_f	SHEAR STRENGTH
c'	EFFECTIVE COHESION INTERCEPT
ϕ'	EFFECTIVE ANGLE OF SHEARING RESISTANCE, OR FRICTION
c_u	APPARENT COHESION
ϕ_u	APPARENT ANGLE OF SHEARING RESISTANCE, OR FRICTION
μ	COEFFICIENT OF FRICTION
S_t	SENSITIVITY

GENERAL

π	= 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

STRESS AND STRAIN

u	PORE PRESSURE
σ	NORMAL STRESS
σ'	NORMAL EFFECTIVE STRESS ($\bar{\sigma}$ IS ALSO USED)
τ	SHEAR STRESS
ϵ	LINEAR STRAIN
γ	SHEAR STRAIN
ν	POISSON'S RATIO (μ IS ALSO USED)
E	MODULUS OF LINEAR DEFORMATION (YOUNG'S MODULUS)
G	MODULUS OF SHEAR DEFORMATION
K	MODULUS OF COMPRESSIBILITY
η	COEFFICIENT OF VISCOSITY

EARTH PRESSURE

d	DISTANCE FROM TOP OF WALL TO POINT OF APPLICATION OF PRESSURE
δ	ANGLE OF WALL FRICTION
K	DIMENSIONLESS COEFFICIENT TO BE USED WITH VARIOUS SUFFIXES IN EXPRESSIONS REFERRING TO NORMAL STRESS ON WALLS
K_0	COEFFICIENT OF EARTH PRESSURE AT REST

FOUNDATIONS

B	BREADTH OF FOUNDATION
L	LENGTH OF FOUNDATION
D	DEPTH OF FOUNDATION BENEATH GROUND
N	DIMENSIONLESS COEFFICIENT USED WITH A SUFFIX APPLYING TO SPECIFIC GRAVITY, DEPTH AND COHESION ETC. IN THE FORMULA FOR BEARING CAPACITY
k_s	MODULUS OF SUBGRADE REACTION

SLOPES

H	VERTICAL HEIGHT OF SLOPE
D	DEPTH BELOW TOE OF SLOPE TO STRATUM
β	ANGLE OF SLOPE TO HORIZONTAL

56-F-12

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10.45A

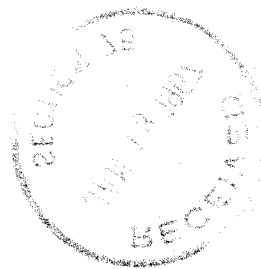
A G STERMAC PRINCIPAL FOUNDATION ENGR

RE W P 251-62 BRIDGE SITE 20-67

LYNN RIVER BRIDGE IN SIMCOE HWY 24 DIST 2

MAY I PLEASE HAVE A REPLY TO MEMO DATED DEC 22/66.

A P WAIT REGL BRIDGE LOC ENGR



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Mr. A. P. Watt,
Regional Bridge Location Engineer,
Bridge Section,
Regional Office, London.

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

January 16, 1967

Lynn River Bridge, Site 20-67,
Hwy. #24, District #2 (London).
W.P. 251-62 -- W.J. 66-F-12

We have reviewed Plan No.
D 5924-1 for the above structure.

We have no comments.

KGS/mdeP

cc: Mr. S. McCombie

Foundations Files ✓
Gen. Files

K. G. Selby
K. G. Selby,
SUPERVISING FOUNDATION ENGR.
For:
A. G. Stermac,
PRINCIPAL FOUNDATION ENGR.

MEMORANDUM

To: Mr. A. G. Stermac
Principal Foundation Engineer
Lab Building
D O W N S V I E W

FROM: A. P. Watt

DATE: December 22, 1966

OUR FILE REF.

IN REPLY TO

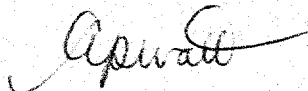
SUBJECT:

W.P. 251-62, Bridge Site 20-67,
Lynn River Bridge,
In Simcoe,
Highway 24,
District 2, London.

Attached please find one copy of the General
Arrangement plan D-5924-1 for the above noted structure.

Would you kindly review the bridge foundation
proposed and inform me if they are satisfactory.

A reply would be appreciated as soon as possible.



A. P. WATT
REGIONAL BRIDGE LOCATION ENGINEER

APW:gf
ATT'D

c.c. Mr. S. McCombie

$$4 \text{ N } L_1 + \frac{\text{N } A_2}{50}$$

$$= 4 \times 60 + \frac{30 \times 94}{50} =$$

$$= 240 + \frac{2820}{50} = 240 + 56 = 296$$

$$A_p = 0.8 \text{ sq ft}$$

$$A_s = 1.4 \pi \times L =$$

$$= 3.14 \times 30 = 94 \text{ sq ft}$$

$$Q_s = \frac{300}{3} = 100 \text{ T/pile}$$

TEL. CONVERSATION ON 24 TH. JAN/67

MR. L. HO OF MR. CORNICIL & RANKIN ASKED THE DEPTH OF PILES OF THE PIERS ASSUMING A SCOUR DEPTH OF 13 FT.

AFTER REVIEWING THE REPORT IT WAS FELT THAT THE ORIGINALLY RECOMMENDED EL OF 670-690 FT WILL BE ADEQUATE FOR 50 T/pile.

A. BARSUDAY

APPROVED BY K.G.S.

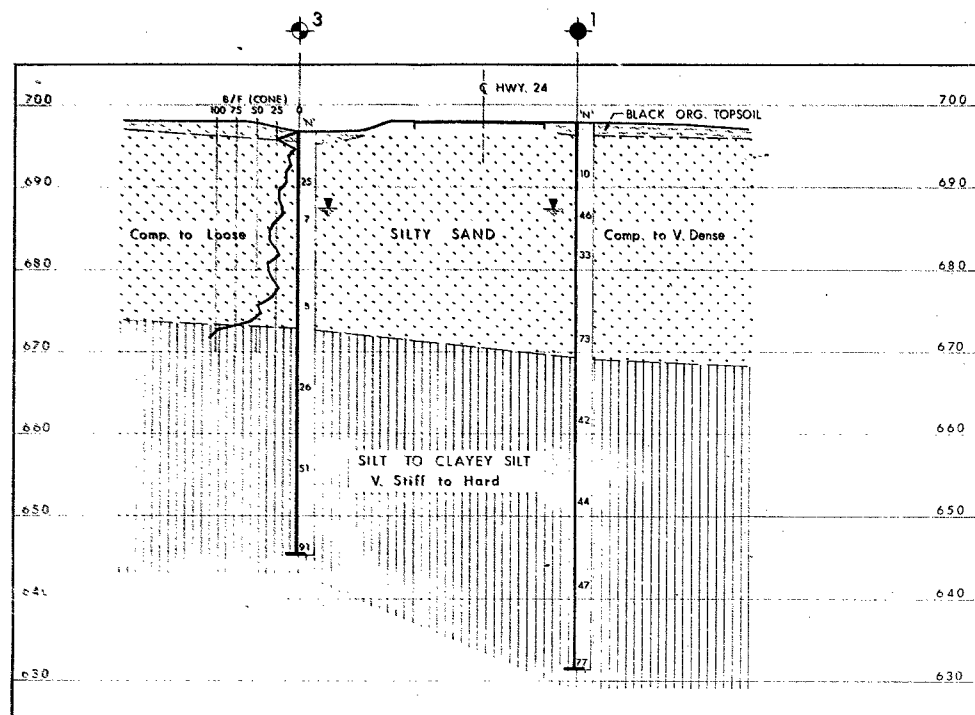
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W.P. #251-62

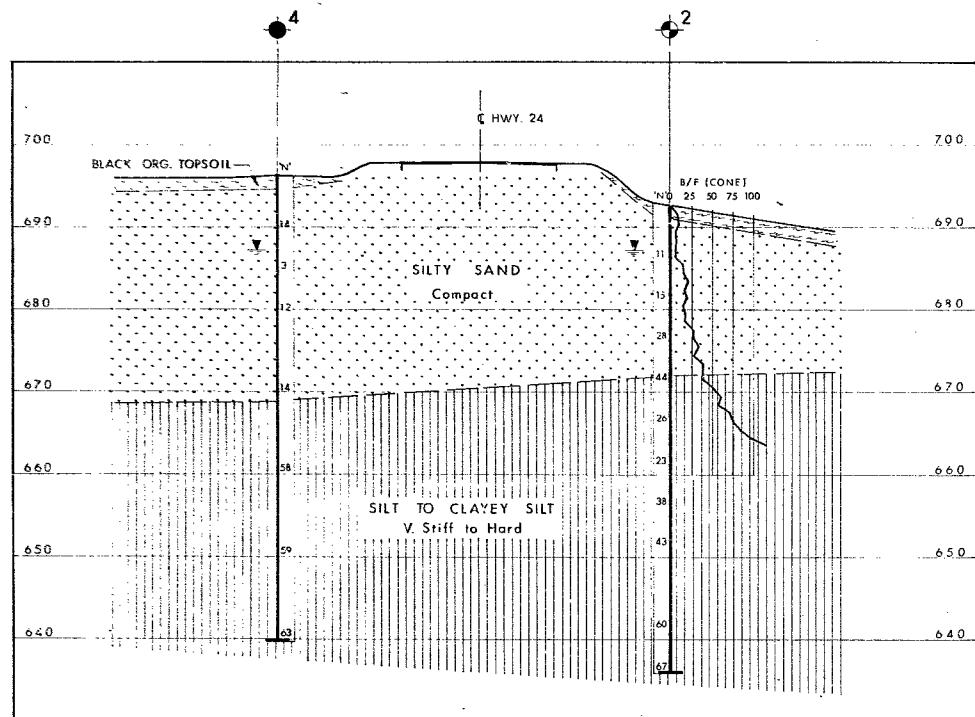
Hwy. #24

PROP. CROSSING

LYNN RIVER

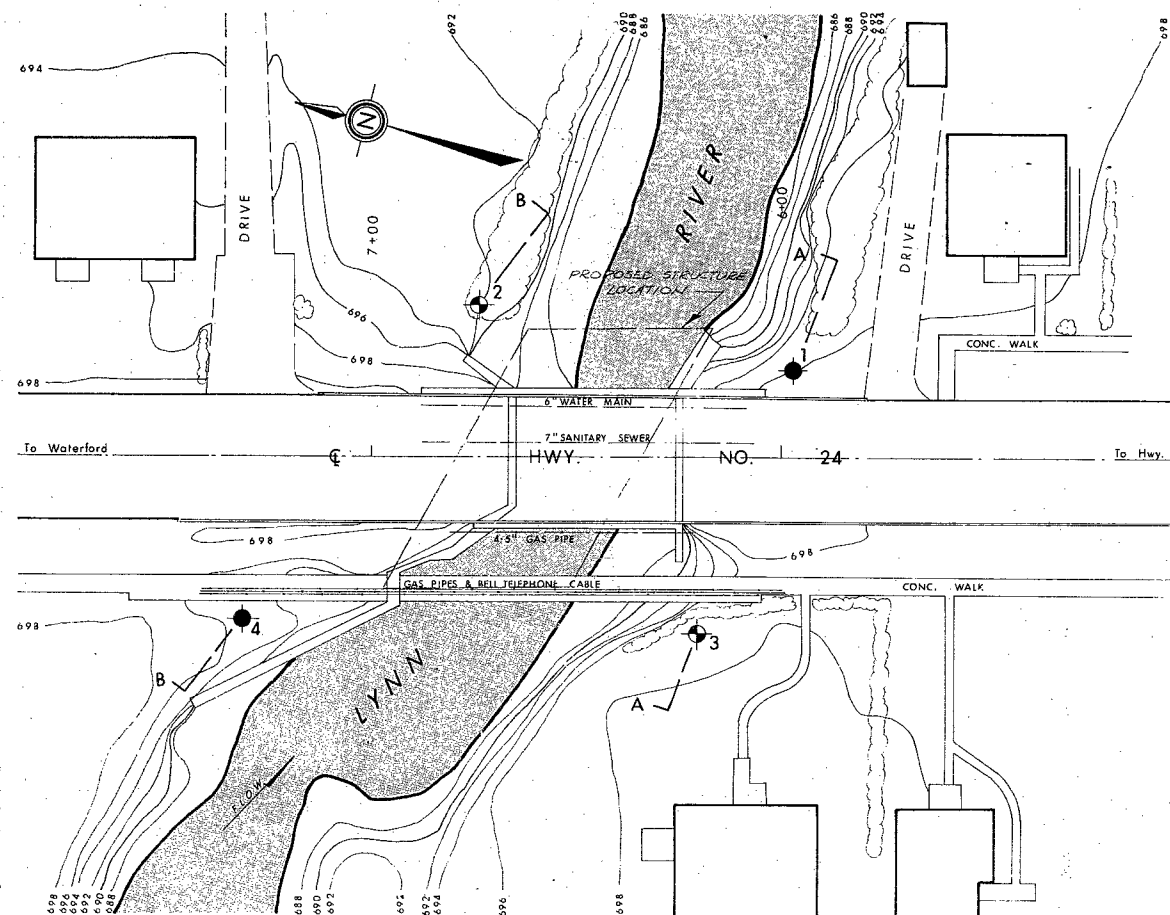


SECTION A-A



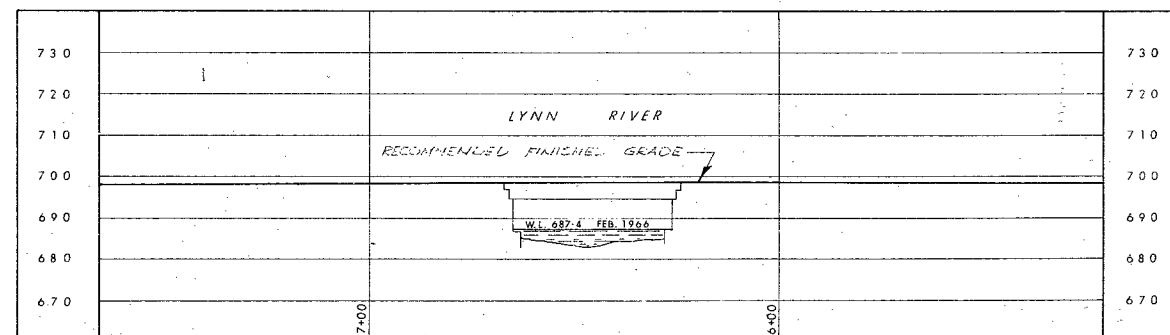
SECTION B-B

VERT. 10 5 0 10 20 FT.
HORI. 20 10 0 20 40 FT.



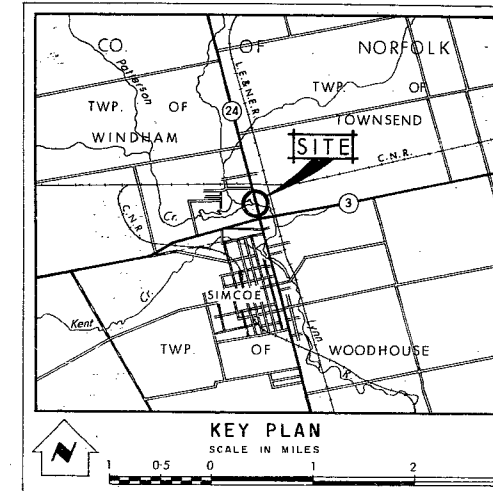
PLAN

SCALE 0 20 40 FT.



PROFILE

SCALE 0 20 40 FT.



LEGEND

- Bore Hole
- Cone Penetration Hole
- /○ Bore & Cone Penetration Hole
- Water Levels established at time of field investigation. FEB. 1966

NO.	ELEVATION	STATION	OFFSET
1	698.0	5+97	21' RT.
2	692.6	6+74	37' RT.
3	696.9	6+20	43' LT.
4	696.7	7+31	40' LT.

NOTE

The boundaries between soil strata have been established only at Bore Hole locations. Between Bore Holes the boundaries are assumed from geological evidence and may be subject to considerable error.

DATE	BY	DESCRIPTION

DEPARTMENT OF HIGHWAYS - ONTARIO
MATERIALS & TESTING DIVISION - FOUNDATION SECTION

LYNN RIVER

KING'S HIGHWAY NO. 24 DIST. NO. 2
CO. NORFOLK TOWN OF SIMCOE
TWP. TOWNSEND & WINDHAM LOT CON.

BORE HOLE LOCATIONS & SOIL STRATA

SUB'D. W.K. CHECKED	W.P. NO. 251-62	M.B.T. DRAWING NO.
DRAWN S.O. CHECKED	JOB NO. 66-F-12	66-F-12 A
DATE 30 MAR. 1966	SITE NO.	BRIDGE DRAWING NO.
APPROVED	CONT. NO.	

REF. NO. E-4187-1