

MEMORANDUM

W.P. 201-64
23-65-50

To: Mr. A. M. Toye,
Bridge Engineer,
Bridge Division.

From: Foundation Section,
Materials & Research Div.,
Room 107, Lab. Bldg.

Attention: Mr. S. McCombie

DATE: June 1, 1964

OUR FILE REF.

IN REPLY TO

SUBJECT

FOUNDATION INVESTIGATION REPORT

For

Lake Erie and Northern Electric Rwy.
and Proposed County Road - Line 'B',
Norfolk County, Townsend Township.
District #32
W.J. 64-F-26 -- W.P. 201-64

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 future design work. Should there be any queries in connection with this project, please do not hesitate to contact our Office.

AGS/MdeF
Attach.

cc: Messrs. A. M. Toye (2)
H. A. Tregaskes
H. D. McMillan
A. Gater
L. D. Barrett
J. Roy
A. Watt

Foundations Office
Gen. Files

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

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FOUNDATION INVESTIGATION REPORT

For

Lake Erie and Northern Electric Rwy.
and Proposed County Road - Line 'B'
Norfolk County, Townsend Township.

District #3

W.J. 64-F-26

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W.P. 201-64

1. INTRODUCTION:

A request to carry out a Foundation investigation at realigned County Road Line "B" and Lake Erie and Northern Electric Rwy., was received from the Bridge Location Engineer, Mr. G. Scott, dated April 3, 1964.

It is proposed to erect a new bridge to carry the Lake Erie and Northern Electric Rwy. over the realigned County Road Line "B". The site of the proposed bridge is located approx. 0.5 miles west of the Town of Waterford. At this location, the chainage of the realigned County Road Line "B" is 31+73.

In order to determine the soil properties and decide on the type of foundation, an investigation was carried out by this Section. Results and the discussion of the field and laboratory investigations, as well as conclusions and recommendations for the future design work, are contained in the following paragraphs of this report.

2. DESCRIPTION OF SITE:

The site of the proposed bridge is located approx. 0.5 miles west of the Town of Waterford. The surrounding area

2. DESCRIPTION OF SITE: (cont'd.) ...

is generally flat terrain, but the north side of the site is somewhat swampy.

Physiographically, the site is located in the so-called "Horseshoe Moraines".

The wingwalls of the existing bridge which was built in 1920, are cracked up and in a bad condition, but the abutments are sound. From the information gathered at the site, it seems that the bridge was constructed on spread footings placed 6 feet below existing ground elevations.

3. FIELD AND LABORATORY WORK:

In order to obtain sufficient information on the type and properties of the subsoil, four sampled boreholes and four dynamic cone penetration tests were carried out at this site.

Split-spoon samples were taken at various depth intervals. Samples were used to determine the following physical properties:

1. Natural Moisture Content.
2. Atterberg Limits.
3. Grain Size Distribution.

Results of these laboratory tests are summarized in Appendix I of this report.

4. SUBSOIL CONDITIONS:

4.1) General:

The stratigraphy of the soil at the site was found to be generally uniform. A detailed description of various soil types encountered during the investigation, is shown in Appendix I of this report and is also given in subsequent paragraphs. The estimated stratigraphical profile, shown on Dwg. No. 64-F-26A, is based upon this information.

4.2) Loose to Very Dense Silty Sand, with Traces of Gravel:

This layer, which extends to approx. El. 740.0, for a depth of about 29.0 to 46.0 feet, was found immediately below the topsoil. The sand in this layer has been subjected to oxidation and exhibits a predominantly dark brown colour.

The percentage of sand in this layer is 88%, silt forms 9%, and the rest of 3%, is gravel. Moisture content determinations for this layer averaged about 17.9%, ranging from 7.3% to 23.6%. The overall layer was found in a loose to very dense state with an average "N" value of 27 blows/foot.

4.3) Dense to Very Dense Sandy Silt with Traces of Clay - (Glacial Till):

Following the layer of loose to very dense silty sand is a stratum of dense to very dense sandy silt with traces of clay, which extends to the depth investigated.

Grain size distribution curves indicated that this stratum is composed of 79% silt, sand forms 19%, and the rest of 2% is clay. Liquid limits for this stratum varied from 19.5% to 24.5%, while

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

4.3) Dense to Very Dense Sandy Silt with Traces of Clay - (Glacial Till): Cont'd. ...

plastic limits range from 16.3% to 18.2%. The average moisture content in this stratum was found to be 18.5%, ranging from 11.4% to 21.8%. The overall stratum is in a dense to very dense condition, with an average "N" value of 87 blows/foot. Plasticity charts for all boreholes are given in Appendix I of this report.

5. GROUND WATER CONDITIONS:

The ground water level, at the time of the investigation, was found at the following elevations:

In B.H. #1	at	El. 774.4
B.H. #2	at	El. 774.8
B.H. #3	at	El. 774.6
B.H. #4	at	El. 772.7

It may be assumed that the water level will vary with the seasons of the year.

No artesian water conditions were encountered.

6. DISCUSSION AND RECOMMENDATIONS:

The investigation has revealed that the subsoil conditions at the site are such that adequate support for spread footing type foundations can be obtained at relatively shallow depths. It is therefore recommended that the pier and abutment footings be founded approx. six feet below proposed new grade levels. A net allowable pressure of 2.0 tons/sq.ft. may be assumed for

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

design purposes. If perched abutments would be considered, they may be supported on 12 $\frac{3}{4}$ " x 0.25 steel tube piles, driven about 10 feet into the dense to very dense sandy silt stratum. A safe load of 40 tons per pile may be assumed for design purposes.

Since the subsoil consists of relatively permeable material, dewatering of the proposed excavations may present some problems, and therefore, a scheme should be adopted which would prevent boiling of the excavation bases. Such a scheme may be in the form of interlocking steel sheet piles driven to a depth below the excavation base equal to the height of the prevailing ground water level above it.

7. SUMMARY:

A foundation investigation at the site of the proposed Lake Erie and Northern Electric Rwy. and proposed County Road Line "B" crossing is reported.

Subsoil was found to consist generally of loose to very dense silty sand with traces of gravel, followed by dense to very dense sandy silt with traces of clay (Glacial Till).

Spread footings with an allowable net pressure of 2.0 tons/sq.ft. are recommended for footings placed at a depth of approx. 6 feet below proposed new grade elevations.

If perched abutments would be considered, they could be supported on 12 $\frac{3}{4}$ " O.D. steel tube piles driven approx. 10 feet into the dense to very dense silty sand with traces of clay (Glacial Till) stratum.

7. SUMMARY: (cont'd.) ...

Some dewatering problems may be anticipated, and are further discussed in the main body of the report.

8. MISCELLANEOUS:

The field work, performed during the period from April 14 to April 22, 1964, together with the preparation of this report, was undertaken by Mr. W. W. Kulmatickas, Project Foundation Engineer. The investigation was carried out under the general supervision of Mr. K. G. Selby, Senior Foundation Engineer, who reviewed this report.

June 1964.

APPENDIX I.

SOIL PROFILE			SAMPLES		DYNAMIC PENETRATION RESISTANCE				LIQUID LIMIT ——— w_L			BULK DENSITY P.C.F.	REMARKS		
ELEV DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	BLOWS / FOOT	ELEV. SCALE	BLOWS / FOOT				PLASTIC LIMIT ——— w_p				
							SHEAR STRENGTH P S F				WATER CONTENT ——— w				
							25	50	75	100	125			w_p	w
778.5	Groundlevel														
777.0	Black org. topsoil														
1.5	Loose to very dense.														
	Silty sand with traces of gravel.		1	SS	13	770									
			2	SS	25										
			3	SS	32	760									
			4	SS	63	750									
747.5															
31.0	Dense to very dense.														
	Sandy silt with traces of clay.		5	SS	48	740									
			6	SS	106	730									
727.0			7	SS	107										
51.5	End of borehole.					720									

JOB 64-F-26

LOCATION Lake Erie & Northern Hwy & Cty Rd Line "B" Ch 31/40 53'
Lt

ORIGINATED BY W.W.K.

W.P. 201-64

BORING DATE Apr. 16 & 17, 1964.

COMPILED BY W.W.K.

DATUM 786.8

BOREHOLE TYPE Washboring - BX Casing.

CHECKED BY K.Q.S.

SOIL PROFILE		SAMPLES			ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE					LIQUID LIMIT — WL			BULK DENSITY	REMARKS
ELEV. DEPTH	DESCRIPTION	NUMBER	TYPE	BLOWS / FOOT		BLOWS / FOOT	25	50	75	100	125	PLASTIC LIMIT — WP	WATER CONTENT — W		
							SHEAR STRENGTH P.S.F.					WP	W	WL	
												WATER CONTENT %			
												10	20	30	
786.8	Groundlevel														
784.8	Black org. topsoil														
2.0															
	Loose to very dense.	1	SS	13	780										
	Silty sand with traces of gravel.	2	SS	3											
		3	SS	28	770										
		4	SS	42											
					760										
		5	SS	52											
					750										
		6	SS	25											
					740										
740.8															
46.0	Dense to very dense.														
	Sandy silt with traces of clay.														
735.3		7	SS	63											
51.5	End of borehole.				730										

W.L.
El. 774.8
Observed in casing.

JOB 64-F-26

LOCATION Lake Erie & Northern Hwy & Cty Rd "B" Ch 32/00 23' Lt.

ORIGINATED BY W.W.K.

W P 201-64

BORING DATE Apr. 20 & 21, 1964.

COMPILED BY W.W.K.

DATUM 780.0

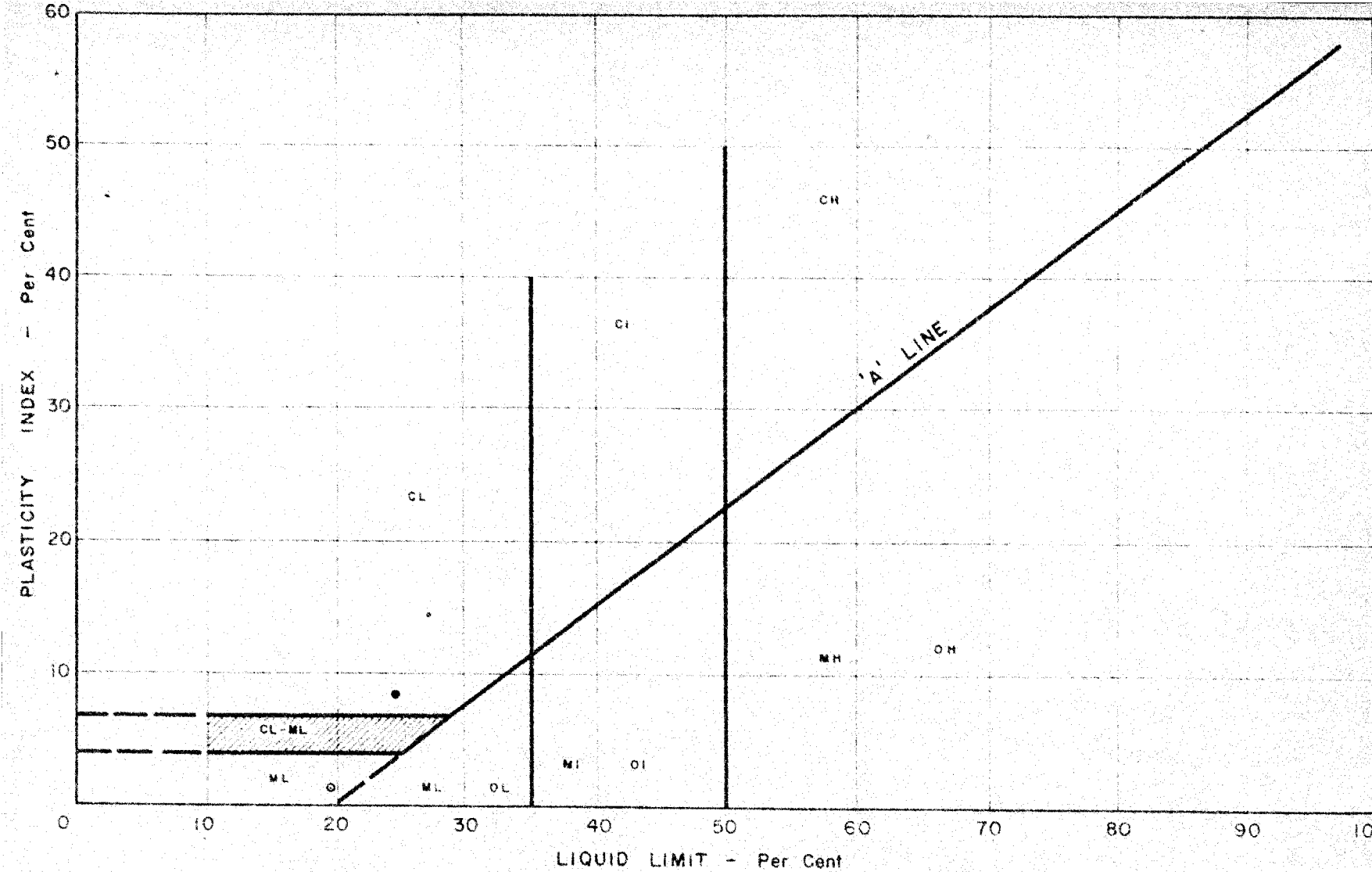
BOREHOLE TYPE Washboring - BX Casing.

CHECKED BY K.G.S.

SOIL PROFILE		SAMPLES			ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT				LIQUID LIMIT --- WL PLASTIC LIMIT --- WP WATER CONTENT --- W			BULK DENSITY PCF	REMARKS
ELEV. DEPTH	DESCRIPTION	NUMBER	TYPE	BLOWS / FOOT		25	50	75	100	125	WL	WP		
780.0	Ground level				780									
777.8	Black org. topsoil													
2.2	Loose to very dense.													
	Silty sand with traces of gravel.	1	SS	10										
		2	SS	41	770									
		3	SS	34										
					760									
		4	SS	26										
					750									
745.5														
34.5	Dense to very dense.	5	SS	40										
	Sandy silt with traces of clay.				740									
733.7		6	SS	146										
46.5	End of borehole.				730									

W.L.
El. 774.6
Observed in casing.

CHECKED BY K.G.S.



NOTES BH 1 •
BH 4 ○

DEPARTMENT OF HIGHWAYS - ONTARIO
MATERIALS & RESEARCH DIVISION
PLASTICITY CHART

Job No. 64-F-26

W.P. No. 201-64

LABORATORY OF SOILS & MATERIALS, UNIVERSITY OF TORONTO

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

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

$$\tau_f = c' + \sigma' \tan \phi'$$

$$\tau_f = c_u + \sigma \tan \phi$$

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 HARD STRATUM
β	ANGLE OF SLOPE TO HORIZONTAL

MEMORANDUM

64-F-26

To: Mr. A. Stermac,
Principal Foundation Engineer,
Lab. Bldg.

From: Bridge Division,
Downsview, Ontario.

Date: April 3, 1964.


Our File Ref.

In Reply To

SUBJECT: W.P. 201-64
Br. Site 21-148
Lake Erie & Northern Electric Rwy.
Subway
Township Road, District 2.

We are sending to you herewith two prints of Bridge Site Plan E-4317-1 on which we have marked in red the proposed location of the above structure.

Please make the necessary arrangements for a foundation soils investigation. We will be pleased to have your report in due course.



NZ/sp

cc. S. McCombie
G. Scott
M. D. Smith
W. Kinnear
R. Fitzgibbon

N. Zoltay
for G. Scott,
Bridge Location Engineer.

X

LONG DOWN 2 APR 14/64 914A VR

J ROY REG MATS ENGR

FOUNDATION SECTION WILL START FIELD WORK FOR PROPOSED STRUCTURE

WP201-64 AT WATERFORD APRIL 14TH/64

AT COMPLETION OF THIS WE WILL CARRY OUT FIELD WORK FOR PROPOSED

PATROL YARD AT WALLACETOWN LOT 10 CON 7 TWP DUNWICH

WE WILL REQUIRE FROM YOU BY MAY 15TH RECOMMENDATIONS AS TO GRADING
AND PAVING FOR THE PATROL YARD

X G SELBY SR FOUND ENGR FOR

A G STERNAC PRINC FOUND ENGR MATS & RES

6002

REC'D APR 14 AM 9:21

64-F-26

Mr. G. Scott,
Regional Bridge Location Engr.,
Bridge Division.

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

Attention: Mr. N. Zoltay

April 8, 1965

Your Memo -- Mar. 11/65

W.P. 201-64 Bridge Site 20-148
Lake Erie and Northern Railway
Subway at Waterford,
township Road District #2.

201-F-26

We have reviewed Preliminary Plan D 5515-P1
of the above structure.

As the design appears to comply with the
recommendations made by the Foundation Section, we have
no comments concerning same.

AB/MdeF

a. e. J.
for A. G. Stermac,
PRINCIPAL FOUNDATION ENGINEER

cc: Foundations Office ✓
Gen. Files

MEMORANDUM

To: Mr. A. E. Stermac,
Principal Foundation Engineer,
Room 107,
Lab. Building.

FROM: Bridge Division,
Downsview, Ontario.

DATE: March 11, 1965.

OUR FILE REF.

IN REPLY TO

SUBJECT: W.P. 201-64 Bridge Site 20-148
Lake Erie and Northern Railway
Subway at Waterford,
Township Road District # 2.

We are sending to you herewith one print of
Preliminary Plan D 5515-P1 of the above structure.

Would you please let us have your written
comments.

N. Zoltay

NZ/kp
c.c. S. McCombie
G. Scott
N.D. Smith

N. Zoltay,
for G. Scott,
Regional Bridge Location Engineer.

MEMORANDUM

To: Mr. A.G. Stermac,
Principal Foundation Engineer,
Materials & Testing,
Downsview

FROM: Materials & Testing,
London

DATE: October 26, 1965.

OUR FILE REF. Attn: Mr. K. Selby

IN REPLY TO

SUBJECT: Re: W.P. 201-64 Site No. 20 - 148 Lake Erie and Northern
Railway Subway at Waterford

This will confirm our telephone conversation of this morning regarding this site.

Boreholes placed to a depth of 4 feet in the railway embankment as directed (i.e. 20' from the wing walls 10' above the toe of slope) indicated that the fill material is a fine sand with some gravel. No boulders were encountered.



DS/jb
cc: file

for: D. Suzuki
J.R. Roy
Regional Materials Engineer

Copy for M. Gvildys

MEMORANDUM

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

From: Bridge Division,
Downsview, Ontario.

Date: March 18, 1965.

Our File Ref.

IN REPLY TO

SUBJECT: W.P. 201-64
Site 20-148
Lake erie and Northern Railway
Subway at Waterford - Twp. Rd. - Dist. 2

We are sending to you herewith one print of our Preliminary Plan D-5515-P2 (revised March 10, 1965) for the above structure.

Would you please let us have your written comments.

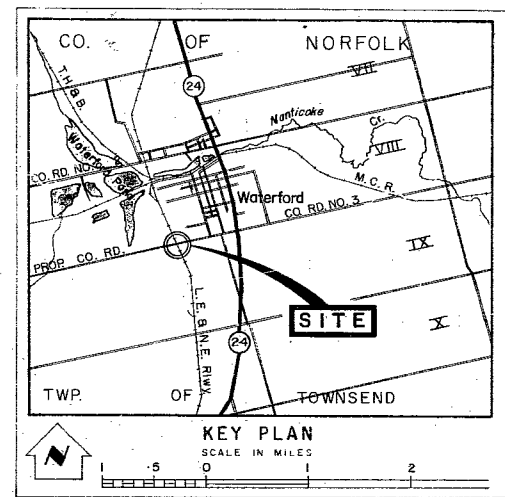
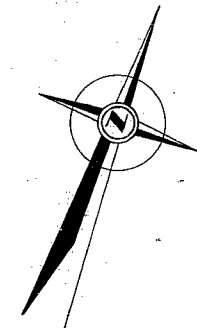
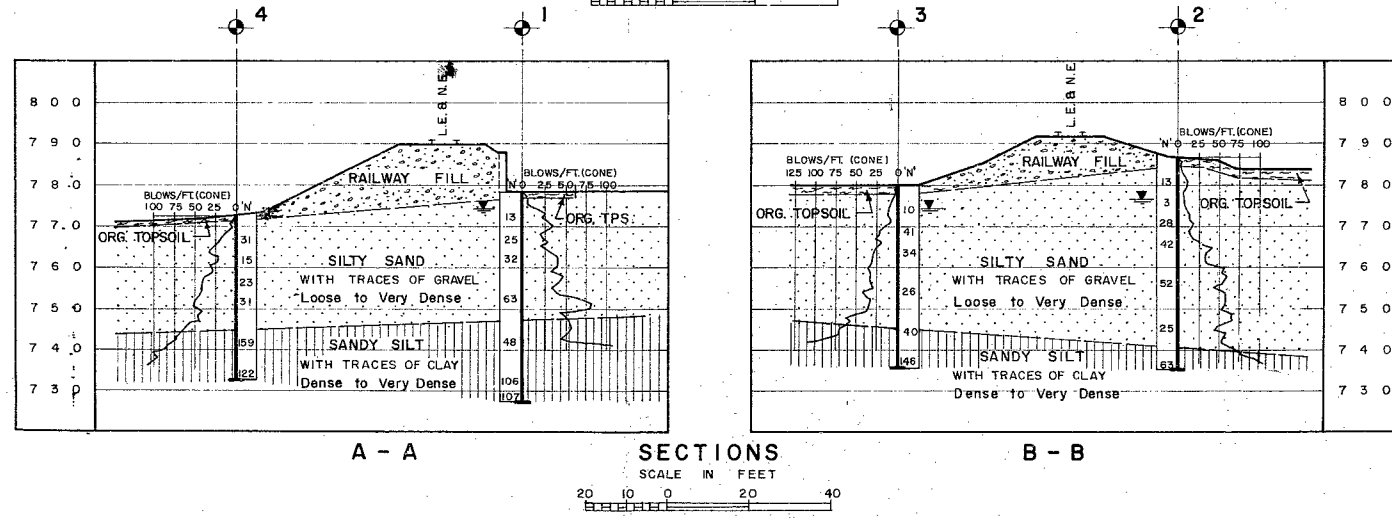
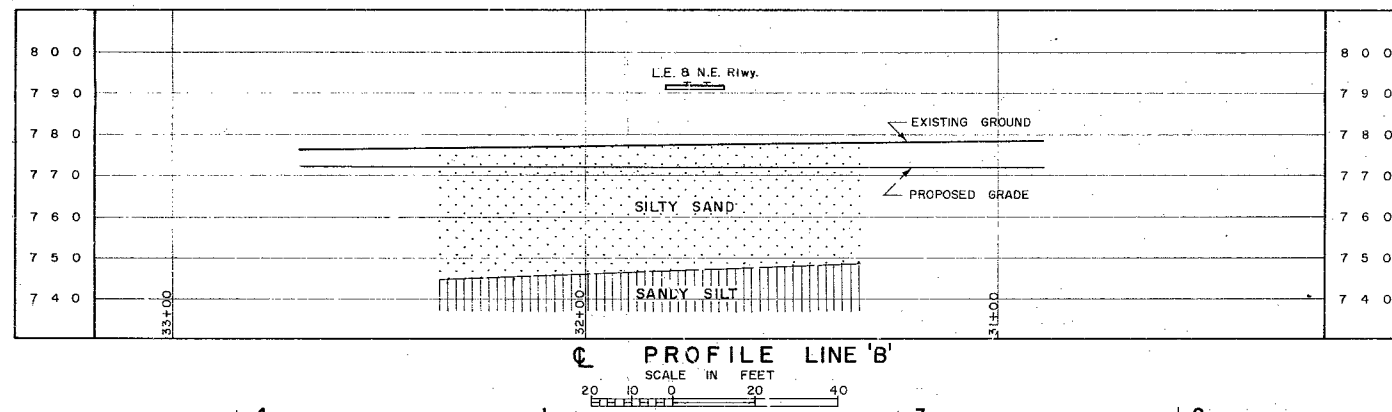
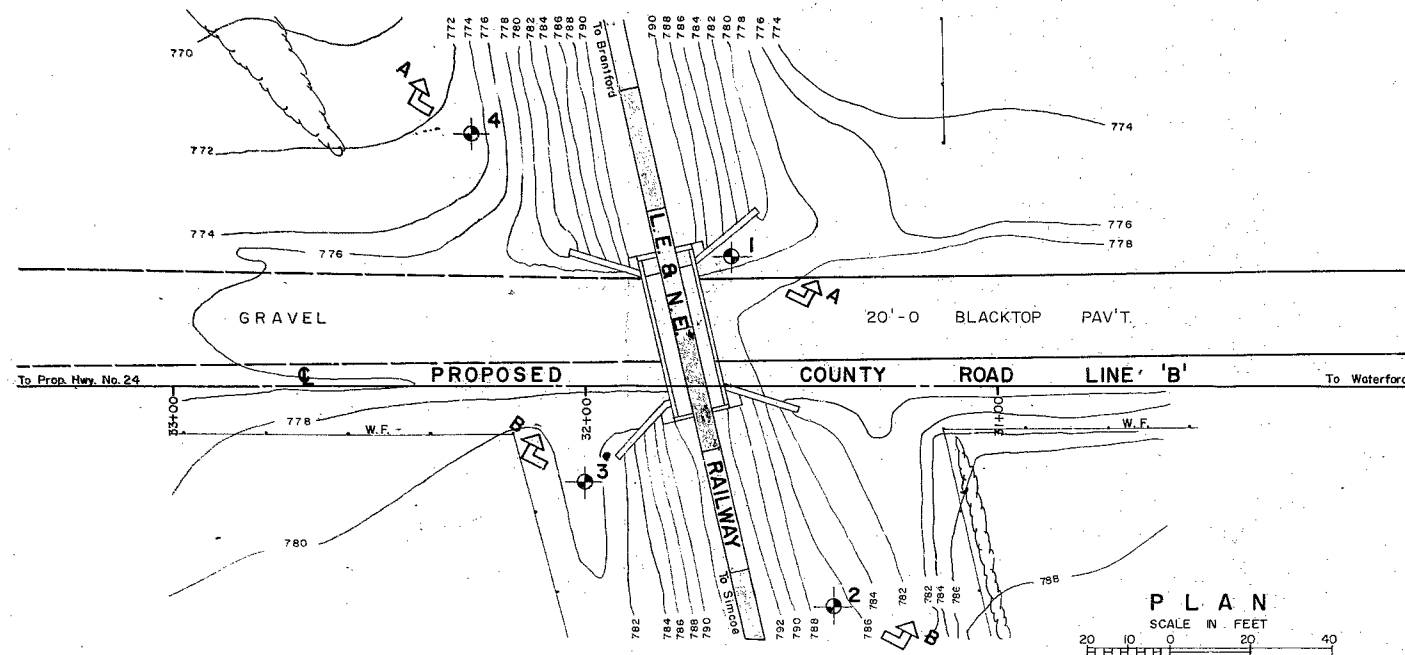


NZ/sp

N. Zoltay,
for G. Scott,
Regional Bridge Location Engineer

cc. S. McCombie
G. Scott
N. D. Smith

#64-F-26
W.P. # 201-64
LAKE ERIE &
NORTHERN
ELECTRIC R.WY.
& PROP. CTY. RD.
LINE 'B'



LEGEND			
	Bore Hole		
	Cone Penetration Hole		
	Bore & Cone Penetration Hole		
	Water Levels established at time of field investigation. (Apr. 1964)		
NO.	ELEVATION	STATION	OFFSET
1	778.5	31+65	32' RT.
2	786.8	31+40	53' LT.
3	780.0	32+00	23' LT.
4	773.9	32+28	62' RT.

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.

REVISIONS	DATE	BY	DESCRIPTION

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

LAKE ERIE & NORTHERN ELECTRIC RAILWAY

KING'S HIGHWAY NO. CO. RD. Line 'B' DIST. NO. 2
CO. NORFOLK
TWP. TOWNSEND LOT 5 CON. VIII & IX

BORE HOLE LOCATIONS & SOIL STRATA

SUB'D W.W.K. CHECKED W.W.K. W.P. NO. 201-64 M.B.R. DRAWING NO.
DRAWN D.M. CHECKED D.M. JOB NO. 64-F-26 **64-F-26A**
DATE 11 MAY 1964 SITE NO. BRIDGE DRAWING NO.
APPROVED *[Signature]* CONT NO.

PRINT RECORD	NO.	FOR	DATE