cc: Gen. Files

23-68-06

DEPARTMENT OF HIGHWAYS ONTARIO

MEMORANDUM

To: Mr. B. R. Davis,
Bridge Engineer,
Bridge Division.

Attention: Mr. S. McCombie

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

Date: June 16, 1966

Our File Ref.

In reply to

JUN 24 1966

Subject:

FOUNDATION INVESTIGATION REPORT
For
Proposed Bridge at Belle River and
Proposed Hwy. 401 Service Road,
District No. 1 (Chatham)

W.J. 66-F-44 -- W.P. 311-64

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

We believe that the factual data and recommendations contained therein, will suffice for your design requirements.

Should additional information be required, please feel free to contact our Office.

A. G. Stermac,
PRINCIPAL FOUNDATION ENGINEER

AGS/MdeF
Attach.
cc: Messrs. B. R. Davis (2)
H. A. Tregaskes
D. W. Farren
A. Gater
F. C. Brown
J. Roy
A. Watt

Foundations Office
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FOUNDATION INVESTIGATION REPORT
For
Proposed Bridge at Belle River and
Proposed Hwy. 401 Service Road,
District No. 1 (Chatham)
W.J. 66-F-44 -- W.P. 311-64

1. INTRODUCTION:

The Foundation Section was requested to carry out a foundation investigation for the proposed structure at the crossing of Belle River and Hwy. 401 Service Road. A request was contained in a memo dated March 21, 1966, from the Bridge Location Section (Mr. G. Scott, Regional Bridge Location Engineer).

A foundation investigation was subsequently carried out by this Section to determine the subsoil conditions existing at the site.

Presented in this report are the results of the investigation, together with our recommendations regarding the structure foundations and approach fill stability.

2. DESCRIPTION OF SITE:

The site is located in Essex County in Southwestern Ontario, some 15 miles east of Windsor along Hwy. 401. The surrounding area is mainly flat farmland, crossed by ditches and rivers generally flowing south to north. The west bank of Belle River at the site, tapers down gradually to almost river level, while the east bank rises sharply to the general ground level in the area.

Physiographically the area belongs to the "Essex Clay Plain" sub-region. It is essentially a till plain levelled by deposits of lacustrine clay which settled in the depressions while the knolls were being lowered by wave action.

cont'd. /2 ...

3. FIELD INVESTIGATION PROCEDURE:

Four sampled boreholes and six dynamic cone penetration tests were carried out during the course of the field investigation. A Penn. Drill, utilizing 4" Ø augers, was used. Thin-walled Shelby tube samplers were pushed manually into the soils, wherever possible, in order to recover undisturbed samples, while split-spoon sampling was undertaken for the disturbed samples. In addition, in-situ vane tests were conducted in the field to determine the shear strength of the cohesive materials. Standard and dynamic penetration tests were performed using a driving energy of 350 ft. lbs.

The locations and elevations of all boreholes are shown on Dwg. 66-F-44A, accompanying this report.

4. LABORATORY WORK:

After visual examination of the samples, laboratory tests were performed on representative soil specimens in order to define moisture contents, Atterberg limits, undrained shear strengths, bulk densities and grain-size distributions.

The results of the field and laboratory tests have been compiled on borelog sheets which are attached to this report. The estimated soil profile on Dwg. 66-F-44A, is based on this report.

5. SUBSOIL CONDITIONS:

5.1) Silty Clay to Clayey Silt:

This major stratum underlies a thin layer of topsoil and was encountered in all boreholes. The thickness of the deposit varies from 86 ft. in borehole 5 to 90 ft. in boreholes 2 and 6, with the lower boundary of the stratum ranging between approximate elevations 501 and 504.

cont'd. /3 ...

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

5.1) Silty Clay to Clayey Silt: (cont'd.) ...

The deposit mainly consists of clayey silt and silty clay with occasional traces of sand. Within the stratum there are distinct layers of silty sand or sandy silt. A summary of these layers as determined in the boreholes during the field investigation, is as follows:

B.H.	Material	Depth of Layer	Elevation	'N' Values
1	Silty Sand	7' - 9'	583.5 - 581.5	-
	Silty Sand	25' - 33'	565.5 - 557.5	125, 100/4"
2	Silty Sand	21' - 24'	569.5 - 566.5	-
5	Sandy Silt	9' - 12.5'	580 - 577	85
	Sandy Silt	56' - 65.5'	533 - 524	40
6	Silty Sand	15' - 18'	579 - 576	80/6"

Physical properties of the overall cohesive deposit as determined from the laboratory tests are summarized as follows:

	Clayey Silt	Silty Clay
Liquid Limit (W_L%)	22% - 34%	36% - 52%
Plastic Limit (W_P%)	15% - 19%	18% - 25%
Moisture Content (W%)	12% - 18%	19% - 23%
Bulk Density	125 p.c.f. - 130 p.c.f.	118 p.c.f. - 134 p.c.f.

The upper 4 to 8 ft., in general, was mottled grey and brown, and appeared to be disturbed. In this portion the undrained shear strength of the deposit varied from a low of 1000 p.s.f. to in excess of 2000 p.s.f. The 'N' values ranged from 11 to 17 blows/ft. Based on these values, the consistency of the material within this zone may be described as stiff. Below this, the consistency of the clay increases, as shown by the 'N' values which range from 16 to 59

cont'd. /4 ...

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

5.1) Silty Clay to Clayey Silt: (cont'd.) ...

blows/ft. Based on these values, it is estimated that the consistency of the deposit is very stiff to hard. At a greater depth above the till stratum and below approximate elev. 540, the consistency of the deposit changes considerably with undrained shear strength values of 800 p.s.f. to in excess of 2000 p.s.f.

5.2) Glacial Till (Silt, Sand and Gravel with some Clay):

Underlying the deposit of silty clay to clayey silt is a stratum of glacial origin consisting of a mixture of silt, sand and gravel with some clay. The stratum was penetrated in all boreholes to depths varying from 7 ft. in borehole 2 to 18 ft. in borehole 1. Standard Penetration test results in the stratum varied from 73 blows/ft. to 100 blows/1 in. with one isolated result of 37 blows/f.. near the surface of the layer in borehole 6. Based on the above results, the relative density of the deposit may be described as very dense.

6. GROUND WATER:

During the time of investigation, ground water measurements were carried out in the boreholes. These indicate that the ground water level at the site very closely corresponds to the creek level at approx. elevation 587. No artesian conditions were encountered during the field investigation.

7. DISCUSSION AND RECOMMENDATIONS:

It is proposed to construct a 3-span bridge at the crossing of Belle River and the proposed Hwy. 401 Service Road.

Subsoil at the site consists of 86 ft. to 91 ft. of firm to hard silty clay to clayey silt, followed by a very dense deposit of glacial till (silt, sand and gravel with some clay).

cont'd. /5 ...

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

For the piers, the upper clay crust is suitable for spread footing type of foundations. An allowable design load of 2.5 t.s.f. may be applied at elevation 582 or lower.

This deposit is predominantly cohesive, but it contains layers of sand and silt which may be water-bearing. In view of this, some dewatering problems may be expected and, therefore, a dewatering scheme may be necessary.

Two proposals can be considered for the abutment supports:

1) Abutments can be supported on spread footings founded on compacted granular fill using a safe bearing pressure of 2 t.s.f.

The fill should extend for a horizontal distance of at least 10 ft. from the footing edges in the plane of the footing tops. This portion of the fill should be built with side slopes of 2:1. The remainder of the fill (not necessarily granular material), should be completed to about profile grade for a distance of about 50 ft. behind the abutments before excavating for the abutment footings. The granular fill should be placed in 6-in. layers and compacted to at least 100% Proctor Density.

2) Abutments can be supported on 12-3/4" O.D. steel tube piles driven to, but not beyond, elevation 575. For piles driven to this depth, a design load of 20 tons per pile can be used.

With standard 2:1 side slopes, no stability problems are expected for the proposed approach embankments.

cont'd. /6 ...

8. SUMMARY:

A bridge is planned at the crossing of Belle River and proposed Hwy. 401 Service Road.

Subsoil consists of an extensive deposit of silty clay and clayey silt, underlain by glacial till.

The structure piers may be supported on spread footings placed at elevation 582 or below, using a safe design load of 2.5 t.s.f. The abutments may be supported either on spread footings placed on compacted granular fill, in which case a safe load of 2.0 t.s.f. may be used, or on 12-3/4" O.D. steel tube piles driven to elevation 575 using a load of 20 tons per pile.

Dewatering problems may arise in connection with the pier footing. No approach fill stability problems are anticipated.

9. MISCELLANEOUS:

The field work, performed during May 1966, together with the preparation of this report, was undertaken by Mr. R. Magi, Project Foundation Engineer. The investigation was carried out under the general supervision of Mr. M. Devata, Senior Foundation Engineer, who also reviewed this report.

Equipment was owned and operated by Johnston Drilling Ltd., of Ottawa.

June 1966

APPENDIX I

65-1831

DEPARTMENT OF HIGHWAYS - ONTARIO
MATERIALS & TESTING DIVISION

RECORD OF BOREHOLE NO. 1

FOUNDATION SECTION

JOB 66-F-44
W.P. 311-64
DATUM Geodetic

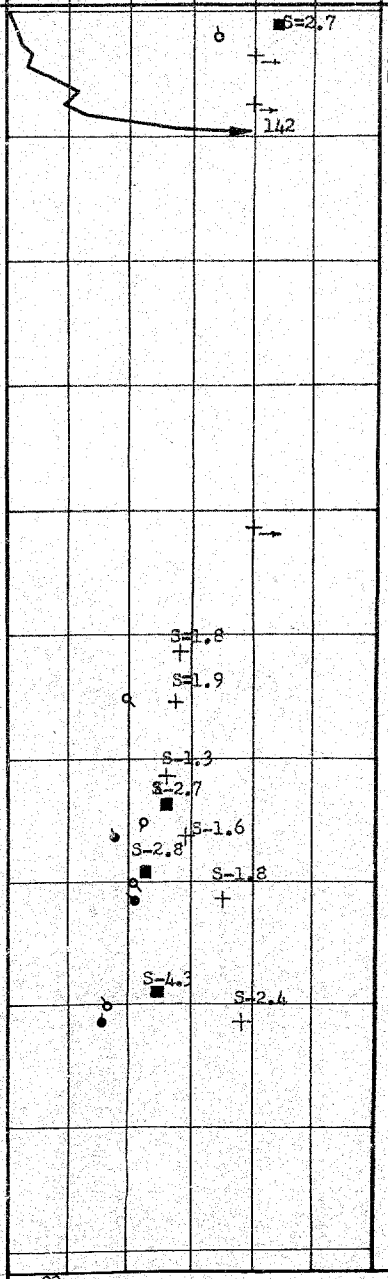
LOCATION Sta. 12472, 0/S 17' Lt.
BORING DATE May 17, 18, 19, 20/66
BOREHOLE TYPE Penn Drill, Cone Penetration

ORIGINATED BY R.M.
COMPILED BY W.T.E.
CHECKED BY HR

ELEV. / DEPTH	SOIL PROFILE DESCRIPTION	STRAT. PLOT	SAMPLES NUMBER	TYPE	BLOWS / FOOT	ELEV. SCALE
590.5	Ground Level					
0.0			1	TW	P	
			1A	SS	11	
583.5			2	T.W.	P	
			2A	SS	17	
581.5	Silty Sand		3	SS	20	580
9	Silty Clay to Clayey Silt		4	SS	20	
			5	SS	29	
			6	SS	24	570
565.5						
25	Silty Sand Very Dense		7	SS	100/4"	
			8	SS	125	560
557.5						
33	Firm to Hard		9	SS	35	
			10	SS	24	550
			11	SS	27	
			12	SS	10	540
			13	TW	P	
			14	TW	P	530
			15	TW	P	
			16	TW	P	520
			17	TW	P	510
501.5						
89	Glacial Till (Silt, Sand and Gravel with some Clay)		18	SS	100/6"	500
			19	SS	100/6"	
	Very Dense		20	SS	100/4"	490
484.0						
106.5	End of Borehole		21	SS	100/1"	

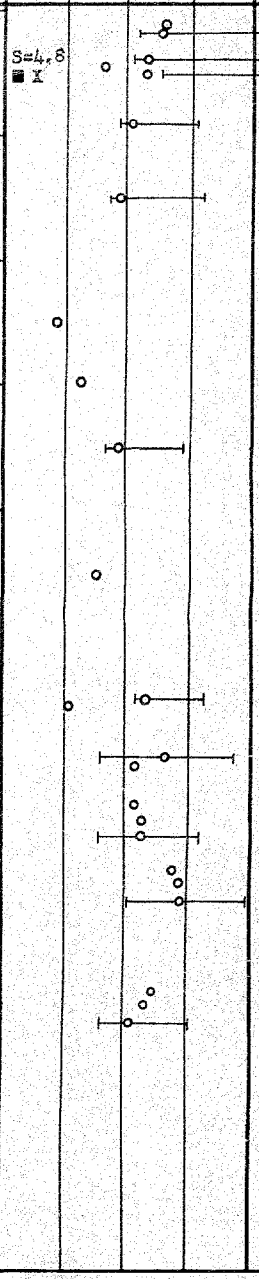
DYNAMIC PENETRATION RESISTANCE
BLOWS / FOOT
20 40 60 80 100

SHEAR STRENGTH P.S.F.
• Uncon. Comp. ○ Quick Triaxial
+ Field Vane ■ Lab. Vane
500 1000 1500 2000 2500



LIQUID LIMIT ——— w_L
PLASTIC LIMIT ——— w_P
WATER CONTENT ——— w
w_P w w_L

WATER CONTENT %
10 20 30



BULK DENSITY P.C.F.	REMARKS
124	W.L. El. 588
118	
127	
127	
127	
129	
131	
123	
122	
126	
125	

20
15 10 5 Percent Strain at Failure

FORM OB-MT-124 (FORMERLY OB-ML-126)
65-1931

OFFICE REPORT ON SOIL EXPLORATION

DEPARTMENT OF HIGHWAYS - ONTARIO
MATERIALS & TESTING DIVISION

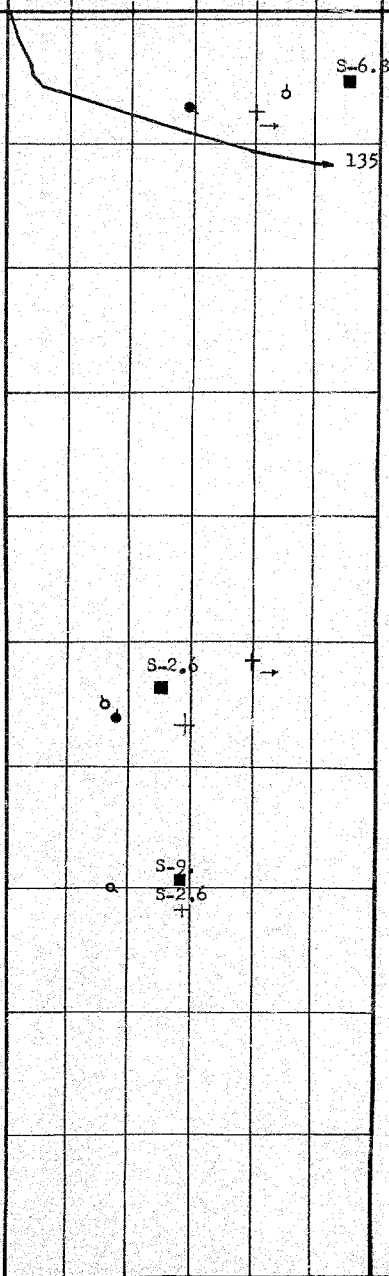
RECORD OF BOREHOLE NO. 2

FOUNDATION SECTION

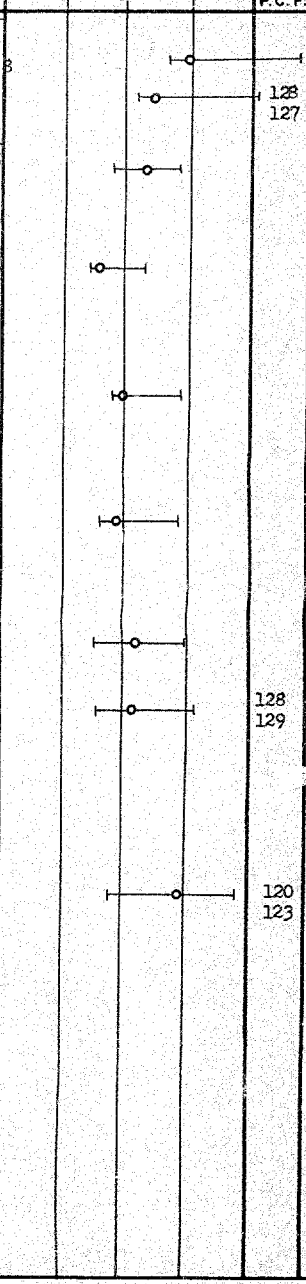
JOB 66-F-44 LOCATION Sta. 12+45, O/S 17' Rt. ORIGINATED BY R.M.
W.P. 311-64 BORING DATE May 20, 24, 1966 COMPILED BY W.T.E.
DATUM Geodetic BOREHOLE TYPE Penn Drill, Cone Penetration CHECKED BY

SOIL PROFILE ELEV. / DEPTH	DESCRIPTION	STRAT. PLOT	SAMPLES NUMBER	TYPE	BLOWS / FOOT	ELEV. SCALE
590.5	Ground Level					
	Silty Clay to Clayey Silt		1	TW	P	
			2	TW	P	
			3	SS	28	580
			4	SS	22	
			5	SS	22	
569.5 / 21			6	SS	59	570
566.5 / 24	Silty Sand		7	SS	23	
			8	SS	20	560
			9	SS	23	
			10	SS	29	550
	Firm to Hard		11	SS	25	
			12	SS	16	540
			13	TW	P	
						530
			14	TW	P	520
						510
			15	TW	P	
500.5 / 90	Glacial Till (Silt, Sand and Gravel with some Clay) Very Dense					500
494.0 / 96.5	End of Borehole		16	SS	100/4"	

DYNAMIC PENETRATION RESISTANCE
BLOWS / FOOT 20 40 60 80 100
SHEAR STRENGTH P.S.F.
● Uncon. Comp. ○ Quick Triaxial
+ Field Vane ■ Lab. Vane
500 1000 1500 2000 2500



LIQUID LIMIT — w_L
PLASTIC LIMIT — w_P
WATER CONTENT — w
w_P w w_L
WATER CONTENT %
10 20 30



BULK DENSITY γ P.C.F.	REMARKS
	W.L. Elev. 588
128	
127	
128	
129	
120	
123	

Percent Strain at Failure
15 20 5 10

FORM CB-MT-126 (FORMERLY CB-ML-126)
65-1831

OFFICE REPORT ON SOIL EXPLORATION

DEPARTMENT OF HIGHWAYS – ONTARIO
MATERIALS & TESTING DIVISION

RECORD OF BOREHOLE NO. 3

FOUNDATION SECTION

JOB 66-F-44 LOCATION Sta. 12+45, 17' Lt. ORIGINATED BY R.M.
W.P. 311-64 BORING DATE May 20, 1966 COMPILED BY W.T.E.
DATUM Geodetic BOREHOLE TYPE Cone Penetration CHECKED BY

SOIL PROFILE			SAMPLES				DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT 20 40 60 80 100	LIQUID LIMIT w_L / PLASTIC LIMIT w_P / WATER CONTENT w	BULK DENSITY γ P.C.F.	REMARKS
ELEV. / DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	BLOWS / FOOT	ELEV. SCALE	SHEAR STRENGTH P.S.F.	WATER CONTENT %		
589.0	Ground Level									
0.0						580				
576.0										
13.0	End of Test					570				

FORM CB-MT-126 (FORMERLY CB-ML-126)
65-1831

OFFICE REPORT ON SOIL EXPLORATION

DEPARTMENT OF HIGHWAYS – ONTARIO
MATERIALS & TESTING DIVISION

RECORD OF BOREHOLE NO. 4

FOUNDATION SECTION

JOB 66-F-44 LOCATION Sta. 12+72, 17' Rt. ORIGINATED BY R.M.
W.P. 311-64 BORING DATE May 24, 1966 COMPILED BY W.T.E.
DATUM Geodetic BOREHOLE TYPE Cone Penetration CHECKED BY

SOIL PROFILE			SAMPLES				DYNAMIC PENETRATION RESISTANCE	LIQUID LIMIT w_L	BULK DENSITY	
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	BLOWS / FOOT	ELEV. SCALE	BLOWS / FOOT 20 40 60 80 100	PLASTIC LIMIT w_P	γ P.C.F.	REMARKS
							SHEAR STRENGTH P.S.F.	WATER CONTENT w		
								w_P w w_L		
								WATER CONTENT %		
590.5	Ground Level									
						580				
575.5										
15.0	End of Test					570				

65-1831

DEPARTMENT OF HIGHWAYS - ONTARIO

MATERIALS & TESTING DIVISION

RECORD OF BOREHOLE NO. 5 (&5A)

FOUNDATION SECTION

JOB 66-F-44 LOCATION Sta. 11+95, O/S 17' Lt. ORIGINATED BY R.M.

W.P. 311-64 BORING DATE May 24, 25, 1966 COMPILED BY W.T.E.

DATUM Geodetic BOREHOLE TYPE Penn Drill, Cone Penetration CHECKED BY

ELEV. / DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	BLOWS / FOOT	ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT 20 40 60 80 100	SHEAR STRENGTH P.S.F. ●Uncon. Comp. ○Quick Triaxial +Field Vane ■Lab Vane 500 1000 1500 2000 2500	LIQUID LIMIT w_L PLASTIC LIMIT w_P WATER CONTENT w WATER CONTENT % 10 20 30	BULK DENSITY γ P.C.F.	REMARKS
589.2	Ground Level										
0.0			1	SS	13			S-2.1		131	▼W.L. Elev. 587
			1A	TW	P					131	
580.2			2	SS	25	580		100/6"			
9	Sandy Silt		3	SS	85						
576.7	Very Dense		4	SS	40						
12.5											
			5	SS	26	570					
			6	SS	26						
	Silty Clay to		7	SS	35						
	Clayey Silt					560					
			8	SS	29						
			9	SS	21						
						550		S-1.9			
			10	SS	18						
			11	TW	P			S-2.0		130	
						540		S-2.0		130	
			12	TW	P			S-1.9		128	
										129	
533.2			13	TW	P					128	Sa. 70% Si&Cl.30%
56	Sandy Silt					530					
			14	TW	P						Sa.36% Si.58% Cl. 6%
	Dense		15	SS	40						
523.7											Sa.22% Si.71% Cl.7%
65.5			16	SS	21						
						520					
	Firm to Hard										
			17	SS	24						
						510					
503.7											
85.5			18	SS	140						
	Glacial Till(Silt Sand and Gravel with some Clay)					500					
			19	SS	98						
	Very Dense										
			20	SS	100/6"						
						490					
487.7			21	SS	100/2"						
101.5	End of Borehole										

15 20 10 5 Percent Strain at Failure

FORM DS-M-125 (FORMERLY DS-ME-125)
65-1831

DEPARTMENT OF HIGHWAYS - ONTARIO
MATERIALS & TESTING DIVISION

RECORD OF BOREHOLE NO. 6

FOUNDATION SECTION

JOB 66-F-44 LOCATION Sta.11+68. 0/S 17' Rt. ORIGINATED BY R.M.
W.P. 311-64 BORING DATE May 25, 26, 27, 1966 COMPILED BY W.T.E.
DATUM Geodetic BOREHOLE TYPE Penn Drill, Cone Penetration CHECKED BY

ELEV. / DEPTH	DESCRIPTION	NUMBER	TYPE	BLOWS / FOOT	REMARKS
594.1	Ground Level				
0.0		1	TW	P	
		2	SS	48	W.L. Elev. ▽ 587
		3	SS	57	
		4	SS	33	
578.6		5	SS	80/6"	Gr.12% Sa.40% Si.42% Cl.6%
576.1	Silty Sand				
18		6	SS	32	
	Silty Clay to Clayey Silt	7	SS	27	
		8	SS	27	
		9	SS	21	
		10	SS	23	
	Firm to Hard	11	SS	17	
		12	TW	P	
		13	TW	P	
		14	TW	P	
		15	TW	P	
		16	TW	P	
503.6		17	SS	37	
90.5	Glacial Till (Silt, Sand and Gravel with some Clay	18	SS	73	
	Very Dense	19	SS	100/5"	
487.6		20	SS	80/6"	
106.5	End of Borehole				

ELEV. SCALE: 590, 580, 570, 560, 550, 540, 530, 520, 510, 500

DYNAMIC PENETRATION RESISTANCE
BLOWS / FOOT — 20 40 60 80 100

SHEAR STRENGTH P.S.F.
●Uncon. Comp. ○ Quick Triaxial
+Field Vane ■ Lab Vane
500 1000 1500 2000 2500

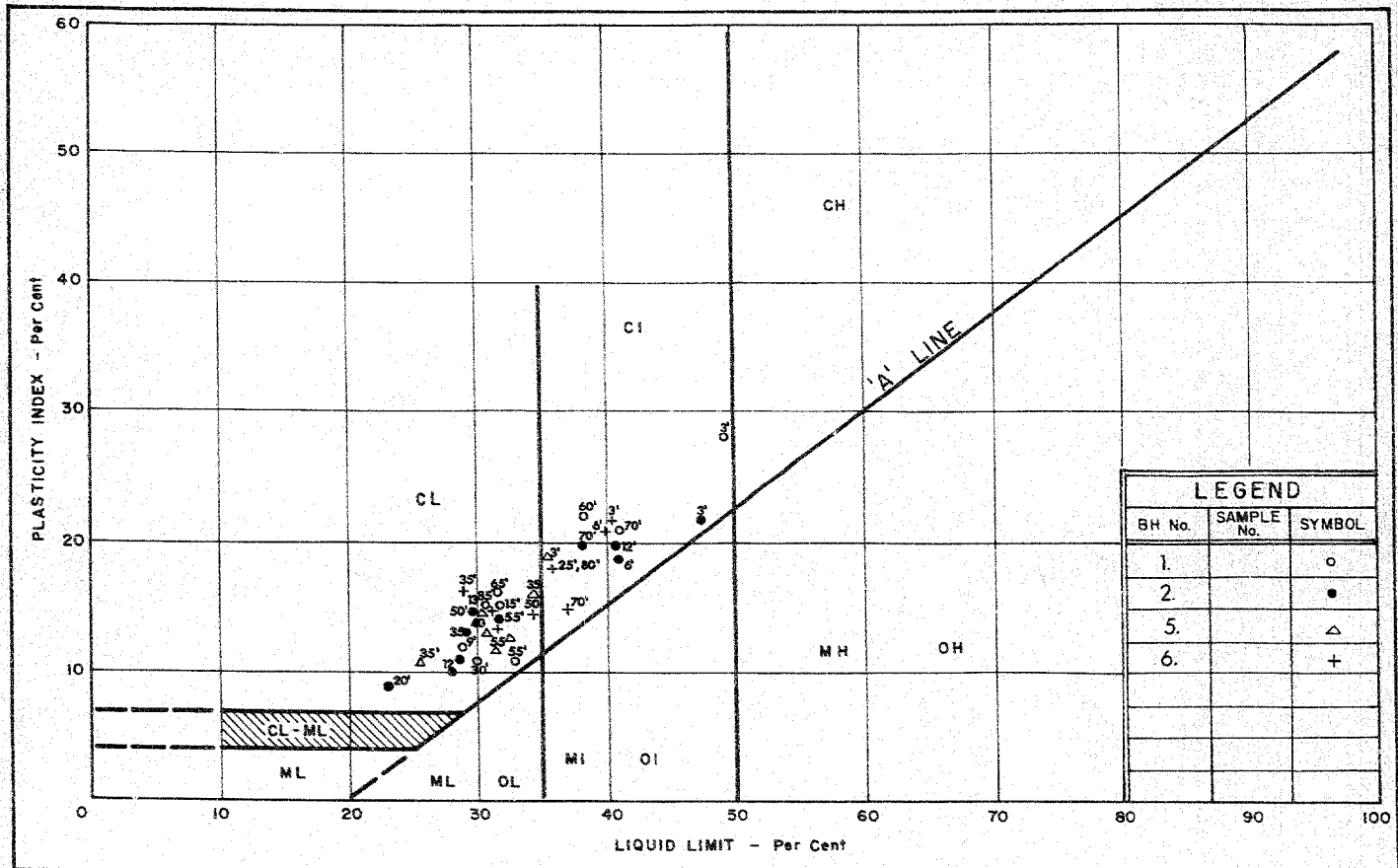
S-1.9
S-2.0
S-1.8
S-2.0
S-1.8
S-4.1
S-2.1
S-2.2
S-2.4

LIQUID LIMIT — w_L
PLASTIC LIMIT — w_P
WATER CONTENT — w
w_P w w_L
WATER CONTENT % 10 20 30

BULK DENSITY γ P.C.F.
128
128
128
127
127
122
124
124

20
15 — 5 Percent Strain at Failure
10

(REV. JUNE 1965)
65-1624



DEPARTMENT OF HIGHWAYS
MATERIALS and TESTING DIVISION
ONTARIO

PLASTICITY CHART

W.P. No. 311 - 64
JOB No. 66-F-44

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 :-

CONSISTENCY	'N' BLOWS / FT.	c LB. / SQ. FT.	DENSENESS	'N' BLOWS / FT.
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

Qu	UNCONFINED COMPRESSION	L.V.	LABORATORY VANE
Q	UNDRAINED TRIAXIAL	F.V.	FIELD VANE
Qcu	CONSOLIDATED UNDRAINED TRIAXIAL	C	CONSOLIDATION
Qd	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 $= \frac{-\Delta e}{(1+e)\Delta \sigma'}$
	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
	IN TERMS OF EFFECTIVE STRESS $\tau_f = c' + \sigma' \tan \phi'$
c_u	APPARENT COHESION
ϕ_u	APPARENT ANGLE OF SHEARING RESISTANCE, OR FRICTION
	IN TERMS OF TOTAL STRESS $\tau_f = c_u + \sigma \tan \phi$
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 (YOUNGS 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_o	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

cc: Foundations Office (Rm. 110)

66-F-6

Mr. A. P. Watt,
Regional Bridge Location Engr.,
London Regional Office.

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

October 25, 1966

Your Memo -- Oct. 21/66

W.P. 311-64, Bridge Site 6-243,
Belle River Bridge,
8.7 miles west of Hwy. 77,
Highway 401 South Service Road,
District 1 (Chatham)

We have reviewed the Preliminary Plan No. D-6018-P1 for the above mentioned structure.

It appears that the designer has complied with our foundation recommendations.

N. Devata

N. Devata,
SUPERVISING FOUNDATION ENGR.
For:
A. G. Stermac,
PRINCIPAL FOUNDATION ENGR.

MD/MdeF

cc: Mr. S. McCombie
Foundations Office
Gen. Files

DEPARTMENT OF HIGHWAYS ONTARIO

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: October 21, 1966

Our File Ref.

In reply to

Subject: W.P 311-64, Bridge Site 6-243, 66-F-40
Belle River Bridge,
8.7 miles west of Hwy. 77,
Highway 401 South Service Road,
District 1, Chatham.

Attached please find one copy of the preliminary plan D-6018-P1 for the above structure.

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

A. P. WATT
REGIONAL BRIDGE LOCATION ENGINEER

APW:gf
ATT'D

c.c. Mr. S. McCombie

No comments.

M. Devata 25 oct/66.

00162

C

CHAT DOWN 4 SEPT 13/68 11.50 A VR

F C BROWN DIST ENGR

ATT P H PEACOCK CONST ENGR

RE SETTLEMENT PLATES WP-299-60 HWY 401 AND DILLON SIDE ROAD

AND WP-311-64 BELLE RIVER BRIDGE ON SOUTH SERVICE ROAD

WE APPRECIATE YOUR ADVISE REGARDING SETTLEMENT OBSERVATIONS

FOR THE ABOVE MENTIONED PROJECTS SINCE WE HAVE INSTRUMENTED

SOME PROJECTS VERY CLOSE TO THESE SITES WE FEEL THAT SETTLEMENT

OBSERVATIONS ARE NOT REQUIRED FOR THE ABOVE MENTIONED PROJECTS.

M DEVATA FOR A G STERMAC MATLS AND TESTG DIV

TELETYPE

10 SEP 10 PM 2:49

DOWN CHAT 9 SEPT 10/68 2:44

M DEVATA FOUNDATIONS MAI AND TEST

SETTLEMENT PLATES

IN ABOUT SIX WEEKS WE SHALL START WORK ON WP 299-60 HWY 401 DILLON SIDE ROAD AND WP 311-64 BELLE RIVER BRIDGE ON SOUTH SERVICE ROAD.

ALSO SOMETIME THIS FINANCIAL YEAR THE REMAINDER OF THE 401 FLYOVERS.

DO YOU WANT ANYMORE SETTLEMENT PLATES PUT IN ON THESE JOBS.

P H PEACOCK CONST ENGR

TELETYPE

P H PEACOCK CONST ENGR

DO YOU WANT ANYMORE SETTLEMENT PLATES PUT IN ON THESE JOBS.

ALSO CONFIRM THIS FINANCIAL YEAR THE REMAINDER OF THE 401 FLYOVERS.

SIDE ROAD AND WP 311-64 BELLE RIVER BRIDGE ON SOUTH SERVICE ROAD.

IN ABOUT SIX WEEKS WE SHALL START WORK ON WP 295-60 HWY 401 DILLON

SETTLEMENT PLATES

& DEVAIN FOUNDATIONS 401 AND TEST

DOM CHE 5 SEPT 10/68 2:44

ID ON 2:00

W/P 27-58-69

WS 65-F-67

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

From: A. P. Watt

Date: October 21, 1966

Our File Ref.

In reply to

Subject: W.P. 299-60, Bridge Site 13-292,
Dillon Side Road Underpass,
9.0 miles east of east Jct. Hwy. 2, Tillbury,
Highway 401,
District 1, Chatham.

Attached please find one copy of the preliminary plan D-6040-P1 for the above structure.

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

A. P. WATT
REGIONAL BRIDGE LOCATION ENGINEER

APW:gf
ATT'D

c.c. Mr. S. McCombie

No Comments : Designer has complied with our report and abutment memo.

Ken Selby
Oct. 26 '66

57. F. 61
66. E. 27

66-F-44

MAY 17 AM 11:43

C

CHAT DOWN 5 MAY 17/66 11.35 A VR

F C BROWN D E

ATN R W LANGLANDS MTCE ENGR

CORRECTION TO TT SENT MAY 17TH

RE PROPOSED STRUCTURE AT BELLE RIVER & PROPOSED SERVICE ROAD

WP 311-64 WJ 66-F-44 DIST 1 CHATHAM

FOUNDATION INVESTIGATION WORK WILL BE COMMENCED ON

18 MAY 1966 FOR THE ABOVE MENTIONED PROJ.

THIS IS FOR YOUR INFORMATION

M DEVATA SNR FOUND ENGR FOR A STERMAC MATLS & TESTG

#66-F-44

W.P. #311-64

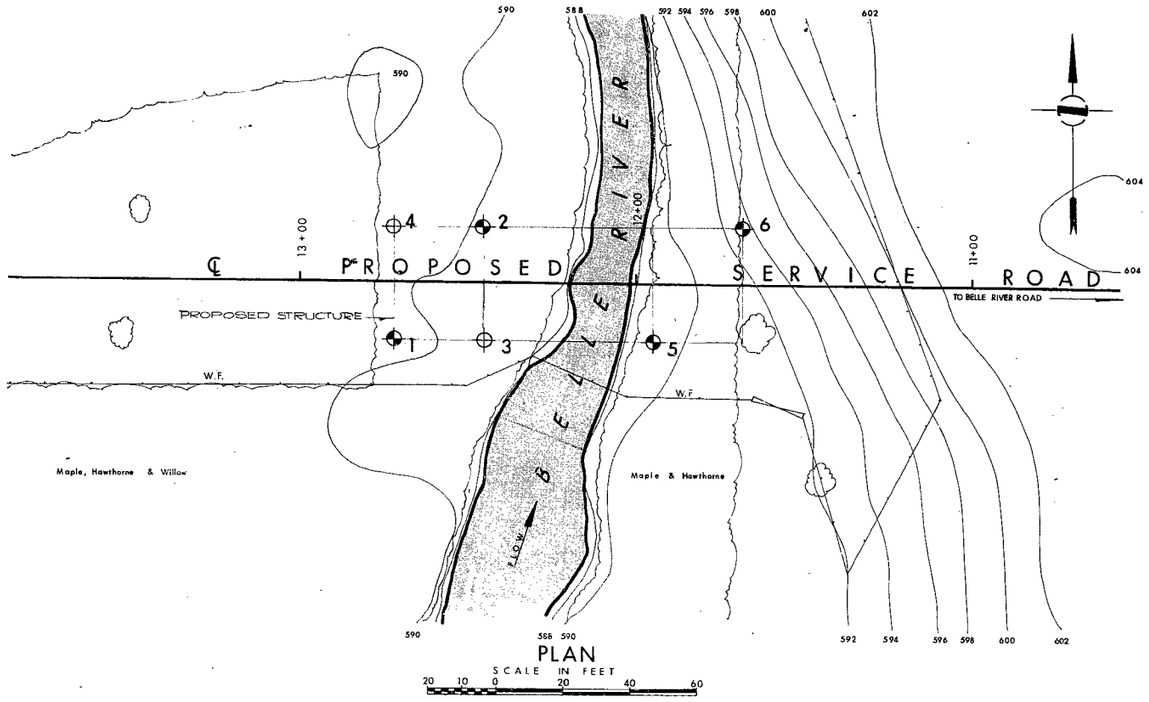
Hwy. # 401

Service Rd.

(Prop) ℄

Belle River

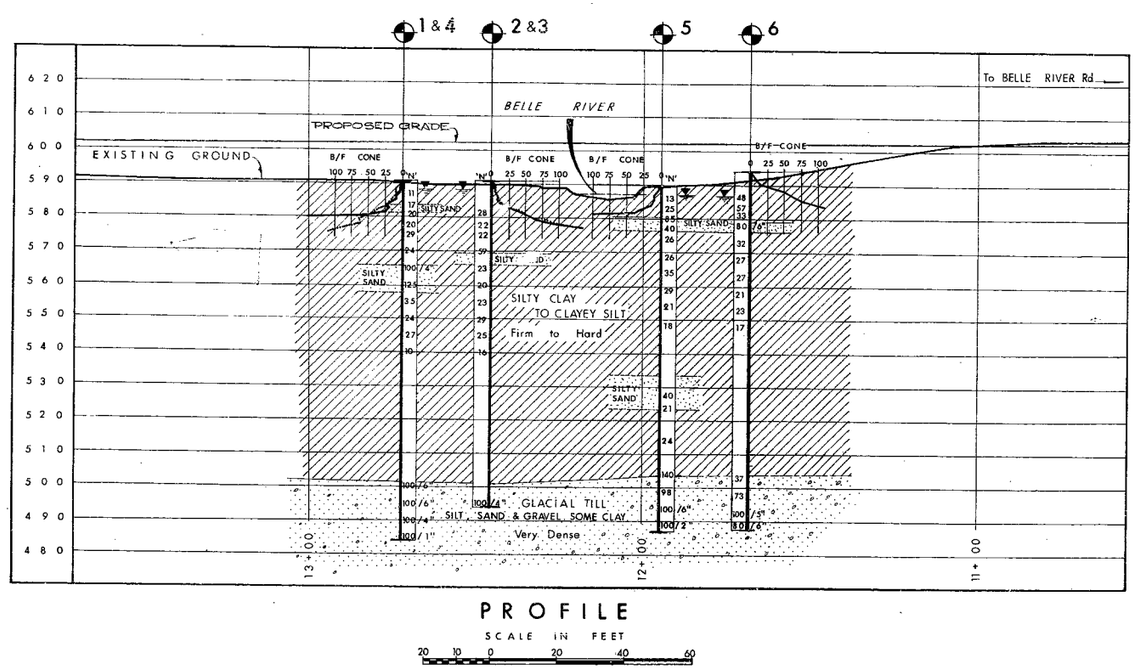
40J2E



PLAN

SCALE IN FEET

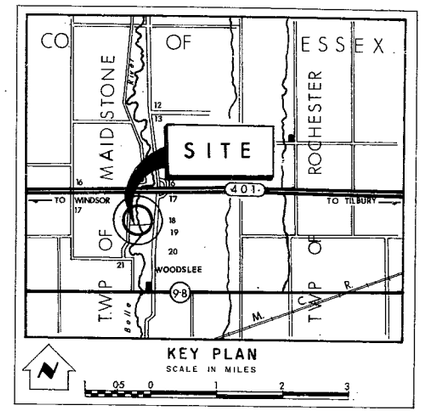
20 10 0 20 40 60



PROFILE

SCALE IN FEET

20 10 0 20 40 60



LEGEND

- Bore Hole
- Cone Penetration Hole
- Bore & Cone Penetration Hole
- Water Levels established at time of field investigation. MAY, 1966

NO.	ELEVATION	STATION	OFFSET
1	590.5	12+72	17'LT
2	590.5	12+45	17
3	589.0	12+45	17
4	590.5	12+72	17
5	589.2	11+95	17'LT
6	594.1	11+68	17'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 & TESTING DIVISION – FOUNDATION SECTION

BELLE RIVER

KING'S HIGHWAY NO. 401 – PROPOSED SERVICE ROAD DIST. NO. 1

CO. ESSEX

TWP. MAIDSTONE ROCHESTER LOT 18 CON. 1 WBR EBR

BORE HOLE LOCATIONS & SOIL STRATA

SUBM'D. R.M.	CHECKED A.D.	W.P. NO. 311-64	M.B.T. DRAWING NO. 66-F-44A
DRAWN J.N.	CHECKED	JOB NO. 66-F-44	
DATE 17 JUNE, 1966		SITE NO.	BRIDGE DRAWING NO.
APPROVED		CONT. NO.	

PRINCIPAL FOUNDATION ENGINEER

REF. NO.: E-4369-1

PRINT RECORD

NO.	FOR	DATE