

MEMORANDUM

13-64-268

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

FROM: Mr. A. G. Stermac,
Principal Foundation Engr.,
Foundation Section,
Materials & Research Division.

Attn: Mr. K. L. Kleinsteinber,
Mun. Bridge Liaison Engr.

DATE: December 20, 1963.

OUR FILE REF.

IN REPLY TO

SUBJECT:

FOUNDATION INVESTIGATION REPORT

For

Proposed New Structure at Crossing
of Wright Creek and Dev. Rd. 4767,
Lot 7, Conc. I, Twp. of Brockton
(On Townline with Twp. of Cassy)
Dist. #14 (Mun. Job) - W.J. 63-F-130

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

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

KYL/MdeF

Attach.

cc: Messrs. A. M. Toye (3)
J. P. Howard
J. Moffat
E. R. Saint

KYL

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

Foundations Office
Gen. Files

"Structure" Wright
Creek & Dev. H. 767.

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

Attn: Mr. C.C.E. Burkhardt

Mr. A. G. Stermac,
Principal Foundation Engr.,
Foundation Section,
Materials & Research Division.
February 11, 1964

Proposed New Structure at Crossing of
Wright Creek and Dev. Rd. #P.E. 767,
Lot 7, Conc. 1, Township of Brethour
(On Townline with Township of Casey),
Dist. #14 (Mun. Job) - W.J. 63-F-130.

This is to confirm our verbal discussion on the requirements for the stability of the approach embankment and foundation design for the proposed bridge at the above site, if the existing grade is not raised.

A study of the natural slopes at the site, as shown in our foundation report, leads to the conclusion that a slope of 4:1 is required for stability. Experience indicates, however, that most of the slope failures are relatively shallow at the vicinity of the site. Therefore, if for economical reasons a very minimum factor of safety is aimed at, a bridge of at least 125 ft. span is required so that the foundations will be located outside a possible slip. A berm of 6 ft. should be constructed in front of the abutment footings and the front slope should be trimmed down to El. 78. The footings should be supported by timber piles as recommended in the report. The river banks and the approach embankment should be rip-rapped.

KYL/MdeF

cc: Foundations Office
Gen. Files

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

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FOUNDATION INVESTIGATION REPORT

For

Proposed New Structure at Crossing of
Wright Creek and Development Rd. #P.E.767,
Lot 7, Conc. I, Twp. of Brethour -
(on Townline with Twp. of Casey)
District #14 -- W. J. 63-F-130

1. INTRODUCTION:

A request dated October 10, 1963, for a foundation investigation at the site of the proposed new structure at the crossing of Wright Creek and Dev. Road #767, was received from the Municipal Bridge Liaison Engineer.

In order to determine the soil properties and decide on the type of foundations, an investigation was carried out by this Section. Presented in this report are the results of this investigation, together with the recommendations pertaining to the design of the structure foundations and approach embankments.

2. DESCRIPTION OF THE SITE:

The site is located approximately 4.0 miles north of Judge in the Twp. of Brethour on townline with Twp. of Casey, District of Timiskaming. At this location the river flows in a northeast to southwest direction. The width of the river at the proposed crossing is about 45 ft. and the maximum depth is 6.0 ft. The existing banks of the river in the vicinity of the structure location are approximately 10 ft. to 15 ft. high, having 2:1 to 3:1 natural slopes. The banks of the river show many signs of instability in the form of slope failures. The surrounding area mostly consists of cultivated farmland and pasture.

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

The existing structure over Wright Creek is only 15 ft. wide and some 82.0 ft. long (16' - 50' - 16'), which carries only single-lane traffic. The existing structure, in general, is in poor condition.

3. DESCRIPTION OF FIELD AND LABORATORY WORK:

Field work consisted of two sampled boreholes and one dynamic cone penetration test. The boring was carried out by means of conventional diamond drilling equipment adapted for soil sampling purposes.

Samples were recovered at required depths by means of a 2" O.D. split-spoon sampler and by a 2" I.D. Shelby tube sampler. The dimensions of the split-spoon sampler and the energy used in driving it, conform to the requirements of the Standard Penetration Test. In-situ vane tests were carried out wherever possible, in order to determine the shear strength of the cohesive deposits. A dynamic cone penetration test was carried out adjacent to B.H. #1. Driving energy to advance the 2-inch cone was 350 ft.-lbs. per blow.

The locations and elevations of all boreholes are shown on Dwg. #63-F-130A, which accompanies this report.

Samples were visually examined and identified in the field as well as in the laboratory. Tests were carried out in the laboratory on a selection of both disturbed and undisturbed samples to determine:

- i) Natural Moisture Contents
- ii) Bulk Densities
- iii) Atterberg Limits
- iv) Grain Size Distributions
- v) Undrained Shear Strengths.

3. DESCRIPTION OF FIELD AND LABORATORY WORK: (cont'd.) ...

Laboratory and field test results have been summarized and are included under Appendix I of this report.

4. SUBSOIL CONDITIONS:

Subsoil at the site was found to consist of about 6 - 8 ft of silty clay to clayey silt containing sand and fine gravel underlain by an extensive deposit of varved clay to at least 120 ft., as indicated by the cone test. The maximum depth sampled is 63 ft. The upper 6 - 8 ft. is believed to be fill material placed during the construction of the existing bridge and approaches.

The varved clay deposit consists of alternate layers of clay of high plasticity and clayey silt. The clay layers range from 1/2" to 2-1/4" in thickness and are spaced 1/4" to 1/2" apart. The Atterberg Limits and moisture content ranges for the various layers are tabulated below:

	Clay Layers	Clayey Silt Layers
Liquid Limit (W _L %)	56% - 73%	29% - 34%
Plastic Limit (W _p %)	24% - 29%	18% - 23%
Moisture Content (W %)	65% - 72%	28% - 34%

The undrained shear strength of the deposit as determined from field vane tests, was found to vary from a low of 320 p.s.f. at the surface, to a maximum of 1000 p.s.f. at a depth of 63.0 ft., whereas the results from the laboratory tests were found to vary randomly from 180 to 520 p.s.f.

cont'd. /4 ...

5. GROUND WATER CONDITIONS:

Observations carried out during the time of the field investigation, indicate that the water level is approximately 5.0 ft. below ground level. The exact water levels observed at the time of the investigation are shown on borehole logs (Appendix I). Artesian water conditions were not observed in any of the boreholes during the time of the field investigation.

The water level of Wright Creek at the crossing, was at elev. 78.0, which corresponds to the water levels observed in the boreholes.

6. DISCUSSION AND RECOMMENDATIONS:

It is proposed to construct a new structure at this site to replace the existing one. The new centreline will be the same as the existing one, and the new profile grade will be approximately 3 - 4 ft. higher.

Subsoil at the site mainly consists of a deep deposit of soft to firm varved clay extending for at least 63.0 ft. below ground level at the toe of the present approach fill.

Recommendations for the proposals are as follows:

Structure:

The upper layers of this deposit are not competent to provide an adequate bearing capacity for an economical spread footing design. The new structure should, therefore, be supported by a piled foundation. For this purpose, a design load of 10 tons may be attributed to 12" Ø timber piles driven 45.0 ft. into the original ground. It is pointed out that a piled foundation as such,

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

Structure: (cont'd.) ...

will not eliminate settlements and therefore, a simply supported structure is recommended. The most suitable type of structure at this site would be a timber trestle bridge.

The presence of the soft varved clay deposit immediately below the existing approach embankment, will necessitate certain measures to ensure the stability of the future heightening and widening of the approach fill. It is recommended that the forward slopes be constructed so as to provide a gradient not steeper than 4 horizontal to 1 vertical. The abutments would, therefore, be located at Sta. 1+60 and Sta. 3+20 approximately. The sides of the embankment may, however, be constructed with a slope of 2 horizontal to 1 vertical.

Precautions should be taken to protect the river banks and the approach embankments from scour action of the river. This may be achieved by suitably placed rip-rap.

7. SUMMARY:

Subsoil at the site mainly consists of a soft to firm varved clay deposit extending for at least 120 ft. below ground surface.

A new structure is proposed at this site over Wright Creek to replace the existing one. The structure can be supported on large displacement timber piles driven into the varved clay deposit. A design load of 10 tons per pile may be used for 12" Ø timber piles driven to 45.0 ft. below the ground surface.

cont'd. /6 ...

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

Approach embankments should be constructed with forward slopes 4:1 and side slopes 2:1. Adequate protection for the scour from the river should be provided for the approach fills.

8. MISCELLANEOUS:

The field work was carried out by Mr. A. Barsvary, Project Foundation Engineer, during October 22 - October 25, 1963, under the general supervision of Mr. K. Y. Lo, Supervising Foundation Engineer. This report was prepared by Mr. M. Devata, Senior Foundation Engineer.

December 1963

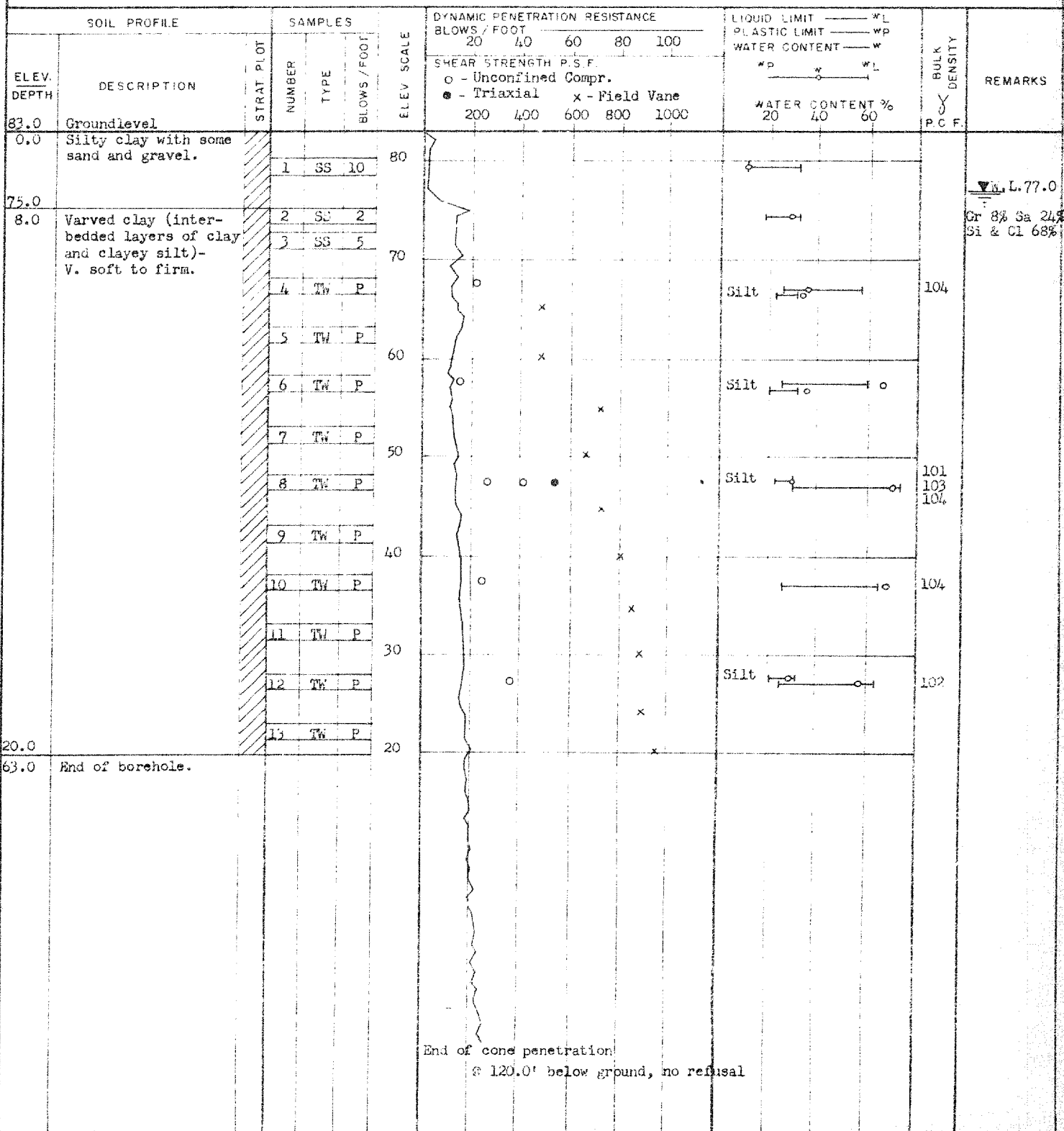
APPENDIX I.

DEPARTMENT OF HIGHWAYS - ONTARIO
MATERIALS & RESEARCH DIVISION

RECORD OF BOREHOLE NO. 1

FOUNDATION SECTION

JOB 63-F-130 LOCATION Sta. 2+70; 10' Rt. of C ORIGINATED BY A.B.
 W.P. - BORING DATE Oct. 23, 1963. COMPILED BY A.B.
 DATUM Assumed BOREHOLE TYPE Washboring, NX Casing. CHECKED BY M.D.



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	SHOTTED 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 _{co}	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_i	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
$\bar{\sigma}$	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

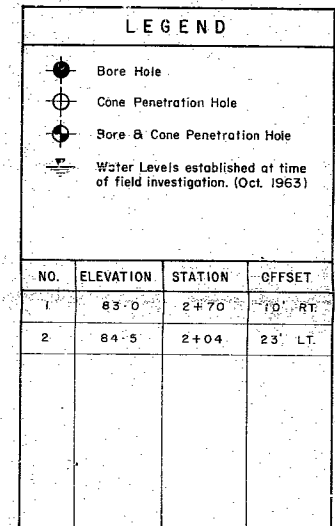
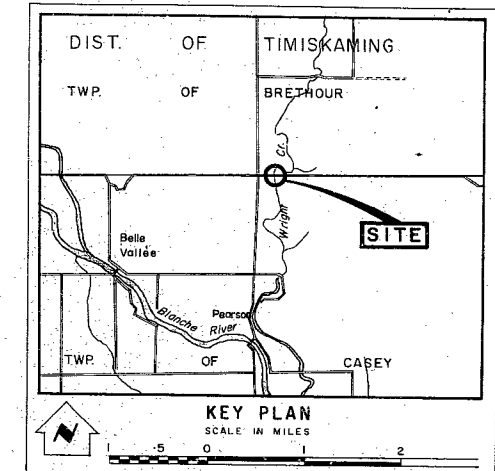
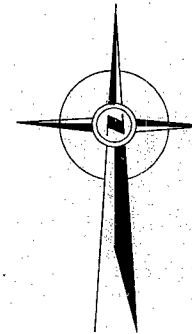
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W.P. MUNICIPAL

DEV. RD. #P.E. 767

WRIGHT CREEK

BRETHOUR TWP.



- 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

WRIGHT CREEK.

KING'S HIGHWAY NO. DEV. RD. NO. P.E. 767 DIST. NO. 14
DIST. TIMISKAMING
TWP. BRETHOUR & CASEY LOT 7 CON. I & VII

BORE	HOLE	LOCATIONS	&	SOIL	STRATA
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SUBM'D. A.B.	CHECKED <i>[Signature]</i>	W.P. NO.	M.S.R. DRAWING NO.
DRAWN D.M.	CHECKED <i>[Signature]</i>	JOB NO. 63 - F - 130	63 - F - 130 A
DATE 30 DEC. 1963	SITE NO.	BRIDGE DRAWING NO.	
APPROVED <i>[Signature]</i>	CONT. NO.		

[illegible]