

DEPARTMENT OF HIGHWAYS ONTARIO

MEMORANDUM

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

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

Attn: Mr. K. L. Kleinstelber

DATE: April 17, 1964

OUR FILE REF.

IN REPLY TO

SUBJECT:

FOUNDATION INVESTIGATION REPORT

For

Proposed Structure at Intersection
of Side Road No. 20 (Dev. Rd. 744)
& Humber River, Sta. 3+61, Twp. of
Albion, District No. 6, Toronto.

W.J. 63-F-144 -- (Municipal Job)

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 there be any queries concerning this
project, please do not hesitate to contact our Office.

KYL/MdeF
Attach.

cc: Messrs. A. M. Toye (3)
J. P. Howard
J. G. Tillcock
T. J. Kovich

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

Foundations Office
Gen. Files ✓

TABLE OF CONTENTS

1. INTRODUCTION.
 2. DESCRIPTION OF THE SITE.
 3. FIELD AND LABORATORY WORK.
 4. DESCRIPTION OF THE SUBSOIL:
 - 4.1) General.
 - 4.2) Silty Sand with Gravel.
 - 4.3) Silt with Fine Sand.
 5. GROUND WATER.
 6. DISCUSSION AND RECOMMENDATIONS.
 7. SUMMARY.
 8. MISCELLANEOUS.
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FOUNDATION INVESTIGATION REPORT

For

Proposed Structure at Intersection
of Side Road No. 20 (Dev. Rd. 744)
& Humber River, Sta. 3+61. Twp. of
Albion, District No. 6, Toronto.

W.J. 63-F-144 -- (Municipal Job)

1. INTRODUCTION:

A request dated November 25, 1963, for a foundation investigation at the site of the proposed structure at the crossing of the Humber River diversion and relocated Side Road No. 20, (Dev. Rd. No. 744) near Bolton, was received from Mr. T. J. Kovich, Regional Materials Engineer.

In order to determine the properties of the soil 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 structure foundations.

2. DESCRIPTION OF THE SITE:

The proposed Side Road No. 20 new centre line crosses the Humber River at about 360 ft. west of Hwy. No. 50 and about 250 ft. north of the existing Side Road No. 20.

The topography of the area consists of a rolling knob and basin relief. The river is about 40 ft. wide and flows in an east to west direction following a meandering course.

cont'd. /2 ...

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

The site is located in the physiographic region of Oak Ridges which consists of interlobate moraines built between two opposing lobes of a glacier. Much of this moraine is covered with sand hills and coarse outwash.

3. FIELD AND LABORATORY WORK:

The field investigation was carried out by means of a diamond drill adapted for soil sampling. The field work consisted of three boreholes at the location of the proposed structure with adjacent dynamic cone penetration tests and two shallow boreholes along the centre line of the proposed river diversion.

In non-cohesive soils disturbed samples were taken by means of a 2" O.D. split-barrelled spoon sampler. The dimensions of this sampler and the energy used in driving it, conform to the requirements of the Standard Penetration Test.

The samples were brought to the laboratory and representative samples were tested for Atterberg limits, natural moisture content and grain size distribution.

The location of boreholes and their elevations are shown on log sheets and Drawing No. 63-F-144A, attached to this report.

4. DESCRIPTION OF THE SUBSOIL:

4.1) General:

The subsoil stratification at the site was found to be quite uniform. An upper layer of silty sand with gravel is underlain by a deposit of silt with occasional seams of fine sand.

From ground level downward, the various soil types encountered are as follows:

cont'd. /3 ...

4. DESCRIPTION OF THE SUBSOIL: (cont'd.) ...

4.2) Silty Sand with Gravel:

Underlying the topsoil, a layer of silty sand with gravel was encountered in all the boreholes. The thickness of the stratum was found to vary from a maximum of 11.5 ft. in B.H. #1 to a maximum of 2.0 ft. in B.H. #20. Occasional traces of organics were observed in samples from B.H. #2.

Standard Penetration resistances or 'N' values of 13 to 37 blows/ft. were obtained in this material. From these values it is estimated that the relative density varies from compact to dense.

4.3) Silt with Fine Sand:

Underlying the silty sand with gravel layer is a deposit of silt with fine sand, extending at least 66 ft. below ground. The percentage of silt and sand varies somewhat throughout the stratum but in general, the deposit may be described as fine-grained granular material. Occasional thin seams of sand and clayey silt were observed within the deposit. Wherever possible, Atterberg limits were carried out in the cohesive clayey-silt layers. The test results indicate that the liquid limit of the clayey-silt layers ranges from 13% to 23%, whereas the plastic limit ranges from 10% to 17%. The overall moisture content of the deposit ranges from 11% to 19%.

Standard Penetration resistances or 'N' values ranged from 12 to 74 blows/ft. indicating a relative density of compact to very dense for the entire deposit.

cont'd. /4 ...

5. GROUND WATER:

During the time of the field investigation (January, 1964) the creek water level was found to be at approx. elev. 826.0.

The measured ground water levels in the boreholes are the following:

B.H.	1	--	Elev.	827.0
B.H.	2	--	Elev.	827.0
B.H.	2A	--	Elev.	827.4
B.H.	2B	--	Elev.	827.8
B.H.	2C	--	Elev.	829.4

6. DISCUSSION AND RECOMMENDATIONS:

It is proposed to construct a new 40-ft. wide barrel arch bridge at the crossing of the new Side Road No. 20 and the Humber River diversion.

The subsoil at this site was found to be generally uniform. For spread footing type foundations at about elevation 819 ft. or below, the estimated safe bearing value is 1.5 t.s.f. If larger bearing loads are required, the structure may be supported on large displacement timber piles driven into the silt stratum. For example, #12 timber piles driven some 30 ft. into the silt stratum can provide a safe bearing load of 25 tons/pile.

The driving of piles in the field should be controlled by the use of the Hiley Formula as per current D.H.O. Standards DD 1218 and DD 1219.

A dewatering scheme will be necessary as excavation for the footings will be carried out below river water level. If sheeting is used in a dewatering scheme or as a means of scour

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

protection, this should be driven to a depth below the excavation base equal to the height of the prevailing ground water above it.

It is assumed that footing elevations will be subject to hydrological requirements at this site.

The proposed grade of the new roadway at this location will be at approx. elev. 849.0. This indicates that the approach fills will be in the order of 20 ft. The subsoil generally consists of fine-grained granular material and, consequently, no stability problems are anticipated for the standard 2:1 side slopes. No stability problems are anticipated with regard to the side slopes for the proposed river diversion. Precaution should be taken to prevent surface erosion.

7. SUMMARY:

The subsoil conditions at this site are quite uniform. The upper silty sand with gravel layer is underlain by a deposit of silt, with fine sand, extending at least 66 ft. below the ground surface.

The structure can be supported on spread footings located at elev. 819.0 or below, with a safe design load of 1.5 t.s.f. As an alternative, the structure may be supported on large displacement timber piles driven to some 30 ft. into the silt. The estimated safe bearing load for these piles is 25 tons per pile.

A dewatering scheme will be necessary as excavations will be carried out below the creek water level. This is discussed in Section 6 above.

It is assumed that the elevation of the footings will be subject to the hydrological requirements at this site.

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

The approach fill embankment and the excavation for the stream diversion do not present any stability problems.

8. MISCELLANEOUS:

The field work was carried out during December 19, 1963 to January 17, 1964, under the supervision of Mr. V. Korlu Project Foundation Engineer, who also wrote this report. The report was reviewed by Mr. M. Devata, Senior Foundation Engineer.

April 1964

APPENDIX I.

FOUNDATION SECTION

ELEV DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER TYPE	BLOWS / FOOT	ELEV SCALE	DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT 20 40 60 80 100 SHEAR STRENGTH P S F	LIQUID LIMIT --- * L PLASTIC LIMIT --- * P WATER CONTENT --- * W * L * P * W	WATER CONTENT % 10 20 30	BULK DENSITY P.C.F.	REMARKS
830.4	Groundlevel				830					
0.8	Topsoil									
827.0	W.L. Silty sand with gravel.		1 SS 13							
3.4			2 SS 33							
818.9	Compact to dense.		3 SS 37		820					
11.5			4 SS 12							
			5 SS 16							
			6 SS 18		810					
	Silt with fine sand and trace of clay - (occasional thin seams of sand).		7 SS 20							
	(Compact to v. dense)		8 SS 23							
			9 SS 31		790					
			10 SS 35		780					
			11 SS 74							
			12 SS 58		770					
763.9			13 SS 65							
66.5	End of borehole.				760					

M. D.

[illegible]

RECORD OF BOREHOLE NO 2B

FOUNDATION SECTION

108 63-F-144

Side Side No. 20 & Humber Ri. (4/27; 95' Ht. of E)

ORIGINATED BY V.K.

W. O. Municipal Job

March 9, 1964.

COMPILED BY V.K.

DATUM Geodetic

8-16-57 10:00 Drive BX Casing and Wash.

CHEROKEE B. M.D.

[illegible]

RECORD OF BOREHOLE NO. 20

FOUNDATION SECTION

JOE 63-F-144	LOCATION Side Rd No. 20 & Humber Rd. (4767; 153' Rt. of E)	ORIGINATED BY V.K.
W P Municipal Job	WORKING DATE March 10, 1964.	COMPILED BY V.K.
DATUM Geodetic	WORKING TIME Drive BX Casing and Wash.	CHECKED BY M.D.

ELEV DEPTH	DESCRIPTION	STRAT. FOOT	SAMPLES		ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT	SHEAR STRENGTH P.S.F.	LIQUID LIMIT PLASTIC LIMIT WATER CONTENT	WATER CONTENT % 10 20 30	BULK DENSITY P.C.F.	REMARKS
			NUMBER	TEST							
832.9	Groundlevel										
830.9	Silty sand with gravel				830						Gr - 0 Sa - 3 Si) 97 Cl)
2.0	W.L.		1	SS 16							
3.5			2	SS 34							
	Silt with occasional seams of fine sand. (Compact).		3	SS 26	820						Gr - 0 Sa - 38 Si) 62 Cl)
			4	SS 20							
			5	SS 29	810						
806.4			6	SS 16							
26.5	End of borehole.				800						
					790						

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

SS	SPLIT SPOON	TW	THINWALL OPEN
WS	WASHED SAMPLE	TP	THINWALL PISTON
SB	SCRAPER BUCKET SAMPLE	DS	DESTERBERG SAMPLE
AS	AUGER SAMPLE	FS	FOIL SAMPLE
CS	CHUNK SAMPLE	RC	ROCK CORE
ST	SLOTTED TUBE SAMPLE		
	PH		SAMPLE ADVANCED HYDRAULICALLY
	PM		SAMPLE ADVANCED MANUALLY

SOIL TESTS

Qu	UNCONFINED COMPRESSION	LV	LABORATORY VANE
Q	UNDRAINED TRIAXIAL	FV	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 $= \frac{-\Delta e}{(1+e)\Delta\sigma}$
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_l	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_r	SENSITIVITY

GENERAL

π	+3.1416
e	BASE OF NATURAL LOGARITHMS 2.7183
$\log_e \sigma$ OR $\ln \sigma$	NATURAL LOGARITHM OF σ
$\log_{10} \sigma$ OR $\log \sigma$	LOGARITHM OF σ 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

g	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

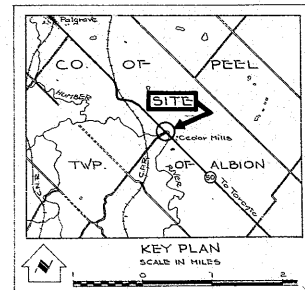
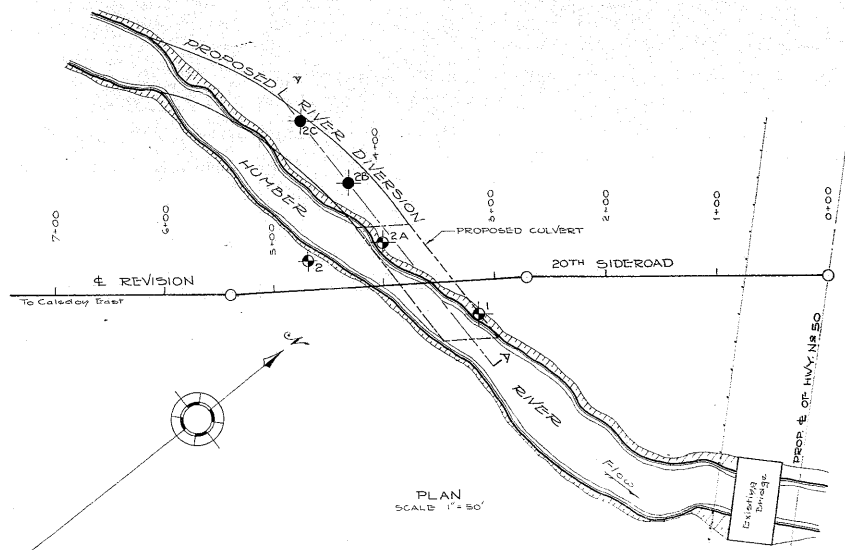
63-F-144

W.P. MUNICIPAL

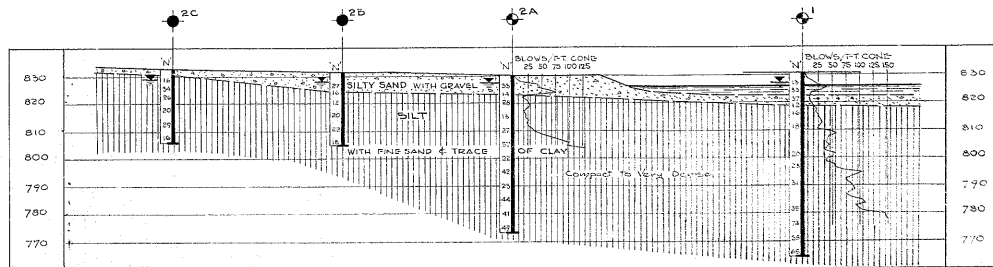
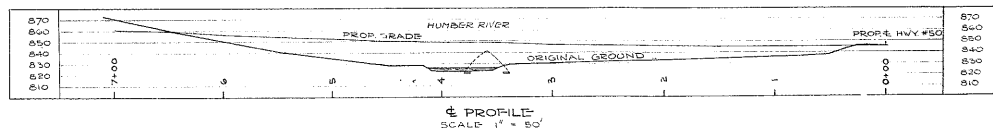
SIDE RD. # 20:

DEV. RD. # 744

HUMBER RIVER



LEGEND			
●	BORE HOLE		
⊙	BORE & CONE PENETRATION HOLE		
⊙	WATER LEVELS AT TIME OF FIELD INVESTIGATION		
NO	ELEVATION	STATION	OFF-SET
1	830.4	3+15	32' LT
2	830.0	4+67	25' RT
2A	829.9	4+00	59' RT
2B	821.3	4+27	75' RT
2C	822.9	4+67	135' RT



SECTION A-A
SCALE 1" = 20'

NOTE
THE BOUNDARIES BETWEEN SOIL STRATA HAVE BEEN DETERMINED ONLY AT BORE HOLE LOCATIONS. BETWEEN BORE HOLES THE BOUNDARIES ARE ASSUMED FROM GEOLOGICAL EVIDENCE AND MAY BE SUBJECT TO CONSIDERABLE ERROR.

DEPARTMENT OF HIGHWAYS - ONTARIO			
HUMBER RIVER			
SHOWING POSITIONS & ELEVATIONS OF HOLES			
ROUTE 20TH SIDEROAD	DISTRICT 6	COUNTY PEEL	
TOWNSHIP CEDAR MILLS	101 20	CON. VI	
LOCATION CEDAR MILLS	CHAINED BY	W.C. MUNICIPAL	
DATE 19 MAR / 64	APPROVED BY	DRAWING NO.	
SCALE AS SHOWN	111.11	63T-144A	

DWG. NO. 6359-2
RBN. NO. DUNCAN HOPPER & ASSOC.