

## 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: April 18, 1966

Our File Ref.

In Reply To

MAY 12 1966

SUBJECT:

FOUNDATION INVESTIGATION REPORT  
For  
Proposed Structure Widening,  
Richmond Road Underpass,  
Ottawa Queensway, Dist. #9.

W.J. 66-F-24 -- W.P. 909-64.

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 design requirements.

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

AGS/Mie  
Attach.

cc: Messrs. B. R. Davis (2)  
H. A. Tregaskes  
D. W. Farren  
R. S. Pillar  
L. E. Walker  
J. E. Gruspier  
A. Watt

Foundations Office  
Gen. Files

*A. G. Sternmac*  
A. G. Sternmac,  
PRINCIPAL FOUNDATION ENGINEER

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FOUNDATION INVESTIGATION REPORT  
For

Proposed Structure Widening,  
Richmond Road Underpass -  
Ottawa Queensway, Dist. #9.  
W.J. 66-F-24 -- W.P. 909-64.

1. INTRODUCTION:

A request, dated February 7, 1966, was received from Mr. G. Scott, Regional Bridge Location Engineer, to investigate the subsoil conditions for the proposed structure widening of the Richmond Road Underpass of the Queensway extension, Ottawa.

The site is on the Trans-Canada Highway 1500\* west of the city limits of Ottawa in the Township of Nepean and the County of Carleton.

A foundation investigation was conducted by this section at the proposed site to determine the subsoil conditions. Field data and laboratory test results are presented in this report together with our recommendations pertaining to future structure foundations and embankments.

2. SITE TOPOGRAPHY AND GEOLOGY:

The area surrounding the site is generally residentially developed. Geologically, Carleton county lies within the physiographic region of Canada known as the Lowlands of the St. Lawrence. The site is on the boundary between two physiographic divisions, the Ottawa Valley Clay Plain and the Russell and Prescott Sand Plains. The deposits are predominantly of glacial origin probably laid down during and immediately following the Wisconsin glaciation and overlie bedrock chiefly of Paleozoic age.

### 3. FIELD AND LABORATORY WORK:

Using conventional diamond drilling equipment adapted for soil sampling purposes, three sampled boreholes and four dynamic cone penetration tests were carried out at the site. A driving energy of 350 ft. lbs. was used for the dynamic cone penetration tests.

Wherever possible in cohesive materials in-situ vane tests were conducted to determine the shear strength of the material and 2-inch I.D. Shelby tube samples were obtained either by pushing the tubes into the soil manually or by the use of a piston sampler. Otherwise, samples were obtained using a 2-inch O.D. split-spoon sampler driven according to the specifications of the Standard Penetration Test. In addition, AXT rock core samples were obtained to prove bedrock.

Samples were visually examined and identified in the field and subsequently in the laboratory. Laboratory tests were conducted on selected representative samples to determine, where applicable, Atterberg limits, bulk density, grain-size distribution, natural moisture content and undrained shear strength.

Results of the laboratory and field tests together with the location and elevations of the boreholes are presented in Appendix I of this report. Elevations were determined by a D.H.O. survey crew and are referred to a geodetic bench-mark.

### 4. SOIL TYPES AND SUBSOIL CONDITIONS:

#### 4.1 General.

The upper forty feet of the subsoil consists of a layered deposit of clayey silt and sand. The clayey silt layers are soft to very stiff and the sand layers are loose to very dense.

cont'd. /3 .....

4. SOIL TYPES AND SUBSOIL CONDITIONS: (cont'd.) ...

The stratigraphy is quite irregular and reference should be made to the borehole log sheets in the appendix for details.

Beneath this deposit and extending to bedrock at a depth of about 70 to 90 feet is a deposit of sand to sandy silt which varies in density from very loose to very dense.

4.2 Clayey Silt.

This material occurred as irregular layers or deposits from ground surface to a depth of 38 to 43 feet. The deposit varied from four 3 - 7 foot layers in borehole 2 to two layers 4 and 6 feet thick in borehole 3.

The consistency of this material also varied considerably from soft to very stiff although stiff to very stiff material predominated. "N" values were between 4 and 20 blows per foot, and shear strength, as determined by laboratory tests and two field vane tests, varied from about 400 to 2990 p.s.f.

4.3 Sandy Silt to Sand.

This deposit encountered at a depth of 38 to 43 feet below ground surface extended to bedrock at a depth of 69 to 88 feet. The deposit varied considerably from very loose to dense in borehole 2, to compact to very dense in boreholes 1 and 3. From a depth of 42.5 feet to about 55 feet in borehole 2 the sampling spoon penetrated the deposit under its own weight; otherwise, "N" values ranged from 26 to 68 blows per foot.

The material varied from medium to fine sand in general, with some sandy silt occurring in borehole 3. A 2 to 6 foot deposit of coarse sand overlaid the bedrock.

cont'd. /4 .....

4. SOIL TYPES AND SUBSOIL CONDITIONS: (cont'd.) ...

4.4 Bedrock.

The bedrock was proven for a depth of about five feet in boreholes 1 and 2 and for three feet in borehole 3 and consisted of calcareous shale probably of the Chazy formation of Paleozoic age. The rock core appeared sound and recovery was about 100%.

5. GROUNDWATER:

Ground water elevation was observed in borehole 1 at an elevation of about 211.5 feet (ground elev. 215.9 ft.) over a period of ten days. Boreholes 2 and 3 caved in and were dry at a depth of 2.5 feet and 3.5 feet respectively.

6. DISCUSSION AND RECOMMENDATIONS:

To accommodate future traffic on the Richmond Road underpass as well as traffic interchanging with the Queensway extension it is proposed to widen the existing structure from 54 feet to some 100 ft. The existing 2 span underpass is founded on steel H piles driven to bedrock and has perched abutments with forward embankment slopes of  $1\frac{1}{2}$  to 1. The structure and embankments appear to be in good condition.

In order to avoid differential settlements it is recommended that the widened structure be supported on small-displacement end-bearing piles driven to bedrock both for the pier and the abutment foundations. Allowable loads will depend upon the section chosen (e.g. 14 BP 74 may be designed for 90 tons per pile).

The pile length will vary considerably due to the slope of the bedrock which rises to the north from an elevation of about 128 feet at the south abutment to about 147 feet at the north abutment.

cont'd. /5 .....

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

No stability problems are anticipated for the approach embankments provided that standard side slopes of 2 horizontal to 1 vertical. If forward slopes of  $1\frac{1}{2}$  to 1 are desired to be compatible with the existing slopes no stability problems are expected.

Some settlement is to be expected for the embankment. The amount of settlement is difficult to estimate due to the variability of the subsoil, however no particular problems are anticipated.

Any excavation for pier footings below the water table in granular material may require some form of dewatering.

7. SUMMARY:

The subsoil consists generally of a variable deposit of clayey silt, and silty sand to sand layers underlain at about 40 feet by a deposit of sandy silt to sand which extends to shale bedrock.

Bridge piers and abutments should be supported on end-bearing piles driven to bedrock (e.g. 14 BP 74 may be designed for 90 tons per pile).

No stability problems are anticipated for the proposal approach embankments with standard 2 to 1 side slopes and  $1\frac{1}{2}$  to 1 forward slopes if desired.

8. MISCELLANEOUS:

The field work was conducted in March 1966 using equipment owned and operated by Johnson Drilling Company Ltd., under the supervision of Mr. P. L. Wang, Project Foundation Engineer.

cont'd. /6 .....

8. MISCELLANEOUS: (cont'd.) ...

The report was prepared by Mr. L. Palmer, Project Foundation Engineer and reviewed by Mr. M. Devata, Senior Foundation Engineer who also supervised, in general, the entire project.

April 1966.

APPENDIX I

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## RECORD OF BOREHOLE NO. 1

DEPARTMENT OF HIGHWAYS - ONTARIO

MATERIALS &amp; TESTING DIVISION

JOB 66-E-24

LOCATION Richmond Rd. & Queensway Extension - Ottawa 244-15.

ORIGINATED BY P.L.W.

W. P. 909-64

BORING DATE March 2, 1966

0/s 79' Lt.

COMPILED BY L.P.

DATUM

BOREHOLE TYPE Wash-Boring & Diamond drill

CHECKED BY AK

FOUNDATION SECTIC

[illegible]

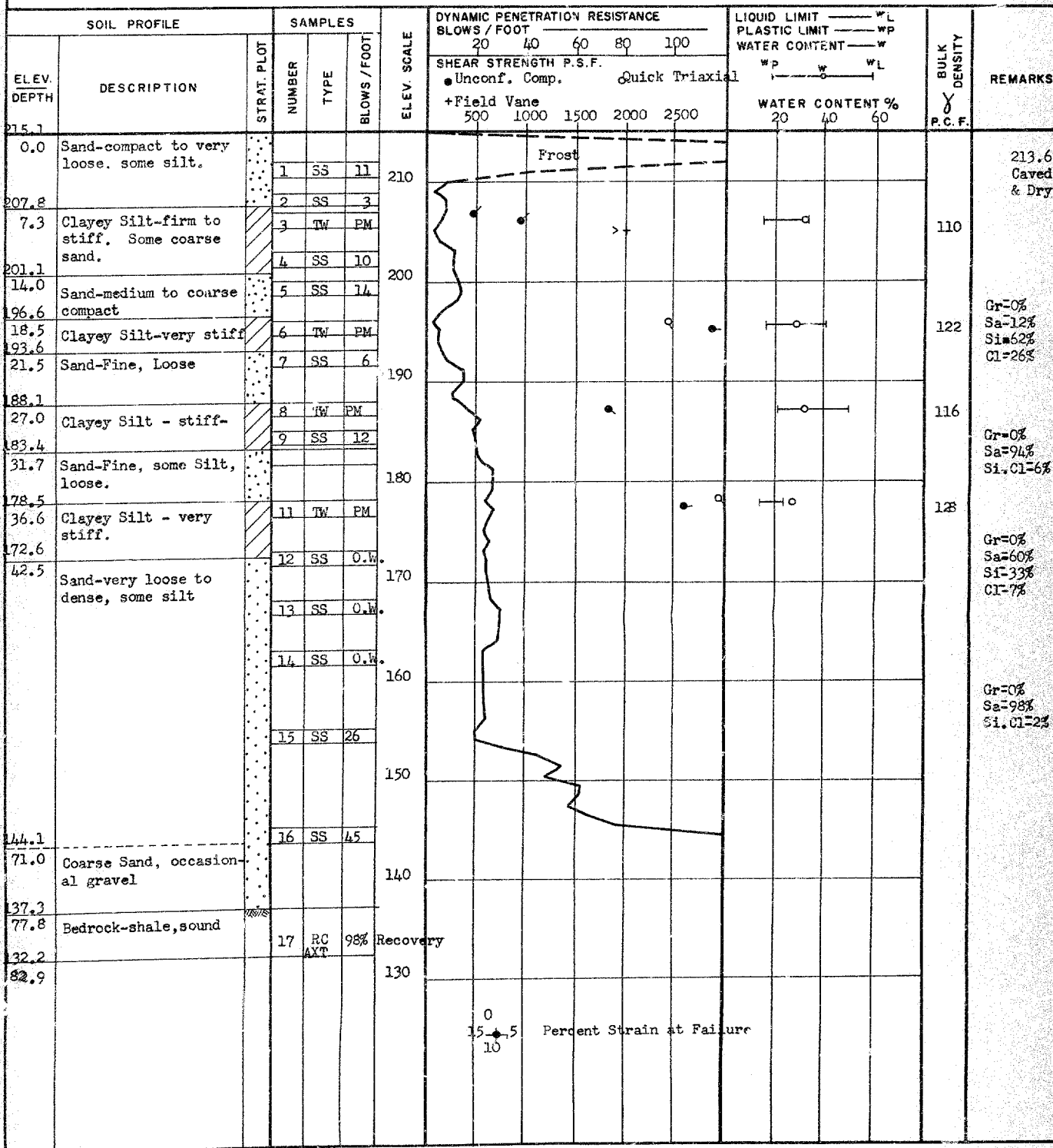
DEPARTMENT OF HIGHWAYS - ONTARIO

MATERIALS & TESTING DIVISION

RECORD OF BOREHOLE NO. 2

FOUNDATION SECTION

JOB 66-F-24 LOCATION Richmond Rd. & Queensway Extension, Ottawa, 245/49. ORIGINATED BY P.L.W.  
W.P. 909-64 BORING DATE March 7, 1966 o/s 43' Lt. COMPILED BY L.P.  
DATUM \_\_\_\_\_ BOREHOLE TYPE Wash-boring & Diamond Drill CHECKED BY dk

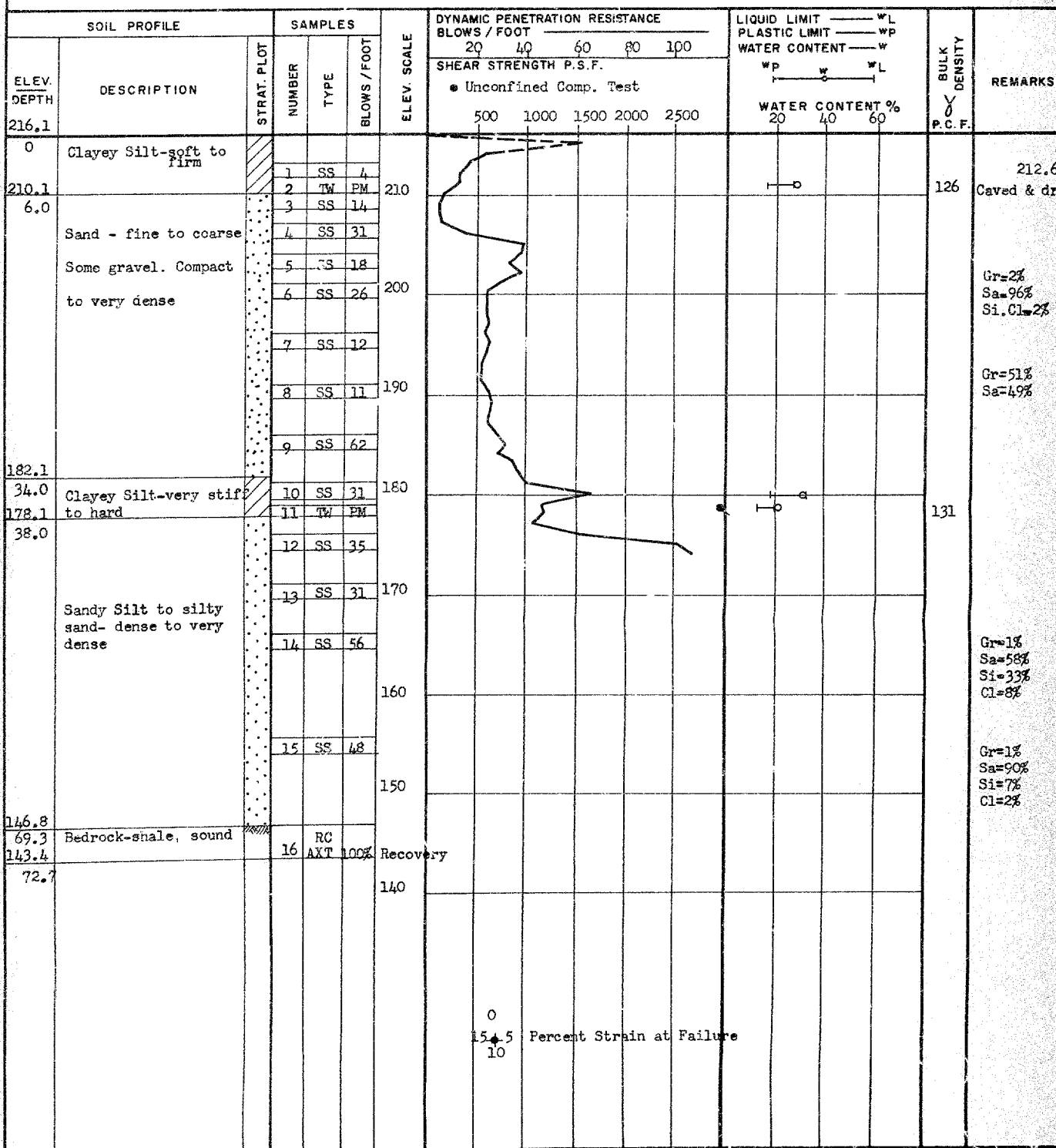


DEPARTMENT OF HIGHWAYS - ONTARIO  
MATERIALS & TESTING DIVISION

## RECORD OF BOREHOLE NO. 3

FOUNDATION SECTION

JOB 66-F-24 LOCATION Richmond Rd. & Queensway Extension, Ottawa, 246/45 ORIGINATED BY P.I.W.  
W.P. 909-64 BORING DATE March 10, 1966 o/s 75 Lt. COMPILED BY L.P.  
DATUM \_\_\_\_\_ BOREHOLE TYPE Wash-boring & Diamond Drilling CHECKED BY LL



DEPARTMENT OF HIGHWAYS - ONTARIO

RECORD OF BOREHOLE NO. 4

FOUNDATION SECTION

MATERIALS & TESTING DIVISION

JOB 66-F-24 LOCATION Richmond Rd. & Queensway Extension, 245/26, o/s 80' Lt. ORIGINATED BY P.L.W.  
W.P. 909-64 BORING DATE March 11, 1966 COMPILED BY L.P.  
DATUM \_\_\_\_\_ BOREHOLE TYPE Dynamic Cone Penetration Test CHECKED BY HL

SOIL PROFILE		SAMPLES			ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE		LIQUID LIMIT — WL		BULK DENSITY	REMARKS
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE		BLOWS / FOOT	SHEAR STRENGTH P.S.F.	PLASTIC LIMIT — WP	WATER CONTENT — W		
215.0											
0.0											
					210						
					200						
					190						
					180						
					170						
					160						
					150						
149.0											
66.0	End of Borehole										
					140						

## 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 <sub>u</sub>	UNCONFINED COMPRESSION	L.V.	LABORATORY VANE
Q	UNDRAINED TRIAXIAL	F.V.	FIELD VANE
Q <sub>cu</sub>	CONSOLIDATED UNDRAINED TRIAXIAL	C	CONSOLIDATION
Q <sub>d</sub>	DRAINED TRIAXIAL	S	SENSITIVITY

# ABBREVIATIONS USED IN THIS REPORT

## SOIL PROPERTIES

$\gamma$	UNIT WEIGHT OF SOIL (BULK DENSITY)
$\gamma_s$	UNIT WEIGHT OF SOLID PARTICLES
$\gamma_w$	UNIT WEIGHT OF WATER
$\gamma_d$	UNIT DRY WEIGHT OF SOIL (DRY DENSITY)
$\gamma'$	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
$\tau_f$	SHEAR STRENGTH
$c'$	EFFECTIVE COHESION
$\phi'$	EFFECTIVE ANGLE OF SHEARING RESISTANCE, OR FRICTION
$c_u$	APPARENT COHESION
$\phi_u$	APPARENT ANGLE OF SHEARING RESISTANCE, OR FRICTION
$\mu$	COEFFICIENT OF FRICTION
$S_t$	SENSITIVITY

## GENERAL

$\pi$	= 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
$\sigma$	NORMAL STRESS
$\sigma'$	NORMAL EFFECTIVE STRESS ( $\bar{\sigma}$ IS ALSO USED)
$\tau$	SHEAR STRESS
$\epsilon$	LINEAR STRAIN
$\gamma$	SHEAR STRAIN
$\nu$	POISSON'S RATIO ( $\mu$ IS ALSO USED)
E	MODULUS OF LINEAR DEFORMATION (YOUNG'S MODULUS)
G	MODULUS OF SHEAR DEFORMATION
K	MODULUS OF COMPRESSIBILITY
$\eta$	COEFFICIENT OF VISCOSITY

## EARTH PRESSURE

d	DISTANCE FROM T.O. OF WALL TO POINT OF APPLICATION OF PRESSURE
$\delta$	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
$\beta$	ANGLE OF SLOPE TO HORIZONTAL

## MEMORANDUM

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

FROM: Bridge Division,  
Downsview, Ontario

DATE: February 7, 1966

OUR FILE REF.

IN REPLY TO

SUBJECT: W.P. 909-64  
Site No. 3-39  
Richmond Road (Highway 7) Underpass Interchange  
Ottawa Queensway. District 9

Attached herewith please find one print of Bridge Design Plan D4394-2 on which we have marked in blue pencil the location of the proposed structure widening. Also attached is a copy of your form OB-ML-137.

Please arrange for the necessary soils investigation for the proposed structure and we will be pleased to have your completed report as soon as possible.

A copy of the soil investigation report for the adjacent structure is available under our file nos. BA 901 and BA 932.



GS/pr  
Encl.

G. Scott,  
Regional Bridge Location Engineer.

cc. S. McCombie  
A. P. Watt

## MEMORANDUM

TO:

Mr. M. Devata,  
Senior Foundation Engineer,  
Room 107, Lab. Building.

FROM:

Bridge Division,  
Downsview, Ontario

DATE:

January 31, 1966

OUR FILE REF.

IN REPLY TO

SUBJECT:

W.P. 909-64, Site No. 3-39  
Richmond Road (Highway 7) Underpass Interchange  
Ottawa Queensway, District No. 9

66-1-24

This will confirm the following points established during our recent discussion concerning the possibility of increasing the horizontal clearances for traffic under the existing structure.

The following Data was obtained from plans D4394 and C-52-22.

1. Distance face of beam seat (vertical edge)  
to centre of pier.
 

a. skew measurement	113.42'
b. square "	95.90'
2. Slope paving elevation at face of beam seat.
 

a. North end of structure	230.5
b. South " " "	229.5
3. Finished pavement elevation at crown.  
(32' from centre line pier)
 

217.4+
--------
4. Estimated shoulder elevation  
(72.75 ft. from centre line pier)
 

216.5+
--------

Based on the above data, together with a review of the foundation soils report BA 932 issued by De Leuw, Cather & Co. on 19th August, 1959 you considered as follows.

- a) That the embankment slopes could be steepened to  $1\frac{1}{2}:1$  slopes, provided these slopes were adequately protected against erosion.
- b) That increasing the slopes steeper than  $1\frac{1}{2}:1$  was not recommended.

RE: W.P. 909-64, Site No. 3-39

The  $1\frac{1}{2}$ :1 slopes in front of the abutments will permit establishment of the following clearances for traffic under the existing structure and I understand from Mr. P. J. Harvey that these clearances will be acceptable to the Functional Planning Section.

6' clearance to  $1\frac{1}{2}$ :1 embankment slope  
11' speed change lane  
48' traffic lanes (4 westbound lanes)  
6' clearance to pier  
3 $\frac{1}{2}$ ' pier  
6' clearance to pier  
48' traffic lanes (4 eastbound lanes)  
11' speed change lane  
6' clearance to  $1\frac{1}{2}$ :1 embankment slope

*Gavin Scott*

GS/pr

G. Scott,  
Regional Bridge Location Engineer.

cc. S. McCombie  
P. J. Harvey  
L. R. Forster  
S. Markiewicz  
A. P. Watt

cc: Foundations Office (Rm. 110)

Mr. G. Scott,  
Regional Bridge Location Engr.,  
Kingston Regional Office.

Foundations Office,  
Materials & Testing Div.,  
Room 107, Lab. Bldg.

August 19, 1966

Richmond Rd. Underpass Interchange  
Hwy. 17, Ottawa Queensway, Dist. #9.  
W.P. 909-64 -- W.J. 66-P-24

The Preliminary Plan D-5956-P1 for the  
above mentioned structure has been reviewed.

The designer appears to have complied  
with the recommendations contained in the  
foundation report.

MD/MdeF

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

cc: Foundations Office /  
Gen. Files



WJ

66-F-24



DEPARTMENT OF HIGHWAYS

Bridge Office, Postal Bag 4000, Kingston, Ontario.

August 18, 1966.

Mr. A. Stermac,  
Principal Foundation Engineer,  
Room 107, Lab. Building,  
DOWNSVIEW, Ontario.

RE: W.P. 909-64, Site 3-39, Richmond Rd. Underpass Interchange,  
Hwy 17 Ottawa Queensway, District 9.

We are sending you herewith one print of Preliminary  
Plan D-5956-PI.

Will you kindly let us have your written comments.

Yours truly,

A handwritten signature in cursive script, appearing to read "J. A. Fisher".

J. A. Fisher,  
For: G. Scott,

REGIONAL BRIDGE LOCATION ENGINEER

JAF/GS/mb  
Att'd.

#66-F-24

W.P. #909-64

OTTAWA

QUEENSWAY

(T.C.H.) :

RICHMOND RD.

(Hwy. #7 & 15)

