

MEMORANDUM

Mr. B. R. Davis,
Bridge Engineer,
Bridge Division,
Admin. Bldg.

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

Attention: Mr. C. McCombie

Date: April 19, 1968

Our File No.

In Reply to

SUBJECT

FOUNDATION INVESTIGATION REPORT

For

New Structure at Proposed Crossing
Of C.P.B. and Hwy. 35 & 115
Line 'P', Southbound Lane, Village
Of Newcastle, Township of Clarke
District No. 7 (Port Hope)
W.J. 68-P-19 -- W.P. 200-65-0

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 prove adequate for your design
requirements. Should additional information be required,
please feel free to contact our Office.

AGS/MdeP

Attach.

cc: Messrs. B. R. Davis (2)
E. A. Tregaskes
D. W. Parren
G. K. Hunter (2)
D. P. Collins
W. S. Melinyshyn
T. J. Kovich
B. A. Singh

Foundations Files
Gen. Files

A. G. Sternac
A. G. Sternac
PRINCIPAL FOUNDATION ENGINEER

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FOUNDATION INVESTIGATION REPORT
For
New Structure at Proposed Crossing
Of C.P.R. and Hwy. 25 & 115
Line 'F', Southbound Lane, Village
Of Newcastle, Township of Clarke
District No. 7 (West Hope)
A.P. 68-F-19 S.P. 200-21-2

1. INTRODUCTION:

The Foundation Section was requested to carry out an investigation for the proposed overhead structure at the crossing of the C.P.R. and proposed Southbound lane of Hwy. 25 and 115 (Line 'F'), about 1.5 miles northeast of Newcastle, Ontario. The request was contained in a memo from the Bridge Division (Mr. W. S. Melnyshyn, Regional Bridge Location Engineer), dated March 15, 1968. An investigation was subsequently carried out by this Section to determine the subsoil conditions at this site.

Presented in this report are the results of this investigation, together with the recommendations pertaining to the foundations of the proposed structure, and the stability of the approach embankments.

2. SUBSOIL CONDITIONS:

A total of five sampled boreholes, supplemented with dynamic cone penetration tests, was carried out using a skid-mounted diamond drill adapted for soil sampling. The boundaries between the different deposits, together with detailed descriptions of the material in the deposits, are shown on the borelog sheets attached to this report.

The estimated stratigraphical profile shown on Drawing 68-F-19A, is based upon this information.

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

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

2.1) Clayey Silt and Silty Sand - Surficial Deposit:

A surficial deposit of clayey silt and silty sand was encountered in B.H.'s #2, 3, 4 and 5; the thickness of this deposit ranges from 5 to 7 ft. In general, the deposit is cohesive, consisting of clayey silt with sand and traces of gravel. In B.H. #3 only, the surficial deposit consists of a granular deposit of silty sand. Physical properties of the cohesive and non-cohesive portion of the deposit, as determined from laboratory and field tests, are as follows:

Liquid Limit (w_L %)	:	11.3% - 35.8%
Plastic Limit (w_P %)	:	9.1% - 22.4%
Moisture Content (w %)	:	8.0%

'N' values (for the overall deposit) : 4 - 17 blows/ft.

The consistency of the cohesive portion of the deposit is estimated to range from firm to very stiff; relative density of the granular portion of the deposit is generally loose.

2.2) Glacial Till - (Heterogeneous Mixture of Clay, Silt, Sand and Gravel):

This heterogeneous deposit was encountered immediately below the surficial layer described above, or the ground surface, at all borehole locations. The maximum thickness of this deposit was not established, but was proved down to elev. 318. The texture of the material shows the deposit to be of glacial origin being a heterogeneous mixture of clayey silt, sand and gravel in the upper portion, gradually changing to a non-cohesive mixture of silt, sand and gravel with traces of clay with increasing depth. The exact boundaries between the cohesive and non-cohesive material are shown on the appended borehole log sheets.

cont'd. /3 ...

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

2.2) Glacial Till - (Heterogeneous Mixture of Clay, Silt, Sand and Gravel): (cont'd.) ...

Physical properties of the material in the deposit, as determined from field and laboratory tests, are summarized below:

Liquid Limit (W_L)	:	12.4% - 15.4%
Plastic Limit (W_P)	:	11.4% - 11.7%
Moisture Content (W)	:	6.4% - 6.5%

'N' values (for the overall deposit) : 82 - 142 blows/ft.

Based on the 'N' values, the consistency of the cohesive portion of the layer is estimated to be hard and the denseness of the non-cohesive portion to be very dense.

3. GROUNDWATER CONDITIONS:

The observations carried out during the field investigation showed the groundwater levels in the boreholes to be at the following elevations:

B.H. #1	:	Elev. 343
B.H. #2	:	Elev. 343
B.H. #3	:	Elev. 343
B.H. #4	:	Elev. 351
B.H. #5	:	Elev. 345

4. DISCUSSION AND RECOMMENDATIONS:

It is proposed to widen the existing two lanes of Hwy. 35 and 115 to a four-lane highway. The present structure at the crossing of the C.F.R. and Hwy. 35 and 115 will be utilized for future northbound lane traffic, and a new overhead structure is proposed parallel to the existing one to accommodate the traffic for the Line 'P' Southbound lane. Present proposals call for a 50-ft. single-span structure with profile grade at approximate elev. 372.

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

Subsoil at the site consists of a surficial deposit of clayey silt and silty sand followed by an extensive glacial till deposit extending at least 32 ft. below the ground surface.

In view of the presence of a hard or very dense glacial till deposit at a relatively shallow depth, conditions are favourable for spread footing type foundations. Specific recommendations are as follows:

North Abutment (Ref. B.H.'s 4 & 5):

At this location the footings can be located on spread footings within the non-cohesive glacial till deposit at or below elev. 353 with a safe bearing pressure up to 4 tons/sq.ft. No major dewatering problems are anticipated for the proposed footing excavations.

South Abutment (Ref. B.H.'s #1, 2 & 3):

At this location the glacial till layer extends from elev. 346 to elev. 336.0. In view of this, it is recommended that the south abutment footings be placed within the glacial till stratum at a sufficient depth for frost protection. A safe bearing pressure up to 4 t.s.f. can be used for design. Depending upon the location of the footing formation level and the seasonal fluctuation of the water table, a dewatering scheme may be required.

Approach Fills:

The proposed approach fills for the Southbound lane Line 'P' of Hwy. 35 and 11- will be in the order of 37 ft. No stability problems are anticipated for the proposed approach fills with standard 2:1 slopes.

cont'd. /5 ...

5. MISCELLANEOUS:

The field work, performed during the period of March 29 to April 1, 1968, was supervised by Mr. V. Korlu, Project Foundation Engineer, who also wrote this report.

The investigation was carried out under the general supervision of Mr. M. Devata, Supervising Foundation Engineer, who reviewed the report.

Equipment used was owned and operated by Dominion Soil Co. Ltd. of Toronto.

April, 1968.

1000

1000

DEPARTMENT OF HIGHWAYS - ONTARIO

RECORD OF BOREHOLE NO. 1

FOUNDATION SECTION

MATERIALS & TESTING DIVISION

JOB 68-2-19

LOCATION Hwy. 35 & 115 & C.F.R. Sta. 418 84' Lt.

ORIGINATED BY VR

W.P. 200-62-2

BORING DATE March 25, 1968

COMPILED BY VR

DATUM Guelph

BOREHOLE TYPE Drill Tricone bit, Drive Casing & Wash

CHECKED BY

SOIL PROFILE		SAMPLES		DYNAMIC PENETRATION RESISTANCE					LIQUID LIMIT			REMARKS
ELEV DEPTH	DESCRIPTION	NUMBER	TYPE	BLOWS / FOOT	ELEV SCALE	20	40	60	80	100	WATER CONTENT	
317.5	Ground level					400	800	1200	1600	2000	10 30 50	Gr. Sa. Sl. Cl.
315.5	Front											
	Hom. mix. of clayey silt, sand & gravel.	1	SS 100/6"									34.0
330.5	Hard.	2	SS 100/4"									
8.0	Hom. mix. of silt, sand & gravel & trace of clay. Plastic 7.71	3	SS 100/6"									
332.0	Very dense.	4	SS 100/5"									
15.5	End of Borehole				330							

DEPARTMENT OF HIGHWAYS - ONTARIO

MATERIALS & TESTING DIVISION

RECORD OF BOREHOLE NO. 3

FOUNDATION SECTION

JOB 68-P-19

LOCATION Hwy. 35 & 115 & C.P.R. Sta. 91+00 10' Rt.

ORIGINATED BY VK

W P 200-65-0

BORING DATE March 27, 1968

COMPILED BY VK

DATUM Geodetic

BOREHOLE TYPE Drill Tricone bit, Drive Casing & Wash

CHECKED BY

SOIL PROFILE			SAMPLES		DYNAMIC PENETRATION RESISTANCE					LIQUID LIMIT			REMARKS		
ELEV DEPTH	DESCRIPTION	STRAT PLT	NUMBER	TYPE	BLOWS / FOOT	ELEV SCALE	BLOWS / FOOT					PLASTIC LIMIT			
							20	40	60	80	100	WATER CONTENT			
							SHEAR STRENGTH P S F					PP			
												WL			
							400	800	1200	1600	2000	WATER CONTENT %			
												10	20	30	Dr. Sa. S1. C1 342.5 3 27 L2 28
343.5	Ground Level														
0.0	Silty sand with trace of clay.		1	SS	4	340									
337.0	Ret. mixture of silt, sand & gravel & trace of clay		2	SS	100/5"										
6.5	Glacial Till		3	SS	100/5"										
	Very dense.		4	SS	100/5"	330									
			5	SS	100/6"										
318.0			6	SS	100/5"	320									
25.5	End of Borehole					310									

DEPARTMENT OF HIGHWAYS - DISTRICT

MATERIALS & TESTING DIVISION

JOB 68-P-19

W.P. 200-65-0

DATUM Geodetic

RECORD OF BOREHOLE NO. 1

FOUNDATION SECTION

LOCATION Hwy. 35 & 115 & C.P.R. Sta. 91+56 36' 11".

BORING DATE March 28, 1968

BOREHOLE TYPE Drill Tricone bit. Drive Casing & Wash

ORIGINATED BY VK

COMPILED BY VK

CHECKED BY

SOIL PROFILE		SAMPLES		DYNAMIC PENETRATION RESISTANCE					LIQUID LIMIT		WATER CONTENT	REMARKS
ELEV. / FEET	DESCRIPTION	NUMBER	TYPE	BLOWS / FOOT	ELEV. / FEET	20	40	60	80	100		
359.0	Ground Level					400	800	1200	1600	2000	10 20 30	Gr. Sa. Si. Cl.
0.0	Clayey silt with sand & traces of gravel.											
353.0	Firm.	1	SS	7								
6.0	Hot mix. of clayey silt, sand & gravel.	2	SS	100/6"	350							351.5
348.0	Hard.											
11.0	Heterogeneous mixture of silt, sand & gravel and a trace of clay.	3	SS	100/5"								
	Glacial Till	4	SS	100/6"	340							15 49 30 6
	Very dense.	5	SS	100/4"								
		6	SS	100/5"	330							
327.5		7	SS	100/6"								
31.5	End of Borehole				320							

DEPARTMENT OF HIGHWAYS - ONTARIO

RECORD OF BOREHOLE NO 5

FOUNDATION SECTION

MATERIALS & TESTING DIVISION

JOB 60-1-19

LOCATION Hwy. 35 & 115 & C.P.R. Sta. 91+80 6' Bl.

ORIGINATED BY VR

W.P. 232-5-0

BORING DATE April 1, 1964

COMPILED BY VR

DATUM Trochelic

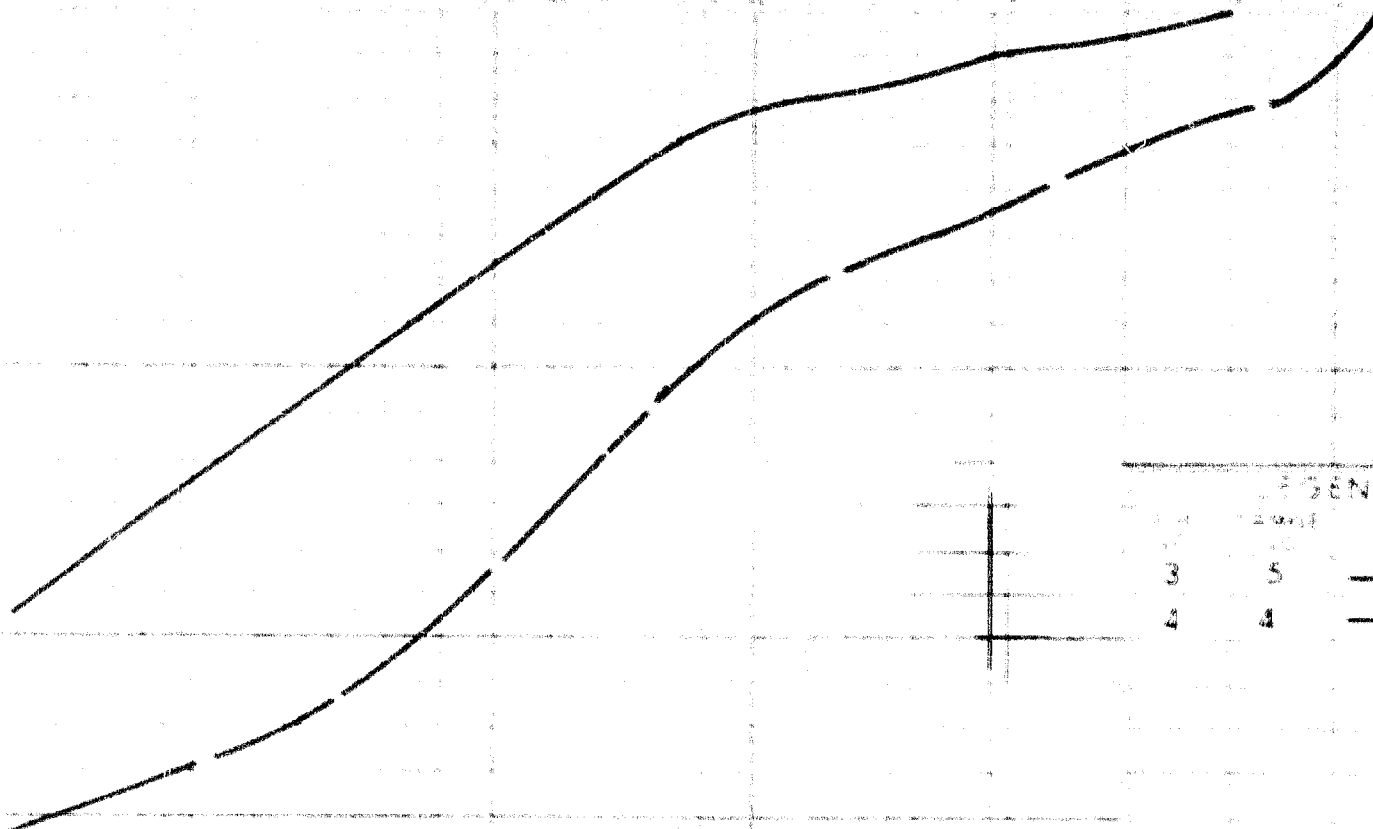
BOREHOLE TYPE Drill Tricone bit, Drive Casing & Wash

CHECKED BY

SOIL PROFILE		SAMPLES		DYNAMIC PENETRATION RESISTANCE		LIQUID LIMIT		WATER CONTENT	REMARKS
DEPTH	DESCRIPTION	NUMBER	TYPE	BLOWS / FOOT	ELV SCALE	BLOWS / FOOT	PLASTIC LIMIT		
327.5	Ground Level								
353.5	Clayey silt with sand & traces of gravel.	1	SS	17					
360.0	Very stiff.	2	SS	82	350				
360.0	Hard.	3	SS	112					
360.0	Heterogeneous mixture of silt, sand & gravel & a trace of clay.	4	SS	100/6"	340				
360.0	Glacial Till	5	SS	100/4"					
360.0	Very dense.	6	SS	100/5"	330				
328.0		7	SS	100/5"					
31.5	End of Borehole				320				

344.5

UNIFIED SOIL CLASSIFICATION SYSTEM



3
4

5
4

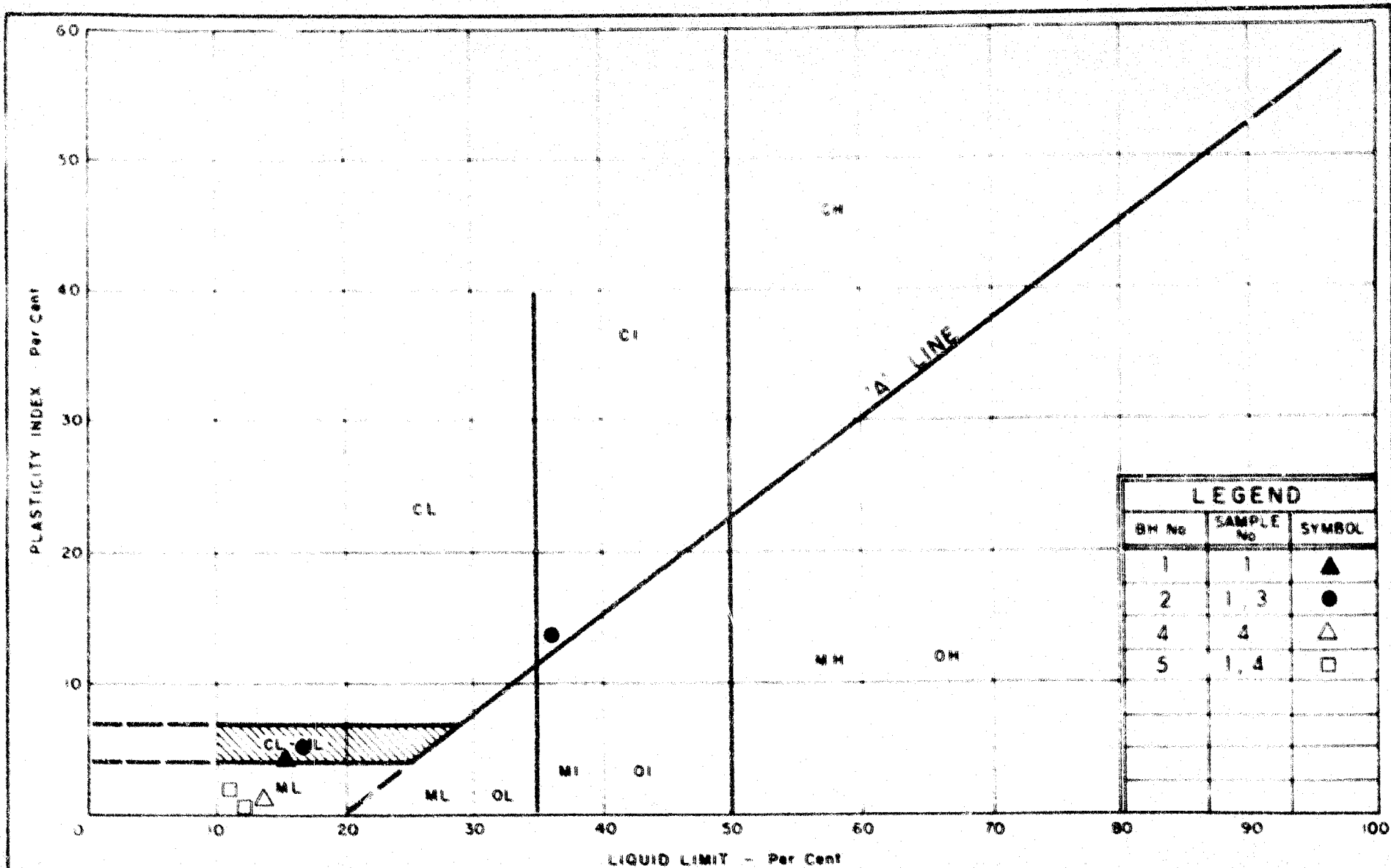
END
200-65-0
68-F-19

DEPARTMENT OF HIGHWAYS
MATERIALS AND
TESTING
DIVISION

GRAIN SIZE DISTRIBUTION
GLACIAL TILL

DEFECTS IN NEGATIVE DUE TO
CONDITION OF ORIGINAL DOCUMENT

200-65-0
68-F-19



DEPARTMENT OF HIGHWAYS
MATERIALS and
TESTING
DIVISION

PLASTICITY CHART

WP No. 200-65-0

JOB No. 68-F-19

ABBREVIATIONS USED IN THIS REPORT

PENETRATION RESISTANCE

STANDARD PENETRATION RESISTANCE (N) - THE NUMBER OF BLOWS REQUIRED TO ADVANCE A STANDARD SPLIT SPOON SAMPLE 12 INCHES INTO THE SUBSOIL, DRIVEN BY WEIGHT 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 150 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 - 150	VERY LOOSE	0 - 4
SOFT	2 - 4	150 - 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	* * THINWALL OPEN
WS	WASHED SAMPLE	* * THINWALL PISTON
SB	SCRAPER BUCKET SAMPLE	CS DESTERBERG SAMPLE
AS	AUGER SAMPLE	FS FOIL SAMPLE
CS	CHUNK SAMPLE	RC ROCK CORE
ST	SLOTTED TUBE SAMPLE	

PM SAMPLE ADVANCED HYDRAULICALLY

PM SAMPLE ADVANCED MANUALLY

SOIL TESTS

CU	UNCONFINED COMPRESSION	LV	LABORATORY VANE
U	UNDRAINED TRIAXIAL	FV	FIELD VANE
CU	CONSOLIDATED UNDRAINED TRIAXIAL	C	CONSOLIDATION
CD	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 _v	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 $= \frac{w - w_L}{I_p}$
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	SHEAR STRENGTH
c	EFFECTIVE COHESION
c'	EFFECTIVE ANGLE OF SHEARING RESISTANCE OR FRICTION
c _u	APPARENT COHESION
c _u	APPARENT ANGLE OF SHEARING RESISTANCE OR FRICTION
μ	COEFFICIENT OF FRICTION
S	SENSITIVITY

GENERAL

π	PI 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
σ'	NORMAL EFFECTIVE STRESS ($\bar{\sigma}$ IS ALSO USED)
τ	SHEAR STRESS
e	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

z	DISTANCE FROM TOP OF WALL TO POINT OF APPLICATION OF PRESSURE
δ	ANGLE OF WALL FRICTION
K	DIMENSIONLESS COEFFICIENT TO BE USED WITH VARIOUS SURFACES IN EXPRESSIONS REFERRING TO NORMAL STRESS ON WALLS
K ₀	COEFFICIENT OF EARTH PRESSURE AT REST

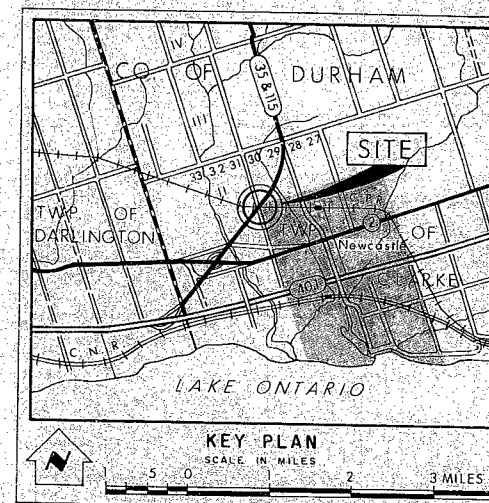
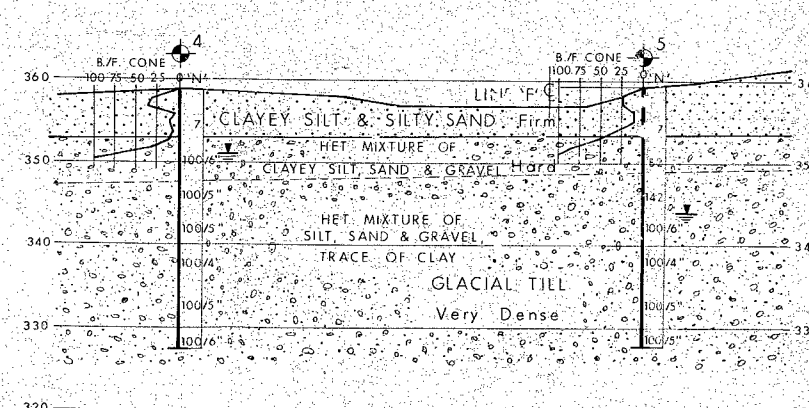
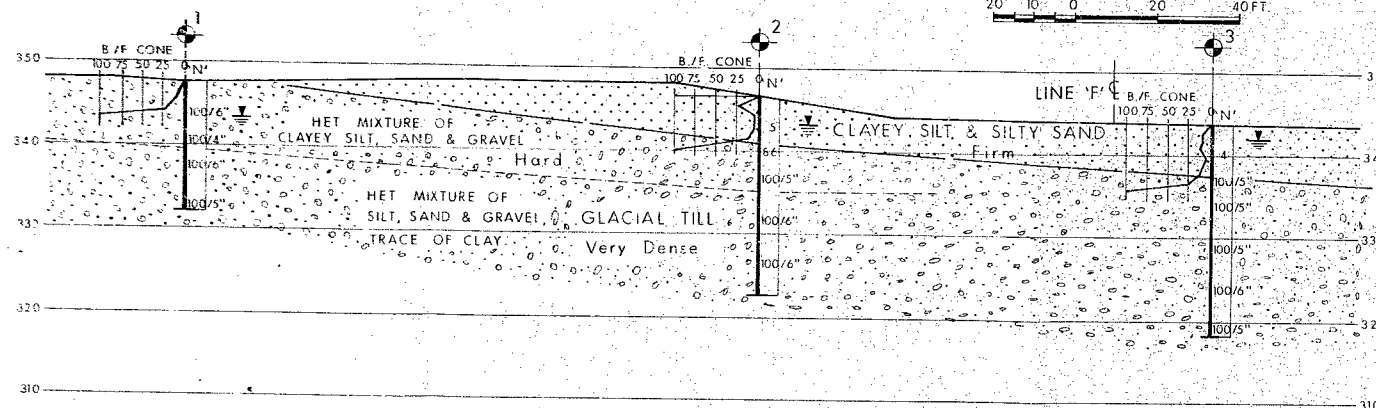
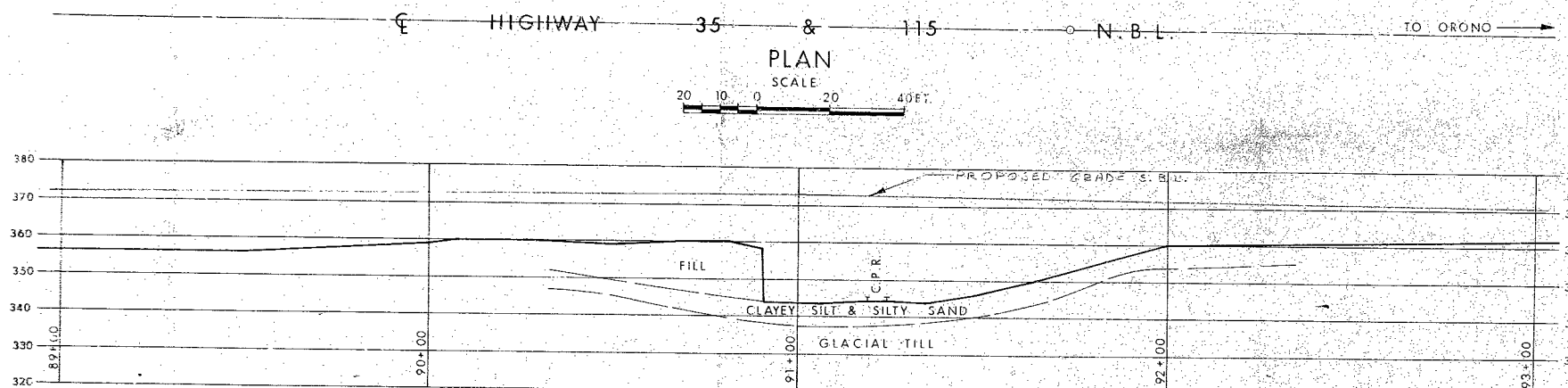
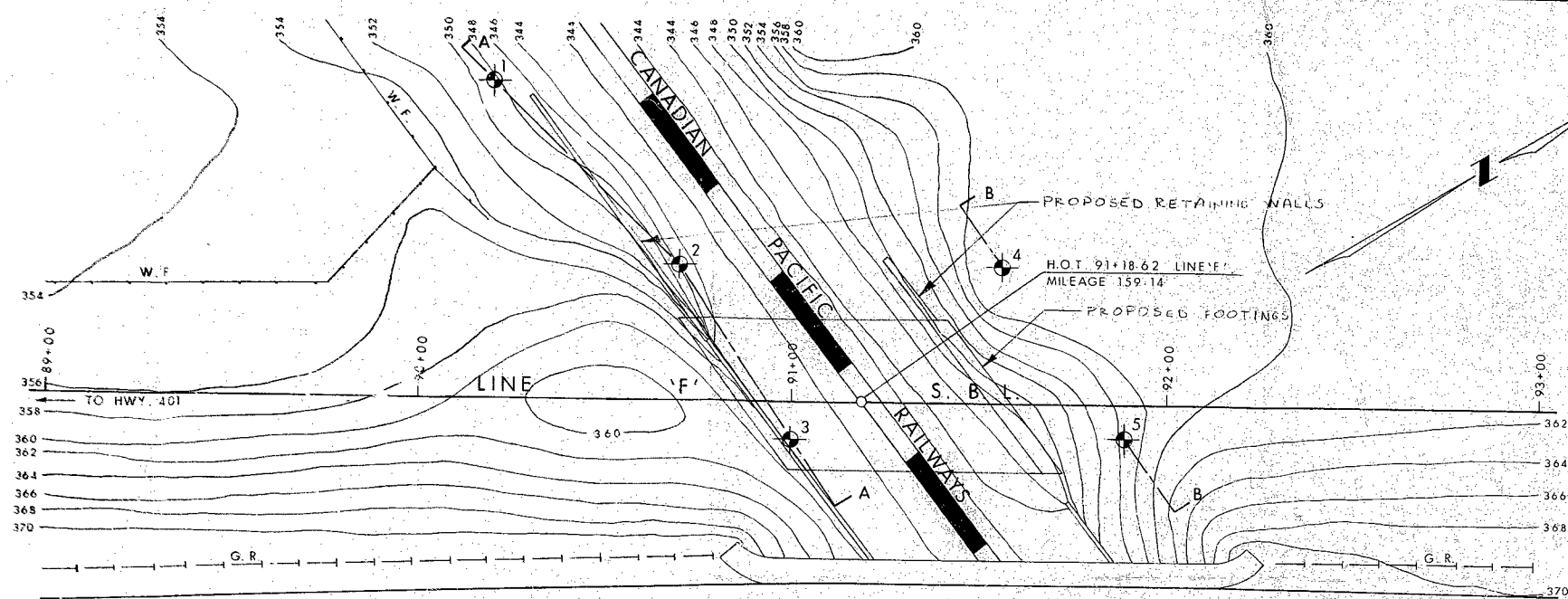
FOUNDATIONS

B	BREADTH OF FOUNDATION
L	LENGTH OF FOUNDATION
D	DEPTH OF FOUNDATION BENEATH GROUND
N	DIMENSIONLESS COEFFICIENT USED WITH γ 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

68-F-19
W.P. # 200-65-0
Hwy. # 35 & 115
LINE F SOUTH BOUND
LANE C.P.R
CLARKE TWP.



LEGEND

- Bore Hole
- ⊕ Cone Penetration Hole
- ⊙ Bore & Cone Penetration Hole
- Water Levels established at time of field investigation, March 1968

NO.	ELEVATION	STATION	OFFSET
1	347.5	90+38	8' LT
2	346.5	90+69	36' LT
3	343.5	91+00	10' RT
4	359.0	91+56	36' LT
5	359.5	91+89	9' 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.

NO.	FOR	DATE

REVISION	DATE	BY	DESCRIPTION

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

CANADIAN PACIFIC RAILWAYS (NEWCASTLE)

KING'S HIGHWAY NO. 35 & 115 LINE 'F' DIST. NO. 7
CO. DURHAM
TWP. CLARKE LOT 30 CON. 11

BORE HOLE LOCATIONS & SOIL STRATA

SUBM'D. V. K.	CHECKED	W.P. NO. 200-65-0	M.B.T. DRAWING NO.
DRAWN G. P.	CHECKED	JOB NO. 68-F-19	68-F-19A
DATE: APRIL 19, 1968	SITE NO.	BRIDGE DRAWING NO.	
APPROVED <i>A. J. Thomas</i>	PRINCIPAL FOUNDATION ENGINEER	REF. NO. E-4908-1	