

MEMORANDUM

To: Mr. B. R. Davis,
Bridge Engineer,
Bridge Office,
Admin. Bldg.

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

ATTENTION: Mr. S. McCombie

DATE: Mar. 3, 1969

OUR FILE REF:

IN REPLY TO MAR 12 1969

SUBJECT:

FOUNDATION INVESTIGATION REPORT

For

Proposed Hwy. 416 (N.B.L.) Line 'A'

And C.P.R. Crossing

Twp. of Oxford -- Co. of Grenville

District No. 8 (Kingston)

W.J. 69-F-1 -- W.P. 202-67-01

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 do not hesitate to contact our Office.

AGS/MleF
Attach.

cc: Messrs. B. R. Davis (2)
H. A. Tregaskes
D. W. Farren
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A. G. Stermac
PRINCIPAL FOUNDATION ENGINEER

Foundations Files
Gen. Files

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FOUNDATION INVESTIGATION REPORT
For
Proposed Hwy. 416 (N.B.L.) Line 'A'
And C.P.R. Crossing
Twp. of Oxford -- Co. of Grenville
District No. 8 (Kingston)
W.J. 69-F-1 -- W.P. 202-67-01

1. INTRODUCTION:

The Foundation Section was requested to carry out a subsurface investigation for the above mentioned crossing, located some 1.5 miles south-east of the Town of Kemptville. The request was contained in a memo from the Bridge Office - (Mr. G. Scott, Regional Bridge Location Engineer), dated January 9, 1969. Subsequently, an investigation, to determine the subsoil conditions at the above site, was carried out by this Section. This report contains the results of the investigation, as well as recommendations for the design of foundations and the stability of the approach fills.

2. DESCRIPTION OF THE SITE AND GEOLOGY:

The site is located some 1.5 miles south-east of the Town of Kemptville in Lot 28, Con. 5, of Oxford Township. The proposed crossing will be located some 0.5 miles east of the existing overhead, which carries Hwy. 16 across the C.P.R. twin tracks. At the location of the proposed crossing, the C.P.R. tracks are elevated some 8 ft. above the surrounding ground level. Shallow drainage ditches are located on either side of the railway embankment. In the immediate vicinity of the site, the ground is generally flat and is used for farming. During the time of this investigation the ground surface was frozen only at isolated locations; it was generally covered with 16 to 20 inches of well-packed snow.

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

Physiographically, the site is situated within the "Edwardsburg Sand Plain" region in which the bedrock and most of the cohesive deposits are covered by a surficial sand stratum. The dolomitic limestone bedrock in this area is believed to be of Beekmantown Age, Ordovician Period.

3. FIELD AND LABORATORY WORK:

A total of 6 boreholes, 5 of which were accompanied by dynamic cone penetration tests, and one separate dynamic cone penetration test, was carried out at the site by means of two standard diamond drill rigs adapted for soil sampling purposes.

Samples were recovered at the required depths in a 2-inch O.D. split-spoon sampler which was hammered into the soil in accordance with the specifications for the Standard Penetration Test. The same method was used for the dynamic cone penetration tests. In addition, undisturbed samples of the cohesive strata were obtained by manually pushing 2-inch I.D. Shelby tubes. Field vane tests were attempted in the cohesive portion of the soil wherever possible. However, due to insufficient penetration of the vane into the undisturbed material, it was not possible to determine the in-situ undrained shear strength characteristics.

Bedrock was proven by core drilling in Boreholes 3 and 4 in AXT size. At the location of the other boreholes, the bedrock elevation was inferred, on the basis of practical refusal, to further penetration of a bicone bit or the cone tip.

Surveying was carried out by personnel from the Eastern Region Engineering Surveys Section. The elevations given in this report are referenced to geodetic datum. The locations and elevations of the boreholes are shown on Drawing 69-F-1A, together with the estimated stratigraphical profile across the site.

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

All samples were subjected to a careful visual examination in the field and subsequently in the laboratory. Following this examination, tests were carried out on selected samples to determine the following physical properties of the various soil strata:

Natural Moisture Contents
Bulk Densities
Atterberg Limits
Undrained Shear Strengths
Grain-Size Distributions

The results of these tests are plotted on the individual Record of Borelog sheets, and are summarized on Figure #1 and #2 in the Appendix of this report.

4. SUBSOIL CONDITIONS:

4.1) General:

Underlying a surficial deposit of sand is a stratum of silty clay to clayey silt, ranging in thickness between 8 and 14.5 ft.; this stratum is followed by a deposit consisting of a heterogeneous mixture of silt, sand and gravel. Sound bedrock is encountered at between elevations 289 and 290 - i.e., some 24 to 27 ft. below ground surface.

4.2) Fine to Medium Sand:

Underlying a layer of topsoil, or organic material, is a surficial deposit of fine to medium sand. The thickness of the sand stratum averages about 2.5 ft. across the site. The upper 4 to 6 inches of the sand contains organic inclusions. Based on a limited number of Standard Penetration Tests, it is estimated that the relative density of the deposit is loose to compact.

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

4.3) Silty Clay to Clayey Silt:

A deposit of silty clay, changing to clayey silt with depth, was encountered immediately below the surficial sand stratum at all the borehole locations. The thickness of this deposit ranged from 8 ft. at Borehole 5A to 14.5 ft. at Borehole 6, averaging about 12 ft. across the site. The upper 6 to 8 ft. of the deposit exhibited a "blocky" structure. Occasional silt and fine sand seams, up to 2 inches in thickness, were observed within the deposit.

The results of laboratory tests, carried out to determine the physical properties of the material, are shown on the Figures in the Appendix, and are summarized below, together with the Standard Penetration Test 'N' values.

		<u>Range</u>	<u>Average</u>
Natural Moisture Content	(W) %	24 - 38	31
Liquid Limit	(W _L) %	30 - 59	44
Plastic Limit	(W _P) %	17 - 28	23
Liquidity Index	(I _L)	0.25 - 0.80	0.4
Bulk Density	PCF	117 - 124	120
Undrained Shear Strength - Lab. Tests	PSF	2,000 - 7,260 (4 Tests)	-
'N' Values - Blows/ft.		3 - 21	14

The Atterberg limits indicate the stratum to be an inorganic silty clay of low to intermediate plasticity.

Based on the results of the undrained shear strengths and the 'N' values, it is inferred that the consistency of the deposit ranges from stiff to very stiff.

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

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

Immediately underlying the cohesive deposit is a stratum composed of a heterogeneous mixture of silt, sand and gravel (glacial till). The upper boundary of this stratum, across the site, was found to be generally at about elevation 300. The deposit contains essentially gravel sizes embedded in a silty sand matrix; however, isolated pockets of either gravel or sand were also encountered throughout. At Boreholes 1 and 3, boulders were encountered within the upper portion of this deposit. These boulders were found to range from about 2.5 to 3.5 ft. in size, on the basis of the core drilling carried out. Typical grain-size distribution curves for samples obtained from this deposit, are included in the Appendix.

The Standard Penetration Resistance testing, carried out within this deposit, gave 'N' values which ranged between 14 and 59 blows/ft., indicating that the relative density of the deposit is in the compact to very dense range.

4.5) Bedrock:

Bedrock was encountered at Boreholes 3 and 4 at about elevation 289.5 and was proven by core drilling some 7.5 and 5 ft. in each borehole. At the other borehole locations, bedrock is inferred to have been encountered at between elevations 289.0 and 290.0. The cores indicate the bedrock to be jointed. However, the core recoveries were generally over 95%, indicating the bedrock to be sound. The bedrock consists of a dolomitic limestone. Occasional calcite inclusions are present in the bedrock.

5. GROUNDWATER CONDITIONS:

Observations of the groundwater conditions were made, both during drilling operations and after completion of the boreholes. These observations indicate the existence of a perched water table within the surficial sand stratum. The perched water level, during the investigation, was found to be at ground surface. In addition, artesian water conditions were encountered at Boreholes 4, 5A and 6 once the boreholes penetrated beyond the cohesive stratum into the underlying granular deposit. The artesian water level was found to be at about elevation 316 at Borehole 5A - i.e., some 3 ft. above the ground level. At Boreholes 4 and 6 the artesian head was at about elevation 315.3 - i.e., some 3 to 6 inches above the ground surface. At Boreholes 1, 2 and 3, the water level in the open boreholes was found to be at elevation 315.4 - i.e., 8 to 15 inches below the ground surface.

6. DISCUSSION AND RECOMMENDATIONS:

6.1) General:

It is contemplated to construct an Overhead to carry the N.B.I. of proposed Hwy. #416 (Line 'A') across the twin tracks of the C.P.R. at a site located some 1.5 miles south-east of the Town of Kemptville. Present proposals call for a three-span (45'-57'-45') structure having a width of about 45 feet. The centre span will have sufficient length to accommodate a possible additional track on the south side of the existing twin tracks. The proposed profile grade will be at about elevation 351, which will, therefore, require some 35 feet high approach embankments.

Subsoil conditions at the site consist of a surficial deposit of sand extending to about 4 feet below the ground surface, followed by a very stiff to stiff deposit of silty clay to clayey silt having an average thickness of about 12 feet.

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

6.1) General: (cont'd.) ...

Underlying this cohesive stratum is a dense to very dense deposit composed of a heterogeneous mixture of silt, sand and gravel (glacial till). This deposit directly overlies bedrock, the surface of which is encountered at about elevation 289.

6.2) Structure Foundations:

The subsoil conditions at this site are not favourable for the support of the proposed structure on spread footings located at a relatively shallow depth. It is, therefore, recommended that the abutments and piers be founded on end-bearing steel H-piles driven to bedrock or, alternatively, to practical refusal within the competent glacial till deposit. In view of the presence of occasional boulders in the overburden, it would be advantageous to reinforce the pile tips in order to ensure adequate penetration into the glacial till (or to bedrock). Ductalloy H-beam pile shoes, or any other comparable alternate could be used for this purpose. The design load will depend on the pile section chosen. For example, 12 BP 73 steel H-piles may be designed for an allowable load of 90 tons/pile.

The pile caps should be located sufficiently below the ground surface in order to have adequate cover for frost protection. Dewatering may not be a major problem if the pile caps are located in the relatively impervious cohesive stratum. However, seepage from the relatively permeable surficial sand deposit can be anticipated; this seepage can be controlled by ordinary pumping methods, such as sumps.

Care should be taken to ensure that no bouldery fill is placed in the areas through which piles have to be driven.

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

6.3) Approach Fills:

No major stability problems are anticipated for the approach fills, having maximum heights of about 35 ft., and constructed with standard 2:1 slopes, provided all organic material is sub-excavated. The sub-excavation so formed, should be backfilled with suitable granular material prior to construction of the approach embankments. The sub-excavation and backfilling should be carried out as per current D.H.O. standards. (DD-406)

The extent of the organic material was not completely determined during this investigation. The Regional Materials Section should, therefore, carry out an additional investigation in order to determine the vertical and lateral extent of the organic material within the plan limits of the structure and related embankments.

It is estimated that the consolidation settlements of the approach fills will be in the order of 1 to 2 inches for fill heights of the order of 35 ft. above existing ground surface.

7. MISCELLANEOUS:

The field work, performed during the period February 10 - 17, 1969, together with the preparation of this report, was undertaken by Mr. C. Mirza, Project Foundation Engineer.

Equipment used was owned and operated by P. E. Johnston Drilling Co. Ltd.

The investigation was carried out under the general supervision of Mr. M. Devata, Supervising Foundation Engineer, as well as the review of the report.

March 1969

APPENDIX 1

DEPARTMENT OF HIGHWAYS - ONTARIO

MATERIALS & TESTING DIVISION

RECORD OF BOREHOLE NO. 1

FOUNDATION SECTION

JOB 69-E-1

LOCATION Sta. 302+00 @ Prop. Hwy. 416 NEL Line 'A'

ORIGINATED BY CM

W.P. 202-67-01

BORING DATE February 14, 1969

COMPILED BY CM

DAYUM Geodetic

BOREHOLE TYPE Washboring - NX & BX Casing; Cone

CHECKED BY CM

SOIL PROFILE			SAMPLES			ELEV SCALE	DYNAMIC PENETRATION RESISTANCE	LIQUID LIMIT ——— %	BULK DENSITY	REMARKS
ELEV DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	BLOWS / FOOT		GLOWS / FOOT	PLASTIC LIMIT ——— %		
							20 40 60 80 100	WATER CONTENT ——— %		
							SHEAR STRENGTH P.S.F.	WATER CONTENT %		
316.1	Ground Level							20 40 60		Gr. Sn. Si. Cl
312.1	Sand - fine-medium Compact									315.4
310.0	Silty clay to clayey silt. Occ. silt seams Very stiff		1	SS	11					118.5
			2	SS	16					
			3	SS	19					
			4	SS	16					
300.0	Grey		5	SS	25					
16.1	Heterogeneous mixture of silt, sand & gravel (Glacial till)		6	SS	20					Boulder
	Isolated boulders up to 3.5' in size. Dense to very dense.		6A	SS	40					
			7	SS	59					
289.1			8	SS	50					29 41 29 2
27.0	End of Borehole Probably Bedrock									Refusal to bicone bit.

FOUNDATION SECTION

CHECKED BY _____

[illegible]

DEPARTMENT OF HIGHWAYS - ONTARIO

MATERIALS & TESTING DIVISION

JOB 69-F-1

LOCATION Sta. 303-89 @ Prop. Hwy. 416-NBI Line 'A' o/s 23' Rt.

W. P. 202-67-01

BORING DATE February 11-12, 1969

DATUM Geodetic

BOREHOLE TYPE Washboring, NX & BX Casing, Cone

FOUNDATION SECTION

ORIGINATED BY **CM**

COMPILED BY _____ CM

CHECKED BY _____

SOIL PROFILE			SAMPLES			ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE		LIQUID LIMIT ——— WL		BULK DENSITY	REMARKS
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	BLOWS / FOOT		BLOWS / FOOT	WATER CONTENT ——— W	WATER CONTENT %	WATER CONTENT %		
314.6	Ground Level											
313.9	Organic soil - muck											
310.8	Sand. Fine - med.		1	SS	12							
301.3	Silty clay to clayey silt. occ. silt and fine sand seams. Very stiff. Grey.		2	SW	12							
13.5	Heterogeneous mixture of silt, sand and gravel (Glacial till)		3	SS	19							
289.5	Compact		4	SS	12							
25.3	Dolomitic Limestone		5	WS	-							
234.4	Bedrock. Sound.		6	SS	28							
30.4	End of Borehole		7	SS	24							
			8	AXT RC	96% Rec							

DEPARTMENT OF HIGHWAYS - ONTARIO

MATERIALS & TESTING DIVISION

RECORD OF BOREHOLE NO. 5A

FOUNDATION SECTION

JOB 69-F-1

LOCATION Sta. 303+70 @ Prop. Hwy. 416 NBL Line 'A' o/s 23' Lt.

ORIGINATED BY CM

W.P. 202-67-01

BORING DATE February 13-14, 1969

COMPILED BY CM

DATUM Geodetic

BOREHOLE TYPE Washboring NX & BX Casing

CHECKED BY

SOIL PROFILE			SAMPLES			ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT				LIQUID LIMIT — WL PLASTIC LIMIT — WP WATER CONTENT — W		BULK DENSITY Y	REMARKS
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	BLOWS / FOOT		SHEAR STRENGTH P.S.F. x Lab Vane				WP	WL		
313.2	Ground Level						2000	4000	6000	8000				
310.2	Organic soil - Muck													
310.2	Sand, Fine - Med.													
3.0	Silty clay to clayey silt, occ. silt seams. Stiff to very stiff.		1	SS	12	310							124	
			2	SS	8									
			3	SS	7									
302.2			4	SS	42									
11.0	Heterogeneous mixture of silt, sand and gravel (Glacial Till)		5	SS	14	300								
			6	SS	11									
	Compact to dense		7	SS	33									
289.4						290								
23.8	End of Borehole Probably bedrock					280								refusal

Art.
 301.7
 22 36 37 5
 Drill with
 bicone bit

DEPARTMENT OF HIGHWAYS - ONTARIO

RECORD OF BOREHOLE NO. 5B

FOUNDATION SECTION

MATERIALS & TESTING DIVISION

JOB 69-F-1

LOCATION Sta. 303+70 @ Prop. Hwy. 416-NEL Line 'A' o/s 43' Lt.

ORIGINATED BY CM

202-67-01

BORING DATE February 13, 1969

COMPILED BY CM

Datum Geodetic

SOREHOLE TYPE Dynamic Cone Penetration Test

CHECKED BY

SOIL PROFILE			SAMPLES			ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE		LIQUID LIMIT ——— WL		BULK DENSITY	REMARKS
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	BLOWS / FOOT		SLOWS / FOOT	SHEAR STRENGTH P.S.F.	PLASTIC LIMIT ——— wp	WATER CONTENT ——— w		
313.1	Ground Level											
300.0	Probably silty clay to clayey silt.											
289.1	Probably granular glacial till											
24.0	End of Cone Test Probably Bedrock	END OF TEST										Practical refusal to cone

DEPARTMENT OF HIGHWAYS - ONTARIO

MATERIALS & TESTING DIVISION

RECORD OF BOREHOLE NO. 6

FOUNDATION SECTION

JOB 69-F-1

LOCATION Sta. 30h + 73 @ Prop. Hwy. 416 - NBL Line 'A'

ORIGINATED BY CM

W.P. 202-67-01

BORING DATE February 14 - 15, 1969

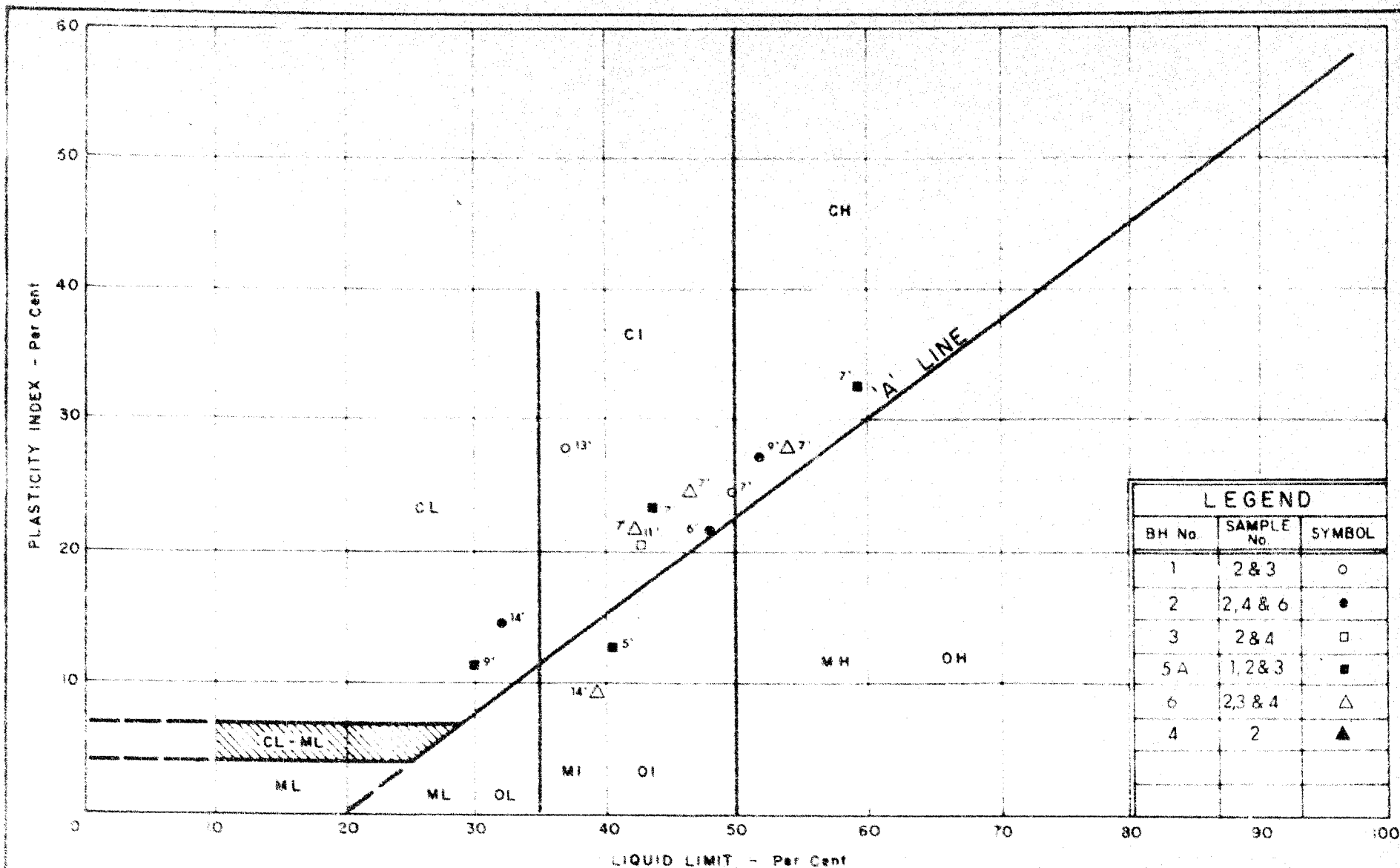
COMPILED BY CM

DATUM Geodetic

BOREHOLE TYPE Washboring - NX, BX Casing, Cone

CHECKED BY *[Signature]*

SOIL PROFILE			SAMPLES			ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE					LIQUID LIMIT — WL PLASTIC LIMIT — WP WATER CONTENT — W		BULK DENSITY PC F.	REMARKS
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	BLOWS / FOOT		BLOWS / FOOT					WATER CONTENT %			
							20	40	60	80	100	20	40		
							SHEAR STRENGTH P.S.F.					WP — W — WL			
311.8	Ground Level														315.3
0.0	Topsoil														
1.0	Sand, Fine - Med.														
310.3	loose		1	SS	8	310								117	
4.5	Stiffy caly to clayey silt, occ. silt layers.		2	TM	10									121	
	Stiff to very stiff.		3	TM	10										
			4	SS	15										
	Grey		5	SS	3	300									Silt layer
295.8															Art.
19.0	Heterogeneous mixture of silt, sand & gravel (Glacial till)		6	SS	24										294.8
289.0	Compact to dense.					290									
25.8	End of Borehole Presumably Bedrock														Practical refusal cone
						280									



DEPARTMENT OF HIGHWAYS
MATERIALS and
TESTING
DIVISION

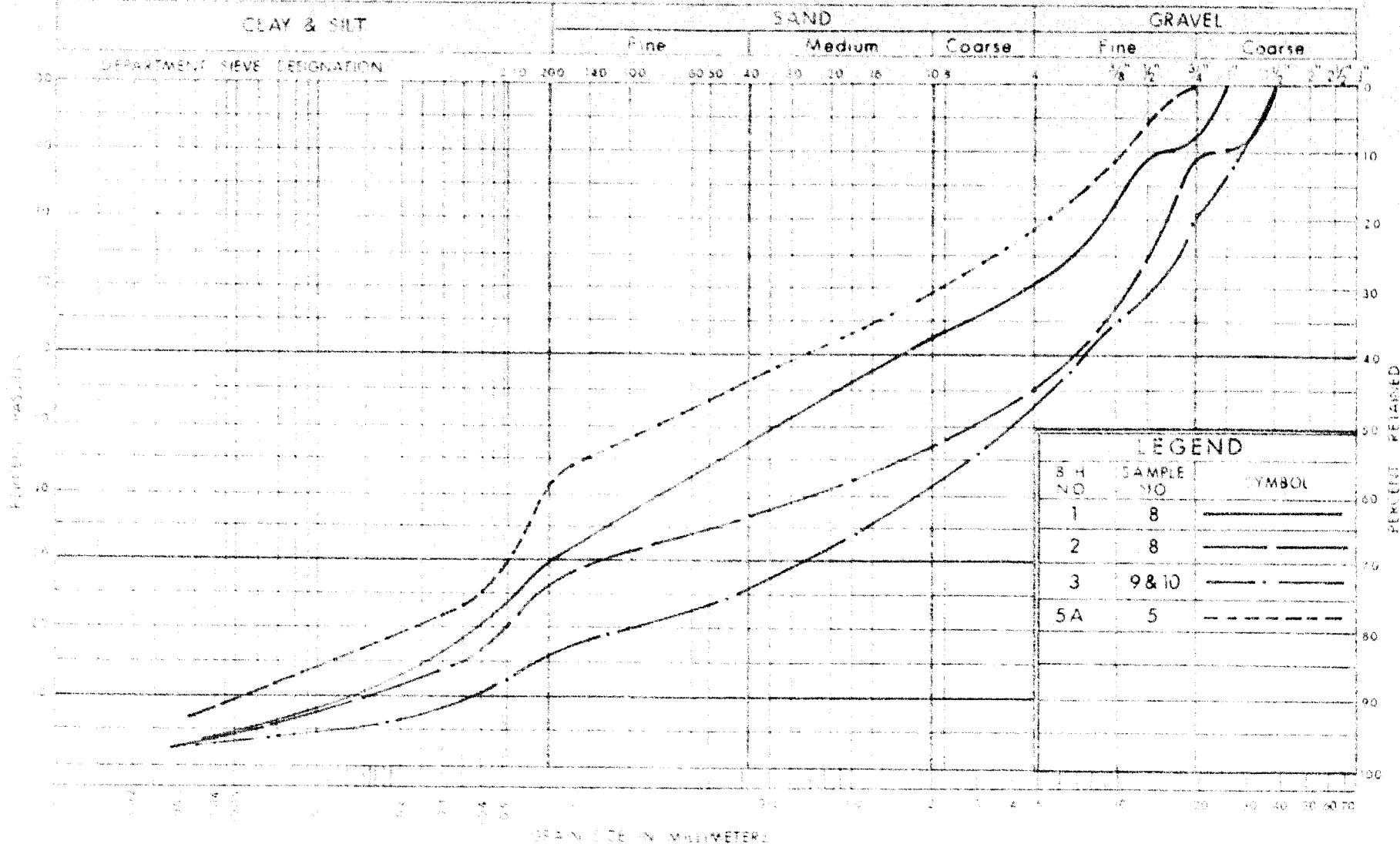
PLASTICITY CHART SILTY CLAY TO CLAYEY SILT

WP No. 202-67-01

JOB No. 69-F-1

FIG. 1

UNIFIED SOIL CLASSIFICATION SYSTEM



DEPARTMENT OF HIGHWAY
MATERIALS AND
TESTING
DIVISION

GRAIN SIZE DISTRIBUTION HETEROGENEOUS MIXTURE OF SILT, SAND & GRAVEL (GLACIAL TILL)

W.P. No. 202-67-01

JOB No. 69-F-1

FIG. 2

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	OS	OESTERBERG 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_s	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

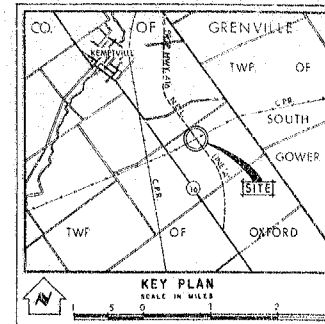
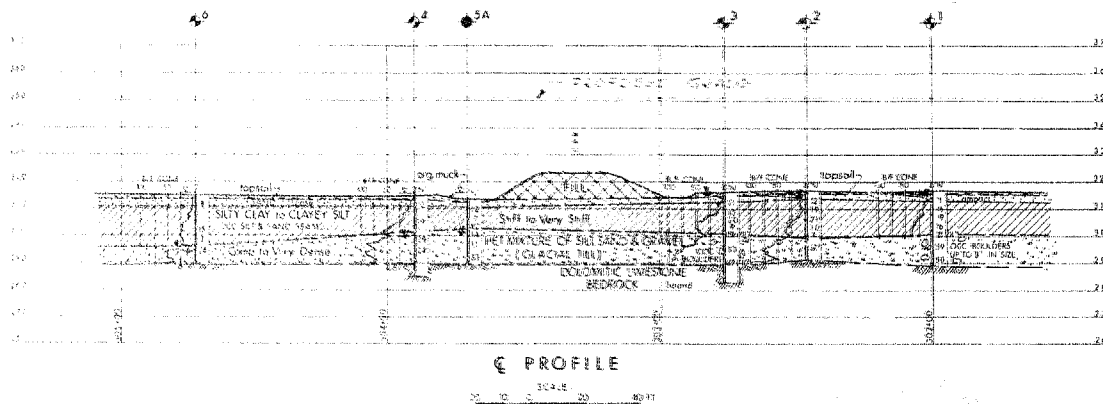
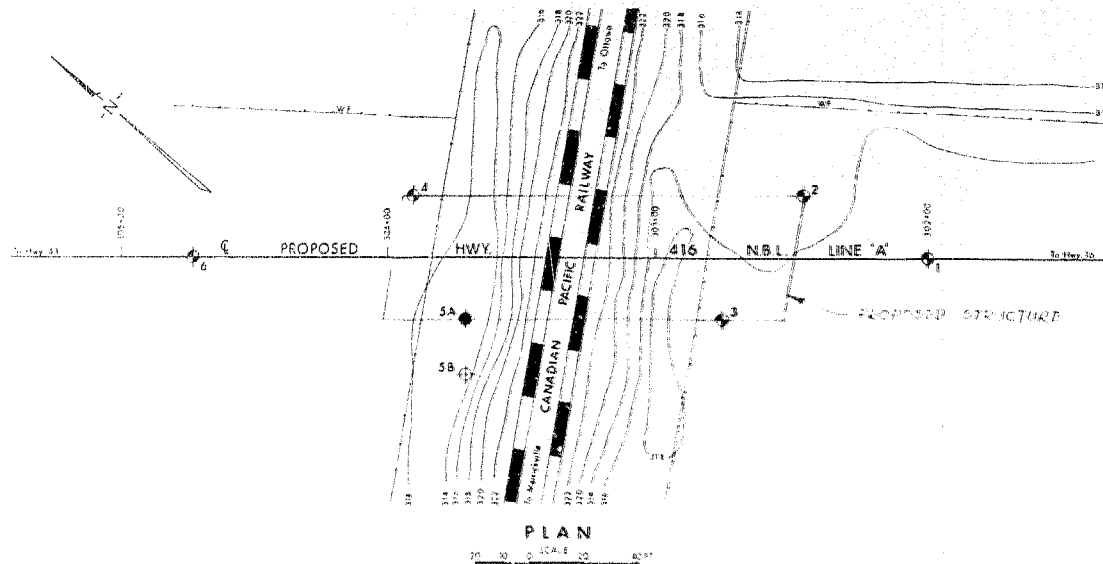
d	DISTANCE FROM TOP OF WALL TO POINT OF APPLICATION OF PRESSURE
δ	ANGLE OF WALL FRICTION
K	DIMENSIONLESS COEFFICIENT TO BE USED WITH VARIOUS SUFFIXES IN EXPRESSIONS REFERRING TO NORMAL STRESS ON WALLS
K_0	COEFFICIENT OF EARTH PRESSURE AT REST

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



LEGEND			
	Bore Hole		
	Cone Penetration Hole		
	Bore & Cone Penetration Hole		
	Water Levels established at time of field investigation, FEB 1969		
	H. Head		
	Encountered		
	Artesian Water Levels		
NO.	ELEVATION	STATION	OFFSET
1	316.1	302+00	6
2	316.0	302+46	23' RT.
3	315.4	302+76	23' LT.
4	314.8	303+89	23' RT.
5A	313.2	303+70	23' LT.
5B	313.1	303+70	43.5' LT.
6	314.8	304+73	6

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.

REVISION	DATE	BY	DESCRIPTION

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

CANADIAN PACIFIC RAILWAY

KIND'S HIGHWAY NO. 416, LINE 'A' ST. NO. 8
CO. GRENVILLE
TWP. OXFORD LOT 28 C 5

BORE HOLE LOCATIONS & SOIL STRATA

Soils C.M. CHECKED ☒ W.P. NO. 202-07-01
SPAWN S.O. CHECKED ☒ J.M. NO. 69-F-1
DATE: 5 MAR 1969 SITE NO. 69-F-1A
APPROVED: [Signature] DIST NO. []

MEMORANDUM

To: Mr. A. G. Stermac, P. Eng.,
Principal Foundation Engineer,
Laboratory Building,
Downsview, Ontario.

ATTENTION:

FROM: Bridge Section,
Kingston, Ontario.

DATE: January 9, 1969.

OUR FILE REF.

IN REPLY TO

SUBJECT:

W.P. 202-67-01, Site 16-193, C.P. Railway
Overhead, Highway 416, District 8

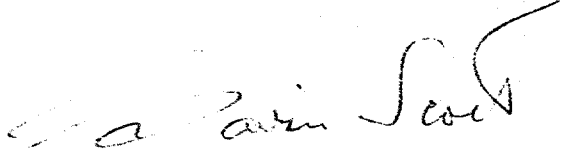
29-F-1

We are sending to you herewith two prints of Bridge Site Plan E-4669-1 on which we have marked the proposed location of the subject structure. You will note that provision has been made for an extra track. This has been done at the request of the Functional Planning Section.

We would be pleased if you will make arrangements for the necessary foundation investigation.

Two copies of your Field Reconnaissance Report FF-69 together with copy of letter dated January 9, 1969 to Mr. D. H. Graham are also enclosed.

We would be pleased to receive your report, the scheduled date for which is February 5, 1969.



Gavin Scott, P. Eng.
Regional Bridge Location Engineer

GS/hl
Encls.
c.c. (with Plan)
Bridge Office Files Section

Department of Highways Ontario

Copy for the information of

Mr. A. Stermac

Mr. G. Scott,
Reg. Bridge Location Engineer,
Kingston Regional Office,
Kingston, Ontario

Bridge Office,
Downsview, Ontario

April 25, 1969

C.P.R. Overhead
1½ Miles South of Kerapville
W.P. 202-67-01, Site 16-193
Highway 416, District No. 8

Attached herewith are prints of the Preliminary Bridge Plan Drawing D-6645-F for the above-mentioned structure.

The estimated cost of the proposed structure is \$110,000. This cost includes tender, materials, engineering and sundry construction.

Any comments or revisions you may have should be submitted within three weeks.

CSG:rd

C.S. Grebski,
Bridge Design Engineer

Attach.

c.c. S. McCombie
A. Stermac (2)
J. Anderson

69-F-1

1 No Comments.

2. Should indicate on
diag that subexcavation of any
organic material is necessary beneath
plan limits of approach fills.

C Mirza Apr 28/69.

Mr. C. B. Grabski,
Bridge Design Engineer,
Bridge Office,
Admin. Bldg.

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

April 30, 1969

C.B.R. Overhead
1-1/2 Miles South of Acapville
W.P. 202-67-01, Site 16-193, W.J. 60-F-1
Hwy. 416, District No. 8 (Kingston)

We have reviewed the Preliminary Bridge Plan Drawing B-6649-P for the above mentioned structure and submit the following comments:

Our investigation revealed the presence of a thin layer of organic material (muck) immediately below the ground surface in the North approach fill area. This material should be sub-excavated and backfilled with suitable granular material prior to placing any fill. These details are not shown in the Bridge Design drawings and we assume that the Road Design drawings will include the necessary information.

20/41ef

M. Deveta
M. Deveta,
SUPERVISING FOUNDATION ENGR.
For:
A. C. Sternac,
PRINCIPAL FOUNDATION ENGR.

cc: Messrs. S. McConbie
G. Scott
J. E. Crusier
S. J. Markiewicz

Foundations Files
Gen. Files

MEMORANDUM

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

FROM: C.S. Grebski,
Bridge Office

ATTENTION:

DATE: July 16, 1969

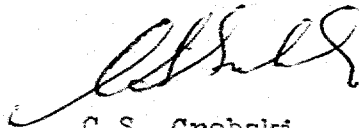
OUR FILE REF.

IN REPLY TO

SUBJECT: C.P.R. Overhead
1½ Miles South of Kemptville
W.P. 202-67-01, Site 16-193
Highway 416, District No. 8

Attached herewith we are submitting the final bridge drawings which show the foundation design for this structure.

Kindly give us your comments at your earliest convenience.



C.S. Grebski,
Bridge Design Engineer

CSG:rd

Attach.

c.c. Foundation Section

No Comments.

M. Levata

July 24th 1969

G.I.-30 SEPT. 1976

GEOCRES No. 31600-102DIST. 8 REGION EasternW.P. No. 202-67-01CONT. No. 70-045W. O. No. 69-F-100STR. SITE No. 16-193HWY. No. 416

LOCATION CPR X-ing (1.5 M. S.E. of
Town of Kemptville + 2.5 M. S. of
Hwy 43) Overhead

=====

OVERSIZE DRAWINGS TO BE INCLUDED WITH THIS REPORT. _____

REMARKS: DOCUMENTS TO BE UNFOLDEDBEFORE MICROFILM

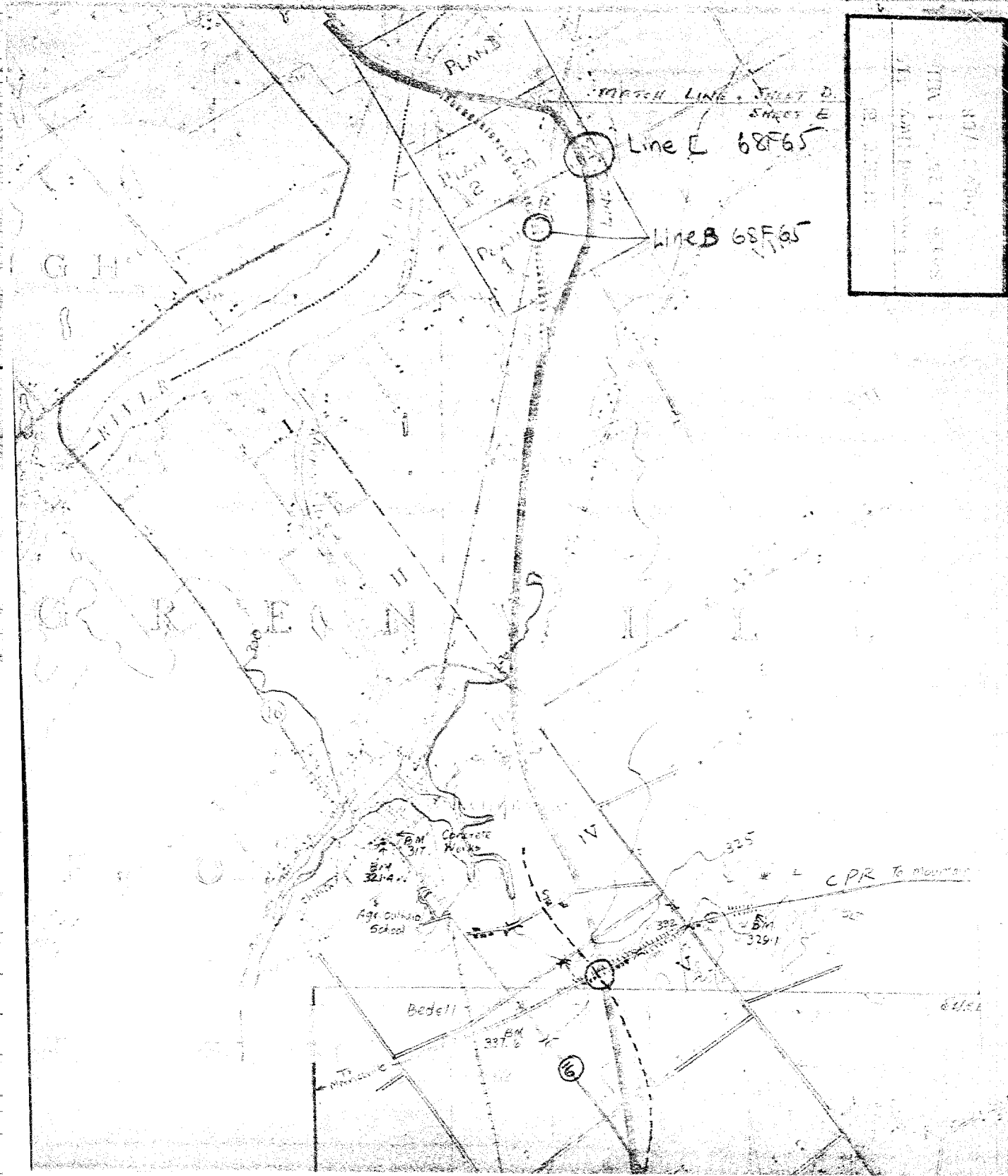
DEPARTMENT OF HIGHWAYS ONTARIO
DESIGN BRANCH - ENGINEERING SURVEYS DIVISION
WORK ORDER

69-F-1

Requested By Foundation SectionOrder No. 9393-202-67-01Issued P. A. G. BoucherDate Feb 10/69Priority 'A'Charge To Engineering Surveys 9393Work Project No. 202-67-01Highway No. 416 District 8 Kingston Region Eastern Length siteTownship Oxford County (Name & Number) GrenvilleIssued To C. Buffan Riding (Name & Number) Grenville DundasJob Description Proposed structure - C.P.R. Hwy 416

INSTRUCTIONS:

Locate boreholes for Foundation investigation as per survey request.Contact Foundation Engineer in the field - one p.m. Monday, Feb. 10/69.



VISUAL CLASSIFICATION SHEET

PROJECT 69-F-1 SITE Kemptville BOREHOLE No. 1 GROUND ELEVATION 816.1

SAMPLE No.	DEPTH	GRAIN SIZE DISTRIBUTION					DRY STRENGTH	SHINE	DIALATANCY	TOUGHNESS	ODOR	COLOUR	ACID TEST	CONSISTENCY OR UNDRAINED SHEAR STRENGTH	CLASSIFICATION WITH DESCRIPTION	SYMBOL
		LARGEST GRAIN SIZE	SHAPE	PERCENTAGE												
				GRAVEL	SAND	SILT & CLAY										
1	3-4½	40	-	0	100	-	-	Quick	-	Earthy	Grey	Strong		Fine-Med. sand, occ. silt seams. Boundary w/ silty clay	SP	
2	6-7½	-	-	0	Tr	100	-	shiny	none	High	"	"	Med		clayey silt - silty clay; occ silt pockets	CL-CI
3	9-10½	-	-	0	5	95	-	dull-shiny	"	"	"	"	strong		" " " " few " "	CL-C2
4	12-13½	-	-	0	5	95	-	dull	"	Med	"	"	"		clayey silt, occ silt pockets	CL
5	16-16½	½	angular	10	10	80	-	"	Quick	"	"	"	"		silt - boundary with silt sand & gravel	ML
7	21-21½	2"	"	85	15	Tr	-	-	-	-	-	-	slow		Gravel with sand (sand is angular - probably derived from gravel)	GP
8	24-25½	¾	Subangular	30	65	5	-	dull	Stiff	low	Earthy	Grey	Strong		Gravelly Sand with Tr silt	SW

NOTES:- VISUAL CLASSIFICATION MUST BE CARRIED OUT ON ALL SAMPLES BY THE ENGINEER AS SOON AS POSSIBLE AFTER THE SAMPLES REACH THE LABORATORY.

REMARKS:-

VISUAL CLASSIFICATION SHEET

PROJECT 69-F-1 SITE Kemptville BOREHOLE No. 2 GROUND ELEVATION 316.6

SAMPLE No.	DEPTH	GRAIN SIZE DISTRIBUTION					DRY STRENGTH	SHINE	DIALATANCY	TOUGHNESS	ODOR	COLOUR	ACID TEST	CONSISTENCY OR UNDRAINED SHEAR STRENGTH	CLASSIFICATION WITH DESCRIPTION	SYMBOL
		LARGEST GRAIN SIZE	SHAPE	PERCENTAGE												
				GRAVEL	SAND	SILT & CLAY										
1	3-4 1/2	8"	angular	-	5	95	-	dull	none	high	Earthy	Grey, mottled	Strong		clayey silt - silty clay Tr sand, occ silt seams 1/4" thick	CL CF
3	6-7 1/2	-	-	-	Tr	100		shiny	"	"	"	Grey	"		silt / clay, occ silt pockets [combination could result in clayey silt]	CL
5	9 1/2 - 11	3/16"	subround	0	5	95		dull	slow	med	"	"	"		clayey silt, Tr sand, isolated x occ. silt pockets,	CL
6	12-13 1/2	-	-	0	Tr	100		dull	slow	med	"	"	"		clayey silt to silt	CL ML
7	15-16 1/2	1/2"	angular	Tr	20	2	-	dull, shiny	quick	low	"	"	"		silt, some portions are clayey silt Tr gravel some fine sand	ML
8	20-21 1/2	1 1/2"	subang	50	45	5	-	dull	quick	-	"	"	"		sandy Gravel Tr silt	GS-SG

NOTES:- VISUAL CLASSIFICATION MUST BY CARRIED OUT ON ALL SAMPLES BY THE ENGINEER AS SOON AS POSSIBLE AFTER THE SAMPLES REACH THE LABORATORY.

REMARKS:-

VISUAL CLASSIFICATION SHEET

PROJECT <u>69-F-1</u>		SITE <u>Kemptville</u>		BOREHOLE No. <u>3</u>		GROUND ELEVATION <u>315.4</u>										
SAMPLE No.	DEPTH	GRAIN SIZE DISTRIBUTION					DRY STRENGTH	SHINE	DILATANCY	TOUGHNESS	ODOR	COLOUR	ACID TEST	CONSISTENCY OR UNDRAINED SHEAR STRENGTH	CLASSIFICATION WITH DESCRIPTION	SYMBOL
		LARGEST GRAIN SIZE	SHAPE	PERCENTAGE												
				GRAVEL	SAND	SILT & CLAY										
1	3-4½	-	-	0	Tr	100	-	Shiny	none	high	Earthy	Grey	strong		silt + clay - Body with ^{upper} sand layer.	CE
3	6½-8	-	-	0	Tr	100	-	dull	none	"	"	"	"		clayey silt - silty clay, see silt pockets	CL-CE
4	9-10½	-	-	0	-	100	-	"	low	med	"	"	"		clayey silt (Brittle)	CL
5	12-13½	-	-	0	5	95	-	"	"	"	"	"	"		clayey silt - one ½" ^{fine} thick sandy silt seam	CL
6	15-15.8	1½	Angular	90	5	5	-	-	-	-	"	"	"		shattered rubble in clayey silt to silt matrix.	-
9	17½-21	1"	subang	85	15	5	-	Shiny	crumbly	-	"	"	"		Sandy Gravel - gravelly sand to silt.	SA-GS
10	25-25.8	1"	"	60	35	5	-	"	-	"	"	"	"		sandy Gravel to silt	-

NOTES:- VISUAL CLASSIFICATION MUST BY CARRIED OUT ON ALL SAMPLES BY THE ENGINEER AS SOON AS POSSIBLE AFTER THE SAMPLES REACH THE LABORATORY.

REMARKS:-

VISUAL CLASSIFICATION SHEET

PROJECT 69-F-1 SITE Kemptville BOREHOLE No. 4 GROUND ELEVATION 314.8

SAMPLE No.	DEPTH	GRAIN SIZE DISTRIBUTION					DRY STRENGTH	SHINE	DIALATANCY	TOUGHNESS	ODOR	COLGUR	ACID TEST	CONSISTENCY OR UNDRAINED SHEAR STRENGTH	CLASSIFICATION WITH DESCRIPTION	SYMBOL
		LARGEST GRAIN SIZE	SHAPE	PERCENTAGE												
				GRAVEL	SAND	SILT & CLAY										
1	3-4½	-	-	0	100	100	-	-	Quick	-	organic	light Grey	Shore	-	Uniform med sand - Bdry with silty clay -	SV CI
3	9-10½	-	-	0	8	100	-	Shiny fractures	slow	med	Earthy	Grey	"	-	Clayey silt - fractured & brittle. one 2" thick sandy silt to silty sand seam	CL
5	12-15	1"	angular				W	A	SI-1						Sand & gravel - angular.	
6	15-16½	¾"	angul	90	10	Tr	-	-	-	-	-	-	"	-	Gravel with sand (probably lost sample whole)	G
7	20-21½	1"	subang	80	20	Tr	-	-	-	-	Earthy	Grey	"	-	sandy gravel - (fine - med sand)	GS

NOTES:- VISUAL CLASSIFICATION MUST BY CARRIED OUT ON ALL SAMPLES BY THE ENGINEER AS SOON AS POSSIBLE AFTER THE SAMPLES REACH THE LABORATORY.

REMARKS:-

B = clay.

VISUAL CLASSIFICATION SHEET

PROJECT 69-F-1 SITE Kemptville BOREHOLE No. 5-A GROUND ELEVATION 313.2

SAMPLE NO.	DEPTH	GRAIN SIZE DISTRIBUTION					DRY STRENGTH	SHINE	DIALATANCY	TOUGHNESS	ODOR	COLOUR	ACID TEST	CONSISTENCY OR UNDRAINED SHEAR STRENGTH	CLASSIFICATION WITH DESCRIPTION	SYMBOL
		LARGEST GRAIN SIZE	SHAPE	PERCENTAGE												
				GRAVEL	SAND	SILT & CLAY										
1	3-4 1/2	-	-	0	0	100	-	Shiny	none	high	Earthy	grey	strong		clayey silt - silty clay- Blocky structure	CL- CI
3	6-8-8.3			0	0	100		"	"	"	"	"	"		clayey silt - silty clay- one 2" thick seam of SILT with Tr. sand	CL- CI
4	10-11 1/2	1"	angular	50	30	40	-	"	quartz	low	"	"	"		clayey silt to silt- shattered gravel.	CL- ML
5	12-13 1/2	3/4"	subang	30	50	20		"	"	"	"	"	"		silty sand with gravel, Tr. clay	SM
6	16-17 1/2	1 1/2"	"	85	10	5	-	-	-	-	"	"	"		Gravel, with some sand	GS
7	20-21 1/2	1"	subangular	15	20	5									sandy Gravel, Tr. clay (lilt-like texture)	G

NOTES:— VISUAL CLASSIFICATION MUST BE CARRIED OUT ON ALL SAMPLES BY THE ENGINEER AS SOON AS POSSIBLE AFTER THE SAMPLES REACH THE LABORATORY.

REMARKS:—

VISUAL CLASSIFICATION SHEET

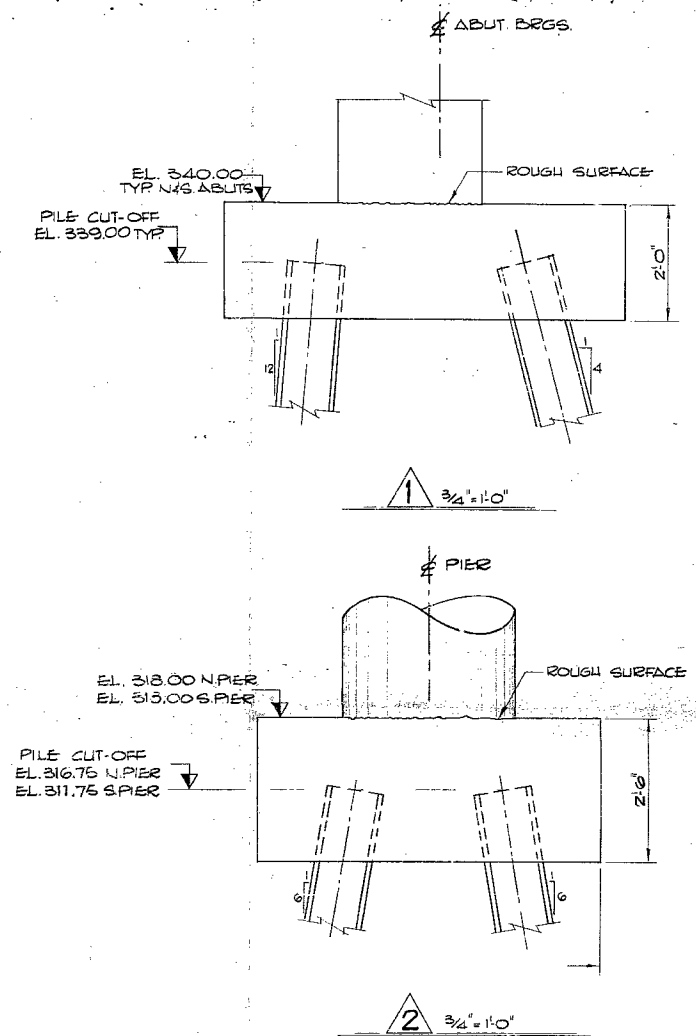
PROJECT 69-F-1 SITE Kemptville BOREHOLE No. 6 GROUND ELEVATION 514.8

SAMPLE No.	DEPTH	GRAIN SIZE DISTRIBUTION					DRY STRENGTH	SHINE	DIALATANCY	TOUGHNESS	ODOR	COLOUR	ACID TEST	CONSISTENCY OR UNDRAINED SHEAR STRENGTH	CLASSIFICATION WITH DESCRIPTION	SYMBOL
		LARGEST GRAIN SIZE	SHAPE	PERCENTAGE												
				GRAVEL	SAND	SILT & CLAY										
1	3-4½	1½"	Subsandy	occ	100	Tr.	-	-	Quick	none	Earthy to org.	grey	strong		Fine - med sand. occ. stone	SP.
4	12-13½	-	-	0	0	100	-	dull	slow - none	low	Earthy	"	"		clayey silt - silt	CL ML
5	15-16½	-	-	0	PT	100	-	shiny	Quick	low	"	"	"		silt to clayey silt Tr f. sand	ML CL
6	20-21½	3/16"	Subsandy	45	45	10	-	-	-	-	"	"	"		sand & gravel Tr silt	GS

NOTES:- VISUAL CLASSIFICATION MUST BE CARRIED OUT ON ALL SAMPLES BY THE ENGINEER AS SOON AS POSSIBLE AFTER THE SAMPLES REACH THE LABORATORY.

REMARKS:-

69-F-1
WP 202-67-01
Hwy #416 (NBL)
LINE 'A'
AND C.P.R. CROSSING



PILES SUPPLIED					
LOCATION	SLOPE	QTY.	LENGTH	TYPE	DESIGN LOAD
NORTH ABUT. #	1:4	8	52'-0"	12 BP 53 "H" PILES	70 TONS/PILE
SOUTH ABUT.	1:12	6	52'-0"		
NORTH PIER #	1:6	8	29'-0"		
	1:4	2	29'-0"		
SOUTH PIER	1:6	8	24'-0"		
	1:4	2	24'-0"		

NOTES:

- PILE SPACING TO BE MEASURED AT UNDERSIDE OF FOOTING.
- PILES TO BE DRIVEN TO REFUSAL IN ACCORDANCE WITH STD. DD-1219 (SEE DWG. D-6645-12)
- FOR PILE SPLICE & PILE TIP REINFORCEMENT DETAILS SEE STD. DD-82-1 ON DWG. D-6645-12

[illegible]