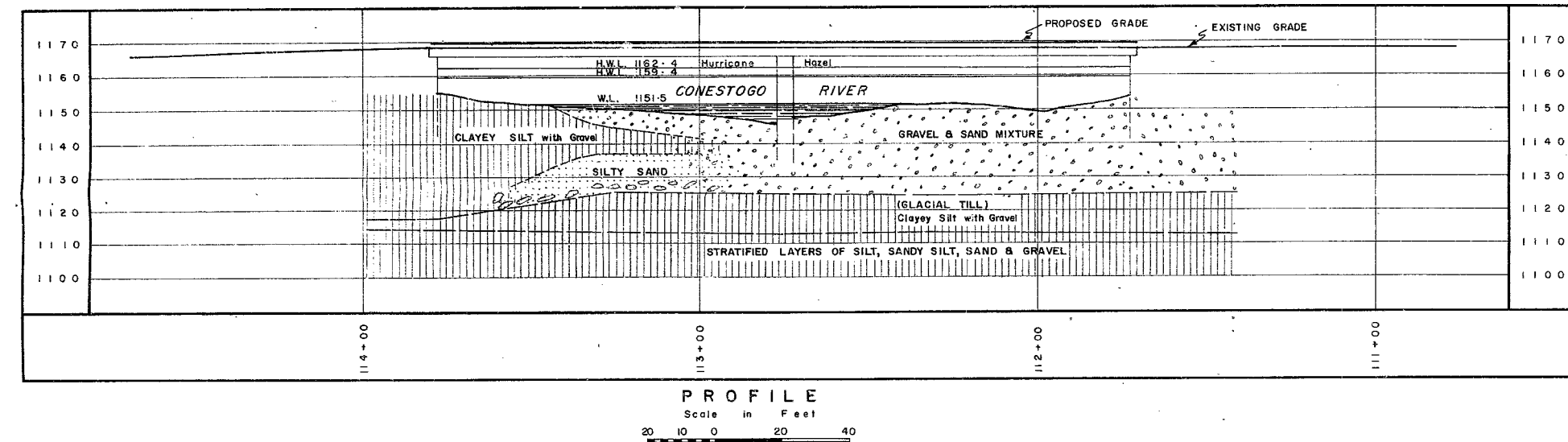
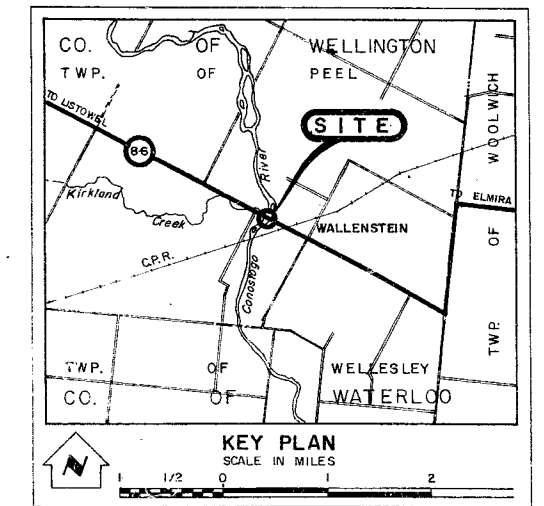
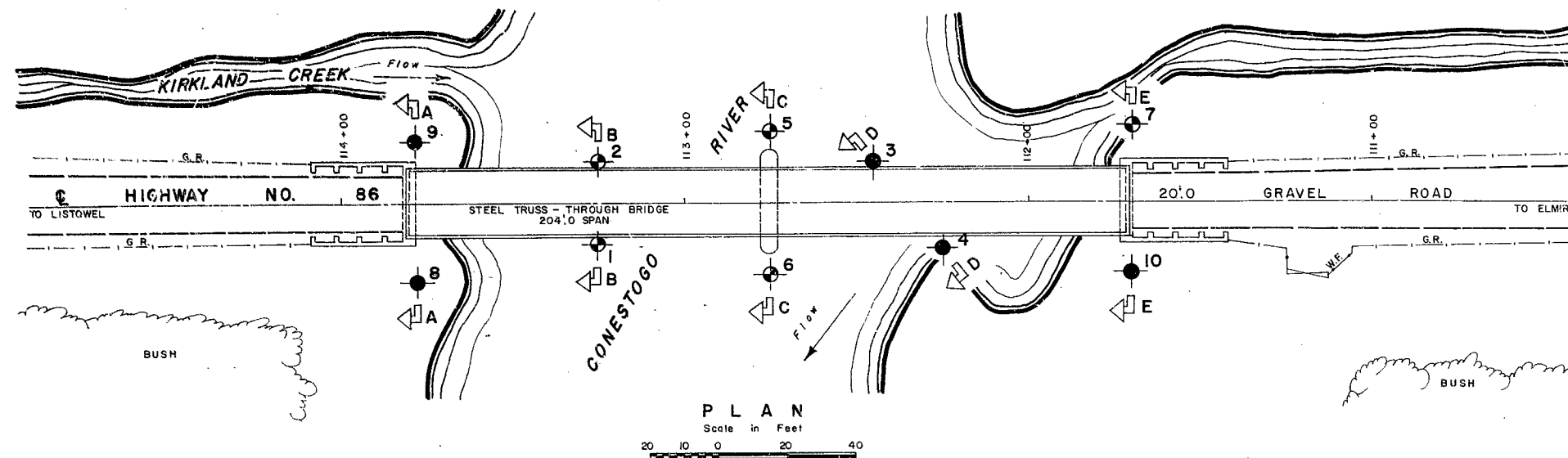


#  
62-F-45  
W.P. # 528-56  
Hwy # 86  
CONESTOGO  
RIVER

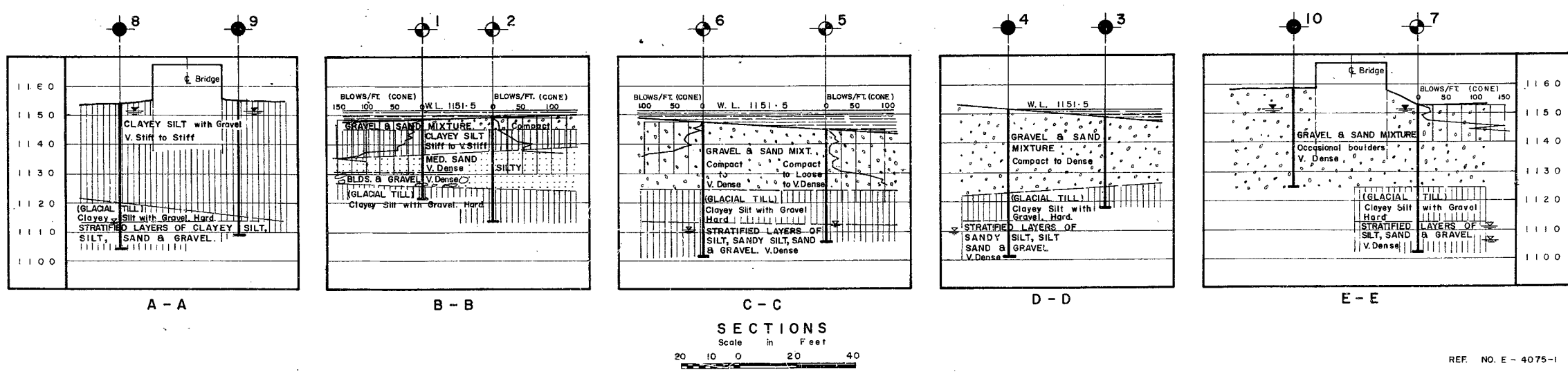


LEGEND			
	Bore Hole		
	Cone Penetration Hole		
	Bore & Cone Penetration Hole		
	Water Levels established at time of field investigation.		
	Artesian Water Level		

NO.	ELEVATION	STATION	OFFSET
1	1148.5	113+25	12' LT.
2	1149.5	113+25	12' RT.
3	1149.0	112+45	12' RT.
4	1152.0	112+25	13' LT.
5	1145.0	112+75	21' RT.
6	1147.5	112+75	21' LT.
7	1153.0	111+70	23' RT.
8	1154.0	113+77	23' LT.
9	1155.0	113+78	18' RT.
10	1158.5	111+70	20' LT.

**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.



DEPARTMENT OF HIGHWAYS - ONTARIO  
MATERIALS & RESEARCH SECTION

**CONESTOGO RIVER  
AND  
HIGHWAY NO. 86**

ORIGINATED A. BARSVARY	DISTRICT NO. 3	DATE 19 JUNE 1962
DRAWN D. MUMFORD	W.P. NO. 528-56	JOB NO. 62-F-45
CHECKED <i>[Signature]</i>	CONTRACT NO.	DRAWING NO.
APPROVED <i>[Signature]</i>		62-F-45A

REF. NO. E-4075-1



*Contract: 23-64-123*

Mr. A. M. Toye,  
Bridge Engineer.  
Materials & Research Division,  
(Foundation Section)  
Attention: Mr. S. McCombie.

June 14, 1962.

D.H.O. FOUNDATION INVESTIGATION  
REPORT.  
W.J. 62-F-45 -- W.P. 528-56.

Re: Proposed New Bridge at Conestogo River and  
Hwy. #86, 0.5 Mi. N.W. of Wallenstein,  
District #3, Stratford.

Attached, we are forwarding you our detailed  
foundation report on the subsoil conditions existing at  
the above structure location.

We believe the factual data and recommendations  
contained therein, should prove adequate for your future  
design work. If further information is required, please  
do not hesitate to contact our Office.

AGS/MdeF

cc: Messrs. A. M. Toye (2)  
H. A. Tregaskes  
H. D. McMillan  
A. Gater  
L. D. Barrett  
J. Roy  
T.J. Kovich  
J.E. Gruspier  
E.R. Saint  
F. Norman  
A. Watt  
Foundations Office  
Gen. Files.

For:

*K.Y.L.*  
K. Y. Lo,  
SUPERVISING FOUNDATION ENGR.  
A. G. Stermac,  
PRINCIPAL FOUNDATION ENGR.

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-

# FOUNDATION INVESTIGATION

For

Proposed New Bridge at Conestogo River and  
Hwy. #86, 0.5 Mi. N.W. of Wallenstein,  
District #3, Stratford.

W.J. 62-F-45

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W.P. 528-56

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## 1. INTRODUCTION:

A memo from the Bridge Location Section, dated April 9, 1962, was received, requesting a foundation investigation at the site of the proposed new bridge at the Conestogo River and Hwy. #86, 0.5 Mi. N.W. of Wallenstein.

A field investigation was subsequently carried out by this Section to determine the subsoil conditions existing at the location of the proposed structure.

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

## 2. DESCRIPTION OF THE SITE:

The site is located some 0.5 mi. N.W. of the Village of Wallenstein on Hwy. #86. The immediate surrounding area is generally flat, and consists partly of pastures and partly of bush containing deciduous trees. During high water of the river this area is inundated. At the crossing, the Conestogo River is roughly 180' wide. During the field investigation (1 - 18 May 1962) the elevation of the river waterlevel was 1151.5 - 1152.0,

cont'd. /2 ...

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

the greatest depth being about 6.5' near the bridge pier. On both banks of the river, rounded boulders are visible, their sizes ranging from a few inches to 1 - 2'. At the north side of both approach fills - immediately beside the toe of the slopes - there are small, torrent watercourses running into the Conestogo River. The average depth of these watercourses near the abutments was about 1' at the time of the field work. The highest observed waterlevel of the river, according to Mr. Alex Cooper (Elmira) former D.H.O. Patrolman, was about 3' below the existing grade. The north side of both approach fills are protected with rip-rap against scour.

The present structure is a 204.4' long, 2-span steel truss through bridge. According to the information received from the Bridge Location Section, the central pier is supported by a spread footing. The approximate size of the footing is 7'-8" x 33'-2", and the base is located roughly at El. 1130.5'. The concrete 'U' abutments are founded on 9'-8" wide spread footings, the bottom of the footings being at the approximate elevation of 1137.0'. A few narrow cracks on the east abutment indicate a slight movement of the structure.

Although the site physiographically belongs to the Waterloo Hills geological region, the Conestogo River disconnects it from the main body of the area. Generally, it is made up of sandy hills, some of them ridges of sandy till, and others, kames

cont'd. /3 ...

with outwash sand occupying the intervening hollows. The Conestogo River, itself, is a spillway, that is an abandoned channel of a glacier.

3. FIELD INVESTIGATION PROCEDURE:

A total of 10 boreholes and 8 dynamic cone penetration tests was carried out during the course of the field investigation. Boring was achieved by means of conventional diamond drilling equipment adapted for soil sampling purposes. Five of the boreholes were carried out on dry land, five were located in the waterway and were drilled from a raft. Undisturbed soil samples were obtained by means of 2-inch I.D. Shelby tubes, which were either pushed into the soil by hand or hammered by means of a 140-lb. hammer. Disturbed samples were secured by means of a standard split spoon sampler. The dimensions of the split spoon sampler and the energy used in driving it, conform to the requirements of the "Standard Penetration Test". Driving energy of the dynamic cone penetration tests was 350 ft. lbs. per blow.

Ground water level observations were carried out during the field work.

The locations and elevations of all boreholes are shown on Drawing #62-F-45A, which accompanies this report.

4. LABORATORY TESTS:

Samples were visually examined and classified at the site as well as in the laboratory.

cont'd. /4 ...



4. LABORATORY TESTS: (cont'd.) ...

Laboratory tests were carried out on various representative samples to determine the natural moisture content, Atterberg limits and grain size distributions of the different deposits. Additional tests on cohesive samples were performed to define the shear strength, density, sensitivity and compressibility of the samples.

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

5. SUBSOIL CONDITIONS:

5.1) General:

Subsoil at the site can be divided into two main groups. The upper layers consist of alluvial deposits of gravel and sand mixtures and clayey silts. The lower layers are glacial in origin, (drift) composed of silty fine sands, sands, gravels and occasional boulders (glacial outwash) and clayey silts with gravel (glacial till).

The boundaries of the different deposits are shown on the accompanying borelog sheets. The estimated stratigraphical profiles and cross sections shown on Drawing #62-F-45A are based upon this information. A more detailed description of the various soil types is as follows:

cont'd. /5 ...

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

5.2) Gravel and Sand Mixture:

This material was observed in all boreholes except B.H. #8 and #9. The thickness of the layer diminishes in an east-west direction. At the east abutment it extends from groundlevel down to about El. 1124.0', having a total thickness of 34'. In B.H. #1 and #2, the layer has an average thickness of only 3.5' - 4.0'. With one exception, the relative density of the stratum was found to be compact to very dense, corresponding to standard penetration 'N' values from about 20 to 100 blows per foot. However, this layer was observed to have a loose relative density in B.H. #5 down to 20' below waterlevel. This borehole was located upstream beside the existing pier, and may be within the limits of a former excavation. The grain size distribution shows the deposit to vary from clean gravelly sand to sandy gravel, having fines (smaller than #200 sieve) between 5 - 16% in weight. (See grain distribution curves under Appendix I.)

5.3) Clayey Silt with Gravel:

This deposit was encountered in B.H. #8 and #9 as the upper layer and had an overall depth of about 35'. In B.H. #1 and #2, the stratum immediately underlies the gravel and sand mixtures and its thickness was observed to be about 8'. The consistency of the material is stiff to very stiff. The minimum and maximum values of shear strength based on laboratory unconfined compression tests, were found to be 336 p.s.f. and 1445 p.s.f., respectively,

cont'd. /6 ...

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

5.3) Clayey Silt with Gravel: (cont'd.) ...

with an average value of about 1000 p.s.f. The sensitivity of the deposit was calculated by performing lab. vane tests and unconfined compression tests on undisturbed and remolded soil samples, and was found to be between 1 - 3. The layer has low to medium plasticity and it is greyish-brown in colour. The average values of the Atterberg limits are 30.0% and 19.0% for liquid limit and plastic limit, respectively; the average moisture content is 23%. The average bulk density was found to be about 127 p.c.f.

5.4) Sand, Gravel and Boulders:

In B.H. #1 and #2 immediately underlying the clayey silt layer, various coarse grained soil deposits were encountered, within a depth of about 12'. The constituent materials of the layers are boulders, gravel and sand. The relative density of the deposit is very dense; standard penetration 'N' values are 50 blows/foot and above.

5.5) Clayey Silt with Gravel (Glacial Till):

This material underlies the alluvial deposits in each borehole and forms the upper layer of the glacial drifts. The elevation at which the stratum was encountered varies from 1115.0' to 1125.0' and its thickness from a few inches to 12'. The consistency of the material is hard, 'N' values being in the neighborhood of 100 blows/foot and above. The average liquid limit and plastic limit of the deposit is 30% and 15%, respectively.

cont'd. /7 ...

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

5.5) Clayey Silt with Gravel (Glacial Till): (cont'd.) ...

The natural moisture content is below the plastic limit which is characteristic of a preconsolidated material. The layer is reddish in colour.

5.6) Stratified Layers of Silt, Clayey Silt, Sand & Gravel:

Underlying the red clayey silt deposit, stratified layers of silt, clayey silt, sand and gravel layers were observed in random order. The various strata were generally 1 - 2' in thickness and extended from an elevation of 1105.0' to 1101.0', the latter being the full depth of the boreholes. The relative density of the deposit is very dense, corresponding to a penetration 'N' value of 100 blows/foot and above. During the investigation, an artesian water pressure was encountered in the upper part of this layer immediately below the red clayey silt deposit.

6. GROUND WATER CONDITIONS:

During the field investigation, the elevation of the water in the river was observed to be between 1151.5 - 1152.0'. The water level in the boreholes, drilled on the dry land, was encountered at the same elevation as the river water level, or slightly above it.

Artesian water level was observed in the deeper boreholes right below the clayey silt deposit. The layer containing the artesian water is sandy gravel, its thickness is approximately 1'. The elevation of the artesian water level was found to be 1111.0 - 1113.0' and in the casing it rose about 3' above river water level.

7. DISCUSSION AND RECOMMENDATIONS:

It is proposed to construct a new bridge over the Conestogo River at the site of the existing structure on Hwy. #86. It is understood that the proposed opening width and the centre of opening will coincide with that of the present structure, and that the width of the new structure will be approx. 40'. According to the information, received from the Bridge Location Section, it has not been decided whether to construct a two or three span bridge.

Preliminary hydrological requirements for scour protection, call for certain minimum depths of the footings as follows:-

If the piers are supported on spread footings, the minimum depth of the bottom of the footings should be 15' - 20' below the normal river water level. If the abutments are supported on spread footings, the bottom of the footings should be at the same elevation as the existing ones (approx. 1137.0') or below that depth. However, if piled foundations are to be used, the bottom of the pile caps of the piers can be as high as 4' - 6' below the stream bed and those of the abutments 6' - 8' below normal water level.

In the preceding paragraphs, the different layers and their respective properties have been described. Considering only the strength and load bearing values of the various layers, it can be stated, that with the exception of the clayey silt stratum observed in B.H. #1, 2, 8 & 9, the subsoil has sufficient strength to support the structure on spread footings. However, it

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

should be realized that in the case of using a spread type of foundation, an expensive dewatering scheme is inevitable because of the permeable nature of the sand and gravel mixture and the high water head in the open excavations.

Due to the uncertainties as to the design of the proposed bridge - mentioned previously - recommendations are given below for each possibility.

7.1) Abutments:

If closed type abutments are used, it will be possible to place the structure on spread footings. For the east abutment, the afore-mentioned hydrological stipulations should be closely followed and the bottom of the footing be placed at the same elevation as the existing one (El. 1137.0'). Subsoil at this elevation consists of a gravel and sand mixture, and a net safe bearing load of 2.5 T.S.F. can be used. Adopting the above type of foundation, a dewatering scheme will be necessary as excavation for the footing will be about 15' below water level. The most practical solution of the problem would probably be to carry out the excavation inside a cofferdam of interlocking sheet piling. The sheeting should be driven to about El. 1122.0' or about 1' below the upper boundary of the red glacial till deposit. For the west abutment, subsoil conditions for spread footings are less favourable. The calculated net safe bearing capacity of the 34' - 40' thick upper clayey silt deposit is only 1 T.S.F.

cont'd. /10 ...

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

7.1) Abutments: (cont'd.) ..

It is anticipated that such a low bearing value is not sufficient for economical design. Placing the spread footing below the clayey silt layer - where the design load would be much higher - does not seem practical because of the very deep (approx. 40') excavation which would be necessary. It is recommended, therefore, to use piled foundations for the west or for both abutments. Large section 'H' piles should be used with reinforced tips as driving through the very dense gravel and sand, and into the hard glacial till is likely to be difficult. Piles should be driven 2 - 3' into the glacial till deposit. It is estimated that practical refusal will be reached at or about this depth. The elevation of the upper boundary of the glacial till layer at the east abutment was established at about 1124.0' and at the west abutment at about 1115.0' - 1120'.

In the case of 12 BP at 74 'H' piles, a design load of 70 T/pile may be used. Driving in the field should be controlled by means of the Hiley formulae according to D.H.O. standards DD 1218 & 1219. If open spill through type abutments are to be used, a piled foundation seems to be the practical and economical solution. The above recommendations regarding piled foundations for closed type abutments are also applicable in this case. According to the hydrological requirements, pile caps can be placed as high as 6 - 8' below the normal water level.

cont'd. /11 ...

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

7.2) Piers:

In the case of a two span structure, the centre pier would be at the same location as the existing one. Spread footings at the same elevation as the present footing (approx. 1130.0') will lie on the very dense gravel and sand deposit, and a design load of 2.5 T.S.F. may be used. However, if a three span structure is used, the bottom of the spread footings can be placed as high as hydrological requirements permit, that is, 15' below normal water level. Presuming that the piers of a three span bridge will be at or very near to B.H. #1 & #2 and B.H. #3 & #4, a safe design load of 2.5 T.S.F. can also be used. In this case, the bottom of the spread footings will lie at the approx. elevation of 1137.0'. A dewatering scheme will be necessary for constructing the piers on spread footings. Recommendations given under paragraph 7.1 for suggested dewatering procedures, should be followed. The depths and elevations of the glacial till deposit - into which the sheet piles should be driven - are plotted on the borelog sheets accompanying this report. Normal pumping procedure could be used inside the sheet piles if constructed by the method described in this and the previous paragraphs.

Consideration should be given to an alternative solution of piled foundations for the piers. By using piles the dewatering scheme would be simplified, and pile caps could be placed at a higher elevation. Recommendations as to the use of 'H' piles for



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

7.2) Piers: (cont'd.) ...

the footings of the abutments are also applicable for the piers, and for details, reference may be made to paragraph 7.1. The precise elevation of the pile caps will be governed by the hydrological requirements.

7.3) Slope Stability:

No slope stability problem is anticipated with regard to the approach fills, provided that standard 2:1 slopes are used. The slopes adjacent to the river should be protected by means of rip-rap to an elevation above high water level.

8. SUMMARY:

- (1) It is proposed to construct a new bridge at the crossing of the Conestogo River and Hwy. #86, at the same location as the existing bridge.
- (2) Subsoil at the site consists of deposits of gravel and sand mixtures and clayey silt. The lower layers are clayey silt with gravel, and stratified layers of silt, sandy silt, sand and gravel. The latter deposits are glacial in origin.
- (3) Recommendations pertaining to the foundation of the proposed structure are given separately for the abutments and the piers.

cont'd. /13 ...

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

(4) Alternative methods for the use of spread footing type foundations and piled foundations, are discussed - Details of recommendations are contained in 7 - "Discussion and Recommendations".

(5) No stability problems are anticipated with regard to the approach embankments. Slopes adjacent to the river should be protected with rip-rap.

9. MISCELLANEOUS:

The field investigation was carried out during the period from April 1 to April 18, 1962. Equipment used was owned and operated by Johnston Drilling Co., Ltd., Ottawa. The field work, together with the preparation of the report, was undertaken by Mr. A. K. Barsvary of the Foundation Section, D.H.O., under the general supervision of Mr. K. G. Selby.

June 1962.

APPENDIX I.

RECORD OF BOREHOLE NO. 1

ORIGINATED BY A.B.

COMPILED BY B.K.

CHECKED BY            A.B.

SOIL PROFILE			SAMPLES			DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT	Liquid Limit ——— W <sub>L</sub> Plastic Limit ——— W <sub>P</sub>	BULK DENSITY	REMARKS
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	BLOWS / FOOT	SHEAR STRENGTH P.S.F.	WATER CONTENT %	P.C.F.	
						Unconfined compr    undisturbed Lab. vane +undisturbed	WP ————— WL		
						400    800    1200    1600    2000	20      40      60		
1151.5 (0.0)	River level								
	Water								
1148.5 3.0	Gravel and sand mixture.		1	SS	24				
1145.0 6.5	Compact Grey Clayey silt stiff to v. stiff grey.		2	SS	15				
			3	TW	18				127.0
1136.5 15.0	Medium sand. Very dense grey.		4	TW	22				139.0
			5	SS	97				
1131.0 20.5	Boulder gravel. Very dense.		6	CS					
1125.5 26.0	Clayey silt with gravel. (Glacial Till)		7	CS					
1121.5 30.0	Hard Red End of borehole.		8	CS					

RECORD OF BOREHOLE NO. 2

JOB 62-F-45 LOCATION Sta. 113/25, 12' Rt. of E ORIGINATED BY A.B.  
W.P. 528-56 BORING DATE May 4-7 1962 COMPILED BY B.K.  
DATUM G.S.C. BOREHOLE TYPE Washboring NX Casing. CHECKED BY A.B.

SOIL PROFILE			SAMPLES			DYNAMIC PENETRATION RESISTANCE			LIQUID LIMIT ——— w <sub>L</sub>			BULK DENSITY P.C.F.	REMARKS			
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	BLOWS / FOOT	ELEV SCALE	BLOWS / FOOT	PLASTIC LIMIT ——— w <sub>P</sub>	WATER CONTENT ——— w	WATER CONTENT %						
							20	40	60	80	100			w <sub>P</sub>	w	w <sub>L</sub>
							SHEAR STRENGTH P.S.F.							200	400	600
1151.5	River Level															
0.0	Water					1150										
1149.5																
2.0	Gravel and sand mixture. Compact. Grey.															
1145.0			1	SS	22											
6.5	Clayey silt  Stiff to v. stiff  Grey.															
			2	TW	20											
			3	TW	30	1140										
1137.5																
14.0	Gravel and sand mixture. V. dense		4	CS												
1135.0																
16.5	Silty sand with gravel.  V. dense.  Grey.		5	SS	50											
			6	SS	65	1130										
1125.0			7	SS	>100											
26.5	Clayey silt with gravel.  (Glacial Till) Hard  Red  Seams of sand and silt.															
			8	SS	>100	1120										
1113.5			9	SS	>100											
38.0	End of borehole.					1110										

FOUNDATION SECTION

JOB <u>62-F-45</u>	LOCATION <u>Sta. 112+45, 12' Rt. of C</u>	ORIGINATED BY <u>A.B.</u>
W.P. <u>528-56</u>	BORING DATE <u>May 7-9 1962.</u>	COMPILED BY <u>B.K.</u>
DATUM <u>G.S.C.</u>	BOREHOLE TYPE <u>Washboring NX Casing</u>	CHECKED BY <u>A.B.</u>

[illegible]

DEPARTMENT OF HIGHWAYS - ONTARIO  
MATERIALS & RESEARCH DIVISION

## RECORD OF BOREHOLE NO. 4

FOUNDATION SECTION

JOB 62-F-45

LOCATION Sta. 112+25, 13' Lt. of E

ORIGINATED BY A.B.

W.P. 528-56

BORING DATE May 9-14, 1962.

COMPILED BY B.K.

DATUM G.S.C.

BOREHOLE TYPE Washboring BX Casing.

CHECKED BY A.B.

SOIL PROFILE			SAMPLES			ELEV SCALE	DYNAMIC PENETRATION RESISTANCE					LIQUID LIMIT ——— W <sub>L</sub> PLASTIC LIMIT ——— W <sub>P</sub> WATER CONTENT ——— W			BULK DENSITY P.C.F.	REMARKS			
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	BLOWS / FOOT		BLOWS / FOOT					SHEAR STRENGTH P.S.F.					WATER CONTENT %		
							20	40	60	80	100						W <sub>P</sub>	W	W <sub>L</sub>
1152.0	Groundlevel																		
0.0																			
						1150													
			1	SS	100/5"														
			2	SS	80														
	Gravel & sand mixture																		
	Occasional boulders																		
			3	SS	52	1140													
	Compact to very dense																		
	Grey.		4	SS	25														
			5	SS	124	1130													
			6	SS	76														
1123.0																			
29.0	Clayey silt with gravel (Glacial Till)		7	SS	120	1120													
	Hard																		
	Red																		
1113.5																			
38.5	Stratified layers of sandy silt, silt sand and gravel.		8	SS	>100														
	Very dense.					1110													
			9	SS	50														
1101.0			10	SS	>100														
31.0	End of borehole.					1100													

Artesian  
W.L.  
1110.0

DEPARTMENT OF HIGHWAYS - ONTARIO  
MATERIALS & RESEARCH DIVISION

## RECORD OF BOREHOLE NO 5

FOUNDATION SECTION

JOB 62-F-45 LOCATION Sta. 112+75, 21' Rt. of E ORIGINATED BY A.B.  
W.P. 528-56 BORING DATE May 9-10, 1962. COMPILED BY B.K.  
DATUM G.S.C. BOREHOLE TYPE Washboring NX Casing. CHECKED BY A.B.

SOIL PROFILE			SAMPLES			ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT					LIQUID LIMIT — WL PLASTIC LIMIT — WP WATER CONTENT — W			BULK DENSITY P.C.F.	REMARKS
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	BLOWS / FOOT		20	40	60	80	100	wp	w	wL		
1151.5	River Level															
0.0	Water					1150										
1145.0																
6.5	Gravel & sand mixture Compact to Loose to V. dense grey.		1	SS	29	1140										
			2	SS	7											
			3	SS	68	1130										
			4	SS	77											
1124.5			5	SS	107	1120										
27.0	Clayey silt with gravel. (Glacial Till) Hard Red		6A	CS												
			6	SS	120											
1112.5			7	SS	100/3"	1110										
39.0	Stratified layers of silt, sand and gravel. V. dense.		8	SS	50/3"											
1106.5																
45.0	End of borehole.															

Artesian  
w.l.  
= 1112.5





DEPARTMENT OF HIGHWAYS - ONTARIO  
MATERIALS & RESEARCH DIVISION

## RECORD OF BOREHOLE NO. 7

FOUNDATION SECTION

JOB 62-F-45 LOCATION Sta. 111-70, 25' Rt. of C ORIGINATED BY A.B.  
W.P. 528-56 BORING DATE May 15-16, 1962. COMPILED BY B.K.  
DATUM G.S.C. BOREHOLE TYPE Washboring BK Casing. CHECKED BY A.B.

SOIL PROFILE		SAMPLES		ELEV SCALE	DYNAMIC PENETRATION RESISTANCE	Liquid Limit — % Plastic Limit — % Water Content — %	BULK DENSITY P.C.F.	REMARKS
ELEV. DEPTH	DESCRIPTION	NUMBER	TYPE		BLOWS / FOOT	BLOWS / FOOT 20 40 60 80 100 SHEAR STRENGTH P.S.F.		
1153.0	Groundlevel							
	Gravel & sand mixture.  Very dense  Grey.	1	SS	55/6"				
		2	SS	100/6"				
		3	SS	70/6"				
		4	SS	87				
		5	SS	91				
1124.0	Clayey silt with gravel. (Glacial Till) Hard Red	6	SS	92				
29.0								
1112.5	Stratified layers of silt sand and gravel.  Very dense.	7	SS	82				Artesian w.l. 1111.0
40.5		8	SS	12				
		9	SS	50/3"				Artesian w.l. 1106.0
1102.0		10	SS	87				
51.0	End of borehole.							

## FOUNDATION SECTION

ORIGINATED BY A.B.

COMPILED BY B.K.

CHECKED BY A.B.

[illegible]

## NOTATION SECTION

JOB 62-F-45 LOCATION Sta. 113+78, 18' Rt. of E ORIGINATED BY A.B.  
W.P. 528-56 BORING DATE May 16-17, 1962. COMPILED BY B.K.  
DATUM G.S.C. BOREHOLE TYPE Washboring NX Casing. CHECKED BY A.B.

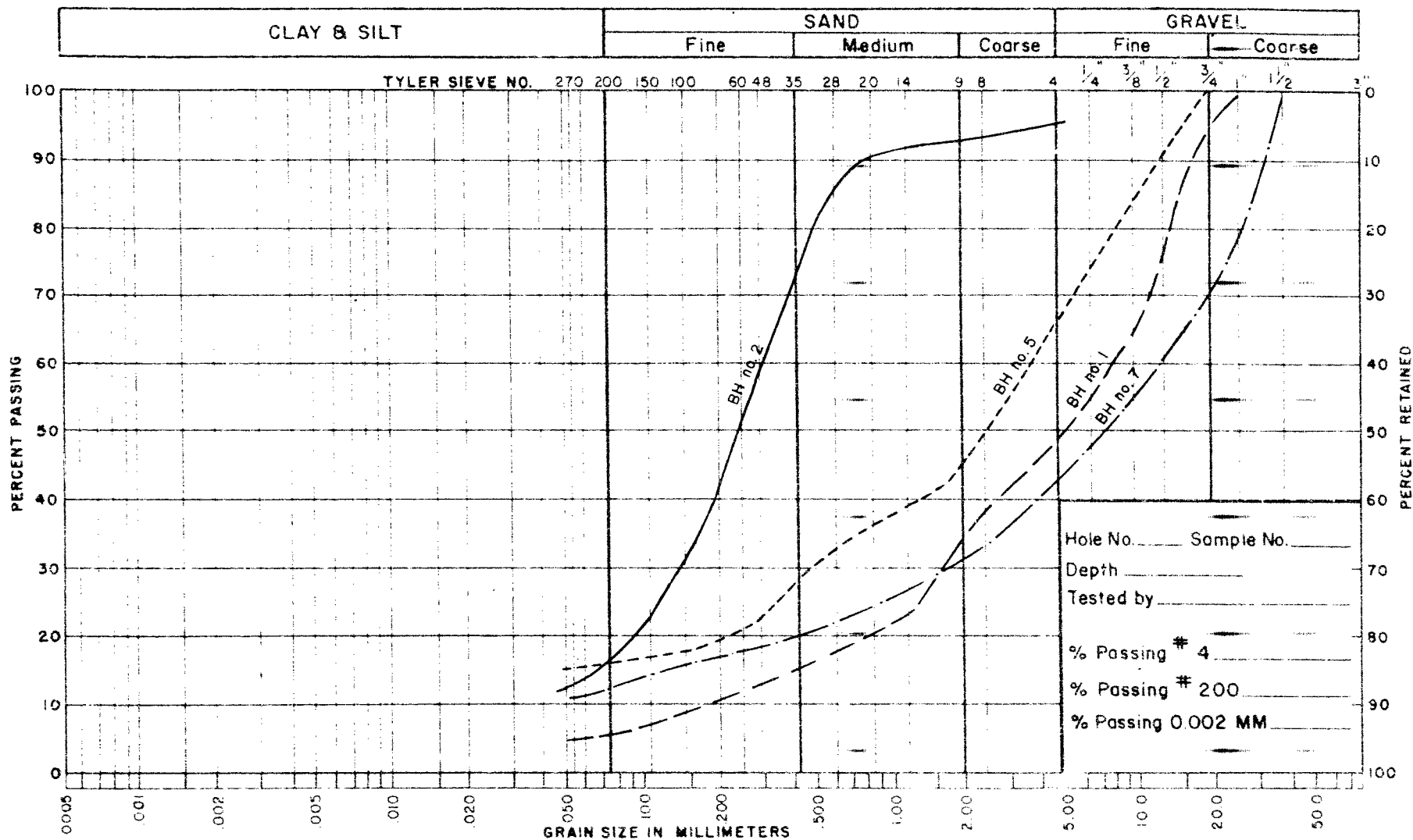
[illegible]

RECORD OF BOREHOLE NO. 10

JOB 62-F-45 LOCATION Sta. 111/70, 20' Lt. of E ORIGINATED BY A.B.  
W.P. 528-56 BORING DATE May 17-18, 1962. COMPILED BY B.K.  
DATUM G.S.C. BOREHOLE TYPE Washboring BX Casing. CHECKED BY A.B.

SOIL PROFILE			SAMPLES			ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE		LIQUID LIMIT ——— W <sub>L</sub>		BULK DENSITY	REMARKS
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	BLOWS / FOOT		BLOWS / FOOT	SHEAR STRENGTH P.S.F.	PLASTIC LIMIT ——— W <sub>P</sub>	WATER CONTENT ——— W		
1158.5	Groundlevel											
0.0			1	SS	63							
			2	SS	24/6"	1150						
	Gravel and sand mixture, with occasional boulders.		3	SS	50/3"	1140						
			4	SS	+100							
	Very dense											
	Grey.					1130						
1124.5			5	CS								
34.0	End of borehole.					1120						

# UNIFIED SOIL CLASSIFICATION SYSTEM



NOTES Representative Samples of "Sand and Gravel Mixtures"

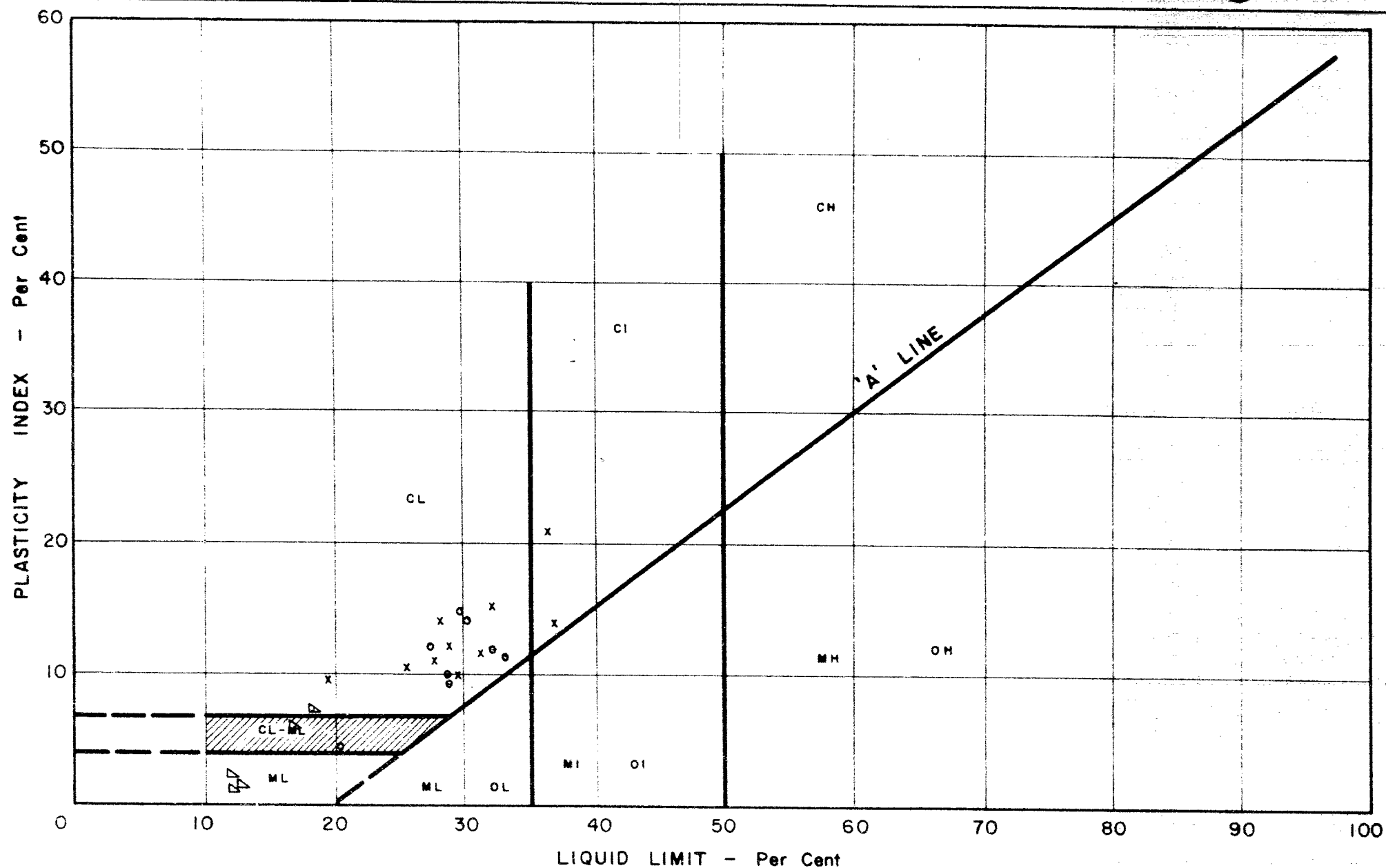
DEPARTMENT OF HIGHWAYS - ONTARIO  
MATERIALS & RESEARCH SECTION  
**GRAIN SIZE DISTRIBUTION**

Job No. 62-F-45

No. 528-56

Location Wallenstein

Hwy 86 and Conestogo River



NOTES

- x - Alluvial Clayey Silt
- o - Clayey Silt with Gravel (glacial till)
- Δ - Silt (glacial drift)

DEPARTMENT OF HIGHWAYS - ONTARIO  
MATERIALS & RESEARCH DIVISION  
PLASTICITY CHART

Job No. 62-F-45 W.P. No. 528-56  
Location Wallenstein Hwy 86 and Conestogo River

## 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

Qu	UNCONFINED COMPRESSION	L.V.	LABORATORY VANE
Q	UNDRAINED TRIAXIAL	F.V.	FIELD VANE
Qcu	CONSOLIDATED UNDRAINED TRIAXIAL	C	CONSOLIDATION
Qd	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 TOP 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

Mr. S. McCombie,  
Bridge Planning Engr.,  
Bridge Division.

Attention: Mr. Gavin Scott

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

June 27, 1963

2-F-45

Preliminary Drawing No. D-5265-P1,  
Conestogo River Bridge at Hwy. No. 86, -  
District No. 3 -- W.P. 528-56.

We are in receipt of the above-mentioned plan, and herewith, submit our comments for your consideration:

The piles used for the support of the bridge will be basically end-bearing piles resting in the dense fill stratum. In order to assure adequate penetration, the driving should be controlled by the use of the Hiley Formula according to D.H.C. Standards DD 1218 and DD 1219. It is our opinion that a note in this respect, should appear on the drawing.

AGE/MdeF

cc: Foundations Office ✓  
Gen. Files

*A. G. Stermac*  
A. G. Stermac,  
PRINCIPAL FOUNDATION-ENGINEER