

# 62-F-204

W.P. # 41-62

HWY. # 86

+ KIRKLAND  
CREEK

FOUNDATION INVESTIGATION REPORT

W.P. 41, HIGHWAY 86,

41-62

KIRKLAND CREEK, 4.6 MI. W. OF ELMIRA

DISTRICT NO. 3 STRATFORD

DEPARTMENT OF HIGHWAYS OF ONTARIO

Submitted By

ASSOCIATED GEOTECHNICAL SERVICES LIMITED

211 Davenport Road, Toronto 5, Ontario.

May 23, 1962.

## INTRODUCTION

23-64-123

The purpose of this report is to present the results of a foundation investigation carried out in connection with the proposed new bridge on Highway 86 over Kirkland Creek, 4.6 miles west of Elmira. The site is located on Lot 16, Concessions I and XIV, W.S., Townships of Peel and Wellesley, Counties of Wellington and Waterloo.

The work was authorized by Mr. A. Rutka, Materials and Research Engineer, on April 16, 1962.

## SUMMARY OF RESULTS

The soils at the site were found to consist of 2 to 3 feet of medium dense silt, sand and gravel overlying several feet of very dense till textured soil. The structure may be founded on spread footings with a bearing capacity of 4.5 kips per square foot as shown on the bearing capacity chart enclosed.

## FIELD PROCEDURES

The borehole layout for this investigation was established by the field Soils Engineer. The locations of the boreholes are shown on the plan, Figure 1, in the Appendix. The borings were laid out in the field by transit and chain survey using the centrelines of the abutments of the existing structure as reference points. The elevation of each borehole and probe was determined by spirit level from G.B.M. No. 628F.

The field drilling program consisted of two soil borings and four dynamic cone probes. One skid mounted Boyles screw feed drilling rig was

used on this project. All soil boring and sampling operations were completed by an experienced soil sampling crew under the full time supervision of a qualified Soils Engineer.

The soil boring was carried out using normal wash boring techniques. Samples of cohesionless soil were obtained in split spoon samplers in conjunction with the standard penetration test. Dynamic cone probes were made by using a 2-inch O.D. 60 degree cone point attached to the end of an A-rod. The probe was advanced into the soil by ramming, using a 140 lb hammer falling freely 30 inches. The number of blows for each foot of penetration was recorded. The depths at which samples were taken in each borehole and the dynamic cone probe penetration resistance have been plotted on the borehole logs included in the Appendix.

#### LABORATORY PROCEDURES

Moisture Content, Unit Weight and Mechanical Analysis laboratory tests were carried out on representative samples of soil from beneath the proposed structure. All soil tests were carried out in the soils laboratory of Associated Geotechnical Services Limited. In general, the methods of test followed those outline in "Soil Testing for Engineers" by T. W. Lambe. The unit weights were determined by the mercury immersion method. The results of these tests are shown on the borehole logs and on the charts in the Appendix.

## DISCUSSION OF THE SITE

The soils at the site are shown in profile on Figure 1 in the Appendix. The soil details for each boring are shown on the Borehole Logs and in the laboratory test results. Bedrock was not encountered in any of the borings at the site.

The main types of soil encountered in the soil borings are listed below in order of their occurrence below ground surface.

1. Two to three feet of medium dense silt, sand and gravel interbedded with organic material. This stratum of recent alluvium was probably formed by flooding waters of Kirkland Creek. This material was not found at an elevation below the bottom of the Creek bed in any of the borings.
2. 13 to 16 feet of very dense brown silt with sand, some gravel and clay, till texture. The soil in this stratum has a moisture content of about 10% and a unit weight of about 147 lbs/cft. For design purposes, we recommend that an angle of internal friction of 32 degrees and zero cohesion be used for this soil.

The lower two to three feet of this stratum was found in Borehole No. 2 to consist of a very dense silt with clay, some sand, till texture. As can be seen on the Borehole Log, the unit weight here becomes 140 lbs/cft and the moisture content increases to 17%.

3. Below elevation 1172 in each boring, a very dense brown silt was encountered. The silt gradually graded into a very dense sand at about elevation 1168.

The ground water level in Borehole No. 1 was measured at elevation 1189, whereas in Borehole No. 2 it was measured at about elevation 1173 several days after completion of the work, even though the water level in the holes was near surface at the completion of each hole. It is apparent that drainage of water in Borehole No. 2 is taking place, probably through the sand layer between 22 and 26 feet. This is apparently not taking place in Borehole No. 1 for some unknown reason. For design purposes we suggest that the ground water table be taken at elevation 1189.

#### DISCUSSION OF PROPOSED STRUCTURE

At the time of writing this report, it had been proposed to replace the existing bridge with a 24 foot span structure having a deck grade of 1200.5 or higher. Considering this proposal, we wish to comment as follows on the foundation conditions.

##### (a) Scour

According to the field soils engineer who made an examination of the existing structure, there was no apparent sign of scour action at the existing bridge abutments. It can, therefore, be assumed that scour action at the new structure will also be minor, thus for design purposes we have assumed that scour will not extend more than one foot below the bottom of the existing stream bed during the life of the new structure. This assumption should be checked by the Department of Highways hydrologists who are more expert in matters pertaining to scour than we are.

(b) Spread Footing Bearing Capacity

Considering the use of spread footings for the foundations of the abutments and assuming that at least 5 feet of soil surcharge will surround the footings, we have determined the allowable bearing capacity for various effective footing widths as shown below in Table No. A.

<u>TABLE NO. A.</u> <u>ALLOWABLE BEARING CAPACITY - ABUTMENT FOOTINGS</u> <u>ELEVATION OF FOOTING BASE = 1182.0</u> <u>MINIMUM SURCHARGE = 5 FT</u>					
Effective Footing width (Ft.)	3.0	3.5	4.0	4.5	5.0
Allowable Reactive Pressure (Kips per sq.ft.)	3.6	3.8	4.1	4.3	4.5
Allowable Reactive Load (Kips per ft)	11.8	13.3	16.4	19.3	22.5

Settlement of the abutments should not exceed one inch if the above values of bearing capacity are used.

(c) Dewatering

With respect to excavation for the footings, material will have to be removed down to elevation 1181, a depth of 8 ft below the ground water table. Although considerable excavation will take place below the water table, it is expected that the excavation can be satisfactorily drained down to the required elevation from open sumps.

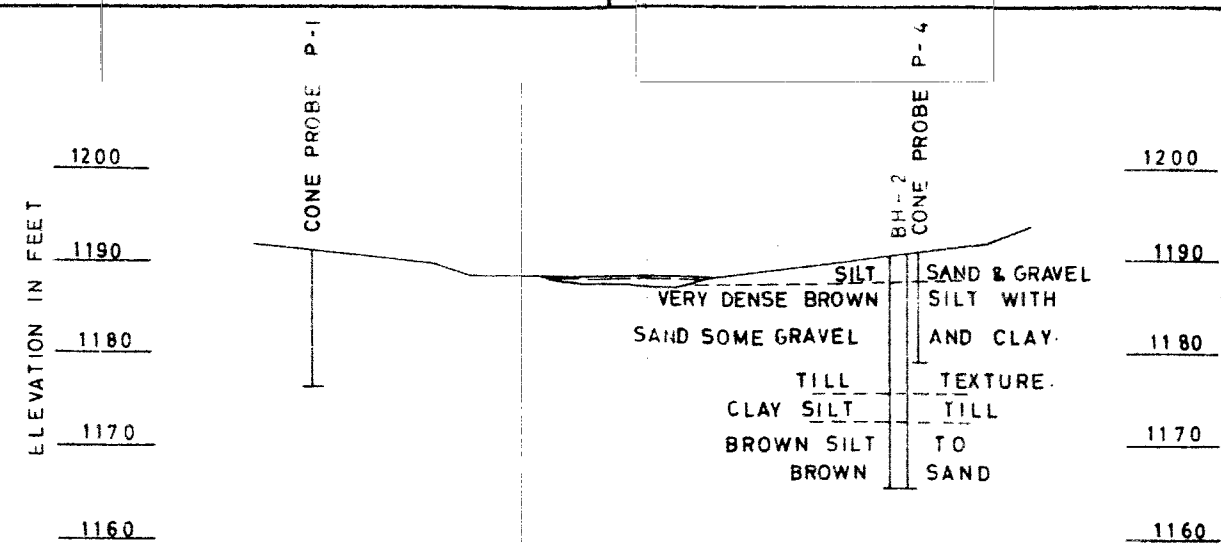
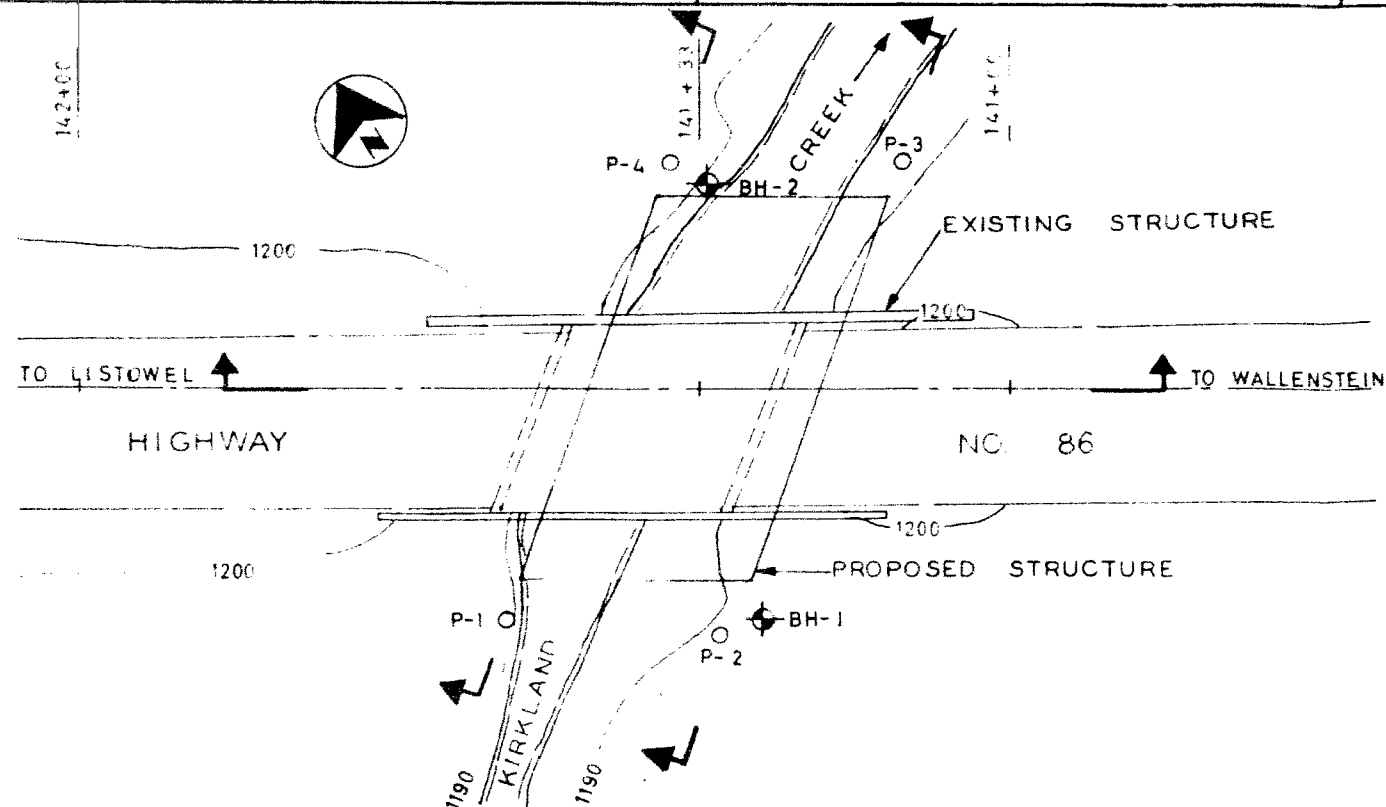
(d) Approach Fills

No stability problems are anticipated with the approach fills for this structure assuming that a granular fill approach embankment will be provided with side slopes of 2 horizontal to 1 vertical.

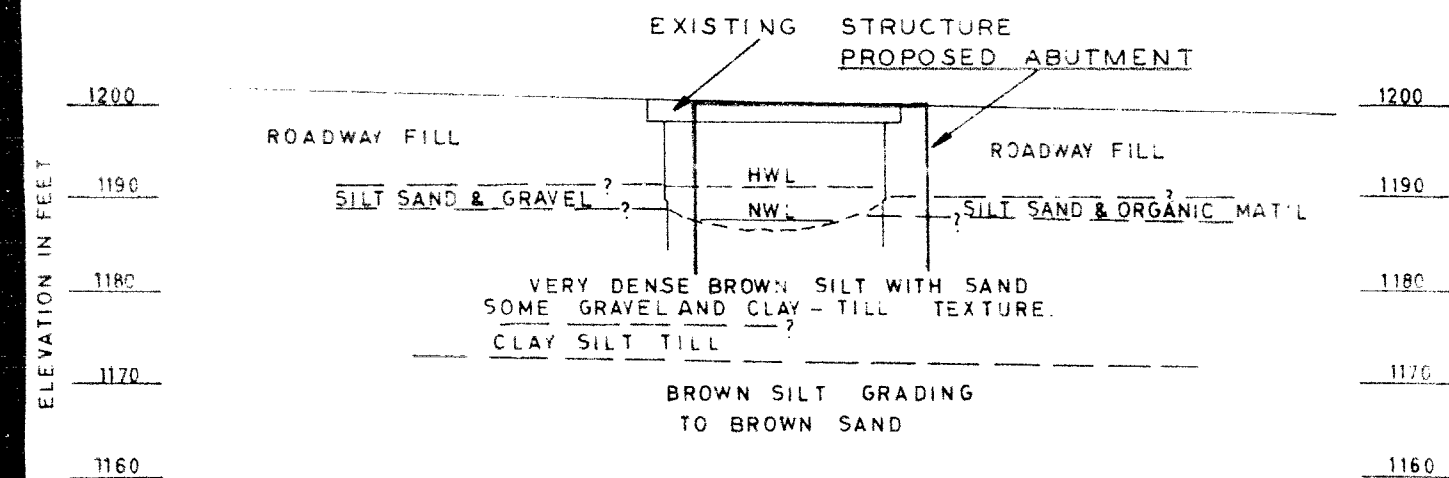


## APPENDIX

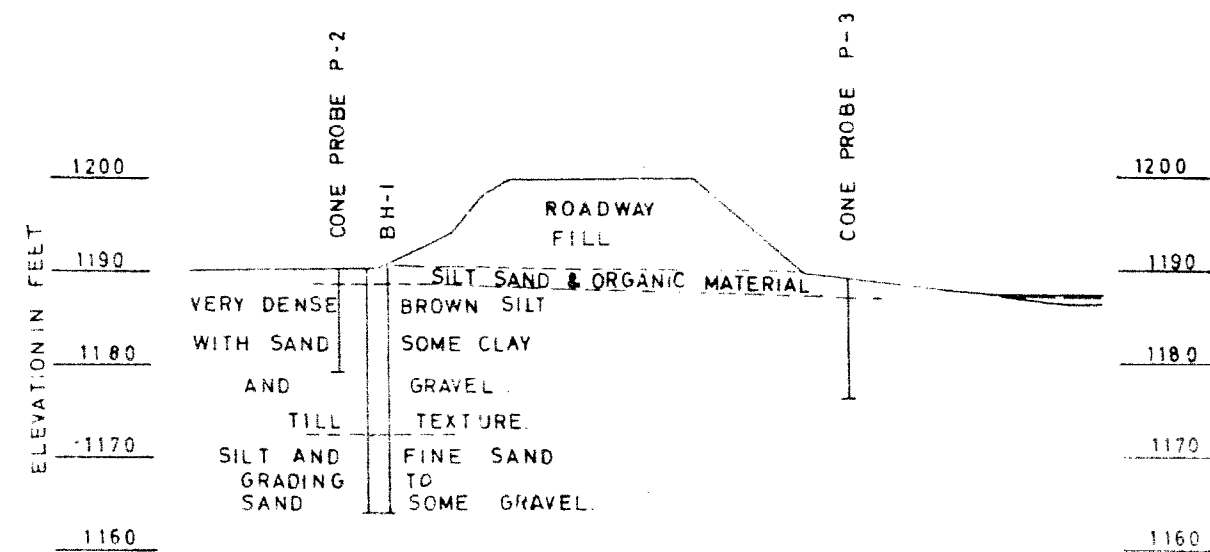
CLIENT DEPARTMENT OF HIGHWAYS - ONTARIO		LEGEND		SCALES		ASSOCIATED GEOTECHNICAL SERVICES	
JOB NO 6213 LOCATION WP 41 - 62		SOIL BORING		HORIZONTAL 1 INCH = 20 FEET		Limited	
PROJECT KIRKLAND CREEK BRIDGE		DYNAMIC CONE PROBE		VERTICAL 1 INCH = 20 FEET		PLAN AND SOIL PROFILES	
DATE FIELD INVESTIGATION APRIL 1962							
DATE REPORT BY CHKD.							



PROBABLE SOILS PROFILE THROUGH WEST ABUTMENT

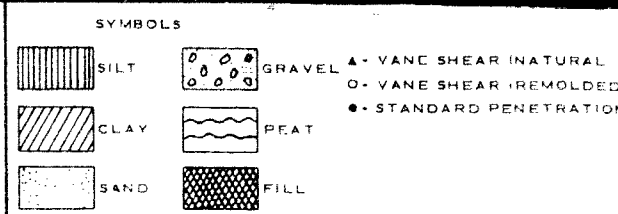


PROBABLE SOILS PROFILE ALONG ROAD CENTRELINE



PROBABLE SOILS PROFILE THROUGH EAST ABUTMENT.

CLIENT: D.H.O.  
 JOB NO. 6213 LOCATION: WP 41-62  
 CO-ORDINATES: CHNG 141+34.8 OFFSET 24' LT.  
 ELEVATION (SURFACE) 1191.4 COLLAR: DATUM D.H.O.  
 DATE (STARTED) 19/4/62 FINISHED: 23/4/62 (COMPILED) R.J.G.  
 RIS. NO. 1 TYPE: BBS-1 FIELD SURV. D.S.O.



**ABBREVIATIONS**

UNDISTURBED: [X symbol]  
 DISTURBED BUT REPRESENTATIVE: [diagonal lines symbol]  
 FAIR: [horizontal lines symbol]  
 LOST: [solid black symbol]

SS - SPLIT SPOON  
 ST - SHELBY TUBE  
 TWP - THIN WALLED PISTON  
 DB - DIAMOND BIT

C - CONSOLIDATION TEST  
 M - MECHANICAL ANALYSIS  
 T - TRIAXIAL COMPRESSION  
 K - PERMEABILITY  
 U - UNCONFINED COMP.  
 PCF - POUNDS PER CUBIC FOOT  
 WN - NATURAL WATER CONTENT

**ASSOCIATED GEOTECHNICAL SERVICES**  
 Limited

**OFFICE BOREHOLE LOG**  
 BOREHOLE NO. 1

BORING LOG				FIELD TESTS			SAMPLING				LABORATORY		TESTS		REMARKS			
DEPTH FEET	DEPTH FEET	ELEVATION FEET	WATER OBSERVATION	DESCRIPTION	SHEAR STRENGTH (TONS PER SQUARE FOOT)		PENETRATION RESISTANCE (BLOWS PER FOOT)	SAMPLE NUMBER	DEPTH		RECOVERY LENGTH REC. DIST. DRIV.	UNIT WEIGHT PCF		ATTERBERG LIMITS				
					STANDARD PENETRATION TEST (BLOWS PER FOOT)				FROM FEET	TO FEET		TYPE	140	150		WP X	WN	20
					2.0	4.0			6.0	8.0								
2	2.0	1188.5	GWL	MEDIUM DENSE BROWN SILT, SOME SAND AND ORGANIC MATERIAL.			6	1	0.0	2.0	SS	14/24			W <sub>n</sub>	X	M	GWL RECORDED 11 DAYS AFTER COMPLETION.
4	3.8	1187.6		DYNAMIC CONE PROBE		18	2	2.0	3.5	SS	16/18			V	V			
6																		DYNAMIC CONE PROBE - HIT BOULDER AT 7.3 ?
8																		
10					VERY DENSE BROWN SILT WITH SAND SOME CLAY AND GRAVEL.			22	3	5.5	7.0	SS	12/18			V	V	V
12					TILL TEXTURE.													
14																		
16																		
18	18.0	1172.5					59	4	10.0	11.0	SS	10/12			V	V		
20				VERY DENSE BEDDED SILT AND FINE SAND GRADING TO VERY DENSE SAND SOME GRAVEL.														CLEAN OUT TOOLS LOST IN HOLE AT 24' - COULD NOT RETREIVE
22																		
24																		
25	25.0	1166.4					45	5	14.7	16.2	SS	18/18			V	V		
26																		
				END OF BOREHOLE			116	6	20.0	21.0	SS	12/12						

BORING LOG					FIELD TESTS		SAMPLING			LABORATORY		TESTS		REMARKS
DEPTH FEET	ELEV. FEET	LOG	DESCRIPTION	SHEAR STRENGTH (TONS PER SQUARE FOOT)	PENETRATION RESISTANCE (BLOWS PER FOOT)	SAMPLE NUMBER	DEPTH FROM FEET	TO FEET	TYPE	RECOVERY LENGTH REC. DIST. DRIV.	UNIT WEIGHT PCF 140 150	ATTERBERG LIMITS WP X 10 WN 20 OWL		
				STANDARD PENETRATION TEST (BLOWS PER FOOT) 2.0 4.0 6.0 8.0										
2.8	1189.1		BROWN SILT, SAND AND GRAVEL.											
4.0			VERY DENSE BROWN SILT WITH SAND SOME GRAVEL AND CLAY. TILL TEXTURE.	DYNAMIC CONE PROBE P-4		23	1	3.0	4.5	SS	16/18		V	V
6.0				24	2	6.0	7.5	SS	10/18			V	V	V
8.0				42	3	10.0	11.5	SS	15/18			V	V	
10.0				51 / 12 22 / 2"	4	14.8	16.1	SS	10/14			V	V	
15.6	1176.3		VERY DENSE BROWN SILT WITH CLAY SOME SAND. TILL TEXTURE.											
17.0	1174.9		VERY DENSE BROWN SILT GRADING TO VERY DENSE BROWN SAND.			134	5	20.0	21.5	SS	10/18			
18.2	1173.7			107	6	24.6	26.1	SS	15/18					
26.1	1165.8		END OF BOREHOLE.											

DYNAMIC CONE PROBE  
REFUSAL 12.0 - 12.9 = 220  
BLOWS.

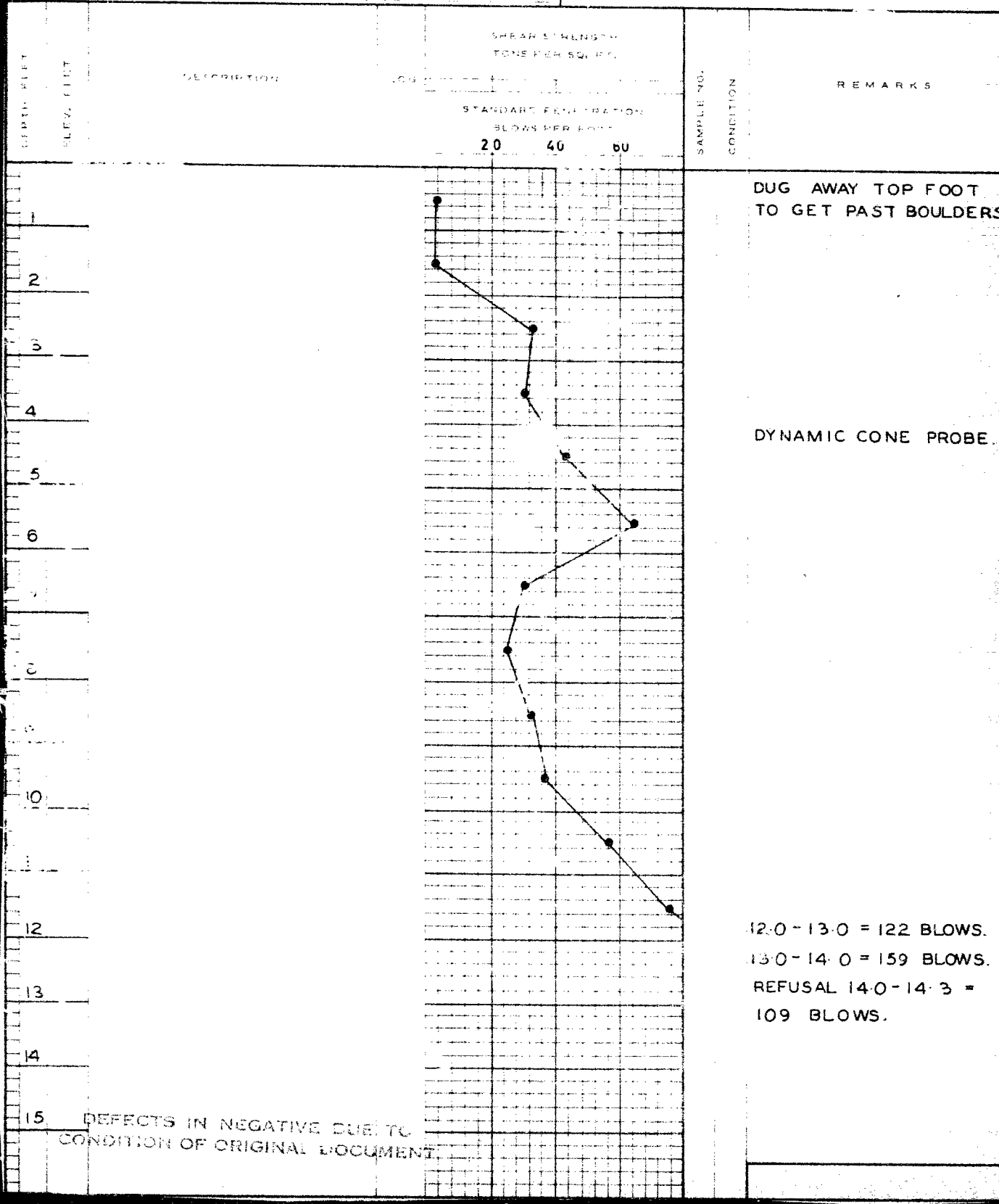
GWL RECORDED 10 DAYS  
AFTER COMPLETION.

SAMPLE 6 LOST - REDROVE  
TO 26.1 RECOVERED 15"

CLIENT **DEPARTMENT OF HIGHWAYS - ONTARIO**  
 JOB NO. **6213** LOCATION **WP 41 - 62**  
 CO-ORDINATES **CHNG 141 +57** OFFSE T **24.4' LT.**  
 ELEVATION (SURFACE) **1192.8** (COLLAR) **DHO**  
 DATE (STARTED) **18/4/62** (FINISHED) **18/4/62** COMPILED **RJG**  
 P.G. NO. **1** TYPE **BBS-1** FIELD SUP. **D.S.O.**

**ASSOCIATED GEOTECHNICAL SERVICES**  
 Limited

**OFFICE BOREHOLE LOG**  
 BOREHOLE NO. **P-1**



DEFECTS IN NEGATIVE DUE TO  
 CONDITION OF ORIGINAL DOCUMENT

CLIENT DEPARTMENT OF HIGHWAYS - ONTARIO.  
 JOB NO. 6213 LOCATION WP - 41 - 62  
 CO-ORDINATES CHNG. 141 + 15 OFFSET 24.4' RT.  
 ELEVATION (SURFACE) 1188.9 (COLLAR) \_\_\_\_\_ DATUM D.H.O.  
 DATE (STARTED) 23/4/62 (FINISHED) 23/4/62 (COMPILED) R J G  
 RIG. NO. 1 TYPE BBS-1 FIELD SUP. \_\_\_\_\_ DSO

ASSOCIATED GEOTECHNICAL SERVICES  
 Limited

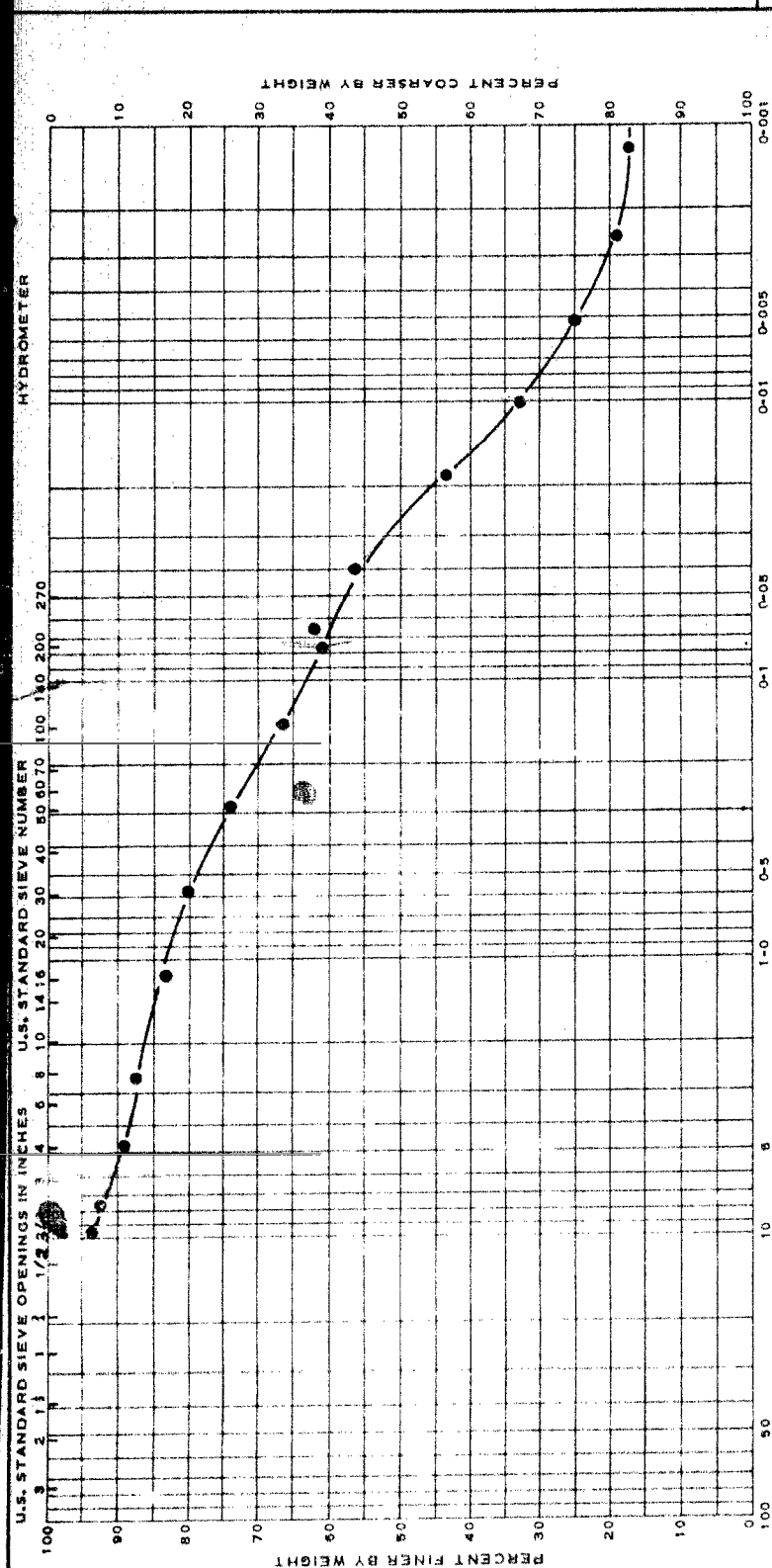
OFFICE BOREHOLE LOG  
 BOREHOLE NO. P-3

DEPTH FEET	ELEV. FEET	DESCRIPTION	LOG	SHEAR STRENGTH TONS PER SQ. FT.			SAMPLE NO.	CONDITION	REMARKS
				STANDARD PENETRATION BLOWS PER FOOT					
				20	40	60			
1									
2									
3									
4									
5									
6									
7									
8									
9									
10									
11									
12									
13									

DYNAMIC CONE PROBE	
7.0 - 8.0 = 85 BLOWS.	
8.0 - 9.0 = 91 BLOWS.	
9.0 - 10.0 = 100 BLOWS.	
10.0 - 11.0 = 135 BLOWS.	
11.0 - 12.0 = 139 BLOWS.	
REFUSAL 12.0 - 13.0 = 185 BLOWS.	

DYNAMIC CONE PROBE

7.0 - 8.0 = 85 BLOWS.  
 8.0 - 9.0 = 91 BLOWS.  
 9.0 - 10.0 = 100 BLOWS.  
 10.0 - 11.0 = 135 BLOWS.  
 11.0 - 12.0 = 139 BLOWS.  
 REFUSAL 12.0 - 13.0 = 185 BLOWS.

CLIENT DEPARTMENT OF HIGHWAYS - ONTARIOJOB. NO. 6213 LOCATION WP 41-62BOREHOLE NUMBER 1 DEPTH 5.5 - 7.0SAMPLE NUMBER 3 DATE MAY 2/62ASSOCIATED GEOTECHNICAL SERVICES  
LimitedSOIL MECHANICS LABORATORY  
MECHANICAL ANALYSIS

GRAIN SIZE IN MILLIMETERS

M.I.T. CLASSIFICATION

STONES	GRAVEL		SAND		SILT		CLAY	
	COARSE	FINE	COARSE	FINE	COARSE	FINE	COARSE	FINE

CLASSIFICATION

SILT, WITH SAND, SOME  
CLAY AND GRAVEL.

14% GRAVEL

27% SAND

40% SILT

19% CLAY

SOIL MECHANICAL ANALYSIS

BOREHOLE - 1 DEPTH - 5.5 - 7.0

CLIENT **DEPARTMENT OF HIGHWAYS - ONTARIO**

**ASSOCIATED GEOTECHNICAL SERVICES**  
Limited

JOB. NO. **6213**

LOCATION **WP 41 - 62**

BOREHOLE NUMBER

**2**

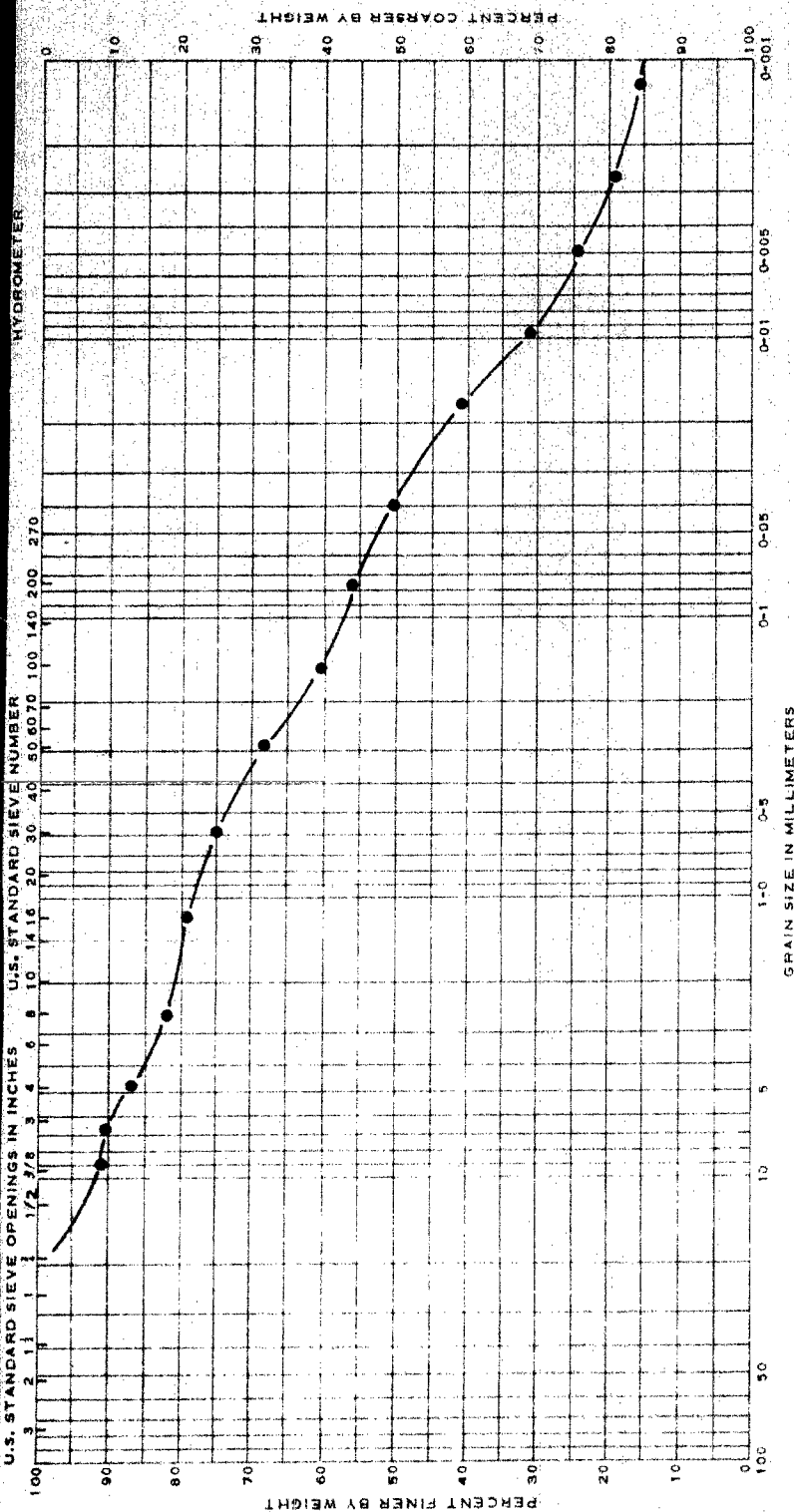
DEPTH

SAMPLE NUMBER

**2**

DATE **MAY 2/62**

**SOIL MECHANICS LABORATORY**  
**MECHANICAL ANALYSIS**



M.I.T. CLASSIFICATION

STONES	GRAVEL		SAND		SILT		CLAY
	COARSE	FINE	COARSE	FINE	COARSE	FINE	

CLASSIFICATION

**SILT WITH SAND, SOME GRAVEL  
AND CLAY.**

**19% GRAVEL.**  
**27% SAND**  
**36% SILT**  
**18% CLAY**

SOIL MECHANICAL ANALYSIS

BOREHOLE - **2**

DEPTH -



## SOIL CLASSIFICATION SYSTEM

The following system was used to describe the various soils encountered at the site as determined by visual field examination and test. It was also used to classify those soils upon which a laboratory grain size determination had been made.

<u>Soil Components</u>	<u>Particle Size</u>
Clay	$< .002$ mm
Silt	$> .002$ mm $< .06$ mm
Sand	$> .06$ mm $< 2.0$ mm
Gravel	$> 2.0$ mm $< 2$ in.
Cobbles	$> 2$ in. $< 6$ in.
Boulders	$> 6$ in.

<u>Descriptive Terms</u>	<u>Range of Proportions</u>
and	greater than 40%
with	25% to 40%
some	10% to 25%
trace	less than 10%

### Example

1. Silt (predominant type) with (25% - 40%) sand.
2. Sand and silt (predominant types), some (10% - 25%) gravel, trace ( $< 10\%$ ) clay.

CLIENT \_\_\_\_\_

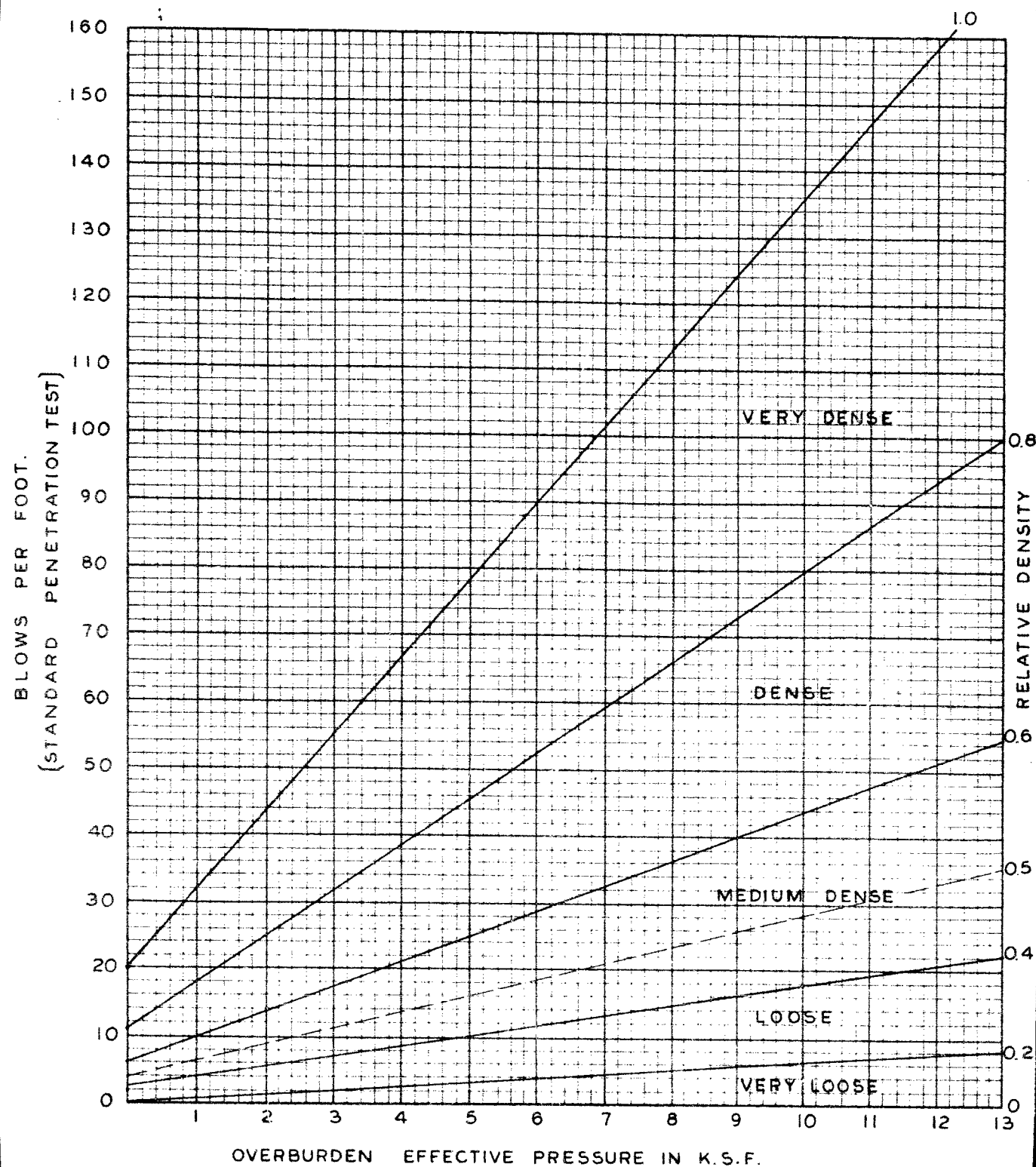
JOB NO. \_\_\_\_\_ LOCATION \_\_\_\_\_

BOREHOLE NUMBER \_\_\_\_\_ DATE \_\_\_\_\_

SAMPLE NUMBER \_\_\_\_\_ DEPTH \_\_\_\_\_

ASSOCIATED GEOTECHNICAL SERVICES  
Limited

SOIL MECHANICS LABORATORY  
DENSITY CHART



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

25-64-123  
May 30, 1962.

FOUNDATION INVESTIGATION REPORT  
By: Associated Geotechnical  
Services, Ltd.

Re: (W.P. 41-62) Highway 36,  
Kirkland Creek, 4.6 Mi. W. of Elmira,  
District No. 3, Stratford, Ontario.

Attached, we are sending you the above-mentioned report prepared by the Consultant, Associated Geotechnical Services, Ltd. We have reviewed the report and have found the factual information adequate and well presented.

In his report, the consultant has presented a table giving different bearing values for different footing widths. It is our opinion that such a refinement is not justified, considering the averaging of the penetration test results and the approximate method used for bearing capacity calculations. It is recommended that a value of 4.5 Kips/sq.ft. be used, irrespective of footing width, provided normal design standards are used.

AGS/MceP

Attach.

cc: Messrs. A. M. Toye (2)  
H. A. Freganekes  
H. D. McMillan  
A. Gater  
L. D. Berrett  
J. Roy  
T. J. Kovich  
J. E. Gruspiar  
A. B. Saint  
F. Norman  
A. Watt  
Foundations Office  
Gen. Files.

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

Phone call from Bill Hashizumi  
April 4, 1963

Q: What is the allowable pressure  
at elevation 1183?

A: 4.5 k/sq ft can be used

Reason:

This elevation is already in very  
dense till. Footing width is 6-7 ft.

The consultant arrived at elev. 1182 on the  
basis of scour depth and having 5 ft  
of overburden.

Note:

Elevation 1183 should be also considered  
from the hydrology point of view

April 4, 1963

Afternoon