

# 66-F-282 M

KILBOURNE BRIDGE

LOTS 72/73

WEST OF N. BRANCH

TALBOT RD

WESTMINSTER TWP.

BA 2238  
FRED. A. BELL AND ASSOCIATES  
17 HINCKS ST  
ST. THOMAS ONTARIO

Report on  
SOIL INVESTIGATION  
for  
KILBOURNE BRIDGE  
LOTS 72 & 73, WEST OF N. BRANCH  
OFF TALBOT ROAD  
TOWNSHIP OF WESTMINSTER

66-282M

by  
DOMINION SOIL INVESTIGATION LIMITED  
369 Queens Avenue  
LONDON ONTARIO

Reference No. 5-11-L8  
January 4th, 1966

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SUMMARY

The two boreholes revealed that the natural soil consists of generally granular fluvio-glacial deposits increasing in relative density from loose to very dense with depth, overlying hard glacial clay till.

It is recommended that the structure be supported on spread footings at or below El. 85 using a maximum net soil pressure of 8000 pounds per square foot. It is estimated that total settlement of the structure will not exceed 1-inch.

Dewatering problems are discussed.

## I INTRODUCTION

Verbal authorization was received from Fred. A. Bell and Associates, consulting engineers, to carry out a soil investigation at a site in the Township of Westminster where it is proposed to replace an existing road bridge with a new structure.

The existing structure is located on the road allowance between Lots 72 and 73, west of the north branch of Talbot Road where the road crosses Dingman Creek.

It is understood that the proposed structure is a concrete rigid-frame with about a 60 foot span. The longitudinal and transverse centre lines will be the same as the existing bridge. The requirements of the project were discussed with Mr. R. L. Lemon who supplied the foregoing information.

The purpose of this investigation was to reveal the subsurface conditions at the site and to determine the relevant soil properties for the design and construction of the new foundations.

## II FIELD WORK

The field work, consisting of 2 boreholes, was carried out on November 30 and December 1, 1965, at the locations shown on Enclosure 2. The holes were advanced by washboring methods, and were lined with Bx casing.

Standard Penetration Tests using a 2-inch outside diameter split-spoon sampler were performed at frequent intervals of depth, using a driving force of a 140 lb. hammer falling freely through 30-inches. The tube is first driven an initial 6-inches to allow for the presence of disturbed material at the bottom of the borehole. The number of standard blows required to drive the sampler a further 12-inches was recorded as the standard penetration resistance (or 'N' value). This test determines the relative density of granular strata and gives an indication of the consistency of cohesive strata. It also enables samples to be obtained for classification purposes.

A falling head permeability test was performed with the casing at a depth of 21 feet 8-inches in borehole 1 to determine the coefficient of permeability of the soil.

Dynamic cone penetration tests were performed adjacent to each borehole location to obtain an indication of the soil density changes with depth.

The results of the field tests are presented on the Geotechnical Data Sheets, Enclosures 3 and 4. Elevations were referred to a site benchmark which has been given the arbitrary value El. 100 feet. (Nail in hydro pole at northwest corner of existing structure, see Enclosure 2).

### III LABORATORY TESTS

Grain size analyses were performed on 4 samples of the natural soil to determine the grading and to obtain an indication of the permeability. The results are presented graphically on Enclosures 5, 6, 7 and 8.

### IV SUBSURFACE CONDITIONS

Detailed descriptions of the strata encountered in each borehole are given on the Geotechnical Data Sheets, comprising Enclosures 3 and 4, and a general picture of the soil stratigraphy is given in the form of a Subsurface Profile on Enclosure 2.

Both boreholes penetrated a layer of fill material associated with the construction of the approaches to the existing bridge. The fill is made up of silty sand containing gravel size particles and is generally in a 'loose' condition.

Natural soil was encountered at El. 93<sup>±</sup> in both boreholes and consists of fluvio-glacial deposits which extend down to El. 78 in borehole 1 and El. 86 in borehole 2. At borehole 1 location the material varies in grain size and can be classified as successive layers or lenses of silt, gravelly sand and silt, clayey silt and silty clay, and fine to coarse sand and fine gravel. At borehole 2 location the deposit is more uniform and generally consists of silty fine and medium sand, although a layer of gravel was encountered at El. 90. The relative density of the granular material increases rapidly with depth and is described as 'loose' to 'very dense' as estimated from standard penetration test results ranging from 9 to 127 blows per foot. The layer or lens of clayey silt and silty clay encountered in borehole 1 is described as 'very stiff' as indicated by a standard penetration test result of 15 blows per foot.

Underlying the fluvio-glacial deposits, both boreholes penetrated into a glacial deposit consisting of silt and clay-size particles with traces of sand and fine gravel. A visual and tactile examination of the soil indicates that it is a clay of low plasticity and compressibility with the natural moisture content about the same as the Plastic Limit of the soil. The consistency is described as 'hard' as indicated by standard penetration test results ranging from 38 blows per foot to a refusal value of 175 blows for 10-inch penetration. Both boreholes were terminated in the clay till stratum.

### V GROUNDWATER CONDITIONS

Groundwater levels were recorded at El. 92.7 in borehole 1 and at El. 97.1 in borehole 2. The water level in borehole 1 was about 1 foot higher than the water level in the creek whereas the higher level in borehole 2 can be attributed to the higher ground and consequent rise in the water table on the east side of the bridge.

VI DISCUSSION

The natural soil consists of generally granular fluvio-glacial deposits increasing in relative density from loose to very dense with depth, overlying hard glacial clay till which probably extends to a considerable depth.

The bed of the creek extends to El. 89 and allowing for scour it is recommended that footings should bear at or below El. 85. This level lies at the interface between the silty clay and the sand and gravel strata at borehole 1 location and within the hard clay till at borehole 2 location and on the basis of the borehole results a maximum net soil pressure of 8000 pounds per square foot will be appropriate for the design of footings. Furthermore the footings will have a factor of safety at least 3 against shear failure of the underlying soil.

The footing depth should be decided after a hydrological study has been made to determine the maximum depth of scour. It would appear that due to the bend in the river, the maximum scour will take place on the east side of the bridge and in this respect the hard clay till will provide a better protection against scour than the granular deposits on the west side.

It is estimated that total settlement of the structure will not exceed 1-inch, and in view of the different types of subsoil beneath each abutment and the longer time required for the clay to consolidate, it is anticipated that differential settlement between abutments will occur, although this will not exceed  $3/4$  inch.

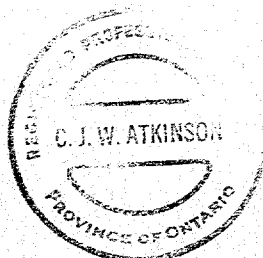
The coefficient of friction between the west abutment and the sand and gravel stratum may be taken as 0.45 and the adhesion between the east abutment and the clay till may be taken as 2000 p.s.f. The factor of safety against horizontal sliding of the abutments should be at least 1.5 in each case.

A major problem in construction of the footings will be to control the groundwater and prevent a flow of water and subsoil into the excavations from the water-bearing granular strata. To prevent this it will be necessary to brace the sides of the excavation with timber sheeting which should be driven into the impervious clay till stratum. Seepage could then be accumulated in sumps dug below the footing grade and removed by pumping.

Yours very truly,

DOMINION SOIL INVESTIGATION LIMITED

*C.J.W. Atkinson*  
C.J.W. Atkinson, M.Sc., P.Eng.,  
Branch Manager



CJWA:jms

Enclosures



# LIST OF SYMBOLS, ABBREVIATIONS AND NOMENCLATURE.

## SOIL COMPONENTS AND GROUND WATER CONDITIONS.

BOULDER	COBBLE	GRAVEL		SAND			SILT	CLAY	ORGANICS	BEDROCK	GROUND WATER LEVEL	DEPTH OF CAVE-IN
		COARSE	FINE	COARSE	MEDIUM	FINE						
Ø > 8"	3"	3/4"	4.75mm	2.0	0.42	0.074	0.002	>	NO SIZE LIMIT			
U.S. Standard Sieve Size:		No. 4	No. 10	No. 40	No. 200							

## SAMPLE TYPES.

AS Auger sample	RC Rock core	TP Piston, thin walled tube sample
CS Sample from casing	% Recovery	TW Open, thin walled tube sample
ChS Chunk sample	SS Split spoon sample	WS Wash sample

SAMPLER ADVANCED BY static weight : w  
 " pressure : p  
 " tapping : t

OBSERVATIONS  
 MADE WHILE  
 CORING

Steady pressure  
 No pressure  
 Intermittent pressure

Washwater returns  
 Washwater lost

## PENETRATION RESISTANCES.

DYNAMIC PENETRATION RESISTANCE : to drive a 2" Ø, 60° cone attached to the end of the drilling rods into the ground, expressed in blows per foot.

STANDARD PENETRATION RESISTANCE, -N- : to drive a 2" outside dia. split spoon sampler 1 foot into the ground, expressed in blows per foot.

### EXTRAPOLATED -N- VALUE

The energy for the penetration resistances is supplied by a 140 lb. hammer falling 30 inches

SYMBOL:

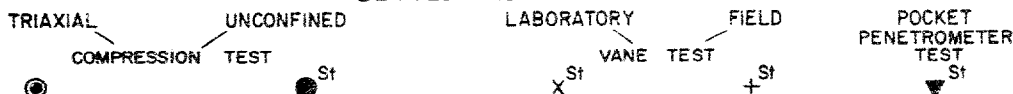
322

## SOIL PROPERTIES.

W % Water content	γ Natural bulk density (unit weight)	k Coeff. of permeability
LL % Liquid limit	e Void ratio	C Shear strength in terms of total stress
PL % Plastic limit	RD Relative density	φ Angle of int. friction in terms of effective stress
PI % Plasticity index	Cv Coeff. of consolidation	C' Cohesion
LI Liquidity index	m <sub>v</sub> Coeff. of volume compressibility	φ' Angle of int. friction

## UNDRAINED SHEAR STRENGTH.

— DERIVED FROM —



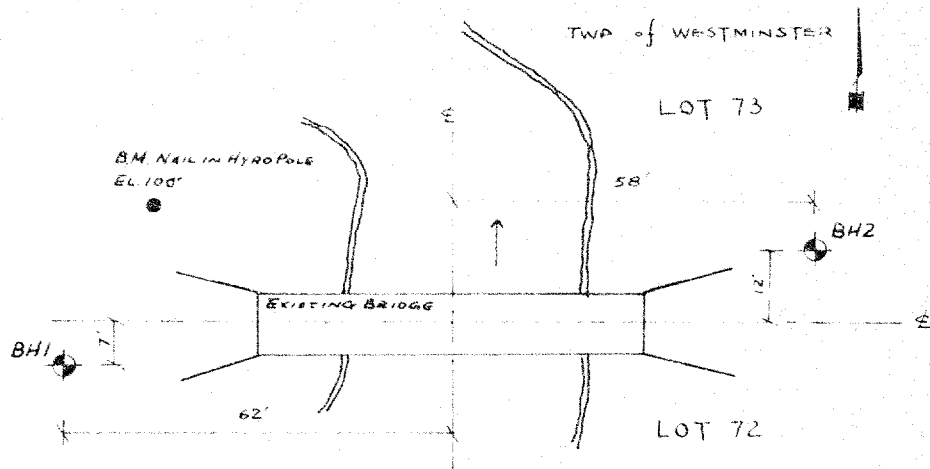
Strain at failure is represented by direction of stem

20%  
 15% + 5%  
 10%

St : sensitivity =  $\frac{\text{shear strength in undisturbed state}}{\text{shear strength in remoulded state}}$

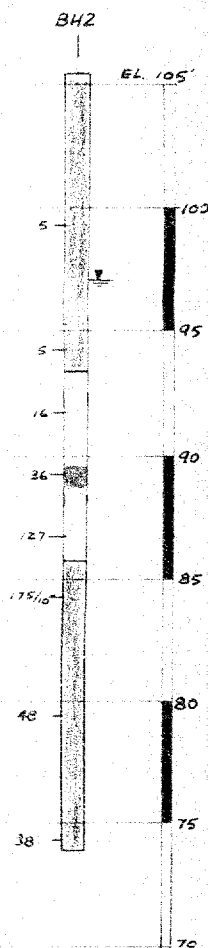
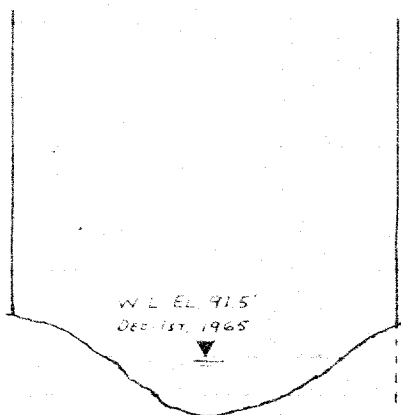
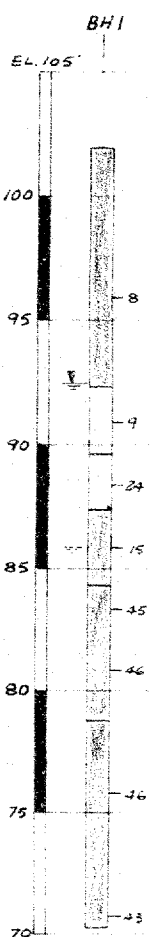
## SOIL DESCRIPTION.

COHESIONLESS SOILS :	RD :	COHESIVE SOILS :	C lbs./sq.ft.
Very loose	0 - 15 %	Very soft	less than 250
Loose	15 - 35 %	Soft	250 - 500
Compact	35 - 65 %	Firm	500 - 1000
Dense	65 - 85 %	Stiff	1000 - 2000
Very dense	85 - 100 %	Very stiff	2000 - 4000
		Hard	over 4000



LOCATION OF BOREHOLES  
SCALE 1" = 20'

- FILL
- SAND & SILT
- SAND & GRAVEL
- SILTY CLAY & CLAYEY SILT
- SILTY CLAY, TILL



SUBSURFACE PROFILE  
VERT SCALE 1" = 5'

# GEOTECHNICAL DATA SHEET FOR BOREHOLE 1

OUR REFERENCE NO. 5-11-18

CLIENT Fred. A. Bell & Associates  
 REQUEST Kilbourne Bridge  
 LOCATION Lots 72-73 Westminster Twp.  
 DATUM ELEVATION 100 feet (See Enclosure 2)

DEPTH OF BOREHOLE Washboring  
 DIAMETER OF BOREHOLE 8x (3-inch)  
 DATE November 30, 1965

ENCLOSURE NO. 3

ELEVATION H FT	DEPTH H FT	STRATIFICATION DESCRIPTION	SWATCHES ON SAMPLE	SAMPLES			PENETRATION RESISTANCE BLASTING UNIT					REMARKS
				NUMBER	TYPE	TEST	20	40	60	80	100	
101.9	0.0	Ground Surface										
95		Loose brown silty sand, some gravel.  (Fill)		1	SS	8						
90	9.5	Loose brown silt, trace of fine sand.		2	SS	9						
	12.3	Compact gravelly sand & silt.		3	SS	24						
85	14.5	Very clayey stiff silt grey silty clay.		4	SS	15						
	17.4	Dense grey fine to coarse sand and fine gravel		5	SS	45						
80	25.5	Hard grey silty clay, trace of sand & fine gravel. (Glacial Till)		7	SS	46						
70	31.5	End of Borehole		8	SS	43						

W.L.  
 St. 92.7  
 Dec 6,  
 1965.

Cave-in  
 11. 85.9  
 Dec 1,  
 1965.

Permeability  
 Test.  
 Casing at 21'-8"  
 $K=6 \times 10^{-4}$  cm/sec

# GEOTECHNICAL DATA SHEET FOR BOREHOLE 2

OUR REFERENCE NO. S-11-L8

CLIENT Fred. A. Bell & Associates  
 PROJECT Kilbourne Bridge, No. 61  
 LOCATION Lots 72-73 Westminster Twp.  
 DATUM ELEVATION 100 feet (See Enclosure 2)

WATERLOGGED BOREHOLE Washboring  
 DIAMETER OF BOREHOLE 8x (3-inch)  
 DATE December 1, 1965

ENCLOSURE NO. 4

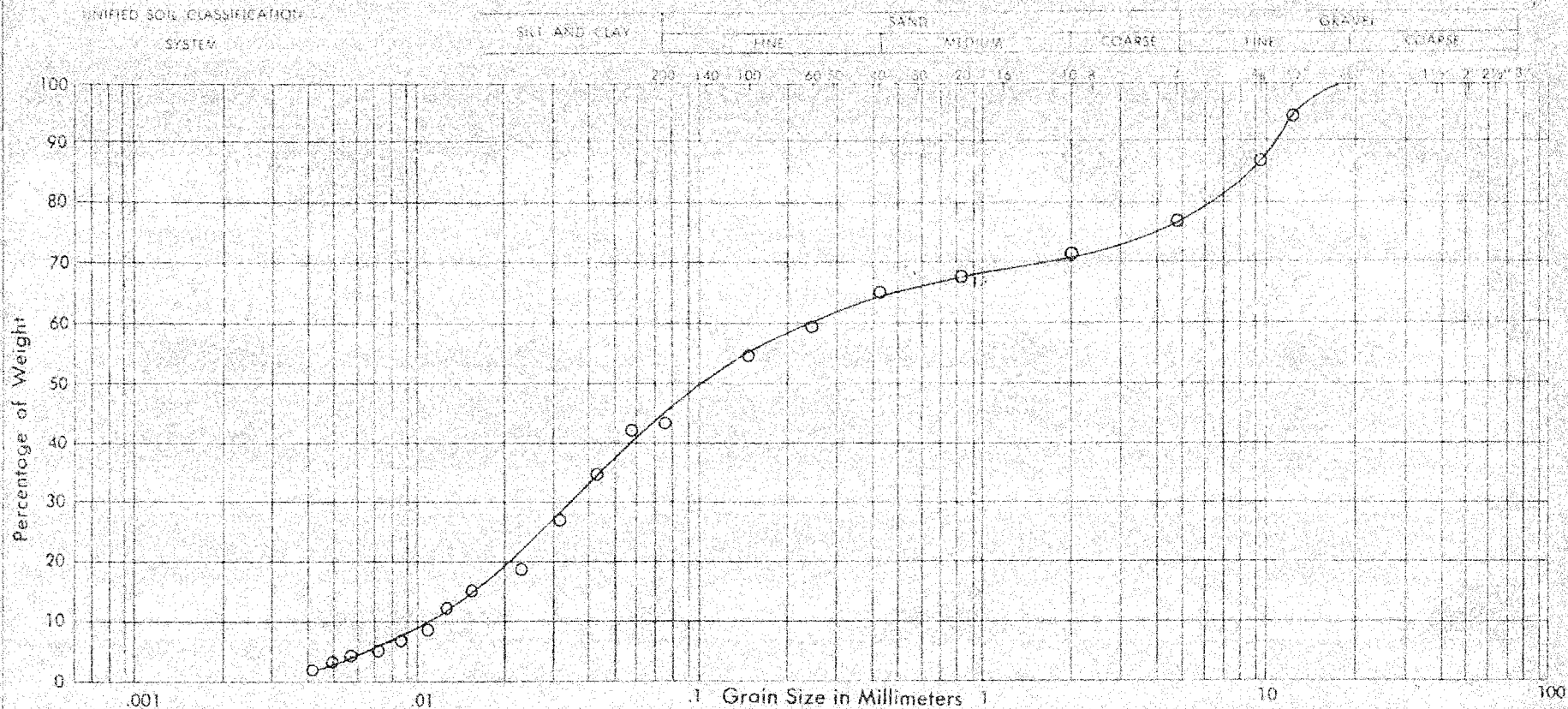
ELEVATION ft.	DEPTH ft.	STRATIFICATION DESCRIPTION	STRATIFICATION SAMPLES	PENETRATION RESISTANCE (Blows per foot)					CONSISTENCY with content	REMARKS
				20	40	60	80	100		
105.4	0.0	Ground Surface								
		Loose brown silty sand, trace of gravel.								
100			1	SS	5					
		(Fill)								
95			2	SS	5					
12.0		Compact to very dense grey silty gravelly fine & medium sand.	3	SS	16					
90			4	SS	36					
			5	SS	127					
19.5		Hard grey silty clay, trace of sand and fine gravel (Glacial Till)	6	SS	175/	10"				
85			7	SS	48					
80										
75			8	SS	32					
51.5		End of Borehole								

W.L.  
 El. 97.1  
 Dec 1,  
 1965.

# DOMINION SOIL INVESTIGATION LIMITED

## GRAIN SIZE DISTRIBUTION

OUR REFERENCE NO. **5-11-L8**



PROJECT: **Kilbourne Bridge**

LOCATION: **Lambeth**

BOREHOLE NO. **1**

SAMPLE NO. **3**

DEPTH OF SAMPLE **12 feet 6 inches**

ELEVATION OF SAMPLE **89 feet**

COEFFICIENT OF UNIFORMITY **25**

COEFFICIENT OF CURVATURE

**Classification of Sample and Group Symbol:**  
**GRAVELLY FINE TO COARSE SAND AND SILT.**

PLASTIC PROPERTIES

LIQUID LIMIT % **—**

PLASTIC LIMIT % **—**

PLASTICITY INDEX % **—**

MOISTURE CONTENT % **—**

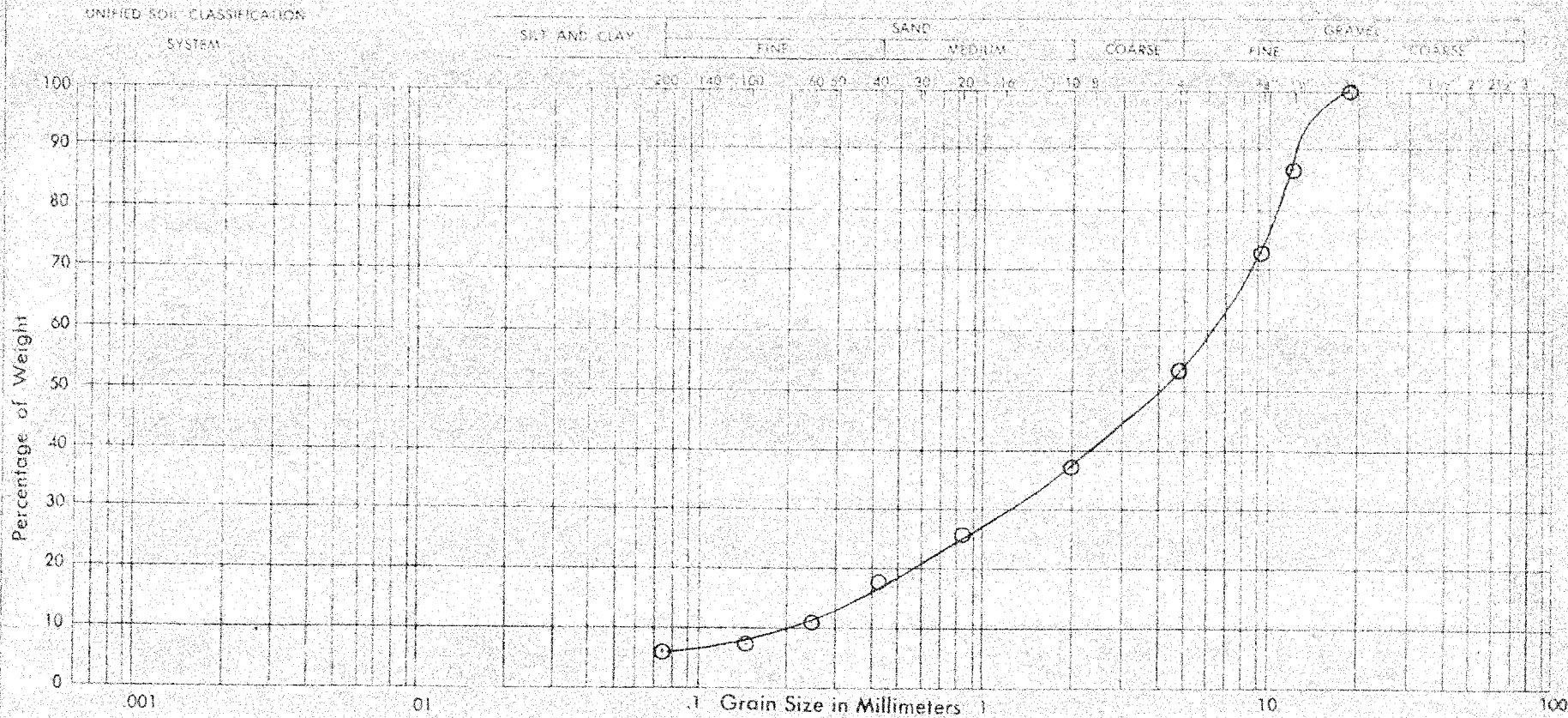
ACTIVITY **—**

Enclosure No. **5**

# DOMINION SOIL INVESTIGATION LIMITED

## GRAIN SIZE DISTRIBUTION

OUR REFERENCE NO. 5-11-L8



PROJECT: **Kilbourne Bridge**  
 LOCATION: **Lambeth**  
 BOREHOLE NO.: **1**  
 SAMPLE NO.: **6**  
 DEPTH OF SAMPLE: **20 feet**  
 ELEVATION OF SAMPLE: **81 feet**

COEFFICIENT OF UNIFORMITY **31**  
 COEFFICIENT OF CURVATURE

Classification of Sample and Group Symbol:  
**PINE GRAVEL AND FINE TO COARSE  
 SAND, TRACE OF SILT.**

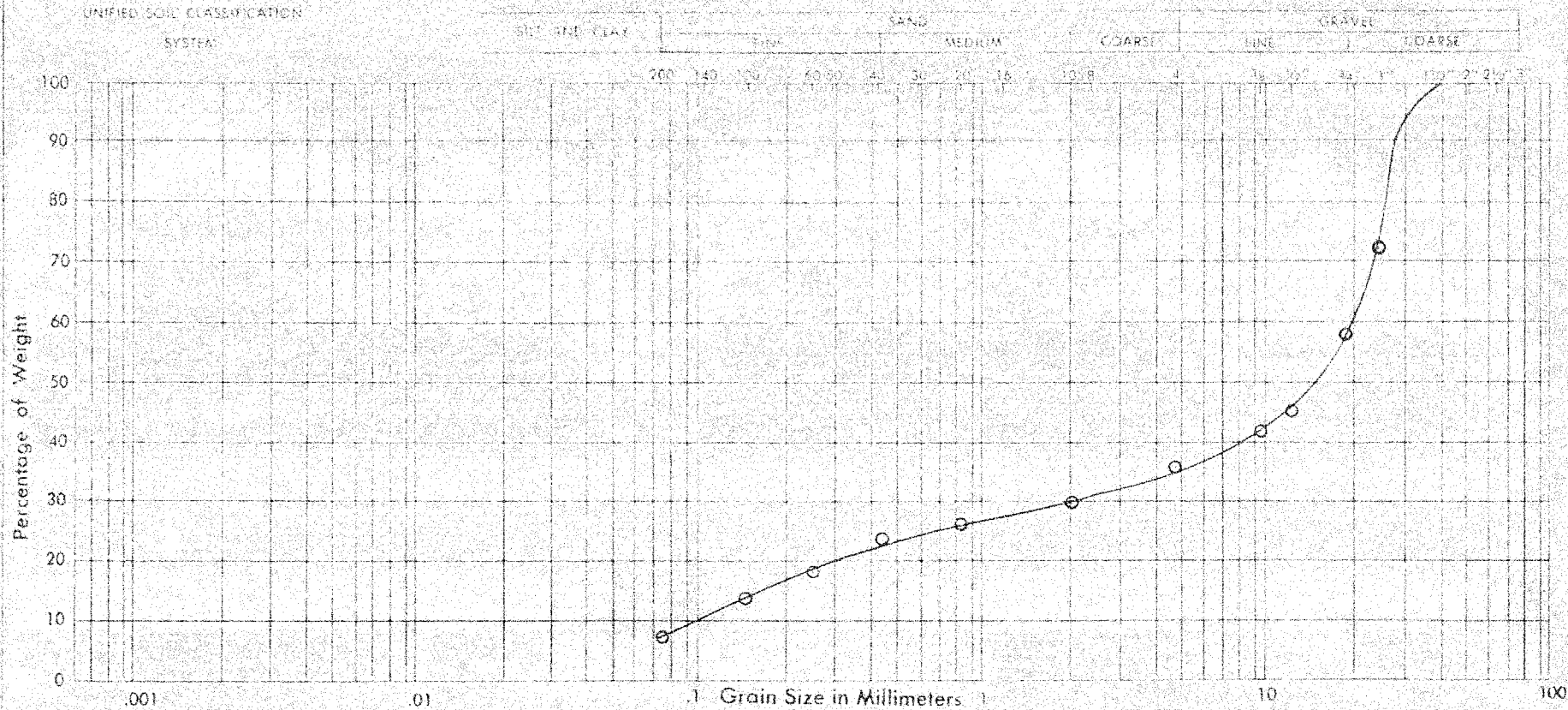
PLASTIC PROPERTIES:

LIQUID LIMIT	%	==
PLASTIC LIMIT	%	==
PLASTICITY INDEX	%	==
MOISTURE CONTENT	%	==
ACTIVITY		

# DOMINION SOIL INVESTIGATION LIMITED

## GRAIN SIZE DISTRIBUTION

OLD REFERENCE NO 5-11-18



PROJECT **Kilbourne Bridge**  
 LOCATION **Lambeth**  
 BOREHOLE NO. **2**  
 SAMPLE NO. **4**  
 DEPTH OF SAMPLE **15 feet**  
 ELEVATION OF SAMPLE **90 feet**

COEFFICIENT OF UNIFORMITY **200**  
 COEFFICIENT OF CURVATURE

Classification of Sample and Group Symbol:  
**SANDY FINE TO COARSE GRAVEL WITH  
 A TRACE OF SILT.**

PLASTIC PROPERTIES:

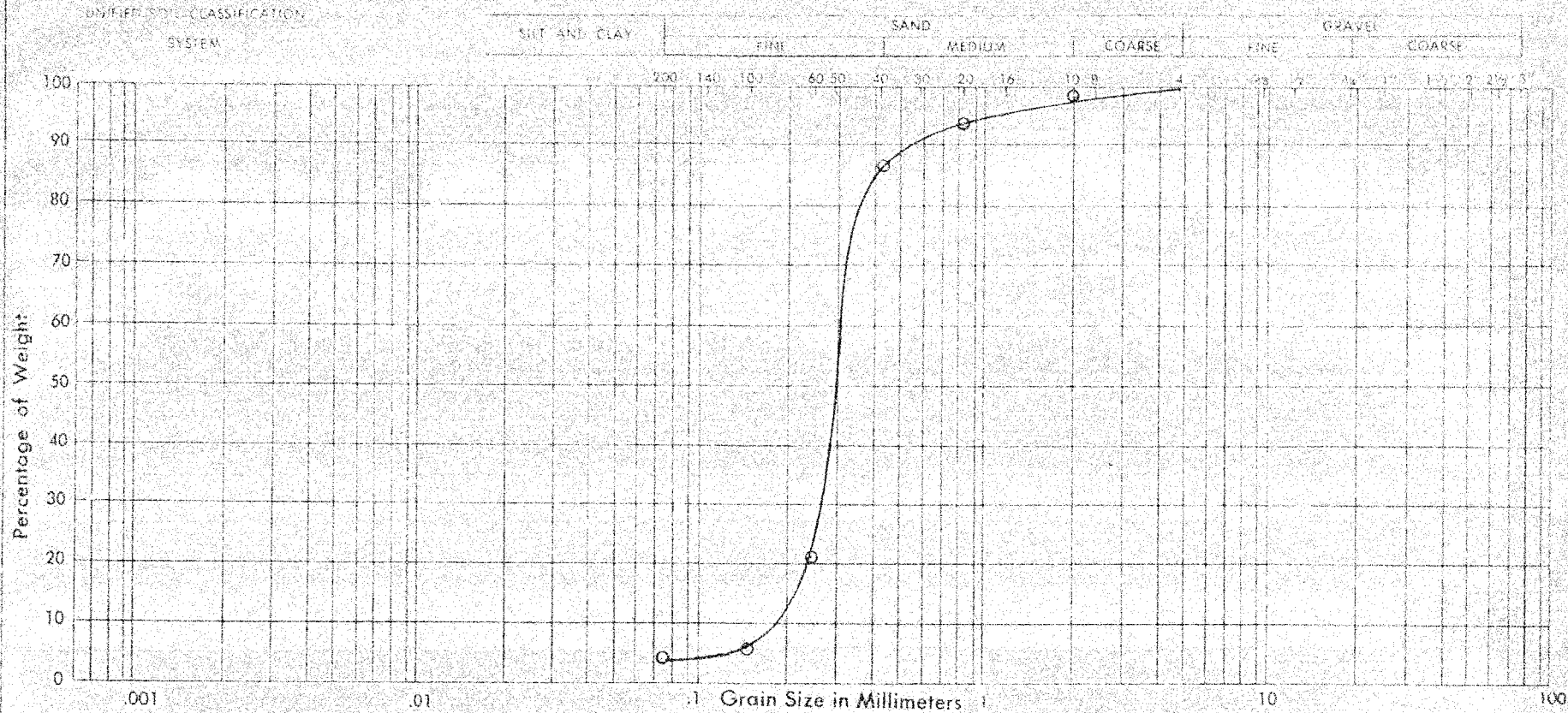
LIQUID LIMIT	%	=
PLASTIC LIMIT	%	=
PLASTICITY INDEX	%	=
MOISTURE CONTENT	%	=
ACTIVITY		=



# DOMINION SOIL INVESTIGATION LIMITED

## GRAIN SIZE DISTRIBUTION

OUR REFERENCE NO. 5-11-L8



PROJECT: **Kilbourne Bridge**  
 LOCATION: **Lambeth**  
 BOREHOLE NO.: **2**  
 SAMPLE NO.: **5**  
 DEPTH OF SAMPLE: **17 feet 6 inches**  
 ELEVATION OF SAMPLE: **87 feet**

COEFFICIENT OF UNIFORMITY: **1.6**  
 COEFFICIENT OF CURVATURE

**Classification of Sample and Group Symbol:**  
**FINE TO MEDIUM SAND WITH A TRACE OF SILT.**

PLASTIC PROPERTIES:

LIQUID LIMIT	%	==
PLASTIC LIMIT	%	==
PLASTICITY INDEX	%	==
MOISTURE CONTENT	%	==
ACTIVITY		==