

66 - F - 284 M

ARTHUR STREET

BRIDGE

ELMIRA TOWN

B.A. 2397

McCARGAR & HACHBORN LIMITED
CONSULTING ENGINEERS
546 BELMONT AVENUE WEST
KITCHENER ONTARIO

66-F-284M

Report on
SOIL INVESTIGATION
for
ARTHUR STREET BRIDGE
TOWN OF ELMIRA
COUNTY OF WATERLOO

by
DOMINION SOIL INVESTIGATION LIMITED
369 Queens Avenue
LONDON ONTARIO

Reference No. 6-7-L9
August 18th, 1966.

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SUMMARY

The two boreholes showed the following ground succession:- silt, sand and clay fill (9'-0" to 10'-6" thick); peaty sand and gravel (2'-6" to 3'-0" thick); compact to very dense glacial sand and silt (6'-6" to 11'-0" thick); and very dense silty fine sand (7'-6" maximum penetrated).

It is recommended that the structure be supported on spread footings at or below El. 1135.5 using a maximum net soil pressure of 8000 pounds per square foot. Total settlement is estimated to be less than 3/4 inch.

I INTRODUCTION

In accordance with a letter of authorization from McCargar And Hachborn, consulting engineers, dated July 20, 1966, a soil investigation has been carried out in the County of Waterloo where it is proposed to replace an existing road bridge with a new structure.

The existing structure is located on Arthur Street in the Town of Elmira where the road crosses the Canagagigue Creek.

It is understood that the proposed structure has a span of about 60 feet and that the transverse centre line will be the same as the existing bridge.

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 July 28 and 29, 1966, 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 diameter split-spoon sampler were performed at frequent intervals of depth. The number of blows required to drive the sampler one foot (after an initial penetration of 6-inches) using an energy of 350 foot pounds per blow, were recorded as the standard penetration resistance (or N_6 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.

The results of the field tests are presented on the Geotechnical Data Sheets, Enclosures 3 and 4. Elevations were referred to the top of hydrant on Riverside Drive West which has the elevation 1162.84 feet Geodetic.

III 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 fill material which is associated with the construction of the approaches to the existing bridge. The fill material is generally granular ranging in particle size and distribution from sandy silt to silty fine sand. A 2 foot thick layer of silty clay fill was encountered below the sand fill in borehole 1.

Natural subsoil was encountered at El. 1142⁺, the upper part consisting of a 2 1/2 to 3 foot thick layer of alluvial sand and gravel. This layer contained considerable peat content in borehole 2 and can be considered to be a river bed deposit.

Between El. 1140 and El. 1128 at borehole 1 location and between El. 1138 and El. 1132 at borehole 2 location the subsoil consists of a glacial sand and silt stratum containing a trace of gravel. The relative density of this stratum is described as 'compact' to 'very dense' as estimated by 'N' values ranging from 21 to 79 blows per foot.

Both boreholes were terminated in a silty fine sand stratum, the relative density being described as 'very dense' based on extrapolated 'N' values in excess of 100 blows per foot.

IV GROUNDWATER CONDITIONS

The groundwater levels in the boreholes 1 and 2 reached equilibrium at El. 1137.8 and El. 1140.3 respectively.

V LABORATORY TESTS

Grain size analyses were performed on 2 samples of the natural soil taken at the assumed footing elevation to determine the grading and obtain an indication of the permeability. The results of the tests are presented as grading curves on Enclosures 5 and 6.

The grading curves are typical of glacial deposits, ranging in particle size from clay to fine gravel. Due to the high percentage of clay and silt size particles the permeability of the stratum can be considered to be relatively low and it is anticipated that seepage through the bottom of excavations will be controlled by pumping from filtered sumps.

VI DISCUSSION

The natural soil profile consists of a compact to very dense glacial sand and silt stratum overlying a very dense silty fine sand stratum in which the boreholes were terminated. The glacial sand and silt stratum exhibits a slight cohesion due to the dense packing of the particles and it will therefore be the ideal stratum in which to construct footings due to its relatively impermeable condition.

The bed of the creek extends to El. 1139.8 and allowing for frost protection it is recommended that footings should bear at or below El. 1135.5. The footing depth should be decided after a hydrological study has been made to determine the maximum depth of scour. This level lies within the stratum of dense sand and silt, and on the basis of the borehole results a maximum net soil pressure of 8000 pounds per square foot is appropriate for the design of footings. Furthermore the footings will have a factor of safety of at least 3 against shear failure of the underlying soil.

It is estimated that total settlement will not exceed 3/4 inch and in view of the similar conditions encountered in the two boreholes, no appreciable differential settlement is anticipated.

The coefficient of friction between the footings and the sandy silt may be taken as 0.35 and the factor of safety against horizontal sliding of the abutments should be at least 1.5.

Providing that the footing elevation is not placed below El. 1134.5, no unusual construction problems are anticipated. Seepage into excavations may be collected in sumps dug below the footing grade and removed by pumping. However should it be necessary to lower the footing grade, the stability of the bottom of the excavation should be investigated and pre-cautionary measures taken to prevent uplift or 'bottom heave' in the excavation due to excessive hydrostatic pressure in the silty fine sand stratum. This condition is usually prevented by carrying out the excavation inside a sheet-pile enclosure which is driven to the same depth below the footing grade as the water table is above the grade. Alternatively a well-point system of dewatering may be used.

Yours very truly,

DOMINION SOIL INVESTIGATION LIMITED



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









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Enclosures

LIST OF SYMBOLS, ABBREVIATIONS AND NOMENCLATURE.

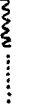
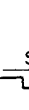
SOIL COMPONENTS AND GROUND WATER CONDITIONS.

										
BOULDER	COBBLE	GRAVEL		SAND			SILT	CLAY	ORGANICS	BEDROCK
		COARSE	FINE	COARSE	MEDIUM	FINE				
Ø	> 8"	3"	3/4"	4.76mm	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	OBSERVATIONS	Steady pressure
"	pressure : p	MADE WHILE	No pressure
"	tapping : t	CORING	Intermittent pressure

	Washwater returns
	Washwater lost

PENETRATION RESISTANCES.

DYNAMIC PENETRATION RESISTANCE : to drive a 2" ϕ , 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 :



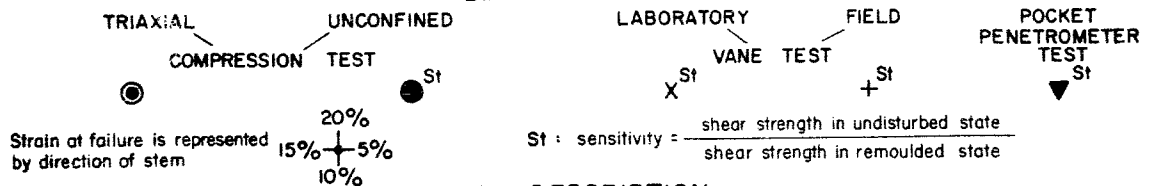
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SOIL PROPERTIES.

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	C _v Coeff. of consolidation	C' Cohesion
LI Liquidity index	m _v Coeff. of volume compressibility	ϕ' Angle of int. friction

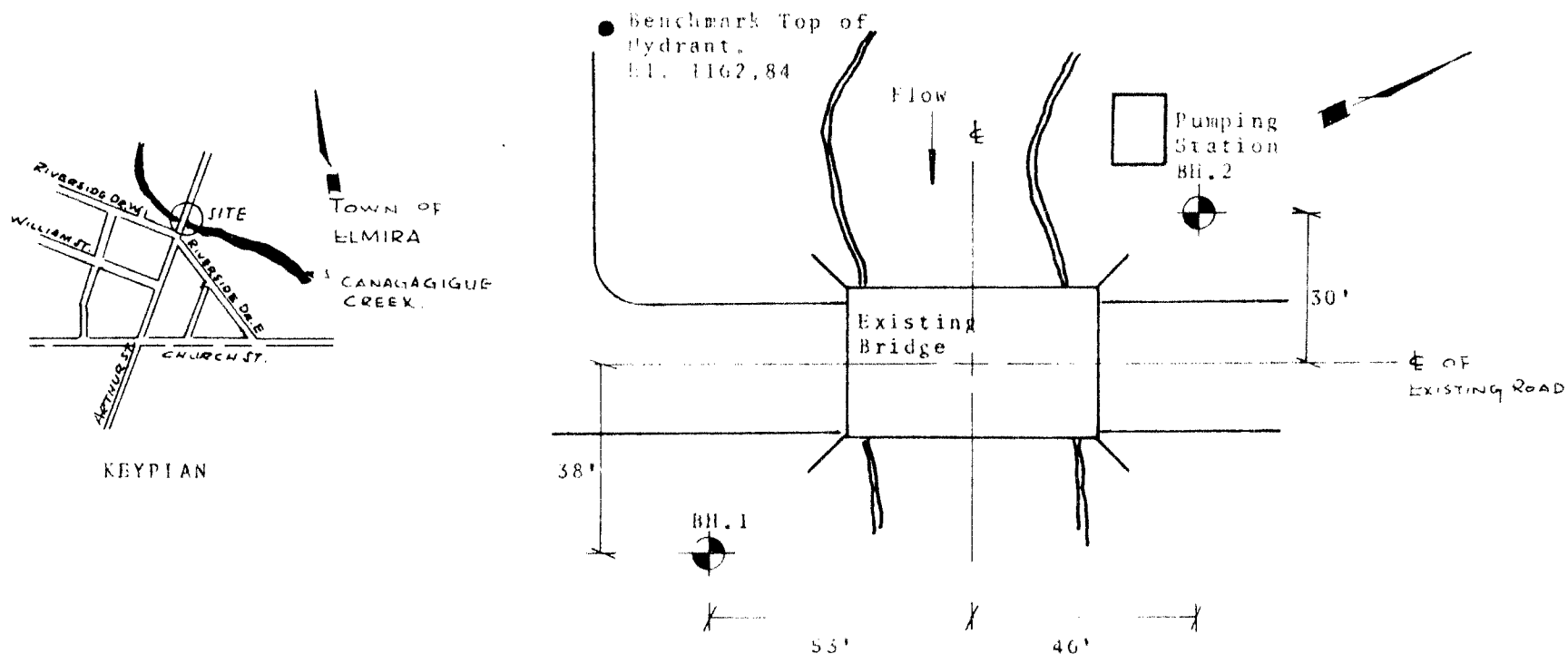
UNDRAINED SHEAR STRENGTH.

— DERIVED FROM —



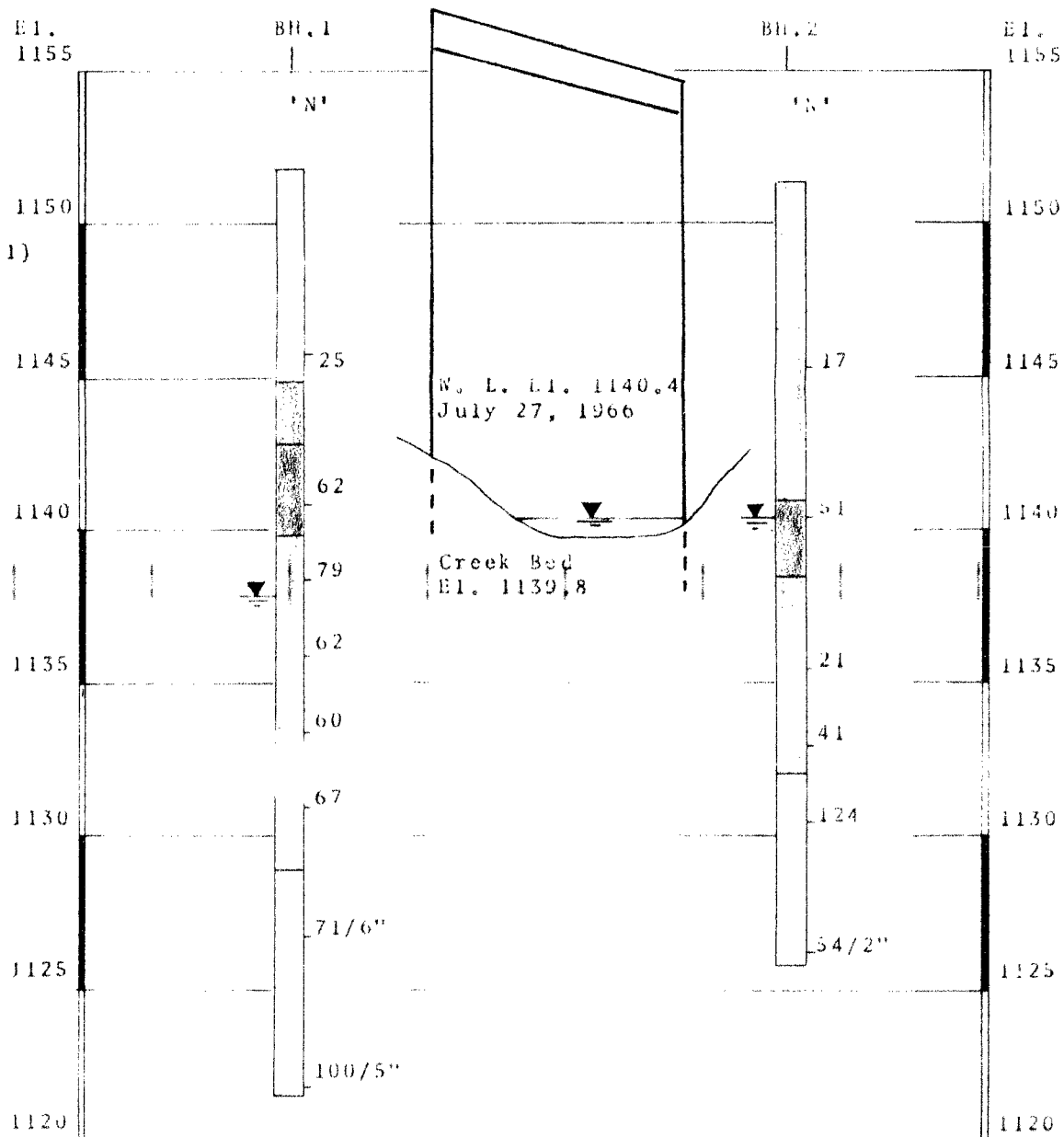
SOIL DESCRIPTION.

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



LEGEND

- Sandy silt, silty sand (Fill)
- Silty clay (Fill)
- Peaty sand and gravel
- Compact to very dense sand/silt or silty sand (Glacial Till)
- Very dense silty fine sand.



LOCATION OF BOREHOLES SCALE 1" = 30'

AND

SUBSURFACE PROFILE

Vertical Scale 1" = 5'

GEOTECHNICAL DATA SHEET FOR BOREHOLE . 4

OUR REFERENCE NO. 6-7-L9

CLIENT McCargar & Hachborn
PROJECT Arthur Street Bridge
LOCATION Elmira, Ontario
DATUM ELEVATION 1162.84 feet

METHOD OF BORING Washboring
DIAMETER OF BOREHOLE Bx (3-inch)
DATE July 28, 1966

ENCLOSURE NO. 3

ELEVATION ft	DEPTH ft	STRATIFICATION DESCRIPTION	STRATIFICATION SYMBOL	SAMPLES			PENETRATION RESISTANCE blows per foot					CONSISTENCY water content %			REMARKS
				NUMBER	TYPE	No. of Advancement of Sampler	20	40	60	80	100		W	U	
1151.8	0.0	Ground Surface													
1150		Compact brown gravelly silty sand. (Fill)		1	SS	25									
1145	7.0	Silty clay (Fill)													
	9.0	Very dense brown sandy gravel		2	SS	62									
1140	12.0	clayey Very dense grey silty fine to coarse sand, silt gravel (Clastic Till)		3	SS	79									
				4	SS	62									
1135				5	SS	60									
				6	SS	67									
1130	23.0														
		Very dense fine silty sand.		7	SS	71/6"									
1125															
	30.5			8	SS	100/5"									
1120		End of Borehole													

W. L.
El. 1137.8

OUR REFERENCE NO.

6-7-L9

GEOTECHNICAL DATA SHEET FOR BOREHOLE . . 2 . . .

CLIENT McCargar & Hachborn
PROJECT Arthur Street Bridge
LOCATION Elmira, Ontario
DATUM ELEVATION 1162.84 feet

METHOD OF BORING Washboring
DIAMETER OF BOREHOLE 8x (3-inch)
DATE July 29, 1966

ENCLOSURE NO. 4

ELEVATION ft.	DEPTH ft.	STRATIFICATION DESCRIPTION	STRATIFICATION SYMBOL	SAMPLES			PENETRATION RESISTANCE BLAS (lb./sq. in.)					CONSISTENCY water content %			REMARKS
				NUMBER	TYPE	DEPTH ft.	40	40	60	80	100	PL	W	LI	
1151.3	0.0	Ground Surface													
1150		Compact dark brown sandy silt, trace of organics		1	SS	17									
1145		(Fill)													
1140	10.5	Peat & gravel		2	SS	51									
	13.0	clayey													
1135		Compact to very dense brown sandy silt, trace of gravel.		3	SS	21									
		(Glacial Till)		4	SS	41									
1130	19.5	Very dense brown silty fine sand.		5	SS	124									
1125	25.7	End of Borehole		6	SS	54/2"									

W. L.
El. 1140.3

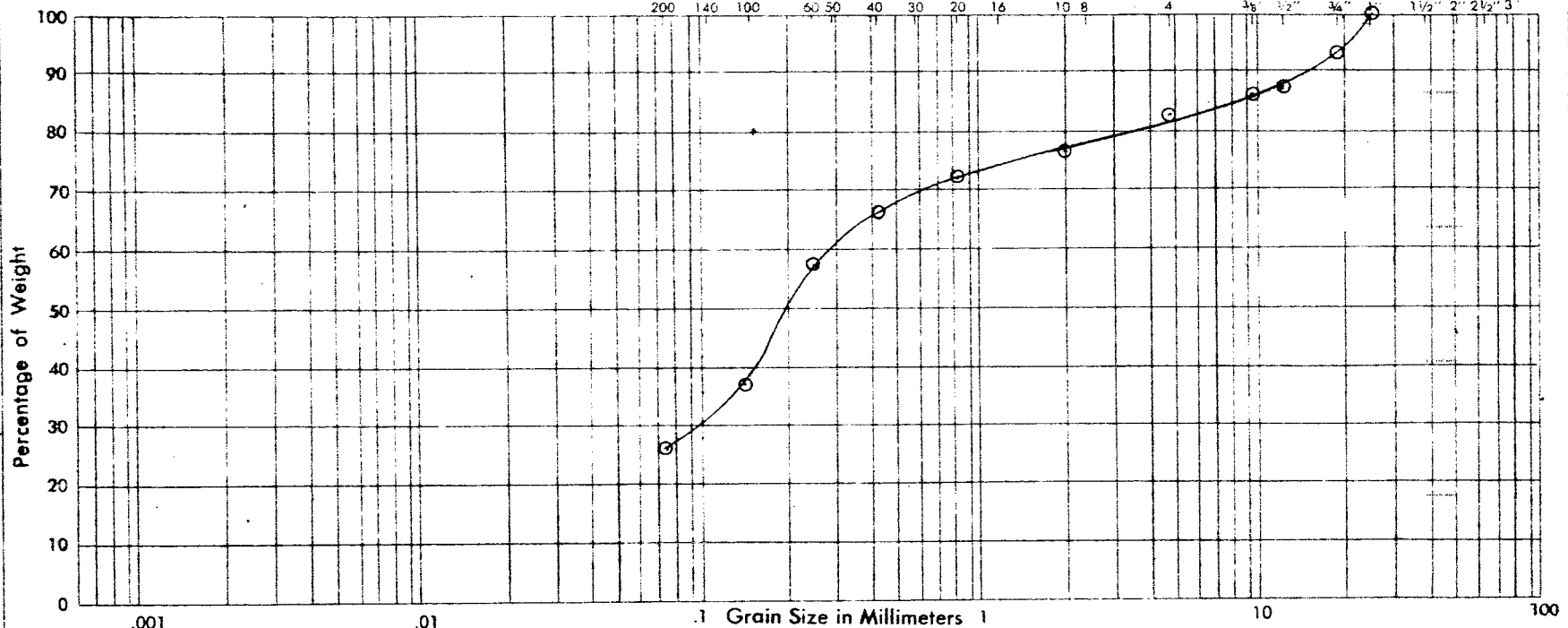
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GRAIN SIZE DISTRIBUTION

OUR REFERENCE NO 6-7-L9

UNIFIED SOIL CLASSIFICATION
SYSTEM

SILT AND CLAY	SAND			GRAVEL	
	FINE	MEDIUM	COARSE	FINE	COARSE



PROJECT Arthur Street Bridge
 LOCATION Elmira, Ontario.
 BOREHOLE NO.: 1
 SAMPLE NO.: 4
 DEPTH OF SAMPLE: 15 feet
 ELEVATION OF SAMPLE: 1136 feet

COEFFICIENT OF UNIFORMITY
 COEFFICIENT OF CURVATURE

Classification of Sample and Group Symbol:
 SILTY FINE TO COARSE SAND WITH SOME
 GRAVEL CONTENT

PLASTIC PROPERTIES:

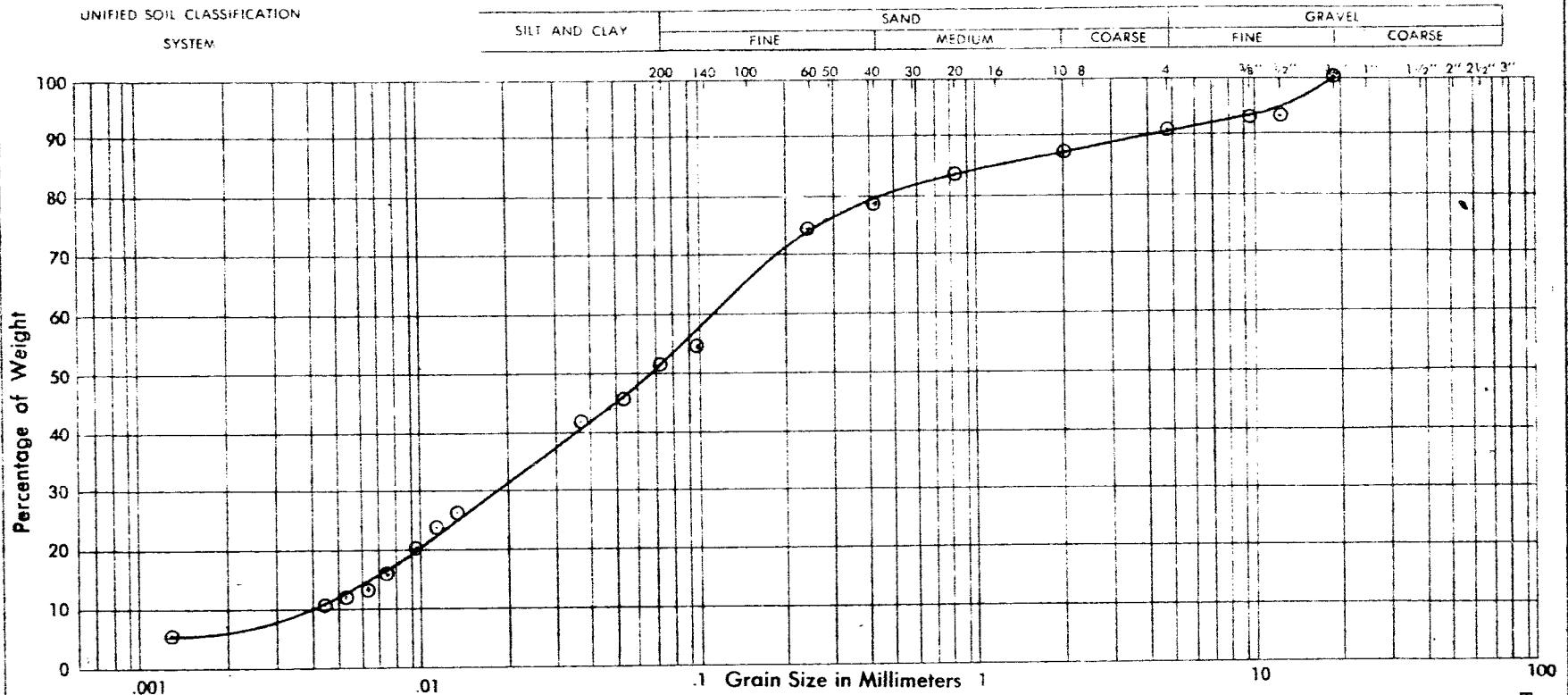
LIQUID LIMITED	%	=
PLASTIC LIMIT	%	=
PLASTICITY INDEX	%	=
MOISTURE CONTENT	%	=
ACTIVITY		=

Enclosure No. 5

DOMINION SOIL INVESTIGATION LIMITED

GRAIN SIZE DISTRIBUTION

OUR REFERENCE NO. 6-7-19



PROJECT: Arthur Street Bridge
 LOCATION: Elmira, Ontario.
 BOREHOLE NO.: 2
 SAMPLE NO.: 3
 DEPTH OF SAMPLE: 15 feet
 ELEVATION OF SAMPLE: 1136 feet

COEFFICIENT OF UNIFORMITY
 COEFFICIENT OF CURVATURE

Classification of Sample and Group Symbol:
 VERY SANDY SILT WITH TRACES OF FINE
 GRAVEL AND CLAY

PLASTIC PROPERTIES:

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

Enclosure No. 6