

68-F-219 M

BRIDGE

WATERLOO CTY. RD.#7

WILMOT TWP.



BA 2820
site 33-110

DOMINION SOIL INVESTIGATION LIMITED
CONSULTING SOIL & FOUNDATION ENGINEERS

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ASSOCIATED COMPANY

SOIL TESTING AND ENGINEERING LTD.
39 BRENTFORD ROAD
KINGSTON 5, JAMAICA
WEST INDIES

Our Ref. No: 8-1-22

26th February 1968.

McCargar and Hachborn Limited,
Consulting Engineers,
546 Belmont Avenue West,
P.O. Box 368,
Kitchener, Ontario.

Re: Proposed Bridge on Waterloo County Road No. 7
Township of Wilmot
Foundation Conditions

Gentlemen,

In accordance with your authorization of 29th January 1968 we completed the soils investigations at the above site. The field work consisted of two boreholes which explored the subsurface conditions to a depth of 36½ ft. below the ground level and two adjoining dynamic cone penetration tests.

The purpose of the explorations was to reveal the subsurface stratigraphy and groundwater conditions at the site and to determine the engineering properties of the subsoil for the design and construction of the bridge substructure.

This report presents the results of the field work, subsequent laboratory tests, engineering analyses and recommendations.

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SUMMARY

Dense granular strata underlie the site at about 10 ft. below the present creek bed. To avoid expensive dewatering measures, short end bearing displacement type (timber, precast concrete or closed end steel pipe) piles should support the bridge abutments.

THE SITE

The proposed bridge will replace the existing inadequate structure on County Road No. 7 where the latter crosses Alder Creek. The site lies about 4 miles to the south-east from Petersburg, Ontario.

Physiographically the site is located in the Waterloo Hills region. The hills are kames or are of sandy till and sandy outwash prevails in the low lying areas. The kames, which were formed at the edge of the melting glaciers, consist of irregularly stratified sand and gravel and are excellent sources of granular material as indicated by the many borrow pits found in the vicinity.

SOIL CONDITIONS

The location of the boreholes is shown on Enclosure No. 1 whilst a subsurface profile was prepared on Enclosure No. 2, inferred from the logs of the individual borings (Enclosures No. 3 and 4).

From the soil profile it can be seen that the significant soil stratum is a heterogeneous and stratified granular deposit containing occasional thin layers of silty clay.

The properties of the subsoil will be discussed in the following paragraphs.

1. Layers of GRAVEL, SAND and SILT
mixed in varying proportions

This is a layered deposit of probably glacio-fluvial origin. It is very heterogeneous and consists of gravel, sand and silt of varying proportions. The gradation curves on Enclosures No. 5 and 6 illustrate the varied composition of the stratum. Enclosure No. 5 contains the grain size distribution of principally gravel and sand samples, whereas on Enclosure No. 6 are shown the grain size distribution curves of sandy silt materials.

The stratum is cohesionless and derives its shear strength from friction between the grains. The standard penetration resistances in the upper zone of the deposit (above elevation 1050 ft.) varied between 12 and 33 blows per foot indicating a compact density, whereas the lower zones are very dense giving 'N' values between 42 and 99 blows per foot.

The permeability of the stratified and granular stratum is high although in the vertical direction the free movement of the groundwater could be hindered by the silty clay layers.

2. SILTY CLAY CL

Layers of silty clay were encountered in both boreholes; in borehole No. 1 between elevations 1055.3 and 1053.3 whereas in borehole No. 2 between elevations 1062.0 and 1059.0 and 1050.0 and 1046.5 ft.

These cohesive strata have a stiff to hard consistency and have an average liquid and plastic limit of 27.6 and 17.1 respectively, from which the average plasticity index of 10.5% was derived. The average moisture content is about 21%.

GROUNDWATER CONDITIONS

The groundwater level in both boreholes corresponded roughly to the water level in the creek (~ 1061.0 ft.).

DISCUSSION AND RECOMMENDATIONS

We were informed that the new bridge will be a statically determinate structure of 35 to 40 ft. span. Precast concrete beams resting on the abutments will support the reinforced concrete deck. Our recommendations were based on this information.

The strata, which are sufficiently dense to support spread footings, lie at different depths on the two sides of the creek. Whilst elevation 1054 ft. would be a suitable foundation base level for the east abutment, the footings would have to be carried down to elevation 1047 ft. on the west side. The allowable bearing pressure at these levels is 6000 P.S.F.

The above foundation levels, however, are 7 to 14 ft. below the present water level in the creek, (which is believed to be near its minimum value) thus extensive dewatering measures would be required during construction in the highly permeable substrata. The footings could only be constructed either within a steel cofferdam or by the tremie concreting method. These procedures are deemed to be expensive, consequently other foundation methods were investigated.

It was found that short timber piles driven into the dense, granular strata will develop sufficient load carrying capacity. Based on the standard penetration test results, timber piles with 6-inch tip diameter would meet a satisfactory set between elevations 1045 and 1040 ft. and would have a safe load carrying capacity

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(factor of safety = 3) of about 20 tons per pile. The Hiley formula can be used for the pile driving analysis, however the pile tips have to be provided with a protective shoe to prevent damage during driving.

The portion of timber piles extending above the lowest position of the groundwater table (allowance should be made for future changes) should be pressure treated to prevent decay.

Precast concrete or closed-end steel pipe piles would also perform satisfactorily. Twelve-inch diameter piles driven to elevation 1040 ft. would develop about 50 tons safe bearing capacity. Steel H piles could also be used but they would penetrate much deeper due to the low displacement volume. For instance, a 12 BP 53 driven to elevation 1035 ft. would have about 75 tons ultimate load carrying capacity which, divided by a safety factor of 3, would result in 25 tons per pile design load. Since H piles of greater length appear to be uneconomical, their use is not recommended. If, however, high capacity steel H piles driven below elevation 1025 ft. seemed to be an economical solution, additional deep borings would be necessary to determine the length and bearing capacity of the piles more accurately.

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During the construction of the pile caps the excavation can be dewatered by pumping from temporary sumps.

There are no problems in connection with the design and construction of the approach embankments.

We trust that the foregoing report is sufficient for your present requirements. However, should you have any further queries please do not hesitate to contact us.



Yours very truly,

DOMINION SOIL INVESTIGATION LIMITED

A handwritten signature in cursive script that reads "L. S. Rolko".

L.S. Rolko, P.Eng., A.M. ASCE

LSR/me



APPENDIX

1. Location and Elevation of the Boreholes

The bridge site and the boreholes were located in the presence of a representative of Messrs. McCargar and Hachborn Limited. The elevations were referred to the top of the concrete stair in front of Mr. F. Wallace's house (= elevation 1067.95 ft.) located north-west of the site.

2. Field and Laboratory Work

On 5th and 6th February 1968 two boreholes of a total length of 73 ft. and two adjoining dynamic cone penetration tests of a total length of 33 ft. were put down at the locations shown on Enclosure No. 1. They were advanced with a skid mounted washboring rig.

Representative samples were taken at frequent intervals of depth with a 2-inch outside diameter split spoon driven into the subsoil with a constant driving energy (140 lb. hammer dropping 30-inches). By counting the number of blows to advance the sampler 1 ft., the standard penetration resistances (= 'N' values) are obtained which were plotted on the relevant borehole logs. The 'N' values are indicative of the relative density or consistency of cohesionless and cohesive soils, respectively and the soil samples recovered are suitable for general classification.

The dynamic cone penetration tests were carried out using a 2-inch diameter, 60 degree apex cone driven into the subsoil with the

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above mentioned energy. These probes produced a continuous record of soil density.

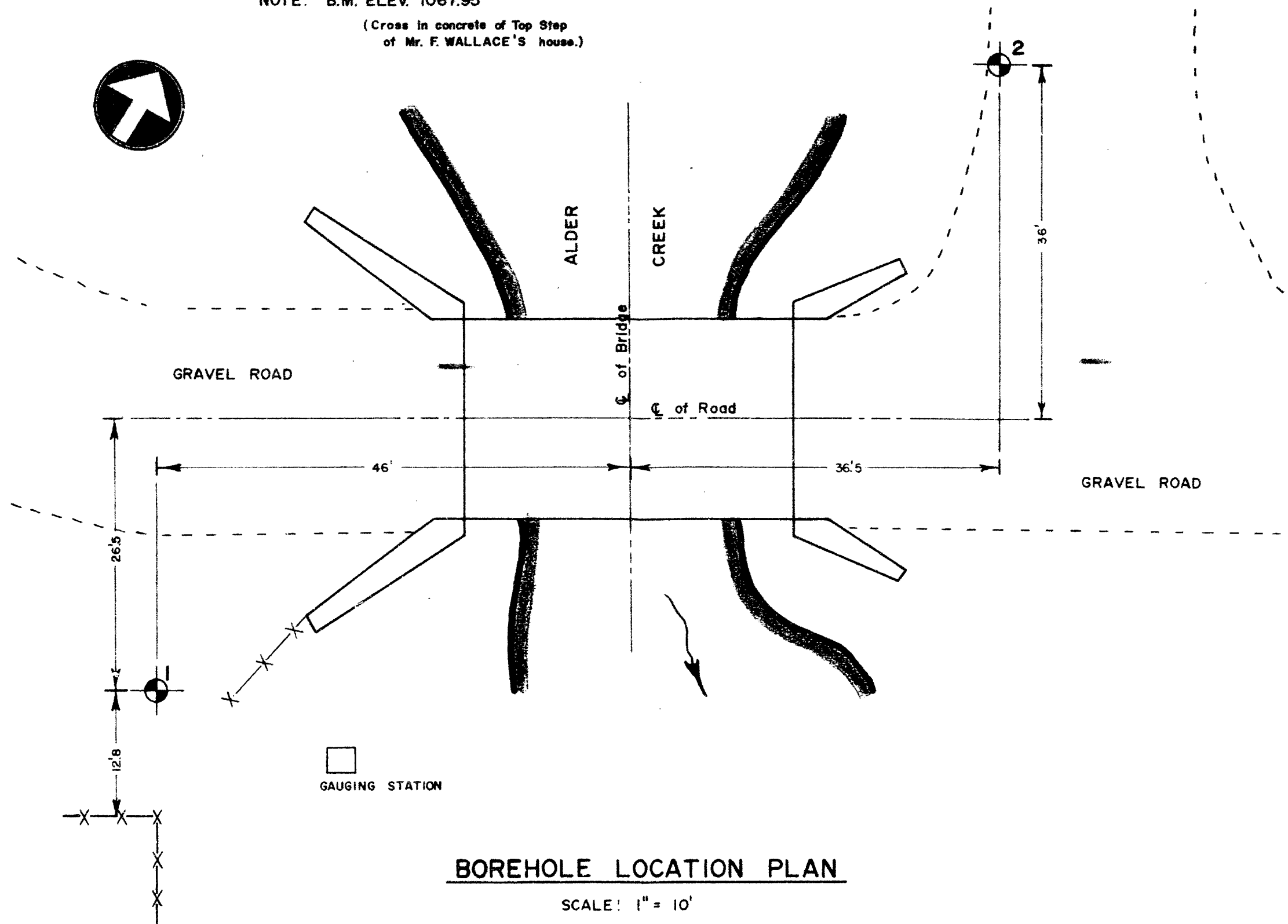
All samples were shipped to our laboratory where they were thoroughly examined and classified. Nine grain size analyses were performed.

The soil samples will be preserved for a period of three months and thereafter disposed of unless otherwise instructed.

E n c l o s u r e s

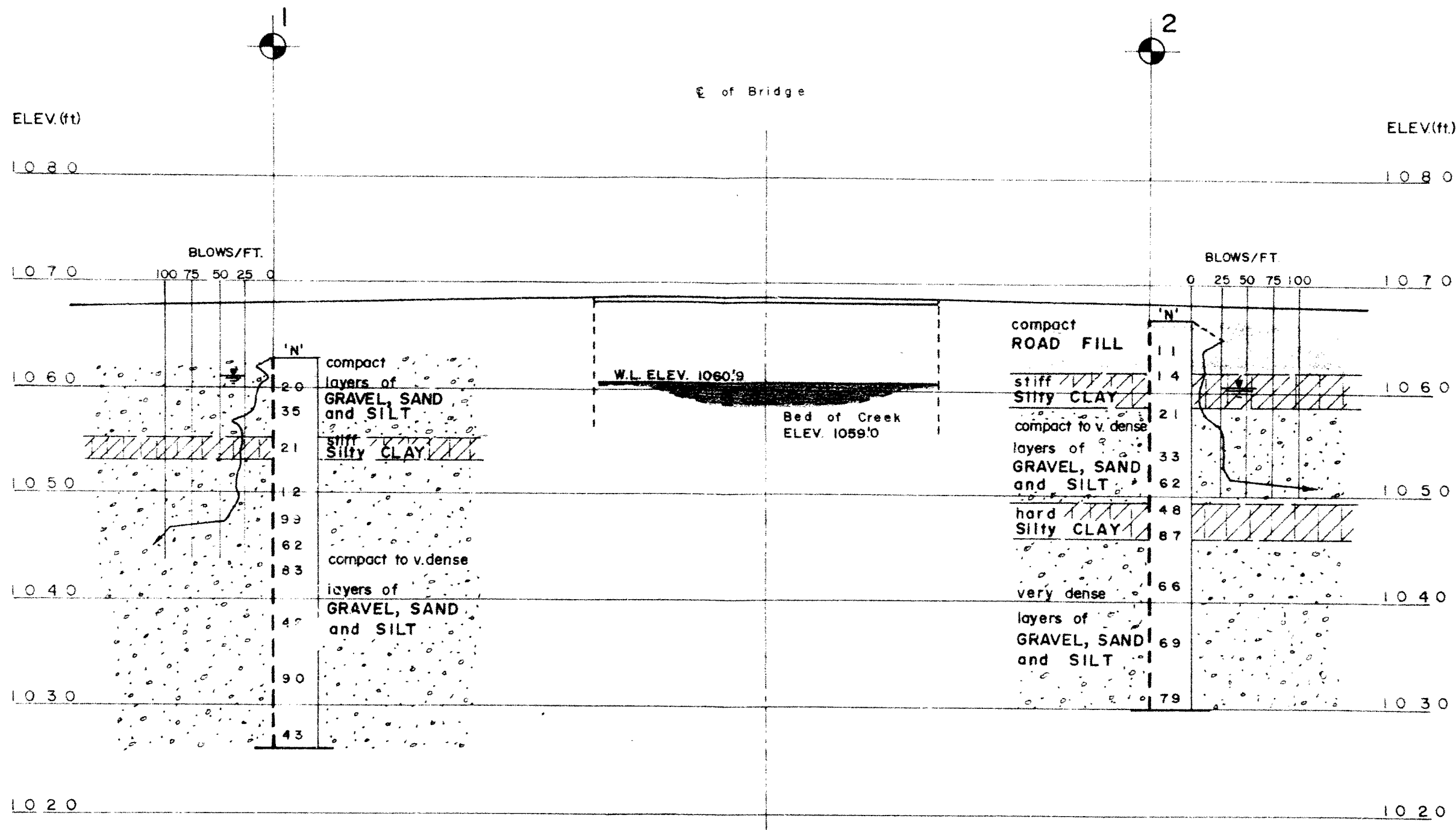
NOTE: B.M. ELEV. 1067.95

(Cross in concrete of Top Step
of Mr. F. WALLACE'S house.)



BOREHOLE LOCATION PLAN

SCALE: 1" = 10'



Q SUBSURFACE PROFILE

SCALE: 1" = 10'

DEFECTIVE NEGATIVE DUE TO
CONDITION OF ORIGINAL DOCUMENT

LOG OF BOREHOLE.....I.....

Our Reference No. 8-1-22

Enclosure No. 3

CLIENT: McCARGAR & HACHBORN LTD.
PROJECT: PROPOSED BRIDGE
LOCATION: NEW DUNDEE
DATUM ELEVATION: GEODETIC

DRILLING DATA

Method: WASHBORING
Diameter: 3.0"
Date: FEB. 5, 1968.

SUBSURFACE PROFILE				SAMPLES			PENETRATION RESISTANCE Blows / Foot					WATER CONTENT %			REMARKS						
ELEVATION Ft.	DEPTH Ft.	DESCRIPTION	SYMBOL	GROUND WATER	NUMBER	TYPE	'N' Blows / Foot	20	40	60	80	100	PLASTIC LIMIT	NATURAL		LIQUID LIMIT					
								UNDRAINED SHEAR STRENGTH					lb/sq. ft.					W _p	W	W _L	
								+ FIELD VANE TEST					• COMPRESSION TEST								
5 10 15 20 25																					
1062.8	0	compact trace organics																			
1060	5	layers of GRAVEL, SAND and SILT. mixed in varying proportions	G, S, ML		1	SS	20														
1055	7.5	stiff grey Silty CLAY	CL		2A B	SS	35														
1053.3	9.5				3A B	SS	21														
1050	15	compact very dense			4A B	SS	12														
					5A B	SS	99														
1045	20	layers of GRAVEL, SAND and SILT. mixed in varying proportions			6	SS	62														
1040	25				7	SS	83														
1035	30				8	SS	42														
1030	35				9	SS	90														
	36.5		G, S, ML		10	WS	—														
		END OF BOREHOLE.			11	SS	43														
1025																					

VERTICAL SCALE: 1 inch to 5 feet

DOMINION SOIL INVESTIGATION LIMITED

MADE: B. B.

CHECKED: *Roller*

LOG OF BOREHOLE2.....

Our Reference N^o 6-1-22

Enclosure № 4

CLIENT: McCARGAR & HACHBORN LTD.
PROJECT: PROPOSED BRIDGE
LOCATION: NEW DUNDEE
DATUM ELEVATION: GEODETIC

DRILLING DATA

Method: WASHBORING
Diameter: 3.0"
Date: FEB. 6, 1968.

SUBSURFACE PROFILE				SAMPLES			PENETRATION RESISTANCE					WATER CONTENT %			REMARKS	
ELEVATION Ft.	DEPTH Ft.	DESCRIPTION	SYMBOL	GROUND WATER	NUMBER	TYPE	'N' Blows / Foot	Blows / Foot					PLASTIC LIMIT W _p	NATURAL W		LIQUID LIMIT W _L
								20	40	60	80	100				
								UNDRAINED SHEAR STRENGTH + FIELD VANE TEST • COMPRESSION TEST								
967.0	0	compact														
1065		ROAD FILL (gravel, sand, loam)			1	SS	11									
1062	5	stiff			2	SS	14									
1060		Silty CLAY weathered, brown	CL													
1059	8	layers of			3	SS	21									
1055	10	GRAVEL, SAND and SILT mixed in varying proportions.			4	SS	33									
		compact			5	SS	62									
1050	15	very dense	G, S, ML		6	SS	48									
	17	hard			7	SS	87									
	20	greyish brown														
1046.5	20.5	Silty CLAY	CL													
1045		very dense			8	SS	66									
	25	layers of			9	SS	69									
1040	30	GRAVEL, SAND and SILT mixed in varying proportions.														
1035																
	35	wet	G, S, ML		10	SS	79									
1030	36.5	END OF BOREHOLE.														

FOR GRADATION
SEE ENCL. Nº 6

FOR GRADATION
SEE ENCL. Nº 5

FOR GRADATION
SEE ENCL. Nº 6

FOR GRADATION
SEE ENCL. Nº 6

DEFECTS IN NEGATIVE DUE TO
CONDITION OF ORIGINAL DOCUMENT

VERTICAL SCALE: 1 inch to 5 feet

DOMINION SOIL INVESTIGATION LIMITED

MADE: B. B.

CHECKED: *K. [unclear]*

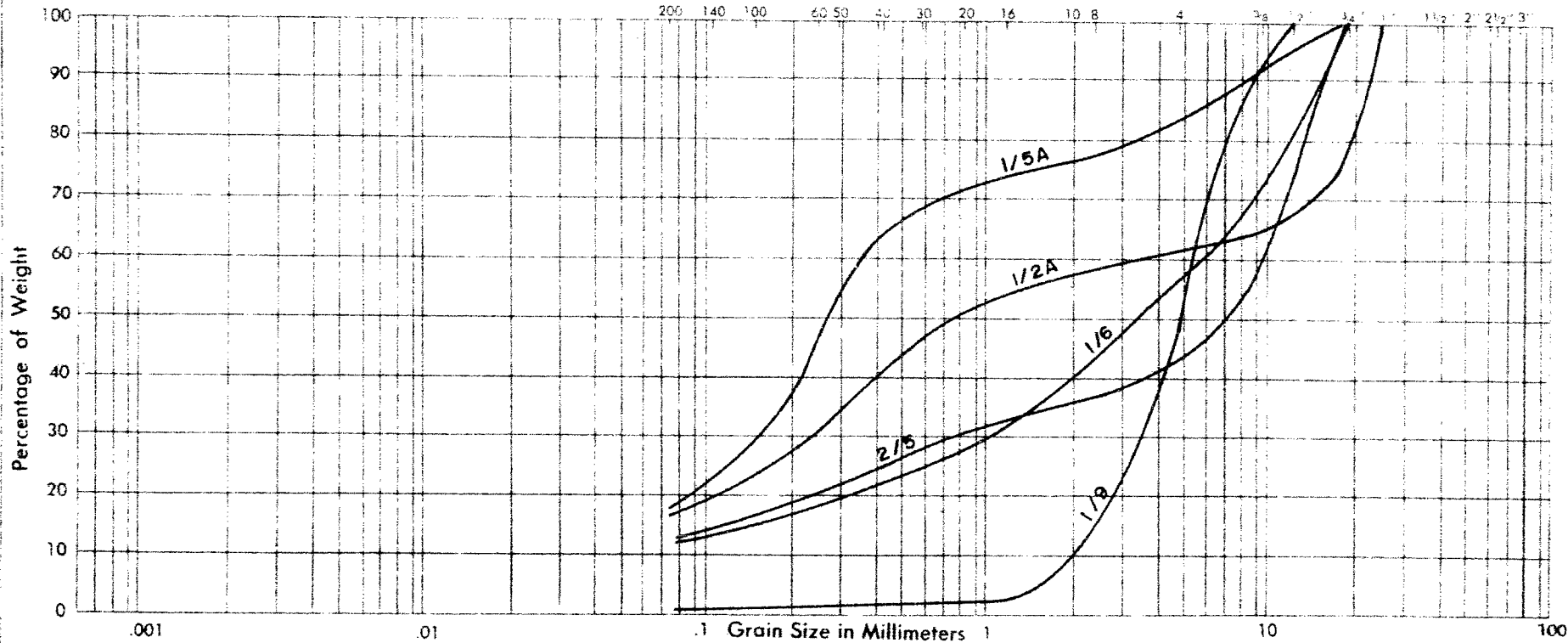
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GRAIN SIZE DISTRIBUTION

OUR REFERENCE NO. 8 - 1 - 22

UNIFIED SOIL CLASSIFICATION
SYSTEM

SILT AND CLAY	SAND						GRAVEL		
	FINE		MEDIUM		COARSE		FINE		COARSE



PROJECT **PROPOSED BRIDGE**

LOCATION **NEW DUNDEE**

BOREHOLE NO. 1 1 1 1 2

SAMPLE NO. 2A 5A 6 9 5

DEPTH OF SAMPLE 5' 15' 18' 30' 15'

ELEVATION OF SAMPLE 1057' 1047' 1044' 1032' 1052'

COEFFICIENT OF UNIFORMITY

COEFFICIENT OF CURVATURE

Classification of Sample and Group Symbol:

GRAVEL and SAND GP - GS

to

SAND some Gravel, Silty SP - SM

PLASTIC PROPERTIES:

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

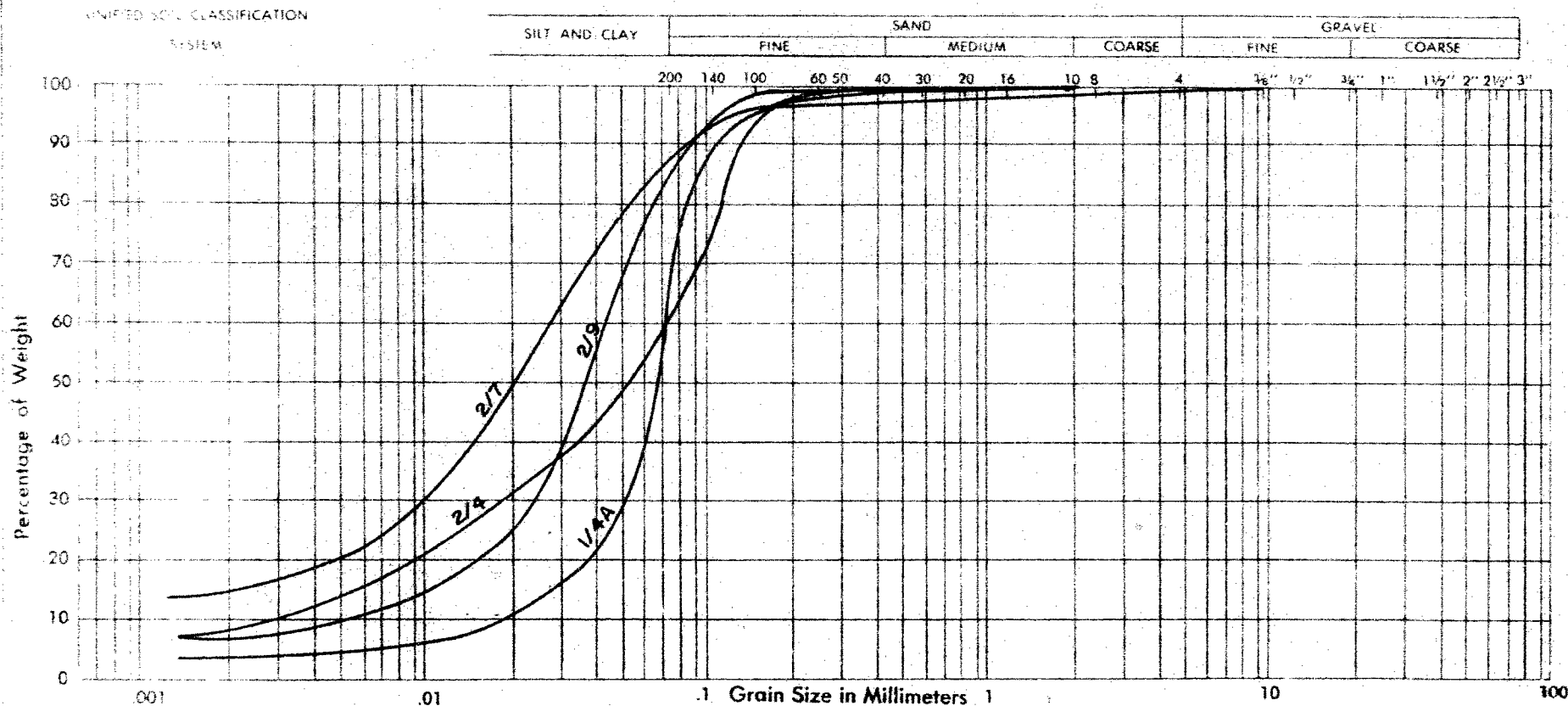
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Enclosure No. 5

DOMINION SOIL INVESTIGATION LIMITED

GRAIN SIZE DISTRIBUTION

OUR REFERENCE NO. 8-1-22



PROJECT **PROPOSED BRIDGE**
 LOCATION **NEW DUNDEE**
 BOREHOLE NO. **1 2 2 2**
 SAMPLE NO. **4A 4 7 9**
 DEPTH OF SAMPLE **13' 13' 21' 31'**
 ELEVATION OF SAMPLE **1049' 1054' 1046' 1036'**

COEFFICIENT OF UNIFORMITY
 COEFFICIENT OF CURVATURE

Classification of Sample and Group Symbol:
Sandy SILT

ML - SM

PLASTIC PROPERTIES

LIQUID LIMIT % =
 PLASTIC LIMIT % = **NON**
 PLASTICITY INDEX % = **APPLICABLE**
 MOISTURE CONTENT % =
 ACTIVITY % =

Enclosure No. 6

DEFECTS IN NEGATIVE DUE TO
 CONDITION OF ORIGINAL DOCUMENT