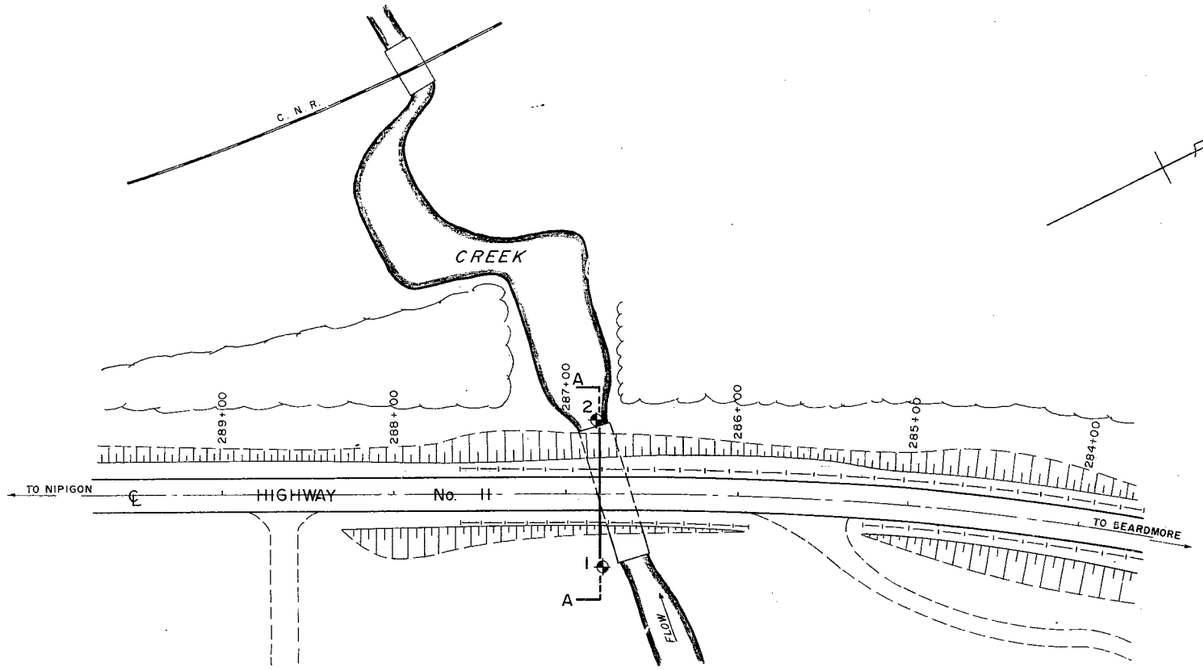
#65-F-236
W.P. #16-63
Hwy. #11
SOUTH OF
BEARDMORE
CULVERT
REPLACEMENT

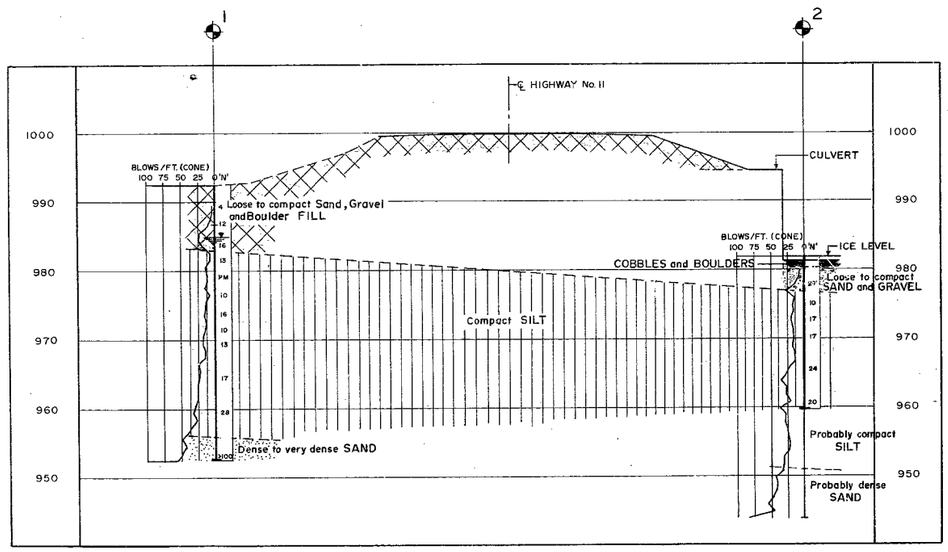
42 E 12 W



PLAN

SCALE

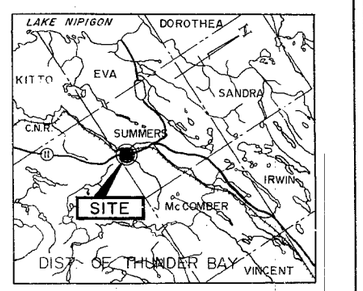
40 20 0 40 80 FT.



SECTION A-A

SCALE

10 5 0 10 20 FT.



KEY PLAN

SCALE IN MILES

5 0 5 10

LEGEND

- Bore Hole
- Cone Penetration Hole
- Bore & Cone Penetration Hole
- Water Levels established at time of field investigation.

NO.	ELEVATION	STATION	OFFSET
1	992.5	286+78	43' LT.
2	981.9	286+82	43' RT.

- 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.

PRINT RECORD		
NO.	FOR	DATE

REVISIONS		
DATE	BY	DESCRIPTION

H.Q. GOLDER & ASSOCIATES LTD.

DEPARTMENT OF HIGHWAYS - ONTARIO

MATERIALS & RESEARCH DIVISION - FOUNDATION SECTION

CULVERT REPLACEMENT

KING'S HIGHWAY NO. 11 DIST. NO. 19

DISTRICT OF THUNDER BAY

TWP. OF SUMMERS LOT — CON. —

BORING PLAN AND SOIL STRATIGRAPHY SECTION

SUBM'D.	CHECKED F.H.	W.P. NO.	16-63	DRAWING NO.
DRAWN J.A.	CHECKED	JOB NO.	65024	
DATE APRIL 21, 1965		SITE NO.		BRIDGE DRAWING NO.
APPROVED		CONT. NO.		

PRINCIPAL FOUNDATION ENGINEER

REFERENCE No. B-905-6
No. C-905-9

H. Q. GOLDER & ASSOCIATES LTD.

CONSULTING CIVIL ENGINEERS

H. Q. GOLDER
V. MILLIGAN
L. G. SODERMAN

2444 BLOOR STREET WEST
TORONTO 9, ONTARIO
767-9201
763-4103

W.P. 16-63

REPORT

TO

DEPARTMENT OF HIGHWAYS, ONTARIO

ON

SOIL CONDITIONS AND FOUNDATIONS

PROPOSED CULVERT REPLACEMENT

HIGHWAY 11 - STATION 287+00

NEAR BEARDMORE ONTARIO

Distribution:

11 copies - Department of Highways, Ontario.
Toronto, Ontario.

2 copies - H. Q. Golder & Associates Ltd.,
Toronto, Ontario.

April, 1965

65024

TABLE OF CONTENTS

ABSTRACT

The results of an investigation to determine the subsoil conditions at the site of a damaged culvert on Highway 11, 2 miles west of Beardmore, Ontario, are reported and recommendations are made for the design and construction of the proposed culvert replacement.

It was found that the creek bed is underlain by some 4 feet of locse to compact sand and gravel, followed by an extensive deposit of compact silt.

It is recommended that the proposed culvert be founded on spread footings within the silt stratum at a depth sufficient to provide scour protection.

In excavating for the footings in the silt below the water level, adequate control will be necessary to avoid loosening the subsoil at and below foundation grade. Construction methods to avoid "boiling" of the excavation bottom are discussed in the report.

INTRODUCTION

H. Q. Golder & Associates Ltd., have been retained by the Department of Highways, Ontario, to carry out a soil investigation for a proposed concrete culvert to replace an existing culvert near Beardmore, Ontario which was damaged by a washout in July, 1964. The purpose of this investigation was to determine the subsoil conditions at the site and to provide information for the foundation design of the proposed culvert.

PROCEDURE

The field work for this investigation was carried out during the period March 10 to 15, 1965. Two boreholes with accompanying dynamic penetration tests were put down at the site using a machine drillrig supplied and operated by Canadian Longyear Limited. Borehole 1, put down through the roadway approach fill adjacent to the culvert was taken down to casing refusal at a depth of 40 feet below ground surface. Borehole 2, put down in the creek bed from the ice surface, was taken down to a depth of 22 feet. The holes were advanced by the wash boring method and both undisturbed and disturbed samples of the subsoil were obtained. The field work was supervised throughout by an engineer from our staff.

A detailed log for each boring is given on the Records of Boreholes following the text of this report. The locations of the borings together with a section of inferred soil stratigraphy across the site are shown on Figure 1 located in a pocket following the Records of Boreholes.

The samples obtained during the investigation were shipped to our laboratory for detailed examination and testing. The results of the tests carried out are shown on the Records of Boreholes and on Figures 2 to 5, inclusive.

The elevations given in this report were obtained by reference to Profile No. C-905-9, dated April, 1964 and prepared by the Engineering Surveys Division, Department of Highways, Ontario. These elevations are referred to Geodetic datum.

SITE AND GEOLOGY

The site of the proposed culvert replacement is approximately 2 miles west of Beardmore, Ontario on Highway 11 in the District of Thunder Bay. The creek bed at the crossing is some 5 to 10 feet below the general flood plain level which extends about ¼ mile on either side of the narrow creek channel. The flood plain level which forms the floor of a valley some ½ mile wide is about 90 feet below the surrounding area. The topography of the general area is hilly.

From available geological information it is known that during the retreat of the glaciers, Lake Nipigon existed at a higher elevation and covered a much larger area than it does presently. The meltwater from the glaciers deposited sands and silts in the Nipigon Lake basin, including the site under investigation.

SUBSURFACE CONDITIONS

The detailed stratigraphy encountered in each boring is given on the Records of Boreholes. Following is a summary account of the inferred soil conditions at the site.

Borehole 1, put down adjacent to the existing culvert through a berm to the existing roadway embankment placed following a washout in 1964, encountered 9 feet of brown sand and gravel fill. The upper 5 feet of the fill is essentially a silty sand. The lower portion of this granular fill contains a large proportion of cobbles and boulders of up to about 2 foot in size. It is believed that this lower coarse fill was dumped to stem the washout that took place. A grain size curve for a sample of the upper portion of the fill is shown on Figure 2. Based on the standard penetration tests, which gave "N" values of 4, 13 and 16 blows/ft., the relative density of the fill is considered to be loose to compact.

Borehole 2, put down in the creek bed, encountered a 1 foot surface layer of cobbles and boulders, then 3 feet of loose to compact brown, well graded, sand and gravel, with a trace of silt. A grain size curve for the sand and gravel deposit is shown on Figure 3.

The main soil stratum at the site underlying the granular fill and creek bed deposits is a grey uniform silt about 25 feet thick. Typical grain size curves for the silt are shown on Figure 4 and 5. As can be seen from these figures, the stratum consists mainly of coarse silt sizes with 10 to 40 percent fine sand sizes and a trace of clay. Layers of silty clay up to about 2 inches in thickness were encountered at infrequent intervals throughout the silt in the borings.

Standard penetration tests carried out in the silt gave "N" values ranging from 10 to 28 blows/ft. with an average of about 17 blows/ft. Based on these values and on the results of the dynamic penetration tests, the relative density of the silt is considered to be compact.

The silt grades into a grey sand with depth. No samples were recovered from this sand deposit, though from observation of the wash water in borehole 1 the sand is believed to consist of medium to coarse sizes. The sand was penetrated for 4 feet in bore-

hole 1. From the results of the dynamic penetration tests and one standard penetration test, the relative density of the sand is estimated to be dense to very dense.

At the time of the investigation the creek was frozen with the ice level at elevation 982 or some 0.7 feet above creek bed. The water level observed in the piezometer in borehole 1 was at elevation 985 on March 15, 1965, that is, about 3 feet above creek ice level.

DISCUSSION

General

It is understood that the existing reinforced concrete culvert of the rigid frame open type at the site under investigation was undermined during a washout in 1964. As a result of undermining, the south end of the culvert settled by about 1 foot relative to the north end and the structure cracked. The roadway fill alongside the south culvert wall was washed out and coarse granular fill was dumped at that time to stem the erosion of the approach fill.

It is understood that the existing culvert will be replaced by a similar rigid frame culvert in excess of 16 feet wide and 10 feet high which is the size of the existing culvert. It is assumed that the roadway grade will remain essentially the same at

about 20 feet above creek bed.

Foundation Design

It is recommended that the abutments of the proposed culvert be founded on spread footings placed in the silt stratum which underlies the site below about elevation 980 or a few feet below the creek bed. To provide full frost protection, in the event that the creek bed runs dry during the winter, the footings would have to be taken down at least 6 feet below the creek bed. This depth would also provide some scour protection for the footings.

The "N" values obtained within the silt stratum range from 10 to 28 blows/ft. with an average of about 17 blows/ft. Based on these results, an allowable bearing pressure of up to 4,000 lb/sq.ft. may be used in design of footings founded in the silt. With this bearing pressure, the resulting settlement of the footings should be less than 1 inch, provided precautions are taken during construction to prevent loosening or a decrease in the relative density of the silt at and below foundation grade.

In the computation of sliding resistance between a rough concrete footing base and the undisturbed silt subsoil, a coefficient of friction of 0.35, which is a limiting value, may be used in design.

It is recommended that free draining and non-frost susceptible granular backfill be provided behind the culvert walls. The granular backfill should extend at least 6 feet horizontally behind the walls and provision for drainage from this material should be made to ensure that no hydrostatic or ice pressures build up behind the walls. With full effective drainage of the backfill and assuming the culvert to be a rigid structure, it is recommended that a coefficient of earth pressure at rest, Ko, of 0.4 and a total unit weight, γ, of 135 lb/cu.ft. be used for the compacted granular fill in design of the walls.

Rip-rap should be placed in the bottom of the creek channel and on the embankment side slopes in the vicinity of the culvert to prevent scour.

Construction Procedures

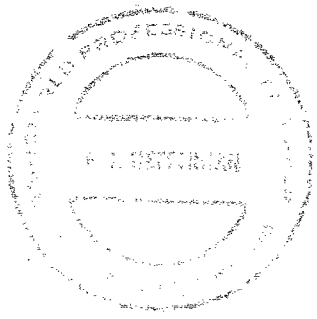
Depending on the water level in the creek at the time of construction and on the proposed footing depth, excavation of the order of 5 to 10 feet below creek water level will be required for the culvert foundations. Due to the susceptibility of the silt to loosening or becoming in a "quick" condition in excavations carried down below the water level, control of groundwater will be required in footing excavations to prevent a reduction in the in situ density of the silt at and below foundation level. This con-

trol may be achieved by either the construction of a cofferdam or by dewatering of the silt subsoil prior to excavation.

The granular fill material which contains a large proportion of boulders should be removed prior to the installation of a dewatering system or the driving of a steel sheet pile cofferdam. If a cofferdam is employed the sheeting should be driven to a penetration below final excavation level equal to the depth of the excavation below the water level. Further, the sheeting should be of sufficient height to prevent flooding of the excavation during a flash run-off period.

Alternatively, the subsoil may be dewatered by the use of a properly installed vacuum wellpoint system with each wellpoint surrounded with sand filter material. In this case, the excavation area would have to be dyked and the creek flow diverted.

F. J. Heffernan, P.Eng.



J. L. Seychuk, P.Eng.

FJH:HJB
65024
April, 1965

LIST OF ABBREVIATIONS

The abbreviations commonly employed on each "Record of Borehole," on the figures and in the text of the report, are as follows:

I. SAMPLE TYPES

AS auger sample
CS chunk sample
DO drive open
DS Denison type sample
FS foil sample
RC rock core
ST slotted tube
TO thin-walled, open
TP thin-walled, piston
WS wash sample

II. PENETRATION RESISTANCES

Dynamic Penetration Resistance: The number of blows by a 140-pound hammer dropped 30 inches required to drive a 2-inch diameter, 60 degree cone one foot, where the cone is attached to 'A' size drill rods and casing is not used.

Standard Penetration Resistance, *N*: The number of blows by a 140-pound hammer dropped 30 inches required to drive a 2-inch drive open sampler one foot.

WH sampler advanced by static weight—weight, hammer

PH sampler advanced by pressure—pressure, hydraulic

PM sampler advanced by pressure—pressure, manual

III. SOIL DESCRIPTION

(a) *Cohesionless Soils*

Relative Density	*N, blows/ft.*
Very loose	0 to 4
Loose	4 to 10
Compact	10 to 30
Dense	30 to 50
Very dense	over 50

(b) *Cohesive Soils*

Consistency	c_u, *lb./sq. ft.*
Very soft	Less than 250
Soft	250 to 500
Firm	500 to 1,000
Stiff	1,000 to 2,000
Very stiff	2,000 to 4,000
Hard	over 4,000

IV. SOIL TESTS

C consolidation test
H hydrometer analysis
M sieve analysis
MH combined analysis, sieve and hydrometer[1]
Q undrained triaxial[2]
R consolidated undrained triaxial[2]
S drained triaxial
U unconfined compression
V field vane test

NOTES:

[1]Combined analyses when 5 to 95 per cent of the material passes the No. 200 sieve.

[2]Undrained triaxial tests in which pore pressures are measured are shown as $\bar{Q}$ or $\bar{R}$.

LIST OF SYMBOLS

I. 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

II. STRESS AND STRAIN

u	pore pressure
σ	normal stress
σ'	normal effective stress ($\bar{\sigma}$ is also used)
τ	shear stress
ϵ	linear strain
ϵ_{xy}	shear strain
ν	Poisson's ratio (μ is also used)
E	modulus of linear deformation (Young's modulus)
G	modulus of shear deformation
K	modulus of compressibility
η	coefficient of viscosity

III. SOIL PROPERTIES

(a) *Unit weight*

	unit weight of soil (bulk density)
γ_s	unit weight of solid particles
γ_w	unit weight of water
γ_d	unit dry weight of soil (dry density)
γ'	unit weight of submerged soil
G_s	specific gravity of solid particles $G_s = \gamma_s/\gamma_w$
e	void ratio
n	porosity
w	water content
S_r	degree of saturation

(b) *Consistency*

w_L	liquid limit
w_P	plastic limit
I_P	plasticity index
w_S	shrinkage limit
I_L	liquidity index $= (w - w_P)/I_P$
I_C	consistency index $= (w_L - w)/I_P$
e_{max}	void ratio in loosest state
e_{min}	void ratio in densest state
D_r	relative density $= (e_{max} - e)/(e_{max} - e_{min})$

(c) *Permeability*

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

(d) *Consolidation (one-dimensional)*

m_v	coefficient of volume change $= -\Delta e/(1+e)\Delta\sigma'$
C_c	compression index $= -\Delta e/\Delta \log_{10} \sigma'$
c_v	coefficient of consolidation
T_v	time factor $= c_v t/d^2$ (d, drainage path)
U	degree of consolidation

(e) *Shear strength*

τ_f	shear strength	
c'	effective cohesion intercept	in terms of effective stress $\tau_f = c' + \sigma' \tan \phi'$
ϕ'	effective angle of shearing resistance, or friction	
c_u	apparent cohesion*	in terms of total stress $\tau_f = c_u + \sigma \tan \phi_u$
ϕ_u	apparent angle of shearing resistance, or friction	
μ	coefficient of friction	
S_t	sensitivity	

*For the case of a saturated cohesive soil, $\phi_u = 0$ and the undrained shear strength $\tau_f = c_u$ is taken as half the undrained compressive strength.

RECORD OF BOREHOLE 1

LOCATION See Figure 1 BORING DATE MARCH 11-13, 1965. DATUM GEODETIC

BOREHOLE TYPE WASH BORING BOREHOLE DIAMETER NX & BX CASING

SAMPLER HAMMER WEIGHT 140 LB. DROP 30 INCHES PEN. TEST HAMMER WEIGHT 140 LB. DROP 30 INCHES

ELEVN. / DEPTH	DESCRIPTION	STRAT. PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: BLOWS/FT.
992.5	GROUND LEVEL				
0.0	LOOSE BROWN SILTY SAND SOME FINE TO MEDIUM GRAVEL 6" ORGANIC LAYER AT EL. 992 (FILL)		1	CS	-
			2	2" D.O.	4
986.7			3	"	12
5.8	LOOSE TO COMPACT BROWN SAND, COBBLES AND BOULDERS (FILL)		4	BX RC	-
983.0			5	D.O.	16
9.5			6	"	13
			7 8	T.O D.O	PM —
	COMPACT GREY SILT TRACE TO SOME SAND OCCASIONAL 1/4" TO 2" LAYERS OF SILTY CLAY		9	"	10
			10	"	16
			11	"	10
			12	"	13
			13	"	17
			14	"	28
956.0					
36.5	DENSE TO VERY DENSE GREY SAND, SOME SILT		15	"	>100
952.8					
39.7	END OF HOLE				

ELEVATION SCALE: 995, 990, 985, 980, 975, 970, 965, 960, 955, 950

DYNAMIC PENETRATION RESISTANCE BLOWS/FT. — 20 40 60 80 100

SHEAR STRENGTH C_u, LB./SQ.FT.

END OF PEN. TEST @ EL. 952.3
6 BLOWS FOR 2 INCHES
74 BLOWS FOR NO ADVANCE

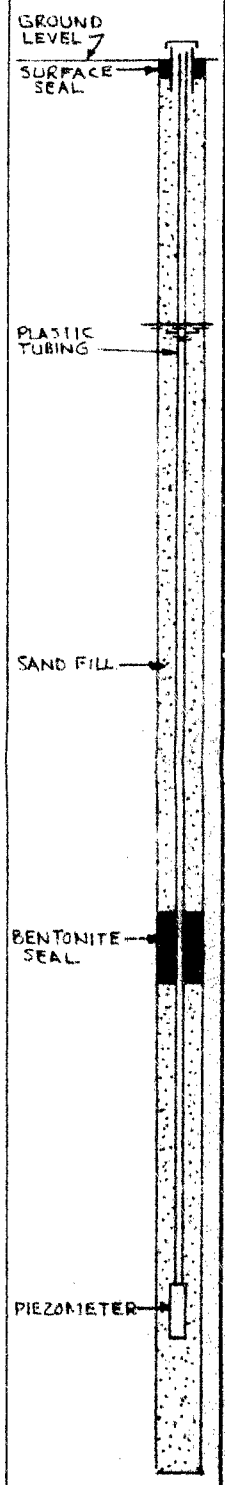
15 — 5 Percent axial strain at failure
10

COEFFICIENT OF PERMEABILITY k, CM./SEC.

WATER CONTENT, PERCENT — W_P W W_L — 10 20 30 40

ADDITIONAL LAB. TESTING: MH, MH, MH, H, H, MH

PIEZOMETER OR STANDPIPE INSTALLATION



WATER LEVEL IN PIEZOMETER @ ELEV. 985.0 MARCH 15, 1965

VERTICAL SCALE
1 INCH TO 5'-0"

GOLDER & ASSOCIATES

DRAWN J.A.
CHECKED F.J.H.

PROJECT No. 65024

RECORD OF BOREHOLE 2

LOCATION See Figure 1 BORING DATE MARCH 14-15, 1965 DATUM GEODETIC

BOREHOLE TYPE WASH BORING BOREHOLE DIAMETER BX CASING

SAMPLER HAMMER WEIGHT 140 LB. DROP 30 INCHES PEN. TEST HAMMER WEIGHT 140 LB. DROP 30 INCHES

ELEVN. / DEPTH	DESCRIPTION	STRAT. PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES BLOWS/FT.
981.9	CREEK LEVEL				
981.2					
0.7	COBBLES AND BOULDERS			CS	—
1.7	LOOSE TO COMPACT BROWN SAND AND GRAVEL TRACE OF SILT		2	D.O.	27
976.9					
5.0	COMPACT GREY SILT TRACE TO SOME SAND OCCASIONAL LAYERS OF SILTY CLAY		3	"	10
			4	"	17
			5	"	17
			6	"	24
			7	"	20
959.7					
22.2	END OF HOLE				
	PROBABLY COMPACT SILT				
950.9					
31.0	PROBABLY DENSE SAND				
943.9					
38.0	END OF PEN. TEST				

ELEVATION SCALE: 985, 980, 975, 970, 965, 960, 955, 950, 945, 940

DYNAMIC PENETRATION RESISTANCE BLOWS/FT. — 20 40 60 80 100

SHEAR STRENGTH C_u, LB./SQ.FT.

END OF PEN. TEST @ EL. 943.9

15-○-5 Percent axial strain at failure
10

COEFFICIENT OF PERMEABILITY k, CM./SEC.

WATER CONTENT, PERCENT — W_P W W_L — 10 20 30 40

ADDITIONAL LAB. TESTING: MH, MH, H, MH

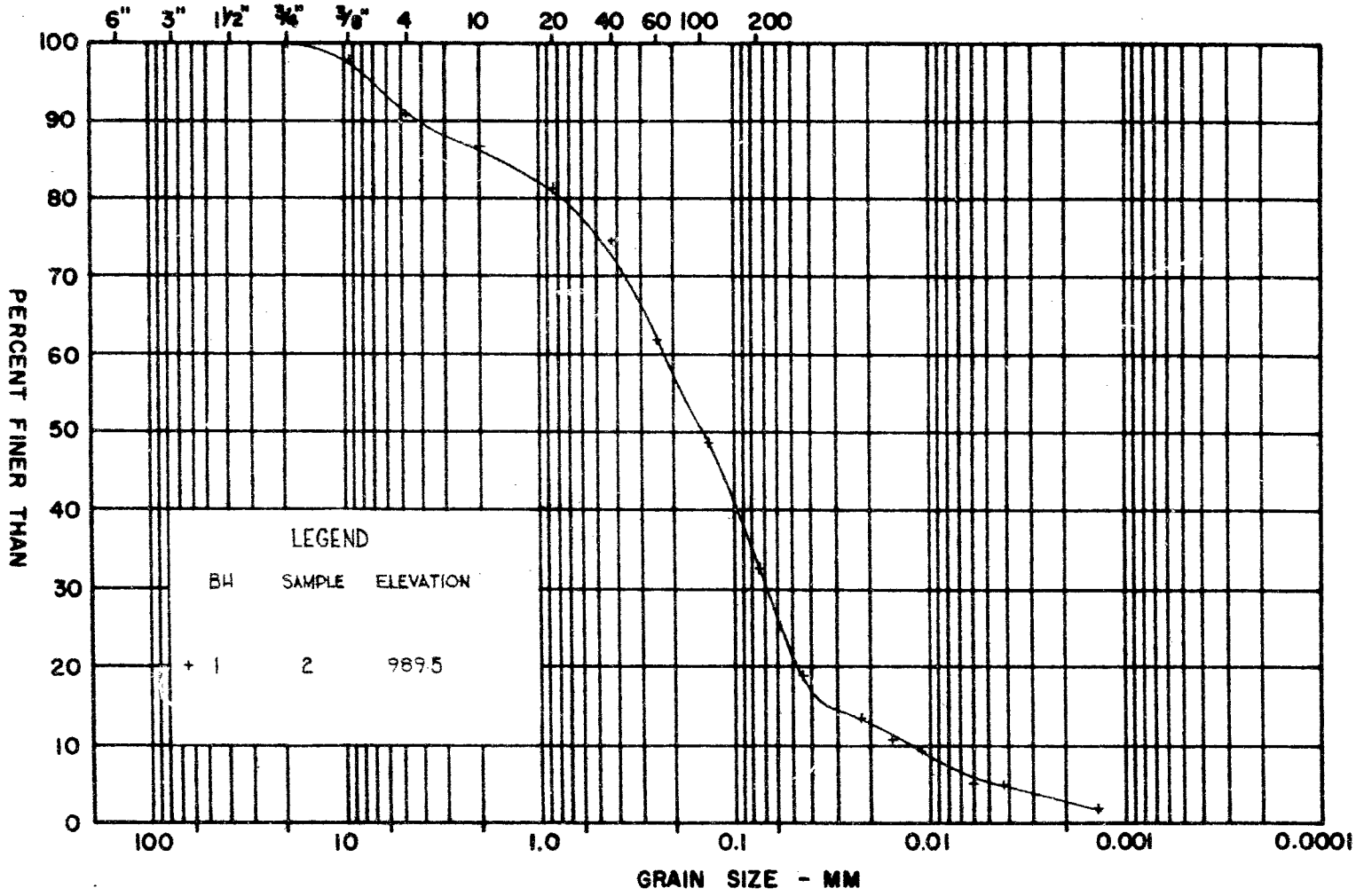
PIEZOMETER OR STANDPIPE INSTALLATION

VERTICAL SCALE
1 INCH TO 5'-0"

GOLDER & ASSOCIATES

DRAWN J.A.
CHECKED F.J.H.

M.I.T. GRAIN SIZE SCALE



GOLDER & ASSOCIATES

GRAIN SIZE DISTRIBUTION

SILTY SAND FILL

FIGURE 2

PROJECT No. 65024

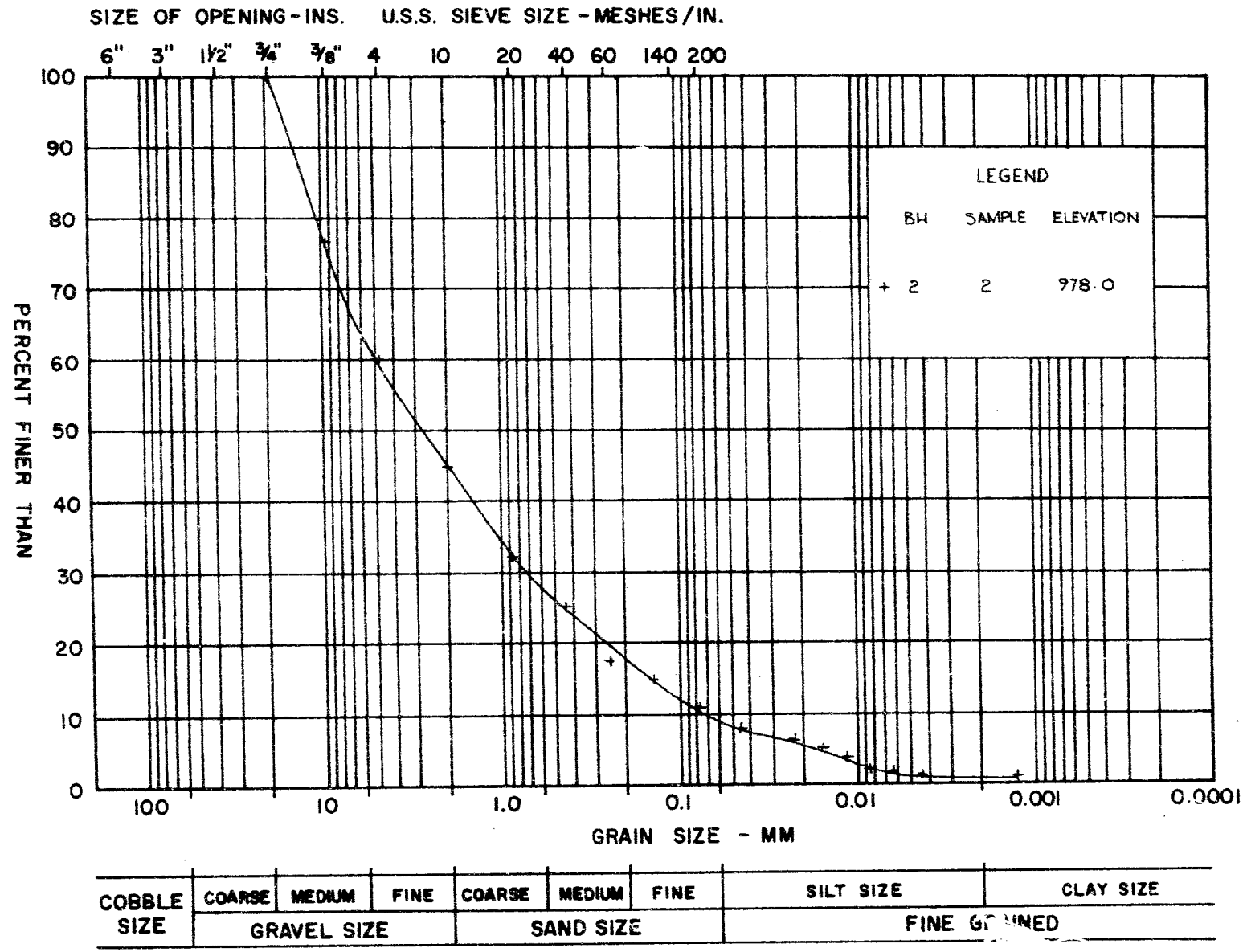
GOLDER & ASSOCIATES

GRAIN SIZE DISTRIBUTION

SAND AND GRAVEL, TRACE OF SILT

FIGURE 3

M.I.T. GRAIN SIZE SCALE



COBBLE SIZE	GRAVEL SIZE			SAND SIZE			FINE GRAINED	
	COARSE	MEDIUM	FINE	COARSE	MEDIUM	FINE	SILT SIZE	CLAY SIZE

PROJECT No. 65024

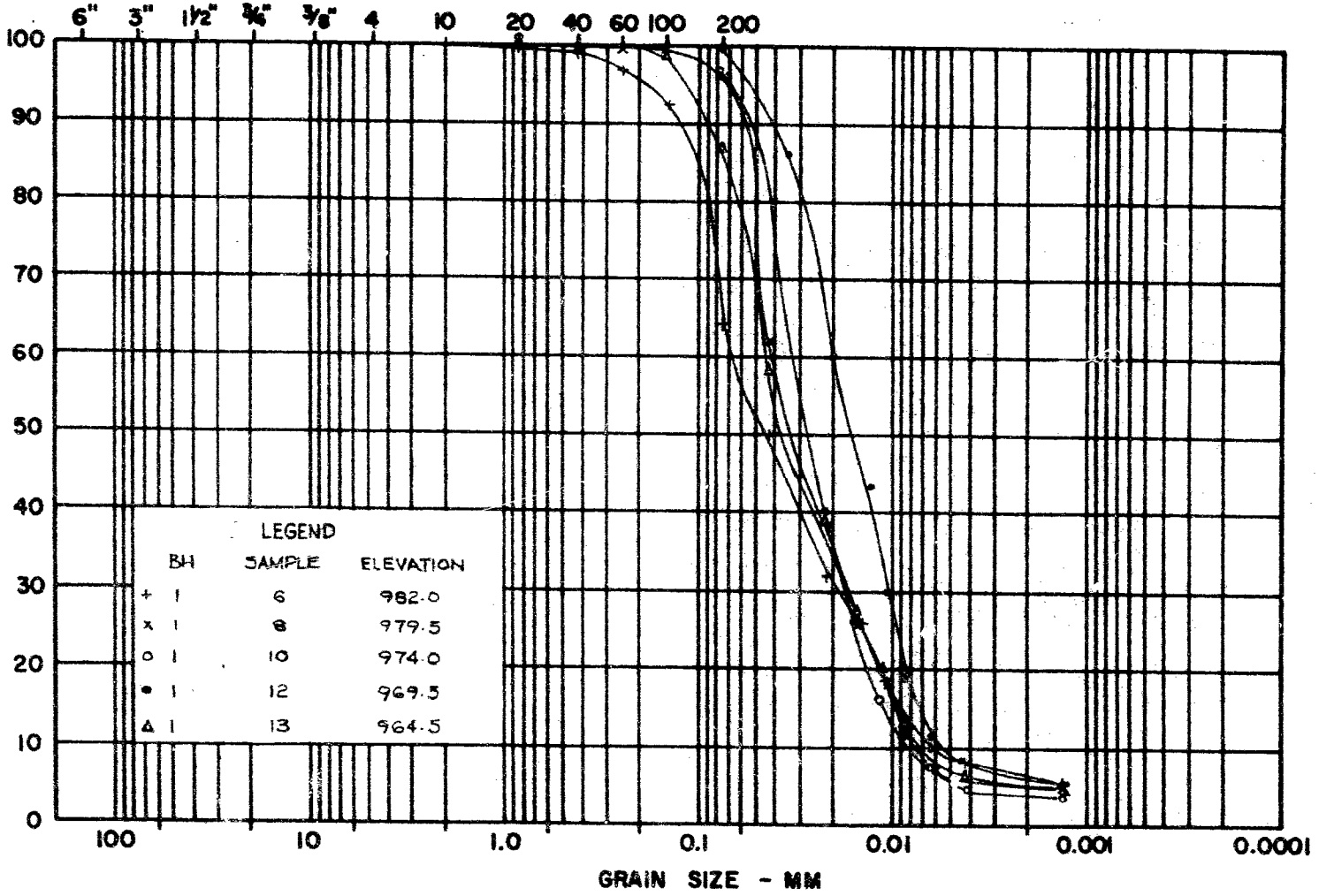
GOLDER & ASSOCIATES

GRAIN SIZE DISTRIBUTION

SILT, TRACE TO SOME SAND

FIGURE 4

M.I.T. GRAIN SIZE SCALE

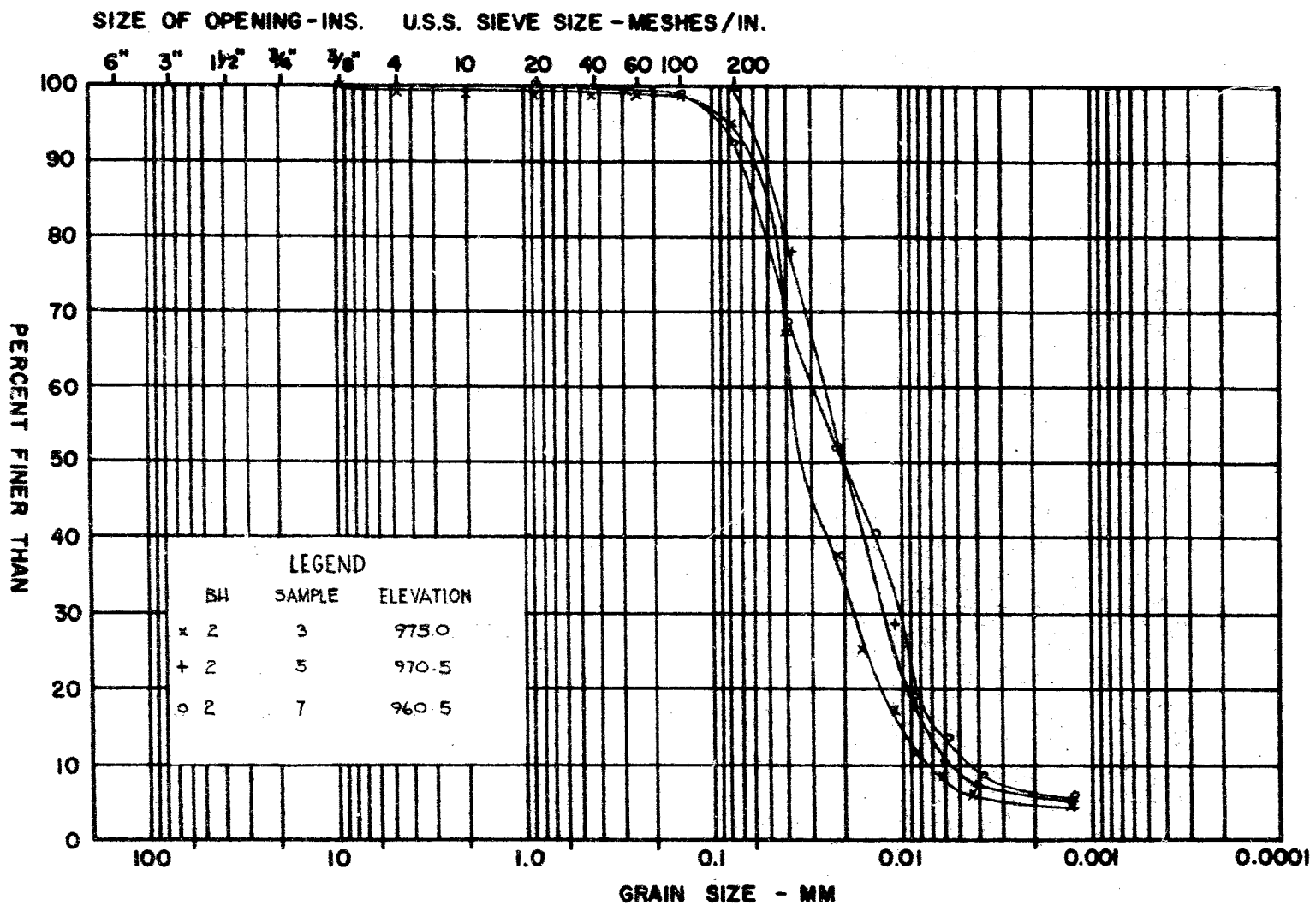


COBBLE SIZE	GRAVEL SIZE			SAND SIZE			FINE GRAINED	
	COARSE	MEDIUM	FINE	COARSE	MEDIUM	FINE	SILT SIZE	CLAY SIZE

PROJECT No. 85024

GOLDER & ASSOCIATES

M.I.T. GRAIN SIZE SCALE



GRAIN SIZE DISTRIBUTION

SILT, TRACE TO SOME SAND

FIGURE 5

cc: Foundations Office (Rm. 110)

Mr. A. M. Toye,
Bridge Engineer,
Bridge Division.

Foundation Section,
Materials & Testing Div.,
Room 107, Lab. Bldg.

Attention: Mr. J. McCombie

April 27, 1965

FOUNDATION INVESTIGATION REPORT BY:
H. G. Golder & Associates Limited.
Proposed Culvert Replacement, Hwy. 11,
Station 287+00, Beardmore, Ontario.
W.P. 16-64 -- District 19

Attached, please find the above-mentioned report submitted by the Consultant, H. G. Golder & Associates Ltd.

We have reviewed the report and found the factual information adequate and well presented. We are also in agreement with the design and construction recommendations and have therefore, no comments to make. However, should there be any questions that you would like to discuss, please feel free to contact our office.

A. O. Stearns,
PRINCIPAL FOUNDATION ENGINEER

AOS/MacF
Attach.
cc: Messrs. A. M. Toye (2)
H. A. Tregashes
H. D. MacMillan
E. W. Hurrell
Y. A. Oneil
F. Norman
F. De Visser
A. Watt

Foundations Office /
Gen. Files

cc: Foundations Office (Rm. 110)

Hwy. 401 & Keele St.,
Downsview, Ontario.

March 8, 1965

Materials and Testing Division

M. M. Golder and Associates Ltd.,
2[illegible] Bloor Street West,
Toronto, Ontario.

Attention: Mr. V. Milligan

Re: W.P. 16-63, Hwy. 11, Culvert S. of Searsboro at Sta. 287+60, District #19, Fort William, Ontario.

Dear Sir:

Please consider this your authority to carry out a foundation investigation at the above site. Plans and profiles were provided to your representative on March 5, 1965, and it is understood that your personnel were in the vicinity of Fort William at that time.

It is understood that a qualified Soils Engineer will be in charge of the field work at all times.

Eleven copies of the completed foundation report, with one additional copy of each subsoil profile, should be submitted to the Foundation Section as soon as possible. Previous requirements as to preliminary borehole information and laboratory testing program, should be followed.

Because the drawings accompanying the foundation reports, showing the location of borings, the inferred subsoil conditions, etc., are to become contract drawings, you are requested to prepare these in accordance with the D.H.O. standards. To enable you to do this, we are supplying you with sample drawings with all the necessary explanations, together with linen sheets for your drawings. You are also requested to provide the D.H.O. with Cronaflex copies of the drawings.

Charges for the work performed will be in accordance with your Schedule of Rates, dated September 10, 1962, and invoice to be addressed to the attention of the undersigned.

cont'd. /2 ...

We are attaching Purchase Order J 34779, covering the purchase of any new material required for this project, in order that you may use this as a basis for exemption from the Federal Tax for such purchases. The Exemption Certificate is printed thereon.

Yours very truly,

A. Rutka,
MATERIALS & TESTING ENGR.

NDS/MdeF
Attach.

cc: Messrs. S. McCombie
F. De Visser
H. Hurrell
V. A. Snell
F. Norman
H. Konings
N. D. Smith (2)
Foundations Office
Gen. Files (2)

DEPARTMENT OF HIGHWAYS ONTARIO

MEMORANDUM

To: Mr. A. Stermac,
Principal Foundation Engineer,
Downsview.

From: Mr. F. DeVisser,
Regional Bridge Location Engineer,
Fort William.

Date: March 1, 1965.

Our File Ref.

In reply to

Subject: Work Project 16 - 63, Culvert south of Beardmore at Station 287 - Highway 11 - District 17 - 19

The subject 16' x 10' open footing type culvert will have to be replaced under Work Project 16 - 63.

Would you please have a foundation investigation carried out.

It seems to me that two holes will be sufficient, to be drilled at opposite corners, unless the soils conditions are so variable that more detailed information is necessary.

I understand that Golder and Associates are now drilling at Rat Rapids. Would it be possible to have them do the drilling at the culvert after they complete work at Rat Rapids? The report should be available as soon as possible.

FD/bep

C.C.
H. Hurrell
F. Norman
S. McCombie
N.S. Smith

F. DeVisser

F. DEVISSER,
REGIONAL BRIDGE LOCATION ENGINEER.

JOB GIVEN TO H.Q. GOLDER WHO ARE IN THE AREA.
MARCH 5. 1965 AGS.