

#60-F-228

W.P. # 303-59

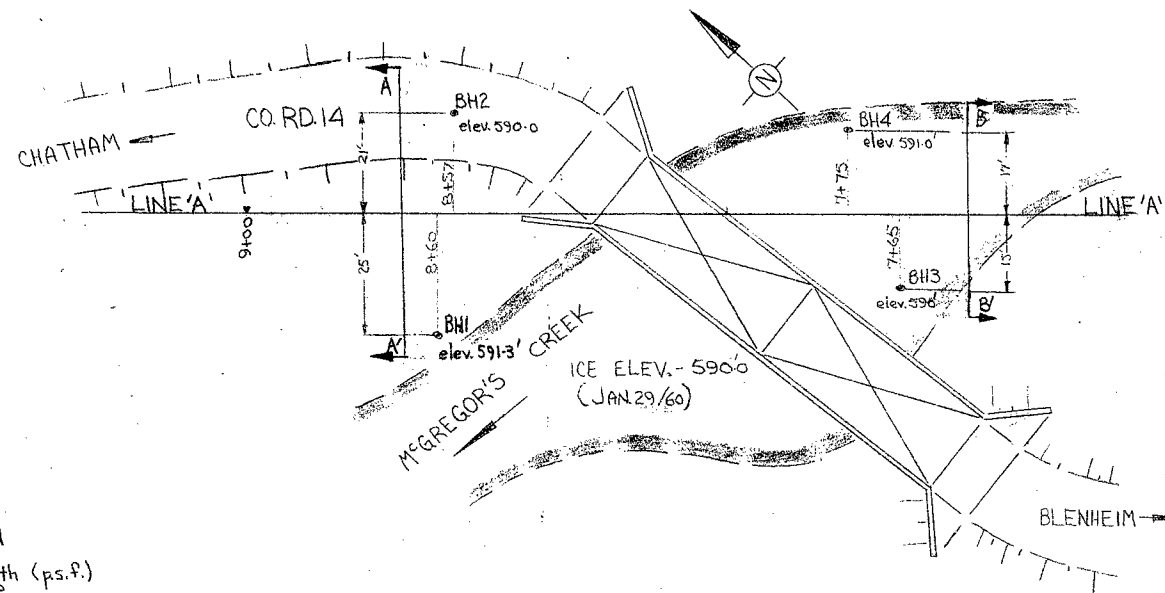
KENT CTY. RD. #14

PROP. BRIDGE

CROSSING

McGREGOR CR.

4038 E



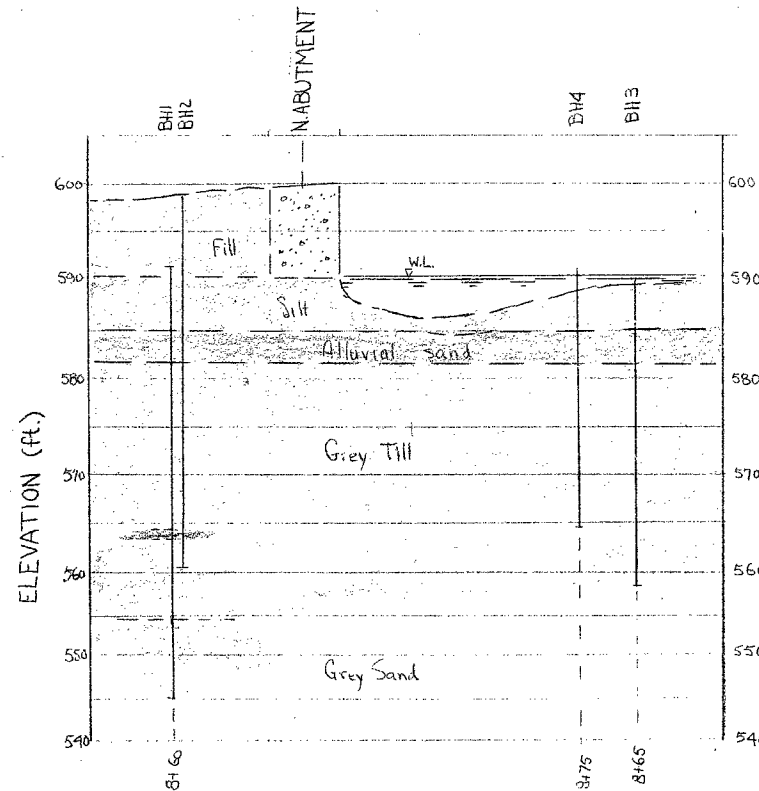
LEGEND:

- BHL Bore hole
- W.L. Free water table level
- Cv In situ vane shear strength (p.s.f.)
- ELEVATION - Geodetic datum

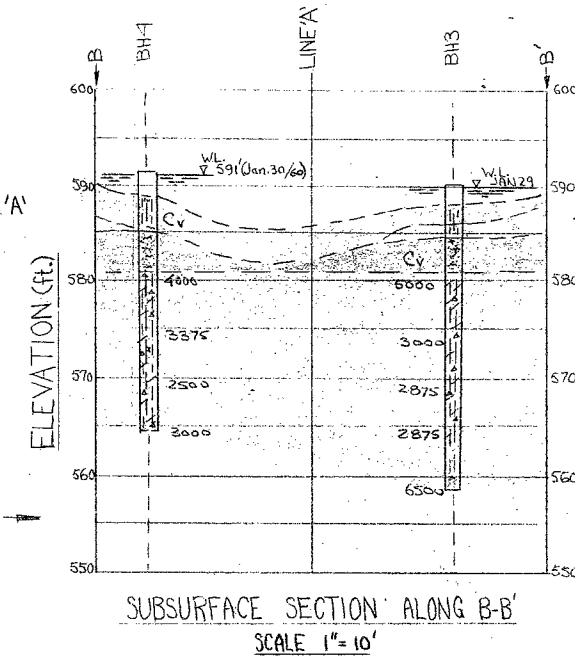
SOILS LEGEND:

- Road fill: clay, grey till, gravel, sand etc.
- Coarse grey silt (some brown at top), some sand, some organic material, iron stained.
- Loose, med., dark grey alluvial sand: some white calcareous material, traces of organic fibre.
- Med. dense grey till: predom. silt, some clay, some med. to fine sand, black shaly gravel.
- Loose coarse sand & gravel, predom. black shale.
- Dense coarse grey sand, almost stratified.

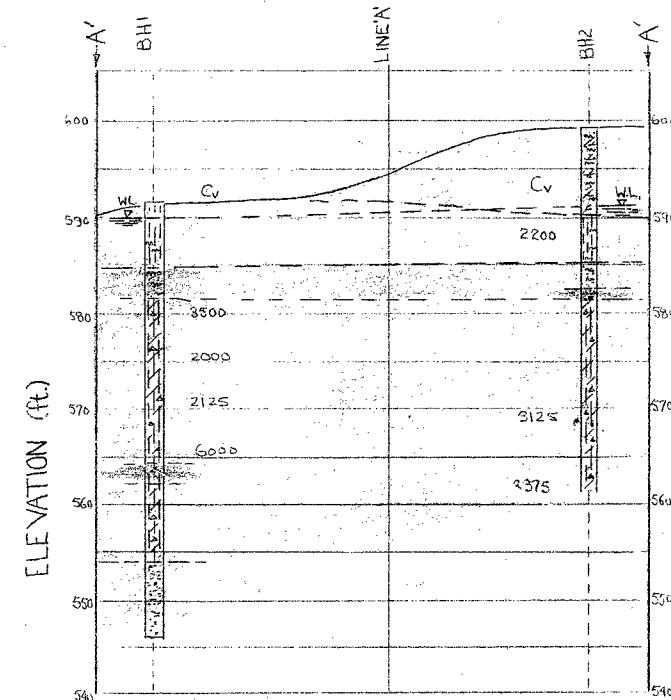
LOCATION OF BOREHOLES SCALE 1"=20'



SUBSURFACE PROFILE ALONG LINE 'A'
HORIZONTAL SCALE 1"=20'
VERTICAL SCALE 1"=10'



SUBSURFACE SECTION ALONG B-B'
SCALE 1"=10'



SUBSURFACE SECTION ALONG A-A'
SCALE 1"=10'

ONTARIO DEPARTMENT OF HIGHWAYS
MATERIALS & RESEARCH SECTION

M^c GREGORS CREEK BRIDGE - KENT CO. RD. 14
HARWICH TWP. BET'N. CONI-ECR & CONI(WCR)-LOT 26
WP-303-59

DOMINION SOIL INVESTIGATION LTD.
TORONTO
FIELD SUP.-PL. JOB NO. 60-106 FEB 18/60 ENCL. #1



ONTARIO
DEPARTMENT OF HIGHWAYS

Memo to Mr. A. M. Toye, **Date** April 22, 1960.
Bridge Engineer. **Subject** FOUNDATION INVESTIGATION -- by
From Materials & Research Section. Dominion Soil Investigation, Ltd

Attention: Mr. S. McCombie.

Re: Proposed Bridge Across McGregor Creek,
Kent County Rd. 14, Harwich Township,
Conc. I, Lot 26, District No. I,
W.P. 303-59.

We have reviewed the above mentioned Report submitted by Dominion Soil Investigation, Ltd., and have found the conclusions and recommendations in the report not adequate and, in some instances, the interpretation misleading.

By reviewing the field data, we have come to the conclusions which we suggest for you to follow in future design work:-

1. Spread footings should be used for the structure. The foundation elevation should be 562.0' - i.e., footings should be placed on top of the medium dense grey till material.
2. The allowable nett bearing capacity at the above mentioned elevation can be taken as 3.0 T/sq.ft.
(Average unconfined compression strength = 4,500 p.s.f.)
(Average shear strength by field vane .. = 4,000 p.s.f.)
3. Anticipated settlements will be in the order of 2 inches over a longer period of time (some 20 - 30 years). It is not expected that detrimental (greater than 3/4") differential settlement would occur.

cont'd. /2 ...

Recommendations: (cont'd.) ...

4. Settlements due to the placement of the approach embankment will take place within a short period of time, because of the silty character of the material below. Some differential settlements of the embankment must be expected because of some interbedded clay layers.

Should any queries arise with respect to the contents of the Consultant's report, or our foregoing comments, we would be pleased to discuss these further, with you.

L. G. Soderman,
PRINCIPAL SOILS & FOUNDATIONS ENGR.

Per:



(A. Stermac,
FOUNDATION OFFICE ENGINEER)

AS/KdeF
Attach.

cc: Messrs. A. M. Toye (2)
H. A. Tregaskes
D. G. Ramsay
A. Gater
C. U. Howell
J. Roy
A. Watt

Foundations Office
Gen. Files.

BA 1034

Department of Highways Ontario
Materials and Research Section
Downsview Ontario

REPORT ON
FOUNDATION INVESTIGATION
PROPOSED BRIDGE ACROSS MCGREGOR CREEK
KENT COUNTY RD. 14 - HARWICH TWP. CONC. 1, LOT 26
WP-303-59

Submitted by:
DOMINION SOIL INVESTIGATION LTD
88 Eglinton Ave. E.
Toronto 12 Ontario
April 1960

DOMINION SOIL INVESTIGATION LTD.

SOIL MECHANICS • FOUNDATION ENGINEERING

TORONTO 12, ONTARIO

FOUNDATION INVESTIGATION FOR
PROPOSED BRIDGE ACROSS MCGREGOR CREEK
KENT COUNTY ROAD 14
HARWICH TOWNSHIP
CONCESSION 1, LOT 26
WP-303-59

INTRODUCTION

Authorization was received from the Department of Highways, Materials and Research Section, to investigate soil condition for a proposed bridge foundation. The proposed bridge will span across McGregor Creek to serve the future Kent County Road 14. It is located near Kent Centre, Ontario.

This report presents:

- 1) An account of field tests and - work
- (2) Laboratory tests and data sheets with results of tests
- (3) Interpretation of results, and
- (4) Recommendations.

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ENGINEERING DATA SHEETS

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1. DESCRIPTION AND GEOLOGY OF THE SITE

There is an existing concrete and steel bridge over McGregor Creek which serves the present county road. In the future this road will be relocated, the creek diverted and a new bridge constructed (about 65' long). The present span is about 95' long and shows no visible sign of settlement.

Geology

McGregor Creek flows slowly and meanders to the north where it empties into the Thames River at Chatham. The creek is slowly dissecting the flat Wisconsin clay till sheets of the area. Floods occur in the spring and fall creating a broad silty alluvial flood plain in the creek valley. The soil has poor ability to absorb moisture. The banks of the valley are not well wooded. A lack of boulders was also noted in the creek valley, which is shallow (about 10 feet) and broad (about 100 feet) at the site.

This flat Wisconsin plain, general elevation in the area is 600[±] above sea level, is underlain by stratified sands occurring at about elevation 522[±].

2. DRILLING PROGRAM

Drilling was carried out between 27-30th January, 1960. Conventional washbore drilling was used. Elevations at every borehole were established by an engineering level. Existing bridge dock was used as benchmark. Holes were located by chainage stations along line 'A' from data supplied by D.H.O.

Water level in the creek changed rapidly due to melting ice, thus cribbing was placed on the bottom of the creek to serve as a platform for the drill. Changing water level made it impossible to place the holes three and four in their proposed positions, hence they were offset.

2. DRILLING PROGRAM - Continued

Sampling was carried out at regular intervals (see data sheet).

Disturbed samples in the 2" split spoon and undisturbed ones in 2" shelly tubes were taken where necessary.

Vane shear tests were carried out in the clay materials of all four boreholes.

LABORATORY TESTS

Laboratory tests were carried out and following values determined:

- (a) Natural moisture contents
- (b) Unconfined compression strength of undisturbed samples
- (c) Sensitivity
- (d) Liquid limits
- (e) Dry unit weight
- (f) Consolidation test was attempted to determine settlement factor. However, considerable gravel content made it impossible. Details of above tests are enclosed in enclosure #9.

4. DESCRIPTION OF SUBSOIL

From samples of subsurface materials, six soil formations were classified. A detailed description of all samples and field tests may be found on "Bore Hole Log Sheets".

(a) Road Fill and Top Soil

Fill and top soil was found only in borehole #2 which penetrated the existing roadbed.

Fill material is highly ironstained and oxydized. It consists of clay and sand with added gravel.

Underlying the fill in borehole #2 is a 4 foot layer of sensitive (sensitivity = 6) blue clay with shear strength about 2200 p.s.f. This was determined from vane tests at elevation 587 feet.

(b) Grey Silt

Grey Silt is the surface material of McGregor Creek's flood plain, and forms the creek bed. Average thickness of this layer is about 4'. It is easily eroded.

(c) Dark Grey Sand

This about 3' thick layer, is well graded, but easily disturbed. Organic material seems to be distributed throughout the layer together with calcareous particles. Underlying this layer is 1' layer of water-bearing gravel, a possible former river bed.

(d) Grey Clay Till

This layer is medium dense. Silt content is increasing with depth. It extends from elevation 582'± in the creek valley where boreholes were taken.

At elevation 564' about a 2' thick lense of gravel was dissected in borehole #1 only.

Grey clay till in general has quite uniform physical properties. Low sensitivity (its value = 1 to 2) is prevalent, except in borehole #4 where a sensitivity of 8 was found.

Unconfined compression strength ranged from 6460 p.s.f. at elevation 580' to 3550 p.s.f. at elevation 571.5'.

(e) Grey Sand

This layer underlying till (see paragraph d) is a coarse-grained dense material. It is stratified. Resistance to penetration test rose to 49 blows per foot. Grey sand continues down from elevation 552'. At elevation 544' the drilling was stopped.

(f) Bedrock

Bedrock in this area is estimated to be about 90' below ground surface. It is a flatlying fissile black shale from Kettle Point Devonian.

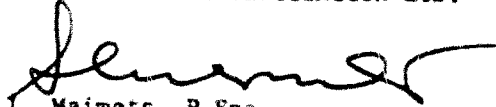
5. RECOMMENDATIONS

Footings could be placed on grey till at elevation 580' or below. Bearing capacity of 6170 p.s.f. was found at top of till based on unconfined compression test for 10' x 30' footing. However in borehole #4 high sensitivity (about 8) and a natural moisture content (about 18) was found. A consolidation test could not be performed because of gravel content. Due to difference in sensitivity in various boreholes a high differential settlement could be expected, thus spread or strip footings are not suitable.

For pile foundation no endbearing strata was encountered at elevations explored. High sensitivity in hole #4 outrules friction type of pile foundation. Organic content can also be considered detrimental to steel H-piles.

A culvert type of structure is most suitable for the location. Due to long span (about 65') a twin or triple culvert can be most advantageously used. Maximum bearing capacity of the soil from unconfined compression test was found to be 4080 p.s.f. for 25' x 65' culvert.

DOMINION SOIL INVESTIGATION LTD.


L. Maimets, P.Eng.

Order No. 60-106

Prep. By P.L.

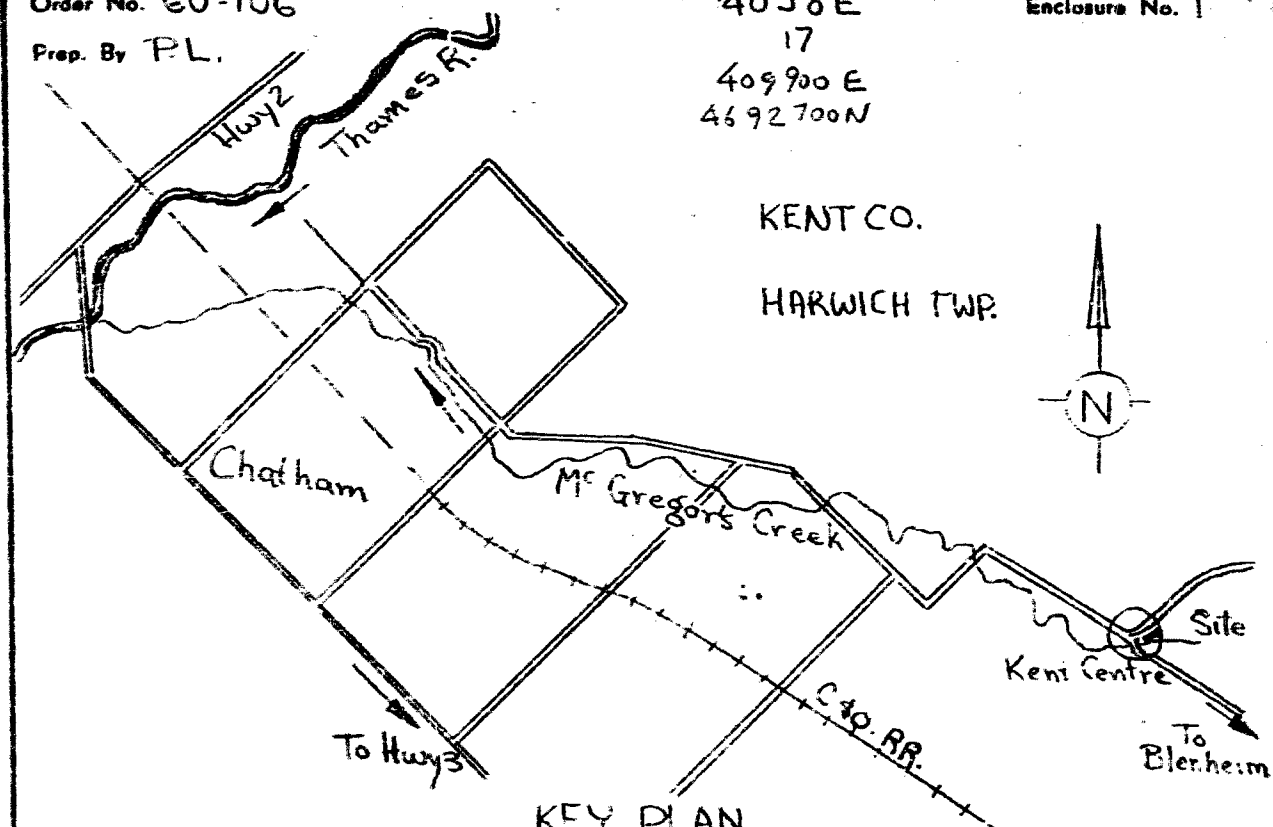
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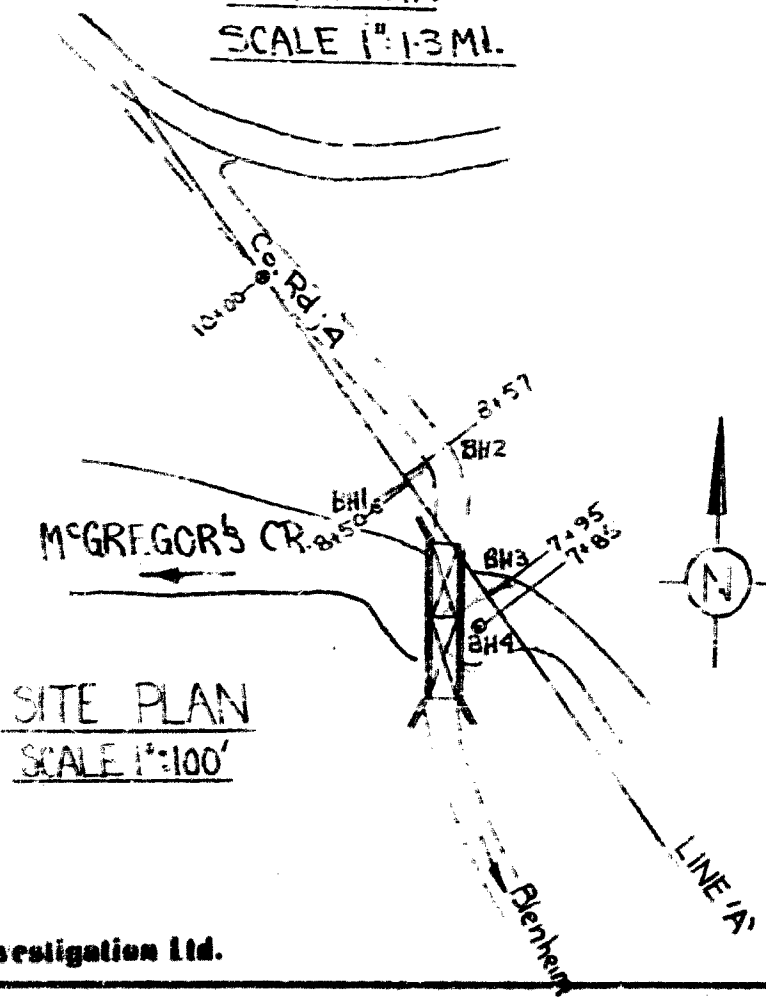
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4692700 N

Enclosure No. 1



KEY PLAN
SCALE 1"=1.3 MI.



SITE PLAN
SCALE 1"=100'

Dominion Soil Investigation Ltd.

Engineering Data Sheet for Borehole:

Project: Bridge across McGregor's Creek
Location: Co. Rd. 14, Harwich Twp., Kent
Hole Location: Sta. 8+60 - 25' Centre, Ont.
Hole Elevation and Datum: 591.3
Field Supervisor: PL & AK Prep.: P.L.
Driller: C.I. Checked:

LEGEND
Shear Strength (C)
Unconfined compression
Vane test and sensitivity (S)
Penetration Resistance (P)
2" Split tube
2" Dia. Cone
Casing

Consistency

Nature!

Liquidity Index (LI)

Liquid limit

Plastic limit

Sampling Method

2" Dia. split tube

Keywords: child sexual abuse; disclosure; social support

2" Shelby tube

SYMBOL	DESCRIPTION	ELEV. FEET	DEPTH FEET	STRENGTH AND PENETRATION RESISTANCE					CONSISTENCY					SAMPLE	NATURAL UNIT WT. P.C.F.	REMARKS
				1	2	3	4	5	MOISTURE CONTENT, % DRY WEIGHT							
				BLOWS/FT.												
	Ground level	591.3	0.0													
	Coarse grey silt, some sand, trace clay, trace organic matter, some iron stain, moist.															
	Loose coarse grey silt, some sand, trace organic fibre.	587.5												SS1		
	Grey coarse sand															
	Coarse silt, some sand, some organic matter, iron-stained, moist.	585.0												SS2		
	Very loose med.-fine alluvial sand, dark grey, some silt, some white calcareous material, trace organic fibre, moist.															
	Med. dense grey till	581.8												SS3		
	Grey till													TW4		
	Same as above													TW5		
	Grey till - increased silt content. Denser from 24"													SS6		
	Dark grey, very coarse sand, fine gravel, black shale, quartz, feldspar - loose.	564.3+														
	Med. dense grey till	562.3+												SS7		
	Med. dense grey sandy till: predominantly med-coarse sand, some gravel, moist.													SS8		
	CONTINUED ON ENCLOSURE #3	554.3+														

Dominion Soil Investigation Ltd.

Engineering Data Sheet for Borehole:

LEGEND

Shear Strength: (C)

- Unconfined compression

Vane test and sensitivity (S)

Penetration Resistance (P)

2.1 Split tube

2" Dia. Cone

Casing

Sampling Method

2" Dia. split tube

2" Shelby tube

LEGEND

Consistency

Natural moisture and

Liquid:

Liquid limit

Plastic limit

Sampling Method

2" Dia. split tube

— 2011 April 10

2" Shelby tube

SYMBOL	DESCRIPTION	ELEV. FEET	DEPTH FEET	STRENGTH AND PENETRATION RESISTANCE		CONSISTENCY		SAMPLE	NATURAL UNIT WT. P.C.F.	REMARKS
				C	P.S.F.	MOISTURE CONTENT, % DRY WEIGHT				
	CONTINUED FROM ENCLOSURE #2			0 20 40 60 80						
	Med. dense grey sandy till: predominantly med.-coarse sand, some gravel, moist.	554.3	35.0	P						
		552.3+								
	Dense grey fine sand. 5" layer of grey coarse sand. 2" layer of grey till		40.0							
		544.3+	45.0							
	END OF B.H.									

Dominion Soil Investigation Ltd.

Engineering Data Sheet for Borehole: 2 - Sheet 1 of 2

Dominion Soil Investigation Ltd.

Engineering Data Sheet for Borehole:

Date: Jan. 23, 60.

Project: McGregor's Creek Bridge
 Location: Co. Rd. 14, Harwich Twp, Kent Centre, Ont.
 Hole Location: Sta. 8+57 - 21' Rt. of Line 'A'
 Hole Elevation and Datum: 599.0
 Field Supervisor: PL & AK Prep.: P.L.
 Driller: C.I. Checked:

LEGEND

Shear Strength (C)

Unconfined compression
Vane test and sensitivity (S)

Penetration Resistance (P)

2" Split tube

2" Dia. Cone

Casing



Sampling Method

2" Dia. split tube

2" Shelby tube

LEGEND

Consistency

Natural moisture and

Liquidity Index (LI)

Liquid limit

Plastic limit



Sampling Method

2" Dia. split tube

2" Shelby tube



SYMBOL	DESCRIPTION	ELEV. FEET	DEPTH FEET	STRENGTH AND PENETRATION RESISTANCE					CONSISTENCY					SAMPLE	NATURAL UNIT WT. P.C.F.	REMARKS
				C _v	1500	2000	2500	3000	MOISTURE CONTENT, % DRY WEIGHT							
	Ground level	599.0	0.0	0	20	40	60	80	20	30	40	50	60			
	Brown clay, fine-med. sand, chunks of grey till, coarse gravel, some organic fibre, iron-stained, moist.															
	Fill - same as above.															
	<u>V.W.L.</u>	590.6														
	Stiff blue-grey clay, some silt, trace organic fibre, iron-stained trace fine gravel.	588.7	10.0											SS1		
	Alluvium, some clay, some silt, brown to grey, coarse gravel, etc. loose.	584.5	15.0											SS2		
	Loose coarse gravel (river material)	581.5														
	Med. dense grey silty till, some clay, some gravel, trace coarse sand.	580.5	20.0											SS3		
	Same as above.		25.0											SS4		
	Same as above, but more plastic and very clayey.		30.0											SS5		
		564.0	35.0											SS6		

CONTINUED ON ENCLOSURE #5

CONTINUED ON ENCLOSURE #5

Dominion Soil Investigation Ltd.

Engineering Data Sheet for Borehole:

Date: Jan. 28, 60.

Project: McGregor's Creek Bridge
Location: Co. Rd. 14, Harwich Twp., Kent Centre, Ont.
Hole Location: Sta. 8+57 - 21' Rt. of Line 'A'
Hole Elevation and Datum: 599.0
Field Supervisor: PL & AK Prep.: P.L.
Driller: C.I. Checked:

LEGEND

Shear Strength (C)

Unconfined compression
Vane test and sensitivity (5)

Penetration Resistance (P)

2" Split tube

2' Dia. Cone

Casing

LEGEND

Consistency

Natural moisture and

Liquidity Index (LI)

Liquid limit

Plastic limit

Sampling Method

2" Dia. split tube

2" Shelby tube

SYMBOL	DESCRIPTION	ELEV. FEET	DEPTH FEET	STRENGTH AND PENETRATION RESISTANCE					CONSISTENCY		SAMPLE	NATURAL UNIT WT. P.C.F.	REMARKS
				\checkmark	1500	2000	2500	3000 P.S.F.	MOISTURE CONTENT, % DRY WEIGHT				
				P	20	40	60	80 BLOWS/FT.					
	CONTINUED FROM ENCLOSURE #4	564.0	35.0										
	Med. dense grey till, very clayey.	560.0	40.0								SS7		

Dominion Soil Investigation Ltd.

Engineering Data Sheet for Borehole: 4 of 4

Dominion Soil Investigation Ltd.

Engineering Data Sheet for Borehole:

Project: McGregor's Creek Bridge

Location: Co. Rd. 14, Harwich, Kent, Ont.

Hole Location: Sta. 7+95 - 17' E. of Line A

Hole Elevation and Datum: 591.0

Field Supervisor: PL & AK Prep.: P.L.

Driller: C.I. Checked:

LEGEND

Shear Strength (C)

Unconfined compression
Vane test and sensitivity (S)

Penetration Resistance (P)

2" Split tube

2" Dia. Cone

Casing

Date: Jan. 30, 60.

LEGEND

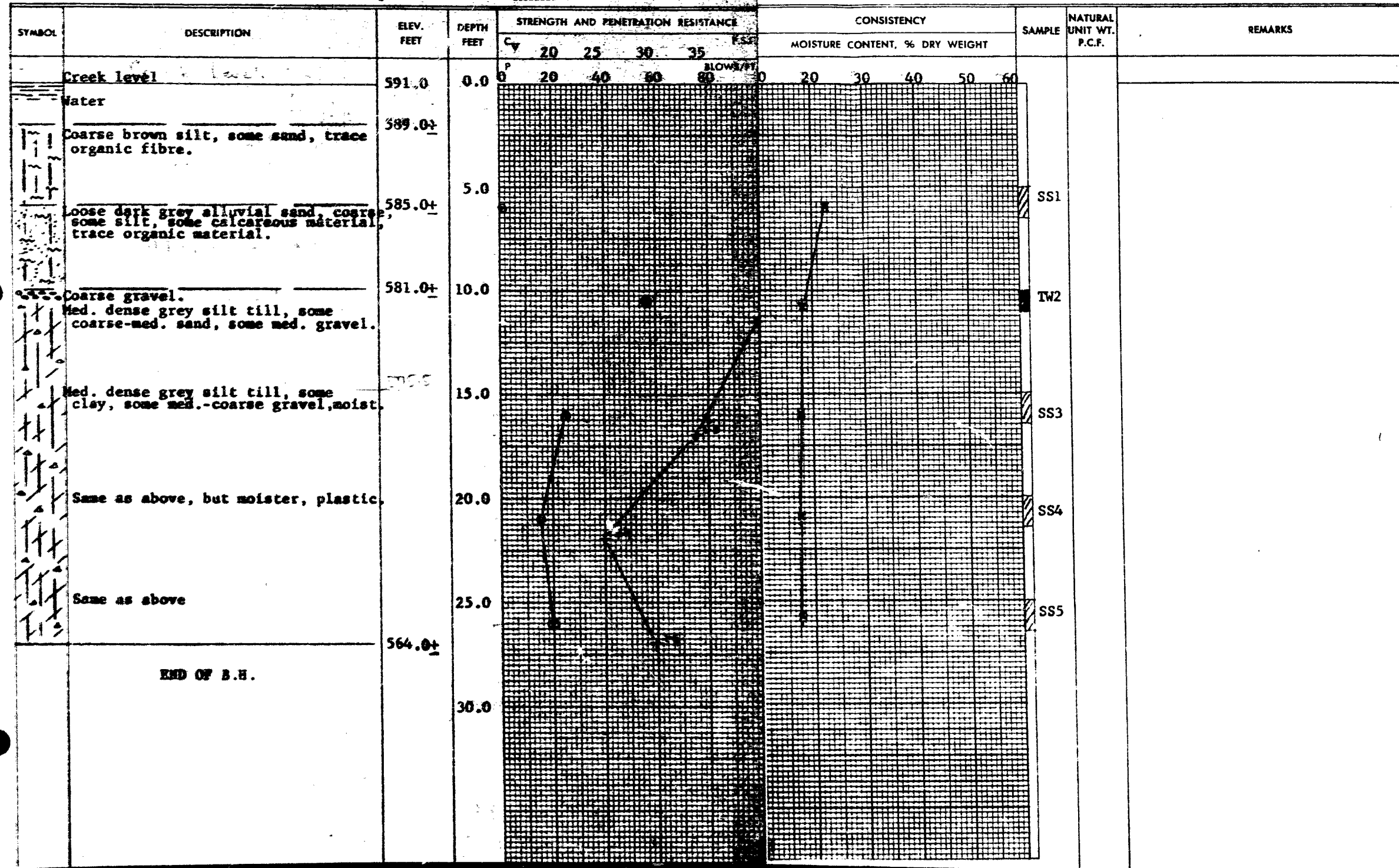
Consistency

Natural moisture and
Liquidity Index (LI)
Liquid limit
Plastic limit

Sampling Method

2" Dia. split tube

2" Shelby tube



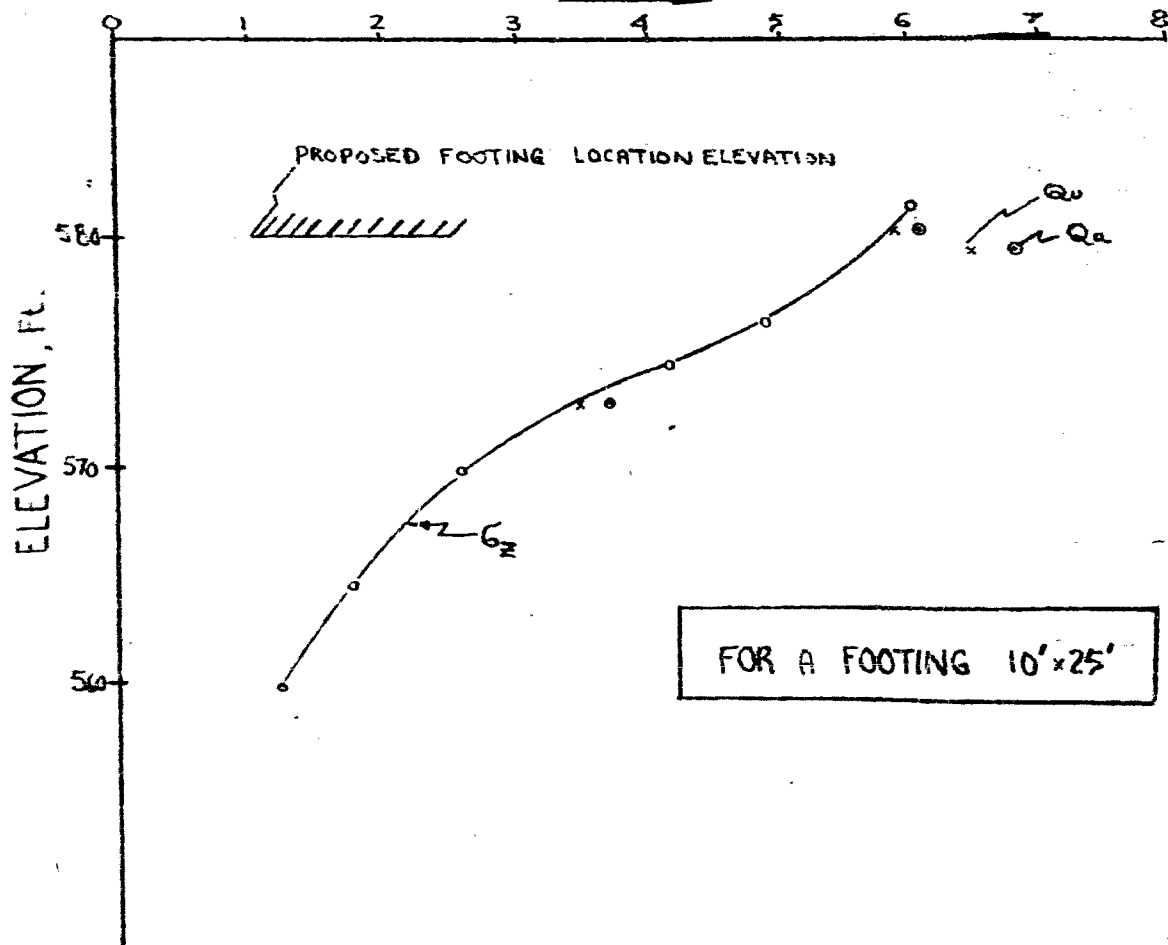
SUMMARY OF LABORATORY TEST RESULTS

Borehole & Sample No.	Elevation	Moisture Content%	W-pec	Uu (psf)	Strain	Liquid Limit	Plastic Limit	Plasticity Index
Borehole 1								
Sample 1	588.8	34.3						
" 2	585.3	52.0						
" 3	581.4	20.2						
" 4	579.55	17.4	133.0	6460	20%	42.3	25.1	17.2
" 5	572.80	18.1	130.6	3550	20%			
" 6	566.80	15.6						
" 7	563.05	22.8						
" 8	556.3	8.9						
Borehole 4								
Sample 1	586	22.7						
" 2	581	18.3	132.0	5825	20%			
" 3	576	17.7						
" 4	571	17.3						
" 5	566	17.9						

Prep. By

STRESS & CAPACITY DISTRIBUTION GRAPH

STRESS VS ELEVATION

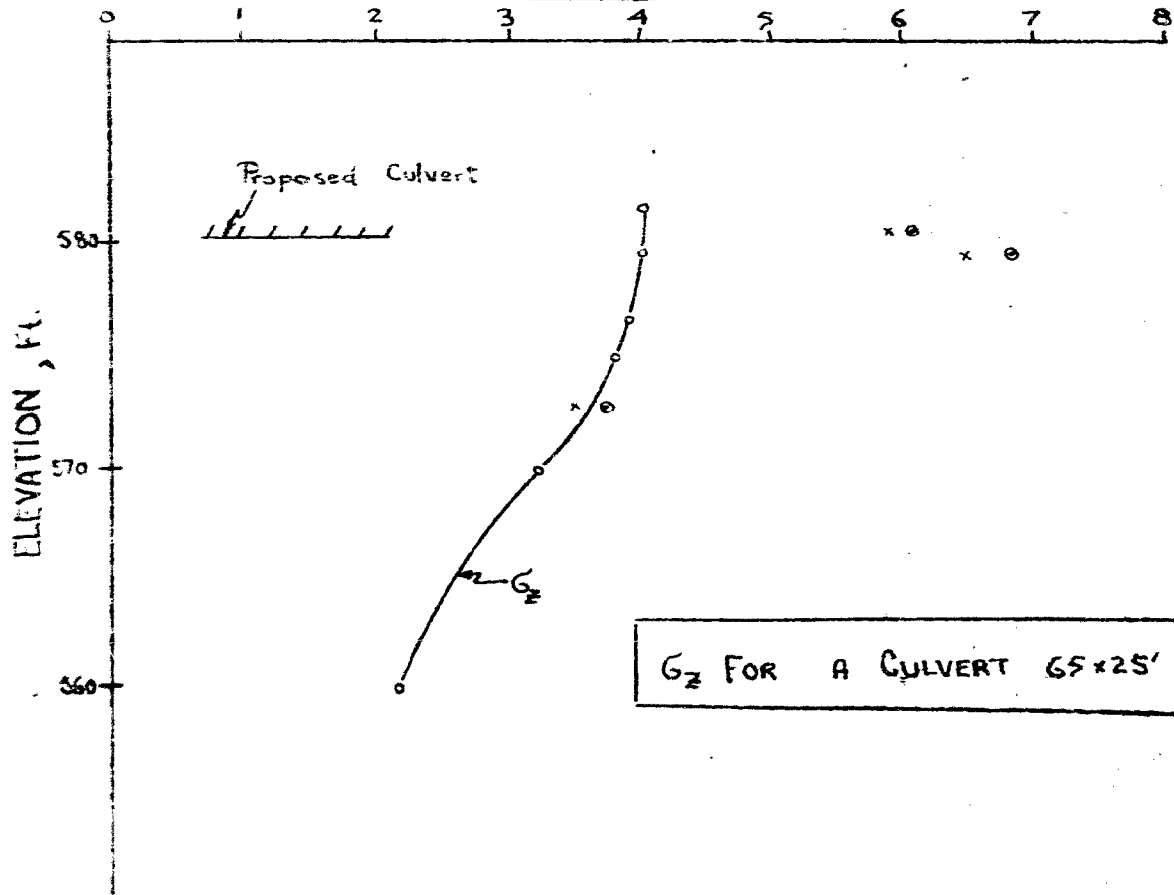
STRESS, PSF $\times 10^3$ LEGEND:

- o - G_z - Boussinesq Vertical Stress Distribution Curve, psf.
- x Q_u - Unconfined Compression Results, psf.
- Q_a - Safe Allowable Bearing Capacity
 $= 0.95 Q_u (1 + 0.3 \frac{B}{L})$ where $\frac{B}{L} = \frac{10}{25}$

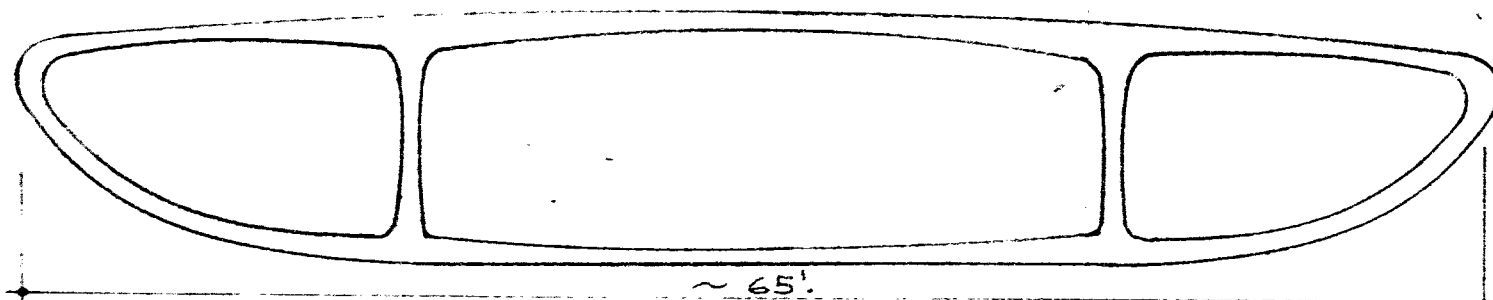
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STRESS & CAPACITY DISTRIBUTION GRAPH

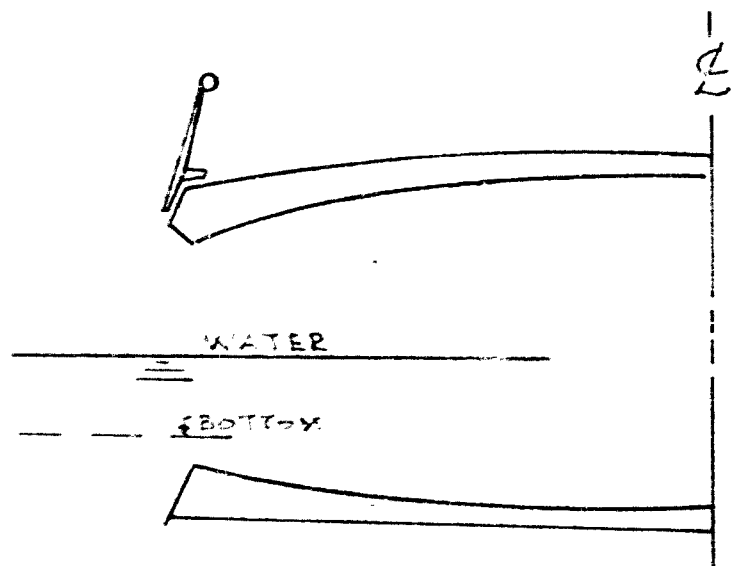
STRESS VS ELEVATION

STRESS, $\text{PSF} \times 10^3$ LEGEND:

- o G_z - Boussinesq Vertical Stress Distribution Curve, psf.
- x Q_u - Unconfined Compression Results, psf.
- o Q_a - Safe Allowable Bearing Capacity
 $= 0.95 Q_u (1 + 0.3 \frac{B}{L})$ where $\frac{B}{L} = \frac{25}{65}$



SUGGESTED
TRIPLE CULVERT.



SECTION.

Job No
60-106

DOM. SOIL INV. LTD.
88 EGLINTON AVE. E.

FOUNDATION CALCULATIONSExplanation:

#1. Safe Allowable Bearing Capacity, Q_a , was calculated from the formula $Q_a = 0.95 Q_u (1 + 0.3 \frac{B}{L})$ where Q_u = unconfined compression test results.

#2. The Bearing Capacity was checked, based on a minimum Q_a i.e. Minimum Q_a was set = G_z in Boussinesq's Formula. The smaller bearing value of ① & ② was taken as safe bearing capacity under the footing.

#3. Curves were plotted, elevation vs stress - G_z , Q_u , Q_a

* Reference - Tschebotarioff, "Soil Mechanics, Foundations and Earth Structures" - p 217

For a 10x30' Footing

$$Q_a = 0.95 \times 6460 (1 + 0.3 \times \frac{10}{30}) = 6740 \text{ psf at elev. 580}$$

$$Q_a = 0.95 \times 3550 (1 + 0.3 \times \frac{10}{30}) = 3650 \text{ psf at elev. 573}$$

$$Q_a \text{ at elev. 582.5} = 6080 \text{ psf at elev. 581}$$

For a Culvert 65'x25'

$$\text{where } \frac{B}{L} = \frac{25}{65}$$

$$Q_a \text{ at elev. 580} = 6340 \text{ psf}$$

$$Q_a \text{ at elev. 573} = 3760 \text{ psf}$$

$$Q_a \text{ at elev. 581} = 6170 \text{ psf}$$

Testing Minimum Q_a from above

- Footing placed at 582 or below

$$Z = 582 - 573 = 9'$$

$$b = 3'$$

$$a = 15'$$

$$\frac{a}{b} = 3$$

$$\frac{Z}{b} = \frac{9}{3} = 1.8$$

$$4 \gamma \bar{G}_z = 3650 \text{ psf}$$

$$\bar{G}_z = 913 \text{ psf}$$

$$\frac{\bar{G}_z}{P} = 0.14$$

$$\text{Capacity, } P = \frac{G_z}{0.14} = \frac{913}{0.14} = 6520 \text{ psf.}$$

∴ Use 6080 as capacity for area at elev. 582.

For 65' x 25' Culvert -

Culvert bottom at 582'

$$Z = 9' \quad b = 12.5 \quad \frac{q}{b} = 2.6 \quad \frac{Z}{b} = \frac{9}{12.5} = .72$$

$$4 \times G_z = 3760 \text{ psf.}$$

$$G_z = 940 \text{ psf.}$$

$$\frac{G_z}{P} = 0.23$$

$$\text{Capacity, } P = \frac{940}{0.23} = 4080 \text{ psf.}$$

∴ Use 4080 as capacity for area at elev. 582

Boussinesq's Stress Distribution - 60-106

A Footing 10 x 20'

Elev.	Z	Z/b	G_z/P	$4 \times G_z$ psf
582	0	0	.25	6170 psf.
580	2	0.4	.242	5980 psf
577	5	1.0	.200	4920 "
575	7	1.4	.170	4260 "
570	12	2.4	.108	2660 psf
565	17	3.4	.075	1850 "
560	22	4.4	.056	1230 "

B Culvert 65' x 25'

Elev	Z	Z/b	G_z/P	$4 \times G_z$
582	0	0	0.25	4080 psf
580	2	0.16	0.250	4050 psf
577	5	0.40	0.242	3950 "
575	7	0.56	0.238	3880 "
570	12	0.96	0.205	3340 "
565	17			
560	22	1.76	0.140	2280 "