FRED. A. BELL AND ASSOCIATES
CONSULTING ENGINEERS
ST. THOMAS ONTARIO

BA - 2250

[illegible] SITE No 5-106

65-F-267M

Report on

SOIL INVESTIGATION

for

ROAD BRIDGE

LOTS 30-31, CONCESSION 9

TOWNSHIP OF MALAHIDE

by

DOMINION SOIL INVESTIGATION LIMITED
369 Queens Avenue
LONDON ONTARIO

Reference No. 5-5-L9
June 22nd, 1965

CONTENTS

ENCLOSURES

SUMMARY

The two borings showed that the soil profile consists of granular sand strata extending down to about El. 54 overlying very stiff silty clay.

It is recommended that the structure should be supported on spread footings at or below El. 58. The soil at this depth is susceptible to scour and a hydrological study should be made to clarify this point. The estimated total settlement is less than 1 inch.

Construction problems are discussed.

I INTRODUCTION

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

The existing structure is located on Lots 30-31 Concession 9 of the Township and has a clear span of 36 feet.

It is understood that the new structure will be a 45 foot span concrete rigid-frame and the centre line will be the same as the centre line of the existing bridge. The requirements of the project were discussed with Mr. R. L. Lemon, P. Eng., 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 two boreholes to a maximum depth of 24 feet was carried out during the period May 21st. to 23rd, 1965, using a diamond drill machine equipped for soil sampling. The holes were advanced by washboring methods and were lined with Bx casing.

Standard Penetration Tests using a 2" outside 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' 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 recovered for classification purposes. The results are plotted as 'N' values on the Geotechnical Data Sheet for each borehole and are also given on the Subsurface Profile, Enclosure 2.

Dynamic Cone Penetration Tests were performed adjacent to each borehole location. This test gives a continuous profile of the soil density changes with depth.

The locations of the boreholes are shown on the site plan, Enclosure 2, and elevations have been referred to a Benchmark which was established by the client (top of north-east wing wall of existing bridge El. 74.58).

III SUBSURFACE CONDITIONS

Detailed descriptions of the strata encountered in each borehole are given on the data sheet comprising Enclosure 3 and a general picture of the soil stratigraphy is given in the form of a Subsurface Profile on Enclosure 2.

The boreholes revealed the following general ground succession:-

		Thickness BH1	Thickness BH2
(a)	TOPSOIL	1'-6"	
(b)	Grey fine to coarse SAND with fine gravel. The relative density of this stratum is described as 'compact' as estimated from Standard Penetration Test Results ranging from 12 to 39 blows per foot.	14'-6"	7'-0"
(c)	Grey fine SAND. The relative density of this stratum is described as 'loose' as estimated from a Standard Penetration Test Result of 9 blows per foot.		3'-9"
(d)	Brown/grey silty CLAY. The consistency of this stratum is described as 'very stiff' as indicated by Standard Penetration Test Results ranging from 21 to 26 blows per foot.	Penetrated 8'-0"	Penetrated 5'-9"

IV GROUNDWATER CONDITIONS

At the time the field work was carried out the elevation of the water in the stream was recorded at El. 64.3. The water level recorded in the boreholes after the drilling was completed was El. 63.8 in borehole 1, and El. 64.4. in borehole 2, indicating that the ground water table is the same as the water level in the stream at any particular time.

V LABORATORY TESTS

Natural moisture content and Atterberg limit tests were carried out on two samples of the silty clay which underlies the sand stratum. The results of the tests, which are presented graphically on the Geotechnical Data Sheet, classify the material as an inorganic clay of low plasticility. The natural moisture content of the soil is slightly lower than the plastic limit.

One grain size analysis was made on a sample of the sand stratum from borehole 1. The grain size distribution curve is presented on Enclosure 4, indicating that the material is predominantly a fine sand with some medium to coarse sand and fine gravel, and a trace of silt.

VI DISCUSSION

The general soil profile consists of granular sand strata extending down to about El. 54, overlying very stiff silty clay.

The bed of the stream extends to El. 64.1 and the soil at this level is susceptible to erosion. If the structure is to be supported on conventional spread footings it is recommended that these should bear at least 6 feet below the stream bed, i.e. El. 58, although even at this level there may still be some danger from scour. It is suggested that a hydrological study should be made to clarify this point.

The recommended maximum net soil pressure for the design of footings at or below El. 58 is 4000 pounds per square foot. The settlement from this pressure is estimated to be less than 1 inch.

A major problem in constructing footings in the prevailing soil conditions will be to control the groundwater and to prevent the natural sand below the footings from being disturbed. This can be done by carrying out the excavation inside a timber or sheet pile enclosure which should penetrate to the silty clay stratum. Interlocking steel sheet piling can be used as a temporary construction measure and also if left in place will confine the sand stratum beneath the footings and provide scour protection.

An alternative procedure would be to use a well-point system to lower the groundwater table below the bottom of the footings during the construction period.

VI Cont'd

The coefficient of friction between the footings and the sand stratum may be taken as 0.40 and the factor of safety against horizontal sliding of the abutments should be at least 1.5.

Yours very truly,

DOMINION SOIL INVESTIGATION LIMITED

C.J.W. Atkinson

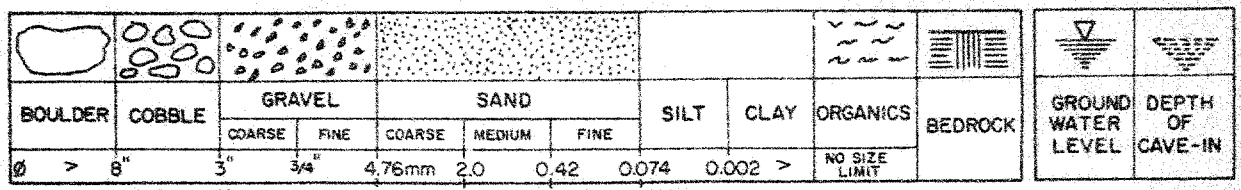
CJWA:jms

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

Enclosures

LIST OF SYMBOLS, ABBREVIATIONS AND NOMENCLATURE.

SOIL COMPONENTS AND GROUND WATER CONDITIONS.



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

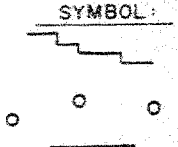
Washwater lost

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.

SYMBOL :



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EXTRAPOLATED -N- VALUE

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

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 total stress
PI %	Plasticity index	C_v	Coeff. of consolidation	C'	Cohesion — in terms of effective stress
LI	Liquidity index	m_v	Coeff. of volume compressibility	ϕ'	Angle of int. friction — in terms of effective stress

UNDRAINED SHEAR STRENGTH.

— DERIVED FROM —

TRIAXIAL COMPRESSION TEST

UNCONFINED TEST St

LABORATORY VANE TEST St

FIELD St

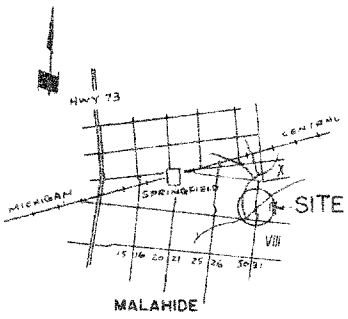
POCKET PENETROMETER TEST St

Strain at failure is represented by direction of stem: 20%, 15%, 5%, 10%

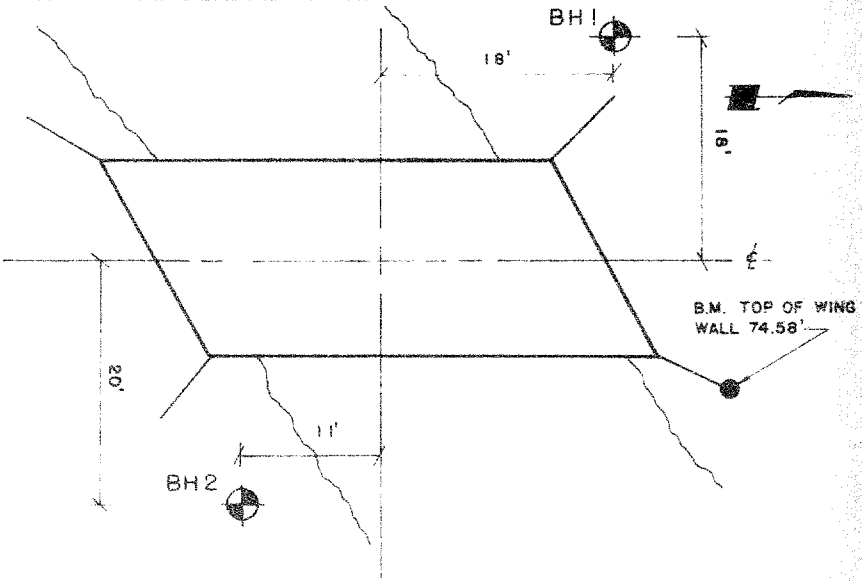
St : sensitivity = $\frac{\text{shear strength in undisturbed state}}{\text{shear strength in remoulded state}}$

SOIL DESCRIPTION.

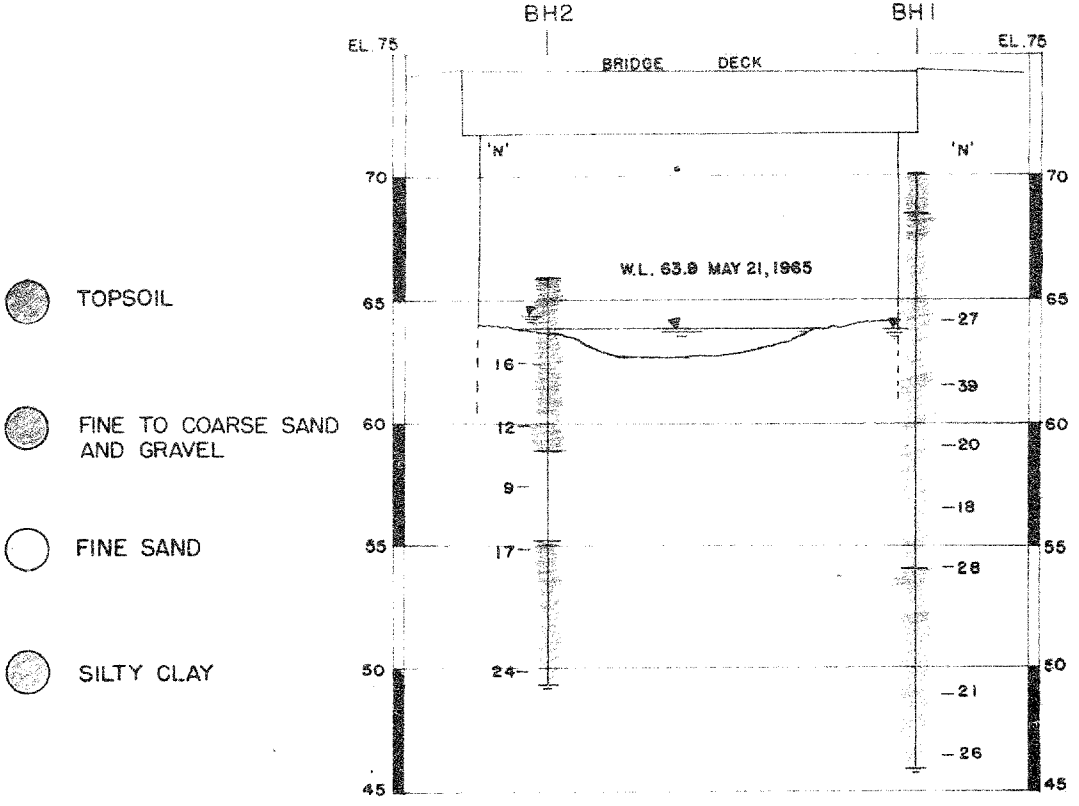
COHESIONLESS SOILS :	RD :	COHESIVE SOILS :	C lbs/sq ft
Very loose	0 – 15 %	Very soft	less than 250
Loose	15 – 35 %	Soft	250 – 500
Compact	35 – 65 %	Firm	500 – 1000
Dense	65 – 85 %	Stiff	1000 – 2000
Very dense	85 – 100 %	Very stiff	2000 – 4000
		Hard	over 4000



KEY PLAN
SCALE
1" = 4 MILES



LOCATION OF BOREHOLES
SCALE 1" = 10'



SUBSURFACE PROFILE
VERT. SCALE 1" = 5'

DOMINION SOIL INVESTIGATION LIMITED

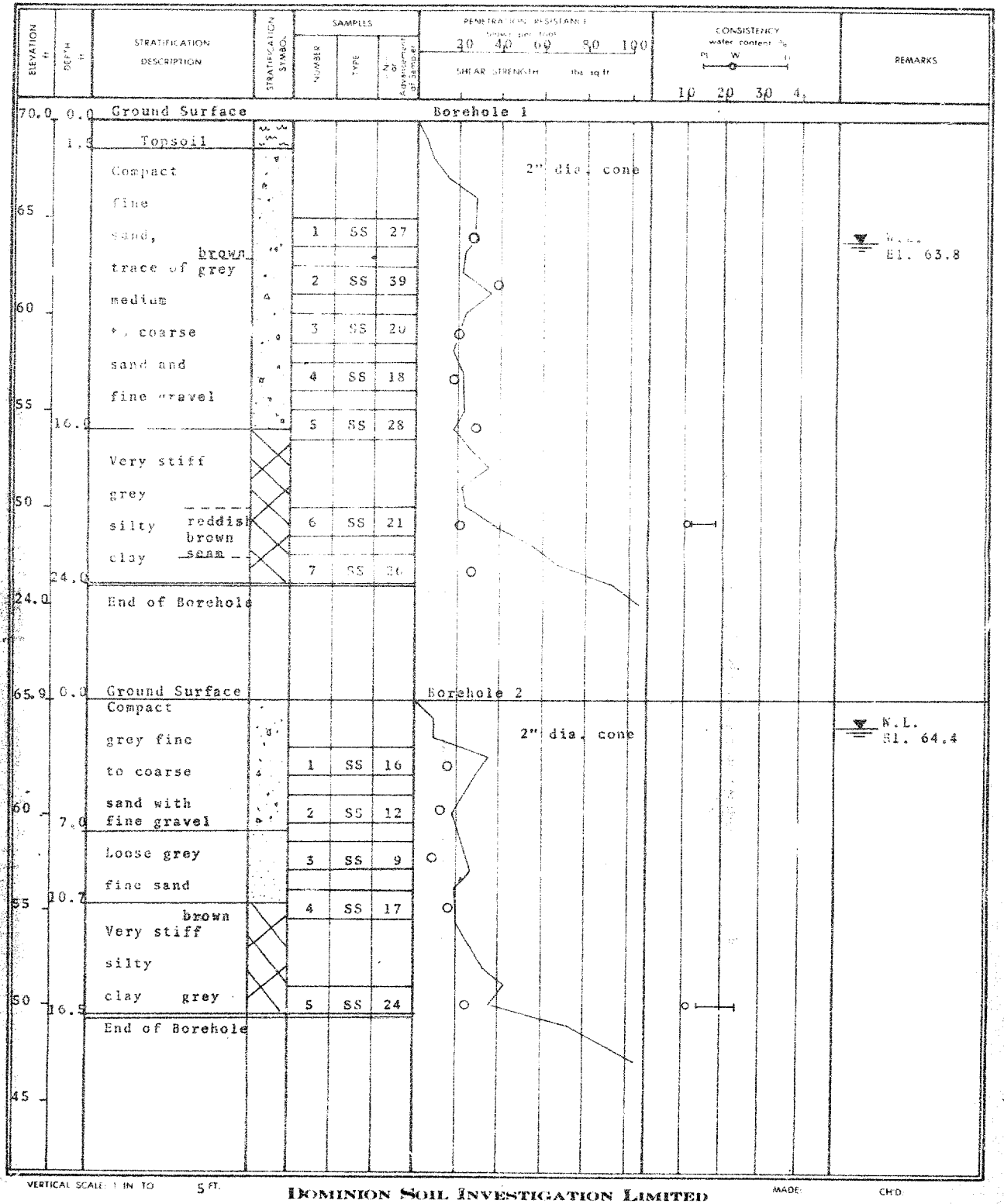
GEOTECHNICAL DATA SHEET FOR BOREHOLES 1 and 2

OUR REFERENCE NO 5-S-L9

CLIENT: Fred A. Bell and Associates
PROJECT: Bridge
LOCATION Lots 30-31, Conc. 9, Twp. of Malahide
DATUM ELEVATION 100 feet

METHOD OF BORING: Washboring
DIAMETER OF BOREHOLE: BX (3-inch)
DATE: May 21st to 23rd, 1

ENCLOSURE NO



VERTICAL SCALE: 1 IN TO 5 FT.

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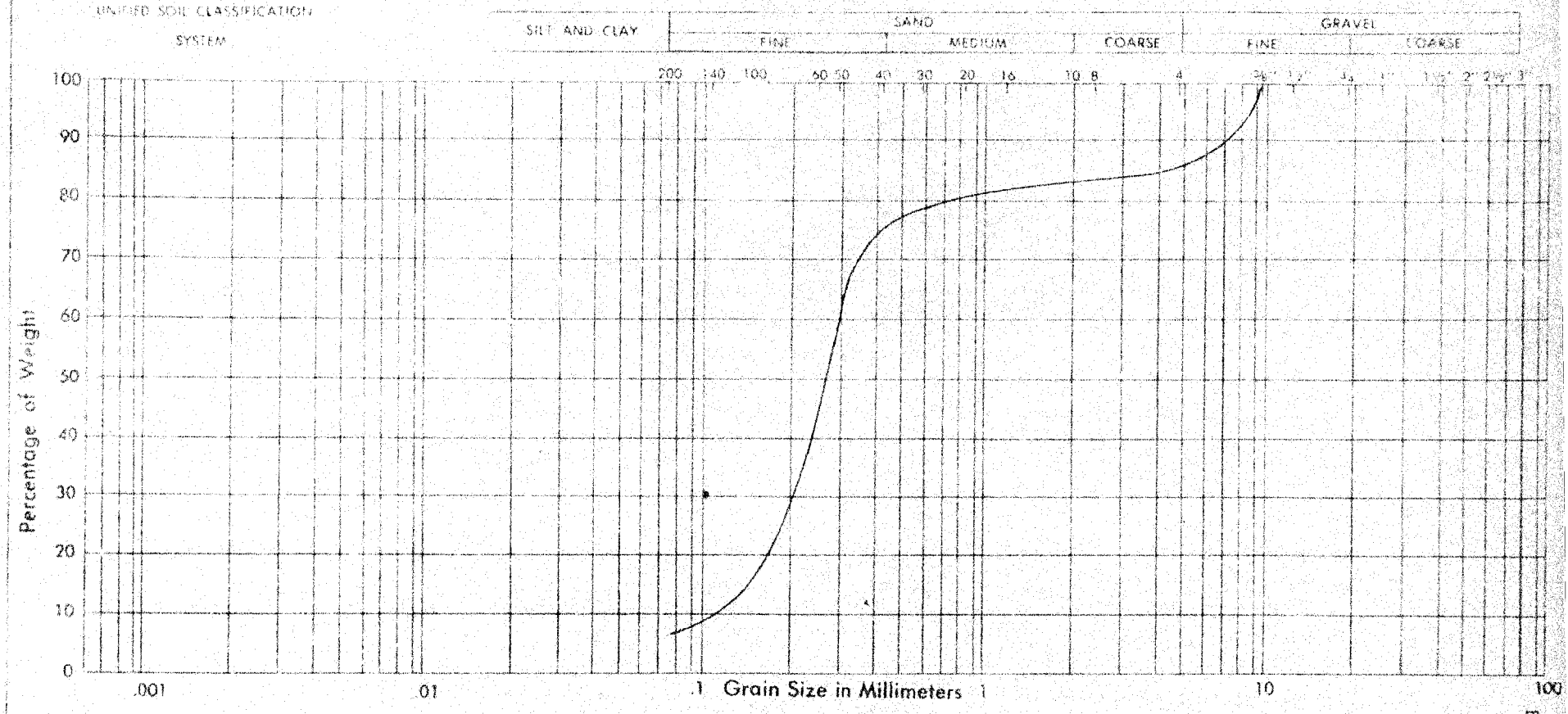
GRAIN SIZE DISTRIBUTION

OUR REFERENCE NO. 5-5-L9



PROJECT: Bridge

LOCATION: Twp. of Malahide

BOREHOLE NO.: 1

SAMPLE NO.: 2

DEPTH OF SAMPLE: 7'-6"

ELEVATION OF SAMPLE: 62.5 feet

COEFFICIENT OF UNIFORMITY: 3.0

COEFFICIENT OF CURVATURE:

Classification of Sample and Group Symbol:
Fine sand with some medium to coarse sand and fine gravel, trace of silt.

PLASTIC PROPERTIES:

LIQUID LIMIT: % —

PLASTIC LIMIT: % —

PLASTICITY INDEX: % —

MOISTURE CONTENT: % —

ACTIVITY: —

Enclosure No. 4

cc: Foundations Office (Rm. 110)

Mr. K. L. Kleinsteiber,
Municipal Bridge Liaison Engr.,
Bridge Division.

Attn: Mr. G. C. E. Burkhardt,
Municipal Bridge
Checking Engineer.

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

February 17, 1966

Your Memo -- Feb. 9/66

Township of Malahide,
Bridge over Catfish Drain,
Lots 30/31, Con. IX,
County of Elgin,
Structure Site No. 5-106.
Your File Ref. BA 2250

With reference to your memo of February 9, 1966, regarding the above structure, we wish to make the following comments:

From the Preliminary Plan, it appears that the consultant has chosen a rigid frame type of structure founded on spread footings. It cannot be overemphasized that dewatering during construction should be carried out in such a manner as to assure that the natural soil below the footing elevation remains undisturbed. Also, adequate permanent scour protection measures should be applied if the hydrological study indicates that such treatment is required.

AGS/MdeP

A. G. Stermac,
PRINCIPAL FOUNDATION ENGINEER

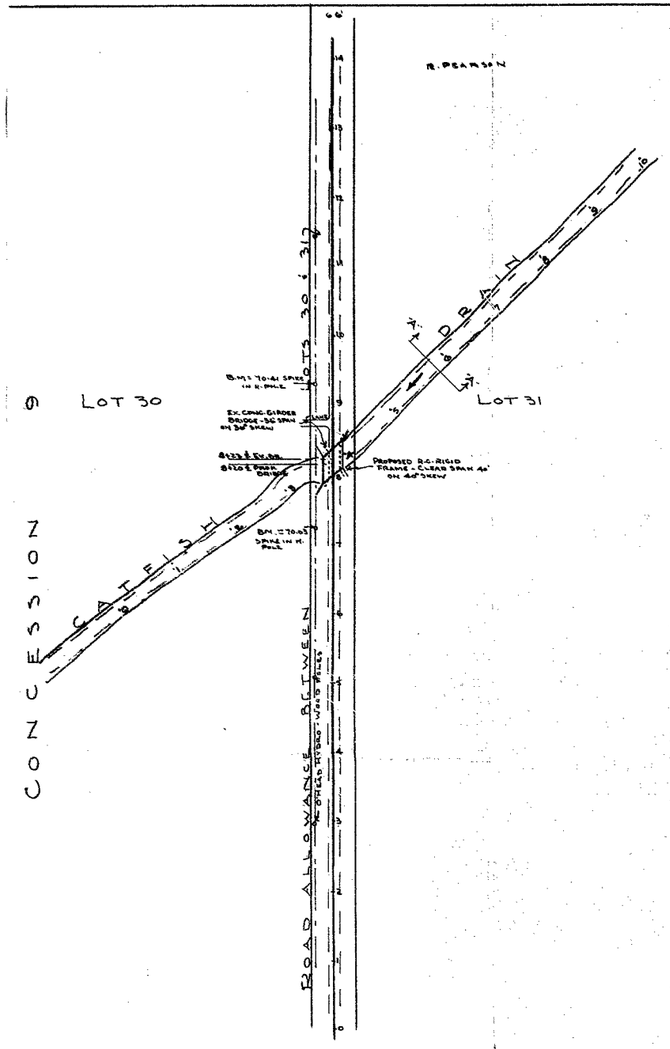
cc: Foundations Office
Gen. Files

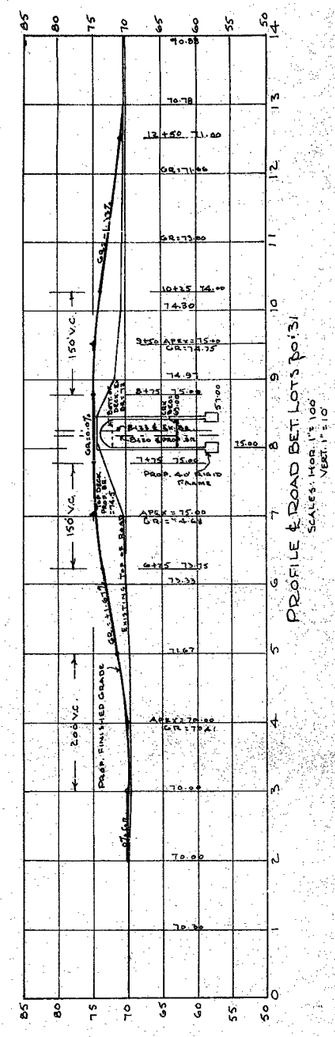
65-F-267M

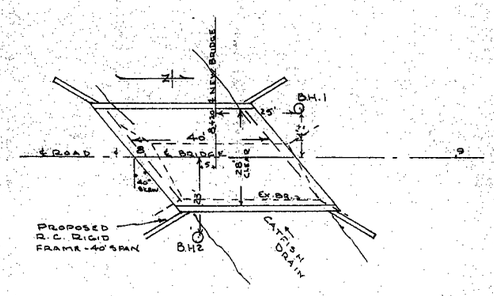
LOTS 30+31, CON. 9

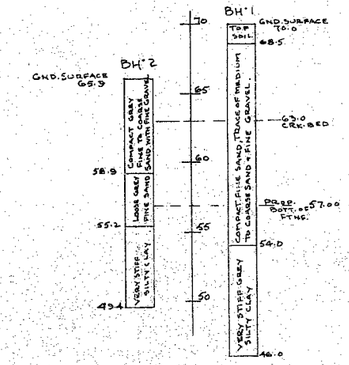
CATFISH DRAIN

MALAHIDE









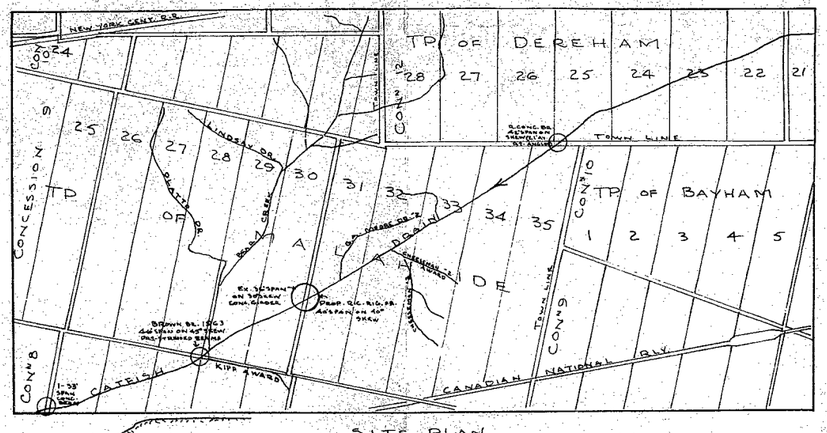
BOREHOLE RESULTS
1" = 5'

DATA

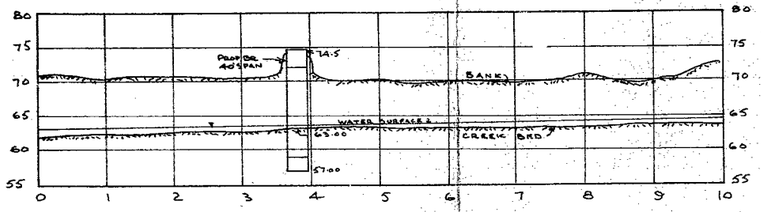
1. SOME DEBRIS, BRUSH, ICE ETC. CARRIED DURING FLOODS. STREAM HAS A GRADIENT OF 3.7 FT. PER MILE.
2. DOWNSTREAM BRIDGES: 0.67 MI. BUILT 1963 - 46'-0" SPAN ON 45° SKEW. PRESTRESSED CONC. BEAMS
   1.57 MI. 35' SPAN - SKEWED - 60± YRS. OLD - CONC. BEAMS.
   BOTH BRIDGES ADEQUATE.
   UPSTREAM BRIDGE: 1.6 MI. BUILT 1941 - 42' SPAN 20° SKEW (21' AT ST. 4) R. CONCRETE.
3. HEIGHT REMAINS SAME APPROX. SPAN INCREASED DUE TO INCREASE OF SKEW ANGLE.
4. DITCH GRADIENT COULD BE LOWERED SMALL AMOUNT UNDER THE DRAINAGE ACT S.O.T.B. - NOT APPLICABLE
5. NO TEMPORARY DETOUR.
10. INFORMATION AND EVIDENCE OF EXTREME FLOODING WAS OBTAINED FROM MR. RONALD PEARSON AREA RESIDENT FOR 17 YEARS. HE ESTIMATES THE HIGHEST WATER ELEVATION IN THE AREA OF THIS CONSTRUCTION TO BE 71' AND THE LOWEST WATER ELEVATION TO BE 64'. THE ABOVE FIGURES ARE FOR INFORMATIONAL PURPOSES ONLY AND NO WARRANTY IS MADE THAT THESE FIGURES ARE IN ANY WAY INDICATIVE OF THE HIGH AND LOW ELEVATION TO BE EXPECTED OR ENCOUNTERED DURING THIS CONSTRUCTION.

STRUCTURE DATA

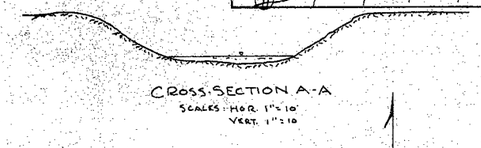
1. NET SPAN LENGTH AND TYPE OF BRIDGE
   1-40' REINFORCED CONC. RIGID FRAME ON 40° SKEW
2. ROADWAY WIDTH ON BRIDGE = 28 FT.
3. NO SIDEWALKS.
4. SKEW ANGLE = 40°
5. PILING - NONE
6. APPROXIMATE VOLUME OF CONCRETE = 400 C.Y.
7. " WEIGHT OF STRUCTURAL STEEL = NIL.
8. " " REINFORCEMENT = 50,000 lbs
9. VOLUME OF APPROACH FILL 100' EACH SIDE OF STRUCTURE.
   NORTH APPROACH = 300 C.yds.
   SOUTH APPROACH = 450 C.yds
   TOTAL = 750 C.yds
10. DRAINAGE AREA = 7000 ACRES.



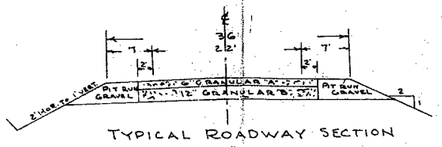
SITE PLAN
1" = 2000'



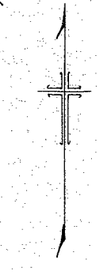
PROFILE: & CATFISH DRAIN
SCALES: HOR: 1" = 10'
VERT. 1" = 10'



CROSS-SECTION A-A
SCALES: HOR. 1" = 10'
VERT. 1" = 10



TYPICAL ROADWAY SECTION
1" = 10'



FRED A. BELL & ASSOCIATES
CONSULTING ENGINEERS ST. THOMAS ONT.

SITE PLAN
1-40' RIGID FRAME CONCRETE SPAN
ON ROAD BET. LOTS 30 & 31
CONⁿ 9 - TP. OF MALAHIDE
OVER CATFISH DRAIN

OWNER: TWP OF MALAHIDE
COUNTY: ELGIN
LOCATION - ROAD BET. LOTS 30 & 31 - CONⁿ 9 - TP. of MALAHIDE
LOADING: H 20-S16
ST. THOMAS ONT. JANUARY 24 1966
Robert L Lemon

563-54