

DOCUMENT MICROFILMING IDENTIFICATION

61-30 SEPT 1976

GEOCRES No. 40I14-89
DIST 2 REGION Southwestern
W.P. No. 41-66-15
CONT. No. 78-66
W. O. No. _____
STR. SITE No. 19-538
HWY. No. _____
LOCATION Concession 1 Road
Underpass

OVERSIZE DRAWINGS TO BE INCLUDED WITH THIS REPORT. 3

REMARKS: documents to be unfolded
before microfilming

ABSTRACT

The results of an investigation to determine the subsurface conditions at the site of the proposed underpass for the Highway 402 crossing of the Concession I Road in Lot 8, between Concession I and Concession D, Township of Delaware, County of Middlesex, Ontario are reported. Geotechnical engineering recommendations are made for the design and construction of the foundations, approach embankments and cuts for the underpass.

It was found that the site is underlain by compact sand over silty clay overlying silt. Beneath the silt, an extensive stratum of silty clay till was encountered overlying clayey silt till. The groundwater level in the upper sand appears to be perched several feet above the water level in the lower granular strata.

It is recommended that the pier and abutments be founded on spread footings bearing on the stiff to very stiff clayey silt or silty clay strata. Alternatively, the structure may be founded on relatively short friction piles driven into the silty clay and underlying silt strata.

No overall stability problems are anticipated with the approach embankments and cuts at the site.

May 1975
753052

1. INTRODUCTION

H. Q. Golder & Associates Ltd. has been retained by the Ministry of Transportation and Communications, Ontario to carry out a subsurface investigation at the site of the proposed underpass to be constructed for the Highway 402 crossing of the Concession I Road, in Lot 8, between Concession I and Concession D, Township of Delaware, County of Middlesex, Ontario. The site is located on the alignment of the proposed Highway 402 about 1.66 miles east of Highway 2 as indicated in the Key Plan on Figure 1. The purpose of the investigation was to determine the soil and groundwater conditions at the site of the proposed structure and to provide geotechnical engineering recommendations for the design and construction of the foundations, approach embankments and cuts required for the underpass.

2. PROCEDURE

A total of five boreholes, three accompanied by dynamic cone penetration tests, were drilled at the locations shown on the plan, Figure 1. The boreholes were drilled between April 15 and 22, 1975 using a truck mounted power auger supplied and operated by Master Soil Investigations Limited. The soil stratigraphy encountered in the boreholes is shown in detail on the Record of Borehole sheets following the text of this report and an inferred stratigraphic section across the site is shown together with the plan on Figure 1.

Standard penetration tests were carried out in all the boreholes and in addition, several relatively undisturbed thin walled tube samples of the cohesive strata were obtained. All the samples obtained during the investigation were brought to our London laboratory for detailed examination and

representative classification testing. The results of the laboratory tests are shown on the Records of Boreholes and on Figures 2 to 6 inclusive.

Groundwater levels were observed in the boreholes during drilling and perforated standpipes and piezometers were installed in the completed boreholes as detailed on the Record of Borehole sheets. The measured groundwater levels are shown on the Records of Boreholes and on the stratigraphic section, Figure 1.

Ground surface elevations at borehole locations have been referred to a bench mark located on a nail and washer in the northwest root of an 18 inch diameter ash tree 339 feet left of station 149+18 on the Highway 402 alignment. The elevation of this point was given by the Ministry of Transportation and Communications, Ontario as 757.44 feet referred to geodetic datum.

The field work was supervised throughout by an engineer from our staff who located the boreholes, determined ground surface elevations at borehole locations, logged the boreholes and cared for the samples obtained.

3. SITE AND GEOLOGY

The proposed underpass is located at Highway 402 chainage 153+43 in Lot 8 between Concession I and Concession D of the Township of Delaware, County of Middlesex, Ontario. This is about 1 mile south of the Village of Delaware and about 1.0 miles east of the Thames River. The site is situated on gently sloping land which falls predominantly to the east. The existing Concession I Road has been provided with a surface treatment wearing surface some 20 feet in width.

The site is located in the physiographic region known as the Caradoc Sand Plain. These beds of clays, silts and fine sands were deposited by the earliest glacial spillways discharging turbid water into a basin in the glacial till. When the standing water level had been lowered to the level of Lake Whittlesey, the early Thames River cut through these deposits to create its present valley located to the west of the site.

Available geological data indicate that the bedrock surface at the site is at about elevation 580 or some 180 feet below ground surface. The bedrock at the site is understood to consist of grey shale and limestone of the Hamilton formation of Devonian Age.

4. SUBSURFACE CONDITIONS

4.1 Soil Conditions

The soil conditions at the site generally consist of 2 feet of road base and topsoil overlying about 8 feet of compact sand which overlies about 22 feet of stiff to very stiff silty clay. Beneath the silty clay in boreholes 1, 4 and 5, up to 28 feet of very loose to very dense silt overlies a further layer of silty clay about 7 feet thick overlying strata of hard silty clay till and hard clayey silt till. Borehole 1 was terminated in a layer of hard silty clay underlying the till strata.

4.1.1 Sand

The sand layer which was encountered beneath the road base and topsoil varied in thickness from 6 to 13 feet at borehole locations. The sand had N values as measured in the standard penetration test of from 3 to 23 blows per foot

and was generally compact with a representative N value of 11 blows per foot. The natural water content of the sand varied from 9 to 21 per cent with an average value of about 18 per cent. Typical grain size distribution curves for the sand are shown on Figure 2.

4.1.2 Silty Clay

Beneath the sand layer, boreholes 1, 4 and 5 encountered from 21 to 24 feet of stiff to very stiff silty clay. The silty clay had N values of from 9 to 28 blows per foot with a representative N value of 18 blows per foot. The natural water content of the silty clay varied from 19 to 28 per cent with an average value of about 23 per cent. The corresponding liquid and plastic limits were 33 and 20 respectively. Typical grain size distribution curves for the silty clay are shown on Figure 3. Occasional layers of compact silt and silt partings were encountered within the silty clay stratum.

4.1.3 Silt

Beneath the silty clay stratum, a layer of very loose to very dense silt about 28 feet in thickness where fully penetrated in borehole 1 was encountered. The silt had measured N values of from 6 to 100 blows per foot and was generally compact with a representative N value of 22 blows per foot. The natural water content of the silt varied from 19 to 33 per cent with an average natural water content of about 24 per cent. Typical grain size distribution curves are shown on Figure 4 for the silt layer.

4.1.4 Tills

Below the silt and a 7 foot thick layer of very stiff to hard silty clay, borehole 1 encountered an extensive stratum of very stiff to hard silty clay till about 60 feet

thick. The silty clay till had measured N values of from 22 to 63 blows per foot. The natural water content of the till varied from 15 to 20 per cent with an average of 18 per cent. The corresponding liquid and plastic limits were 30 and 18 respectively. Typical grain size distribution curves for the silty clay till are shown on Figure 5.

Underlying the silty clay till, borehole 1 encountered a 15 foot thick stratum of hard clayey silt till. This stratum of clayey silt till had N values of from 41 to greater than 100 blows per foot. The average natural water content was about 12 per cent with corresponding liquid and plastic limits of 24 and 18 respectively. A typical grain size distribution curve for the clayey silt till is shown on Figure 6. Borehole 1 was terminated in a layer of hard silty clay. The silty clay had a single N value of greater than 100 blows per foot and a natural water content of 27 per cent.

4.2 Groundwater Conditions

The groundwater levels measured in the piezometers and perforated standpipes installed in the completed boreholes varied from elevation 742 to elevation 758 or from 4 to 22 feet below ground surface. A comparison of the water levels measured in the shallow standpipes and those measured in the piezometers installed at depth indicates, in the absence of long term observations, that the water levels measured in the surficial sand stratum represent a perched condition which is probably susceptible to considerable seasonal fluctuations.

5. DISCUSSION

It is understood that a two span bridge about 196 feet long and 32 feet wide is to be constructed at the location shown on the plan, Figure 1, to carry the Concession I Road over the proposed Highway 402. The probable structure footing locations as provided by the Ministry of Transportation and Communications, Ontario are shown on the plan, Figure 1. The proposed structure will probably consist of precast prestressed concrete girders set on a central pier and the abutments. The abutments may either be full height retaining type or may be perched in the approach fill. The proposed bridge centreline grade for the Concession I Road is at about elevation 770 and the centreline elevation of both the proposed eastbound and westbound lanes of Highway 402 is at about elevation 750.

5.1 Foundations

5.1.1 Spread Footings

The proposed structure may be founded on conventional spread footings bearing in the silty clay stratum. Due to the stiff to very stiff consistency of this stratum, the maximum allowable bearing pressure would be limited to 3 kips per square foot. In order to provide a minimum of at least 3 feet of frost cover the footings would have to be founded at about elevation 744. The total settlement of the bridge founded on spread footings should not exceed 2 inches with a maximum anticipated differential settlement of 1 inch.

5.1.2 Piles

Alternatively, the proposed bridge may be constructed on a pile foundation utilizing relatively short friction piles driven into the silty clay and underlying silt strata.

For 12 inch nominal diameter piles penetrating 25 feet into the clayey silt and silty clay strata, an allowable load of 20 tons per pile may be used in design. The piles may consist of precast, prestressed concrete; steel tubes driven closed ended and filled with concrete following the completion of driving; or pressure treated timber piles. Pile driving data should be carefully recorded and the pile capacity checked using dynamic formula. Increase of the pile capacity above 20 tons per pile should be confirmed by load testing at least 2 piles during construction. Allowance for time effects should form part of the test procedures and evaluation. Pile caps should be provided with at least 3 feet of frost cover. The outer ring of piles should be battered in all directions. The settlement of the completed structure founded as detailed above can be confirmed by the load test but should not exceed 1 inch.

5.2 Abutments

If retaining type abutments are used, it is recommended that free draining and non-frost susceptible granular backfill be used behind the abutments. The granular backfill should be compacted in horizontal thin layers and should extend horizontally from the back face of the abutment walls for a minimum distance of 6 feet. A maximum loose layer thickness of 18 inches may be used providing vibratory equipment is used for compaction of each layer. The granular backfill should be uniformly compacted to at least 95 per cent of standard Proctor maximum dry density. It is recommended that, providing there is effective drainage behind the walls, a coefficient of lateral earth pressure of 0.3 and a total unit weight of 135 pounds per cubic foot be used for the compacted granular backfill in the design of the walls.

5.3 Embankments

No geotechnical problems are anticipated during the construction of the proposed 7 foot high embankment for the Concession I Road and standard 2 horizontal to 1 vertical side slopes may be used. Native material may be used to construct these embankments in accordance with the procedures outlined in the Ministry of Transportation and Communications, Ontario specification, Form 214.

5.4 Cut Slopes

General excavation for the road base for Highway 402 in the area of the proposed structure will require cutting some 14 to 17 feet below the existing ground surface. Based on the soil and groundwater conditions encountered in the boreholes, such cuts will encounter from 2 to 5 feet of saturated sand overlying the silty clay and layers of saturated silt within the silty clay stratum. In order to maintain a stable permanent slope in these materials at normal 2 horizontal to 1 vertical slopes, it is recommended that the cut slopes be blanketed with a suitably graded filter material immediately following excavation.

5.5 Excavations

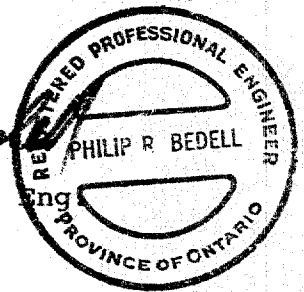
If the footing excavations are carried out following the completion of the cut for Highway 402, no major geotechnical problems are anticipated during construction. Some groundwater seepage will probably be experienced but the anticipated volumes can be handled by pumping from filtered sumps located outside the limits of the footings or pile caps. If foundation construction is carried out prior to cutting the Highway 402 grade at the site, some difficulty due to groundwater seepage from the sand layer and the silt layer and seams in the clayey silt stratum is

anticipated. In this case, the excavation should be sheeted if vertical sides are required or if open cut is used the temporary construction slopes should be blanketed with coarse free draining granular material. The anticipated volumes of groundwater seepage can be handled by pumping from properly constructed sumps located outside the limits of the footings or pile caps. Further, it is recommended that a small berm be provided at the sand/clay interface for all excavations extending below this level. The undrained shear strength of the cohesive deposits at the site is sufficient that no overall stability problems are anticipated for the 20 foot maximum excavations required at the site.

H. Q. GOLDER & ASSOCIATES LTD.,

Philip R. Bedell

Philip R. Bedell, P. Eng.



R. A. Gould

R. A. Gould, P. Eng.

PRB:RAG:az

RECORD OF BOREHOLE 1

CO-ORDINATES N 15,566,860 E 1,293,410

Sheet 1 of 2

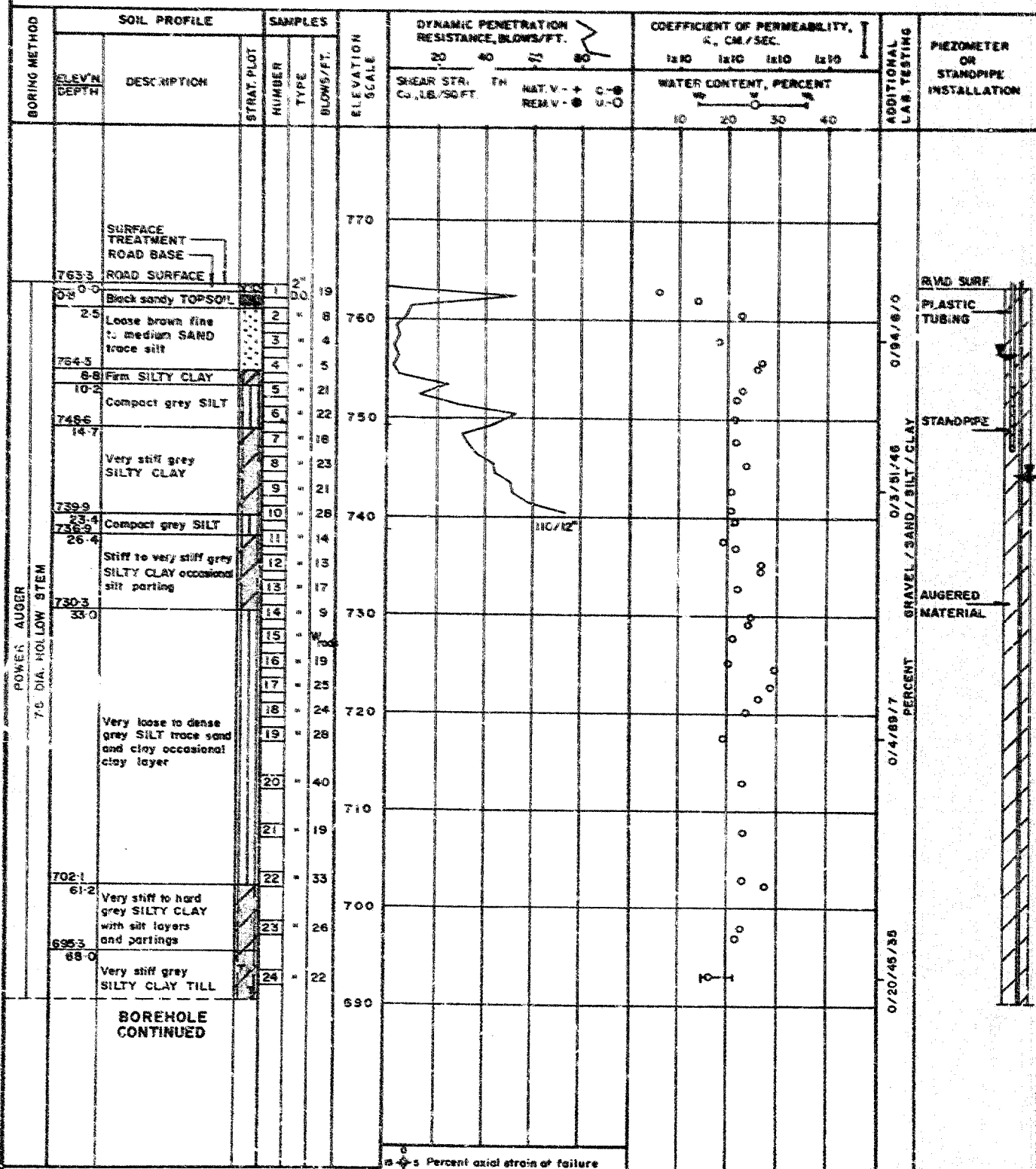
LOCATION See Figure 1

BORING DATE APRIL 15 1975

DATUM GEODETTIC

SAMPLER HAMMER WEIGHT 140 LB., DROP 30 IN.

PENETRATION TEST HAMMER WEIGHT 140 LB., DROP 30 IN.

VERTICAL SCALE
1 IN. TO - FT.

Golder Associates

DRAWN W.D.F.
CHECKED P.R.B.

Sheet 2 of 2

DATUM GEODETIC

PENETRATION TEST HAMMER WEIGHT 140 LB., DROP 30 IN:

[illegible]

RECORD OF BOREHOLE^s 2 & 3

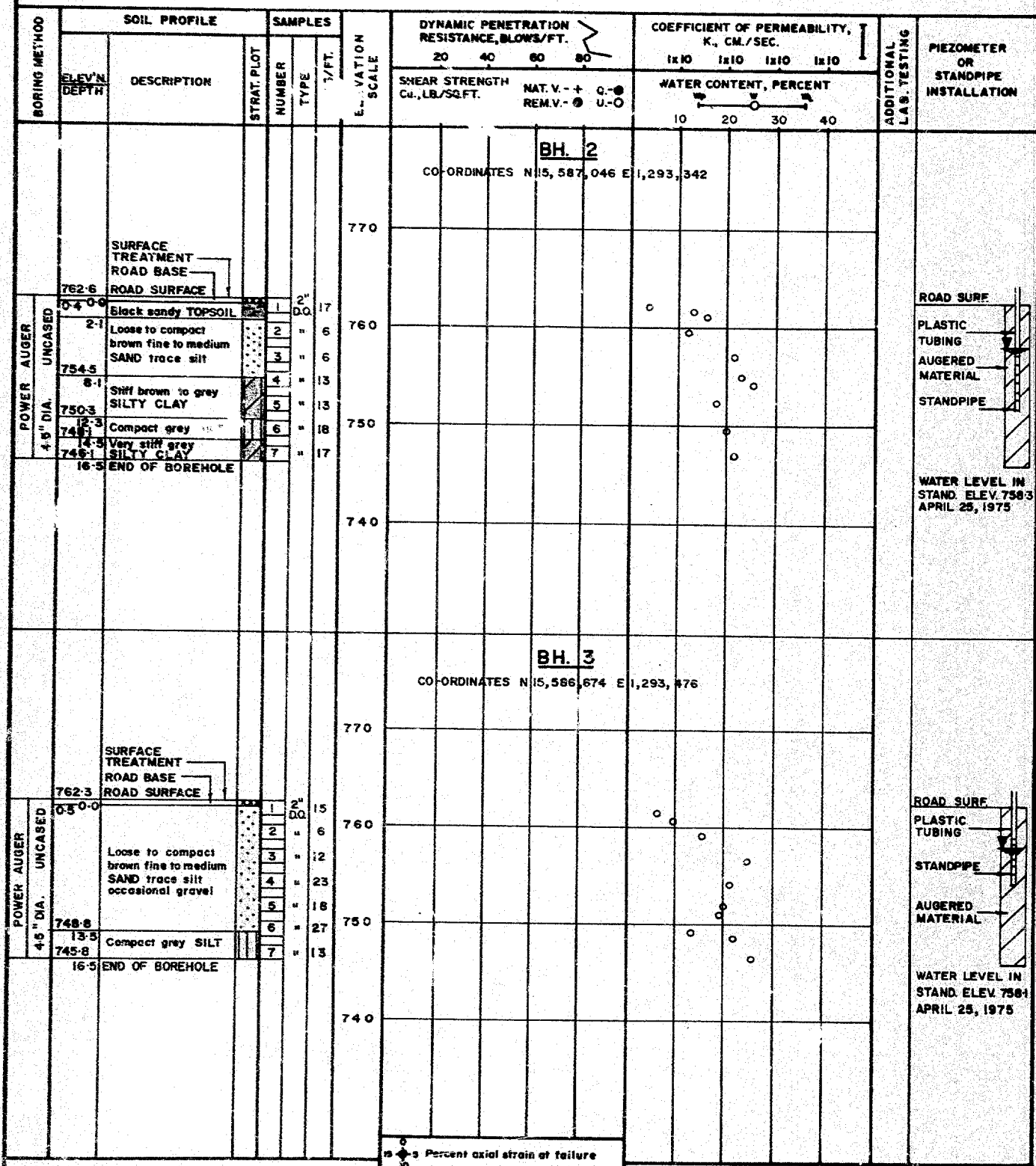
LOCATION See Figure 1

BORING DATE APRIL 18 & 21, 1975

DATUM GEODETIC

SAMPLER HAMMER WEIGHT 140 LB., DROP 30 IN.

PENETRATION TEST HAMMER WEIGHT 140 LB., DROP 30 IN.

VERTICAL SCALE
1 IN. TO - FT.

Golder Associates

DRAWN W.D.F.
CHECKED P.R.B.

RECORD OF BOREHOLE 5

CO-ORDINATES N 15,586,952 E 1,293,376

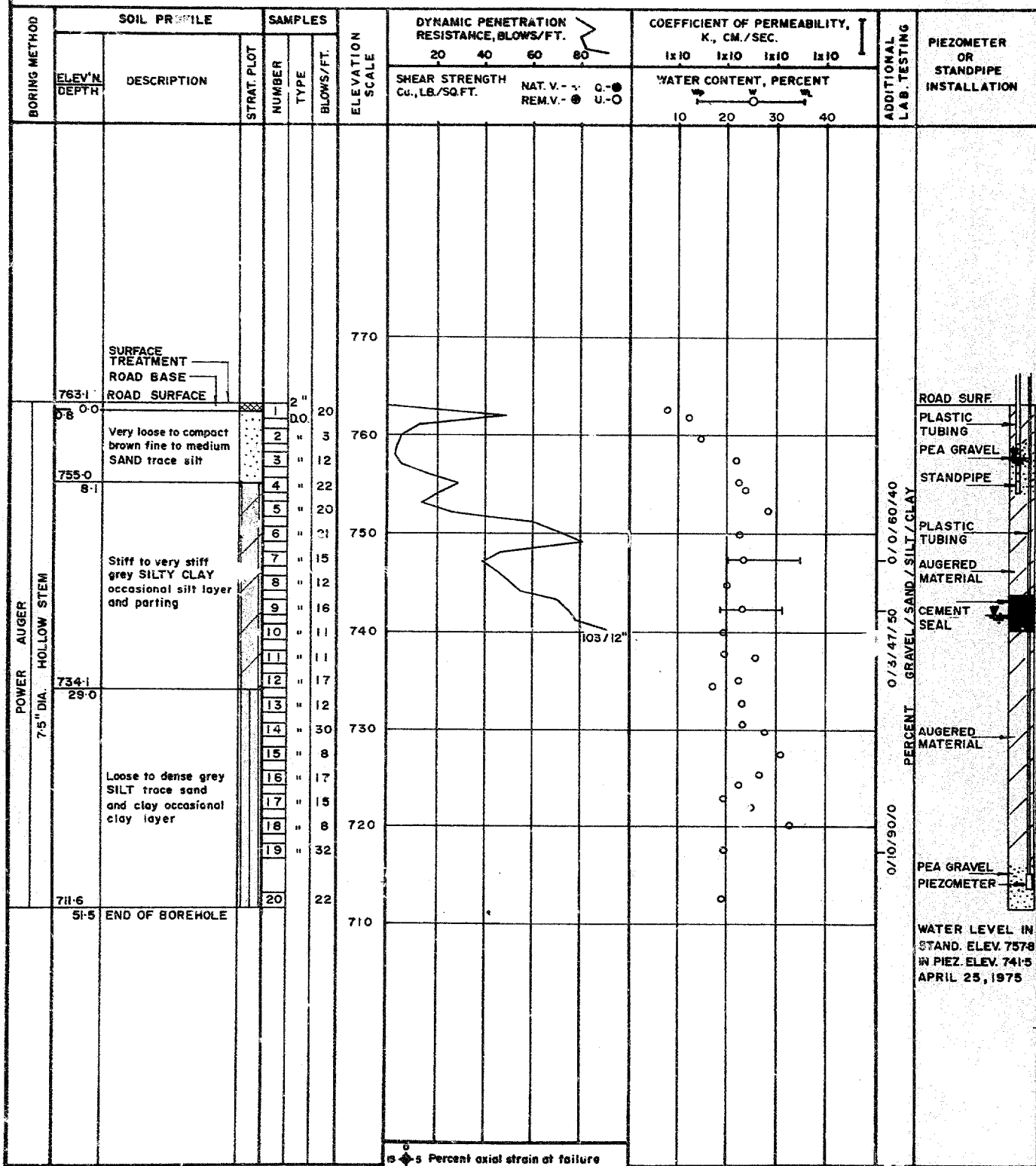
LOCATION See Figure 1

BORING DATE APRIL 22, 1975

DATUM GEODETIC

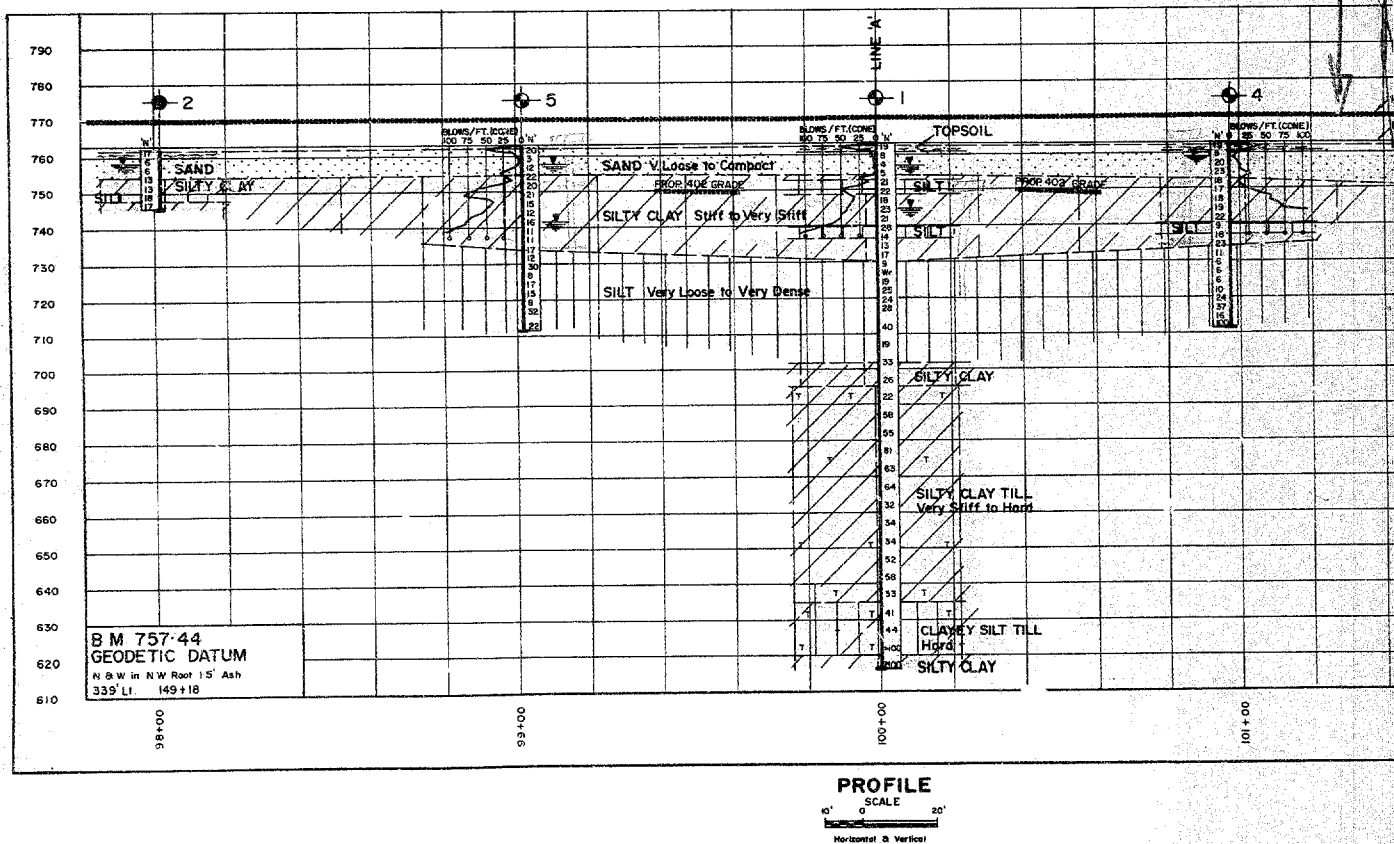
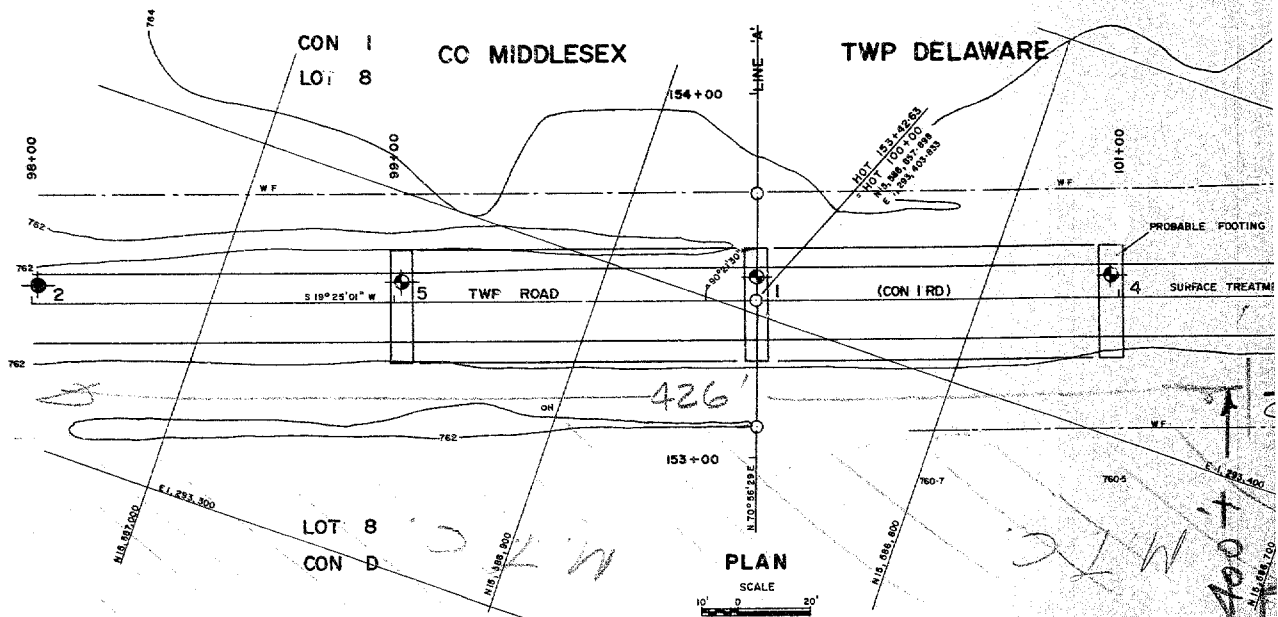
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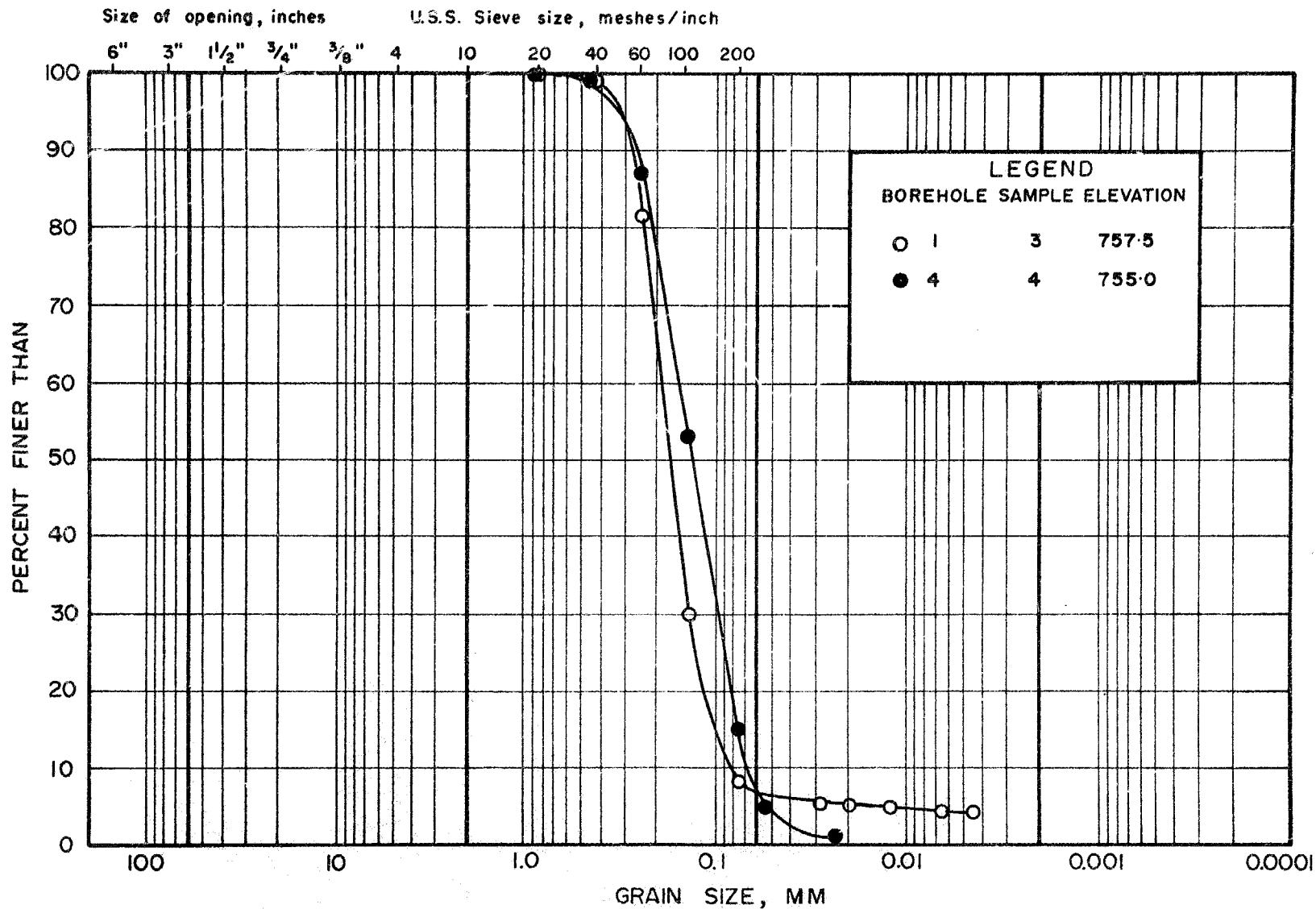
PENETRATION TEST HAMMER WEIGHT 140 LB., DROP 30 IN.

VERTICAL SCALE
1 IN. TO - FT.

Golder Associates

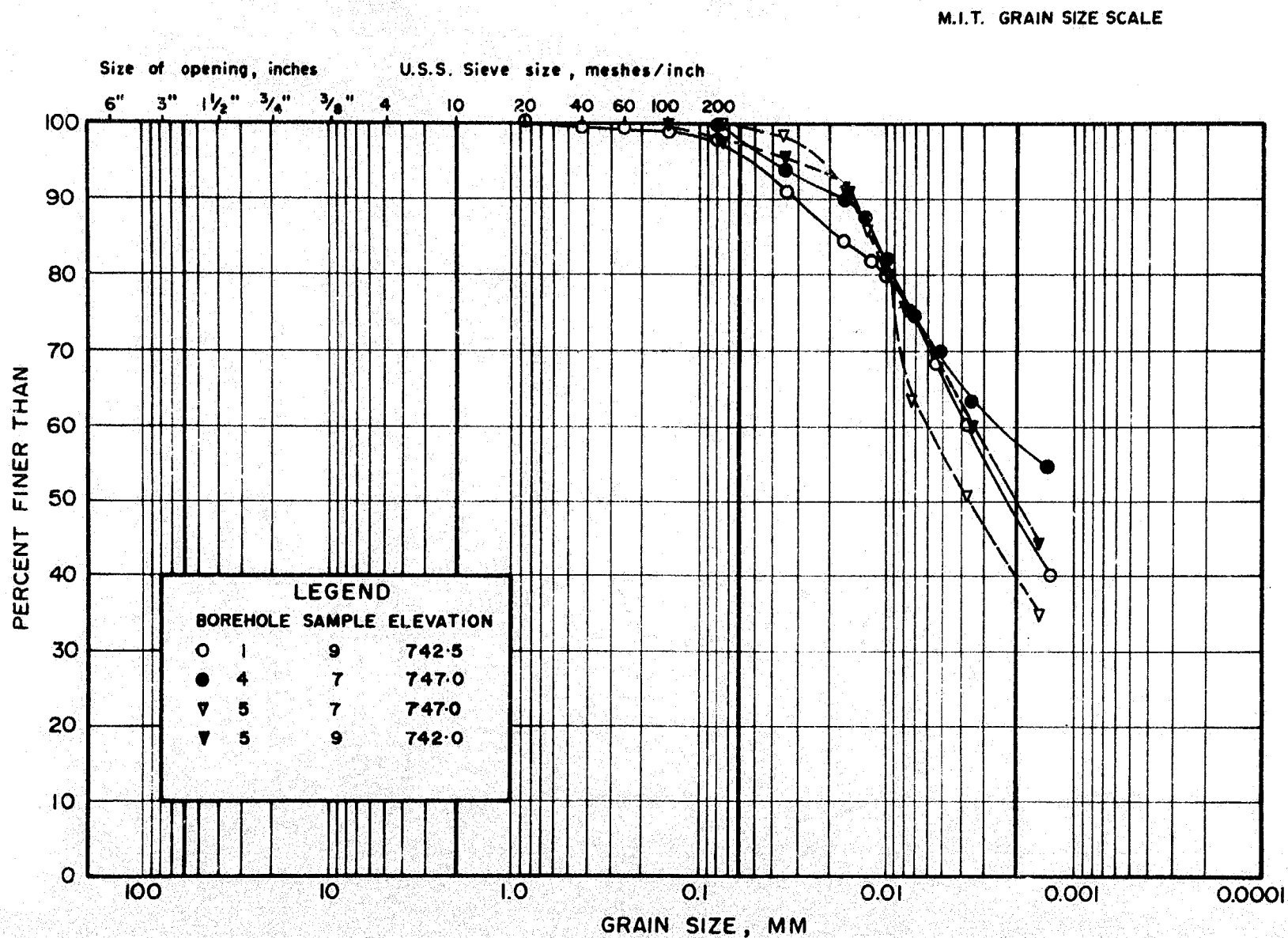
DRAWN W.O.F.
CHECKED P.R.B.





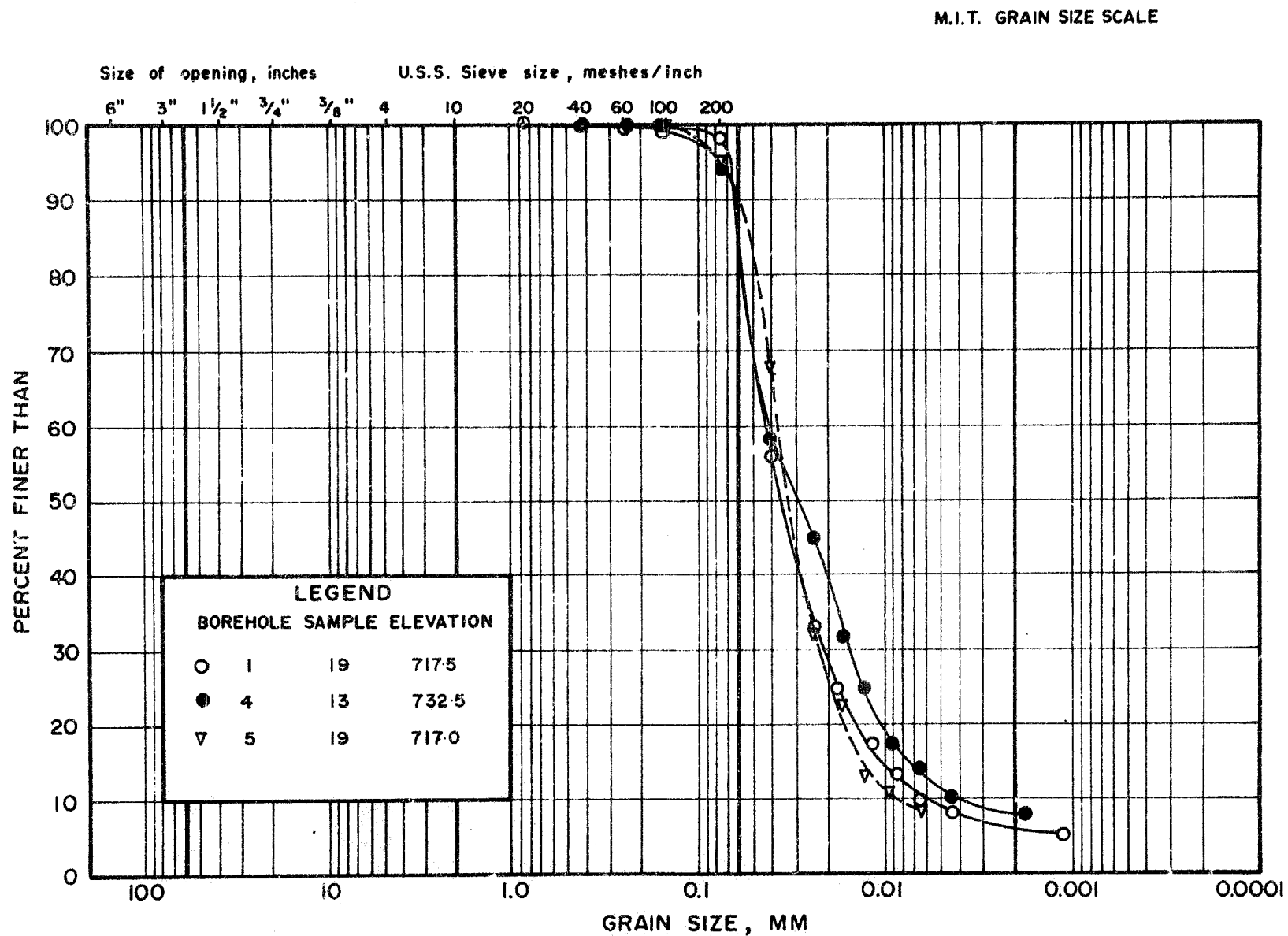
GRAIN SIZE DISTRIBUTION
SAND

FIGURE 2



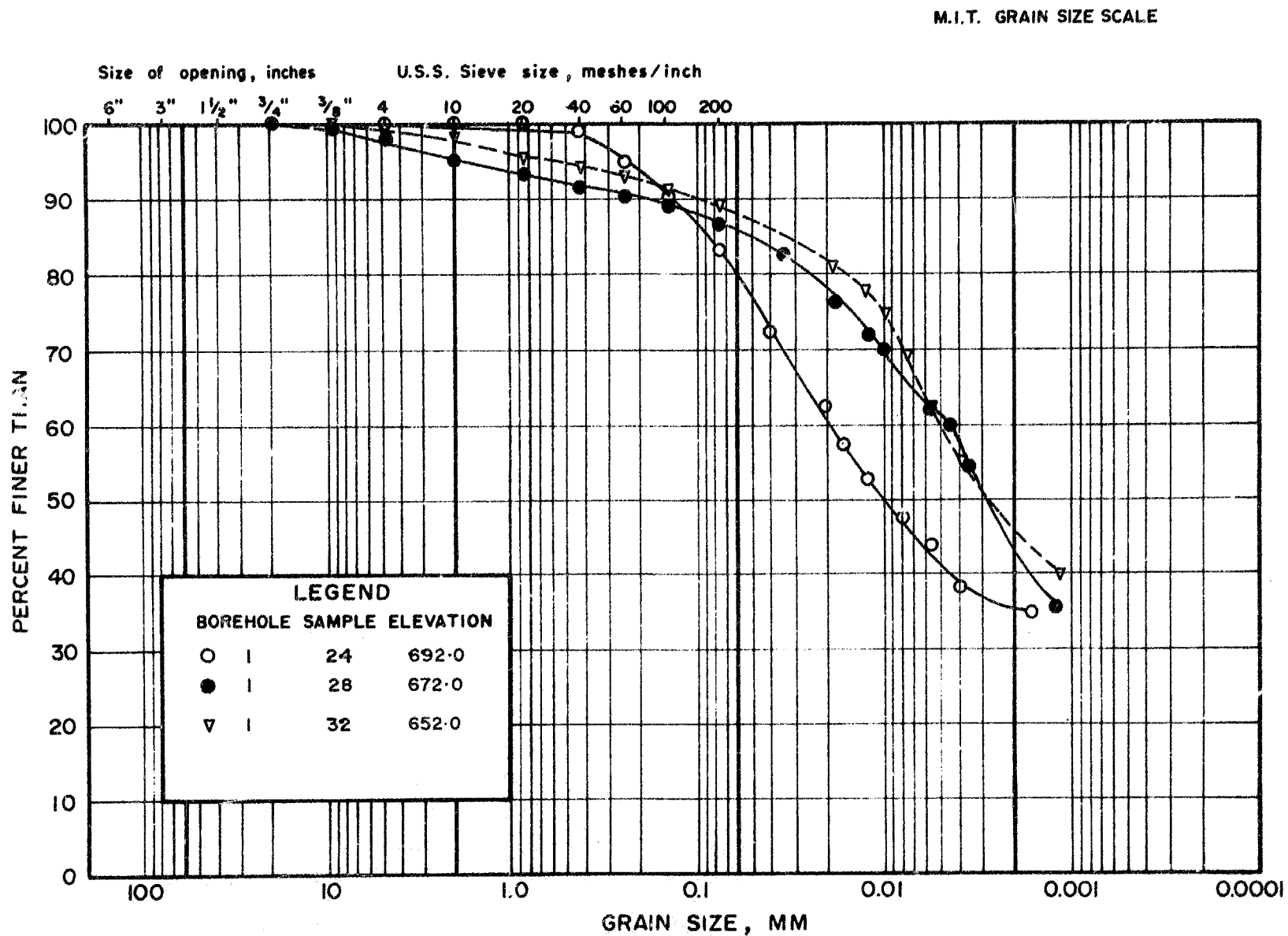
GRAIN SIZE DISTRIBUTION
SILTY CLAY

FIGURE 3



GRAIN SIZE DISTRIBUTION
SILT

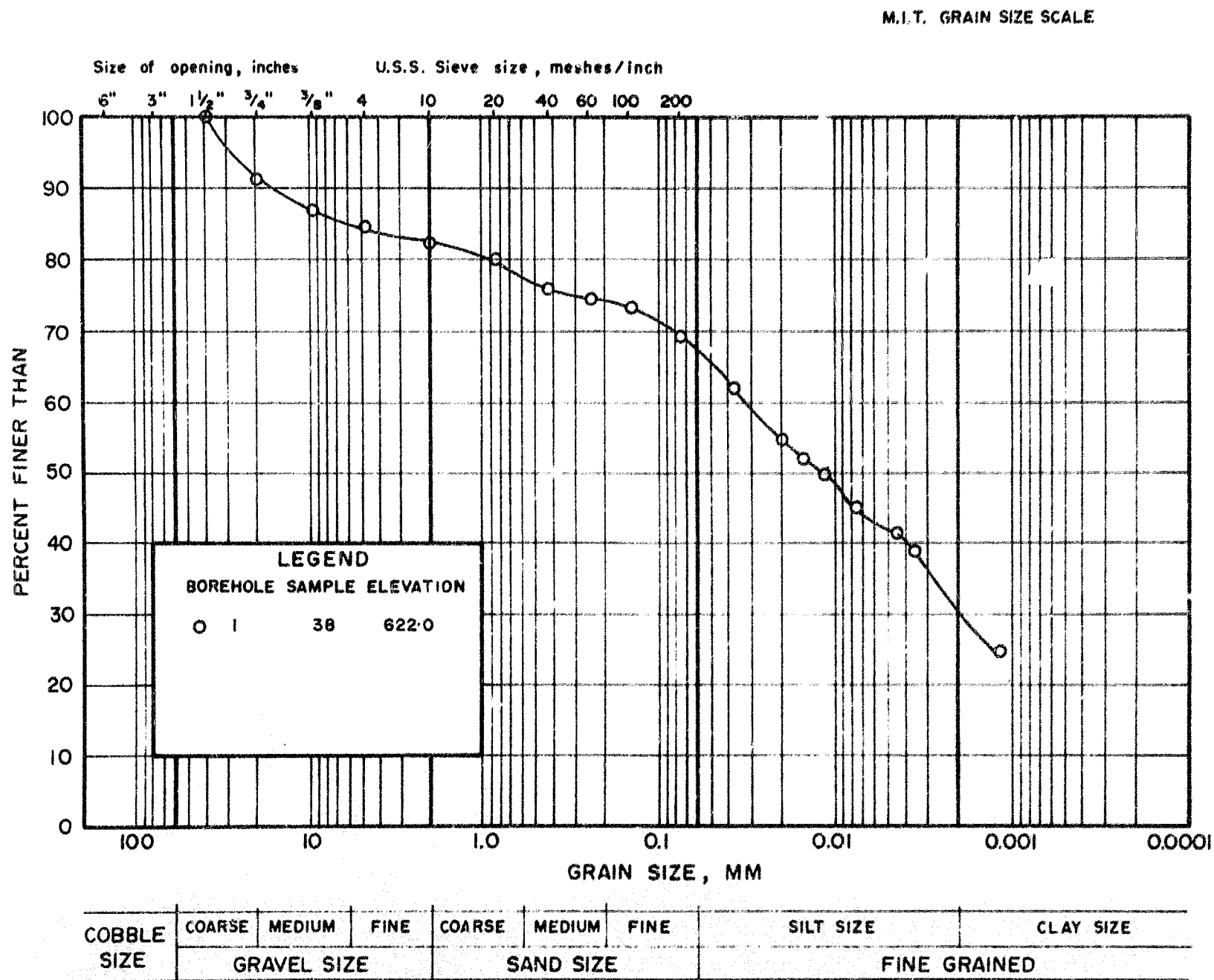
FIGURE 4



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

GRAIN SIZE DISTRIBUTION
SILTY CLAY TILL

FIGURE 5



GRAIN SIZE DISTRIBUTION
CLAYEY SILT TILL

FIGURE 6

DOCUMENT FOR RECORD IDENTIFICATION

GEOCRES No. 40214-89

DIST. 2 REGION Southwestern

W.P. No. 41-46-15

CONT. No. 78-66

W. O. No. _____

STR. SITE No. 19-538

HWY. No. _____

LOCATION Cor. 1 Rd. Underpass

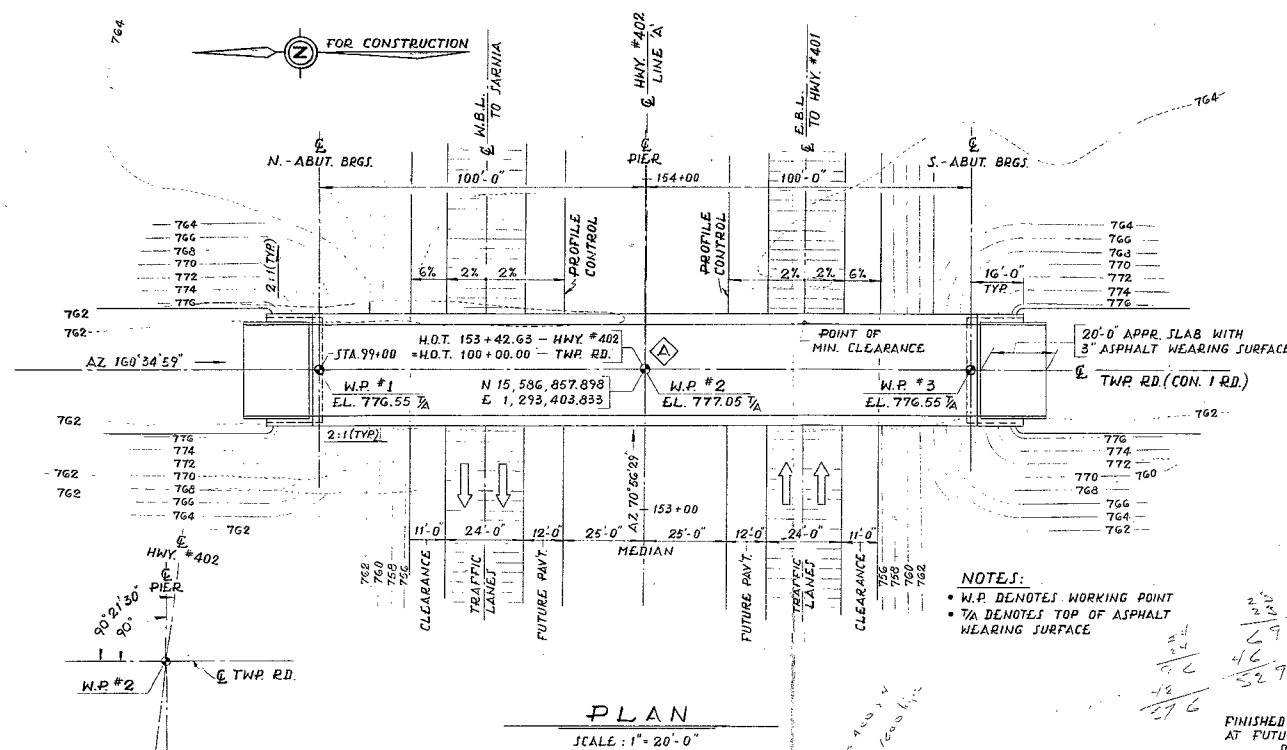
OVERLAY DRAWING TO BE USED FOR IDENT. 3

REMARKS: _____

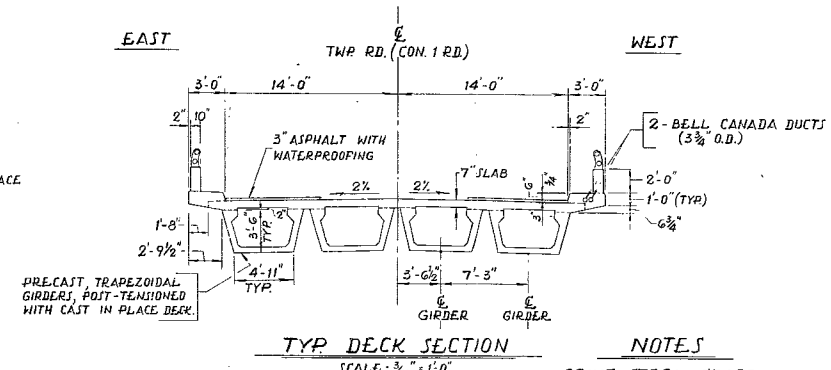
4014-89

REFERENCE BENCH MARK
B.M. 757.44
GEODETIC DATUM
N 1/4 W IN NW 1/4 1'S 4TH
339.0 LT. 149+18

DIST. 2	CONT No	SHEET
WP No	41-66-15	
CONCESSION 1 RD. UPASS 6.8 miles west of hwy 4 GENERAL PLAN		

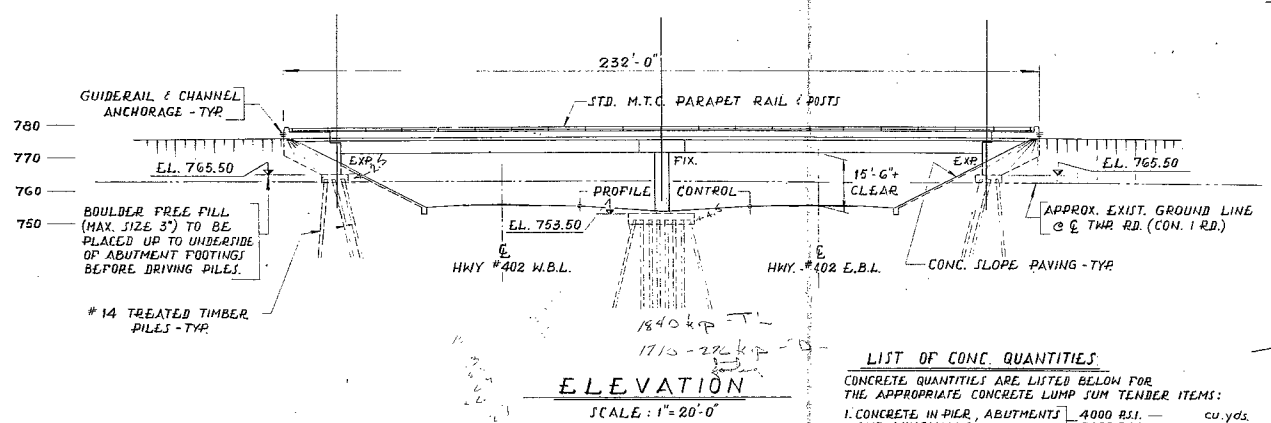


PLAN
SCALE: 1" = 20'-0"

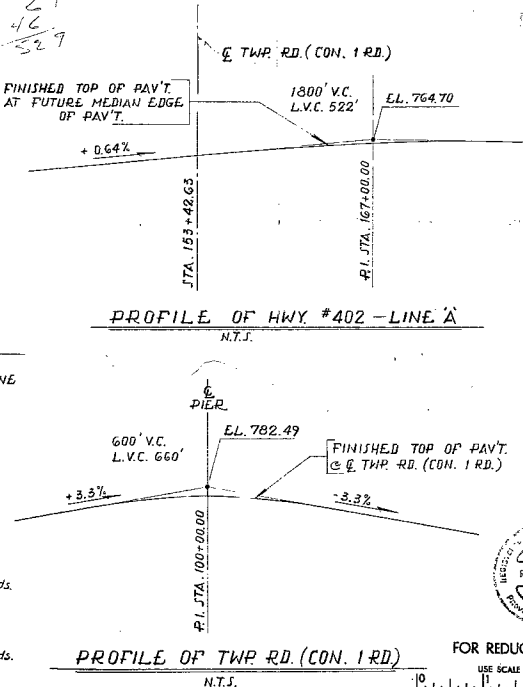


TYP DECK SECTION
SCALE: 3/16" = 1'-0"

- NOTES**
- REINF. STEEL GRADE**
- DECK SLAB TRANSVERSE — 60
 - PRECAST GIRDERS — 40
 - REMAINDER — 50
- CLASS OF CONCRETE**
- DECK, CURBS, PARAPET WALLS — 4000 P.S.I.
 - AND PIER COLUMN — 4000 P.S.I.
 - PRECAST GIRDERS — 6000 P.S.I.
 - REMAINDER — 3000 P.S.I.
- CLEAR COVER TO REINF. STEEL**
- FOOTINGS, ABUTMENTS & WINGWALLS — 3"
 - COLUMN — 2 1/2"
 - PRECAST GIRDERS — 1"
 - DECK — TOP 2", BOT. 1 1/2"
 - CURBS — 2", PARAPET WALLS — 1 1/2"
 - UNLESS NOTED OTHERWISE
- CONSTRUCTION NOTES**
- THE CONTRACTOR IS RESPONSIBLE FOR FINISHING THE BEARING SEATS TO THE SPECIFIED ELEVATIONS WITH A TOLERANCE OF 1/8".
- NO CONCRETE SHALL BE PLACED ABOVE THE ABUTMENT BEARING SEATS UNTIL THE CONCRETE IN DECK HAS BEEN PLACED, STRESSED & GROUTED.



ELEVATION
SCALE: 1" = 20'-0"



- LIST OF CONC. QUANTITIES**
- CONCRETE QUANTITIES ARE LISTED BELOW FOR THE APPROPRIATE CONCRETE LUMP SUM TENDER ITEMS:
- | | | |
|--|-------------|----------|
| 1. CONCRETE IN PIER, ABUTMENTS AND WINGWALLS | 4000 P.S.I. | cu. yds. |
| 2. CONCRETE IN DECK | 6000 P.S.I. | cu. yds. |
| 3. CONCRETE IN PARAPET WALLS | 4000 P.S.I. | cu. yds. |
| 4. CONCRETE IN APPROACH SLABS | 4000 P.S.I. | cu. yds. |
| 5. CONCRETE IN SLOPE PAVING | 3000 P.S.I. | cu. yds. |

- LIST OF DRAWINGS**
- DWG. 1 - GENERAL PLAN
 - 2 - BORE HOLE LOCATIONS & SOIL STRATA
 - 3 - FOUNDATION LAYOUT, REINF. & PIER
 - 4 - ABUTMENTS & BEARINGS
 - 5 - GIRDERS & CABLE DETAILS
 - 6 - GIRDER REINFORCEMENT
 - 7 - DECK DETAILS (TRANSVERSE CABLES)
 - 8 - DECK REINFORCEMENT
 - 9 - PARAPET WALL DETAILS
 - 10 - STEEL PARAPET RAILING
 - 11 - 20 FT. APPROACH SLAB
 - 12 - DETAILS OF CONC. SLOPE PAVING
 - 13 - STANDARD DETAILS I
 - 14 - STANDARD DETAILS II
 - DWG. 15 - STANDARD DETAILS III

REVISIONS	DATE	BY	DESCRIPTION

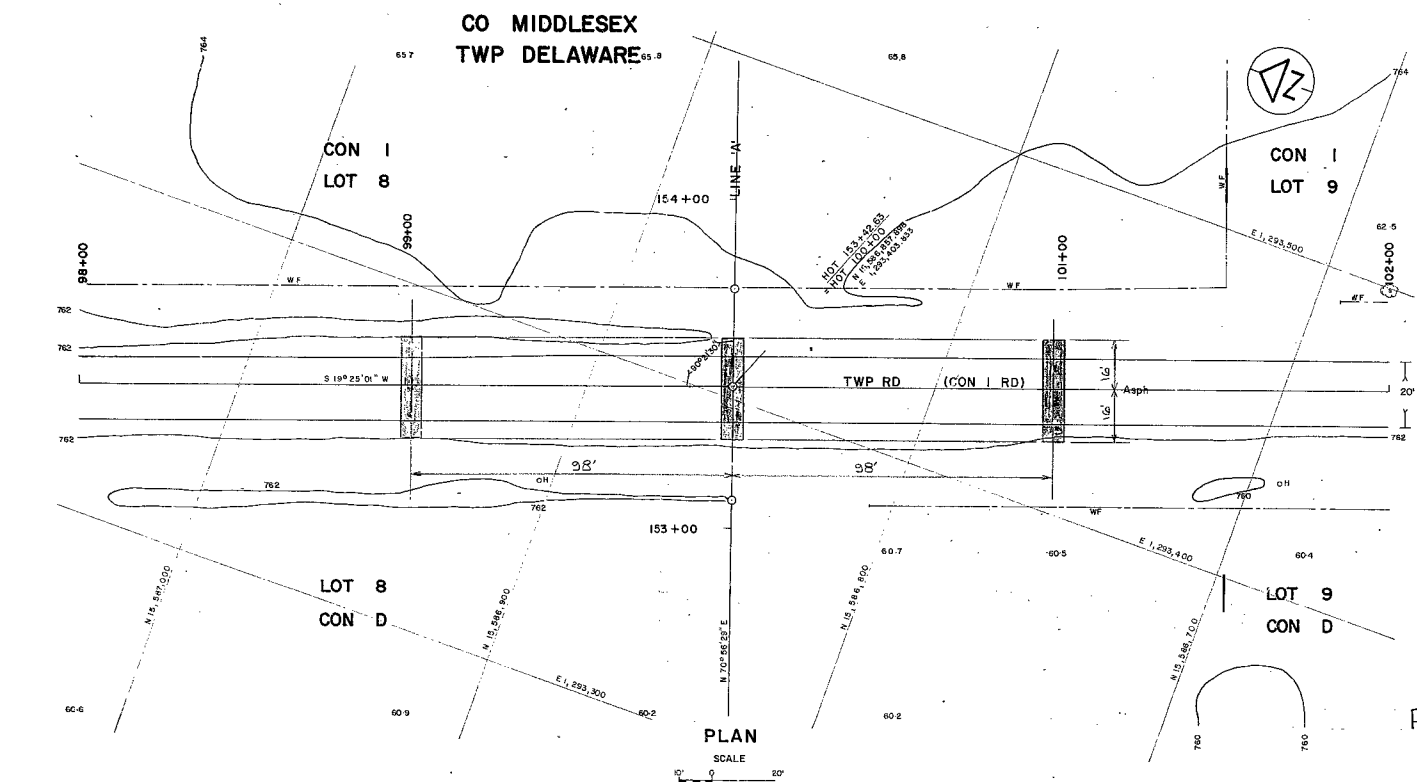
FOR REDUCED PLAN
USE SCALE BELOW
1" = 10' ON ORIGINAL PLAN



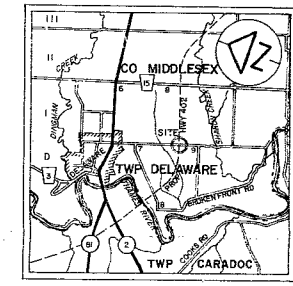
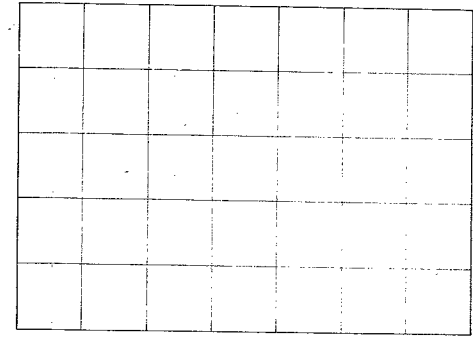
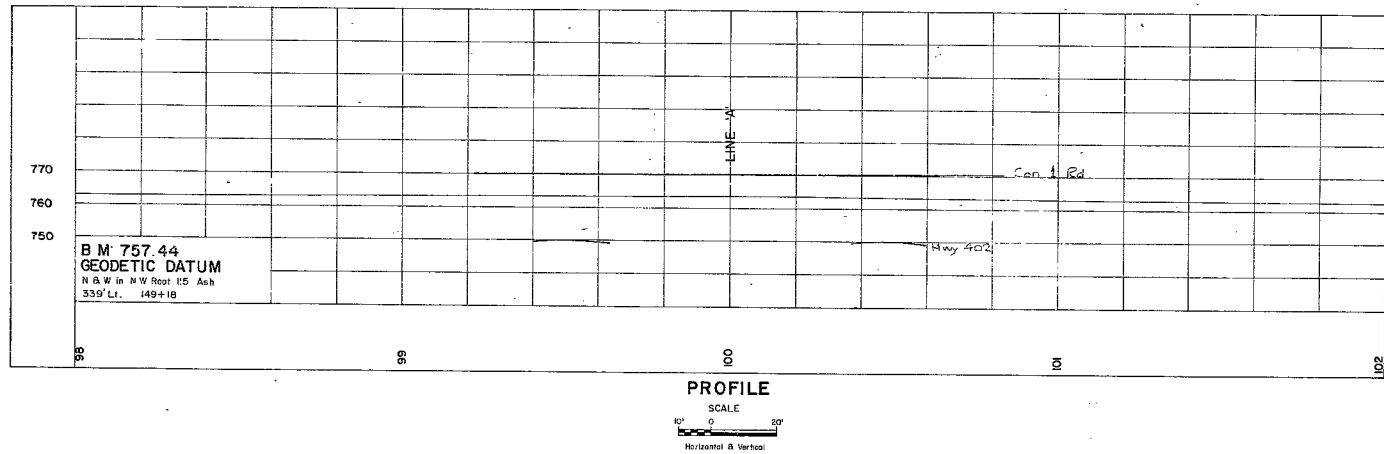


E-5370-1

E-5370-1



PROBABLE FOOTING LOCATIONS



KEY PLAN

STR WP 41-66-15 40119-89			
DATE	REVISIONS & ADDITIONS	BY	CHKD
MINISTRY OF TRANSPORTATION AND COMMUNICATIONS ONTARIO DESIGN DIVISION DESIGN SERVICES BRANCH ENGINEERING SURVEYS OFFICE SOUTHWESTERN REGION			
BRIDGE SITE			
PROPOSED CROSSING			
AT TOWNHILL ROAD CON I RD. & AND PROPOSED KING'S HWY. 402 LINE 'A'			
LOT 8 TWP DELAWARE	CON I RD CO MIDDLESEX		
SCALE AS SHOWN	DISTRICT 2 LONDON	REGION SOUTHWESTERN	
W P 41-66-03	Date of Survey Plan Nov 1974	SITE 19-538	
SURVEY BY Chief of Party Supervisor W FISCHER R ASHBY	DRAWN BY Draftsman Supervisor J BAXTER-D TONNER O SCHUR		
CHECKED BY Draftsman Supervisor J JANUJ O SCHUR	PLAN E-5370-1		