

G.I.-30 SEPT. 1976

GEOCRES No. 4038-36DIST. 1 REGION W.P. No. 89-67-00CONT. No. 75-151W. O. No. STR. SITE No. 13-195HWY. No. 2LOCATION Hwy 2 & Gov't Drain #1No. of PAGES -

OVERSIZE DRAWINGS TO BE INCLUDED WITH THIS REPORT.REMARKS:

MEMORANDUM

40 J-158
GEOCRE No.

Mr. A. P. Watt,
Regional Structural Planning Eng.,
Southwestern Region,
London, Ontario.

FROM:

Foundations Office,
Design Services Branch,
West Bldg., Downsview

ATTENTION:

Mr. S. Jants

DATE:

June 26, 1973.

OUR FILE REF.

IN REPLY TO

JUL - 6 1973

SUBJECT:

40J8-36
GEOCRE No.

FOUNDATION INVESTIGATION REPORT

For

Government Drain No. 1 Bridge
Twp. of Tilbury East, Co. of Kent
Hwy. #2, District No. 1 (Chatham)
W.O. 72-11163 W.P. 89-67-00

DIVERSION

Attached we are forwarding to you our detailed foundation investigation report on the subsoil conditions existing at the above-mentioned site.

We believe that the factual data and recommendations contained therein will prove adequate for your design requirements. Should additional information be required, please do not hesitate to contact our Office.



A. G. Stermac,
PRINCIPAL FOUNDATIONS ENGINEER.

AGS/js

*attach.

c.c. E. J. Orr
B. R. Davis
A. Rutka
A. Wittenberg
F. C. Brown
B. J. Giroux
J. R. Roy
G. A. Wrong
B. A. Singh

Foundations Files, Documents

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FOUNDATION INVESTIGATION REPORT
For
Government Drain No. 1 Bridge
Twp. of Tilbury East, Co. of Kent
Hwy. #2, District No. 1 (Chatham)
W.O. 72-11163 -- W.P. 89-67-00

New Report

1. INTRODUCTION:

A request for a foundation investigation for a structure at the above-mentioned site was received from Mr. A. P. Watt, Regional Structural Planning Engineer, South-western Region, London.

A field investigation was subsequently carried out by the Foundations Office to determine the subsoil conditions existing at the site. This report contains the results of our field and laboratory investigation, together with our recommendations relating to the design of the proposed structure foundations.

2. DESCRIPTION OF THE SITE:

The site is located about 7.3 miles west of Chatham west limits on Hwy. 2, approximately 300 ft. west of the existing structure. The surrounding area is farmland and almost flat. Physiographically, the site is located in the region referred to as the St. Clair Clay Plain.

3. FIELD AND LABORATORY INVESTIGATION PROCEDURES:

A total of two sampled boreholes and one dynamic cone penetration test was carried out during the course of the field work. Boring was achieved by means of a continuous

flight auger machine (Penn Drill), adapted for soil sampling purposes. During the field work, disturbed samples were obtained by means of a standard split-spoon sampler; the energy used in driving it, conformed to the requirements of the Standard Penetration Test.

Dynamic cone penetration test was carried out adjacent to Borehole 1. Driving energy used to advance the cone was 350 ft.-lbs. per blow.

All boreholes were surveyed in the field by personnel from Chatham District Office. The locations and elevations of the borings are shown on Drawing No. 72-11163A, which accompanies this report.

All samples were visually examined and classified at the site as well as in the laboratory. Following this inspection, laboratory tests were carried out on selected samples to determine the following physical properties:

Atterberg Limits

Moisture Content

Grain-Size Distribution

The results of the field and laboratory tests are summarized on the Record of Borehole sheets contained in the Appendix to the report.

4. SUBSOIL CONDITIONS:

Two boreholes were put down at this location. The depths of the boreholes were 51.5 and 87.5 ft.

The subsoil, in general, consists of a deep deposit of clayey silt with some sand and occasional sand layers, traces of gravel. The upper 10 ft. of the deposit has a consistency varying from stiff to very stiff. Below 10 ft. down to approximately 45 ft. (elevation 540) the consistency of the soil varies from very stiff to hard. Below this level, the soil contains very small amounts of sand and gradually becomes softer down to 86 ft. where a very hard layer is encountered. No further penetration with the drilling machine was possible.

Physical properties of the clayey silt deposit as determined from laboratory tests are as follows (Fig. 1) :

Liquid Limit	31 - 38%
Plastic Limit	19 - 22%
Natural Moisture Content	15 - 19%

Grain size distribution curves are included in the Appendix of this report (Fig. 2) .

5. GROUNDWATER CONDITIONS:

The following water levels were observed during the field work:

B.H. #1	Elevation 569.2
B.H. #2	Elevation 568.1

6. DISCUSSION AND RECOMMENDATIONS:

It is proposed to divert Government Drain #1 and construct a new single-span bridge. The profile grade of Hwy. 2 is to be raised by about 5 ft. to elevation 590.

As described in the previous paragraphs, the subsoil at the site consists of a deep deposit of clayey silt. The upper 10 ft. of the deposit is stiff to very stiff. Below this depth the shear strength of the material is greater than 2000 p.s.f. and is suitable for spread footing type foundations.

In view of the foregoing, it is recommended that the entire structure be supported on spread footing type foundations placed at or below elevation 574. A maximum allowable pressure of 2.5 t.s.f. may be used for design purposes. The foundations should be protected against scour. The scour depth may be obtained from the Hydrology Office.

As an alternative the structure may be supported on timber piles driven to the elevation necessary to achieve the required pile capacity. In determining the safe capacity of a timber pile, the following equation may be used.

Q = 0.5 L (tons)

where Q = Safe capacity of one pile

L = Embedded length in original ground (ft.)

As a second alternative the structure may be supported on steel H-piles driven to refusal. It is estimated that refusal will be achieved at elevation 490. The maximum allowable load for the particular section adapted may be used for design purposes.

All footings and/or pile caps should be protected against frost action by at least 4 feet of earth cover.

It is recommended that the proposed channel be constructed with 2:1 slopes and be protected against scour action in the vicinity of the new structure.

No dewatering problems are anticipated because of the relatively low groundwater level (elevation 569) and the relatively impermeable nature of the subsoil.

7. MISCELLANEOUS:

The field work for this project was carried out during the period of February 13 to February 20, 1973, under the supervision of Mr. A. Prakash, Senior Foundation Engineer, who also prepared this report.

The equipment used was owned and operated by Dominion Soil Investigation Ltd.

This report was reviewed by Mr. K. G. Selby, Supervising Foundation Engineer.

A. Prakash

A. Prakash, P. Eng.

K. G. Selby

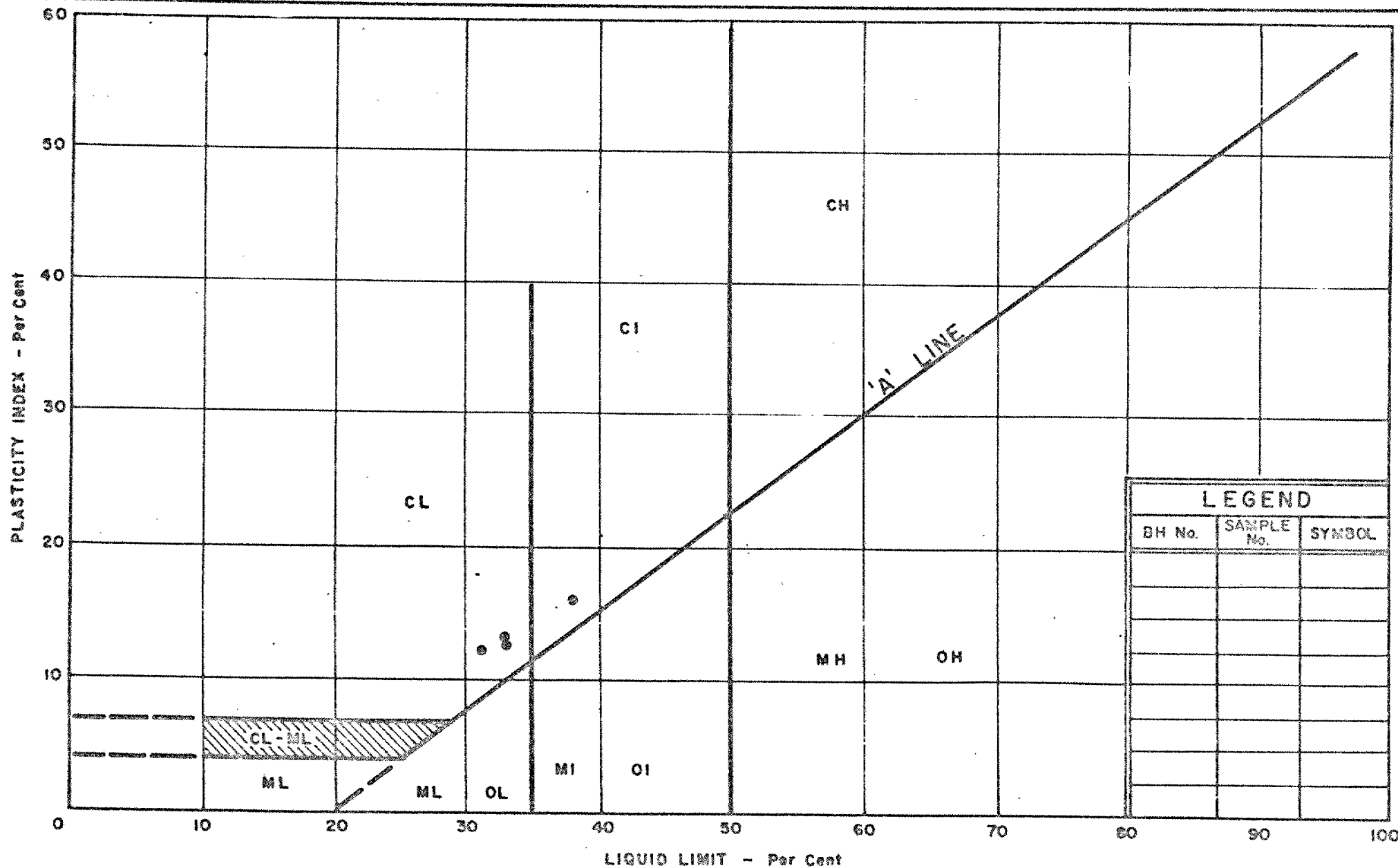
K. Selby, P. Eng.



AP/js

June 25/73.

APPENDIX I



DEPARTMENT OF HIGHWAYS
MATERIALS and
TESTING
DIVISION

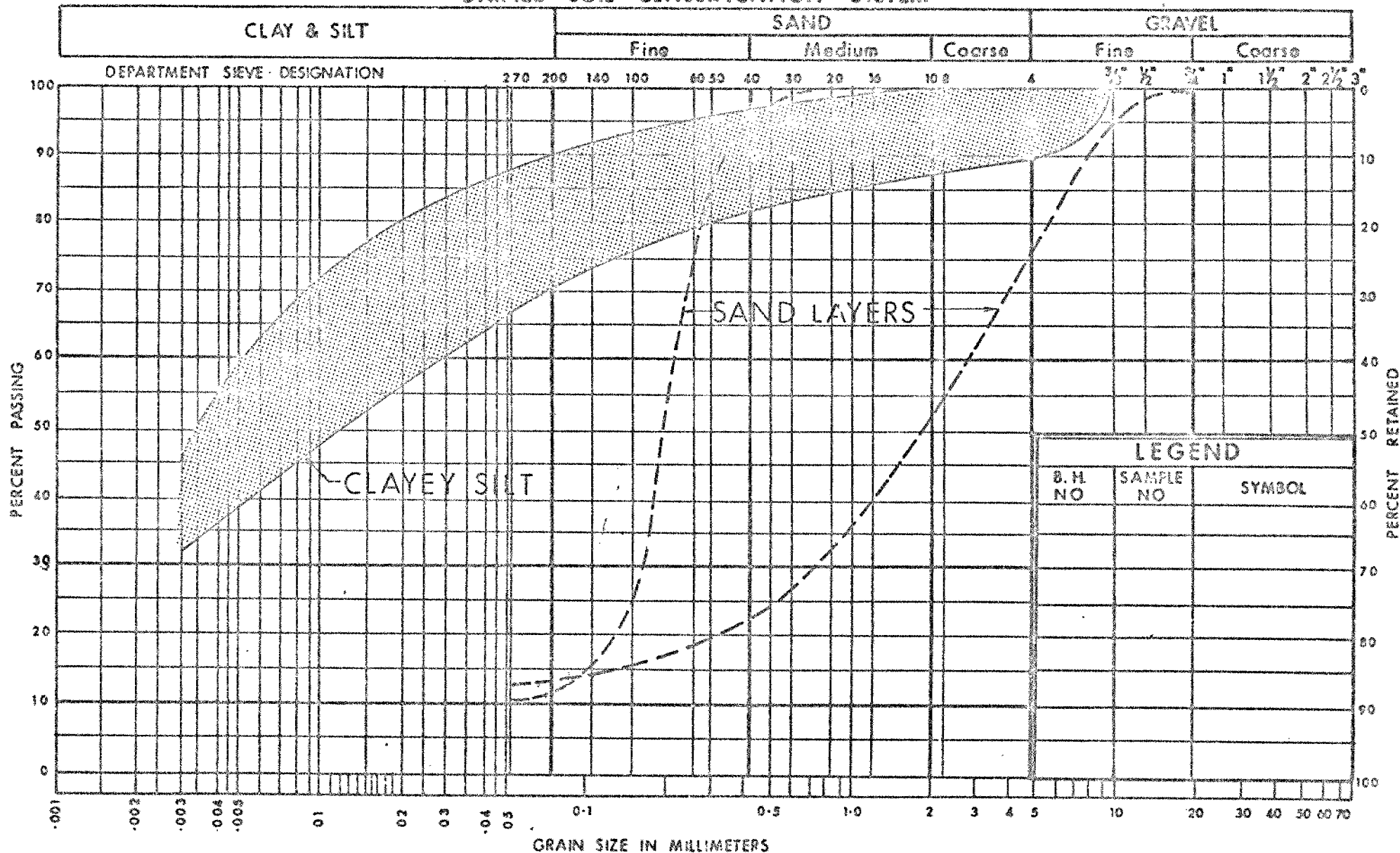
PLASTICITY CHART CLAYEY SILT

W.P. No. 89-67

JOB No. 72-11163

FIG. 1

UNIFIED SOIL CLASSIFICATION SYSTEM



DEPARTMENT
OF
TRANSPORTATION AND COMMUNICATIONS
DESIGN SERVICES
EPLANEN

GRAIN SIZE DISTRIBUTION
CLAYEY SILT
WITH OCC. SAND LAYERS

W.P. No.	89-67
JOB No.	72-11163
FIG. 2	

ABBREVIATIONS & SYMBOLS USED IN THIS REPORTPENETRATION RESISTANCE

'N'-STANDARD PENETRATION RESISTANCE : - THE NUMBER OF BLOWS REQUIRED TO ADVANCE A STANDARD SPLIT SPOON SAMPLER 12 INCHES INTO THE SUBSOIL, DRIVEN BY MEANS OF A 140 POUND HAMMER FALLING FREELY A DISTANCE OF 30 INCHES.

DYNAMIC PENETRATION RESISTANCE :- THE NUMBER OF BLOWS REQUIRED TO ADVANCE A 2 INCH, 60 DEGREE CONE, FITTED TO THE END OF DRILL RODS, 12 INCHES INTO THE SUBSOIL, THE DRIVING ENERGY BEING 350 FOOT POUNDS PER BLOW.

DESCRIPTION OF SOIL

THE CONSISTENCY OF COHESIVE SOILS AND THE RELATIVE DENSITY OR DENSENESS OF COHESIONLESS SOILS ARE DESCRIBED IN THE FOLLOWING TERMS :-

<u>CONSISTENCY</u>	<u>c LB./SQ. FT.</u>	<u>DENSENESS</u>	<u>'N' BLOWS / FT.</u>
VERY SOFT	0 - 250	VERY LOOSE	0 - 4
SOFT	250 - 500	LOOSE	4 - 10
FIRM	500 - 1000	COMPACT	10 - 30
STIFF	1000 - 2000	DENSE	30 - 50
VERY STIFF	2000 - 4000	VERY DENSE	> 50
HARD	> 4000		

TERMS TO BE USED IN DESCRIBING SOILS:-

TRACE < 10% , SOME 10-25% , WITH 25-40% , > 40% SILTY, SANDY, GRAVELLY, CLAYEY ETC.

TYPE OF SAMPLE

S.S.	SPLIT SPOON	T.W.	THINWALL OPEN
W.S.	WASHED SAMPLE	T.P.	THINWALL PISTON
S.T.	SLOTTED TUBE SAMPLE	O.S.	OESTERBERG SAMPLE
A.S.	AUGER SAMPLE	F.S.	FOIL SAMPLE
C.S.	CHUNK SAMPLE	R.C.	ROCK CORE

P.H. SAMPLE ADVANCED HYDRAULICALLY

P.M. SAMPLE ADVANCED MANUALLY

SOIL TESTS

U	UNCONFINED COMPRESSION	L.V.	LABORATORY VANE
UU	UNCONSOLIDATED UNDRAINED TRIAXIAL	F.V.	FIELD VANE
CIU	CONSOLIDATED ISOTROPIC UNDRAINED TRIAXIAL	C	CONSOLIDATION
CID	" " DRAINED "	S	SENSITIVITY
CAU	" " ANISOTROPIC UNDRAINED "		
CAD	" " DRAINED "		

ABBREVIATIONS & SYMBOLS USED IN THIS REPORT

SOIL PROPERTIES

γ	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	SPECIFIC GRAVITY OF SOLID PARTICLES $G = \frac{\gamma_s}{\gamma_w}$
e	VOID RATIO
n	POROSITY
w	WATER CONTENT
S_r	DEGREE OF SATURATION
w_L	LIQUID LIMIT
w_p	PLASTIC LIMIT
I_p	PLASTICITY INDEX
w_s	SHRINKAGE LIMIT
I_L	LIQUIDITY INDEX $= \frac{w - w_p}{I_p}$
I_c	CONSISTENCY INDEX $= \frac{w_L - w}{I_p}$
e_{max}	VOID RATIO IN LOOSEST STATE
e_{min}	VOID RATIO IN DENSEST STATE
I_D	DENSITY INDEX $= \frac{e_{max} - e}{e_{max} - e_{min}}$
	RELATIVE DENSITY D_r IS ALSO USED
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
m_v	COEFFICIENT OF VOLUME CHANGE $= \frac{-\Delta e}{(1+e)\Delta\sigma}$
c_v	COEFFICIENT OF CONSOLIDATION
C_c	COMPRESSION INDEX $= \frac{\Delta e}{\Delta \log_{10} \sigma}$
T_v	TIME FACTOR $= \frac{c_v t}{d^2}$ (d, DRAINAGE PATH)
U	DEGREE OF CONSOLIDATION
τ_f	SHEAR STRENGTH
c'	EFFECTIVE COHESION INTERCEPT
ϕ'	EFFECTIVE ANGLE OF SHEARING RESISTANCE, OR FRICTION
c_u	APPARENT COHESION
ϕ_u	APPARENT ANGLE OF SHEARING RESISTANCE, OR FRICTION
μ	COEFFICIENT OF FRICTION
S_t	SENSITIVITY

GENERAL

π	= 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

STRESS AND STRAIN

u	PORE PRESSURE
σ	NORMAL STRESS
$\bar{\sigma}$	NORMAL EFFECTIVE STRESS ($\bar{\sigma}$ IS ALSO USED)
τ	SHEAR STRESS
ϵ	LINEAR STRAIN
γ	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

EARTH PRESSURE

d	DISTANCE FROM TOP OF WALL TO POINT OF APPLICATION OF PRESSURE
δ	ANGLE OF WALL FRICTION
K	DIMENSIONLESS COEFFICIENT TO BE USED WITH VARIOUS SUFFIXES IN EXPRESSIONS REFERRING TO NORMAL STRESS ON WALLS
K_0	COEFFICIENT OF EARTH PRESSURE AT REST

FOUNDATIONS

B	BREADTH OF FOUNDATION
L	LENGTH OF FOUNDATION
D	DEPTH OF FOUNDATION BENEATH GROUND
N	DIMENSIONLESS COEFFICIENT USED WITH A SUFFIX APPLYING TO SPECIFIC GRAVITY, DEPTH AND COHESION ETC. IN THE FORMULA FOR BEARING CAPACITY
k_s	MODULUS OF SUBGRADE REACTION

SLOPES

H	VERTICAL HEIGHT OF SLOPE
D	DEPTH BELOW TOE OF SLOPE TO HARD STRATUM
β	ANGLE OF SLOPE TO HORIZONTAL

DESIGN SERVICES BRANCH

FOUNDATIONS OFFICE

RECORD OF BOREHOLE NO 1

JOB 72-11163

LOCATION Highway 2, Stn. 3 + 67, O/S 18' Rt.

ORIGINATED BY AP

W.P. 89-67

BORING DATE February 13, 14 and 19, 1973.

COMPILED BY AP

DATUM Geodetic

BOREHOLE TYPE Continuous Flight Auger and Cone

CHECKED BY

SOIL PROFILE			SAMPLES			ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT					LIQUID LIMIT — W _L PLASTIC LIMIT — W _P WATER CONTENT — W			BULK DENSITY γ	REMARKS
ELEV. DEPTH	DESCRIPTION	STRAT. PLT	NUMBER	TYPE	BLOWS/FOOT		20	40	60	80	100	W _P	W	W _L		
584.7 0.0	Ground Level															
	Stiff to Very Stiff		1	SS	18	580										
			2	SS	9											
			3	TW	PH											
			4	SS	36											
			5	SS	26	570										
	Clayey silt, some sand and traces of gravel		6	SS	17											
			7	TW	PH	560										
			8	SS	46											
			9	SS	30	550										
	Very Stiff to Hard		10	SS	31											
			11	SS	21	540										
			12	SS	15	530										
						520										
						510										
						500										
	Fine Sand Compact		13	SS	10											
494.7 90.0	End of Borehole		14	SS	83	490										

DESIGN SERVICES BRANCH

FOUNDATIONS OFFICE

RECORD OF BOREHOLE NO 2

JOB 72-11163

LOCATION Highway 2, Sta. 3 + 14, O/S 17' It.

ORIGINATED BY AD

W.P. 89-67

BORING DATE February 13, 14 and 19, 1973.

COMPILED BY AD

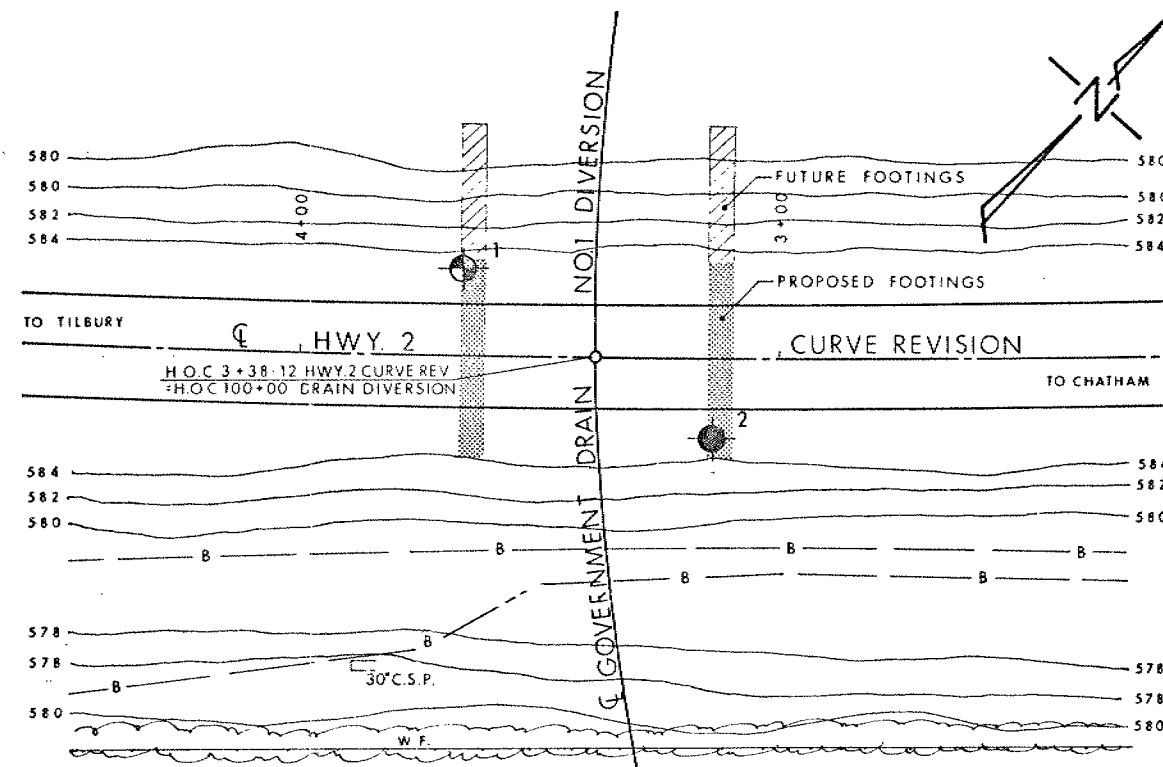
DATUM Geodetic

BOREHOLE TYPE Continuous Flight Auger

CHECKED BY

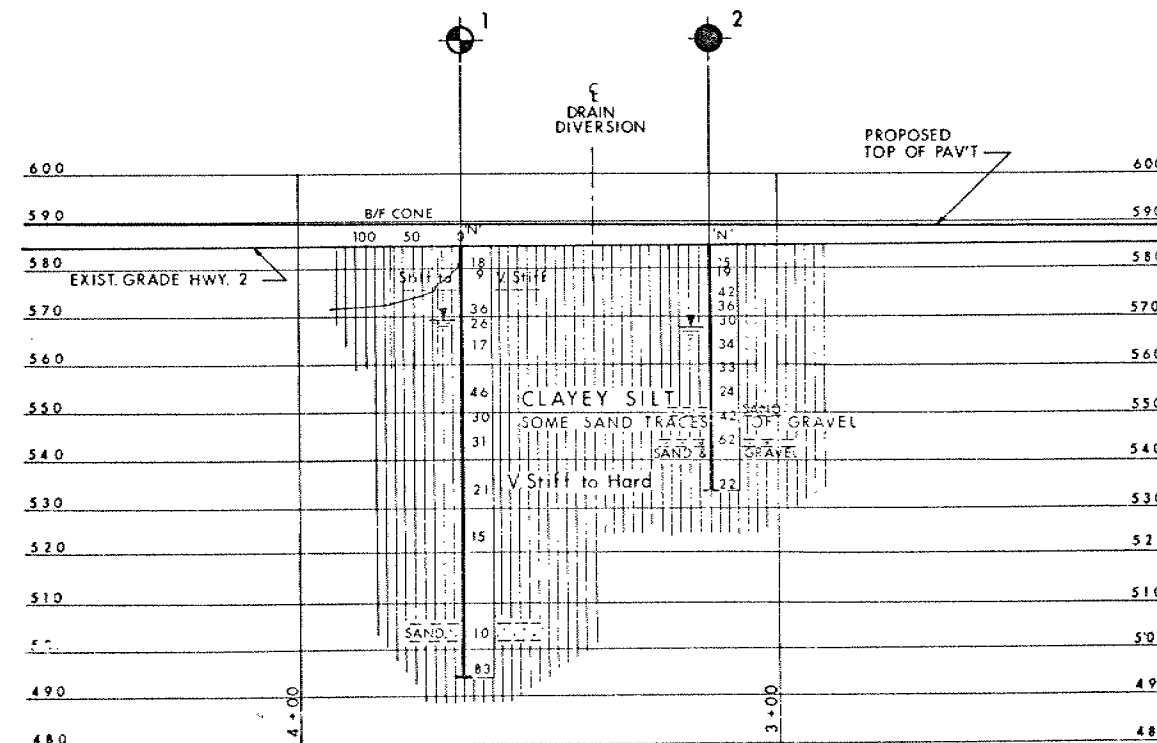
SOIL PROFILE			SAMPLES			ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE					LIQUID LIMIT ——— w_L			BULK DENSITY	REMARKS
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	BLOWS/FOOT		BLOWS / FOOT					PLASTIC LIMIT ——— w_p				
							20	40	60	80	100	WATER CONTENT ——— w				
							SHEAR STRENGTH P.S.F.					w_p ——— w ——— w_L				
○ UNCONFINED + FIELD VANE						● QUICK TRIAXIAL x LAB VANE						WATER CONTENT %			γ	P.C.F. GR.SA.SI.CL.
												10 20 30				
585.1	Ground Level															
0																
	Clayey silt, some sand		1	SS	15	580									10 11 53 36	
			2	SS	19											
	Traces of Gravel		3	SS	42											
			4	SS	36											
	Very Stiff to Hard		5	SS	30	570									10 18 51 2	
			6	SS	34										568.1	
			7	SS	33	560									15 Feb/73	
			8	SS	24											
			9	SS	42	550									0 90 (10)	
	Fine Sand Dense														2 24 43 36	
	Sand and Gravel		10	SS	62	540									25 63 (12)	
533.6																
51.5	End of Borehole		11	SS	22	530										

OFFICE REPORT ON SOIL EXPLORATION



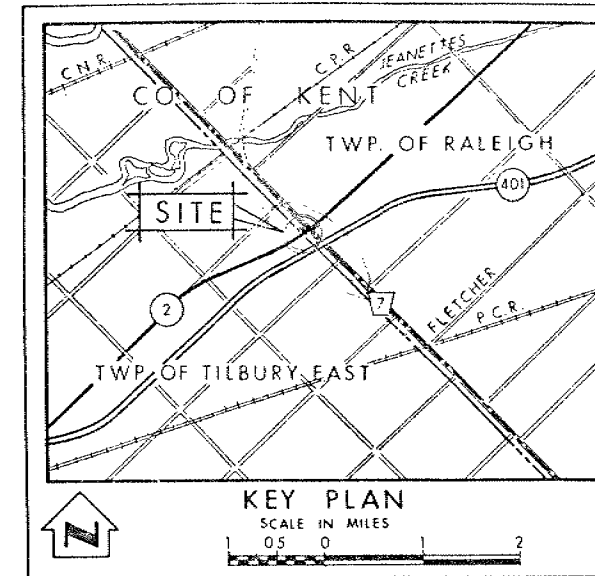
PLAN

SCALE
20 10 0 20 FT



PROFILE

SCALE
20 10 0 20 FT



LEGEND

- Bore Hole
- Cone Penetration Test
- Bore Hole & Cone Test
- Water Levels established at time of field investigation, FEB. 1973

NO.	ELEVATION	STATION	OFFSET
1	584.7	3+67	18' RT.
2	585.1	3+14	17' LT.

NOTE

The boundaries between soil strata have been established only at Bore Hole locations. Between Bore Holes the boundaries are assumed from geological evidence.

REVISIONS	DATE	BY	DESCRIPTION



REF NO E-5340-1

MINISTRY OF TRANSPORTATION AND COMMUNICATIONS—ONTARIO
DESIGN SERVICES BRANCH—FOUNDATIONS OFFICE

PROPOSED CROSSING
GOVERNMENT DRAIN NO. 1 DIVERSION
HIGHWAY NO. 2 DIST. NO. 1
CO. KENT
TWP. TILBURY EAST LOT 1 CON. 6

BORE HOLE LOCATIONS & SOIL STRATA

SUBMD A P	CHECKED <u> </u>	W.P. NO. <u>89-67</u>	DRAWING NO. <u>72-11163A</u>
DRAWN O. J.	CHECKED <u> </u>	W.C. NO. <u>72-11163</u>	
DATE <u>JUNE 12 1973</u>			
APPROVED <u> </u>			

MINISTRY OF TRANSPORTATION AND COMMUNICATIONS, ONTARIO

MEMORANDUM

TO: Mr. A.P. Watt,
Reg. Structural Planning Engineer,
Southwestern Region, London.

FROM: Soil Mechanics Section,
Geotechnical Office,
West Bldg., Downsview.

ATTENTION:

DATE: January 16th, 1975.

OUR FILE REF.

IN REPLY TO

JAN 22 1975

SUBJECT:

FOUNDATION INVESTIGATION REPORT
For
Government Drain No. 1 Bridge,
Twp. of Tilbury East, Co. of Kent,
Hwy. #2, District #1, (Chatham),
W.P. 89-67-00.

40J8-36
GEOCRE No.

Attached we are forwarding to you our detailed Foundation Investigation Report on the subsoil conditions existing at the abovementioned site.

We believe that the factual data and recommendations contained therein will prove adequate for your design requirements. Should additional information be required, please do not hesitate to contact our Office.

K. G. Selby

K.G. Selby,
Supervising Engineer.

KGS/ma

c.c. E.J. Orr
B.R. Davis
A. Wittenberg
F.C. Brown
B.J. Giroux
J.R. Roy
G.A. Wrong
P. Lewycky

Files ✓
Record Services

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 - 4.6) Groundwater.
5. RECOMMENDATIONS.
6. MISCELLANEOUS.

FOUNDATION INVESTIGATION REPORT

For

Government Drain No. 1 Bridge,
Twp. of Tilbury East, Co. of Kent,
Hwy.#2, District #1, (Chatham),

W.P. 89-67-00.

1. INTRODUCTION:

A request for a foundation investigation for a structure at the abovementioned site was received from Mr. A.P. Watt, Regional Structural Planning Engineer, Southwestern Region, London. This site is some 300 ft. east of a previously proposed site for the same structure at which a foundation investigation had already been carried out.

A field investigation was subsequently carried out by the Soil Mechanics Section to determine the subsoil conditions existing at this site. This report contains the results of the field and laboratory investigations, together with recommendations relating to the design of the proposed structure foundations.

2. DESCRIPTION OF THE SITE.

The site is located 7.3 miles west of Chatham west limits on Hwy. 2 just west of Kent Co. Rd. #7.

The existing bridge at the site is a two-span concrete structure with some cracking of the supporting beams.

..... /2

The surrounding area consists of almost level farmland. Physiographically, the site is located in the region referred to as the St. Clair Clay Plain.

3. FIELD AND LABORATORY INVESTIGATION PROCEDURES:

A total of four sampled boreholes and four dynamic cone penetration tests were carried out by means of a CME 750 employing 3¼" hollow-stem augers.

Disturbed samples were obtained using a 2-inch O.D. Split-spoon sampler driven according to the specifications for the Standard Penetration Test.

All boreholes were surveyed in the field by personnel from London Region Engineering Surveys Section. The locations and elevations of the borings are shown on Drawing #896700-A which accompanies this report.

All samples were visually examined and classified at the site as well as in the laboratory. Following these inspections laboratory tests were carried out on selected representative samples to determine the following physical properties:

Unconfined Shear Strength
Atterberg Limits
Natural Moisture Content
Grain-Size Distribution

The test results are summarized on the Record of Borehole Sheets contained in the appendix of this Report.

4. SUBSOIL CONDITIONS:

4.1) General.

Subsoil at the site consists of a deep deposit of about 75 feet of clayey silt to silty clay with some sand and occasional sand seams. Underlying this layer is approximately 7 feet of compact fine sand with silt overlying approximately 10 feet of hard clayey silt some sand and a trace of gravel (Glacial Till). Beneath this some 80 feet below the bed of the drain is Limestone bedrock.

The boundaries between the different deposits are shown on the attached Record of Borehole Sheets. The estimated stratigraphical profile shown on Drawing #896700-A is based upon this information. From groundlevel downwards, the different soil deposits are described as follows:

4.2) Clayey Silt to Silty Clay.

This is the predominant soil deposit at the site and is about 75 feet in depth including the upper 5-6 ft. which is actually fill material. It consists of clayey silt to silty clay, some sand and has occasional sand seams in the lower portion.

Plots of Plasticity Index versus Liquid Limit for samples from the deposit fall within the CL and CI range and are shown in Fig. 1 of the Appendix.

Grain-size analyses are plotted in the form of an envelope in Fig. 2.

Standard Penetration Test 'N' values range from 9 to 44. The higher values generally being at depths between 10 and 20 feet, represent the desiccated crust which has an estimated undrained shear strength in excess of 4000 p.s.f. Strength decreases with depth below this zone to values of approximately 2000 p.s.f. for the remainder of the deposit.

Moisture content varies from 14 to 23 per cent.

4.3) Fine Sand.

This layer consists of approximately 7 feet of compact fine sand with silt. It has a moisture content of 20%, and was the main source of water which filled the boreholes penetrating it to within 21 feet of the surface.

A plot showing grain-size distribution is shown as Fig. 3 of the Appendix.

4.4) Clayey Silt with Sand.

This stratum consists of about 10 feet of clayey silt with sand. It has a moisture content of 10% and a Standard Penetration Test 'N' value of 70 giving it a consistency classified as hard.

4.5) Limestone Bedrock.

Limestone bedrock containing layers of shale was encountered at approximately elevation 493 in the two deep boreholes. This rock was proven by a 4.5 ft. sample taken from borehole #4.

4.6) Groundwater.

Groundwater was encountered in seams of fine sand in the lower portion of the clayey silt to silty clay layer as well as the fine sand layer. This water rose in the boreholes to levels not higher than 21 feet below the ground surface.

5. RECOMMENDATIONS:

It is proposed to replace the existing bridge carrying Hwy. #2 over Government Drain #1 by a single-span structure. The new grade some 3 feet higher than the old is approximately at elevation 589.

It is recommended that the structure be placed on spread footing type foundations at or below elevation 572. The exact footing elevation should be determined by the Hydrology Section to provide adequate scour protection. A safe net bearing pressure of 2.5 tons per square foot may be assumed for design purposes. Under the above loading, longterm settlement is anticipated to be in the order of 1 inch and differential settlement to be less than one inch.

As an alternative the structure may be supported on timber piles driven to an elevation necessary to achieve the required pile capacity. In determining the safe capacity of a timber pile, the following equation may be used:

$$Q = 0.5 L$$

where

Q = Safe capacity of one pile in tons

L = Embedded length of pile in original ground (ft.)

A second alternative is to support the structure on steel end bearing piles. Either H piles or 12-3/4" x 1/4" steel tube piles may be used. The maximum allowable design load for the particular section chosen may be used for design purposes. It is estimated that these piles will achieve the required design load bearing on bedrock at approximately elevation 493, or in the hard

clayey silt till layer at a slightly higher elevation.

All footings or pile caps should be protected against frost action by at least 4' of earth cover.

No dewatering problems are anticipated for footing or pile cap excavations due to the relatively impervious nature of the clayey silt to silty clay subsoil.

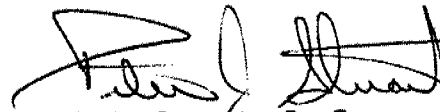
It is recommended that the drain be constructed with 2:1 side slopes which should be protected against scour in the vicinity of the structure.

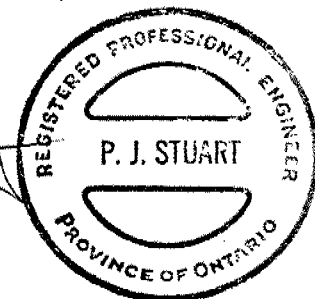
6. MISCELLANEOUS:

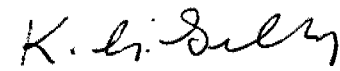
The field work for the project was carried out during the period of December 1st to December 17th, 1974, under the supervision of Mr. B. Stuart, Project Engineer, who also prepared this report.

The equipment was owned and operated by Dominion Soil Investigation Ltd.

This report was reviewed by Mr. K.G. Selby, Supervising Engineer.


P.J. Stuart, P. Eng.,
Project Engineer,




K.G. Selby, P. Eng.,
Supervising Engineer.

PJS/ma

January, 1975.

APPENDIX I

MINISTRY OF TRANSPORTATION AND COMMUNICATIONS-ONTARIO
ENGINEERING SERVICES BRANCH-GEOTECHNICAL OFFICE-SOIL MECHANICS SECTION

RECORD OF BOREHOLE NO 1

W.P. 89-67-00 LOCATION Sta. 0 + 16 o/s 38' Lt. ORIGINATED BY PJS
DIST. 1 HWY. 2 BORING DATE December 11, 1974 COMPILED BY PJS
DATUM Geodetic BOREHOLE TYPE Hollow Stem Auger CHECKED BY _____

SOIL PROFILE			SAMPLES			GROUND WATER ELEV.	DYNAMIC CONE PENETRATION RESISTANCE PLOT					LIQUID LIMIT w_L PLASTIC LIMIT w_p WATER CONTENT w			UNIT WEIGHT γ	REMARKS % GR. SA. SI. CL.
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	'N' VALUES		20	40	60	80	100	w_p	w	w_L		
585.6	Ground Level															
0.0	Clayey silt to silty clay, some sand, trace of gravel.		1	SS	9	580										2 20 49 29
			2	SS	13											
			3	SS	37											
			4	SS	29	570										
	Stiff to Hard		5	SS	16											
			6	SS	20	560										0 32 35 33
			7	SS	19	550										
			8	SS	28	540										
			9	SS	22	530										0 19 56 25
510.6						510										
75.0	Fine Sand Some Silt Compact		10	SS	20	500										0 85 (15)
502.6																
83.0	Clayey silt with sand. Hard															
493.1	Probable Bedrock End of Borehole					490										

20
15 \diamond 5 % STRAIN AT FAILURE
10

OFFICE REPORT ON SOIL EXPLORATION

ENGINEERING SERVICES BRANCH-GEOTECHNICAL OFFICE-SOIL MECHANICS SECTION

RECORD OF BOREHOLE No 2

W.P. 89-67-00 LOCATION Sta. 0 + 16 o/s 44' Rt. ORIGINATED BY PJS
 DIST. 1 HWY. 2 BORING DATE December 13, 1974 COMPILED BY PJS
 DATUM Geodetic BOREHOLE TYPE Hollow Stem Auger CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER ELEV.	DYNAMIC CONE PENETRATION RESISTANCE PLOT					LIQUID LIMIT — w_L PLASTIC LIMIT — w_p WATER CONTENT — w			UNIT WEIGHT γ	REMARKS
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	'N' VALUES		20	40	60	80	100	w_p	w	w_L		
585.3	Ground Level															
0.0	Clayey silt to silty clay, some sand.		1	SS	20	580										0 5 46 49
			2	SS	14											
			3	SS	17											
	Stiff to Very Stiff		4	SS	23											
			5	TW	PH	570									130	0 20 50 30
			6	SS	21											
			7	TW	PH										133	0 20 48 32
			8	SS	22	560										
553.8			9	SS	20											0 20 50 30
31.5	End of Borehole Note: Water Level not established.					550										

RECORD OF BOREHOLE N2 3

W.P. 89-67-00

LOCATION Sta. 1 + 03. o/s 23' Lt.

ORIGINATED BY PJS

DIST. 1 HWY. 2

BORING DATE December 13, 1974

COMPILED BY PJS

DATUM Geodetic

BOREHOLE TYPE Hollow Stem Auger

CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER ELEV.	DYNAMIC CONE PENETRATION RESISTANCE PLOT					LIQUID LIMIT w_L PLASTIC LIMIT w_p WATER CONTENT w			UNIT WEIGHT γ	REMARKS
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	N ^o VALUES		20	40	60	80	100	w_p	w	w_L		
585.2	Ground Level															
0.0	Clayey silt to silty clay, some sand.		1	SS	14	580										
			2	SS	11											
			3	SS	25											
			4	TW	PH											
	Stiff to Hard		5	SS	24	570										
			6	SS	24											
			7	SS	25	560										
553.7			8	SS	41											
31.5	End of Borehole					550										

RECORD OF BOREHOLE NO 4

W.P. 89-67-00 LOCATION Sta. 1 + 03 o/s 23' Rt. ORIGINATED BY PJS
 DIST. 1 HWY. 2 BORING DATE December 16, 1974 COMPILED BY PJS
 DATUM Geodetic BOREHOLE TYPE Hollow Stem Auger CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER ELEV.	DYNAMIC CONE PENETRATION RESISTANCE PLOT					LIQUID LIMIT — W _L PLASTIC LIMIT — W _P WATER CONTENT — W			UNIT WEIGHT γ	REMARKS % GR SA. SI. CL.
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	'N' VALUES		20	40	60	80	100	W _P	W	W _L		
585.3	Ground Level															
0.0	Clayey silt to silty clay, some sand.		1	SS	19	580									132	0 18 48 34
			2	SS	11											
			3	TW	PH											
			4	SS	44											
			5	SS	21	570										
			6	SS	23											
			7	TW	PH										131	0 21 47 32
	Stiff to Hard		8	SS	15	560										
			9	SS	16											
						550										
			10	SS	15											
						540										
			11	SS	21											
						530										
						520										
			12	SS	19											
						510										
510.3																
75.0	Fine Sand															
	Compact															
502.3																
83.0	Clayey Silt with sand.					500										
	Hard															
493.0			13	SS	70											
92.3	Limestone Bedrock															
488.8	Shale Layers					490										
96.5	End of Borehole Note: Water Level not established.															

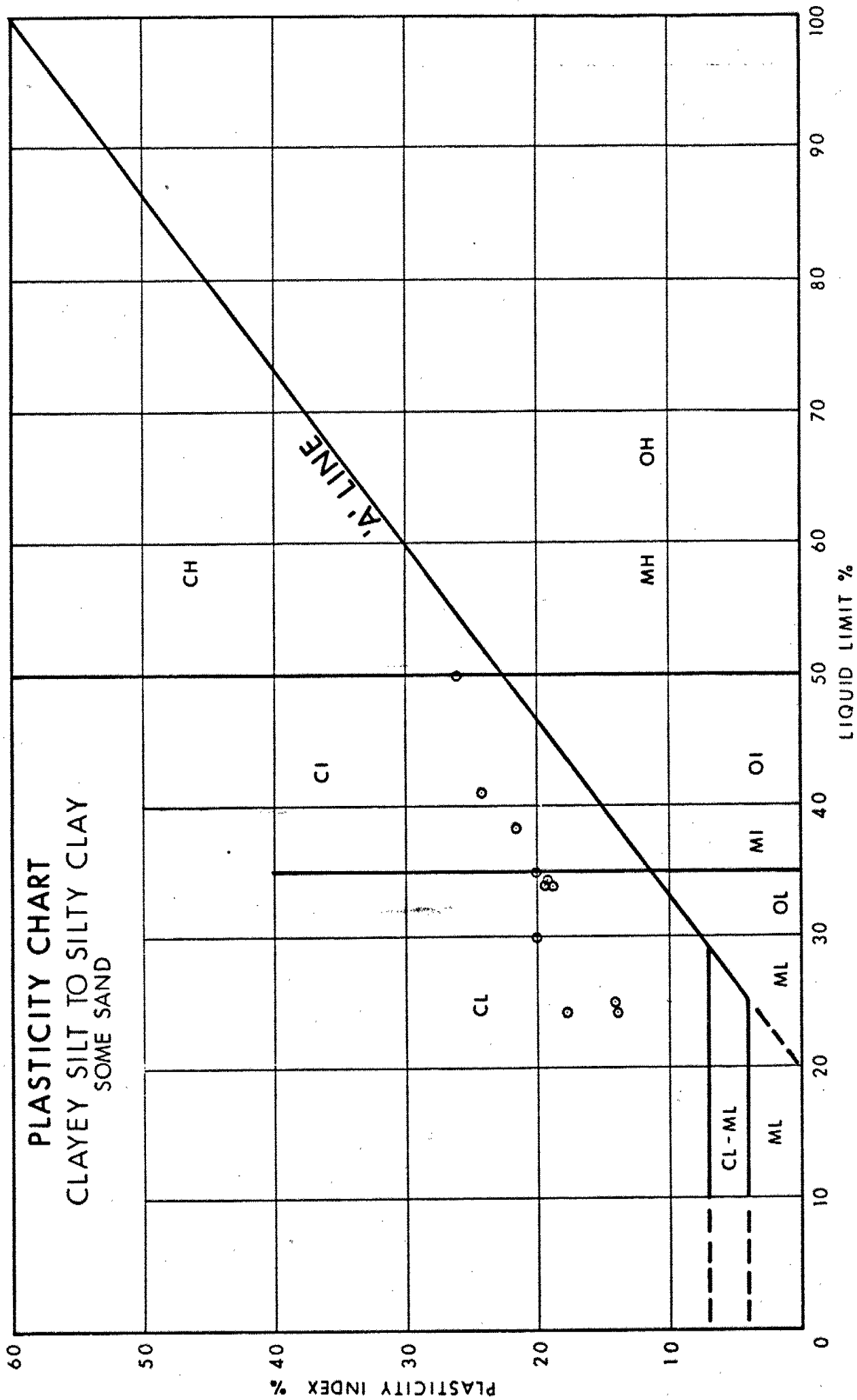


FIG. 1.

GRAIN SIZE DISTRIBUTION

UNIFIED SOIL CLASSIFICATION SYSTEM

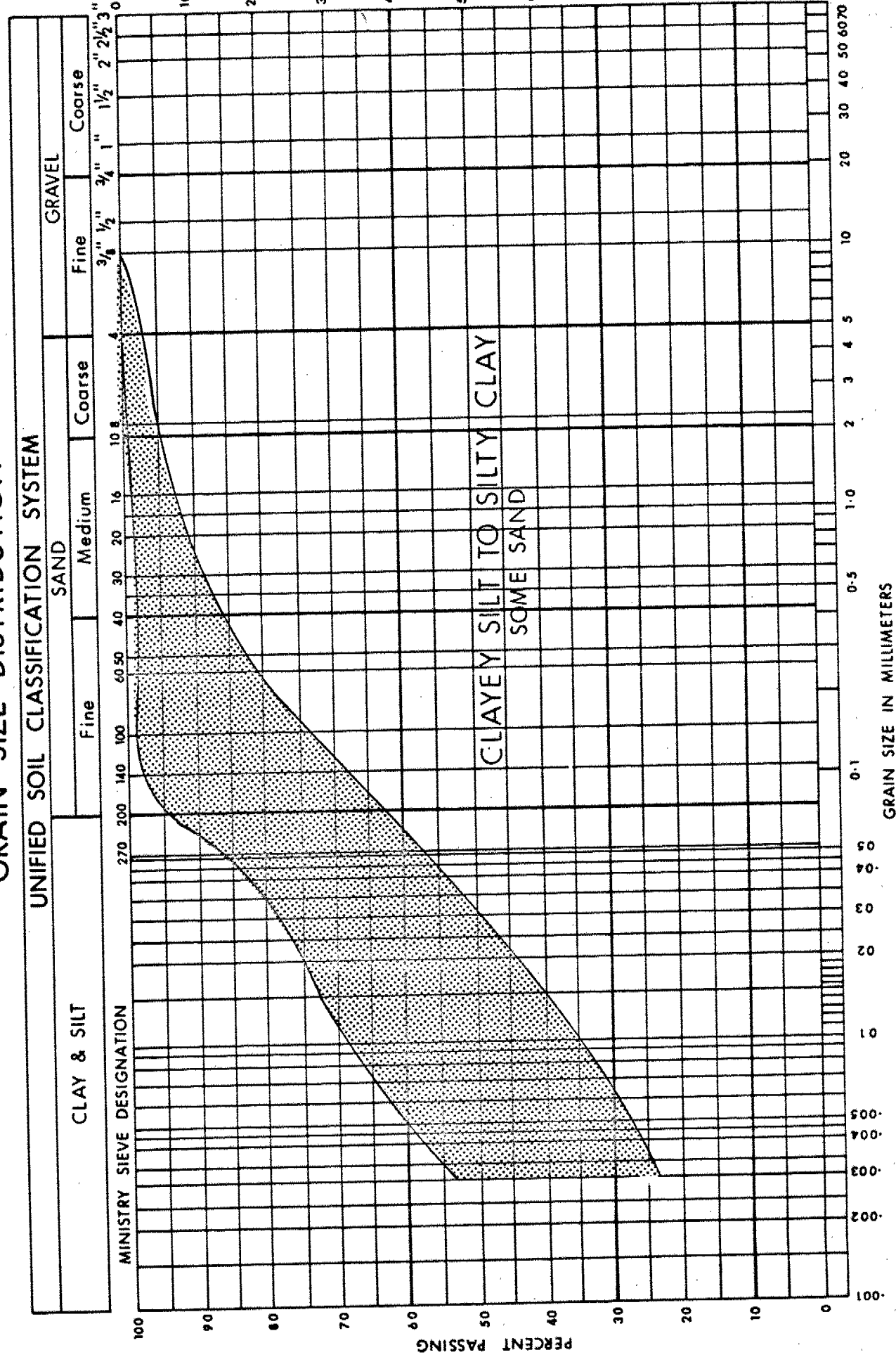


FIG. 2

GRAIN SIZE DISTRIBUTION

UNIFIED SOIL CLASSIFICATION SYSTEM

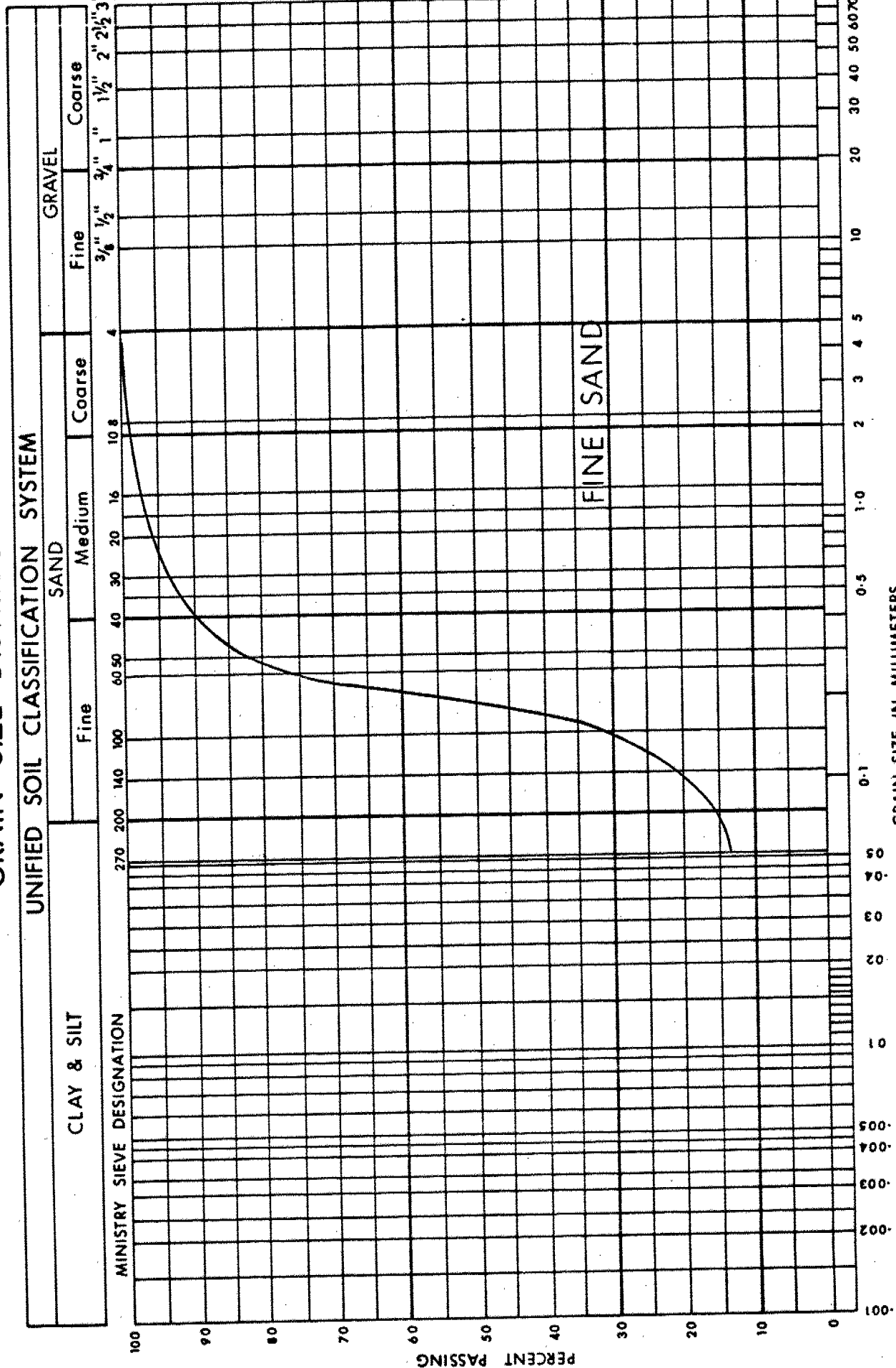


FIG. 3

ABBREVIATIONS & SYMBOLS USED IN THIS REPORTPENETRATION RESISTANCE

'N'-STANDARD PENETRATION RESISTANCE : - THE NUMBER OF BLOWS REQUIRED TO ADVANCE A STANDARD SPLIT SPOON SAMPLER 12 INCHES INTO THE SUBSOIL, DRIVEN BY MEANS OF A 140 POUND HAMMER FALLING FREELY A DISTANCE OF 30 INCHES.

DYNAMIC PENETRATION RESISTANCE :- THE NUMBER OF BLOWS REQUIRED TO ADVANCE A 2 INCH, 60 DEGREE CONE, FITTED TO THE END OF DRILL RODS, 12 INCHES INTO THE SUBSOIL, THE DRIVING ENERGY BEING 350 FOOT POUNDS PER BLOW.

DESCRIPTION OF SOIL

THE CONSISTENCY OF COHESIVE SOILS AND THE RELATIVE DENSITY OR DENSENESS OF COHESIONLESS SOILS ARE DESCRIBED IN THE FOLLOWING TERMS :-

<u>CONSISTENCY</u>	<u>c LB/SQ. FT.</u>	<u>DENSENESS</u>	<u>'N' BLOWS / FT.</u>
VERY SOFT	0 - 250	VERY LOOSE	0 - 4
SOFT	250 - 500	LOOSE	4 - 10
FIRM	500 - 1000	COMPACT	10 - 30
STIFF	1000 - 2000	DENSE	30 - 50
VERY STIFF	2000 - 4000	VERY DENSE	> 50
HARD	> 4000		

TERMS TO BE USED IN DESCRIBING SOILS:-

TRACE < 10% , SOME 10-25% , WITH 25-40% , > 40% SILTY, SANDY, GRAVELLY, CLAYEY ETC.

TYPE OF SAMPLE

S.S.	SPLIT SPOON	T.W.	THINWALL OPEN
W.S.	WASHED SAMPLE	T.P.	THINWALL PISTON
S.T.	SLOTTED TUBE SAMPLE	O.S.	OESTERBERG SAMPLE
A.S.	AUGER SAMPLE	F.S.	FOIL SAMPLE
C.S.	CHUNK SAMPLE	R.C.	ROCK CORE

P.H. SAMPLE ADVANCED HYDRAULICALLY

P.M. SAMPLE ADVANCED MANUALLY

SOIL TESTS

U	UNCONFINED COMPRESSION	L.V.	LABORATORY VANE
UU	UNCONSOLIDATED UNDRAINED TRIAXIAL	F.V.	FIELD VANE
CIU	CONSOLIDATED ISOTROPIC UNDRAINED TRIAXIAL	C	CONSOLIDATION
CID	" " DRAINED "	S	SENSITIVITY
CAU	" ANISOTROPIC UNDRAINED "		
CAD	" " DRAINED "		

ABBREVIATIONS & SYMBOLS USED IN THIS REPORT

SOIL PROPERTIES

γ	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	SPECIFIC GRAVITY OF SOLID PARTICLES $G = \frac{\gamma_s}{\gamma_w}$
e	VOID RATIO
n	POROSITY
w	WATER CONTENT
S_r	DEGREE OF SATURATION
w_L	LIQUID LIMIT
w_p	PLASTIC LIMIT
I_p	PLASTICITY INDEX
w_s	SHRINKAGE LIMIT
I_L	LIQUIDITY INDEX = $\frac{w - w_p}{I_p}$
I_c	CONSISTENCY INDEX = $\frac{w_L - w}{I_p}$
e_{max}	VOID RATIO IN LOOSEST STATE
e_{min}	VOID RATIO IN DENSEST STATE
I_D	DENSITY INDEX = $\frac{e_{max} - e}{e_{max} - e_{min}}$
	RELATIVE DENSITY D_r IS ALSO USED
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
m_v	COEFFICIENT OF VOLUME CHANGE = $\frac{-\Delta e}{(1+e)\Delta\sigma}$
c_v	COEFFICIENT OF CONSOLIDATION
C_c	COMPRESSION INDEX = $\frac{\Delta e}{\Delta \log_{10} \sigma}$
T_v	TIME FACTOR = $\frac{c_v t}{d^2}$ (d, DRAINAGE PATH)
U	DEGREE OF CONSOLIDATION
τ_f	SHEAR STRENGTH
c'	EFFECTIVE COHESION INTERCEPT
ϕ'	EFFECTIVE ANGLE OF SHEARING RESISTANCE, OR FRICTION
c_u	APPARENT COHESION
ϕ_u	APPARENT ANGLE OF SHEARING RESISTANCE, OR FRICTION
μ	COEFFICIENT OF FRICTION
S_t	SENSITIVITY

GENERAL

π	= 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

STRESS AND STRAIN

u	PORE PRESSURE
σ	NORMAL STRESS
σ'	NORMAL EFFECTIVE STRESS ($\bar{\sigma}$ IS ALSO USED)
τ	SHEAR STRESS
ϵ	LINEAR STRAIN
γ	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

EARTH PRESSURE

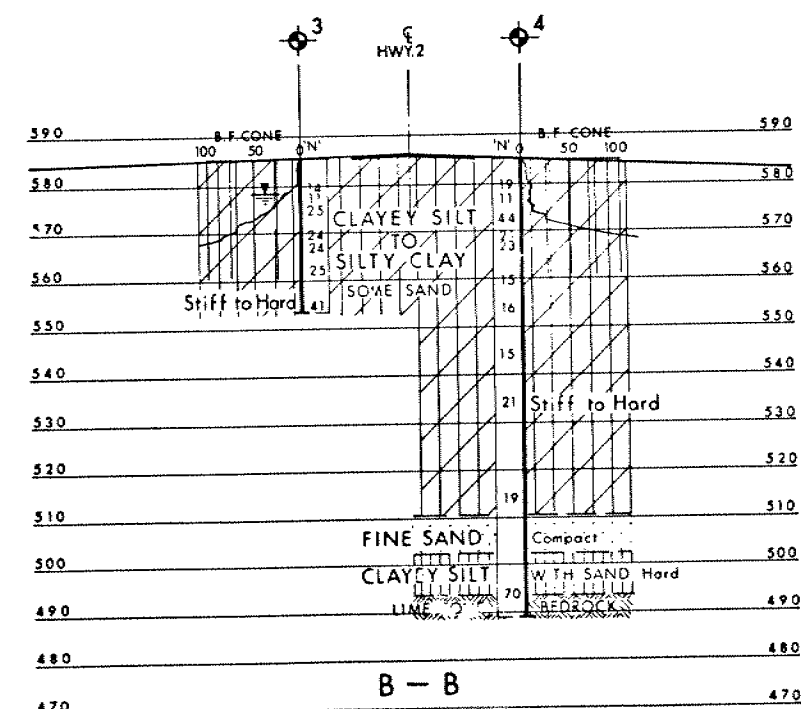
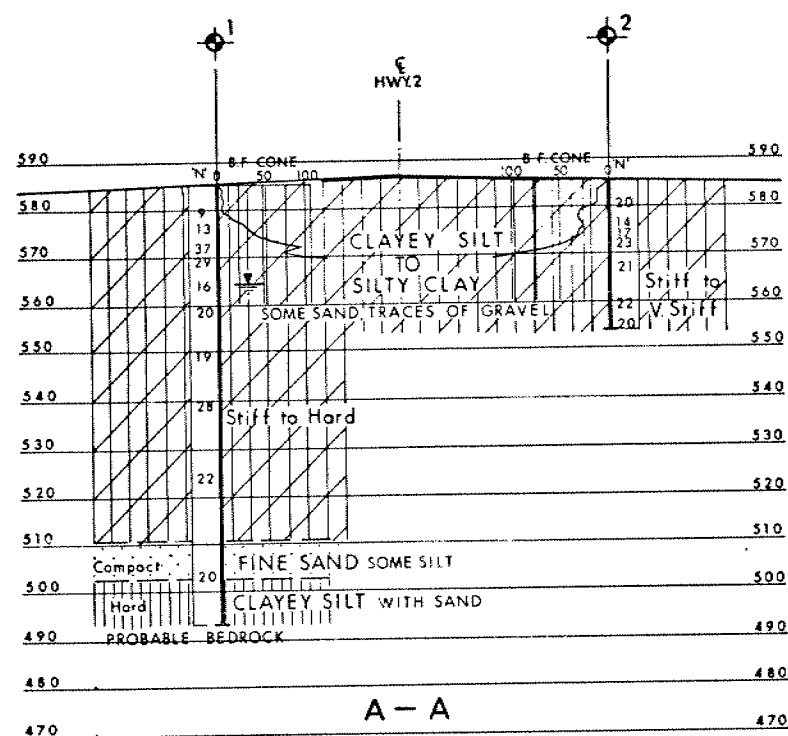
d	DISTANCE FROM TOP OF WALL TO POINT OF APPLICATION OF PRESSURE
δ	ANGLE OF WALL FRICTION
K	DIMENSIONLESS COEFFICIENT TO BE USED WITH VARIOUS SUFFIXES IN EXPRESSIONS REFERRING TO NORMAL STRESS ON WALLS
K_0	COEFFICIENT OF EARTH PRESSURE AT REST

FOUNDATIONS

B	BREADTH OF FOUNDATION
L	LENGTH OF FOUNDATION
D	DEPTH OF FOUNDATION BENEATH GROUND
N	DIMENSIONLESS COEFFICIENT USED WITH A SUFFIX APPLYING TO SPECIFIC GRAVITY, DEPTH AND COHESION ETC. IN THE FORMULA FOR BEARING CAPACITY
k_s	MODULUS OF SUBGRADE REACTION

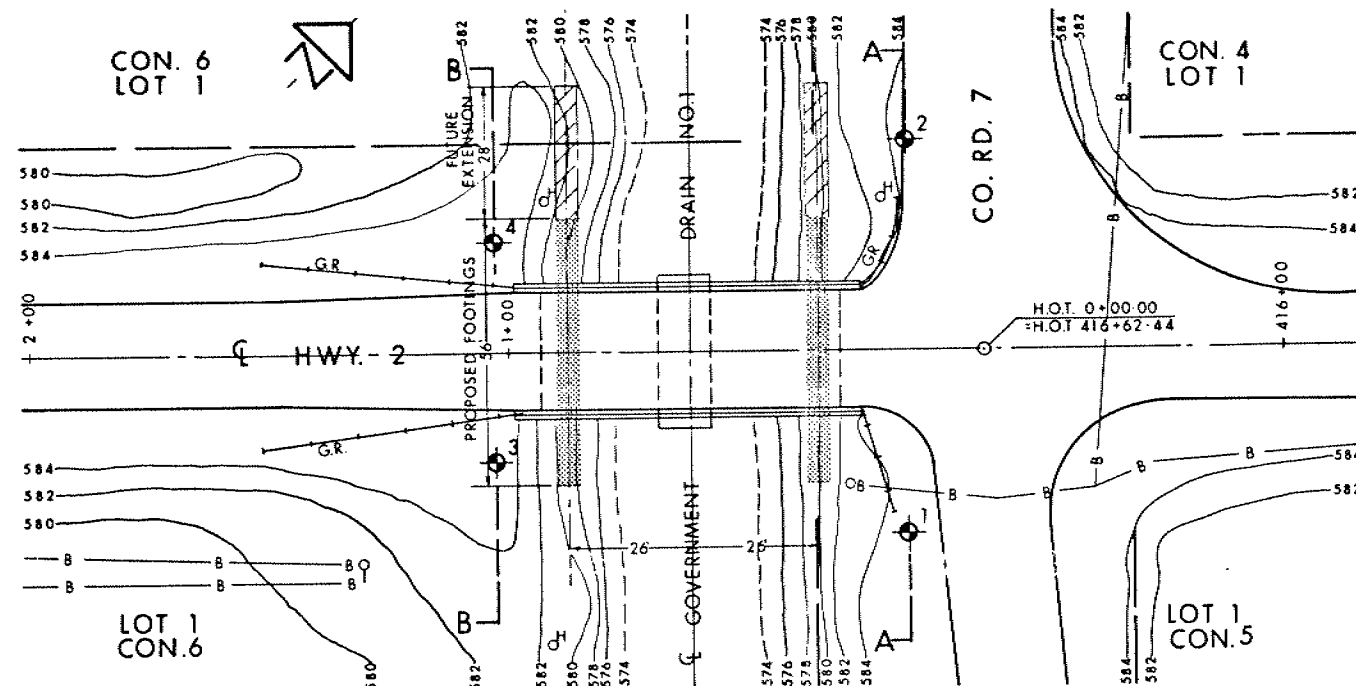
SLOPES

H	VERTICAL HEIGHT OF SLOPE
D	DEPTH BELOW TOE OF SLOPE TO HARD STRATUM
β	ANGLE OF SLOPE TO HORIZONTAL

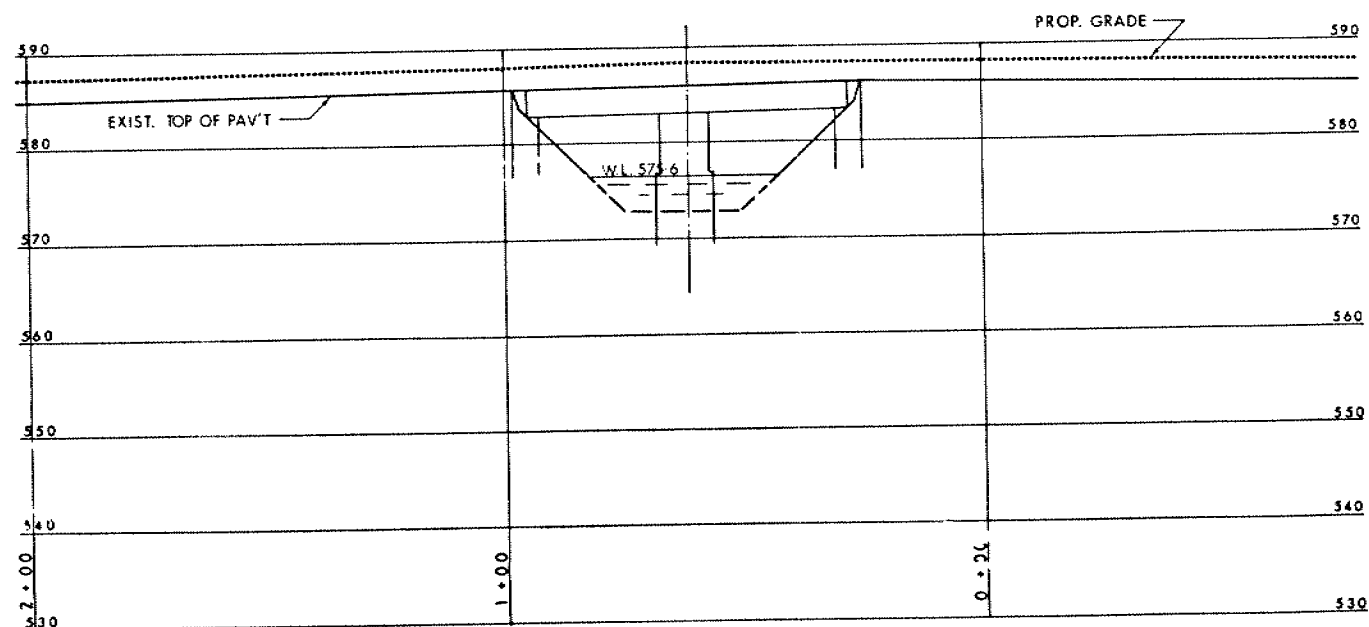


SECTIONS

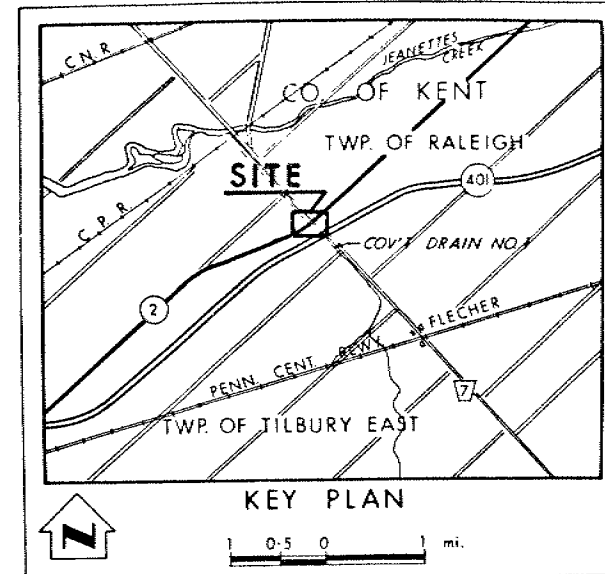
SCALE
20 10 0 20 FT



SCALE
20 10 0 20 FT



SCALE
20 10 0 20 FT
VER. 10 5 0 10



LEGEND

- Bore Hole
- ⊕ Dynamic Cone Penetration Resistance Test
- ⊕ Bore Hole & Cone Test
- Water Levels established at time of field investigation, 11 Dec. 1974
No Water Levels established
B.H. No. 2 & 4

NO.	ELEVATION	STATION	OFFSET
1	585.6	0+16	38' LT.
2	585.3	0+16	44' RT.
3	585.2	1+03	23' LT.
4	585.3	1+03	23' RT.

NOTE: FOR CONTRACT DOCUMENTS
The complete foundation investigation report for this structure may be examined at the Structural Office and Foundations Office, Downsview, and at the CHATHAM District Office.

NOTE

The boundaries between soil strata have been established only at Bore Hole locations. Between Bore Holes the boundaries are assumed from geological evidence.

REVISIONS	DATE	BY	DESCRIPTION

MINISTRY OF TRANSPORTATION AND COMMUNICATIONS-ONTARIO
ENGINEERING SERVICES BRANCH-GEOTECHNICAL OFFICE-SOIL MECHANICS SECTION

**PROPOSED CROSSING
AT
GOVERNMENT DRAIN NO. 1**

HIGHWAY NO. 2 DIST NO. 1
CO. KENT
TWP. TILBURY EAST LOT 1 CON. 6

BORE HOLE LOCATIONS & SOIL STRATA

SUBMD P. 5	CHECKED	WP NO. 89-67-00	DRAWING NO.
DRAWN OL J	CHECKED	W. C. NO.	896700-A
DATE 24 DEC 1974	SITE NO.	BRIDGE DRAWING NO.	
APPROVED	CONT NO.		