

G.I.-30 SEPT. 1976

GEOCRES No. 40J9-17DIST. 1 REGION W.P. No. 27-74-01CONT. No. 75-149W. O. No. STR. SITE No. 13-5HWY. No. 40LOCATION 2 Mi W of WallaceburgNo. of PAGES -

OVERSIZE DRAWINGS TO BE INCLUDED WITH THIS REPORT.REMARKS:

MINISTRY OF TRANSPORTATION AND COMMUNICATIONS, ONTARIO

MEMORANDUM

40J9-17

GEOCREs No.

TO: Mr. A.P. Watt, (2) FROM: Soil Mechanics Section,
Regional Structural Planning Geotechnical Office,
Engineer, West Building, Downsview.
Southwestern Reg., London.

ATTENTION: DATE: September 19th, 1974.

OUR FILE REF. IN REPLY TO SEP 27 1974

SUBJECT:

CONT 75-149
FOUNDATION INVESTIGATION REPORT
For
Skinner Drain Structure,
Hwy. 40 New,
District #1, Chatham.
W.P. 27-74-01, Site 13-5.

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/mj
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
Documents
Attach*

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FOUNDATION INVESTIGATION REPORT
For
Skinner Drain Structure,
Hwy. 40 New,
District #1, Chatham.
W.P. 27-74-01, Site 13-5.

1. INTRODUCTION:

A request for a foundation investigation for the above project was received from Mr. A.P. Watt, Regional Structural Planning Engineer, in a memo dated July 2nd, 1974.

Subsequently a field investigation was carried out by the Foundations Office to determine the subsoil conditions at this location. This report contains the results of the investigation and our recommendations concerning the design of foundations for the proposed structure.

2. SITE CONDITIONS:

The site is located at the junction of Highway 40 and Highway 40 New, 2.0 miles west of the Town of Wallaceburg West Limits.

The structure is required to accommodate a proposed separate right-turn lane. It is intended that the existing 20' x 10' reinforced concrete rigid frame slab bridge be extended approximately 90 feet to the north. Twenty-foot long approach slabs are also to be included.

The creek is approximately 30 feet wide by 3 feet deep. The creek banks are relatively steep, averaging 1:3 slopes, and show evidence of slipping.

The surrounding area is flat, cultivated, farmland.

Physiographically, the site is located in the region referred to as the St. Clair Clay Plains.

3. FIELD AND LABORATORY INVESTIGATIONS:

The field work consisted of two boreholes and four cones. One borehole and two cones were placed adjacent to the existing structure while the remainder were placed at the extreme limits of the proposed new structure. The Boreholes were advanced using a Bombardier mounted CME 45, modified for soil sampling purposes using solid-stem augers. Disturbed samples were obtained by driving a split-spoon sampler 18 inches into the

subsoil according to the specifications for the Standard Penetration Test. Undisturbed samples were obtained using 2-inch I.D. Shelby tubes which were pushed into the soil either by hand or hydraulically. Field vane tests were performed 18 inches below disturbed levels where possible.

The cone tests were carried out using a driving energy of 350 ft.-lbs. per blow for advancement.

The location and elevation of the boreholes and cone tests were established by the field engineer and are marked on drawing 27-74-01A which accompanies this report.

Samples were examined in the field by the field engineer. Laboratory tests were performed on selected samples to determine Unconfined and Triaxial Shear Strengths, Bulk Densities, Natural Moisture Content, and Grain-Size Distribution. The results of the field and laboratory tests are shown on the Record of Borehole sheets contained in the Appendix of this Report.

4. SUBSOIL CONDITIONS:

4.1) General.

The subsoil at the site was found to be uniform in both the horizontal and vertical directions consisting of a deep soft to stiff deposit of silty clay (12 to 110.5 ft., 3.7 to 33.7 m) overlain by a stiff layer (0 to 12 feet, 0 to 3.7 m) of clayey silt. Traces to some sand was found in the upper layer only.

The dynamic penetration cone test values ranged in the majority from 20 to 60 blows per foot; all cones were driven to bedrock.

4.2) Clayey Silt, Traces to Some Sand.

This deposit was encountered in both boreholes from ground elevation to a depth of approximately 12 feet (3.7 m). At borehole No. 1 the deposit was overlain by a 2 foot layer of road fill. The limit of this clayey silt layer was discernable by the abrupt changes in colour from brown to grey.

The Standard Penetration 'N' values ranged from 6 to 21 blows per foot, the average being 13 blows per foot.

The field vane tests taken showed the undrained shear strength to be 1720 p.s.f. (82.6 kN/m^2), decreasing to approximately 1500 p.s.f. as the underlying silty clay layer was entered.

The physical properties as determined by the lab tests are as follows:

Natural Moisture Content 18% - 23%

4.3) Silty Clay.

This layer was encountered from elevation 566.0 ft. (172.5 m) to bedrock (elev. 466.0 ft., 142.0 m). The Standard Penetration 'N' values were generally 2 blows per foot, increasing to 12 blows per foot in the lower region.

The field vane tests taken showed the undrained shear strength to decrease to 240 p.s.f. (11.5 kN/m^2) in the upper regions of this silty clay layer, then in turn, increase with depth, reaching a value of 1120 p.s.f. (57.8 kN/m^2) near bedrock.

The physical properties as determined by the lab tests are as follows:

| | |
|-------------------------------------|---|
| Natural Moisture Content | 23% - 48% |
| Liquid Limit | 34% - 46% |
| Plastic Limit | 18% - 25% |
| Unconfined Undrained Shear Strength | 100 - 810 p.s.f. ($4.8\text{--}38.8 \text{ kN/m}^2$) |
| Undrained Triaxial Shear Strength | 180-365 p.s.f. ($8.6\text{--}17.5 \text{ kN/m}^2$) |

A plasticity chart is included in the appendix.

5. GROUNDWATER CONDITIONS:

Water was encountered in both Boreholes, at the approximate water level of Skinner Drain at the time of drilling; water elevation being 572.0 ft. (174.3 m).

6. RECOMMENDATIONS:

The culvert will be founded within the 'stiff' zone of the clayey silt layer. It appears that the invert culvert elevation will be at elevation 565.0 ft. (172.3 m). At this elevation the net safe bearing capacity of the sub-soil is estimated to be 1500 p.s.f.

This culvert is to be an extension of the existing culvert therefore we anticipate that some differential settlement of around 1 inch may occur. A vertical expansion joint should therefore be provided at the junction of the old and new culverts.

The proposed wingwalls may be founded on spread footings assuming a net safe design pressure of 1500 p.s.f. at or about elev. 565 ft., or on No. 14, treated, timber friction piles. The bearing capacity of these piles may be calculated as follows:

$$Q = 0.4 L \text{ Tons}$$

where Q = maximum allowable load per pile in Tons
 L = length of embedment of pile in ground, in feet.

Some differential settlements are likely to occur between the wingwalls and the culvert. It would be advisable to construct vertical expansion joints between the two.

For protection against frost, the foundations should be set 4 feet below the finished groundlevel, or waterlevel. Since excavations will be carried out below the ground or creek waterlevel, it will be necessary to employ a dewatering scheme.

Due to the relatively impervious nature of the silty clay subsoil, no major problems are anticipated.

7. MISCELLANEOUS:

The field work was carried out under the supervision of Mr. W.P. Greskow, Student Technician. The equipment was owned and operated by Master Soil Investigation.

This Report was written by Mr. W.P. Greskow and reviewed by Mr. K.G. Selby, Supervising Engineer.



W.P. Greskow,
Student Technician.



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

WPG/mj

September/74

A P P E N D I X I

JOB _____ LOCATION 30' Rt. of Sta. 259+65, Hwy. 40N ORIGINATED BY WG
W.P. 27-74-01 BORING DATE July 10, 1974 COMPILED BY WG
DATUM Geodetic BOREHOLE TYPE Solid Stem Auger and Cone Test CHECKED BY (Signature)

[illegible]

DESIGN SERVICES BRANCH

FOUNDATIONS OFFICE

RECORD OF BOREHOLE NO 1 Continued

JOB _____ LOCATION 30' Rt. of Sta. 259+65 Hwy. 40N ORIGINATED BY WG
 W.P. 27-74-01 BORING DATE July 10, 1974 COMPILED BY WG
 DATUM Geodetic BOREHOLE TYPE Solid Stem Auger and Cone Test CHECKED BY WG

| SOIL PROFILE | | | | SAMPLES | | | ft/m | DYNAMIC PENETRATION RESISTANCE | | | | | LIQUID LIMIT ——— w_L | | | BULK DENSITY | REMARKS |
|--------------------|-------------|-------------|--------|---------|-----------------------|----------------------|------|----------------------------------|----|-----|-------------------------|--|------------------------|---------------------|-------------------------|--------------|---------|
| ELEV. DEPTH ft. | DESCRIPTION | STRAT. PLOT | NUMBER | TYPE | BLOWS/FOOT (0.3 m) | BLOWS / FOOT (0.3 m) | | | | | PLASTIC LIMIT ——— w_p | | | WATER CONTENT — w | | | |
| | | | | | | 20 | 40 | 60 | 80 | 100 | SHEAR STRENGTH P.S.F. | | | | w_p ——— w ——— w_L | | |
| | | | | | | | | O UNCONFINED + FIELD VANE | | | | | WATER CONTENT % | | | | |
| | | | | | | | | ● QUICK TRIAXIAL x LAB VANE | | | | | | | | | |
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OFFICE RECORD ON SOIL EXPLORATION

RECORD OF BOREHOLE NO 2

JOB _____ LOCATION 80.0' Rt. of Sta. 259+64, Hwy. 40N ORIGINATED BY WG
W.P. 27-74-01 BORING DATE July 10, 1974 COMPILED BY WG
DATUM Geodetic BOREHOLE TYPE Cone CHECKED BY [Signature]

[illegible]

OFFICE REPORT ON SOIL EXPLORATION

20
15 ϕ 5 % STRAIN AT FAILURE
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Continued

DESIGN SERVICES BRANCH

FOUNDATIONS OFFICE

RECORD OF BOREHOLE No 2 Continued

JOB _____ LOCATION 80.0' Rt of Sta. 259+64, Hwy. 40N ORIGINATED BY WG
 W.P. 27-74-01 BORING DATE July 10, 1974 COMPILED BY WG
 DATUM Geodetic BOREHOLE TYPE Cone CHECKED BY CP

| SOIL PROFILE | | | | SAMPLES | | | ft/m | DYNAMIC PENETRATION, RESISTANCE | | | | | LIQUID LIMIT ——— w_L | | | BULK DENSITY | REMARKS |
|--------------|-------|--------------------------------------|-------------|---------|------|------------|-------------|---------------------------------|----|----|----|-----|-------------------------|-----------|--|--------------|---------|
| ELEV. | DEPTH | DESCRIPTION | STRAT. PLOT | NUMBER | TYPE | BLOWS/FOOT | ELEV. SCALE | BLOWS / FOOT (0.3 m) | | | | | PLASTIC LIMIT ——— w_p | | | | |
| m. | ft. | | | | | | | 20 | 40 | 60 | 80 | 100 | WATER CONTENT ——— w | | | | |
| | | | | | | | | SHEAR STRENGTH P.S.F. kPa | | | | | w_p ——— w ——— w_L | | | | |
| | | | | | | | | ○ UNCONFINED + FIELD VANE | | | | | WATER CONTENT % | | | | |
| | | | | | | | | ● QUICK TRIAXIAL x LAB VANE | | | | | | | | | |
| 144.2 | 473.0 | Continued | | | | | | | | | | | | | | | |
| 31.7 | 104.0 | Probably Silty Clay | | | | | 470 | | | | | | | | | | |
| | | | | | | | 143.3 | | | | | | | | | | |
| 140.9 | 462.1 | | | | | | | | | | | | | | | | |
| 35.0 | 114.9 | End of Cone Test Probable Bedrock | | | | | | | | | | | | 140 @ 10" | | | |

OFFICE REPORT ON SOIL EXPLORATION

DESIGN SERVICES BRANCH

FOUNDATIONS OFFICE

RECORD OF BOREHOLE NO 3

JOB _____ LOCATION 23' Rt. of Sta. 260+07, Hwy. 40N ORIGINATED BY WG
 W.P. 27-74-01 BORING DATE July 17, 1974 COMPILED BY WG
 DATUM Geodetic BOREHOLE TYPE Cone Test CHECKED BY EP

| SOIL PROFILE | | | | SAMPLES | | ft./m ELEV. SCALE | DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT (0.3 m) | | LIQUID LIMIT — w_L PLASTIC LIMIT — w_p WATER CONTENT — w | | BULK DENSITY γ P.C.F. | REMARKS |
|-----------------------|----------------|-------------------------|--------|---------|-----------------------|----------------------|--|----|--|----|---------------------------------------|---------|
| ELEV. DEPTH ft. | DESCRIPTION | STRAT. PLOT | NUMBER | TYPE | BLOWS/FOOT (0.3 m) | | 20 | 40 | 60 | 80 | | |
| m. 176.5 0.0 | 579.0 0.0 | Ground Level | | | | | | | | | | |
| | | Probably Clayey silt | | | | 570 173.7 | | | | | | |
| 172.8 3.7 | 567.0 12.0 | Probably silty clay | | | | 560 170.7 | | | | | | |
| | | | | | | 550 167.6 | | | | | | |
| | | | | | | 540 164.6 | | | | | | |
| | | | | | | 530 161.5 | | | | | | |
| | | | | | | 520 158.5 | | | | | | |
| | | | | | | 510 155.4 | | | | | | |
| | | | | | | 500 152.4 | | | | | | |
| | | | | | | 490 149.3 | | | | | | |
| | | | | | | 480 146.3 | | | | | | |
| 144.8 31.7 | 475.0 104.0 | | | | | | | | | | | |

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Continued

OFFICE REPORT ON SOIL EXPLORATION

DESIGN SERVICES BRANCH

FOUNDATIONS OFFICE

RECORD OF BOREHOLE NO 3 Continued

JOB _____ LOCATION 23' Rt. of Sta. 260+07, Hwy. 40N ORIGINATED BY WG
 W.P. 27-74-01 BORING DATE July 17, 1974 COMPILED BY WG
 DATUM Geodetic BOREHOLE TYPE Cone Test CHECKED BY [Signature]

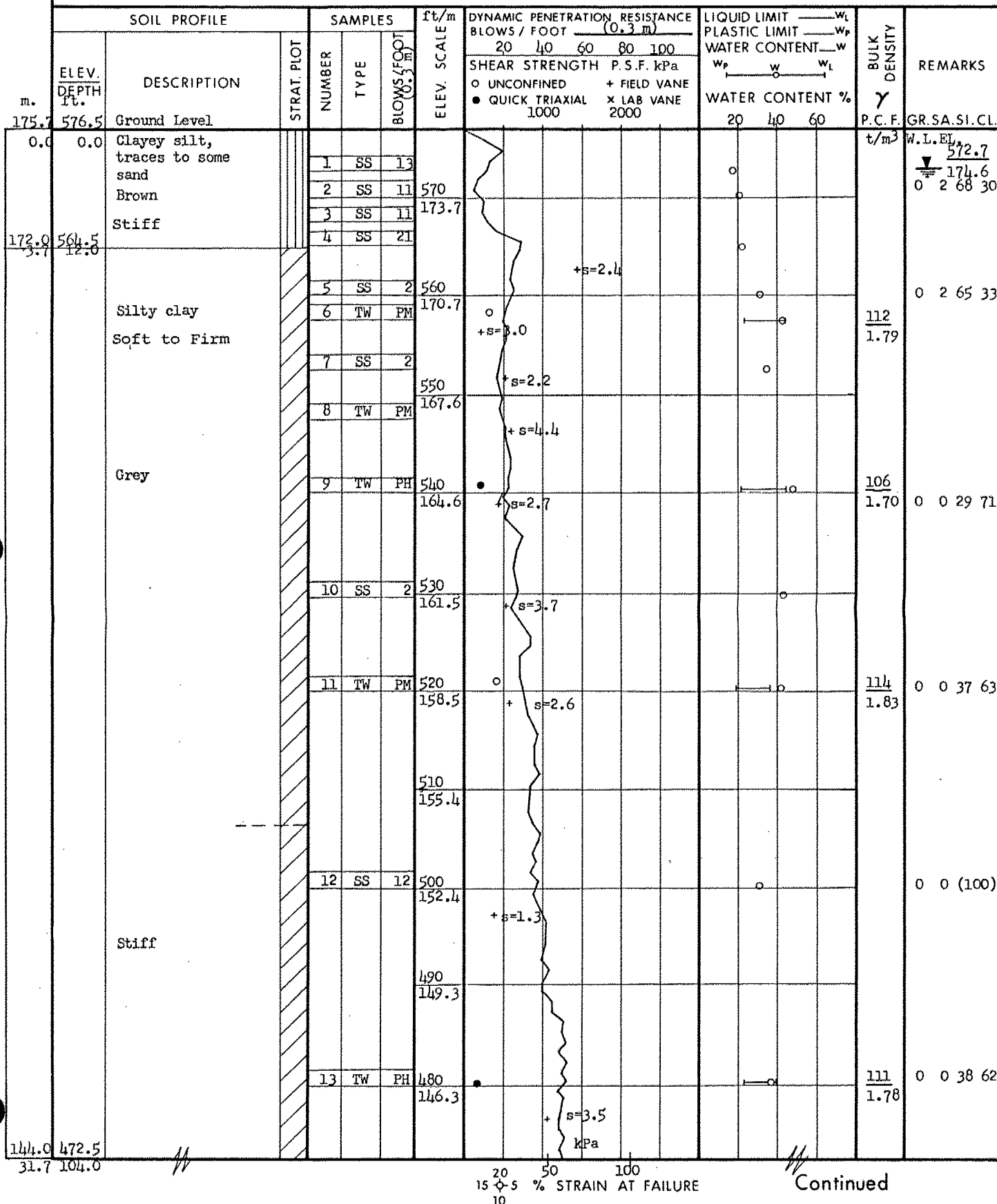
| SOIL PROFILE | | | SAMPLES | | | ft/m | DYNAMIC PENETRATION RESISTANCE | | | | | LIQUID LIMIT — w_L | | | BULK DENSITY | REMARKS |
|-----------------|-------------|---------------------|---------|------|--------------------|-------|--------------------------------|----|----|----|-----|-----------------------|--|--|--------------|---------|
| ELEV. DEPTH ft. | DESCRIPTION | STRAT. PLOT | NUMBER | TYPE | BLOWS/FOOT (0.3 m) | | BLOWS / FOOT (0.3 m) | | | | | PLASTIC LIMIT — w_p | | | | |
| | | | | | | | 20 | 40 | 60 | 80 | 100 | SHEAR STRENGTH P.S.F. | | | | |
| | | | | | | | O UNCONFINED + FIELD VANE | | | | | WATER CONTENT % | | | | |
| | | | | | | | ● QUICK TRIAXIAL X LAB VANE | | | | | WATER CONTENT % | | | | |
| m. | | | | | | | | | | | | | | | | |
| 114.8 | 475.0 | Continued | | | | | | | | | | | | | | |
| 31.7 | 104.0 | Probably silty clay | | | | 470 | | | | | | | | | | |
| | | | | | | 143.3 | | | | | | | | | | |
| 114.1 | 466.0 | End of Cone Test | | | | | | | | | | 140 @ 1" | | | | |
| 30.4 | 113.0 | Probable Bedrock | | | | | | | | | | | | | | |

DESIGN SERVICES BRANCH

FOUNDATIONS OFFICE

RECORD OF BOREHOLE NO 4




JOB _____ LOCATION 100' Rt. of Sta. 260+16, Hwy. 40N ORIGINATED BY WG
W.P. 27-74-01 BORING DATE July 11, 1974 COMPILED BY WG
DATUM Geodetic BOREHOLE TYPE Solid Stem Auger & Cone Test CHECKED BY GP



OFFICE REPORT ON SOIL EXPLORATION

FOUNDATIONS OFFICE

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| JOB | LOCATION | 100' Rt. of Sta. 260+16 Hwy. 40N | ORIGINATED BY | WG |
| W.P. 27-74-01 | BORING DATE | July 11, 1974 | COMPILED BY | WG |
| DATUM Geodetic | BOREHOLE TYPE | Solid Stem Auger & Cone Test | CHECKED BY | 3/1 |

| SOIL PROFILE | | | SAMPLES | | | ft/m ELEV. SCALE | DYNAMIC PENETRATION, RESISTANCE BLOWS / FOOT (0.3 m) 20 40 60 80 100 | | | | | LIQUID LIMIT —w _L PLASTIC LIMIT —w _p WATER CONTENT —w w _p — w — w _L WATER CONTENT % | | | BULK DENSITY γ P.C.F. | REMARKS |
|-----------------------|-------------|---|---|------|------------|---------------------|---|--|--|--|----------|---|--|--|-----------------------------|---------|
| ELEV. DEPTH ft. | DESCRIPTION | STRAT. PLOT | NUMBER | TYPE | BLOWS/FOOT | | SHEAR STRENGTH P.S.F. ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE | | | | | | | | | |
| m. 144.0 | 472.5 | Continued | | | | 470 | | | | | | | | | | |
| 31.7 | 104.0 | Silty Clay Grey Stiff |  | | | 143.3 | | | | | | | | | | |
| 142.0 | 466.0 | |  | | | | | | | | | | | | | |
| 33.7 | 110.5 | End of Borehole | | | | | | | | | | | | | | |
| 140.8 | 462.0 | | | | | | | | | | | | | | | |
| 34.9 | 114.5 | End of Cone Test Probable Bedrock |  | | | | | | | | 140 @ 5" | | | | | |

20
15 ϕ 5 % STRAIN AT FAILURE
10

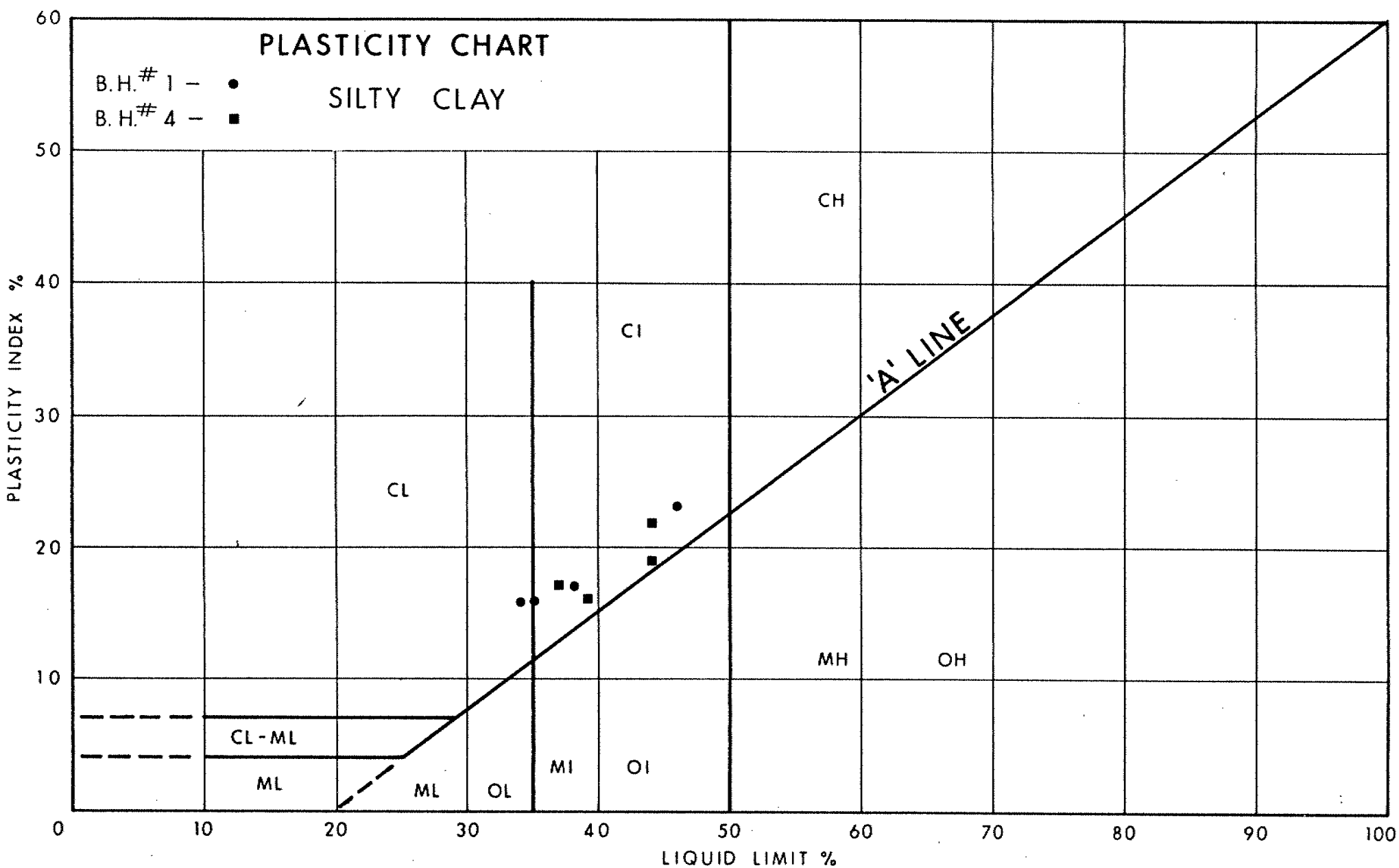


FIG. 1

ABBREVIATIONS & SYMBOLS USED IN THIS REPORT

PENETRATION 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 REPORTSOIL 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_v | 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 |

IN TERMS OF
EFFECTIVE STRESS
 $\tau_f = c' + \sigma' \tan \phi'$

IN TERMS OF
TOTAL STRESS
 $\tau_f = c_u + \sigma \tan \phi$

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

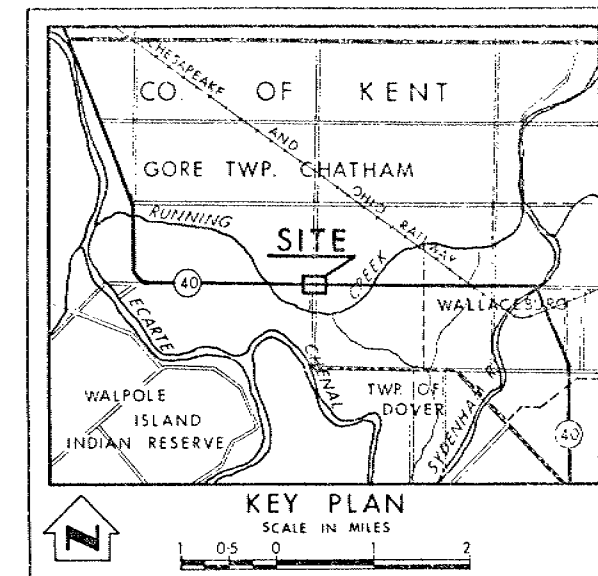
| | |
|----------|---|
| d | DISTANCE FROM TOP OF WALL TO POINT OF APPLICATION OF PRESSURE |
| δ | ANGLE OF WALL FRICTION |
| K | DIMENSIONLESS COEFFICIENT TO BE USED WITH VARIOUS SUFFIXES IN EXPRESSIONS REFERRING TO NORMAL STRESS ON WALLS |
| K_0 | COEFFICIENT OF EARTH PRESSURE AT REST |

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 |



| LEGEND | | | |
|--------|---|--|--|
| | Bore Hole | | |
| | Cone Penetration Test | | |
| | Bore Hole & Cone Test | | |
| | Water Levels established at time of field investigation July 1974 | | |

| NO. | ELEVATION | STATION | OFFSET |
|-----|-----------|---------|----------|
| 1 | 578.0 | 259+65 | 30' RT. |
| 2 | 577.0 | 259+40 | 80' RT. |
| 3 | 579.0 | 260+07 | 23' RT. |
| 4 | 576.5 | 260+16 | 100' 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 |
|-----------|------|----|-------------|
| | | | |
| | | | |
| | | | |

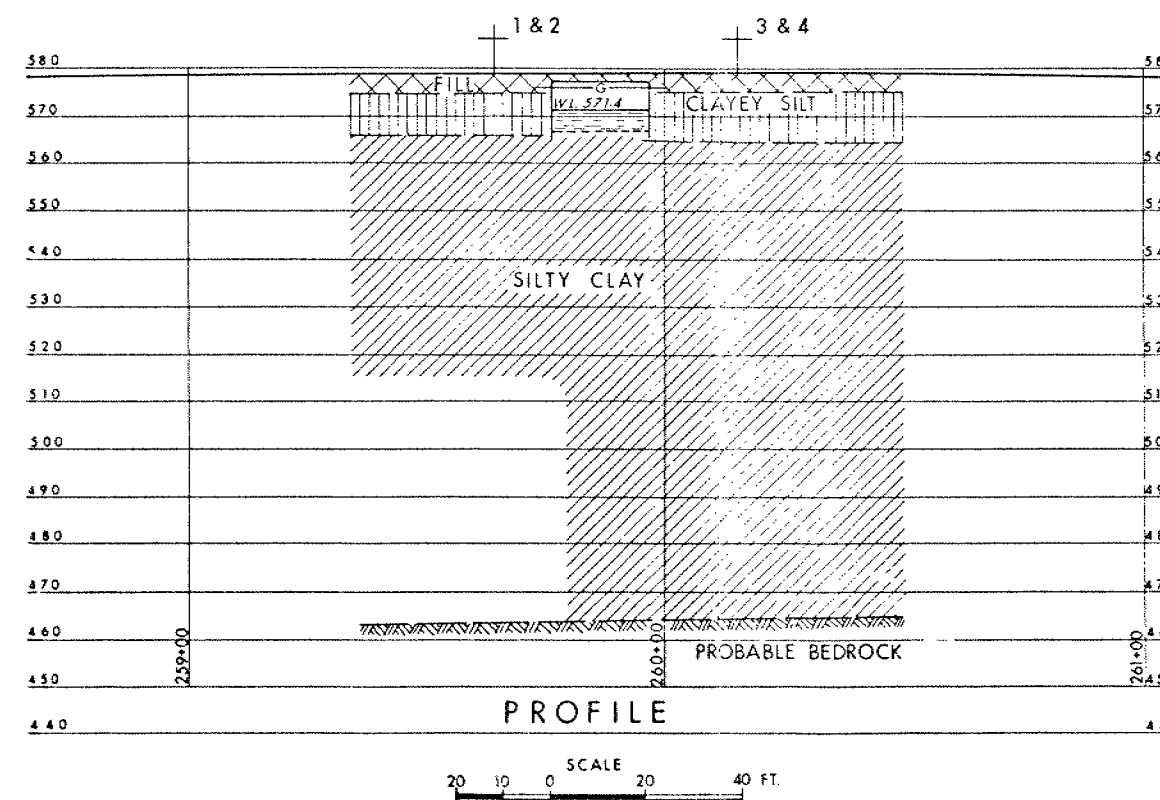
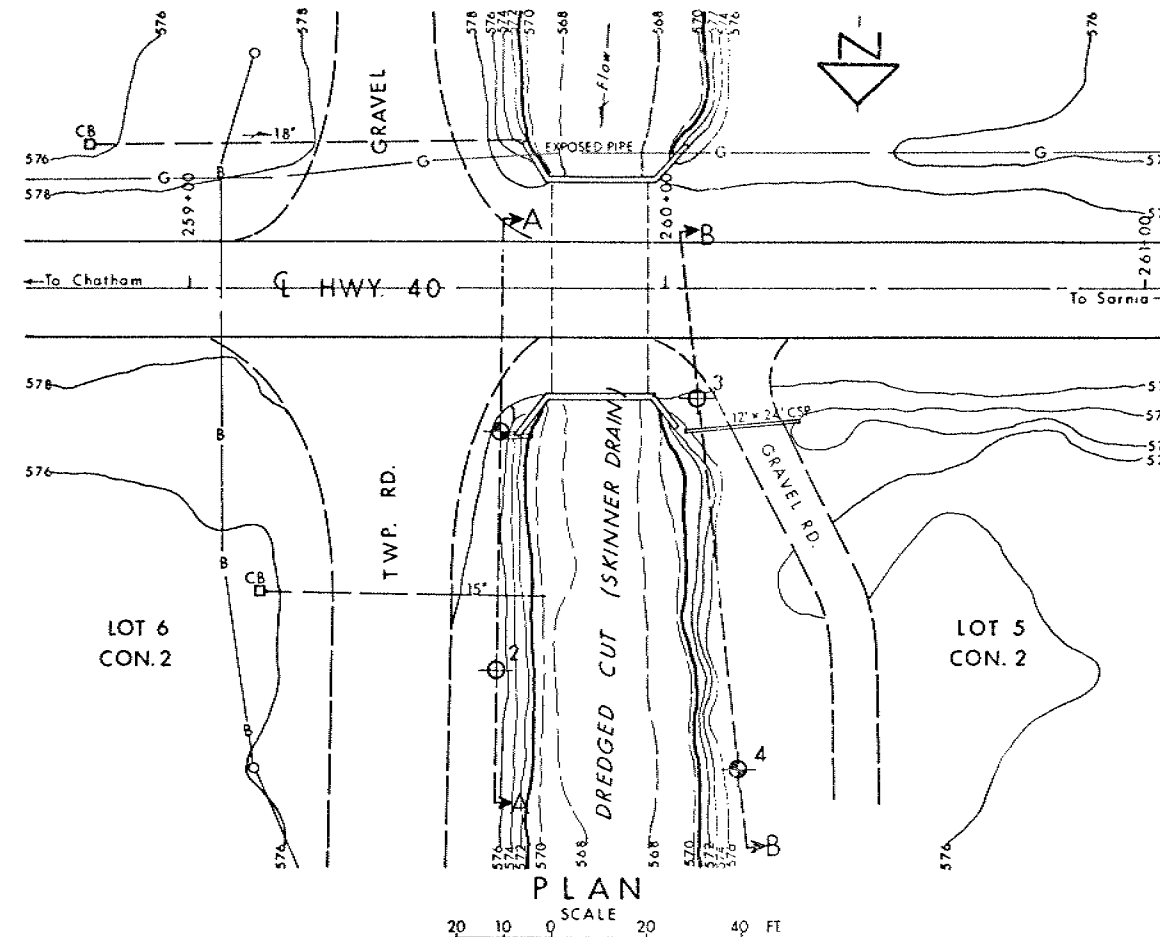
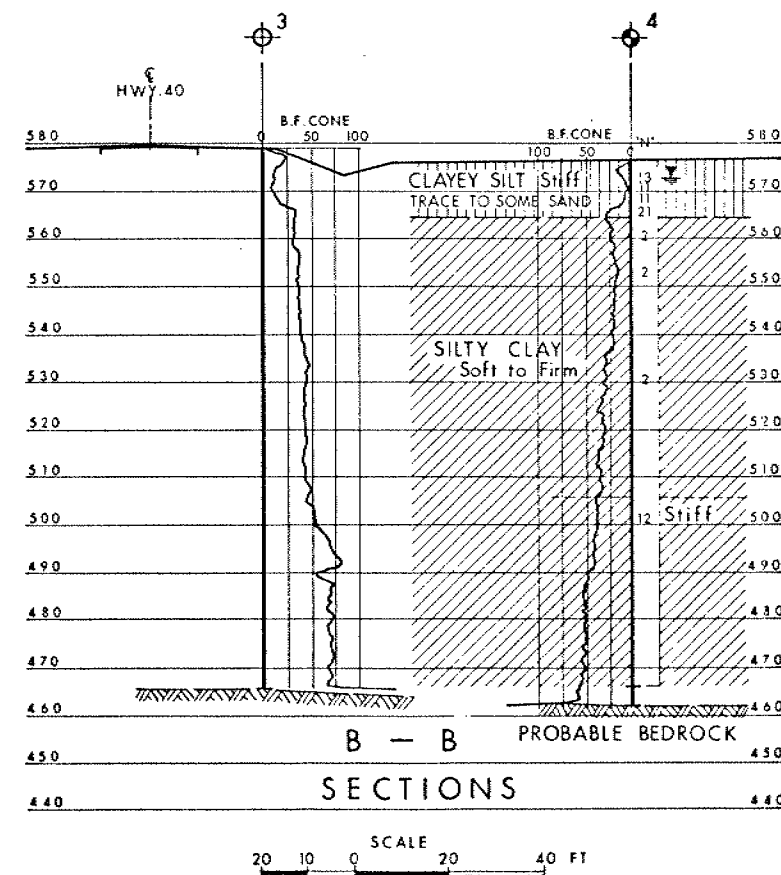
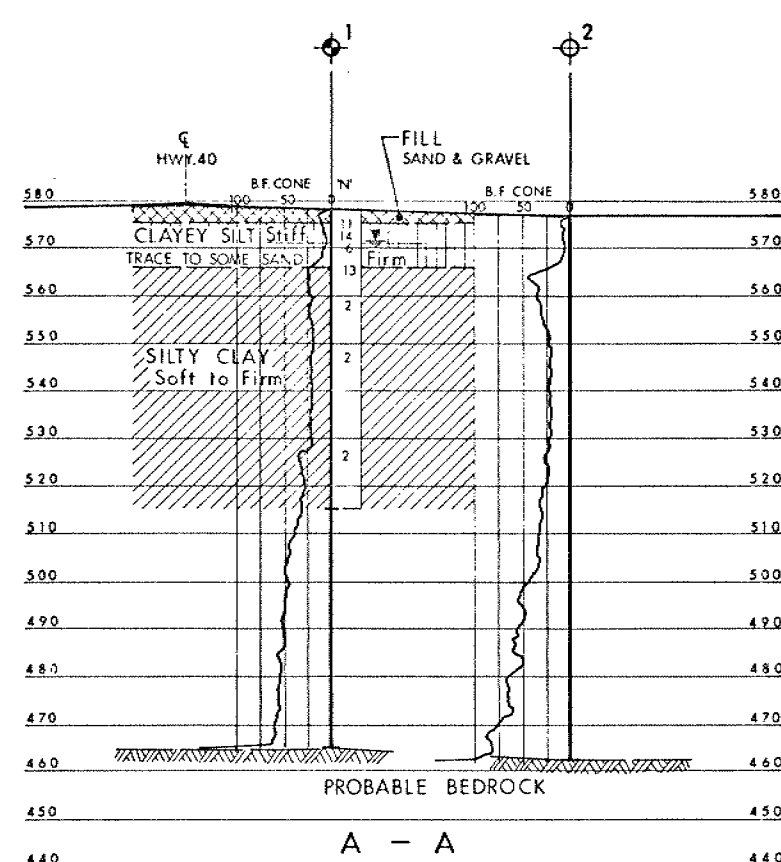
MINISTRY OF TRANSPORTATION AND COMMUNICATIONS—ONTARIO
GEOTECHNICAL OFFICE—SOIL MECHANICS SECTION

DREDGED CUT (SKINNER DRAIN)

HIGHWAY NO. 40 DIST NO. 1
CO. OF KENT
TWP. Gore Twp. Chatham LOT 5 & 6 CON. 1 & 2

BORE HOLE LOCATIONS & SOIL STRATA

| | | |
|---------------------|-----------------|--------------------|
| SUBMD W.G. CHECKED | WP NO. 27-74-01 | DRAWING NO. |
| DRAWN G. J. CHECKED | WO NO. | 277401-A |
| DATE Aug 26, 1974 | SITE NO. | BRIDGE DRAWING NO. |
| APPROVED | CONT NO. | |



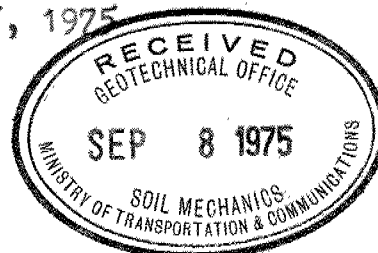
MINISTRY OF TRANSPORTATION AND COMMUNICATIONS, ONTARIO

Copy for the information of Mr. K. Selby

~~Mr. T. A. Hickey~~
Area Manager
Reg'l Planning and Design Office
Southwestern Region
Mr. A. Seppala
Project Manager

Structural Planning Office
Southwestern Region

September 5, 1975



W.P. 27-74-01, Bridge Site 13-5
Skinner Drain Structure
1.1 miles west of Wallaceburg west limits
Highway 40N
District 1, Chatham

Regarding the 12"Ø watermain the following information is provided.

Mr. K. Selby, Supervising Engineer, Soil Mechanics Section, Geotechnical Office, was contacted. He commented that the 12"Ø watermain could be relocated under the new extension of the Skinner Drain Structure as it is designed as a 20 foot box culvert. To locate the watermain 2'-0 below the slab of the culvert is acceptable providing the watermain is backfilled with sand.

Mr. Selby mentioned that the Foundation Investigation Report W.P. 27-74-01, Site 13-5, page 4 under item 6 'Recommendations' stated that the anticipated settlement is around 1 inch. Therefore, the watermain should be designed to withstand the 1 inch settlement. One section of pipe should be considered under the culvert in order to avoid a joint under the culvert.

Mr. Selby suggested that he would be willing to comment further on the watermain relocation if the following information was provided:

- (a) plan showing the alignment of the watermain;
- (b) profile of the existing ground line with the proposed finish grade line superimposed along the alignment of the watermain and profile of the watermain; and
- (c) Mr. Selby would also like to know where the joints in the pipe would be location and how much flexibility there is in the joints should settlement occur.

Should there be any further assistance desired, please advise.

A. P. Watt
Regional Structural Planning Engineer

APW:sm

cc K. Selby
J. Forster

Mr. C. S. Grebski
Structural Design Engineer
West Building, Downsview

Soil Mechanics Section
Geotechnical Office
West Building, Downsview

March 11, 1975

W.P. 27-74-01

SKINNER DRAIN STRUCTURE
1.1 miles W. of Wallaceburg W. Limits
W.P. 27-74-01, Site 13-5
Hwy. #40N, District #1 (Chatham)

We have reviewed the final bridge drawing (13-5, sheet 1) for the above Project. The designers have followed the recommendations contained in the Foundation Investigation Report issued on September 27, 1974.

We have no further comments.

P. PAYER
Senior Engineer

for: K. G. SELBY
Supervising Engineer

Files
Record Services