

DOCUMENT MICROFILMING IDENTIFICATION

GEOCRES No. 4036-10

DIST. _____ REGION _____

W.P. No. 258-66-02

CONT. No. 87-23

W. O. No. _____

STR. SITE No. 6-283

HWY. No. E.C. ROW EXPRESSWAY / HWY 3

LOCATION WINDSOR

No of PAGES -

=====

OVERSIZE DRAWINGS TO BE INCLUDED WITH THIS REPORT. _____

REMARKS: _____

FOUNDATION INVESTIGATION REPORT

CONTRACT NO 87-23



Ministry of
Transportation and
Communications

4056-10

INDEX

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NOTE: For purposes of the contract, this report supercedes all other foundation reports prepared by or for the Ministry in connection with the above-noted project.

EXPLANATION OF TERMS USED IN REPORT

'N' VALUE: AN INDICATOR OF SUBSOIL QUALITY. IT IS OBTAINED FROM THE STANDARD PENETRATION TEST (CSA STD. A119.1). SPT 'N' VALUE IS THE NUMBER OF BLOWS REQUIRED TO CAUSE A STANDARD 2 INCH O.D. SPLIT-BARREL SAMPLER TO PENETRATE 12 INCHES INTO UNDISTURBED GROUND IN A BOREHOLE WHEN DRIVEN BY A HAMMER WEIGHING 140 POUNDS, FALLING FREELY A DISTANCE OF 30 INCHES. FOR PENETRATIONS OF LESS THAN 12 INCHES 'N' VALUES ARE INDICATED AS THE NUMBER OF BLOWS FOR THE PENETRATION ACHIEVED. 'N' VALUES CORRECTED FOR OVERBURDEN PRESSURE ARE DENOTED THUS N_c .

DYNAMIC CONE PENETRATION TEST (CSA STD. A119.3): CONTINUOUS PENETRATION OF A CONICAL STEEL POINT (2" O.D. 60 CONE ANGLE) DRIVEN BY 350 FT-LB IMPACTS ON "A" SIZE DRILL RODS. THE RESISTANCE TO CONE PENETRATION IS MEASURED AS THE NUMBER OF BLOWS FOR EACH 12 INCH ADVANCE OF THE CONICAL POINT INTO THE UNDISTURBED GROUND.

SOIL QUALITY: SOILS ARE DESCRIBED BY THEIR COMPOSITION AND CONSISTENCY OR DENSITY.

CONSISTENCY: COHESIVE SOILS ARE DESCRIBED ON THE BASIS OF THEIR UNDRAINED SHEAR STRENGTH AS FOLLOWS:

| C_u (PSF) | 0 - 250 | 250 - 500 | 500 - 1000 | 1000 - 2000 | 2000 - 4000 | > 4000 |
|-------------|-----------|-----------|------------|-------------|-------------|--------|
| | VERY SOFT | SOFT | FIRM | STIFF | VERY STIFF | HARD |

DENSITY: COHESIONLESS SOILS ARE DESCRIBED ON THE BASIS OF SPT 'N' VALUES AS FOLLOWS:

| 'N' (BLOW/FT) | 0 - 5 | 5 - 10 | 10 - 30 | 30 - 50 | > 50 |
|---------------|------------|--------|---------|---------|------------|
| | VERY LOOSE | LOOSE | COMPACT | DENSE | VERY DENSE |

ROCK QUALITY: ROCKS ARE DESCRIBED BY THEIR COMPOSITION AND STRUCTURAL FEATURES AND/OR STRENGTH.

RECOVERY: SUM OF ALL RECOVERED ROCK CORE PIECES FROM A CORING RUN EXPRESSED AS A PERCENT OF THE TOTAL LENGTH DRILLED IN THAT CORING RUN.

MODIFIED RECOVERY: SUM OF THOSE NATURALLY FRACTURED CORE PIECES, 4" IN LENGTH EXPRESSED AS A PERCENT OF THE LENGTH OF THE CORING RUN. THE ROCK QUALITY DESIGNATION (RQD), FOR MODIFIED RECOVERY, IS:

| RQD (%) | 0 - 25 | 25 - 50 | 50 - 75 | 75 - 90 | 90 - 100 |
|---------|-----------|---------|---------|---------|-----------|
| | VERY POOR | POOR | FAIR | GOOD | EXCELLENT |

JOINTING AND BEDDING:

| SPACING | 2" | 2" - 12" | 1' - 3' | 3' - 10' | > 10' |
|----------|------------|----------|------------|----------|------------|
| JOINTING | VERY CLOSE | CLOSE | MOD. CLOSE | WIDE | VERY WIDE |
| BEDDING | VERY THIN | THIN | MEDIUM | THICK | VERY THICK |

ABBREVIATIONS & SYMBOLS

LABORATORY TESTING

TRIAXIAL TESTS ARE DESCRIBED IN TERMS OF WHETHER THEY ARE CONSOLIDATED (C) OR NOT (U) ISOTROPICALLY (I) OR NOT (A) DRAINED (D) OR UNDRAINED (U) WITH PORE PRESSURE MEASUREMENTS (BAR OVER SYMBOLS) EG. $\bar{C}U$ = CONSOLIDATED ISOTROPIC UNDRAINED TRIAXIAL WITH PORE PRESSURE MEASUREMENT UNLESS OTHERWISE SPECIFIED IN REPORT ALL TESTS ARE IN COMPRESSION

FIELD SAMPLING

SS SPLIT SPOON
WS WASH SAMPLE
ST SLOTTED TUBE SAMPLE
BS BLOCK SAMPLE
CS CHUNK SAMPLE
TW THINWALL OPEN
TP THINWALL PISTON
OS OSTERBERG SAMPLE
FS FOIL SAMPLE
RC ROCK CORE
PH T.W. ADVANCED HYDRAULICALLY
PM T.W. ADVANCED MANUALLY

EARTH PRESSURE TERMS

μ COEFFICIENT OF FRICTION
 δ ANGLE OF WALL FRICTION
 k_o COEFFICIENT OF EARTH PRESSURE AT REST
 k_A COEFFICIENT OF ACTIVE EARTH PRESSURE
 k_p COEFFICIENT OF PASSIVE EARTH PRESSURE
 i ANGLE OF INCLINATION OF SURCHARGE
 ω SLOPE ANGLE-BACKFACE OF WALL
 β ANGLE OF SLOPE
 N_q, N_c, N_{γ} BEARING CAPACITY FACTORS
 D_f DEPTH OF FOOTING
 B, L FOOTING DIMENSIONS

INDEX PROPERTIES

γ UNIT WEIGHT OF SOIL (BULK DENSITY)
 γ_w UNIT WEIGHT OF WATER
 γ_d UNIT DRY WEIGHT OF SOIL (DRY DENSITY)
 γ' UNIT WEIGHT OF SUBMERGED SOIL
 G_s SPECIFIC GRAVITY OF SOLIDS
 e VOIDS RATIO
 e_o INITIAL VOIDS RATIO
 e_{max} " IN LOOSEST STATE
 e_{min} " IN DENSEST STATE
 D_r RELATIVE DENSITY = $\frac{e_{max} - e}{e_{max} - e_{min}}$
 n POROSITY
 w WATER CONTENT
 w_L LIQUID LIMIT
 w_p PLASTIC LIMIT
 w_s SHRINKAGE LIMIT
 I_p PLASTICITY INDEX = $w_L - w_p$
 L_L LIQUIDITY INDEX = $\frac{w - w_p}{w_L - w_p}$
 I_c CONSISTENCY INDEX = $\frac{w_L - w}{w_L - w_p}$
 A_c ACTIVITY = $\frac{I_p \text{ of soil}}{I_p \text{ of } 2\mu m \text{ Soil Fraction}}$
 OM ORGANIC MATTER CONTENT
 S_r DEGREE OF SATURATION
 S SENSITIVITY = $\frac{S_u(\text{undisturbed})}{S_u(\text{remoulded})}$

STRENGTH PARAMETERS

ϕ ANGLE OF SHEARING RESISTANCE
 τ_f PEAK SHEAR STRENGTH
 τ_R RESIDUAL SHEAR STRENGTH
 c COHESION INTERCEPT
 $\sigma_1, \sigma_2, \sigma_3$ NORMAL PRINCIPAL STRESSES
 u PORE WATER PRESSURE
 u_e EXCESS u
 r_u PORE PRESSURE RATIO
 q_u UNCONFINED COMPRESSIVE STRENGTH
 s_u UNDRAINED SHEAR STRENGTH
 ϵ LINEAR STRAIN
 γ SHEAR STRAIN
 ν POISSON'S RATIO
 E MODULUS OF ELASTICITY
 G MODULUS OF SHEAR DEFORMATION
 E_s MODULUS OF SUBGRADE REACTION
 m, n STABILITY COEFFICIENTS
 A, B PORE PRESSURE COEFFICIENTS

NOTE: EFFECTIVE STRESS PARAMETERS ARE DENOTED BY USE OF APOSTROPHE ABOVE THE SYMBOL, THUS:
 σ' = EFFECTIVE ANGLE OF SHEARING RESISTANCE;
 σ'_1 = EFFECTIVE NORMAL STRESS

HYDRAULIC TERMS

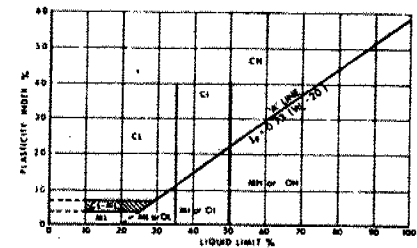
h HYDRAULIC HEAD OR POTENTIAL
 q RATE OF DISCHARGE
 v VELOCITY OF FLOW
 i HYDRAULIC GRADIENT
 j SEEPAGE FORCE PER UNIT VOLUME
 η COEFFICIENT OF VISCOSITY
 k COEFFICIENT OF HYDRAULIC CONDUCTIVITY
 k_h k IN HORIZONTAL DIRECTION
 k_v k IN VERTICAL DIRECTION
 m_v COEFFICIENT OF VOLUME CHANGE
 c_v COEFFICIENT OF CONSOLIDATION
 C_c COMPRESSION INDEX
 C_r RECOMPRESSION INDEX
 d DRAINAGE PATH DISTANCE
 T_v TIME FACTOR
 U DEGREE OF CONSOLIDATION
 O_c OVERCONSOLIDATION RATIO (OCR)

EXTENDED CASAGRANDE SOIL CLASSIFICATION SYSTEM

| FIELD IDENTIFICATION PROCEDURES (EXCLUDING PARTICLES LARGER THAN 75 mm AND BASED ON ESTIMATED MASS) | | | | GRP. SYMB. | TYPICAL NAMES | INFORMATION REQUIRED FOR DESCRIBING SOILS | LABORATORY CLASSIFICATION CRITERIA | | |
|---|--|--|--|--|--|---|---|---|---|
| COARSE GRAINED SOILS MORE THAN HALF OF MATERIAL IS LARGER THAN 75 μ m IF 75 μ m IS ABOUT THE SMALLEST PARTICLE VISIBLE TO THE NAKED EYE | GRAVELS MORE THAN HALF OF COARSE FRACTION IS LARGER THAN 4.75 mm | CLEAN GRAVELS (LITTLE OR NO FINES) | WIDE RANGE IN GRAIN SIZE & SUBSTANTIAL AMOUNTS OF ALL INTERMEDIATE PARTICLE SIZE | | GW | WELL GRADED GRAVELS, GRAVEL-SAND MIXTURES; LITTLE OR NO FINES | GIVE TYPE; NAME, IF NECESSARY, INDICATE APPROX. % OF SAND & GRAVEL; MAX. SIZE; ANGULARITY, SURFACE CONDITION, & HARDNESS OF THE COARSE GRAINS; LOCAL OR GEOLOGIC NAME & OTHER PERTINENT DESCRIPTIVE INFORMATION; & SYMBOL IN PARENTHESES. FOR UNDISTURBED SOILS ADD INFORMATION ON STRATIFICATION, DEGREE OF COMPACTNESS, CEMENTATION, MOISTURE CONDITIONS & DRAINAGE CHARACTERISTICS. DETERMINE PERCENTAGES OF GRAVEL & SAND FROM GRAIN SIZE CURVE. DEPENDING ON PERCENTAGE OF FINES (FRACTION SMALLER THAN 75 μ m) COARSE GRAINED SOILS ARE CLASSIFIED AS FOLLOWS: LESS THAN 5% GW, GP, SW, SP MORE THAN 12% GM, GC, SM, SC 5% TO 12% BORDERLINE CASES REQ. USE OF DUAL SYMBOLS NOT MEETING ALL GRADATION REQUIREMENTS FOR GW ATTERBERG LIMITS BELOW A-LINE, OR I_p LESS THAN 4 ATTERBERG LIMITS ABOVE A-LINE WITH I_p GREATER THAN 7 ABOVE A-LINE WITH I_p BETWEEN 4 AND 7 ARE BORDERLINE CASES REQUIRING USE OF DUAL SYMBOLS $C_u = \frac{D_{60}}{D_{10}}$ GREATER THAN 4 $C_c = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ BETWEEN ONE AND 3 NOT MEETING ALL GRADATION REQUIREMENTS FOR SW ATTERBERG LIMITS BELOW A-LINE OR I_p LESS THAN 4 ATTERBERG LIMITS ABOVE A-LINE WITH I_p GREATER THAN 7 ABOVE A-LINE WITH I_p BETWEEN 4 AND 7 ARE BORDERLINE CASES REQUIRING USE OF DUAL SYMBOLS $C_u = \frac{D_{60}}{D_{10}}$ GREATER THAN 6 $C_c = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ BETWEEN ONE AND 3 NOT MEETING ALL GRADATION REQUIREMENTS FOR SM ATTERBERG LIMITS BELOW A-LINE OR I_p LESS THAN 4 ATTERBERG LIMITS ABOVE A-LINE WITH I_p GREATER THAN 7 ABOVE A-LINE WITH I_p BETWEEN 4 AND 7 ARE BORDERLINE CASES REQUIRING USE OF DUAL SYMBOLS | | |
| | | GRAVEL WITH FINES (APPRECIABLE AMOUNT OF FINES) | PREDOMINANTLY ONE SIZE OF A RANGE OF SIZES WITH SOME INTERMEDIATE SIZES MISSING | | GP | POORLY GRADED GRAVELS, GRAVEL-SAND MIXTURES; LITTLE OR NO FINES | | | |
| | | SANDS MORE THAN HALF OF COARSE FRACTION IS SMALLER THAN 4.75 mm | CLEAN SANDS (LITTLE OR NO FINES) | WIDE RANGE IN GRAIN SIZES & SUBSTANTIAL AMOUNTS OF ALL INTERMEDIATE PARTICLE SIZES | | SW | | WELL GRADED SANDS, GRAVELLY SANDS; LITTLE OR NO FINES | |
| | | | SANDS WITH FINES (APPRECIABLE AMOUNT OF FINES) | PREDOMINANTLY ONE SIZE OR A RANGE OF SIZES WITH SOME INTERMEDIATE SIZES MISSING | | SP | | POORLY GRADED SANDS, GRAVELLY SANDS; LITTLE OR NO FINES | |
| | FINE GRAINED SOILS MORE THAN HALF OF MATERIAL IS SMALLER THAN 75 μ m IF 75 μ m IS ABOUT THE SMALLEST PARTICLE VISIBLE TO THE NAKED EYE | SILTS AND CLAYS | IDENTIFICATION PROCEDURES ON FRACTION SMALLER THAN 425 μ m | | | | | | |
| | | | LIQUID LIMIT LESS THAN 35% | DRY STRENGTH (CRUSHING CHARACTERISTICS) | DILATANCY (REACTION TO SHAKING) | TOUGHNESS (CONSISTENCY NEAR PLASTIC LIMIT) | | | |
| | | | | NONE | QUICK | NONE | | ML | INORGANIC SILTS & SANDY SILTS OF SLIGHT PLASTICITY, ROCK FLOOR |
| | | | | MEDIUM TO HIGH | NONE TO VERY SLOW | MEDIUM | | CL | CLAYEY SILTS (INORGANIC), GRAVELLY CLAYS, SANDY CLAYS, LEAN CLAYS |
| | | | LIQUID LIMIT BETWEEN 35% AND 50% | SLIGHT TO MEDIUM | SLOW | SLIGHT | | OL | ORGANIC SILT OF LOW PLASTICITY, ORGANIC SANDY SILTS |
| | | | | NONE TO SLIGHT | SLOW TO QUICK | SLIGHT | | ML | INORGANIC COMPRESSIBLE FINE SANDY SILT WITH CLAY OF MEDIUM PLASTICITY, CLAYEY SILTS |
| HIGH | NONE | MEDIUM TO HIGH | | CL | SILTY CLAYS (INORGANIC) OF MEDIUM PLASTICITY | | | | |
| LIQUID LIMIT GREATER THAN 50% | SLIGHT TO MEDIUM | VERY SLOW | SLIGHT | DI | ORGANIC SILTY CLAYS OF MEDIUM PLASTICITY | | | | |
| | SLIGHT TO MEDIUM | SLOW TO NONE | MEDIUM | MH | INORGANIC SILTS, HIGHLY COMPRESSIBLE MICACEOUS OR DIATOMACEOUS FINE SANDY SILTS, ELASTIC SILTS | | | | |
| | HIGH TO VERY HIGH | NONE | HIGH | CH | CLAYS (INORGANIC) OF HIGH PLASTICITY, FAT CLAYS | | | | |
| | MEDIUM TO HIGH | NONE TO VERY SLOW | SLIGHT TO MEDIUM | OH | ORGANIC CLAYS OF HIGH PLASTICITY | | | | |
| HIGHLY ORGANIC SOILS | | IMMEDIATELY IDENTIFIED BY COLOR, ODOR, SPRINGY FEEL & REMARKABLY FIBROUS TEXTURE | | | PT | PEAT & OTHER HIGHLY ORGANIC SOILS | | | |

USE GRAIN SIZE CURVE IN IDENTIFYING THE FUNCTIONS AS GIVEN UNDER FIELD IDENTIFICATION

PLASTICITY CHART
FOR LABORATORY CLASSIFICATION OF FINE GRAINED SOILS



PLASTICITY CHART
FOR LABORATORY CLASSIFICATION OF FINE GRAINED SOILS

SUMMARY CLASSIFICATIONS: SOILS POSSESSING CHARACTERISTICS OF TWO GROUPS ARE DESIGNATED BY COMBINATIONS OF GROUP SYMBOLS. FOR EXAMPLE GM-SC, WELL GRADED GRAVEL-SAND MIXTURE WITH CLAY BINDER

FOUNDATION INVESTIGATION REPORT
For
Windsor - Hwy. 3 Overpass
Hwy. E.C.R., District 1, Chatham
W.P. 258-66-02, Site 6-1398-283

4

INTRODUCTION

This report contains the results of a foundation investigation carried out for the proposed overpass structure during the period from March 6 to 11, 1978. A muskeg vehicle mounted power auger machine equipped with solid augers was used to advance four boreholes to depths ranging from 53 to 119 feet in depth. Bedrock was proven in one borehole by obtaining AXT size rock core. Dynamic Cone Penetration Tests were carried out adjacent to each borehole.

SITE DESCRIPTION

The site is located 1.6 miles east of Hwy. 18 along the proposed E.C. Row Expressway alignment within the City of Windsor. The surrounding terrain is flat.

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

SUBSURFACE CONDITIONS

General

Generally, uniform subsoil conditions were found to prevail over the site area. The subsoil consists of a shallow layer of silty sand, underlain by a deep deposit of clayey silt containing some sand and a trace of gravel, followed by a sandy silt, some gravel stratum which is in turn underlain by sound limestone bedrock. The boundaries of the different deposits are shown on the Record of Borehole Sheets attached to the Appendix. The estimated stratigraphical profiles of Drawing No. 2 of the Contract Drawings are based upon this information. A summary plot of the engineering properties is shown on Figure 1. Soil types encountered from ground level downward are described in some detail as follows.

Silty Sand

This deposit was intersected in all borings from immediately below the ground surface to a depth of about 4 feet. The material consists of silty sand. The relative density is estimated to range from loose to compact.

Clayey Silt, Some Sand, Traces of Gravel

The surficial silty sand stratum is underlain by an extensive cohesive type of deposit at each boring location. The lower boundary was found to be at elevation 498±. It was penetrated fully only in BH 1 and 4. The material in the deposit consists of clayey silt containing some sand and a trace of gravel. Occasional silty clay layers and seams of silt were also encountered. A plot of plasticity index versus liquid limit shows the greater majority of points to fall within the CL zone indicating a low to medium plasticity (Figure 2). Physical properties of the overall deposit as determined from field and laboratory tests are as follows:

| | | <u>Range</u> |
|--|---------------------|--------------|
| Natural Moisture Content (W) | % | 13-28 |
| Liquid Limit | (W _L) % | 13-35 |
| Plastic Limit | (W _p) % | 12-19 |
| Bulk Density | (γ) PCF | 126-134 |
| Undrained Shear Strength (C _u) | PSF | |
| Unconfined | | 744-3630 |
| Field Vane | | 920-2000+ |
| Sensitivity | | 2-3 |

The results of mechanical analyses are shown in an envelope form on Figure 3 of the Appendix.

A desiccated zone with a thickness ranging from 10 feet to 12 feet was found in all the boreholes to extend from the upper surface of the stratum. This zone is brown in colour due to oxidation and apart from the upper 2-3 feet (water affected zone), has a very stiff consistency. Standard Penetration 'N' values ranged from 16 to 30 blows per foot. Below the desiccated layer the colour of the soil is grey and the consistency ranges somewhat randomly from firm to very stiff. The average values of the undrained shear strength are as follows.

| | |
|------------------------|---------------|
| Above Elev. 583: | Cu = 2500 PSF |
| Elev. 560 - Elev. 583: | 1450 |
| Elev. 530 - Elev. 560: | 900 |
| Elev. 498 - Elev. 530: | 1500 |

Sandy Silt, Some Gravel

An approximate 4-8 foot thick sandy silt containing some gravel zone was found to underlie the cohesive deposit. The relative density is estimated to vary from compact to dense.

Limestone Bedrock

The bedrock was proven at one borehole location (BH #1) by obtaining AXT size core. The rock was found to be sound limestone, the surface being at elevation 489.6.

Groundwater Conditions

Groundwater level observations have been carried out during the course of the fieldwork by recording the water levels in the open boreholes. The following levels were observed:

| | |
|-------|-----------|
| BH #1 | Elev. 597 |
| BH #2 | Elev. 597 |
| BH #3 | Elev. 598 |
| BH #4 | Elev. 599 |

These figures indicate that the groundwater level is located some 2-3 feet below the existing ground level. It is assumed that the groundwater levels are subjected to seasonal variation.



P. Payer
 P. Payer, P.Eng.
 Senior Foundations Engineer

K. G. Selby
 K. G. Selby, P.Eng.
 Chief Foundations Engineer (West)

APPENDIX

RECORD OF BOREHOLE No 1 (Formerly BH #14, W.O. 65-F-15-1)

W P 258-66-02 LOCATION Coords. N 15,358,234; E 851,615 ORIGINATED BY A.M.S.
DIST 1 HWY E.C.Row BOREHOLE TYPE Continuous Flight Auger (S.A.) COMPILED BY P.P.
DATUM Geodetic DATE March 6, 1968 CHECKED BY

| SOIL PROFILE | | | SAMPLES | | | GROUND WATER CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION RESISTANCE PLOT | | PLASTIC LIMIT W _p | NATURAL MOISTURE CONTENT W | LIQUID LIMIT W _L | UNIT WEIGHT γ | REMARKS & GRAIN SIZE DISTRIBUTION (%) |
|---------------|---|------------|---------|-----------|-------------|----------------------------|-----------------|---|-----------|------------------------------------|-------------------------------------|-----------------------------------|---------------------|---|
| ELEV DEPTH | DESCRIPTION | STRAT PLOT | NUMBER | TYPE | 'N' VALUES | | | 20 40 60 80 100 | 1000 2000 | | | | | |
| 598.6 | Ground Level | | | | | | | | | | | | | |
| 0.0 | Silty Sand | | | | | | | | | | | | | |
| 594.6 | Loose to Compact | | | | | | | | | | | | | |
| 4.0 | | | 1 | SS | 20 | | 590 | | | | | | | 2 20 43 35 |
| | | | 2 | SS | 30 | | | | | | | | | |
| | | | 3A | SS | - | | 580 | | +2 | | | | 126 | |
| | Clayey Silt Some Sand Traces of Gravel | | 4 | TW | PH | | | b | +2 | | | | | |
| | | | 5 | TW | PH | | 570 | | | | | | 127.5 | |
| | | | 6 | TW | PH | | | | +2 | | | | | |
| | | | 7 | TW | PH | | 560 | | +2 | | | | 131.5 | 5 23 41 31 |
| | Firm to Very Stiff | | 8 | TW | PH | | | b | +2 | | | | | |
| | | | 9 | TW | PH | | 550 | | +2 | | | | 133 | |
| | | | 10 | TW | PH | | | b | +2 | | | | | |
| | | | 11 | TW | PH | | 540 | | +2 | | | | | |
| | | | 12 | TW | PH | | 530 | | +2 | | | | 126 | |
| | | | 13 | TW | PH | | 520 | | +2 | | | | | |
| | | | 14 | TW | PH | | 510 | | +2 | | | | 128 | 3 15 49 33 |
| 497.6 | | | 15 | SS | 20 | | 500 | | | | | | | |
| 101.0 | Sandy Silt Some Gravel Compact to Dense | | | | | | 490 | | | | | | | |
| 489.6 | Limestone Bedrock Sound | | 16 | AXT RC | REC 100% | | | | | | | | | |
| 109.0 | | | 17 | AXT RC | REC 100% | | | | | | | | | |
| 479.6 | | | | | | | | | | | | | | |
| 119.0 | End of Borehole | | | | | | | | | | | | | |

+3, x5: Numbers refer to
Sensitivity

20
15-5 (%) STRAIN AT FAILURE
10

RECORD OF BOREHOLE No 2 (Formerly BH. #15. W.O. 68-F-15-1)

W P 258-66-02 LOCATION Coords. N 15,358,109; E 851,694 ORIGINATED BY A.M.S.
 DIST 1 HWY E.C.Row BOREHOLE TYPE Continuous Flight Auger (S.A.) COMPILED BY P.P.
 DATUM Geodetic DATE March 7, 1968 CHECKED BY [Signature]

| SOIL PROFILE | | | SAMPLES | | | GROUND WATER CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION RESISTANCE PLOT | | | | | PLASTIC LIMIT W _p | NATURAL MOISTURE CONTENT W | LIQUID LIMIT W _L | UNIT WEIGHT γ | REMARKS & GRAIN SIZE DISTRIBUTION (%) |
|---------------|---------------------------------|------------|---------|------|------------|----------------------------|--------------------|---|----|----|----|-----|------------------------------------|-------------------------------------|-----------------------------------|---------------------|---|
| ELEV DEPTH | DESCRIPTION | STRAT PLOT | NUMBER | TYPE | 'N' VALUES | | | 20 | 40 | 60 | 80 | 100 | | | | | |
| 599.3 | Ground Level | | | | | | | | | | | | | | | | |
| 0.0 | Silty Sand | | | | | | | | | | | | | | | | |
| 595.3 | Loose to Compact | | | | | | | | | | | | | | | | |
| 4.0 | | | | | | | | | | | | | | | | | |
| | Clayey Silt | | 1 | SS | 18 | | 590 | | | | | | | | | | 2 16 41 41 |
| | Some Sand | | 2 | SS | 22 | | | | | | | | | | | | |
| | Traces of Gravel | | 3 | TW | PH | | | | | | | | | | | 132 | |
| | | | 4 | TW | PH | | 580 | | | | | | | | | | |
| | Occasional Silty Clay Layers | | 5 | TW | PH | | | | | | | | | | | | |
| | | | 6 | TW | PH | | 570 | | | | | | | | | | |
| | Stiff to Very Stiff | | 7 | TW | PH | | | | | | | | | | | | |
| | | | 8 | TW | PH | | 560 | | | | | | | | | | 2 25 41 32 |
| | | | 9 | TW | PH | | 550 | | | | | | | | | | |
| 546.3 | | | | | | | | | | | | | | | | | |
| 53.0 | End of Borehole | | | | | | | | | | | | | | | | |

OFFICE REPORT ON SOIL EXPLORATION

RECORD OF BOREHOLE No 3 (Formerly BH. #16, W.O. 68-F-15-1)

W P 258-66-02 LOCATION Coords. N 15.358,244; E 851, 784 ORIGINATED BY A.M.S.
 DIST 1 HWY E.C.Row BOREHOLE TYPE Continuous Flight Auger COMPILED BY P.P.
 DATUM Geodetic DATE March 7,8, 1968 CHECKED BY [Signature]

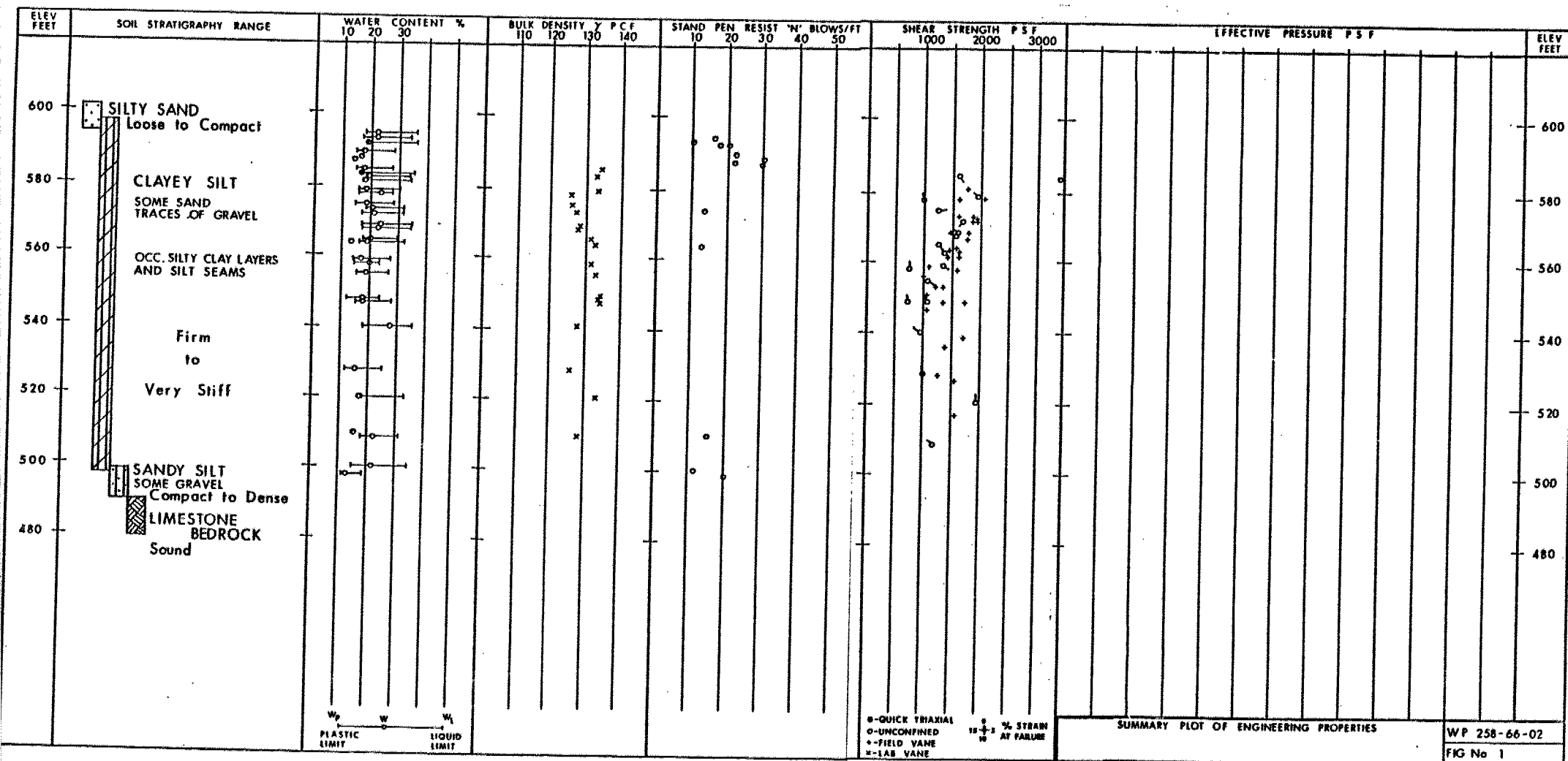
| SOIL PROFILE | | SAMPLES | | | GROUND WATER CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION RESISTANCE PLOT | | PLASTIC LIMIT W _p | NATURAL MOISTURE CONTENT W | LIQUID LIMIT W _L | UNIT WEIGHT γ | REMARKS & GRAIN SIZE DISTRIBUTION (%) |
|---------------|---------------------|------------|--------|------|----------------------------|-----------------|---|--|------------------------------------|-------------------------------------|-----------------------------------|---------------------|---|
| ELEV DEPTH | DESCRIPTION | STRAT PLOT | NUMBER | TYPE | 'N' VALUES | | 20 40 60 80 100 | | | | | | |
| 600.0 | Ground Level | | | | | | | | | | | | |
| 0.0 | Silty Sand | | | | | | | | | | | | |
| 596.0 | Loose to Compact | | | | | | | | | | | | |
| 4.0 | | | 1 | SS | 10 | | | | | | | | |
| | Clayey Silt | | 2 | SS | 30 | 590 | | | | | | | 3 19 48 30 |
| | Some Sand | | 3 | SS | 22 | | | | | | | | |
| | Traces of Gravel | | 4 | TW | PH | 580 | | | | | | 133 | |
| | Stiff to Very Stiff | | 5 | SS | 13 | | | | | | | | |
| | | | 6 | TW | PH | 570 | | | | | | 129 | |
| | | | 7 | SS | 13 | | | | | | | | |
| | | | 8 | TW | PH | 560 | | | | | | 134 | 5 27 39 29 |
| 547.0 | | | 9 | TW | PH | 550 | | | | | | | |
| 53.0 | End of Borehole | | | | | | | | | | | | |

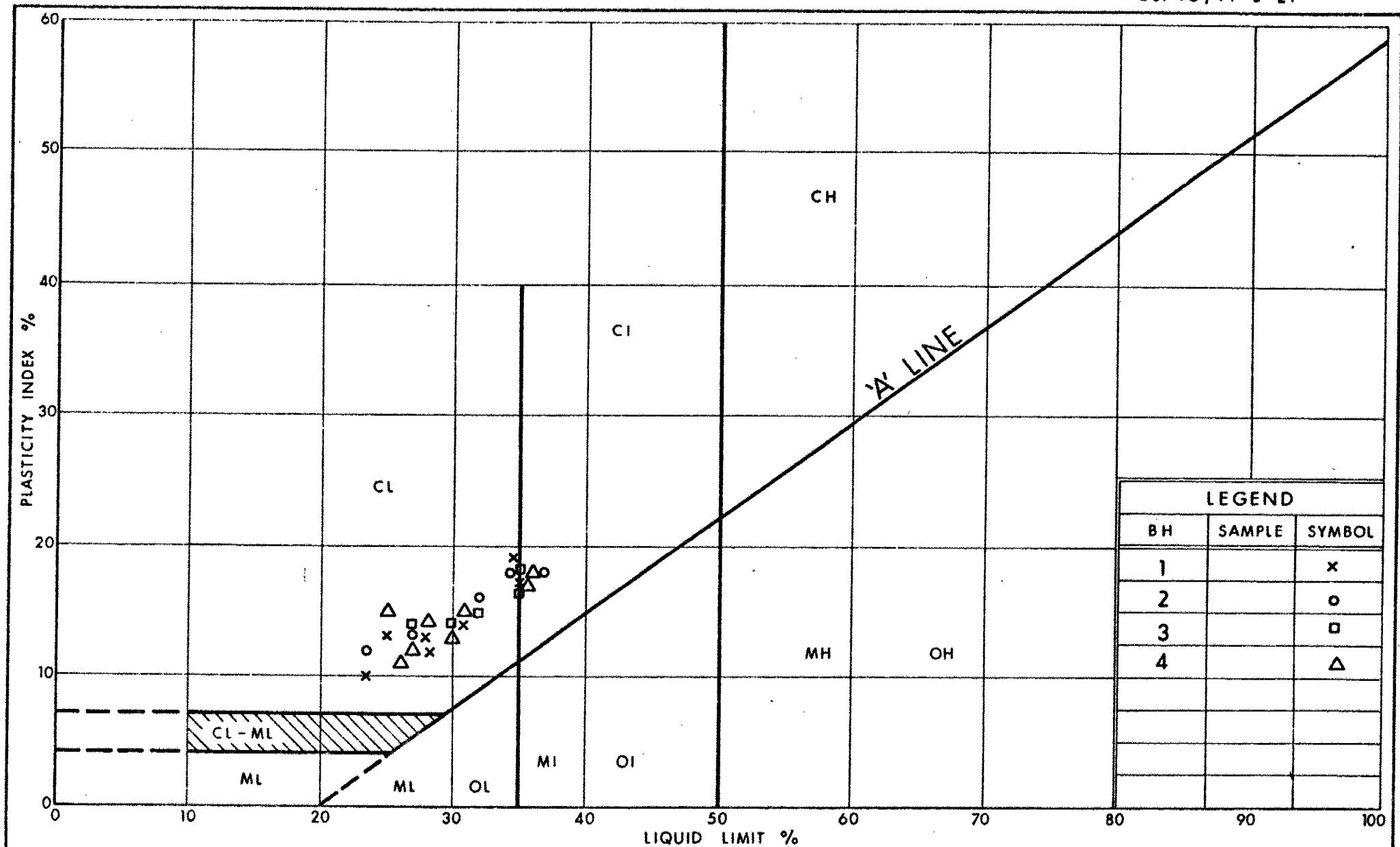
OFFICE REPORT ON SOIL EXPLORATION

RECORD OF BOREHOLE No 4 (Formerly BH. #17, W.O. 68-F-15-1)

W P 258-66-02 LOCATION Coords. N 15,358,191; E 851,886 ORIGINATED BY A.M.S.
DIST 1 HWY E.C.Row BOREHOLE TYPE Continuous Flight Auger (S.A.) COMPILED BY P.P.
DATUM Geodetic DATE March 8 & 11, 1968 CHECKED BY

| SOIL PROFILE | | | SAMPLES | | | GROUND WATER CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION RESISTANCE PLOT | | PLASTIC LIMIT W _p | NATURAL MOISTURE CONTENT W | LIQUID LIMIT W _L | UNIT WEIGHT γ | REMARKS & GRAIN SIZE DISTRIBUTION (%) |
|---------------|--|------------|---------|------|------------|----------------------------|-----------------|---|-------|------------------------------------|-------------------------------------|-----------------------------------|---------------------|---|
| ELEV DEPTH | DESCRIPTION | STRAT PLOT | NUMBER | TYPE | 'N' VALUES | | | 20 40 60 80 100 | PSF | | | | | |
| 601.0 | Ground Level | | | | | | | | | | | | | |
| 0.0 | Silty Sand | | | | | | 600 | | | | | | | |
| 597.0 | Loose to Compact | | | | | | | | | | | | | |
| 4.0 | | | 1 | SS | 16 | | | | | | | | | |
| | | | 2 | SS | 22 | | 590 | | | | | | | 0 19 46 35 |
| | | | 3 | TW | PH | | | | q > + | | | | 134 | |
| | | | 4 | TW | PH | | 580 | | +3 | | | | | |
| | Clayey Silt Some Sand Traces of Gravel | | 5 | TW | PH | | | | +3 | | | | 126 | |
| | | | 6 | TW | PH | | 570 | | +2 | | | | | |
| | | | 7 | TW | PH | | | | q +2 | | | | 131 | 2 22 42 34 |
| | | | 8 | TW | PH | | 560 | | +2 | | | | | |
| | | | 9 | TW | PH | | | | p +2 | | | | 132 | |
| | | | 10 | TW | PH | | 550 | | +2 | | | | | |
| | Stiff to Very Stiff | | | | | | | | | | | | | |
| | Occasional Silt Seams | | 11 | TW | PH | | 540 | | +3 | | | | 127.5 | |
| | | | 12 | TW | PH | | 530 | | +2 | | | | | |
| | | | 13 | TW | PH | | 520 | | δ > + | | | | 133 | |
| | | | 14 | SS | 15 | | 510 | | | | | | | 11 21 41 27 |
| | | | 15 | SS | 12 | | 500 | | | | | | | |
| 498.0 | Sandy Silt | | | | | | | | | | | | | |
| 103.0 | Some Gravel, Compact | | | | | | | | | | | | | |
| 494.5 | | | | | | | | | | | | | | |
| 106.5 | Refusal | | | | | | | | | | | | | |
| | End of Borehole | | | | | | | | | | | | | |





Ontario

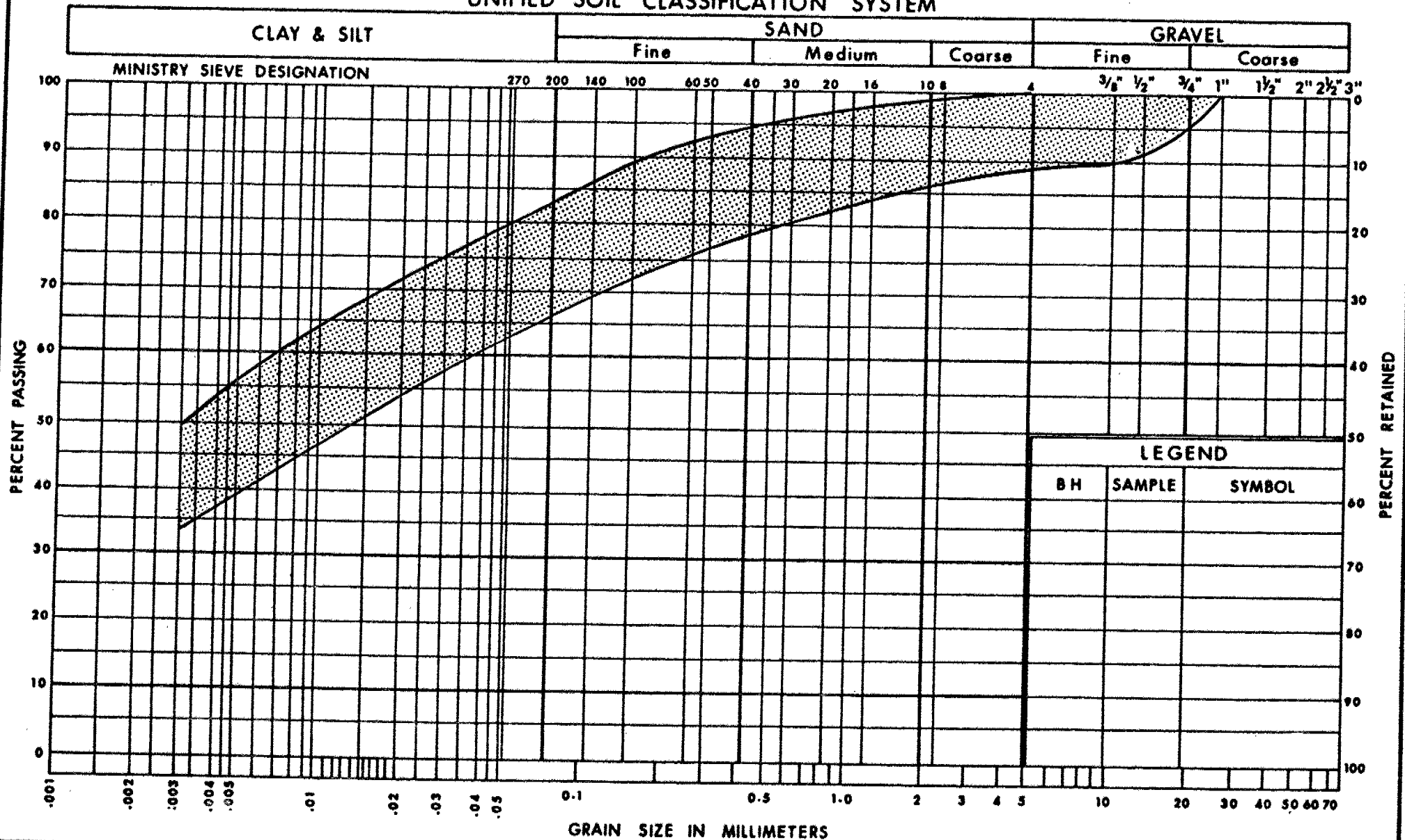
Ministry of
Transportation and
Communications

PLASTICITY CHART
 CLAYEY SILT, SOME SAND, TRACES OF GRAVEL
 OCC. SILTY CLAY LAYERS
 AND SILT SEAMS

FIG No 2

W P 258-66-02

UNIFIED SOIL CLASSIFICATION SYSTEM



Ontario

**Ministry of
Transportation and
Communications**

GRAIN SIZE DISTRIBUTION

CLAYEY SILT, SOME SAND, TRACES OF GRAVEL
OCC. SILTY CLAY LAYERS
AND SILT SEAMS

FIG No 3

WP 258-66-02

ENGINEERING MATERIALS OFFICE
SOIL MECHANICS SECTION

WP 258-66-02 DIST 1
HWY E.C.R. STR SITE 6-283
Windsor - Hwy. 3 Overpass

DISTRIBUTION

A.P. Watt (2)
J. R. Roy
A. Wittenberg
J.H. Blevins (2)

A.E. McKim
G.A. Wrong
B.J. Giroux
R.S. Pillar

R. Hore

A. Crowley)
J. Anderson) cover only
G. Sloan)

Files

| SAMPLE DISPOSITION NOTICE | | |
|---------------------------|---------------|------------|
| TYPE | DISCARD AFTER | RECOMM. BY |
| JARS | 78-07-04 | 1445 |
| TUBES | 78-07-04 | 1488 |
| ROCK CORES | 78-07-04 | 1485 |

FOUNDATION INVESTIGATION REPORT

For

Windsor - Hwy. 3 Overpass
Hwy. E.C.R., District 1, Chatham
W.P. 258-66-02, Site 6-283

INTRODUCTION

This report contains the results of a foundation investigation carried out for the proposed overpass structure during the period from March 6 to 11, 1978. A muskeg vehicle mounted power auger machine equipped with solid augers was used to advance four boreholes to depths ranging from 53 to 119 feet in depth. Bedrock was proven in one borehole by obtaining AXT size rock core. Dynamic Cone Penetration Tests were carried out adjacent to each borehole. The report also contains recommendations relating to the design and construction of the proposed structure and approaches.

SITE DESCRIPTION

The site is located 1.6 miles east of Hwy. 18 along the proposed E.C. Row Expressway alignment within the City of Windsor. The surrounding terrain is flat.

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

SUBSURFACE CONDITIONS

General

Generally, uniform subsoil conditions were found to prevail over the site area. The subsoil consists of a shallow layer of silty sand, underlain by a deep deposit of clayey silt containing some sand and a trace of gravel, followed by a sandy silt, some gravel stratum which is in turn underlain by sound limestone bedrock. The boundaries of the different deposits are shown on the Record of Borehole Sheets attached to the Appendix. The estimated stratigraphical profiles of Drawing No. 2586602-A are based upon this information. A summary plot of the engineering properties is shown on Figure 1. Soil types encountered from ground level downward are described in some detail as follows.

Silty Sand

This deposit was intersected in all borings from immediately below the ground surface to a depth of about 4 feet. The material consists of silty sand. The relative density is estimated to range from loose to compact.

Clayey Silt, Some Sand, Traces of Gravel

The surficial silty sand stratum is underlain by an extensive cohesive type of deposit at each boring location. The lower boundary was found to be at elevation 498+. It was penetrated fully only in B.H. #1 and #4. The material in the deposit consists of clayey silt containing some sand and a trace of gravel. Occasional silty clay layers and seams of silt were also encountered. A plot of plasticity index versus liquid limit shows the greater majority of points to fall within the CL zone indicating a low to medium plasticity (Figure 2). Physical properties of the overall deposit as determined from field and laboratory tests are as follows.

| | | <u>Range</u> |
|--------------------------|---------------------|--------------|
| Natural Moisture Content | (W) % | 13-28 |
| Liquid Limit | (W _L) % | 13-35 |
| Plastic Limit | (W _p) % | 12-19 |
| Bulk Density | (γ) PCF | 126-134 |
| Undrained Shear Strength | (Su) PSF | |
| Unconfined | | 744-3630 |
| Field Vane | | 920-2000+ |
| Sensitivity | | 2-3 |

The results of complete mechanical analyses are shown in an envelope form on Figure 3 of the Appendix.

A desiccated zone with a thickness ranging from 10 feet to 12 feet was found in all the boreholes to extend from the upper surface of the stratum. This zone is brown in colour due to oxidation and apart from the upper 2-3 feet (water affected zone), has a very stiff consistency. Standard Penetration 'N' values ranged from 16 to 30 blows per foot. Below the desiccated layer the colour of the soil is grey and the consistency ranges somewhat randomly from firm to very stiff. For design purposes the following undrained shear strength values are suggested.

| | |
|------------------------|---------------|
| Above Elev. 583: | Su = 2500 PSF |
| Elev. 560 - Elev. 583: | 1450 |
| Elev. 530 - Elev. 560: | 900 |
| Elev. 498 - Elev. 530: | 1500 |

No consolidation tests were carried out at this site but it is estimated that apart from the desiccated zone the deposit is over-consolidated by about 1.5 T.S.F. This estimation is based on tests carried out on samples obtained at the junction of E.C. Row Expressway and Hwy. 3 located about 1.6 miles east (W.P. 257-66-02). Similar subsoil conditions were encountered at both locations.

Sandy Silt, Some Gravel

An approximate 4-8 foot thick sandy silt containing some gravel zone was found to underlie the cohesive deposit. The relative density is estimated to vary from compact to dense.

Limestone Bedrock

The bedrock was proven at one borehole location (B.H. #1) by obtaining AXT size core. The rock was found to be sound limestone, the surface being at elevation 489.6.

Groundwater Conditions

Groundwater level observations have been carried out during the course of the fieldwork by recording the water levels in the open boreholes. The following levels were observed:

| | |
|---------|----------|
| B.H. #1 | Elev.597 |
| B.H. #2 | Elev.597 |
| B.H. #3 | Elev.598 |
| B.H. #4 | Elev.599 |

These figures indicate that the groundwater level is located some 2-3 feet below the existing ground level. It is assumed that the groundwater levels are subjected to seasonal variation.

DISCUSSION AND RECOMMENDATIONS

General

It is proposed to build a two span (103'-103') twin overpass structure at this location. The profile grade of E.C. Row Expressway is set at elevation 621₊, some 21 feet above the surface of Hwy. 3. The existing ground surface adjacent to the proposed structure site is at about elevation 600₊.

Structure Foundations

Piled Foundations: It is recommended that the entire structure (abutments and piers) be founded on end bearing piles driven to bedrock. The bedrock surface is located some 109 feet below ground level. These piles could be either steel 'H' piles or concrete filled steel tube piles. Design loads could be as high as 130 tons/pile for either 12 3/4" x 1/4" steel tubes or 12BP@74 steel 'H' sections. The tips of steel 'H' piles should be reinforced. If tube piling is selected the driving energy should not exceed 30,000 ft. lbs. per blow below elevation 500 to avoid damage to the piles when contact with bedrock is made. These recommendations are based on the obtained load test results and problems encountered during a pile load test in the same general area.

Spread Footings: The entire structure may be supported on spread footings placed within the very stiff desiccated zone of the subsoil between elevation 590 and elevation 595. A safe net pressure of 2.5 T.S.F. may be assumed for design purposes.

The desiccated zone is susceptible to softening on contact with water, therefore, it is recommended that the base of the footing excavations be protected by pouring lean concrete on exposure.

As an alternative, the abutments may be constructed within the approach fills and supported on spread footings placed on well compacted, suitable granular material. A safe design load of 2.5 T.S.F. may be assumed. A construction scheme is outlined on Figure 4 of the Appendix. Settlement considerations are discussed in another paragraph.

Approach Embankments

The shear strength of the subsoil is such that it will be able to support the 21 foot high approach embankments constructed with 2:1 slopes. The fill should consist of well compacted acceptable material. Care should be taken to ensure that no bouldery fill is placed within the approaches through which piles have to be driven. It is recommended that this portion of the fill contain no larger grain size than 2 inches if steel tube piles are considered or larger than 3 inches in the case of steel 'H' piles.

Settlement Considerations

Due to the compressible nature of the predominant subsoil (clayey silt), it is inevitable that consolidation settlements will occur over a longterm period due to the imposed loads of structure abutments on spread footings and embankments. It is estimated that a maximum settlement of 4-5 inches will take place over a long period of time under the 21 foot high fill. Based on the experiences with similar structures under similar subsoil conditions, it can be concluded that 50% of the total settlement will be completed in about 6 months' time.

For the piers, it is estimated that settlements of spread footings will be in the order of 1½ to 2 inches. Thus, differential settlements up to 3½ inches between the piers and abutments if supported on spread footings are anticipated. Regardless of whether the structure is wholly or partly on spread footings, it would be advantageous to construct the embankments well in advance of the structures in order to minimize future differential settlements. Consideration should also be given to surcharging at the abutments' location if spread footing type support is used. The aforementioned granular core should be placed first and earth fill could be placed up to the grade of surcharge level.

Other Considerations

The pile caps and/or the underside of the spread footings should be protected against frost protection.

The topsoil stripping should be in accordance with current MTC standards.

No major dewatering problems are anticipated.

MISCELLANEOUS

The boring programme was carried out during the period of March 6 to 11, 1968 under the supervision of Mr. A.M. Seppalla, Project Engineer.

This report was prepared by Mr. P. Payer, Senior Engineer, and reviewed by Mr. K.G. Selby, Supervising Engineer.

P. Payer

P. Payer, P. Eng.
Senior Engineer



K. G. Selby

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

June, 1978

APPENDIX



RECORD OF BOREHOLE No 1 (Formerly BH #14, W.O. 65-F-15-1)

W P 258-66-02 LOCATION Coords. N 15,358,234; E 851,615 ORIGINATED BY A.M.S.
DIST 1 HWY E.C.Row BOREHOLE TYPE Continuous Flight Auger (S.A.) COMPILED BY P.P.
DATUM Geodetic DATE March 6,7, 1968 CHECKED BY

| SOIL PROFILE | | | SAMPLES | | | GROUND WATER CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION RESISTANCE PLOT | | | | PLASTIC LIMIT W _p | NATURAL MOISTURE CONTENT W | LIQUID LIMIT W _L | UNIT WEIGHT γ | REMARKS & GRAIN SIZE DISTRIBUTION (%) | |
|---------------|---|------------|---------|-----------|-------------|----------------------------|--------------------|---|--------------|------------------|------------|------------------------------------|-------------------------------------|-----------------------------------|---------------------|---|-------------------|
| ELEV DEPTH | DESCRIPTION | STRAT PLOT | NUMBER | TYPE | 'N' VALUES | | | SHEAR STRENGTH PSF | | | | | | | | | WATER CONTENT (%) |
| | | | | | | | | ○ UNCONFINED | + FIELD VANE | ● QUICK TRIAXIAL | x LAB VANE | | | | | | |
| 598.6 | Ground Level | | | | | | | 20 | 40 | 60 | 80 | 100 | | | | | |
| 0.0 | Silty Sand | | | | | | | | | | | | | | | | |
| 594.6 | Loose to Compact | | | | | | | | | | | | | | | | |
| 4.0 | Clayey Silt Some Sand Traces of Gravel Firm to Very Stiff | | 1 | SS | 20 | | | | | | | | | | | | |
| | | | 2 | SS | 30 | | | | | | | | | | | | 2 20 43 35 |
| | | | 3A | SS | - | | | | | | | | | | | | |
| | | | 4 | TW | PH | | | | | | | | | | | 126 | |
| | | | 5 | TW | PH | | | | | | | | | | | | |
| | | | 6 | TW | PH | | | | | | | | | | | 127.5 | |
| | | | 7 | TW | PH | | | | | | | | | | | | |
| | | | 8 | TW | PH | | | | | | | | | | | 131.5 | 5 23 41 31 |
| | | | 9 | TW | PH | | | | | | | | | | | | |
| | | | 10 | TW | PH | | | | | | | | | | | 133 | |
| | | | | | | | | | | | | | | | | | |
| | | | 11 | TW | PH | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | |
| | | | 12 | TW | PH | | | | | | | | | | | 126 | |
| | | | | | | | | | | | | | | | | | |
| | | 13 | TW | PH | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | |
| | | 14 | TW | PH | | | | | | | | | | | 128 | 3 15 49 33 | |
| | | | | | | | | | | | | | | | | | |
| 497.6 | | | 15 | SS | 20 | | | | | | | | | | | | |
| 101.0 | Sandy Silt Some Gravel Compact to Dense | | | | | | | | | | | | | | | | |
| 489.6 | Limestone Bedrock Sound | | 16 | AXT RC | REC 100% | | | | | | | | | | | | |
| 109.0 | | | 17 | AXT RC | REC 100% | | | | | | | | | | | | |
| 479.6 | | | | | | | | | | | | | | | | | |
| 119.0 | End of Borehole | | | | | | | | | | | | | | | | |

+3, x5: Numbers refer to
Sensitivity

20
15 - 5 (%) STRAIN AT FAILURE
10



RECORD OF BOREHOLE No 2 (Formerly BH. #15. W.O. 68-F-15-1)

W P 258-66-02 LOCATION Coords. N 15,358,109; E 851,694 ORIGINATED BY A.M.S.
DIST 1 HWY E.C.Row BOREHOLE TYPE Continuous Flight Auger (S.A.) COMPILED BY P.P.
DATUM Geodetic DATE March 7, 1968 CHECKED BY

| SOIL PROFILE | | | SAMPLES | | | GROUND WATER CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION RESISTANCE PLOT | | | | | PLASTIC LIMIT W _p | NATURAL MOISTURE CONTENT W | LIQUID LIMIT W _L | UNIT WEIGHT γ | REMARKS & GRAIN SIZE DISTRIBUTION (%) |
|---------------|--|------------|---------|------|------------|----------------------------|-----------------|---|----|----|----|-----|------------------------------------|-------------------------------------|-----------------------------------|---------------------|---|
| ELEV DEPTH | DESCRIPTION | STRAT PLOT | NUMBER | TYPE | 'N' VALUES | | | 20 | 40 | 60 | 80 | 100 | | | | | |
| 599.3 | Ground Level | | | | | | | | | | | | | | | | |
| 0.0 | | | | | | | | | | | | | | | | | |
| 595.3 | Silty Sand Loose to Compact | | | | | | | | | | | | | | | | |
| 4.0 | | | | | | | | | | | | | | | | | |
| | Clayey Silt Some Sand Traces of Gravel | | 1 | SS | 18 | | 590 | | | | | | | | | 132 | 2 16 41 41 |
| | | | 2 | SS | 22 | | | | | | | | | | | | |
| | | | 3 | TW | PH | | | | | | | | | | | | |
| | Occasional Silty Clay Layers | | 4 | TW | PH | | 580 | | | | | | | | | | |
| | | | 5 | TW | PH | | | | | | | | | | | 127 | |
| | | | 6 | TW | PH | | 570 | | | | | | | | | | |
| | Stiff to Very Stiff | | 7 | TW | PH | | | | | | | | | | | 132 | 2 25 41 32 |
| | | | 8 | TW | PH | | 560 | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | |
| | | | 9 | TW | PH | | 550 | | | | | | | | | 133 | |
| 546.3 | | | | | | | | | | | | | | | | | |
| 53.0 | End of Borehole | | | | | | | | | | | | | | | | |

+3, x5: Numbers refer to
Sensitivity.

20
15
10
5 (%) STRAIN AT FAILURE



RECORD OF BOREHOLE No 3 (Formerly BH. #16, W.O. 68-F-15-1)

W P 258-66-02 LOCATION Coords. N 15.358.244: E 851.784 ORIGINATED BY A.M.S.
DIST 1 HWY E.C.Row BOREHOLE TYPE Continuous Flight Auger COMPILED BY P.P.
DATUM Geodetic DATE March 7,8, 1968 CHECKED BY

| SOIL PROFILE | | | SAMPLES | | | GROUND WATER CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION RESISTANCE PLOT | | PLASTIC LIMIT W _p | NATURAL MOISTURE CONTENT W | LIQUID LIMIT W _L | UNIT WEIGHT γ | REMARKS & GRAIN SIZE DISTRIBUTION (%) | | | |
|---------------|---|------------|---------|------|------------|----------------------------|-----------------|---|----------------------------|------------------------------------|-------------------------------------|-----------------------------------|---------------------|---|-------------------|-----|-------------|
| ELEV DEPTH | DESCRIPTION | STRAT PLOT | NUMBER | TYPE | 'N' VALUES | | | SHEAR STRENGTH PSF | | | | | | | WATER CONTENT (%) | PCF | GR SA SI CL |
| | | | | | | | | ○ UNCONFINED ● QUICK TRIAXIAL | + FIELD VANE × LAB VANE | | | | | | | | |
| 600.0 | Ground Level | | | | | | | 20 40 60 80 100 | | | | | | | | | |
| 0.0 | Silty Sand | | | | | | | | | | | | | | | | |
| 596.0 | Loose to Compact | | | | | | | | | | | | | | | | |
| 4.0 | Clayey Silt Some Sand Traces of Gravel Stiff to Very Stiff | | 1 | SS | 10 | | 590 | | | | | | | 3 19 48 30 | | | |
| | | | 2 | SS | 30 | | | | | | | | | | | | |
| | | | 3 | SS | 22 | | | | | | | | | | | | |
| | | | 4 | TW | PH | | | | | | | | | | | | |
| | | | 5 | SS | 13 | | | | | | | | | | | | |
| | | | 6 | TW | PH | | | | | | | | | | | | |
| | | | 7 | SS | 13 | | | | | | | | | | | | |
| | | | 8 | TW | PH | | | | | | | | | | | | |
| | | | 9 | TW | PH | | | | | | | | | | | | |
| 547.0 | End of Borehole | | | | | | | | | | | | | | | | |
| 53.0 | | | | | | | | | | | | | | | | | |

+3, x5: Numbers refer to
Sensitivity

20
15 +5 (%) STRAIN AT FAILURE
10

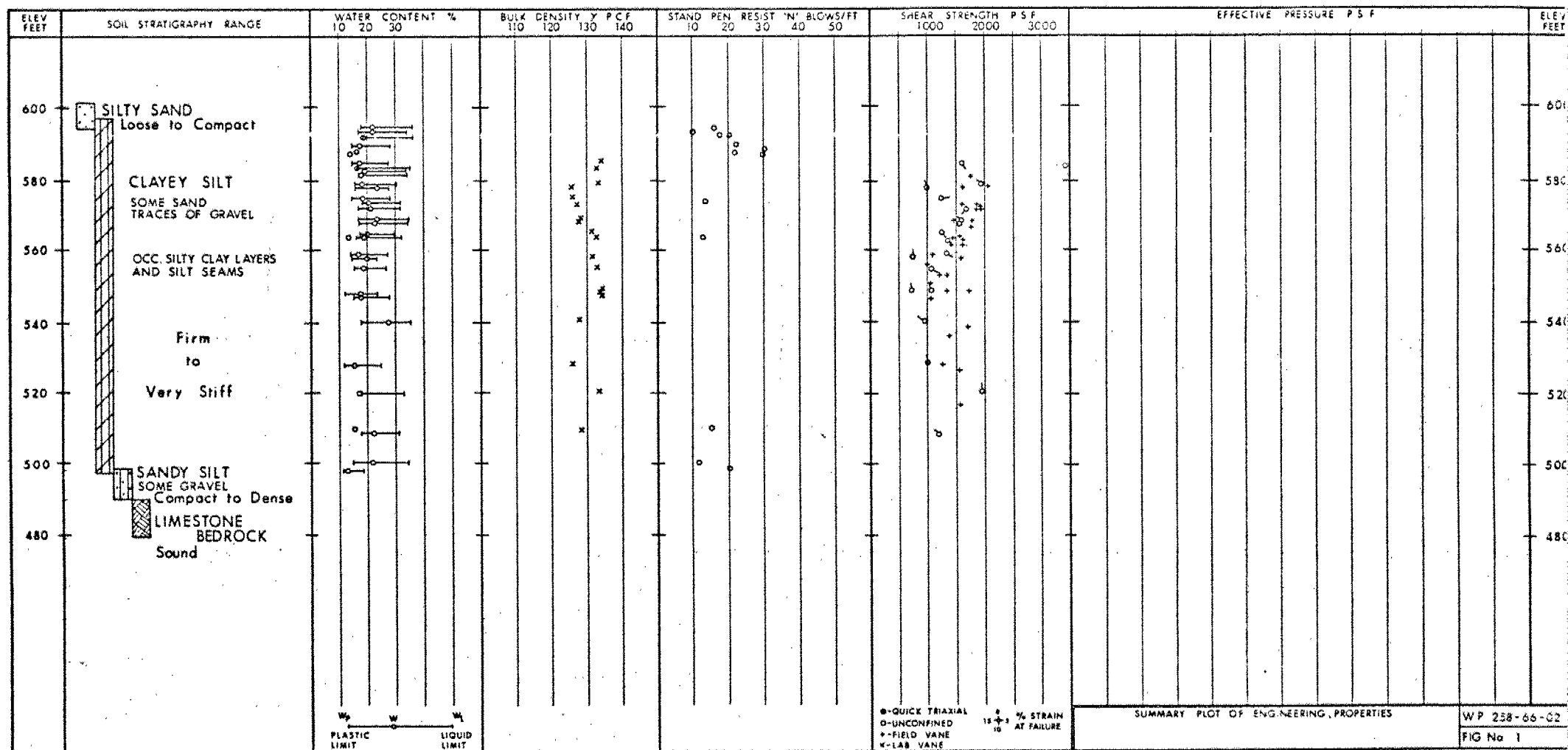


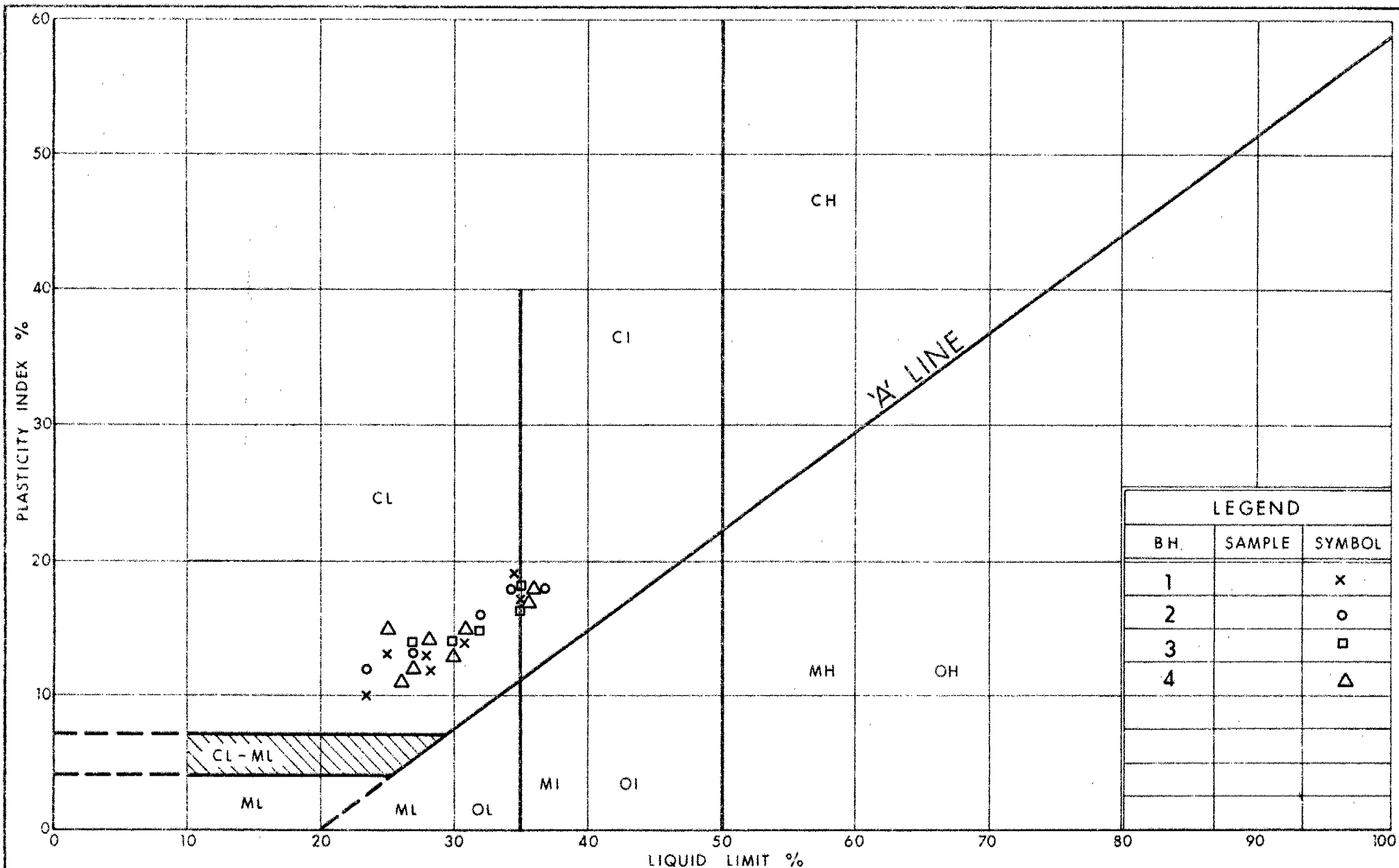
RECORD OF BOREHOLE No 4

(Formerly BH. #17, W.O. 68-P-15-1)

W P 258-66-02 LOCATION Coords. N 15,358,191; E 851,886 ORIGINATED BY A.M.S.
DIST 1 HWY E.C.Row BOREHOLE TYPE Continuous Flight Auger (S.A.) COMPILED BY P.P.
DATUM Geodetic DATE March 8 & 11, 1968 CHECKED BY

| SOIL PROFILE | | | SAMPLES | | | GROUND WATER CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION RESISTANCE PLOT | | | PLASTIC LIMIT W _p | NATURAL MOISTURE CONTENT W | LIQUID LIMIT W _L | UNIT WEIGHT γ PCF | REMARKS & GRAIN SIZE DISTRIBUTION (%) | | |
|-------------------|--|------------|---------|------|------------|----------------------------|--------------------|---|--|--|------------------------------------|-------------------------------------|-----------------------------------|----------------------------|---|--|--|
| ELEV DEPTH | DESCRIPTION | STRAT PLOT | NUMBER | TYPE | 'N' VALUES | | | 20 40 60 80 100 | | | | | | | | | |
| | | | | | | | | SHEAR STRENGTH PSF | | | | | | | | | |
| | | | | | | | | ○ UNCONFINED + FIELD VANE | | | | | | | | | |
| | | | | | | | | ● QUICK TRIAXIAL × LAB VANE | | | | | | | | | |
| | | | | | | | | 1000 2000 | | | | | | | | | |
| WATER CONTENT (%) | | | | | | | | | | | | | | | | | |
| 10 20 30 | | | | | | | | | | | | | | | | | |
| 601.0 | Ground Level | | | | | | | | | | | | | | | | |
| 0.0 | Silty Sand | | | | | | | | | | | | | | | | |
| 597.0 | Loose to Compact | | | | | | | | | | | | | | | | |
| 4.0 | Clayey Silt Some Sand Traces of Gravel Stiff to Very Stiff Occasional Silt Seams Sandy Silt Some Gravel, Compact | | 1 | SS | 16 | | | | | | | | | | | | |
| | | | 2 | SS | 22 | | | | | | | | | | | | |
| | | | 3 | TW | PH | | | | | | | | | | | | |
| | | | 4 | TW | PH | | | | | | | | | | | | |
| | | | 5 | TW | PH | | | | | | | | | | | | |
| | | | 6 | TW | PH | | | | | | | | | | | | |
| | | | 7 | TW | PH | | | | | | | | | | | | |
| | | | 8 | TW | PH | | | | | | | | | | | | |
| | | | 9 | TW | PH | | | | | | | | | | | | |
| | | | 10 | TW | PH | | | | | | | | | | | | |
| | | | 11 | TW | PH | | | | | | | | | | | | |
| | | | 12 | TW | PH | | | | | | | | | | | | |
| | | | 13 | TW | PH | | | | | | | | | | | | |
| | | | 14 | SS | 15 | | | | | | | | | | | | |
| | | | 15 | SS | 12 | | | | | | | | | | | | |
| 498.0 | | | | | | | | | | | | | | | | | |
| 103.0 | Sandy Silt | | | | | | | | | | | | | | | | |
| 494.5 | Some Gravel, Compact | | | | | | | | | | | | | | | | |
| 106.5 | Refusal | | | | | | | | | | | | | | | | |
| | End of Borehole | | | | | | | | | | | | | | | | |





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Communications

PLASTICITY CHART
CLAYEY SILT, SOME SAND, TRACES OF GRAVEL
OCC. SILTY CLAY LAYERS
AND SILT SEAMS

FIG No 2

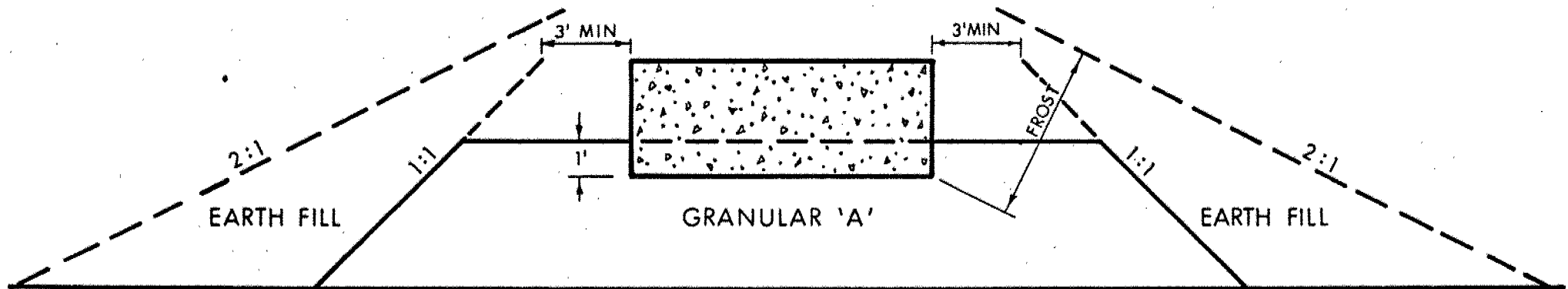
W P 258-66-02



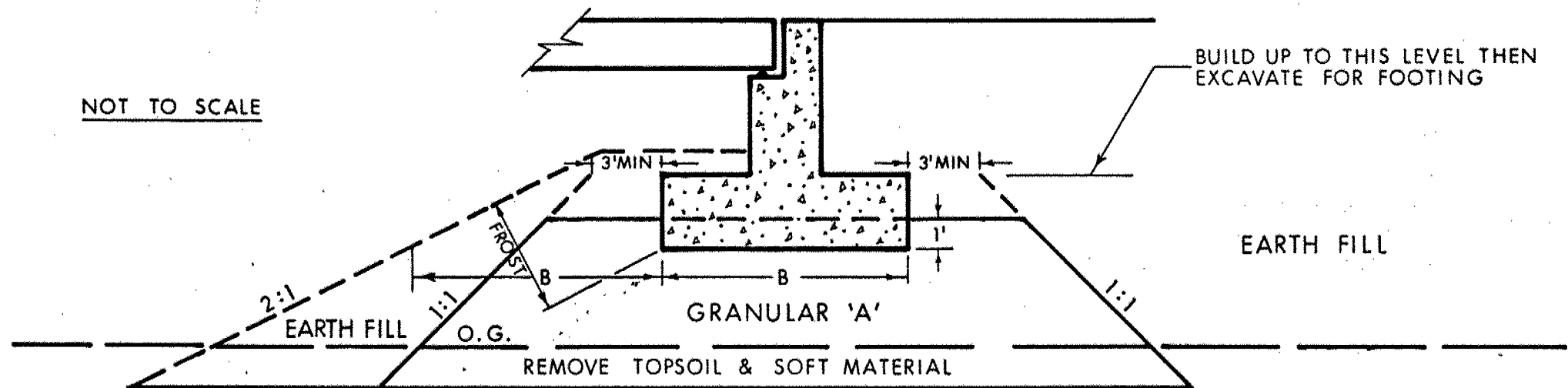
GRAIN SIZE DISTRIBUTION
CLAYEY SILT, SOME SAND, TRACES OF GRAVEL
OCC. SILTY CLAY LAYERS
AND SILT SEAMS

W P 258-66-02

ABUTMENT ON COMPACTED FILL SHOWING GRANULAR 'A' CORE



X SECTION



LONGITUDINAL SECTION

NOTES:

- 1 - REMOVE TOPSOIL &/OR SOFT SUBSOIL UNDER AREA OF COMPACTED GRANULAR 'A' & EARTH FILL.
- 2 - PLACE GRANULAR 'A' & EARTH FILL TO TOP OF FOOTING LEVEL, COMPACTED ACCORDING TO CURRENT M.T.C. STANDARDS.
- 3 - EXCAVATE COMPACTED GRANULAR 'A' & EARTH FILL FOR FOOTING.

FIG. 4

EXPLANATION OF TERMS USED IN REPORT

'N' VALUE: AN INDICATOR OF SUBSOIL QUALITY. IT IS OBTAINED FROM THE STANDARD PENETRATION TEST (CSA STD. A119.1). SPT 'N' VALUE IS THE NUMBER OF BLOWS REQUIRED TO CAUSE A STANDARD 2 INCH O.D. SPLIT-BARREL SAMPLER TO PENETRATE 12 INCHES INTO UNDISTURBED GROUND IN A BOREHOLE WHEN DRIVEN BY A HAMMER WEIGHING 140 POUNDS, FALLING FREELY A DISTANCE OF 30 INCHES. FOR PENETRATIONS OF LESS THAN 12 INCHES 'N' VALUES ARE INDICATED AS THE NUMBER OF BLOWS FOR THE PENETRATION ACHIEVED. 'N' VALUES CORRECTED FOR OVERBURDEN PRESSURE ARE DENOTED THUS N_c .

DYNAMIC CONE PENETRATION TEST (CSA STD. A119.3): CONTINUOUS PENETRATION OF A CONICAL STEEL POINT (2" O.D. 60 CONE ANGLE) DRIVEN BY 350 FT-LB IMPACTS ON "A" SIZE DRILL RODS. THE RESISTANCE TO CONE PENETRATION IS MEASURED AS THE NUMBER OF BLOWS FOR EACH 12 INCH ADVANCE OF THE CONICAL POINT INTO THE UNDISTURBED GROUND.

SOIL QUALITY: SOILS ARE DESCRIBED BY THEIR COMPOSITION AND CONSISTENCY OR DENSITY.

CONSISTENCY: COHESIVE SOILS ARE DESCRIBED ON THE BASIS OF THEIR UNDRAINED SHEAR STRENGTH AS FOLLOWS:

| S_u (PSF) | 0 - 250 | 250 - 500 | 500 - 1000 | 1000 - 2000 | 2000 - 4000 | > 4000 |
|-------------|-----------|-----------|------------|-------------|-------------|--------|
| | VERY SOFT | SOFT | FIRM | STIFF | VERY STIFF | HARD |

DENSENESS: COHESIONLESS SOILS ARE DESCRIBED ON THE BASIS OF SPT 'N' VALUES AS FOLLOWS:

| 'N' (BLOW/FT) | 0 - 5 | 5 - 10 | 10 - 30 | 30 - 50 | > 50 |
|---------------|------------|--------|---------|---------|------------|
| | VERY LOOSE | LOOSE | COMPACT | DENSE | VERY DENSE |

ROCK QUALITY: ROCKS ARE DESCRIBED BY THEIR COMPOSITION AND STRUCTURAL FEATURES AND/OR STRENGTH.

RECOVERY: SUM OF ALL RECOVERED ROCK CORE PIECES FROM A CORING RUN EXPRESSED AS A PERCENT OF THE TOTAL LENGTH DRILLED IN THAT CORING RUN.

MODIFIED RECOVERY: SUM OF THOSE NATURALLY FRACTURED CORE PIECES, 4" IN LENGTH EXPRESSED AS A PERCENT OF THE LENGTH OF THE CORING RUN. THE ROCK QUALITY DESIGNATION (RQD), FOR MODIFIED RECOVERY, IS:

| RQD (%) | 0 - 25 | 25 - 50 | 50 - 75 | 75 - 90 | 90 - 100 |
|---------|-----------|---------|---------|---------|-----------|
| | VERY POOR | POOR | FAIR | GOOD | EXCELLENT |

JOINTING AND BEDDING:

| SPACING | 2" | 2" - 12" | 1' - 3' | 3' - 10' | > 10' |
|----------|------------|----------|------------|----------|------------|
| JOINTING | VERY CLOSE | CLOSE | MOD. CLOSE | WIDE | VERY WIDE |
| BEDDING | VERY THIN | THIN | MEDIUM | THICK | VERY THICK |

ABBREVIATIONS & SYMBOLS




LABORATORY TESTING

TRIAXIAL TESTS ARE DESCRIBED IN TERMS OF WHETHER THEY ARE CONSOLIDATED (C) OR NOT (U) ISOTROPICALLY (I) OR NOT (A) AND SHEARED DRAINED (D) OR UNDRAINED (U) WITH PORE PRESSURE MEASUREMENTS (BAR OVER SYMBOLS) EG. $CU =$ CONSOLIDATED ISOTROPIC UNDRAINED TRIAXIAL WITH PORE PRESSURE MEASUREMENT UNLESS OTHERWISE SPECIFIED IN REPORT ALL TESTS ARE IN COMPRESSION

FIELD SAMPLING

S S SPLIT SPOON
W S WASH SAMPLE
S T SLOTTED TUBE SAMPLE
B S BLOCK SAMPLE
C S CHUNK SAMPLE
T W THINWALL OPEN
T P THINWALL PISTON
O S OSTERBERG SAMPLE
F S FOIL SAMPLE
R C ROCK CORE
P H T.W. ADVANCED HYDRAULICALLY
P M T.W. ADVANCED MANUALLY

EARTH PRESSURE TERMS

μ COEFFICIENT OF FRICTION
 δ ANGLE OF WALL FRICTION
 k_o COEFFICIENT OF EARTH PRESSURE AT REST
 k_a COEFFICIENT OF ACTIVE EARTH PRESSURE
 k_p COEFFICIENT OF PASSIVE EARTH PRESSURE
 i ANGLE OF INCLINATION OF SURCHARGE 
 w SLOPE ANGLE-BACKFACE OF WALL 
 β ANGLE OF SLOPE 
 N_q, N_c BEARING CAPACITY FACTORS
 D_f DEPTH OF FOOTING
 B, L FOOTING DIMENSIONS

INDEX PROPERTIES

γ UNIT WEIGHT OF SOIL (BULK DENSITY)
 γ_w UNIT WEIGHT OF WATER
 γ_d UNIT DRY WEIGHT OF SOIL (DRY DENSITY)
 γ' UNIT WEIGHT OF SUBMERGED SOIL
 G_s SPECIFIC GRAVITY OF SOLIDS
 e VOIDS RATIO
 e_o INITIAL VOIDS RATIO
 e_{max} e IN LOOSEST STATE
 e_{min} e IN DENSEST STATE
 D_r RELATIVE DENSITY = $\frac{e_{max} - e}{e_{max} - e_{min}}$
 n POROSITY
 w WATER CONTENT
 w_L LIQUID LIMIT
 w_p PLASTIC LIMIT
 w_s SHRINKAGE LIMIT
 I_p PLASTICITY INDEX = $w_L - w_p$
 I_L LIQUIDITY INDEX = $\frac{w - w_p}{I_p}$
 I_c CONSISTENCY INDEX = $\frac{w_L - w}{I_p}$
 A_c ACTIVITY = $\frac{I_p \text{ of soil}}{I_p \text{ of } 2\mu m \text{ Soil Fraction}}$
 Om ORGANIC MATTER CONTENT
 S_r DEGREE OF SATURATION
 S SENSITIVITY = $\frac{S_u(\text{undisturbed})}{S_u(\text{remoulded})}$

STRENGTH PARAMETERS

ϕ ANGLE OF SHEARING RESISTANCE
 τ_f PEAK SHEAR STRENGTH
 τ_R RESIDUAL SHEAR STRENGTH
 c COHESION INTERCEPT
 $\sigma_1, \sigma_2, \sigma_3$ NORMAL PRINCIPAL STRESSES
 u PORE WATER PRESSURE
 u_e EXCESS u
 r_u PORE PRESSURE RATIO
 q_u UNCONFINED COMPRESSIVE STRENGTH
 s_u UNDRAINED SHEAR STRENGTH
 ϵ LINEAR STRAIN
 γ SHEAR STRAIN
 ν POISSON'S RATIO
 E MODULUS OF ELASTICITY
 G MODULUS OF SHEAR DEFORMATION
 k_s MODULUS OF SUBGRADE REACTION
 m, n STABILITY COEFFICIENTS
 A, B PORE PRESSURE COEFFICIENTS

NOTE: EFFECTIVE STRESS PARAMETERS ARE DENOTED BY USE OF APOSTROPHE ABOVE THE SYMBOL, THUS:
 ϕ' = EFFECTIVE ANGLE OF SHEARING RESISTANCE;
 σ' = EFFECTIVE NORMAL STRESS

HYDRAULIC TERMS

h HYDRAULIC HEAD OR POTENTIAL
 q RATE OF DISCHARGE
 v VELOCITY OF FLOW
 i HYDRAULIC GRADIENT
 j SEEPAGE FORCE PER UNIT VOLUME
 η COEFFICIENT OF VISCOSITY
 k COEFFICIENT OF HYDRAULIC CONDUCTIVITY
 k_h k IN HORIZONTAL DIRECTION
 k_v k IN VERTICAL DIRECTION
 m_v COEFFICIENT OF VOLUME CHANGE
 c_v COEFFICIENT OF CONSOLIDATION
 C_c COMPRESSION INDEX
 C_r RECOMPRESSION INDEX
 d DRAINAGE PATH DISTANCE
 T_v TIME FACTOR
 U DEGREE OF CONSOLIDATION
 O_r OVERCONSOLIDATION RATIO (OCR)

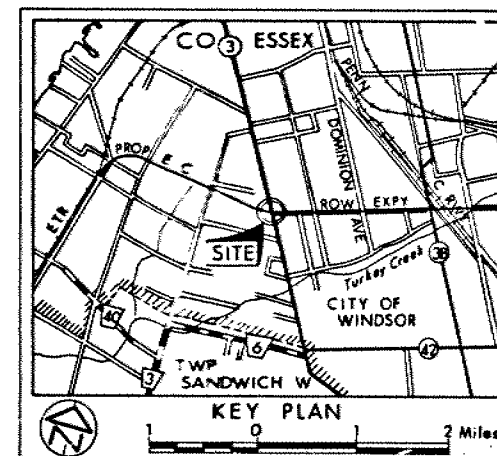
CONT No
WP No 258-66-02

HWY 3 OVERPASS

BORE HOLE LOCATIONS & SOIL STRATA



SHEET



LEGEND

- Bore Hole
- ⊕ Dynamic Cone Penetration Test (Cone)
- ⊙ Bore Hole & Cone
- 'N' Blows/ft (Std Pen Test 350 ft lbs energy)
- CONE Blows/ft (60° Cone, 350 ft lbs energy)
- ↓ WL at time of investigation Mar 1968

| No | ELEVATION | CO-ORDINATES NORTH | EAST |
|----|-----------|-----------------------|---------|
| 1 | 598.6 | 15 358 234 | 851 615 |
| 2 | 599.3 | 15 358 109 | 851 694 |
| 3 | 600.0 | 15 358 244 | 851 784 |
| 4 | 601.0 | 15 358 191 | 851 886 |

-NOTE-

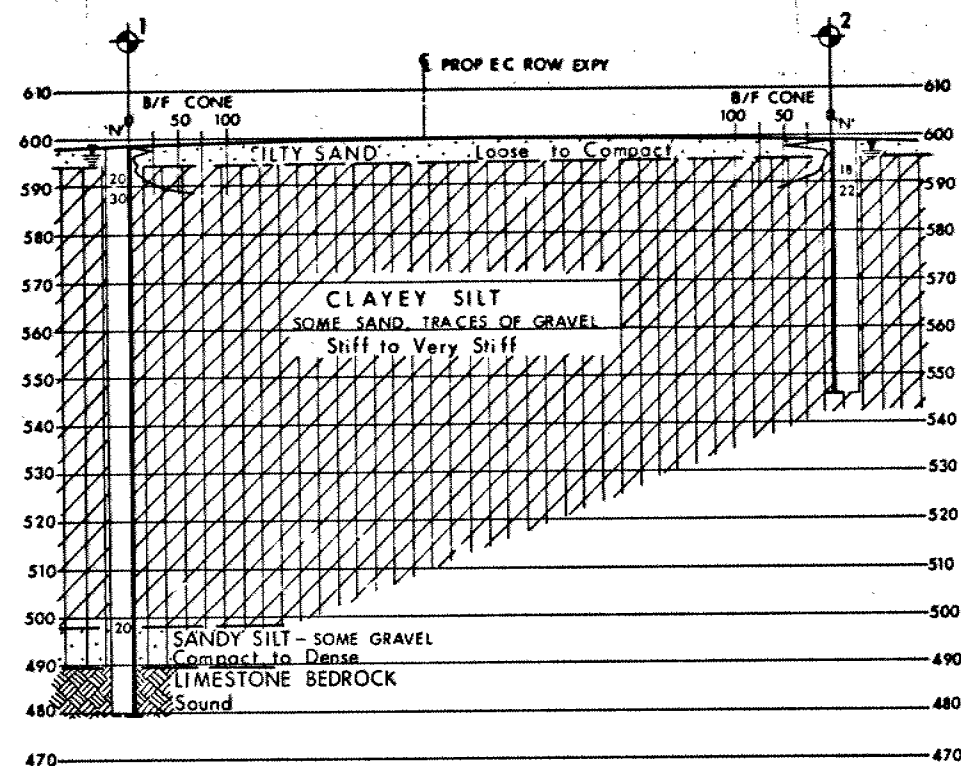
The boundaries between soil strata have been established only at Bore Hole locations. Between Bore Holes the boundaries are assumed from geological evidence.

GEOCRES No 40J6-10

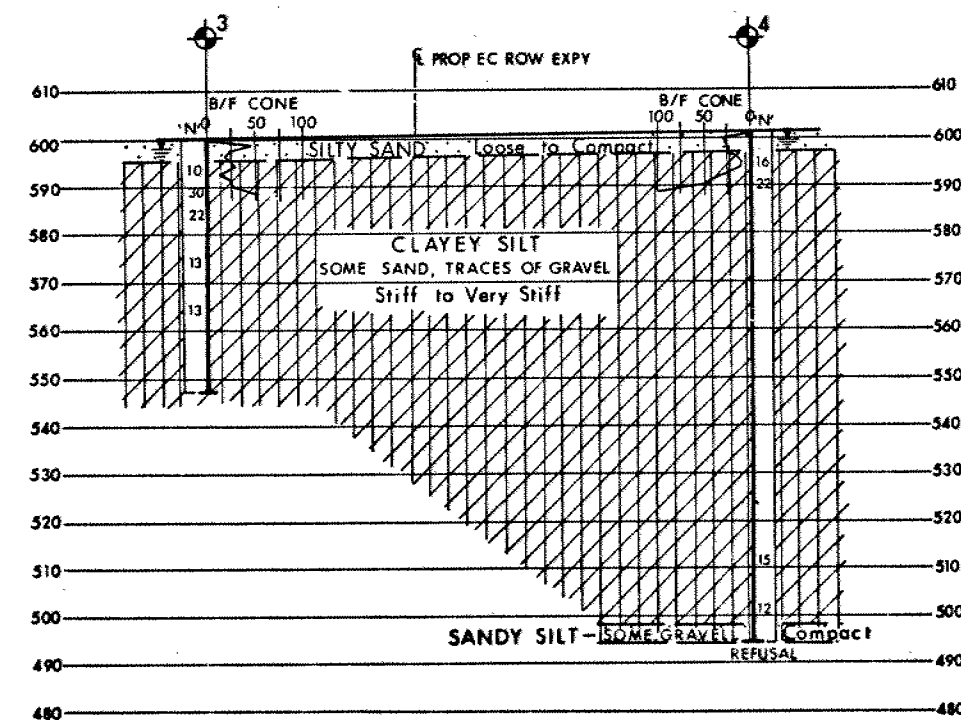
| REVISIONS | DATE | BY | DESCRIPTION |
|-----------|------|----|-------------|
| | | | |
| | | | |
| | | | |

HWY No PROP EC ROW EXPY
SUBMITTED BY: [] CHECKED: [] DATE: 78 06 27
DRAWN BY: [] CHECKED: [] DATE: 78 06 27
SITE: 6-283
DWG: 2586602-A

REF No E-5330-1 ; March 1972



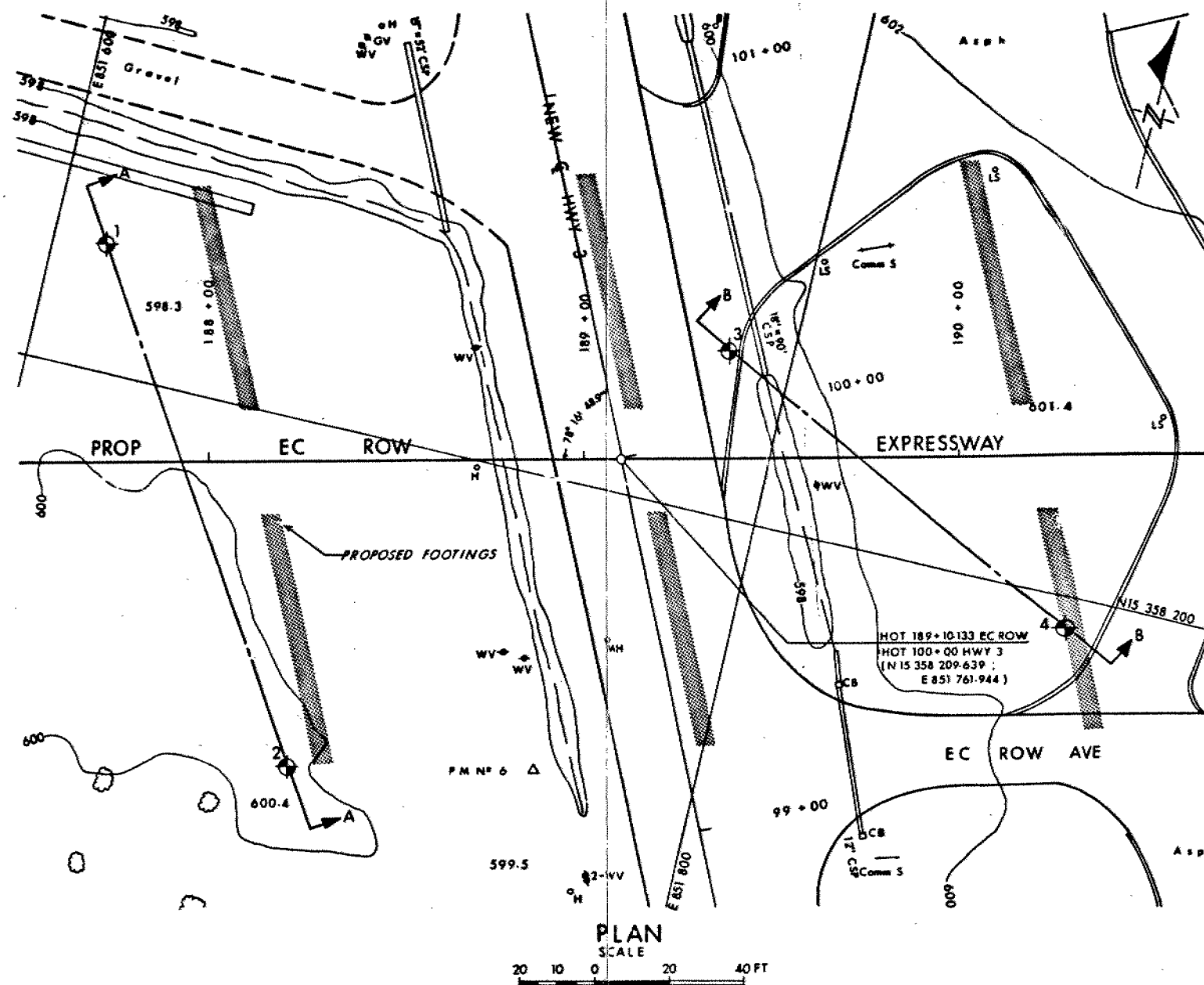
A-A



B-B

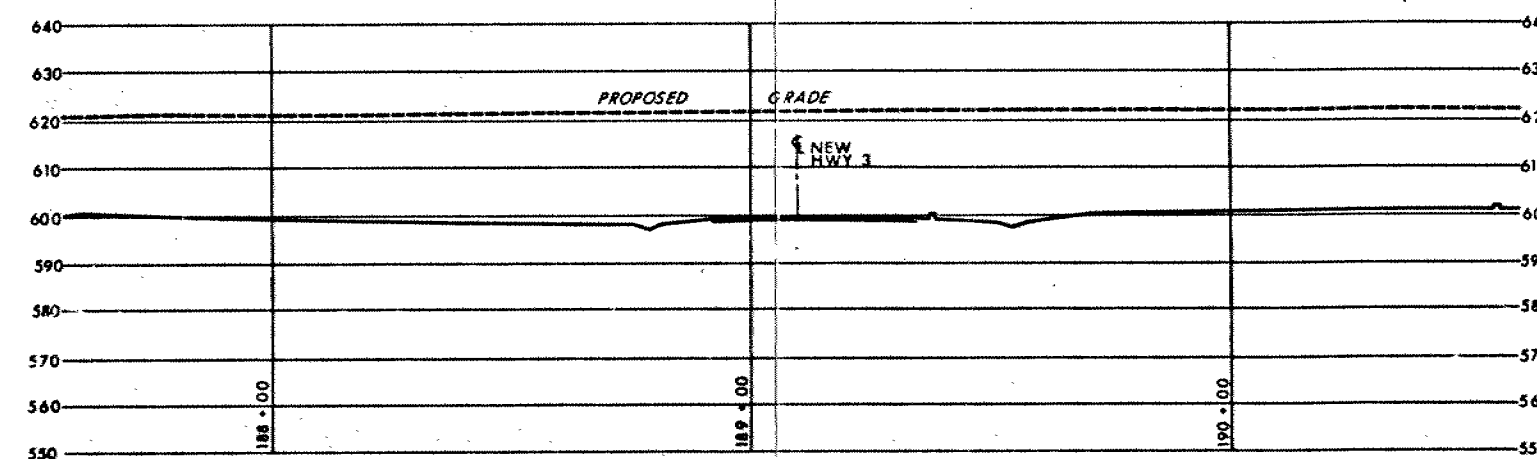
SECTIONS

SCALE
20 10 0 20 40 FT



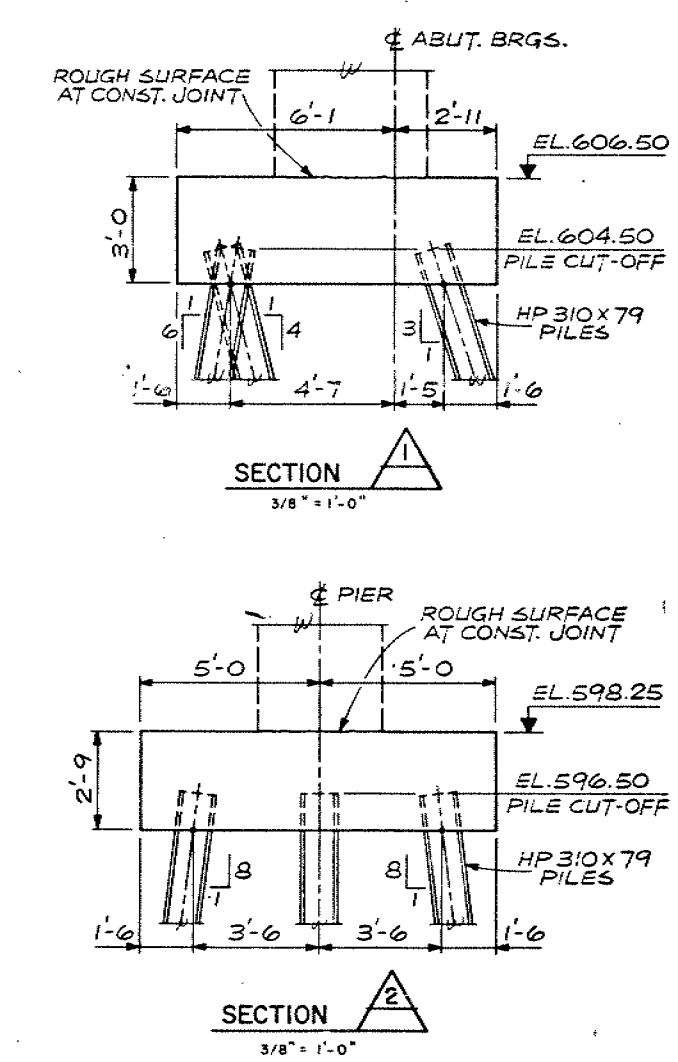
PLAN
SCALE

20 10 0 20 40 FT





Q PROFILE PROP EC ROW EXPY

SCALE
20 10 0 20 40 FT



| PILE DATA TABLE | | | | |
|-----------------|-------|--------|-----|--------|
| LOCATION | ROW | BATTER | NO. | LENGTH |
| WEST ABUTMENT | FRONT | 1:3 | 11 | 130' |
| | REAR | 1:4 | 3 | 127' |
| | | 1:6 | 4 | 125' |
| PIER | EXT. | 1:8 | 18 | 115' |
| | CENT. | VERT. | 2 | 115' |
| EAST ABUTMENT | FRONT | 1:3 | 10 | 130' |
| | REAR | 1:4 | 2 | 127' |
| | | 1:6 | 4 | 125' |

DRAWING NOT TO BE SCALED

| | |
|---|---|
| DISTRICT No. 1 CONT No WP No 258-66-02 |  |
| E.C. ROW EXPRESSWAY E.B.L. HIGHWAY 3 OVERPASS FOUNDATION LAYOUT | SHEET |
|  | |

NOTES
ALL PILES ARE HP 310 X 79.
PILES TO BE DRIVEN TO BEDROCK.
PILE SPACING TO BE MEASURED AT
UNDERSIDE OF FOOTING.
DESIGN LOAD AT S.L.S. II = 130 TONS
FACTORED CAPACITY AT U.L.S. = 180 TONS
PILE LENGTH SHOWN ON DRAWING IS
THEORETICAL LENGTH BELOW CUT-OFF.
LEGEND
H = VERTICAL PILE
H --- = DIRECTION OF PILE BATTER
1:3, 1:4, 1:6 & 1:8 = RATE OF BATTER
PROVIDE DRIVING SHOES FOR ALL PILES
AS PER STD. SS 3-1.

DILLON
Consulting Engineers & Planners

[illegible]

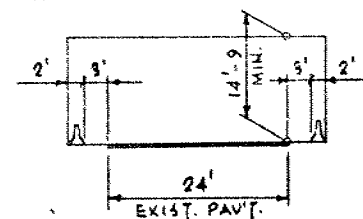
DISTRICT No. 1
CONT No
WP No 258-66-02

E.C. ROW EXPRESSWAY E.B.L.
HIGHWAY 3 OVERPASS
GENERAL ARRANGEMENT

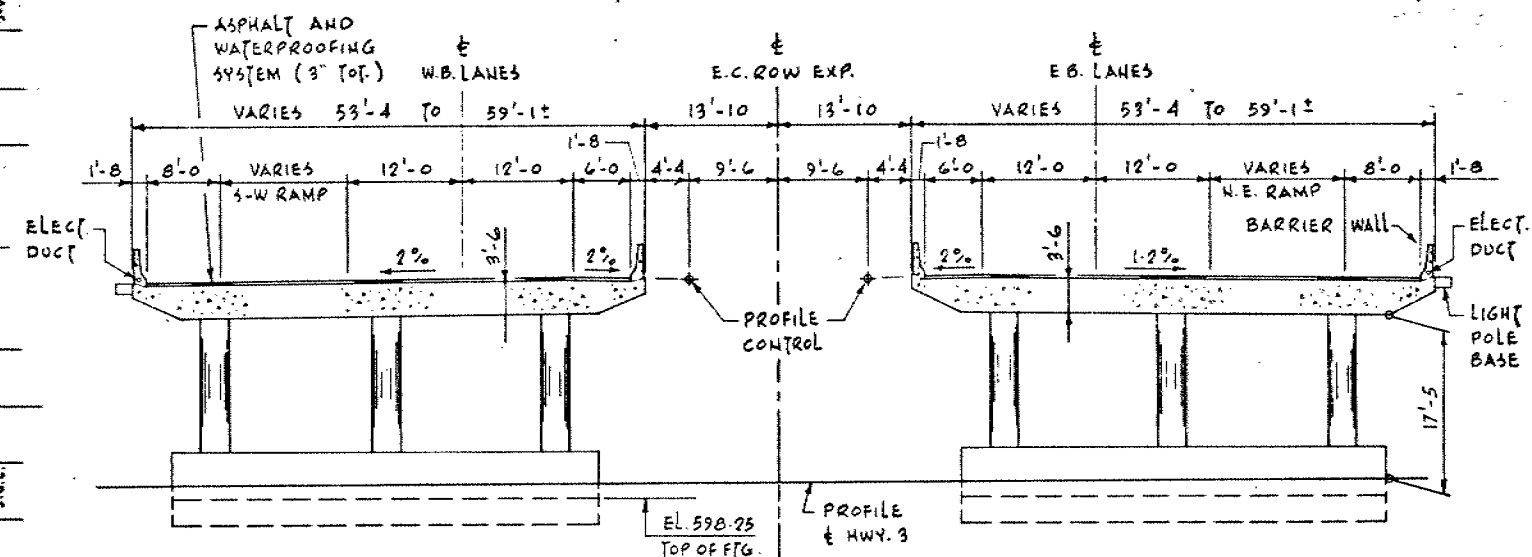
DILLON
Consulting Engineers & Planners

SHEET

ALL HORIZ. DIMENSIONS SHOWN
ARE REQUIRED MINIMUM



FALSEWORK CLEARANCES
TYPICAL N.B. & S.B. LANES



SECTION

1" = 10'

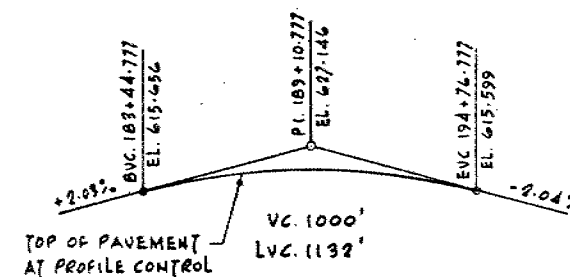
TOP OF EXIST. PAV'T.
AT PROFILE CONTROL
± HWY 3

E.C. ROW EXP.

HWY. No. 3
OVERPASS

| | | | | | | |
|------------|------------|------------|------------|------------|------------|------------|
| 97+00 | 98+00 | 99+00 | 100+00 | 101+00 | 102+00 | 103+00 |
| EL. 599.81 | EL. 599.59 | EL. 599.49 | EL. 599.90 | EL. 600.00 | EL. 599.95 | EL. 600.00 |

HIGHWAY No 3



E.C. ROW EXPRESSWAY

PROFILE DATA

N.T.S.

LIST OF DRAWINGS

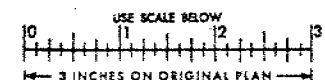
- 1 GENERAL ARRANGEMENT
- 2 BOREHOLE LOCATION AND SOIL STRATA
- 3 FOUNDATION LAYOUT
- 4 FOUNDATION REINFORCEMENT
- 5 WEST ABUTMENT LAYOUT
- 6 WEST ABUTMENT REINFORCEMENT
- 7 EAST ABUTMENT LAYOUT
- 8 EAST ABUTMENT REINFORCEMENT
- 9 PIER DETAILS
- 10 DECK LAYOUT AND SCREED ELEVATIONS
- 11 DECK CABLES LAYOUT
- 12 DECK CABLES DETAILS
- 13 DECK REINFORCEMENT I
- 14 DECK REINFORCEMENT II
- 15 EXPANSION JOINTS
- 16 BARRIER WALL
- 17 APPROACH SLABS
- 18 DETAILS OF CONC SLOPE PAVING
- 19 STANDARD DETAILS I
- 20 STANDARD DETAILS II
- 21 STANDARD DETAILS III
- 22 EMBEDDED ELECTRICAL
- 23 BRIDGE DATE AND SITE NO.
- 24 AS CONSTRUCTED ELEV. & DIM.
- 25 QUANTITIES - STRUCTURE
- 26 QUANTITIES - STRUCTURE

GENERAL NOTES

- CLASS OF CONCRETE
- | | |
|--------------------------|--------|
| PIERS, DECK | 35 MPa |
| BARRIER WALLS, ABUTMENTS | 30 MPa |
| REMAINDER | 20 MPa |
- CLEAR COVER TO REINFORCING STEEL
- | | |
|---------------------------|---------------|
| FOOTINGS | 4" ± 1" |
| PIERS | 3" ± 3/4" |
| ABUTMENTS FRONT FACE (FF) | 3" ± 3/4" |
| BACK FACE (B.F.) | 2 3/4" ± 3/4" |
| DECK TOP BARS | 2 3/4" ± 3/4" |
| BOT. BARS | 2" ± 3/8" |
- REMAINDER 2 3/4" ± 3/4" UNLESS SHOWN OTHERWISE.
- GRADE OF REINFORCING STEEL
- REINFORCING STEEL SHALL BE GRADE 400
- REINFORCING BARS MARKED WITH THE SUFFIX "C"
- SHALL BE EPOXY COATED.
- CONSTRUCTION NOTES
- THE CONTRACTOR IS RESPONSIBLE FOR FINISHING
- THE BEARING SEATS DEAD LEVEL TO THE SPECIFIED
- ELEVATIONS WITH A TOLERANCE OF ± 1/8"
- NO CONCRETE SHALL BE PLACED ABOVE THE
- ABUTMENT BEARING SEATS UNTIL THE CONCRETE
- IN THE DECK HAS BEEN PLACED, STRESSED AND
- GROUTED.

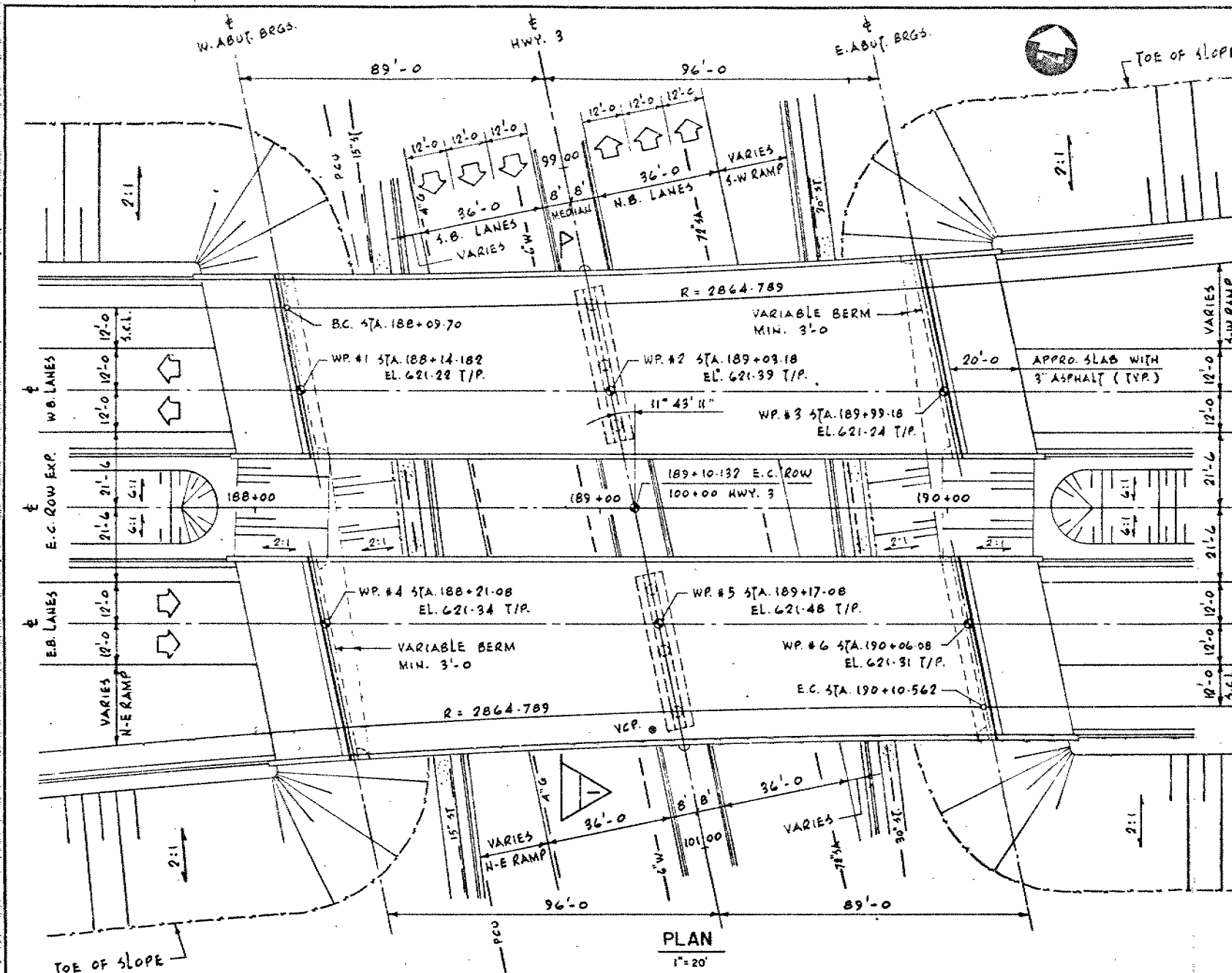


FOR REDUCED PLAN



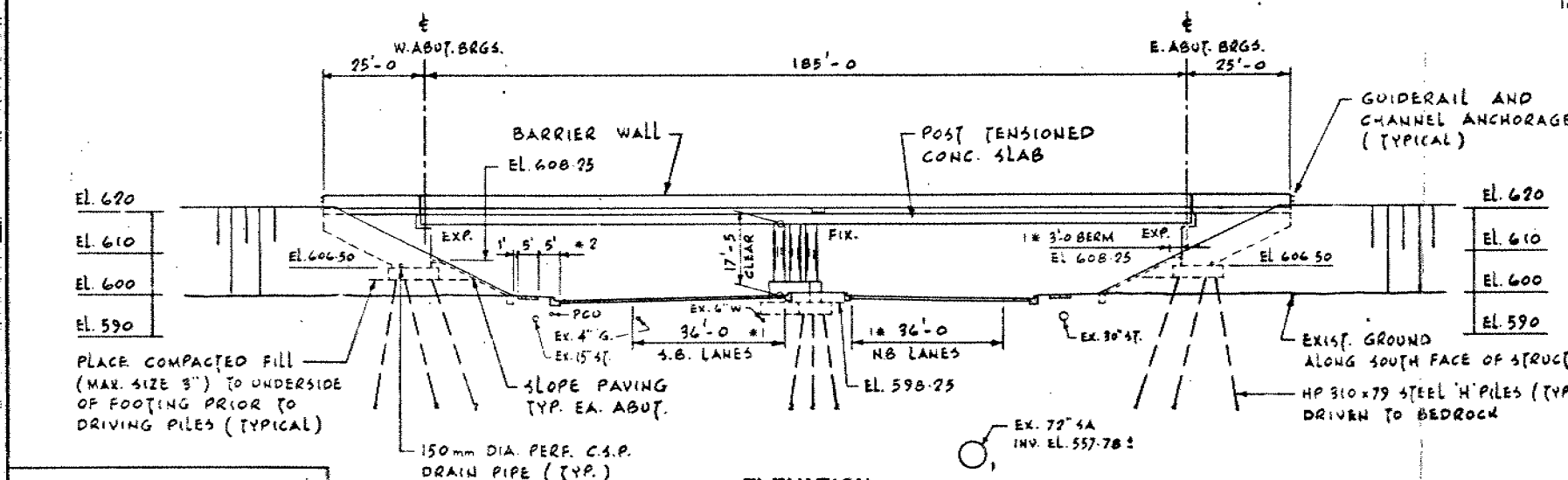
| REVISIONS | DATE | BY | DESCRIPTION |
|-----------|------|----|-------------|
| | | | |
| | | | |
| | | | |
| | | | |

DESIGN M.D.P. CHECK OK LOADING CHECK A-79 DATE MAY 83
DRAWING L.T.L. CHECK OK SITE No 6-1358-283A DWG



PLAN

1" = 20'



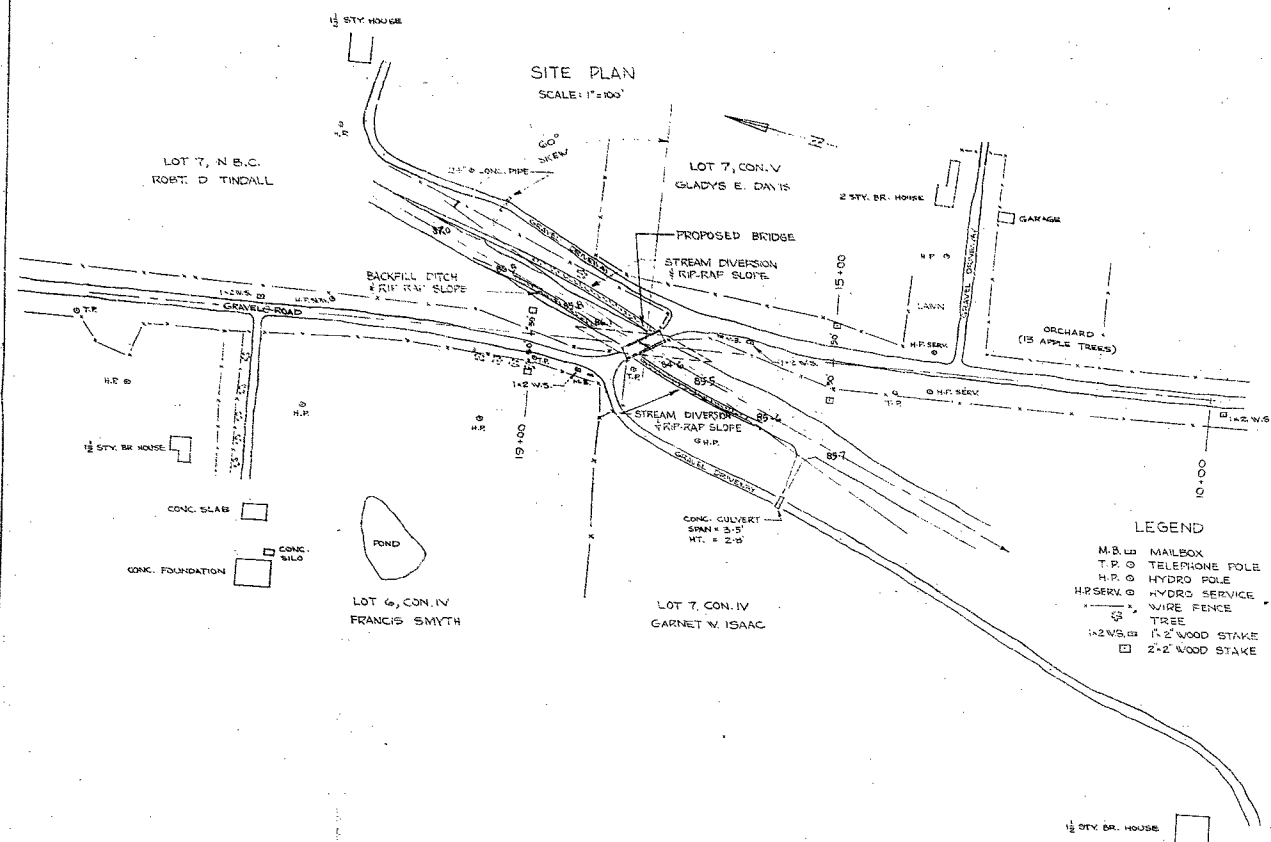
ELEVATION

1" = 20'

- * 1 = MEASURED PERPENDICULAR TO ± HWY. 3
- * 2 = MEASURED PERPENDICULAR TO EDGE OF PAV'T.

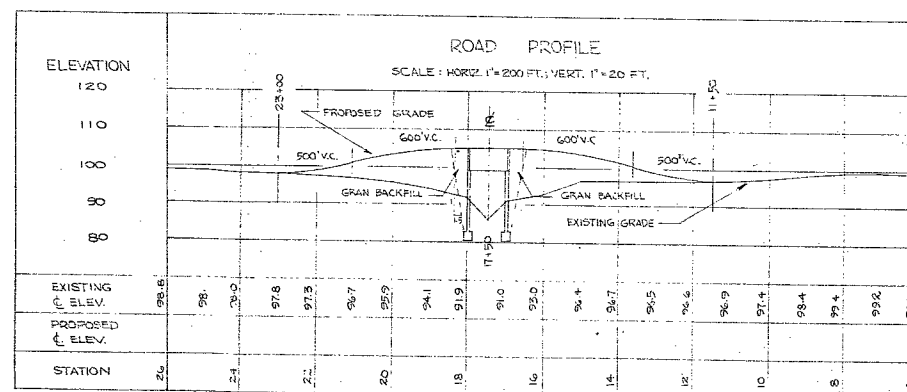
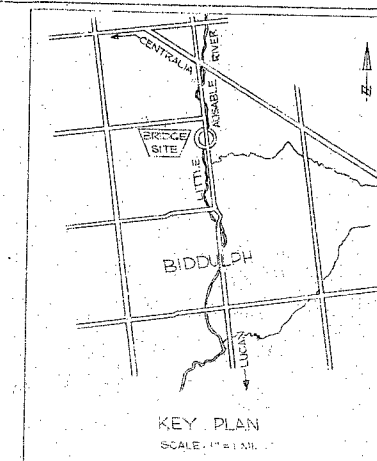
MTC PRECISE B.M. # 524-66
ELEVATION 182.724 M.
599.481 FT.

64-F-263 m
BRIDGE #17
LOT 7, CON. 1V & V
BIDDULPH
Twp.

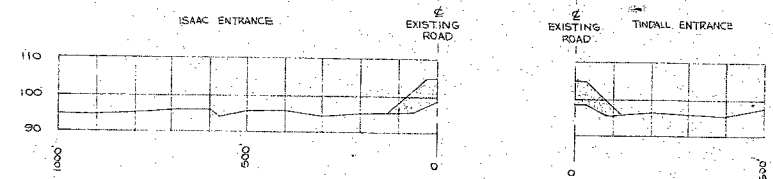


BENCH MARKS

| | |
|--|-------------------------|
| NAIL (WASHER IN CENTRE OF EXISTING STRUCTURE) | ELEV. 100.00 (ASSIGNED) |
| NAIL (WASHER IN 3" x 6" ELM. 1/2" RT. OF STA. 17+40) | ELEV. 98.25 |



PROFILES OF PRIVATE ENTRANCES
SCALE: HORIZ. 1"=200 FT.; VERT. 1"=20 FT.



- DATA**
- SPECIAL FEATURES:**
SURROUNDING TERRAIN IS REASONABLY FLAT.
 - UPSTREAM STRUCTURES:**
0.4 MI. UPSTREAM: 50 FT. SPAN RIGID FRAME BUILT IN 1963.
HT. ABOVE N.H.W.L. = 4 FT. 2"
NET X-SECT. AREA @ H.W. = 550 SQ. FT.
 - DOWNSTREAM STRUCTURES:**
1.0 MI. DOWNSTREAM: 51 FT. SIMPLE SPAN (STEEL TRUSSES).
HT. ABOVE N.H.W.L. = 4 FT. 2"
NET X-SECT. AREA @ H.W. = 560 SQ. FT.
 - EXISTING STRUCTURE:**
52 FT. SIMPLE SPAN (STEEL TRUSSES, BUILT IN 1908).
HT. ABOVE N.H.W.L. = 1.5 FT. 2"
NET X-SECT. AREA @ H.W. = 560 SQ. FT. (OCCASIONAL FLOODING OVER NORTH APPROACH DUE TO POOR BRIDGE ALIGNMENT)
 - Reasons why these bridges are fair indications of size of proposed bridge:
NO EVIDENCE OF SCOUR AT ABOVE BRIDGES.
PROPOSED BRIDGE = 50' x 12' 5" = 625 SQ. FT.
 - Is the stream gradient liable to be lowered? NO
 - Navigation clearance required, if any: NO
 - Railway clearance required, if any: NO
 - Temporary detour required? YES
Who will build it? CONTRACTOR
Who will maintain it? CONTRACTOR
 - Information on water level according to local residents:
H.W.L. = 98.5'
L.W.L. = 87.0'
 - Road Design Information:
APPROACHES ONLY TO BE CONSTRUCTED IN 1964.

STRUCTURAL DATA

- Net span and type of bridge: 100' C-C. BRGS. SIMPLE SPAN OF TYPE III 1/2 AASHTO GRIDERS
- Roadway width on bridge: 28'
- Number and width of sidewalks: NONE
- Sewer Angle: 60°
- Approximate Volume of Concrete: _____
- Approximate Weight of Reinforcing Steel: _____
- Drainage Area: 24 SQ. MI.

Field Investigation Made By
P. McIntyre



STRUCTURE SITE No. 20-17

COUNTY OF MIDDLESEX

BRIDGE #17

APR. 25/64

SCALE: _____

DRAWN BY: _____

DRWG. NO. _____

ENGINEER _____

DATE _____

MR. F. B. D. ARNOLD
COUNTY ENGINEER
COUNTY OF MIDDLESEX
COUNTY OFFICES
LONDON ONTARIO

Report on
SOIL INVESTIGATION
for
BRIDGE #17
LOT 7, CONCESSIONS IV & V
TOWNSHIP OF BIDDULPH
COUNTY OF MIDDLESEX

by
DOMINION SOIL INVESTIGATION LIMITED
363 Queens Avenue
LONDON ONTARIO
Reference No. 4-2-L10
30th March 1964

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| II FIELD WORK..... | 2 |
| III SUBSURFACE CONDITIONS..... | 2 |
| IV FOUNDATIONS..... | 3 |
| V REFERENCES..... | 4 |

ENCLOSURES

| | <u>No.</u> |
|--|------------|
| SYMBOLS, ABBREVIATIONS AND NOMENCLATURE | 1 |
| LOCATION OF BOREHOLES AND SUBSURFACE PROFILE | 2 |
| GEOTECHNICAL DATA SHEETS | 3 and 4 |

SUMMARY

The strata consist of a cohesive silt till underlain by a pervious granular deposit.

It is recommended that the structure should be supported on spread footings bearing in the till at El.80.5 feet. The footings should be designed for a soil pressure not exceeding 5500 p.s.f.

Construction for the footings should be carried out within a steel sheet pile enclosure, the piles being driven to a sufficient depth to protect the bottom of the excavation from heaving.

I INTRODUCTION

In accordance with a letter of authorization dated February 20, 1964, a soil investigation has been carried out at a site in the Township of Biddulph where it is proposed to replace an existing road bridge with a new structure. The existing bridge carries a gravel road across the Little Ausable River which runs at an acute angle to the line of the road. The new structure will have a skew estimated to be 66°, and a span of approximately 120 feet.

The purpose of this investigation has been to reveal the subsurface conditions and to determine the necessary soil properties for the design and construction of the new foundations.

II FIELD WORK

Field work was carried out during the period 26th to 28th of February, 1964 and consisted of 3 boreholes at the locations shown on enclosure 2. The holes were advanced by washboring and lined with Bx (3-inch) casing. Standard Penetration tests were performed at frequent intervals of depth and dynamic cone penetration tests were performed adjacent to each borehole.

The results of the field tests are recorded on geotechnical data sheets comprising enclosures 3 and 4.

III SUBSURFACE CONDITIONS

Details of the stratification at each borehole are shown on the data sheets and a general picture of the subsurface conditions is given by the profile on enclosure 2. The principal strata are as follows.

- (a) Dark brown silty 'oam. This material is basically a silt mixed with organics. It includes the usual top-soil formation below which the proportion of organics diminishes with depth. The depth of organic matter is unusual (4 to 5 feet) and judging from the relative elevations of the strata, probably some of this material is fill. The moisture content is low and it is slightly cohesive.
- (b) Silt-clay deposit. This stratum was encountered only in borehole 1. It consists of fine interlayered seams of cohesionless silt and silty clay, generally less than 1/16th inch in thickness. It is *stiff*, moist, and has a low permeability.
- (c) Clayey silt till. The upper layers of this stratum are brown or mottled due to weathering, and their consistency is *stiff* to *very stiff*. Much of the material

near the top of the stratum is cohesionless. The colour changes to grey near El.85 and the consistency becomes *very stiff* to *hard*. The permeability of the till is very low. The proportion of granular particles ranges from 0 to about 10% and the particle size is generally less than one inch.

- (d) Clayey gravel and sand. This is the top of a dense granular deposit which has become partly intermixed with the overlying clay till. All sizes of gravel and sand are present together with an estimated 25% of clay and silt. The effect of the two latter constituents is to give the stratum some cohesion and to reduce its permeability to a large extent.
- (e) Sand. The upper 2 or 3 feet of this stratum is a fine uniform sand containing a trace of silt. With depth it becomes well graded and contains 10 to 20% of fine gravel. The deposit is *compact* to *very dense* and highly pervious.

The site lies in a shallow spillway which flanks the east side of the Seaforth Moraine - one of the system of "Horse-shoe" moraines. The till is characteristic of the flat ground moraine lying between these parallel ridges, but the origin of the underlying gravel and sand deposits is obscure. The original glacial river appears to have left little in the way of fluvial sediment, except possibly the stratified silt and clay deposit encountered at borehole 1.

IV FOUNDATIONS

The subsurface conditions are suitable for the support of spread footing foundations. It is proposed that the footings should bear at El.80.5 feet which is 5.5 feet below the stream bed and lies within the very stiff to hard till stratum. The 'N' values immediately below this elevation lie in the range 22 to 35, and on this basis a gross soil pressure of 5500 p.s.f. is recommended for the design of the footings. The required width of footing is expected to be 10 to 12 feet, and under the maximum loading it is estimated that total settlement will lie in the range 1.0 to 1.5 inches. This will be due mainly to the consolidation of the till stratum, and will take place over a period of months during and after construction. The differential settlement between the abutments is unlikely to exceed one inch.

The sides of a temporary excavation through the cohesive till stratum will stand vertically without support. The bottom of the excavation, however, must be protected from the unbalanced water pressure which will exist in the pervious sand stratum. Assuming that the natural water level is El.88 and that a dry excavation is made to El.80.5,

an unbalanced hydrostatic pressure of 180 p.s.f. will exist at the top of the sand stratum for the soil profile encountered in borehole 2. This could result in a heaving and complete disturbance of the footing grade. To prevent such an occurrence, the excavation should be carried out within a steel sheet pile enclosure. The piles should be driven to such a depth that the distance from the footing grade to the pile tip is equal to the distance from the footing grade to the prevailing water table. For the conditions encountered at the time of this investigation the piles should be driven to El.72. The calculated factors of safety against heaving and piping are respectively 1.5 and 2.0.

The coefficient of friction against horizontal sliding of the footings in the till should be taken as 0.35.

V

REFERENCES

1. The Physiography of Southern Ontario by L. J. Chapman and D. F. Putnam of the Ontario Research Foundation - University of Toronto Press 1951.
2. Procedures for Testing Soils, ASTM, April 1958. pp.186 to 198. (Unified Soil Classification System - by A. A. Wagner).
3. Proceedings of the 4th International Conference on Soil Mechanics and Foundation Engineering (Research on Determining the Density of Sands by Spoon Penetration Testing - by H. J. Gibbs and W. G. Holtz of the United States Bureau of Reclamation). London, 1957.
4. Terzaghi and Peck: Soil Mechanics in Engineering Practice. John Wiley and Sons, New York 1948.
5. M. E. Harr and R. C. Deen, "Analysis of Seepage Problems", Journal of the Soil Mechanics and Foundation Division Proc. ASCE 1961.

DOMINION SOIL INVESTIGATION LIMITED



James Park
James Park, M.Sc., P.Eng.

LIST OF SYMBOLS, ABBREVIATIONS AND NOMENCLATURE.

SOIL COMPONENTS AND GROUND WATER CONDITIONS.

| | | | | | | | | | |
|----------------------------|--------|-------------|-------------------------------|-------|--------|---------------|---------|--------------------|------------------|
| | | | | | | | | | |
| BOULDER | COBBLE | GRAVEL | SAND | SILT | CLAY | ORGANICS | BEDROCK | GROUND WATER LEVEL | DEPTH OF CAVE-IN |
| | | COARSE FINE | COARSE MEDIUM FINE | | | | | | |
| Ø > 8" | 3" | 3/4" | 4.75mm 2.0 0.42 0.074 0.002 > | | | NO SIZE LIMIT | | | |
| U.S. Standard Sieve Size : | | No.4 | No.10 | No.40 | No.200 | | | | |

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" ϕ , 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.

EXTRAPOLATED -N- VALUE

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

SYMBOL :



322

SOIL PROPERTIES.

| | | |
|-----------------------|---|--------------------------------|
| W % Water content | γ^* Natural bulk density (unit weight) | k Coeff. of permeability |
| LL % Liquid limit | e Void ratio | C Shear strength |
| PL % Plastic limit | RD Relative density | ϕ Angle of int. friction |
| PI % Plasticity index | C _v Coeff. of consolidation | C' Cohesion |
| LI Liquidity index | m _v Coeff. of volume compressibility | ϕ' Angle of int. friction |

UNDRAINED SHEAR STRENGTH.

— DERIVED FROM —

TRIAXIAL COMPRESSION TEST

UNCONFINED TEST

LABORATORY

VANE TEST

FIELD

POCKET PENETROMETER TEST

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 :

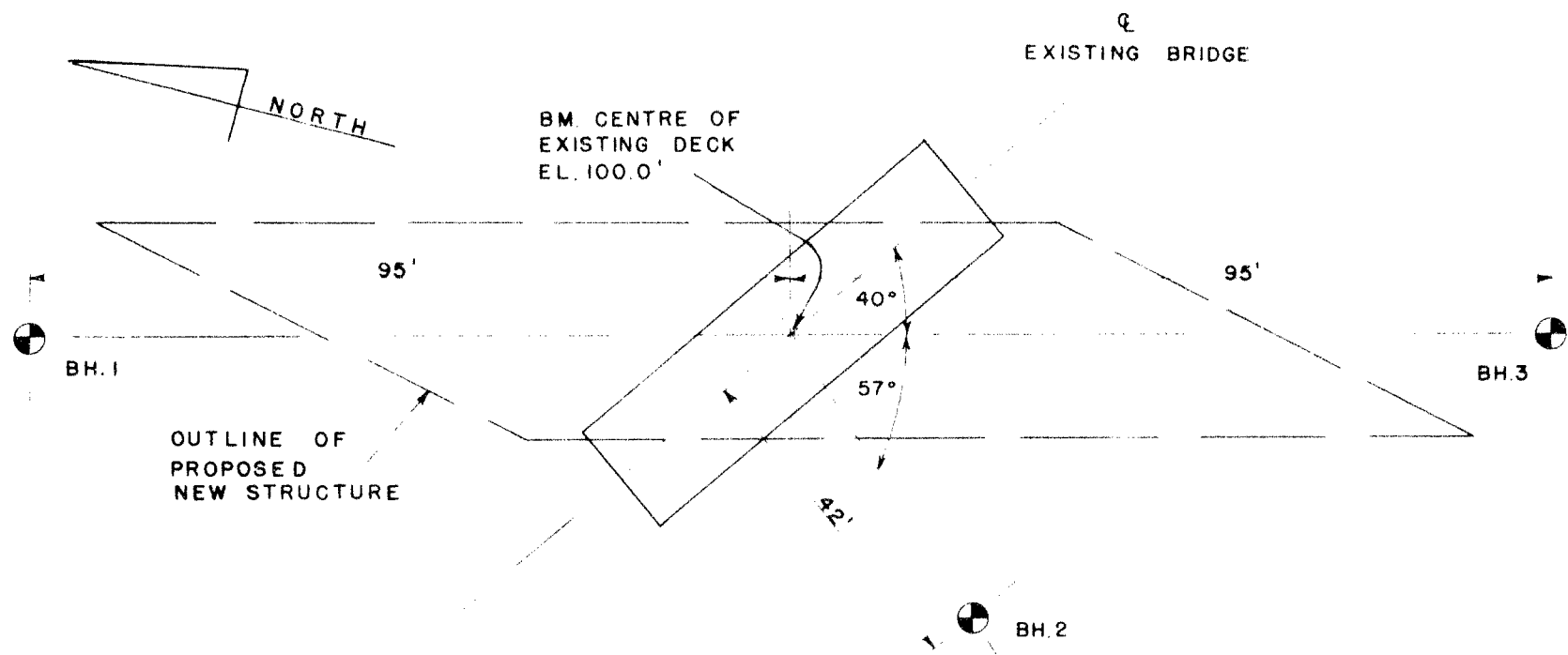
RD :

| | |
|------------|------------|
| Very loose | 0 - 15 % |
| Loose | 15 - 35 % |
| Compact | 35 - 65 % |
| Dense | 65 - 85 % |
| Very dense | 85 - 100 % |

COHESIVE SOILS :

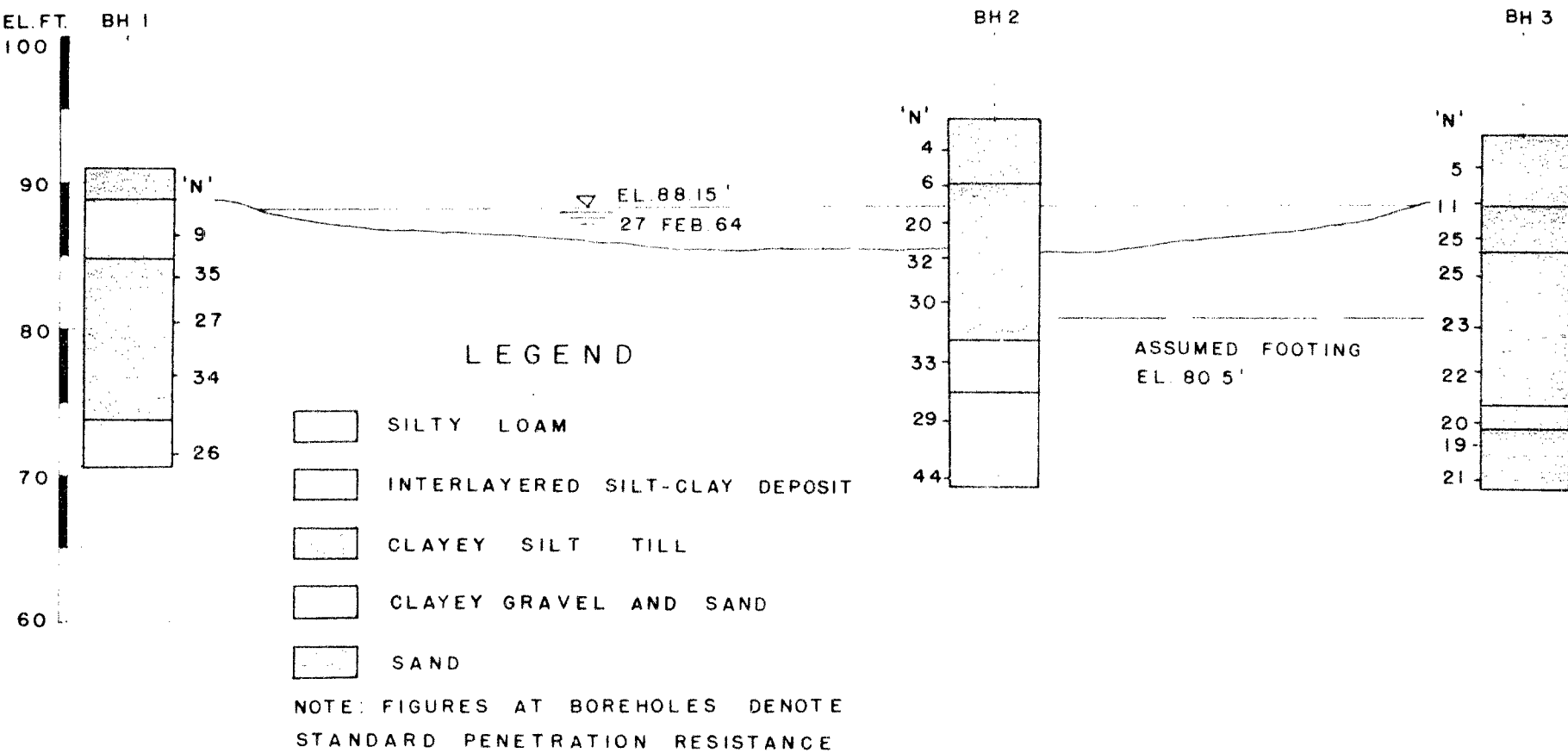
C lbs/sq.ft.

| | |
|------------|---------------|
| Very soft | less than 250 |
| Soft | 250 - 500 |
| Firm | 500 - 1000 |
| Stiff | 1000 - 2000 |
| Very stiff | 2000 - 4000 |
| Hard | over 4000 |



LOCATION OF BOREHOLES

SCALE: 1 INCH TO 20 FEET



SUBSURFACE PROFILE

SCALES: VERTICAL - 1 INCH TO 10 FEET
HORIZONTAL - 1 INCH TO 20 FEET

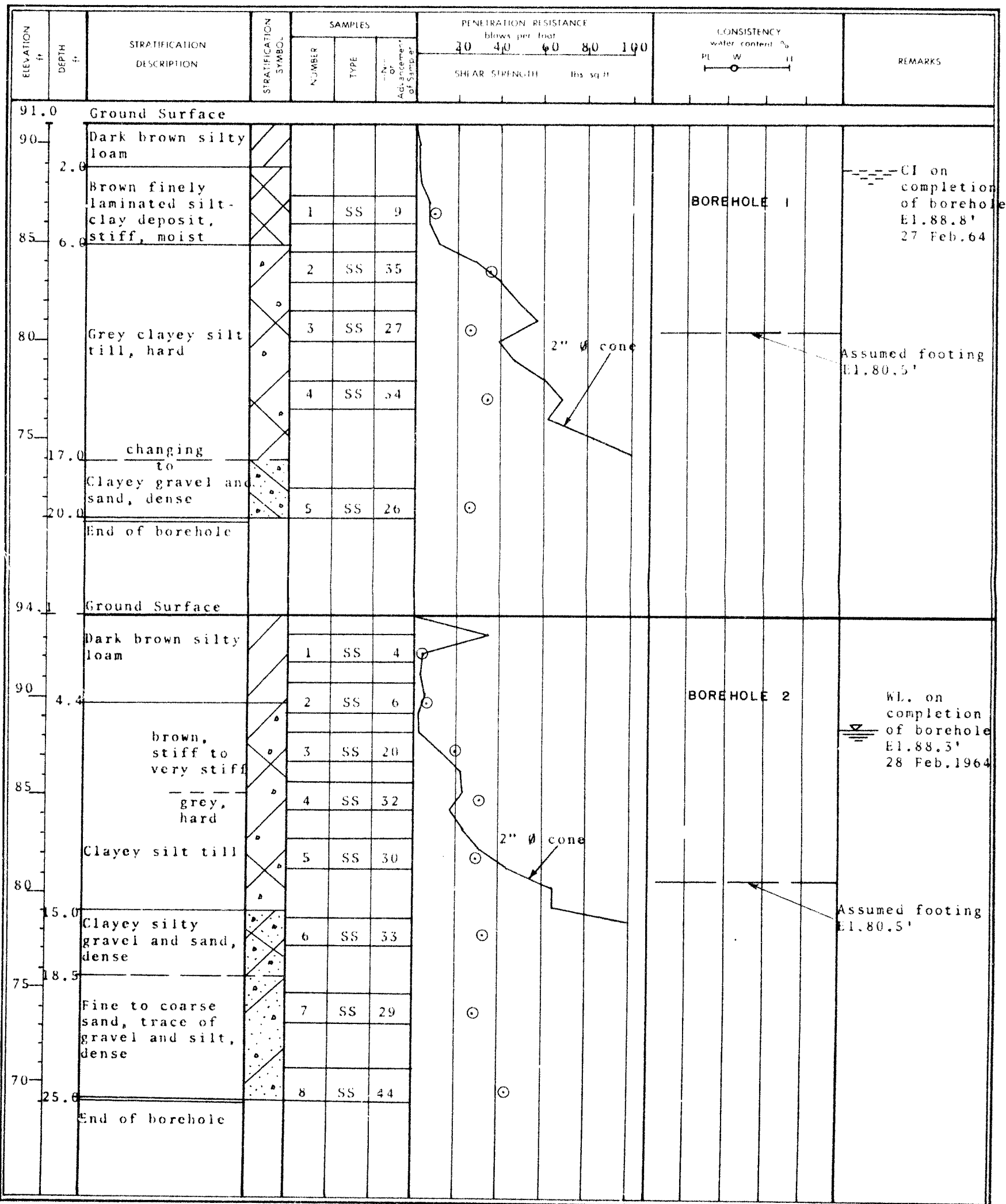
GEOTECHNICAL DATA SHEET FOR BOREHOLES 1 and 2

OUR REFERENCE NO 4-2-L10

CLIENT: County of Middlesex
PROJECT: Road Bridge
LOCATION: Biddulph Township
DATUM ELEVATION: 100.0' (centre of existing bridge deck)

METHOD OF BORING: Washboring
DIAMETER OF BOREHOLE: Bx (5-inch)
DATE: Feb. 27, 1964 (BH 1)
Feb. 28, 1964 (BH 2)

ENCLOSURE NO 3



DOMINION SOIL INVESTIGATION LIMITED

MADE: SB

CHD: JP

OUR REFERENCE NO. 4-2-L10

GEOTECHNICAL DATA SHEET FOR BOREHOLE . 3

CLIENT County of Middlesex

PROJECT: Road Bridge

LOCATION Biddulph Township

DATUM ELEVATION 100.0' (centre of existing bridge deck)

METHOD OF BORING: Washboring

DIAMETER OF BOREHOLE 8x(3-inch)

DATE Feb. 27-28, 1964

ENCLOSURE NO. 4

| ELEVATION ft. | DEPTH ft. | STRATIFICATION DESCRIPTION | STRATIFICATION SYMBOL | SAMPLES | | | PENETRATION RESISTANCE blows per foot | | CONSISTENCY water content % PI — W — LI | REMARKS |
|------------------|--------------|--|--------------------------|---------|------|-----------------------------------|--|----|---|--|
| | | | | NUMBER | TYPE | N or Advancement of Sampler | 40 | 80 | | |
| 93.0 | | Ground Surface | | | | | | | | |
| 90 | | Dark brown silty loam | | 1 | SC | 5 | | | | WL. 5 hours after completion of borehole E1.89.0' 28 Feb. 1964 Assumed footing E1.80.5' |
| 4.8 | | Brown silt till, trace of clay, dense or very stiff | | 2 | SS | 11 | | | | |
| 85 | 8.0 | | | 3 | SS | 25 | | | | |
| | | | | 4 | SS | 25 | | | | |
| 80 | | Grey clayey silt till, very stiff | | 5 | SS | 23 | | | | |
| | | | | 6 | SS | 22 | | | | |
| 75 | 18.2 | Fine to coarse gravel, trace of clay, dense | | 7 | SS | 20 | | | | |
| 20.0 | | | | 8 | SS | 19 | | | | |
| 70 | | Fine to coarse gravelly sand, compact to dense | | 9 | SS | 21 | | | | |
| 24.0 | | End of borehole | | | | | | | | |

2" Ø cone

VERTICAL SCALE: 1 IN. TO 5 FT.

DOMINION SOIL INVESTIGATION LIMITED

MADE: SB

CHD. JP

MEMORANDUM

To: Mr. A. Stermas,
Principal Foundation Engineer,
Materials & Research,
Donview,

From: K. L. Kleinstelber

Date: May 4th, 1964.

OUR FILE REF.

IN REPLY TO

SUBJECT:

County of Middlesex,
Structure Site No. 20-17
Lot 7, Con. IV/V, Biddulph Township.

We are forwarding one copy of Dominion Soils Foundation Report for your comments. We are enclosing as well one copy of the County's preliminary plan for a new single span structure.

Upon our recommendation the county are proceeding with their design for a 100 foot span centre to centre of bearings on a 60 degree skew. For Hydrology reasons we require a rectangular opening thus we suggested to the County that they consider sheet piling protection for the footings. Your comments on this latter item would also be appreciated.



K. L. KLEINSTEIBER
MUNICIPAL BRIDGE LIAISON ENGINEER.

KLK*DW.

Footings could be placed even a little higher say 4.82.0. Steel sheet piles for scour protection are O.K. Some difficulty could be encountered during sheet pile driving, therefore a higher footing elevation may be favourable

*By phone to K.L.K.
May 8th 1964*

Altkmann