

# FOUNDATION INVESTIGATION REPORT

CONTRACT NO 89-454



Ministry of  
Transportation and  
Communications

I N D E X

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NOTE: For the purposes of this contract these reports  
supersede all other reports written by or for the  
Ministry in connection with the above-noted projects.

**N VALUE:** THE STANDARD PENETRATION TEST (SPT) N VALUE IS THE NUMBER OF BLOWS REQUIRED TO CAUSE A STANDARD 51mm O.D. SPLIT BARREL SAMPLER TO PENETRATE 0.3m INTO UNDISTURBED GROUND IN A BOREHOLE WHEN DRIVEN BY A HAMMER WITH A MASS OF 63.5kg, FALLING FREELY A DISTANCE OF 0.76m FOR PENETRATIONS OF LESS THAN 0.3m N VALUES ARE INDICATED AS THE NUMBER OF BLOWS FOR THE PENETRATION ACHIEVED. AVERAGE N VALUE IS DENOTED THUS  $\bar{N}$ .

**DYNAMIC CONE PENETRATION TEST:** CONTINUOUS PENETRATION OF A CONICAL STEEL POINT (51mm O.D. 60° CONE ANGLE) DRIVEN BY 475 J IMPACT ENERGY ON 'A' SIZE DRILL RODS. THE RESISTANCE TO CONE PENETRATION IS MEASURED AS THE NUMBER OF BLOWS FOR EACH 0.3m ADVANCE OF THE CONICAL POINT INTO THE UNDISTURBED GROUND.

SOILS ARE DESCRIBED BY THEIR COMPOSITION AND CONSISTENCY OR DENSENESS.

**CONSISTENCY:** COHESIVE SOILS ARE DESCRIBED ON THE BASIS OF THEIR UNDRAINED SHEAR STRENGTH ( $c_u$ ) AS FOLLOWS:

| $c_u$ (kPa) | 0 - 12    | 12 - 25 | 25 - 50 | 50 - 100 | 100 - 200  | > 200 |
|-------------|-----------|---------|---------|----------|------------|-------|
|             | VERY SOFT | SOFT    | FIRM    | STIFF    | VERY STIFF | HARD  |

**DENSENESS:** COHESIONLESS SOILS ARE DESCRIBED ON THE BASIS OF DENSENESS AS INDICATED BY SPT N VALUES AS FOLLOWS:

| N (BLOWS/0.3m) | 0 - 5      | 5 - 10 | 10 - 30 | 30 - 50 | > 50       |
|----------------|------------|--------|---------|---------|------------|
|                | VERY LOOSE | LOOSE  | COMPACT | DENSE   | VERY DENSE |

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 OF THE CORING RUN.

**MODIFIED RECOVERY:** SUM OF THOSE INTACT CORE PIECES, 100mm+ 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  | 50mm       | 50 - 300mm | 0.3m - 1m  | 1m - 3m | > 3m       |
|----------|------------|------------|------------|---------|------------|
| JOINTING | VERY CLOSE | CLOSE      | MOD. CLOSE | WIDE    | VERY WIDE  |
| BEDDING  | VERY THIN  | THIN       | MEDIUM     | THICK   | VERY THICK |

## ABBREVIATIONS AND SYMBOLS

### FIELD SAMPLING

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

### STRESS AND STRAIN

|                                      |     |                               |
|--------------------------------------|-----|-------------------------------|
| $u_w$                                | kPa | PORE WATER PRESSURE           |
| $r_u$                                | 1   | PORE PRESSURE RATIO           |
| $\sigma$                             | kPa | TOTAL NORMAL STRESS           |
| $\sigma'$                            | kPa | EFFECTIVE NORMAL STRESS       |
| $\tau$                               | kPa | SHEAR STRESS                  |
| $\sigma_1, \sigma_2, \sigma_3$       | kPa | PRINCIPAL STRESSES            |
| $\epsilon$                           | %   | LINEAR STRAIN                 |
| $\epsilon_1, \epsilon_2, \epsilon_3$ | %   | PRINCIPAL STRAINS             |
| E                                    | kPa | MODULUS OF LINEAR DEFORMATION |
| G                                    | kPa | MODULUS OF SHEAR DEFORMATION  |
| $\mu$                                | 1   | COEFFICIENT OF FRICTION       |

### MECHANICAL PROPERTIES OF SOIL

|                |                   |                                      |
|----------------|-------------------|--------------------------------------|
| $m_v$          | kPa <sup>-1</sup> | COEFFICIENT OF VOLUME CHANGE         |
| $C_c$          | 1                 | COMPRESSION INDEX                    |
| $C_s$          | 1                 | SWELLING INDEX                       |
| $C_\alpha$     | 1                 | RATE OF SECONDARY CONSOLIDATION      |
| $c_v$          | m <sup>2</sup> /s | COEFFICIENT OF CONSOLIDATION         |
| H              | m                 | DRAINAGE PATH                        |
| $T_v$          | 1                 | TIME FACTOR                          |
| U              | %                 | DEGREE OF CONSOLIDATION              |
| $\sigma'_{v0}$ | kPa               | EFFECTIVE OVERBURDEN PRESSURE        |
| $\sigma'_p$    | kPa               | PRECONSOLIDATION PRESSURE            |
| $\tau_f$       | kPa               | SHEAR STRENGTH                       |
| $c'$           | kPa               | EFFECTIVE COHESION INTERCEPT         |
| $\phi'$        | -°                | EFFECTIVE ANGLE OF INTERNAL FRICTION |
| $c_u$          | kPa               | APPARENT COHESION INTERCEPT          |
| $\phi_u$       | -°                | APPARENT ANGLE OF INTERNAL FRICTION  |
| $\tau_R$       | kPa               | RESIDUAL SHEAR STRENGTH              |
| $\tau_r$       | kPa               | REMOULDED SHEAR STRENGTH             |
| $S_f$          | 1                 | SENSITIVITY = $\frac{c_u}{\tau_r}$   |

### PHYSICAL PROPERTIES OF SOIL

|                |                   |                                |           |      |   |           |                   |   |
|----------------|-------------------|--------------------------------|-----------|------|---|-----------|-------------------|---|
| $\rho_s$       | kg/m <sup>3</sup> | DENSITY OF SOLID PARTICLES     | e         | 1, % | VOID RATIO                                | $e_{min}$ | 1, %              | VOID RATIO IN DENSEST STATE                             |
| $\gamma_s$     | kn/m <sup>3</sup> | UNIT WEIGHT OF SOLID PARTICLES | n         | 1, % | POROSITY                                  | $I_D$     | 1                 | DENSITY INDEX = $\frac{e_{max} - e}{e_{max} - e_{min}}$ |
| $\rho_w$       | kg/m <sup>3</sup> | DENSITY OF WATER               | w         | 1, % | WATER CONTENT                             | D         | mm                | GRAIN DIAMETER  |
| $\gamma_w$     | kn/m <sup>3</sup> | UNIT WEIGHT OF WATER           | $S_r$     | %    | DEGREE OF SATURATION                      | $D_n$     | mm                | n PERCENT - DIAMETER                                    |
| $\rho$         | kg/m <sup>3</sup> | DENSITY OF SOIL                | $w_L$     | %    | LIQUID LIMIT                              | $C_u$     | 1                 | UNIFORMITY COEFFICIENT                                  |
| $\gamma$       | kn/m <sup>3</sup> | UNIT WEIGHT OF SOIL            | $w_p$     | %    | PLASTIC LIMIT                             | h         | m                 | HYDRAULIC HEAD OR POTENTIAL                             |
| $\rho_d$       | kg/m <sup>3</sup> | DENSITY OF DRY SOIL            | $w_s$     | %    | SHRINKAGE LIMIT                           | q         | m <sup>3</sup> /s | RATE OF DISCHARGE                                       |
| $\gamma_d$     | kn/m <sup>3</sup> | UNIT WEIGHT OF DRY SOIL        | $I_p$     | %    | PLASTICITY INDEX = $w_L - w_p$            | v         | m/s               | DISCHARGE VELOCITY                                      |
| $\rho_{sat}$   | kg/m <sup>3</sup> | DENSITY OF SATURATED SOIL      | $I_L$     | 1    | LIQUIDITY INDEX = $\frac{w - w_p}{I_p}$   | i         | 1                 | HYDRAULIC GRADIENT                                      |
| $\gamma_{sat}$ | kn/m <sup>3</sup> | UNIT WEIGHT OF SATURATED SOIL  | $I_C$     | 1    | CONSISTENCY INDEX = $\frac{w_L - w}{I_p}$ | k         | m/s               | HYDRAULIC CONDUCTIVITY                                  |
| $\rho'$        | kg/m <sup>3</sup> | DENSITY OF SUBMERGED SOIL      | $e_{max}$ | 1, % | VOID RATIO IN LOOSEST STATE               | j         | kn/m <sup>3</sup> | SEEPAGE FORCE   |
| $\gamma'$      | kn/m <sup>3</sup> | UNIT WEIGHT OF SUBMERGED SOIL  |           |      |   |           |                   |   |

FOUNDATION INVESTIGATION REPORT  
For  
Geraldton Patrol Yard Garage Extension  
(Hwy. 11)  
W.P. 2705-85-02  
District 19, Thunder Bay

3

INTRODUCTION

This report summarizes the information obtained from a foundation investigation carried out for the proposed extension of the existing Geraldton Patrol Yard garage on Hwy. 11. The fieldwork was carried out on 86 04 22 and consisted of 3 sampled boreholes advanced by means of hollow stem continuous flight augers to depths of 3.4, 3.5 and 4.9 m below the existing ground surface. A dynamic cone penetration test accompanied each of the boreholes.

SITE DESCRIPTION

The site is located on Hwy. 11 approximately 1.5 km east of Hwy. 584, in the Township of Ashmore, District of Thunder Bay.

Physiographically, the site lies within a glaciofluvial deposit which is characterized by an undulating to rolling topography. However, the topography at this specific site is relatively level.

The land surrounding the site is generally not used and is wooded.

SUBSURFACE CONDITIONS

General

Various soil types were encountered at this site. The Record of Borehole Sheets (BH 1-3) in the Appendix illustrate the boundaries between the soil types, in-situ and laboratory test results, and groundwater conditions. The location of the boreholes are shown in plan on Dwg. 1 in the Appendix.

At the time of the investigation (86 04) frost was encountered down to an elevation of approximately 331 ±, corresponding to a depth of about 1.5 m below the existing ground surface. Within this zone the effects of frost were evident in the form of ice lenses. It is expected that in this area frost can penetrate to a depth of about 2.6 m.

The soils encountered at this site are described as follows:

### Fill

Fill material was encountered in BH 1 and 2. This material was found to extend down to a depth of 1.4 and 1.7 m below the existing ground surface in BH 1 and 2 respectively.

A grain size distribution test was carried out on one sample of this material (BH 2, Sample #1). The results of this single test are shown on Figure 1 in the Appendix, and are summarized as follows: 27% gravel, 59% sand, 12% silt, 2% clay. Generally, the fill can be described as sand, some gravel, silt. However, it should be noted that within the generally non-cohesive fill, occasional pockets of silty clay were encountered, as were occasional boulders.

It is difficult to estimate the denseness of this material since the ground was frozen down to a depth of about 1.5 m at the time of the investigation (86 04). As a result of the frost penetration, Standard Penetration Test 'N' values within the upper 1.5 m do not accurately represent the actual conditions. Lenses and pockets of ice were encountered in the upper frost-affected zone. It should be noted that "boiling" will be experienced when this non-cohesive material is subjected to an unbalanced hydrostatic pressure.

### Organics

A 0.4 m thick seam of organic deposit was encountered in BH #2 under the fill material. The organic seam consists primarily of peat with pieces of decayed

wood and leaves. This most likely represents the original ground surface prior to the placement of the fill previously described.

Ice lenses were encountered within this material.

### Silty Clay

Silty clay was encountered in BH 1 and 3. In BH 1, this material was found immediately below the fill material previously described, and has a thickness of approximately 1.2 m. In BH 3, this cohesive material was found to extend from the ground surface down to a depth of 2.1 m.

Figure 2 in the Appendix shows the results of Atterberg Limits tests carried out on 4 samples of this material. The results can be summarized as follows:

|                                    | <u>Range (%)</u> |
|------------------------------------|------------------|
| Moisture Content (W)               | 17.5 - 41.5      |
| Plastic Limit (W <sub>p</sub> )    | 16.5 - 20        |
| Liquid Limit (W <sub>L</sub> )     | 25 - 28.5        |
| Plasticity Index (I <sub>p</sub> ) | 5 - 12           |

These results, as plotted on Figure 2, indicate that the matrix of this material consists of a silt of slight plasticity to a silty clay of low plasticity (ML-CL).

Moisture content as high as 41.5% was measured in samples of this material. However, it is believed that such high values are not representative of the material. These unrealistically high contents can be attributed to the presence of ice lenses in the upper zone of this cohesive deposit.

The results of a grain size distribution test carried out on one sample of this cohesive material is shown on Figure 1. Typically, however, this deposit may contain up to 10% sand and 5% gravel sized particles.

In BH 3, unrealistic high 'N' values were obtained through the upper zone of this material. The high 'N' values resulted from the effects of frost penetration. Ice lenses and pockets were encountered throughout this material in BH 3.

Generally, the consistency of this material can be considered to be stiff to very stiff.

### Silt

A 1.7 m  $\pm$  thick seam of silt, trace clay was encountered in BH 3 immediately below the silty clay deposit. Based on the interpretation of Standard Penetration Test 'N' values of 19 and 22 blows/0.3 m, this non-cohesive material is considered to be in a compact state.

The results of a grain size distribution test carried out on one sample of this material is shown on Figure 1 in the Appendix. The results indicate that the sample tested consisted of 0% gravel, 1% sand, 96% silt, and 3% clay sized particles.

It should be noted that when this non-cohesive material is subjected to an unbalanced hydrostatic pressure, "boiling" will result.

### Sand

A deposit of sand was encountered in all 3 boreholes at a depth ranging between 2.1 and 3.8 m below the ground surface. The full vertical extent of this non-cohesive deposit was not explored.

Based on the interpretation of Standard Penetration Test 'N' values generally over 30 blows/0.3 m, this material is considered to be in a dense state.

Figure 3 in the Appendix shows the result of grain size distribution tests carried out on 3 samples of this material. It should be noted that boulders may be occasionally encountered within this deposit.

When this non-cohesive material is subjected to an unbalanced hydrostatic pressure, "boiling" will be experienced.

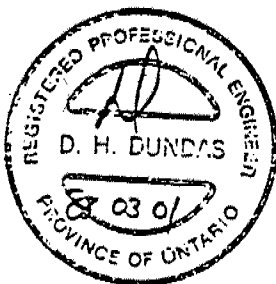
#### Groundwater Conditions

The groundwater level was measured in the open boreholes 2 hours after they were opened. The groundwater level was found between Elev. 231.4 and 231.8. Seasonal variations may be anticipated.

#### MISCELLANEOUS

The fieldwork for this investigation was carried out on 86 04 22 under the supervision of L. Politano, Project Foundations Engineer. The equipment used was owned and operated by Dominion Soil Investigation Inc. of Thunder Bay.

This report was prepared by L. Politano and was reviewed by M. Devata, Chief Foundations Engineer (East).



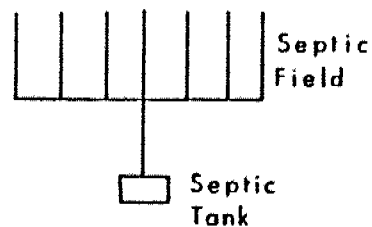
*D. H. Dundas*

D. H. Dundas, P. Eng.

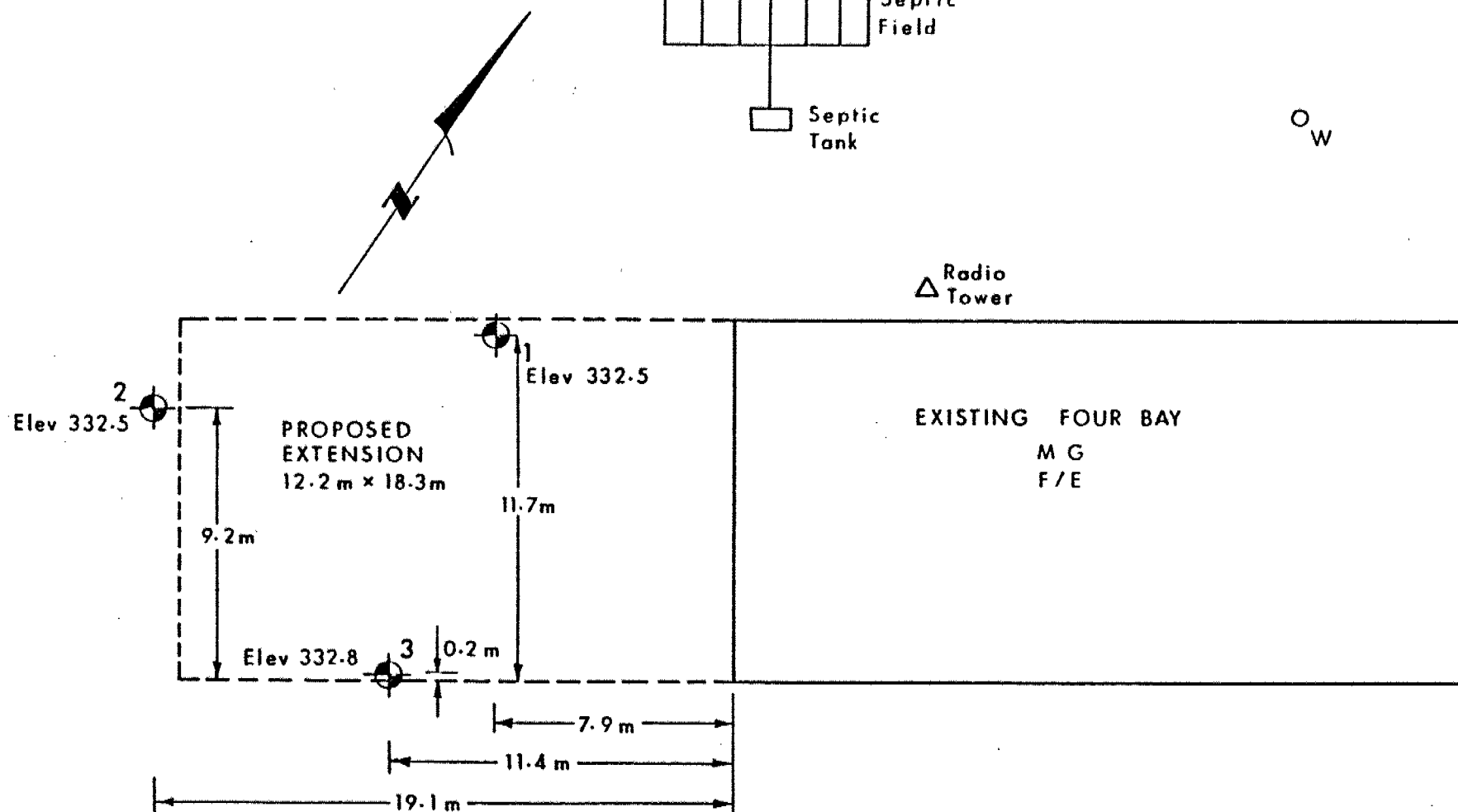
Sr. Foundations Engineer



**APPENDIX**



OW



Geocres No 42E-2

# GERALDTON PATROL YARD EXTENSION

(1.5 km East of Hwy 584 on Hwy 11)

DIST 19 ; TWP OF ASHMORE ; DIST OF THUNDER BAY

Date 1986 05 28

WP 2705-85-02

Dwg No 1



# RECORD OF BOREHOLE No 1

METRIC

W P 2705-85-02 LOCATION REFER TO DRAWING #1 ORIGINATED BY LP  
 DIST 19 HWY 11 BOREHOLE TYPE Hollow Stem Auger & Cone Test COMPILED BY LP  
 DATUM Geodetic DATE 86 04 22 CHECKED BY [Signature]

| SOIL PROFILE  |   |            | SAMPLES |      |            | GROUND WATER<br>CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION<br>RESISTANCE PLOT |                | PLASTIC<br>LIMIT<br>W <sub>p</sub> | NATURAL<br>MOISTURE<br>CONTENT<br>W | LIQUID<br>LIMIT<br>W <sub>L</sub> | UNIT<br>WEIGHT<br>γ | REMARKS<br>&<br>GRAIN SIZE<br>DISTRIBUTION<br>(%)<br>GR SA SI CL |
|---------------|---|------------|---------|------|------------|----------------------------|-----------------|---|----------------|------------------------------------|-------------------------------------|-----------------------------------|---------------------|--|
| ELEV<br>DEPTH | DESCRIPTION   | STRAT PLOT | NUMBER  | TYPE | 'N' VALUES |                            |                 | 20 40 60 80 100                             | SHEAR STRENGTH |                                    |                                     |                                   |                     |  |
| 332.5         | Ground Surface  |            |         |      |            |                            |                 |   |                |                                    |                                     |                                   |                     |  |
| 0.0           | Sand, Some Gravel,<br>Silt, Trace Clay<br>with Pockets of Silty<br>Clay<br>(Fill) |            |         |      |            |                            |                 |   |                |                                    |                                     |                                   |                     |  |
| 331.1         |   |            | 1       | SS   | 15         | **                         |                 |   |                |                                    |                                     |                                   |                     |  |
| 1.4           | Silty Clay, some Sand,<br>Gravel<br>Very Stiff                                    |            | 2       | SS   | 23         |                            |                 |   |                |                                    |                                     |                                   |                     |  |
| 329.9         |   |            | 3       | SS   | 20         |                            |                 |   |                |                                    |                                     |                                   |                     |  |
| 2.6           | Sand, Some Gravel<br>Dense  |            | 4       | SS   | 55/        | *                          |                 |   |                |                                    |                                     |                                   |                     |  |
| 329.1         |   |            |         |      |            |                            |                 |   |                |                                    |                                     |                                   |                     |  |
| 3.4           | End of Borehole   |            |         |      |            |                            |                 |   |                |                                    |                                     |                                   |                     |  |

\* Spoon Bouncing  
 \*\* 'N' value may not be representative due to frost

# RECORD OF BOREHOLE No 2

METRIC

W P 2705-85-02 LOCATION REFER TO DRAWING #1 ORIGINATED BY LP  
DIST 19 HWY 11 BOREHOLE TYPE Hollow Stem Auger & Cone Test COMPILED BY LP  
DATUM Geodetic DATE 86 04 22 CHECKED BY SP

[illegible]

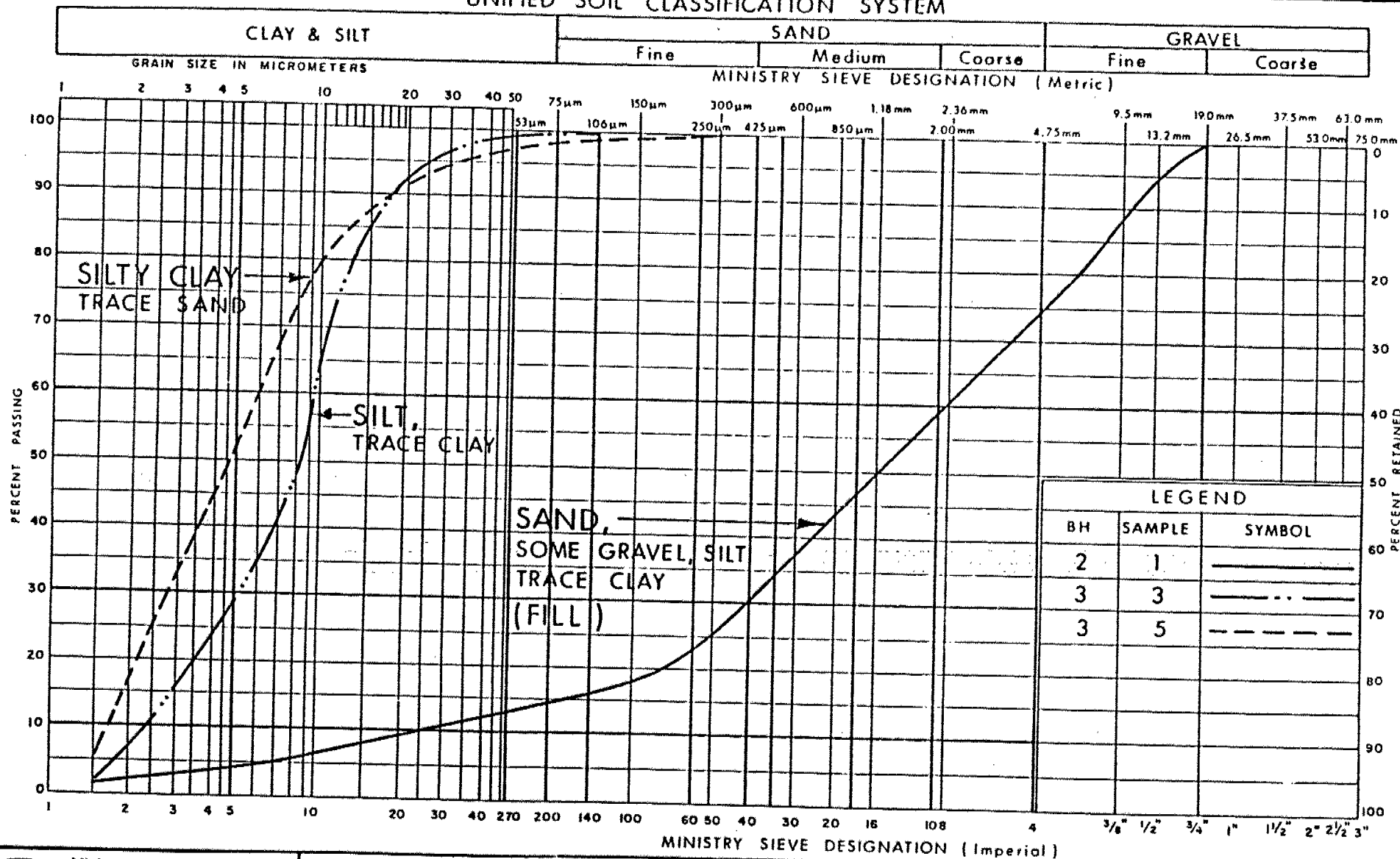
## RECORD OF BOREHOLE No 3

METRIC

W.P. 2705-85-02 LOCATION REFER TO DRAWING #1 ORIGINATED BY LP  
DIST 19 HWY 11 BOREHOLE TYPE Hollow Stem Auger & Cone Test COMPILED BY LP  
DATUM Geodetic DATE 86 04 22 CHECKED BY GP

| SOIL PROFILE                                     |                             |            | SAMPLES |      |            | GROUND WATER<br>CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION<br>RESISTANCE PLOT                                | PLASTIC<br>LIMIT | NATURAL<br>MOISTURE<br>CONTENT | LIQUID<br>LIMIT | UNIT<br>WEIGHT<br>$\gamma$ | REMARKS<br>&<br>GRAIN SIZE<br>DISTRIBUTION<br>(%)<br>GR SA SI CL |
|--|-----------------------------|------------|---------|------|------------|----------------------------|-----------------|--|------------------|--------------------------------|-----------------|----------------------------|--|
| ELEV<br>DEPTH                                    | DESCRIPTION                 | STRAT PLOT | NUMBER  | TYPE | 'N' VALUES |                            |                 | 20 40 60 80 100  | W <sub>p</sub>   | W                              | W <sub>L</sub>  |                            |  |
|  |                             |            |         |      |            |                            |                 | SHEAR STRENGTH<br>○ UNCONFINED + FIELD VANE<br>● QUICK TRIAXIAL x LAB VANE |                  |                                |                 |                            |  |
| 332.8  | Ground Surface              |            |         |      |            |                            |                 |  |                  |                                |                 |                            |  |
| 0.0  | Sand and Gravel             |            |         |      |            |                            |                 |  |                  |                                |                 |                            |  |
|  | Silty Clay, Trace Sand      |            | 1       | SS   | 56         | *                          |                 |  |                  |                                |                 |                            |  |
|  |                             |            | 2       | SS   | 20         | *                          |                 |  |                  |                                |                 |                            |  |
| 330.7  |                             |            |         |      |            |                            |                 |  |                  |                                |                 |                            |  |
| 2.1  | Silt, Trace Clay            |            | 3       | SS   | 19         |                            |                 |  |                  |                                |                 |                            |  |
|  | Compact                     |            | 4       | SS   | 22         |                            |                 |  |                  |                                |                 |                            |  |
|  | Silty Clay                  |            | 5       | SS   | 20         |                            |                 |  |                  |                                |                 |                            |  |
| 329.0  |                             |            | 6       | SS   | 36         |                            |                 |  |                  |                                |                 |                            |  |
| 3.8  | Sand with Gravel, Silt Clay |            |         |      |            |                            |                 |  |                  |                                |                 |                            |  |
|  | Dense                       |            |         |      |            |                            |                 |  |                  |                                |                 |                            |  |
| 327.9  |                             |            |         |      |            |                            |                 |  |                  |                                |                 |                            |  |
| 4.9  | End of Borehole             |            |         |      |            |                            |                 |  |                  |                                |                 |                            |  |
| * 'N' values are not representative due to frost |                             |            |         |      |            |                            |                 |  |                  |                                |                 |                            |  |

## UNIFIED SOIL CLASSIFICATION SYSTEM

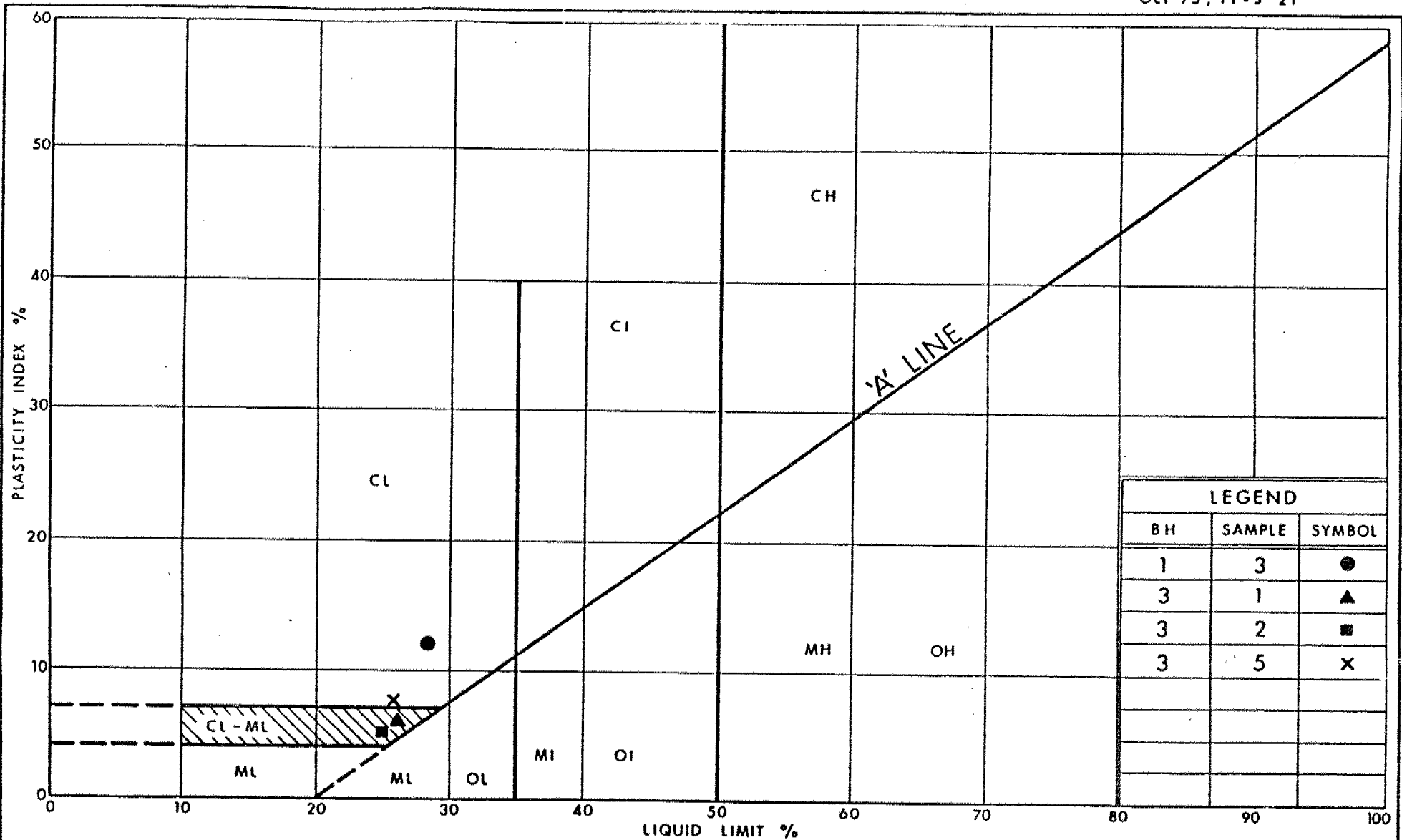


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## GRAIN SIZE DISTRIBUTION

FIG No 1

W P 2705 - 85 - 02



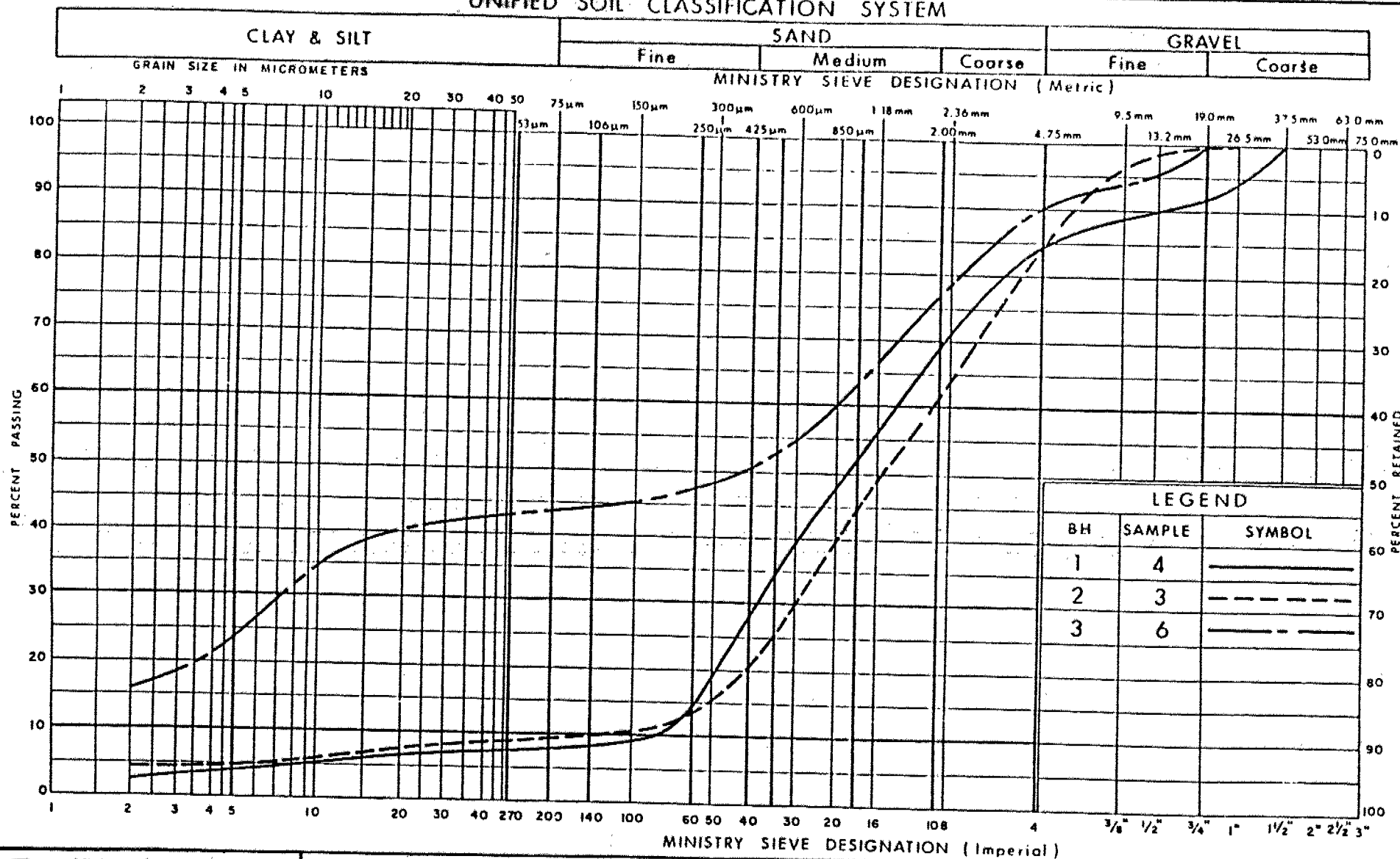
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PLASTICITY CHART  
SILTY CLAY, TRACE SAND

FIG No 2

W P 2705-85-02

## UNIFIED SOIL CLASSIFICATION SYSTEM



GRAIN SIZE DISTRIBUTION  
SAND, SOME TO WITH GRAVEL

FIG No 3

W P 2705-85-02



Ontario

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Communications



ENGINEERING MATERIALS OFFICE  
FOUNDATION DESIGN SECTION

WP 2705-85-02

DIST 19

HWY 11

STR SITE

Geraldton Patrol Yard Garage Extension

DISTRIBUTION

O. Ramakko (3)

J.B. MacMaster

R. Girard

C.E. Pritchard

K. Bassi

J.H. Peer

T. Yakutchuk

D.E. Moorhouse(Cover Only)

M. Maclean (Cover Only)

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FOUNDATION INVESTIGATION REPORT  
For  
Geraldton Patrol Yard Garage Extension  
(Hwy. 11)  
W.P. 2705-85-02  
District 19, Thunder Bay

INTRODUCTION

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SITE DESCRIPTION

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Physiographically, the site lies within a glaciofluvial deposit which is characterized by an undulating to rolling topography. However, the topography at this specific site is relatively level.

The land surrounding the site is generally not used and is wooded.

SUBSURFACE CONDITIONS

General

Various soil types were encountered at this site. The Record of Borehole Sheets (BH 1-3) in the Appendix illustrate the boundaries between the soil types, in-situ and laboratory test results, and groundwater conditions. The location of the boreholes are shown in plan on Dwg. 1 in the Appendix.

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Fill material was encountered in BH 1 and 2. This material was found to extend down to a depth of 1.4 and 1.7 m below the existing ground surface in BH 1 and 2 respectively.

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### Organics

A 0.4 m thick seam of organic deposit was encountered in BH #2 under the fill material. The organic seam consists primarily of peat with pieces of decayed

wood and leaves. This most likely represents the original ground surface prior to the placement of the fill previously described.

Ice lenses were encountered within this material.

### Silty Clay

Silty clay was encountered in BH 1 and 3. In BH 1, this material was found immediately below the fill material previously described, and has a thickness of approximately 1.2 m. In BH 3, this cohesive material was found to extend from the ground surface down to a depth of 2.1 m.

Figure 2 in the Appendix shows the results of Atterberg Limits tests carried out on 4 samples of this material. The results can be summarized as follows:

|                                    | <u>Range (%)</u> |
|------------------------------------|------------------|
| Moisture Content (W)               | 17.5 - 41.5      |
| Plastic Limit (W <sub>p</sub> )    | 16.5 - 20        |
| Liquid Limit (W <sub>L</sub> )     | 25 - 28.5        |
| Plasticity Index (I <sub>p</sub> ) | 5 - 12           |

These results, as plotted on Figure 2, indicate that the matrix of this material consists of a silt of slight plasticity to a silty clay of low plasticity (ML-CL).

Moisture content as high as 41.5% was measured in samples of this material. However, it is believed that such high values are not representative of the material. These unrealistically high contents can be attributed to the presence of ice lenses in the upper zone of this cohesive deposit.

The results of a grain size distribution test carried out on one sample of this cohesive material is shown on Figure 1. Typically, however, this deposit may contain up to 10% sand and 5% gravel sized particles.

In BH 3, unrealistic high 'N' values were obtained through the upper zone of this material. The high 'N' values resulted from the effects of frost penetration. Ice lenses and pockets were encountered throughout this material in BH 3.

Generally, the consistency of this material can be considered to be stiff to very stiff.

### Silt

A 1.7 m  $\pm$  thick seam of silt, trace clay was encountered in BH 3 immediately below the silty clay deposit. Based on the interpretation of Standard Penetration Test 'N' values of 19 and 22 blows/0.3 m, this non-cohesive material is considered to be in a compact state.

The results of a grain size distribution test carried out on one sample of this material is shown on Figure 1 in the Appendix. The results indicate that the sample tested consisted of 0% gravel, 1% sand, 96% silt, and 3% clay sized particles.

It should be noted that when this non-cohesive material is subjected to an unbalanced hydrostatic pressure, "boiling" will result.

### Sand

A deposit of sand was encountered in all 3 boreholes at a depth ranging between 2.1 and 3.8 m below the ground surface. The full vertical extent of this non-cohesive deposit was not explored.

Based on the interpretation of Standard Penetration Test 'N' values generally over 30 blows/0.3 m, this material is considered to be in a dense state.

Figure 3 in the Appendix shows the result of grain size distribution tests carried out on 3 samples of this material. It should be noted that boulders may be occasionally encountered within this deposit.

When this non-cohesive material is subjected to an unbalanced hydrostatic pressure, "boiling" will be experienced.

#### Groundwater Conditions

The groundwater level was measured in the open boreholes 2 hours after they were opened. The groundwater level was found between Elev. 231.4 and 231.8. Seasonal variations may be anticipated.

## DISCUSSION AND RECOMMENDATIONS

It is proposed to extend the existing MTC Geraldton Patrol Yard garage by approximately 18.3 m on the west side. A layout of the existing and proposed areas is shown on Dwg. 1 in the Appendix. The existing 4-bay garage is approximately 24 m long and 12.2 m wide, and is constructed as a rigid steel frame structure. The extension is proposed to be 18.3 long and 12.2 m wide. No additional details are available at this time with regards to the construction of the extension.

Our recommendations for the design and construction of the garage extension are as follows:

### Spread Footings

The garage extension can be founded on strip footings constructed below the frost penetration zone. In this area of the province it can be assumed that frost penetrates to a depth of 2.1 m below the ground surface. It is recommended that the footings be founded on undisturbed soil at or below Elev. 230.5. At or below this elevation the following design loads can be used:

100 kPa at the Serviceability Limit State (SLS Type II)

350 kPa at the Ultimate Limit State (ULS)

If any localized organic, loose, or soft material is encountered at this elevation, it should be completely removed and replaced with well-compacted granular material prior to constructing the footing.

As indicated on the Record of Borehole sheets, the groundwater level across this site was found to be between Elev. 231.4 and 231.8 at the time of the investigation. The material at the founding elevation previously described can be considered to consist of non-cohesive (granular) soil which will boil when subjected to an unbalanced hydrostatic pressure. The effects of the boiling will drastically reduce the bearing capacity at the founding level.

It is therefore required that the area where the footings will be constructed are dewatered prior to carrying out the excavation. The groundwater level should be depressed to a minimum of 0.6 m below the founding elevation. This can be accomplished by various methods. The recommended method involves the use of a vacuum well point system. Alternatively, oversized excavations provided with perimeter ditches could be utilized.

Regardless of the method used, the Contractor should be responsible for ensuring that the founding level is not disturbed as a result of unbalanced hydrostatic pressures or any other causes. Similarly, the Contractor should be responsible for selecting a dewatering method which will accomplish the objectives.

It should be noted that when the water table is depressed some settlement of the west end of the existing garage may occur. It is difficult to predict the amount of any settlement which may result. It is suggested that the existing building be monitored using survey methods during construction to note any vertical movement.

One method of minimizing potential settlement of the existing building is to construct the footings and foundation walls in sections. By using this approach, a smaller area will require dewatering at any particular time, and for a shorter period of time, therefore reducing the lateral effects of the hydraulic drawdown.

### Caissons

In view of the dewatering which is required for the construction of spread footings, the use of caissons could be considered as an alternative.

600 mm diameter reinforced concrete caissons could be constructed at a tip elevation of Elev. 329.5. Such a caisson would be capable of resisting 150 kN at the S.L.S. Type II, and 200 kN at the U.L.S.



However, if caissons are implemented in the design, it will be necessary to carry out their construction by using liners. The hydrostatic pressure in the liner would have to be balanced by keeping it filled with water up to the prevailing groundwater level at all times. Once the liner is advanced to the required tip elevation and is free of soil, the reinforcing steel "cage" could be lowered in the liner. Concrete could then be placed by using tremie methods. The steel liner could remain in place for additional lateral rigidity.

If this scheme is adopted a beam would be required to span the caissons. The garage walls could then be constructed on the beam.

#### OTHER RECOMMENDATIONS

The proposed foundations and walls should not be rigidly connected to the existing structure since some minor post-construction settlement of the proposed garage extension can be anticipated.

The concrete floor slab should be constructed on 200 mm of well-compacted granular material. The Ontario Building Code Act states that this material shall consist of coarse clear granular material containing not more than 15% by weight of material passing the No. 10 sieve. MTC HL-8 aggregate meets these requirements.

Well-compacted granular material should be used as backfill to the excavations.

#### MISCELLANEOUS

The fieldwork for this investigation was carried out on 86 04 22 under the supervision of L. Politano, Project Foundations Engineer. The equipment used was owned and operated by Dominion Soil Investigation Inc. of Thunder Bay.

This report was prepared by L. Politano and was reviewed by M. Devata, Chief Foundations Engineer.



L. Politano, P.Eng.  
Project Foundations Engineer

M. Devata, P.Eng.  
Chief Foundations Engineer  
(East)

June 1986

## APPENDIX

## EXPLANATION OF TERMS USED IN REPORT

**N VALUE:** THE STANDARD PENETRATION TEST (SPT) N VALUE IS THE NUMBER OF BLOWS REQUIRED TO CAUSE A STANDARD 51mm O.D. SPLIT BARREL SAMPLER TO PENETRATE 0.3m INTO UNDISTURBED GROUND IN A BOREHOLE WHEN DRIVEN BY A HAMMER WITH A MASS OF 63.5kg, FALLING FREELY A DISTANCE OF 0.76m. FOR PENETRATIONS OF LESS THAN 0.3m N VALUES ARE INDICATED AS THE NUMBER OF BLOWS FOR THE PENETRATION ACHIEVED. AVERAGE N VALUE IS DENOTED THUS  $\bar{N}$ .

**DYNAMIC CONE PENETRATION TEST:** CONTINUOUS PENETRATION OF A CONICAL STEEL POINT (51mm O.D. 60° CONE ANGLE) DRIVEN BY 475 J IMPACT ENERGY ON 'A' SIZE DRILL RODS. THE RESISTANCE TO CONE PENETRATION IS MEASURED AS THE NUMBER OF BLOWS FOR EACH 0.3m ADVANCE OF THE CONICAL POINT INTO THE UNDISTURBED GROUND.

SOILS ARE DESCRIBED BY THEIR COMPOSITION AND CONSISTENCY OR DENSENESS.

**CONSISTENCY:** COHESIVE SOILS ARE DESCRIBED ON THE BASIS OF THEIR UNDRAINED SHEAR STRENGTH ( $c_u$ ) AS FOLLOWS:

| $c_u$ (kPa) | 0 - 12    | 12 - 25 | 25 - 50 | 50 - 100 | 100 - 200  | > 200 |
|-------------|-----------|---------|---------|----------|------------|-------|
|             | VERY SOFT | SOFT    | FIRM    | STIFF    | VERY STIFF | HARD  |

**DENSENESS:** COHESIONLESS SOILS ARE DESCRIBED ON THE BASIS OF DENSENESS AS INDICATED BY SPT N VALUES AS FOLLOWS:

| N (BLOWS/0.3m) | 0 - 5      | 5 - 10 | 10 - 30 | 30 - 50 | > 50       |
|----------------|------------|--------|---------|---------|------------|
|                | VERY LOOSE | LOOSE  | COMPACT | DENSE   | VERY DENSE |

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 OF THE CORING RUN.

**MODIFIED RECOVERY:** SUM OF THOSE INTACT CORE PIECES, 100mm+ IN LENGTH EXPRESSED AS A PERCENT OF THE LENGTH OF THE CORING RUN. THE ROCK QUALITY DESIGNATION (R Q D), 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  | 50mm       | 50 - 300mm | 0.3m - 1m  | 1m - 3m | > 3m       |
|----------|------------|------------|------------|---------|------------|
| JOINTING | VERY CLOSE | CLOSE      | MOD. CLOSE | WIDE    | VERY WIDE  |
| BEDDING  | VERY THIN  | THIN       | MEDIUM     | THICK   | VERY THICK |

## ABBREVIATIONS AND SYMBOLS

### FIELD SAMPLING

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

### STRESS AND STRAIN

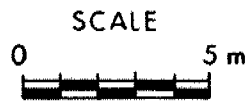
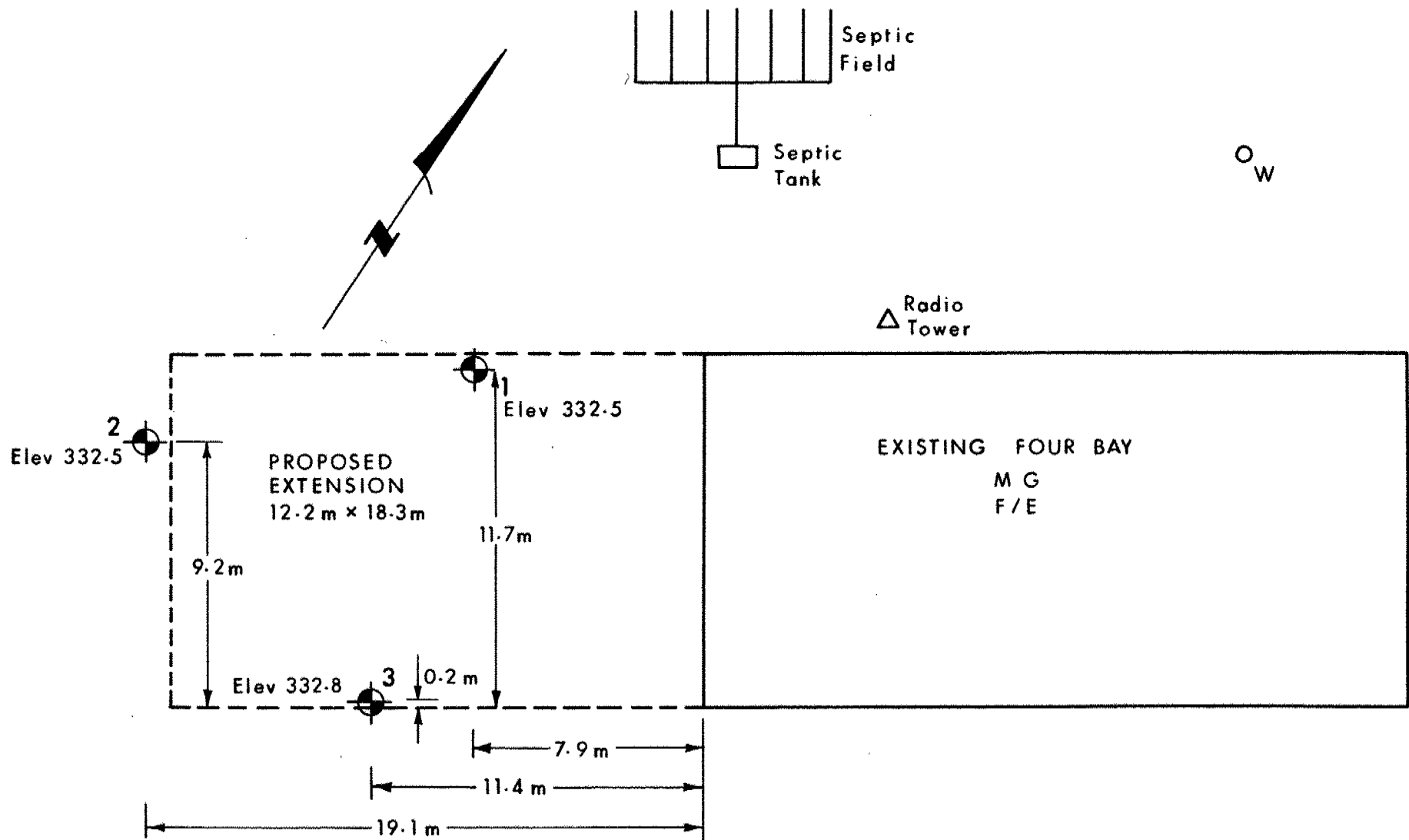
|                                      |     |                               |
|--------------------------------------|-----|-------------------------------|
| $u_w$                                | kPa | PORE WATER PRESSURE           |
| $r_u$                                | 1   | PORE PRESSURE RATIO           |
| $\sigma$                             | kPa | TOTAL NORMAL STRESS           |
| $\sigma'$                            | kPa | EFFECTIVE NORMAL STRESS       |
| $\tau$                               | kPa | SHEAR STRESS                  |
| $\sigma_1, \sigma_2, \sigma_3$       | kPa | PRINCIPAL STRESSES            |
| $\epsilon$                           | %   | LINEAR STRAIN                 |
| $\epsilon_1, \epsilon_2, \epsilon_3$ | %   | PRINCIPAL STRAINS             |
| E                                    | kPa | MODULUS OF LINEAR DEFORMATION |
| G                                    | kPa | MODULUS OF SHEAR DEFORMATION  |
| $\mu$                                | 1   | COEFFICIENT OF FRICTION       |

### MECHANICAL PROPERTIES OF SOIL

|                |            |                                      |
|----------------|------------|--------------------------------------|
| $m_v$          | $kPa^{-1}$ | COEFFICIENT OF VOLUME CHANGE         |
| $C_c$          | 1          | COMPRESSION INDEX                    |
| $C_s$          | 1          | SWELLING INDEX                       |
| $C_a$          | 1          | RATE OF SECONDARY CONSOLIDATION      |
| $c_v$          | $m^2/s$    | COEFFICIENT OF CONSOLIDATION         |
| H              | m          | DRAINAGE PATH                        |
| $T_v$          | 1          | TIME FACTOR                          |
| U              | %          | DEGREE OF CONSOLIDATION              |
| $\sigma'_{vo}$ | kPa        | EFFECTIVE OVERBURDEN PRESSURE        |
| $\sigma'_p$    | kPa        | PRECONSOLIDATION PRESSURE            |
| $\tau_f$       | kPa        | SHEAR STRENGTH                       |
| $c'$           | kPa        | EFFECTIVE COHESION INTERCEPT         |
| $\phi'$        | -°         | EFFECTIVE ANGLE OF INTERNAL FRICTION |
| $c_u$          | kPa        | APPARENT COHESION INTERCEPT          |
| $\phi_u$       | -°         | APPARENT ANGLE OF INTERNAL FRICTION  |
| $\tau_R$       | kPa        | RESIDUAL SHEAR STRENGTH              |
| $\tau_r$       | kPa        | REMOULDED SHEAR STRENGTH             |
| $S_t$          | 1          | SENSITIVITY = $\frac{c_u}{\tau_r}$   |

### PHYSICAL PROPERTIES OF SOIL

|                |          |                                |           |      |   |           |          |   |
|----------------|----------|--------------------------------|-----------|------|---|-----------|----------|---|
| $\rho_s$       | $kg/m^3$ | DENSITY OF SOLID PARTICLES     | e         | 1, % | VOID RATIO                                | $e_{min}$ | 1, %     | VOID RATIO IN DENSEST STATE                             |
| $\gamma_s$     | $kn/m^3$ | UNIT WEIGHT OF SOLID PARTICLES | n         | 1, % | POROSITY                                  | $I_D$     | 1        | DENSITY INDEX = $\frac{e_{max} - e}{e_{max} - e_{min}}$ |
| $\rho_w$       | $kg/m^3$ | DENSITY OF WATER               | w         | 1, % | WATER CONTENT                             | D         | mm       | GRAIN DIAMETER  |
| $\gamma_w$     | $kn/m^3$ | UNIT WEIGHT OF WATER           | $S_r$     | %    | DEGREE OF SATURATION                      | $D_n$     | mm       | n PERCENT - DIAMETER                                    |
| $\rho$         | $kg/m^3$ | DENSITY OF SOIL                | $w_L$     | %    | LIQUID LIMIT                              | $C_u$     | 1        | UNIFORMITY COEFFICIENT                                  |
| $\gamma$       | $kn/m^3$ | UNIT WEIGHT OF SOIL            | $w_p$     | %    | PLASTIC LIMIT                             | h         | m        | HYDRAULIC HEAD OR POTENTIAL                             |
| $\rho_d$       | $kg/m^3$ | DENSITY OF DRY SOIL            | $w_s$     | %    | SHRINKAGE LIMIT                           | q         | $m^3/s$  | RATE OF DISCHARGE                                       |
| $\gamma_d$     | $kn/m^3$ | UNIT WEIGHT OF DRY SOIL        | $I_p$     | %    | PLASTICITY INDEX = $w_L - w_p$            | v         | m/s      | DISCHARGE VELOCITY                                      |
| $\rho_{sat}$   | $kg/m^3$ | DENSITY OF SATURATED SOIL      | $I_L$     | 1    | LIQUIDITY INDEX = $\frac{w - w_p}{I_p}$   | i         | 1        | HYDRAULIC GRADIENT                                      |
| $\gamma_{sat}$ | $kn/m^3$ | UNIT WEIGHT OF SATURATED SOIL  | $I_C$     | 1    | CONSISTENCY INDEX = $\frac{w_L - w}{I_p}$ | k         | m/s      | HYDRAULIC CONDUCTIVITY                                  |
| $\rho'$        | $kg/m^3$ | DENSITY OF SUBMERGED SOIL      | $e_{max}$ | 1, % | VOID RATIO IN LOOSEST STATE               | j         | $kn/m^3$ | SEEPAGE FORCE   |
| $\gamma'$      | $kn/m^3$ | UNIT WEIGHT OF SUBMERGED SOIL  |           |      |   |           |          |   |



Geocres No 42E-2

## GERALDTON PATROL YARD EXTENSION

(1.5 km East of Hwy 584 on Hwy 11)

DIST 19 ; TWP OF ASHMORE ; DIST OF THUNDER BAY

Date 1986 05 28

WP 2705-85-02

Dwg No 1



# RECORD OF BOREHOLE No 1

METRIC

W P 2705-85-02 LOCATION REFER TO DRAWING #1 ORIGINATED BY LP  
DIST 19 HWY 11 BOREHOLE TYPE Hollow Stem Auger & Cone Test COMPILED BY LP  
DATUM Geodetic DATE 86 04 22 CHECKED BY [Signature]

| SOIL PROFILE  |   |            | SAMPLES |      |            | GROUND WATER<br>CONDITIONS | ELEVATION<br>SCALE | DYNAMIC CONE PENETRATION<br>RESISTANCE PLOT              |                | PLASTIC<br>LIMIT<br>W <sub>p</sub> | NATURAL<br>MOISTURE<br>CONTENT<br>W | LIQUID<br>LIMIT<br>W <sub>L</sub> | UNIT<br>WEIGHT<br>γ | REMARKS<br>&<br>GRAIN SIZE<br>DISTRIBUTION<br>(%)<br>GR SA SI CL |
|---------------|---|------------|---------|------|------------|----------------------------|--------------------|--|----------------|------------------------------------|-------------------------------------|-----------------------------------|---------------------|--|
| ELEV<br>DEPTH | DESCRIPTION   | STRAT PLOT | NUMBER  | TYPE | 'N' VALUES |                            |                    | 20 40 60 80 100  | SHEAR STRENGTH |                                    |                                     |                                   |                     |  |
|               |   |            |         |      |            |                            |                    | ○ UNCONFINED + FIELD VANE<br>● QUICK TRIAXIAL x LAB VANE |                |                                    |                                     |                                   |                     |  |
| 332.5         | Ground Surface  |            |         |      |            |                            |                    |  |                |                                    |                                     |                                   |                     |  |
| 0.0           | Sand, Some Gravel,<br>Silt, Trace Clay<br>with Pockets of Silty<br>Clay<br>(Fill) |            |         |      |            |                            | 332                |  |                |                                    |                                     |                                   |                     |  |
| 331.1         |   |            | 1       | SS   | 15         |                            |                    |  |                |                                    |                                     |                                   |                     |  |
| 1.4           | Silty Clay, some Sand,<br>Gravel<br>Very Stiff                                    |            | 2       | SS   | 23         |                            | 331                |  |                |                                    |                                     |                                   |                     |  |
| 329.9         |   |            | 3       | SS   | 20         |                            | 330                |  |                |                                    |                                     |                                   |                     |  |
| 2.6           | Sand, Some Gravel<br>Dense  |            | 4       | SS   | 55/        |                            |                    |  |                |                                    |                                     |                                   |                     |  |
| 329.1         |   |            |         |      |            |                            |                    |  |                |                                    |                                     |                                   |                     |  |
| 3.4           | End of Borehole   |            |         |      |            |                            |                    |  |                |                                    |                                     |                                   |                     |  |

\* Spoon Bouncing  
\*\* 'N' value may not be representative due to frost



# RECORD OF BOREHOLE No 2

METRIC

W P 2705-85-02 LOCATION REFER TO DRAWING #1 ORIGINATED BY LP  
DIST 19 HWY 11 BOREHOLE TYPE Hollow Stem Auger & Cone Test COMPILED BY LP  
DATUM Geodetic DATE 86 04 22 CHECKED BY [Signature]

| SOIL PROFILE  |   |            | SAMPLES |      |            | GROUND WATER<br>CONDITIONS | ELEVATION<br>SCALE | DYNAMIC CONE PENETRATION<br>RESISTANCE PLOT |  |  |  |  | UNIT<br>WEIGHT<br>$\gamma$ | REMARKS<br>&<br>GRAIN SIZE<br>DISTRIBUTION<br>(%)<br>GR SA SI CL |
|---------------|---|------------|---------|------|------------|----------------------------|--------------------|---|--|--|--|--|----------------------------|--|
| ELEV<br>DEPTH | DESCRIPTION   | STRAT PLOT | NUMBER  | TYPE | 'N' VALUES |                            |                    | 20 40 60 80 100                             |  |  |  |  |                            |  |
| 332.5         | Ground Surface  |            |         |      |            |                            |                    |   |  |  |  |  |                            |  |
| 0.0           | Sand; Some Gravel,<br>Silt<br>Trace Clay<br><br>Occasional Pockets of<br>Silty Clay<br>(Fill)<br><br>Silty Clay |            | 1       | SS   | 54         |                            | 332                |   |  |  |  |  |                            | 27 59 12 2   |
| 330.8         |   |            |         |      |            |                            | 331                |   |  |  |  |  |                            |  |
| 1.7           | Organics: Peat with<br>Pieces of Wood, Leaves   |            | 2       | SS   | 14         |                            |                    |   |  |  |  |  |                            |  |
| 330.4         |   |            |         |      |            |                            | 330                |   |  |  |  |  |                            | 15 77 5 3  |
| 2.1           | Sand, Some Gravel<br><br>Dense  |            | 3       | SS   | 33         |                            |                    |   |  |  |  |  |                            |  |
| 329.0         |   |            | 4       | SS   | 33         |                            |                    |   |  |  |  |  |                            |  |
| 3.5           | End of Borehole<br><br>* 'N' value not<br>representative due<br>to frost  |            |         |      |            |                            |                    |   |  |  |  |  |                            |  |

# RECORD OF BOREHOLE No 3

METRIC

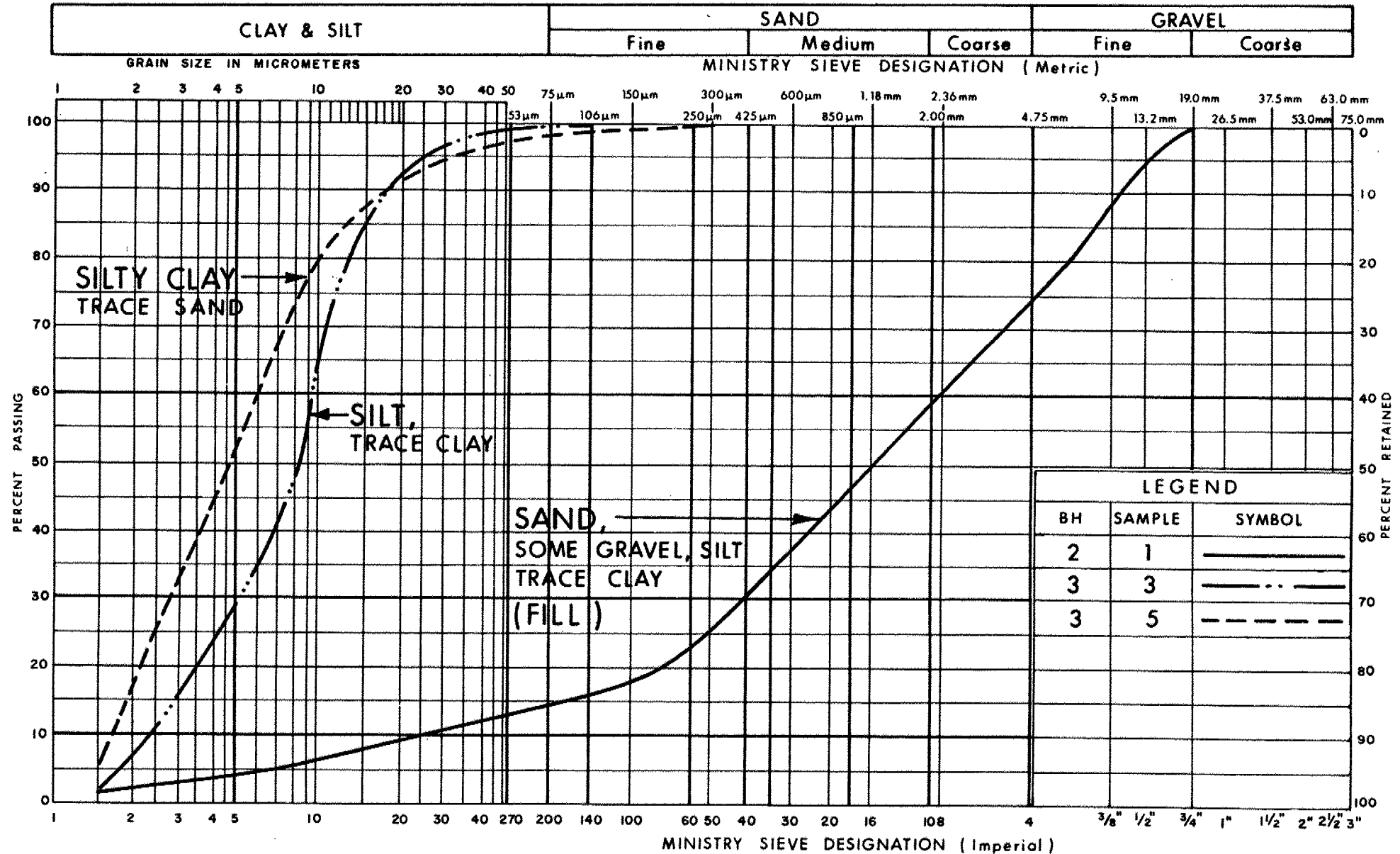
W P 2705-85-02 LOCATION REFER TO DRAWING #1 ORIGINATED BY LP  
 DIST 19 HWY 11 BOREHOLE TYPE Hollow Stem Auger & Cone Test COMPILED BY LP  
 DATUM Geodetic DATE 86 04 22 CHECKED BY GP.

| SOIL PROFILE  |                                |            | SAMPLES |      |            | GROUND WATER<br>CONDITIONS | ELEVATION<br>SCALE | DYNAMIC CONE PENETRATION<br>RESISTANCE PLOT |                                    |                                     |                                   | UNIT<br>WEIGHT<br>$\gamma$ | REMARKS<br>&<br>GRAIN SIZE<br>DISTRIBUTION<br>(%)<br>GR SA SI CL |
|---------------|--------------------------------|------------|---------|------|------------|----------------------------|--------------------|---|------------------------------------|-------------------------------------|-----------------------------------|----------------------------|--|
| ELEV<br>DEPTH | DESCRIPTION                    | STRAT PLOT | NUMBER  | TYPE | 'N' VALUES |                            |                    | 20 40 60 80 100                             | PLASTIC<br>LIMIT<br>W <sub>p</sub> | NATURAL<br>MOISTURE<br>CONTENT<br>W | LIQUID<br>LIMIT<br>W <sub>L</sub> |                            |  |
| 332.8         | Ground Surface                 |            |         |      |            |                            |                    |   |                                    |                                     |                                   |                            |  |
| 0.0           | Sand and Gravel                |            |         |      |            |                            |                    |   |                                    |                                     |                                   |                            |  |
|               | Silty Clay, Trace Sand         |            | 1       | SS   | 56         |                            | 332                |   |                                    |                                     |                                   |                            |  |
|               |                                |            | 2       | SS   | 20         |                            | 331                |   |                                    |                                     |                                   |                            |  |
| 330.7         | Silt, Trace Clay               |            | 3       | SS   | 19         |                            | 330                |   |                                    |                                     |                                   |                            |  |
|               | Compact                        |            | 4       | SS   | 22         |                            | 329                |   |                                    |                                     |                                   |                            |  |
|               | Silty Clay                     |            | 5       | SS   | 20         |                            | 328                |   |                                    |                                     |                                   |                            |  |
| 329.0         | Sand with Gravel, Silt<br>Clay |            | 6       | SS   | 36         |                            |                    |   |                                    |                                     |                                   |                            |  |
| 327.9         | Dense                          |            |         |      |            |                            |                    |   |                                    |                                     |                                   |                            |  |
| 4.9           | End of Borehole                |            |         |      |            |                            |                    |   |                                    |                                     |                                   |                            |  |

\* 'N' values are not  
representative due  
to frost



## UNIFIED SOIL CLASSIFICATION SYSTEM

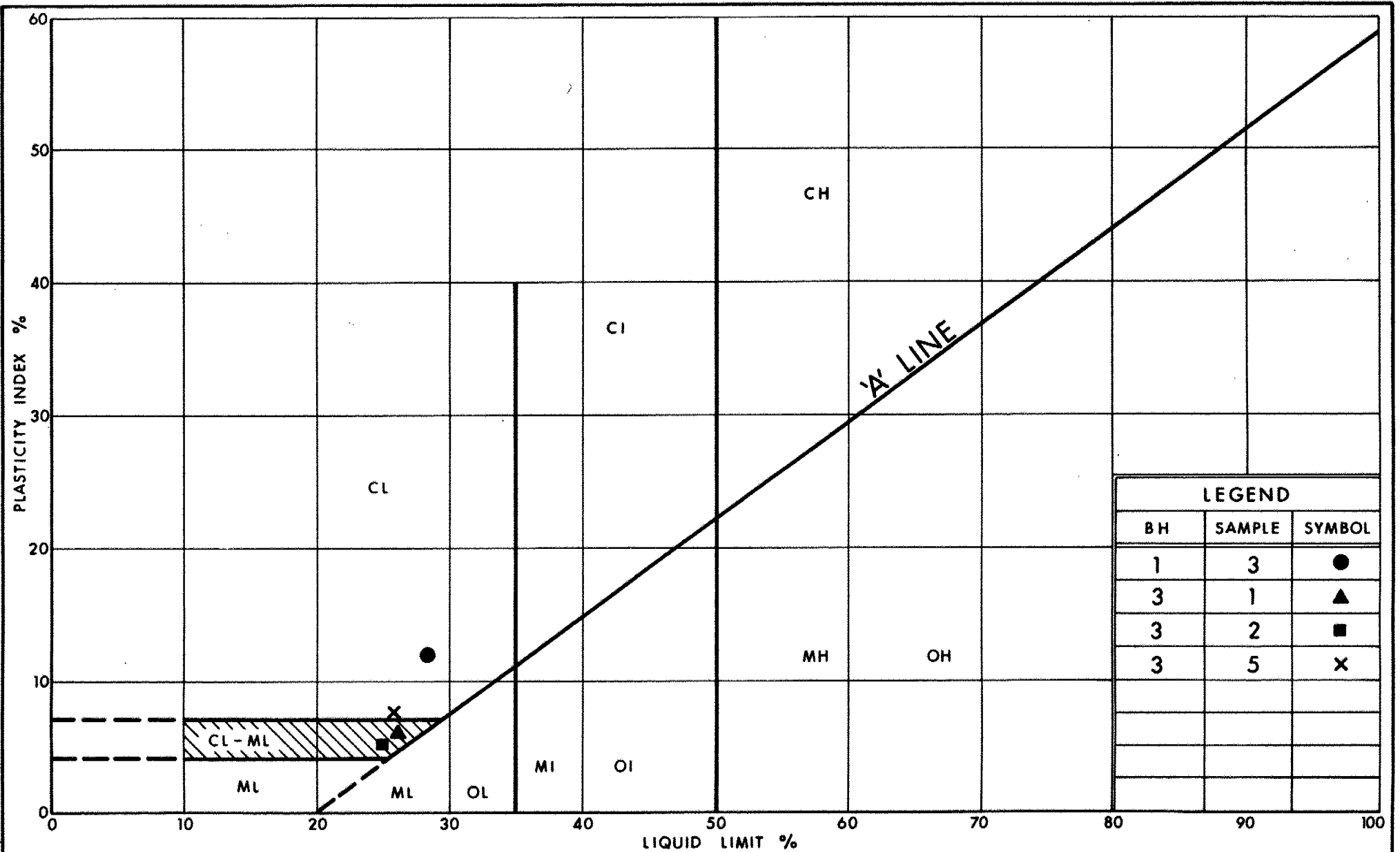


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Communications

## GRAIN SIZE DISTRIBUTION

FIG No 1

W P 2705-85-02



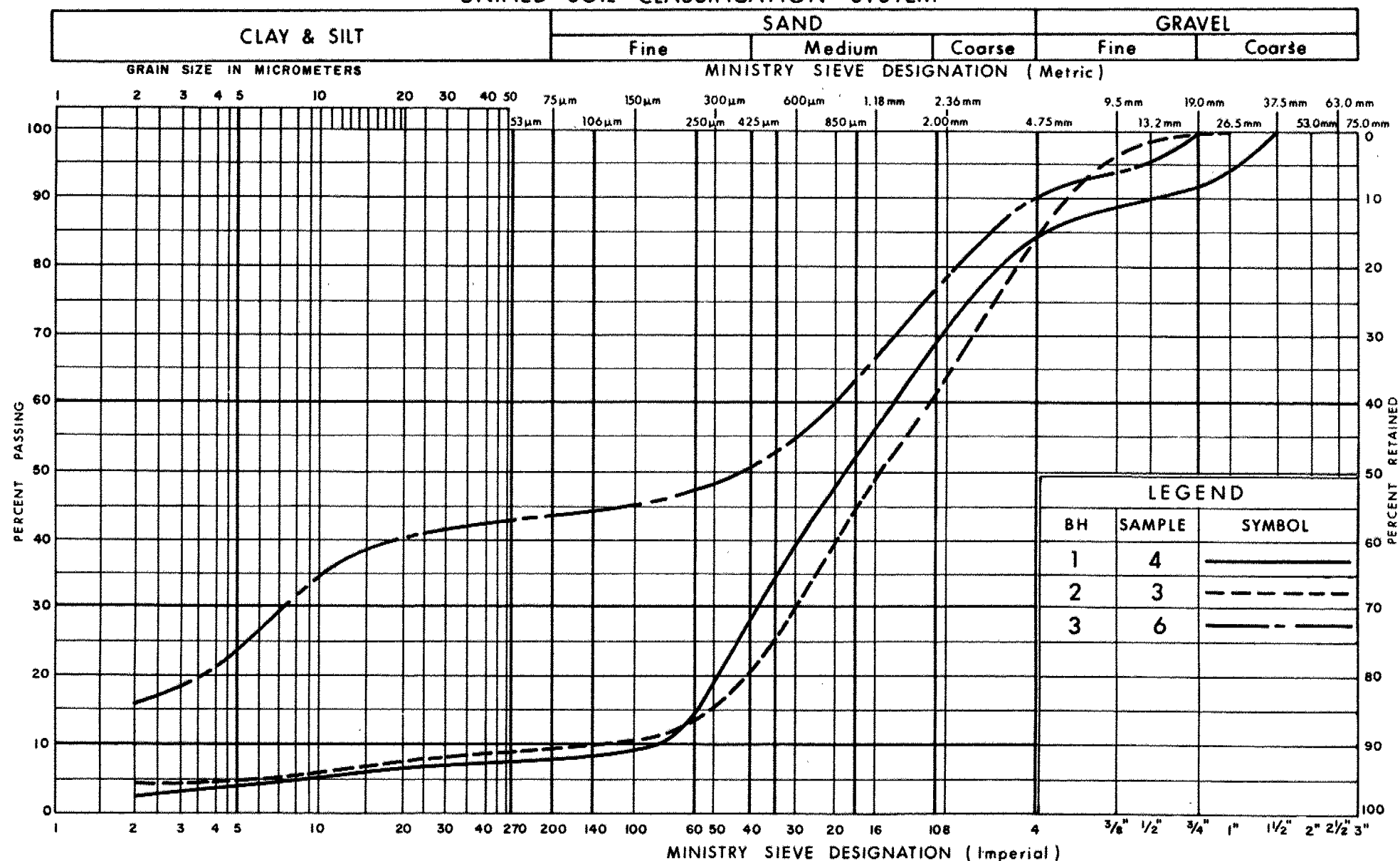
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# PLASTICITY CHART SILTY CLAY, TRACE SAND

FIG No 2

W P 2705-85-02

## UNIFIED SOIL CLASSIFICATION SYSTEM



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GRAIN SIZE DISTRIBUTION

SAND, SOME TO WITH GRAVEL

FIG No 3

W P 2705-85-02