LIST OF TABLES

APPENDICES

APPENDICES (Cont.)

APPENDICES

APPENDIX 16

DRAFT

STANDARD OPERATING PROCEDURE FOR
Classification of Soils for Engineering Purposes
Applicable matrix or matrices:
Standard Compound List and Reporting Limits:

Approvals and Signatures

Laboratory Director: _____ Date: _____
Michael Wheeler Ph.D.

QA Manager: _____ Date: _____
Kirstin L. McC[illegible]ken

Organic Prep Manager: _____ Date _____
Jon K. Zygmuntowicz

1.0 SCOPE AND APPLICATION

This method describes a system for classifying mineral and organo-mineral soils for engineering purposes based on laboratory determination of particle size characteristics, liquid limit and plasticity index and is used when precise classification is required.

2.0 SUMMARY OF METHOD

This classification system identifies three major soil divisions: coarse grained soils, fine grained soils and highly organic soils. These three divisions are further subdivided into a total of 15 basic soil groups.

Based on the results of visual observations and prescribed laboratory tests a soil is catalogued according to the basic soil groups and thereby classified. The various soil groups have been devised to correlate in a general way with the engineering behaviors of soils.

3.0 DEFINITIONS

NA

4.0 INTERFERENCES

See laboratory SOPs LM-SL-D422, LM-SL-D854 and LM-SL-D4318.

5.0 SAFETY

5.1 The toxicity or carcinogenity of each chemical used in this procedure has not been fully established. Each chemical should be regarded as a potential health hazard and exposure should be minimized as reasonably possible. A reference file of Material Safety Data Sheets (MSDS) for this test method is available to all personnel and must be read prior to performing this procedure. All laboratory personnel must be familiar with the laboratory environmental health and safety plan described in the STL Corporate Safety Manual (CSM).

6.0 EQUIPMENT AND SUPPLIES

See laboratory SOPs LM-SL-D422, LM-SL-D854 and LM-SL-D4318.

7.0 REAGENTS AND STANDARDS

See laboratory SOPs LM-SL-D422, LM-SL-D854 and LM-SL-D4318.

8.0 SAMPLE COLLECTION, PRESERVATION, SHIPMENT & STORAGE

See laboratory SOPs LM-SL-D422, LM-SL-D854 and LM-SL-D4318.

9.0 QUALITY CONTROL

See laboratory SOPs LM-SL-D422, LM-SL-D854 and LM-SL-D4318.

10.0 CALIBRATION & STANDARDIZATION

See laboratory SOPs LM-SL-D422, LM-SL-D854 and LM-SL-D4318.

11.0 PROCEDURE

11.1 Perform ASTM Methods D422, D854 and D4318.

11.2 The soil is an inorganic clay if the position of the plasticity index versus liquid limit plot, Fig. 3, falls on or above the "A" line, the plasticity index is greater than 4, and the presence of organic matter does not influence the liquid limit.

11.3 Classify the soils as a lean clay, CL, if the liquid limit is less than 50. See area identified as CL on Fig 3.

11.4 Classify the soils as a fat clay, CH, if the liquid limit is greater than 50. See area identified as CL on Fig 3.

11.5 Classify the soils as a silty clay, CL-ML, if the position of the plasticity index versus the liquid limit plot falls on or above the "A" line and the plasticity index is in the range of 4 to 7. See area identified as CL-ML on Fig 3.

11.6 The soil is an inorganic silt if the position of the plasticity index versus liquid limit plot, fig. 3, falls below the "A" line or the plasticity index is less then 4, and presence of organic matter does not influence the liquid limit.

11.7 Classify the soil as silt, ML, if the liquid limit is less than 50. See area identified as ML on Fig. 3

11.8 Classify the soil as an elastic silt, MH, if the liquid limit is 50 or greater. See area identified as ML on Fig. 3

11.9 The soil is an organic silt or clay if organic matter is present in sufficient amounts to influence the liquid limit.

11.10 If the soil has a dark color and an organic odor when warm and moist, a second liquid limit test should be performed on a test specimen that has been dried at 110°C +/- 5°C, to a constant weight.

11.11 The soil is an organic silt or clay if the liquid limit after oven drying is less than 75% of the liquid limit of the original specimen determined before oven drying.

11.12 Classify the soil as organic silt or clay, OL, if the liquid limit (not oven dried) is less than 50%. Classify the soil as an organic silt, OL, if the plasticity index is less than 4, or the position of the plasticity index versus liquid limit plot falls below the "A" line. Classify the soil as an organic clay, OL, if the plasticity index is 4 or greater and the position of the plasticity index versus the liquid limit plot falls on or above the "A" line. See the area identified as OL (or CL-ML) on Fig. 3.

11.13 Classify the soil as an organic clay or organic silt, OH, if the liquid limit (not oven dried) is 50 or greater. Classify the soil as an organic silt, OH, if the position of the plasticity index versus the liquid limit plot falls on or above the "A" line. See area identified as OH on Fig. 3.

11.14 If less than 30% but 15% or more of the sample is retained on the No. 200 sieve the words "with sand" or "with gravel" (whichever is predominant) shall be added to the group name.

11.15 If 30% or more of the sample is retained on the No. 200 sieve, the words "sandy" or "gravelly" shall be added to the group name. Add the word "sandy" if 30% or more of the test specimen is retained on the No. 200 and the coarse grained portion is predominately sand, likewise for gravel.

11.16 When more than 50% of the test specimen is retained on the No. 200 sieve classify the soil as gravel if more than 50% of the coarse fraction is retained on the No. 4 sieve. Classify the soil as sand if 50% or more of the coarse fraction passes the No. 4 sieve.

11.17 If 12% or less of the test specimen passes the No. 200 sieve, plot the cumulative particle size distribution and compute the coefficient of uniformity, Cu and coefficient of curvature, Cc, as given in equation 1 and 2.

$$Cu = D_{60}/D_{10} \qquad (1)$$
$$Cc = (D_{30})^2/(D_{10} \times D_{60}) \qquad (2)$$

where: D_{10}, D_{30} and D_{60} = the particle size diameters corresponding to 10, 30 and 60%, respectively, passing on the cumulative particle size distribution curve.

11.18 If less than 5% of the test specimen passes the No. 200 sieve, classify the soils as well graded gravel, GW, or well graded sand, SW, if Cu is greater thank or equal to 4.0 for gravel or greater than 6.0 for sand and Cc is at least 1.0 but not more than 3.0.

11.19 If less than 5% of the test specimen passes the No. 200 sieve, classify the soil as poorly graded gravel, GP, or poorly graded sand, SP, if either the Cu or the Cc criteria for well graded soils are not satisfied.

11.20 If 12% of the test specimen passes the No. 200 sieve, the soil shall be considered a coarse-grained soil with fines. The fines are determined to be either clayey or silty based on the plasticity index versus the liquid limit plot.

11.21 Classify the soil as clayey gravel, CG, or clayey sand, SC, if the fines are clayey, that is, the position of the plasticity index versus liquid limit plot falls on or above the "A" line and the plasticity index is greater than 7.

11.22 Classify the soil as a silty gravel, GM, or silty sand, SM, if the fines are silty, that is, the position of the plasticity index versus liquid limit plot falls below the "A" line and the plasticity index is less than 4.

11.23 If the fines plot as a silty clay, CL-ML, classify the soil as a silty, clayey gravel, GC-GM, if it is a gravel or a silty, clayey sand, SC-MC, if it is sand.

11.24 If 5 to 12% of the test specimen passes the No. 200 sieve, give the soil a dual classification using two group symbols. The first group of symbols shall correspond to that for a gravel or sand having less than 5% fines (GW, GP, SW, SP) and the second symbol shall correspond to a gravel or sand having more than 12% fines (GC, GM, SC, SM).

11.25 The group name shall correspond t the first group symbol plus "with clay", or "with silt" to indicate the plasticity characteristics of the fines.

11.26 If the specimen is predominantly sand or gravel but contains 15% or more of the other coarse grained constituent, the words, "with gravel" or "with sand" shall be added to the group name.

11.27 If the field sample contains any cobbles or boulders or both the words "with cobbles" or "with boulders" shall be added to the group names.

12.0 CALCULATIONS

12.1 Compute the coefficient of uniformity, Cu and coefficient of curvature, Cc, as given in equation 1 and 2.

$$Cu = D_{60}/D_{10} \qquad (1)$$
$$Cc = (D_{30})^2/(D_{10} \times D_{60}) \qquad (2)$$

where: D_{10}, D_{30} and D_{60} = the particle size diameters corresponding to 10, 30 and 60%, respectively, passing on the cumulative particle size distribution curve.

13.0 DATA ASSESSMENT, CRITERIA & CORRECTIVE ACTION

See laboratory SOPs LM-SL-D422, LM-SL-D854 and LM-SL-D4318.

14.0 METHOD PERFORMANCE

14.1 An Initial Demonstration of Capability is required for each analyst before unsupervised performance of this method.

15.0 POLLUTION PREVENTION & WASTE MANAGEMENT

15.1 The laboratory optimizes technology to minimize pollution and reduce the production of hazardous waste whenever possible.

15.2 The laboratory procedures for waste management comply with applicable federal, state and local regulations and are described in SOP LP-LB-001HAZWD.

16.0 REFERENCES

16.1 Annual Book of ASTM Standards, volume 04.08 Soil and Rock (I): D 420 - D4914, Section 4, Construction edition; American Society for Testing and Materials, Philadelphia, Pa., 1994.

17.0 TABLES, DIAGRAMS, FLOWCHARTS

NA

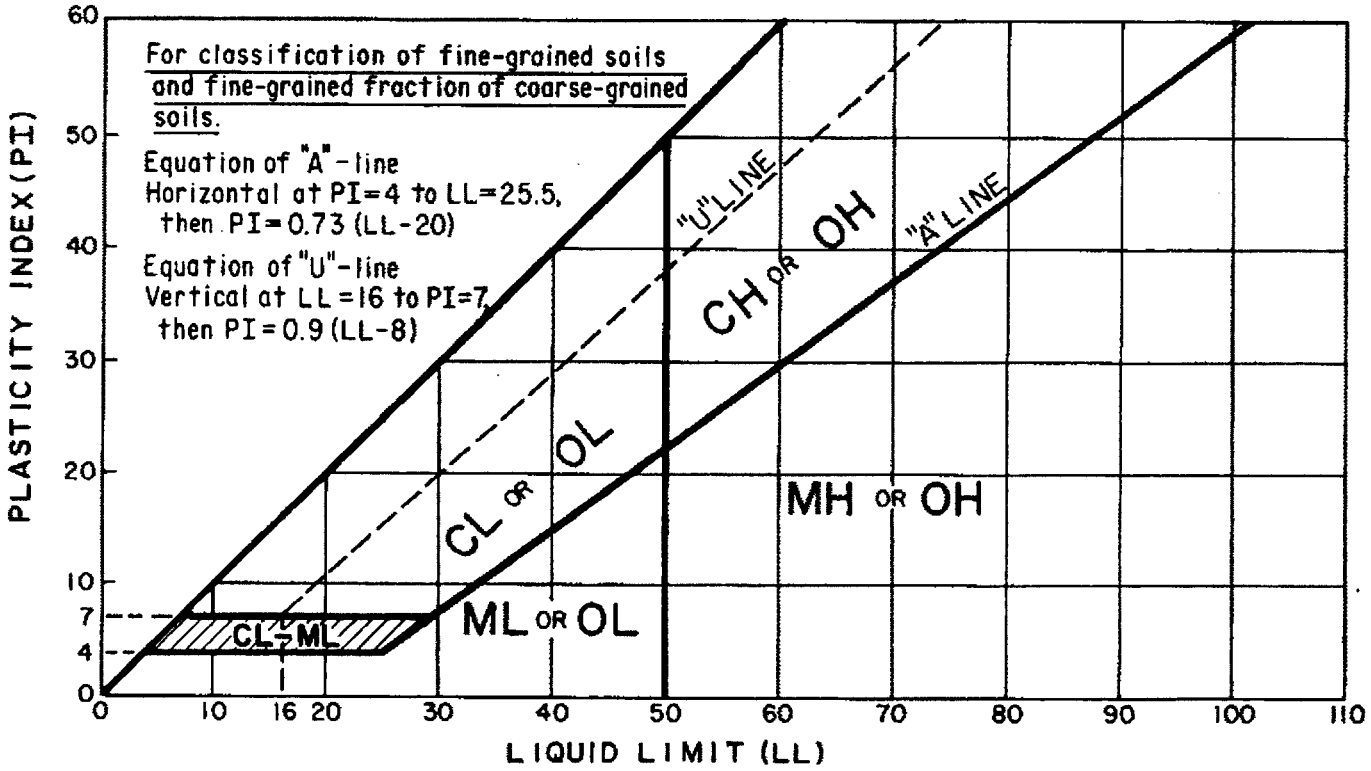
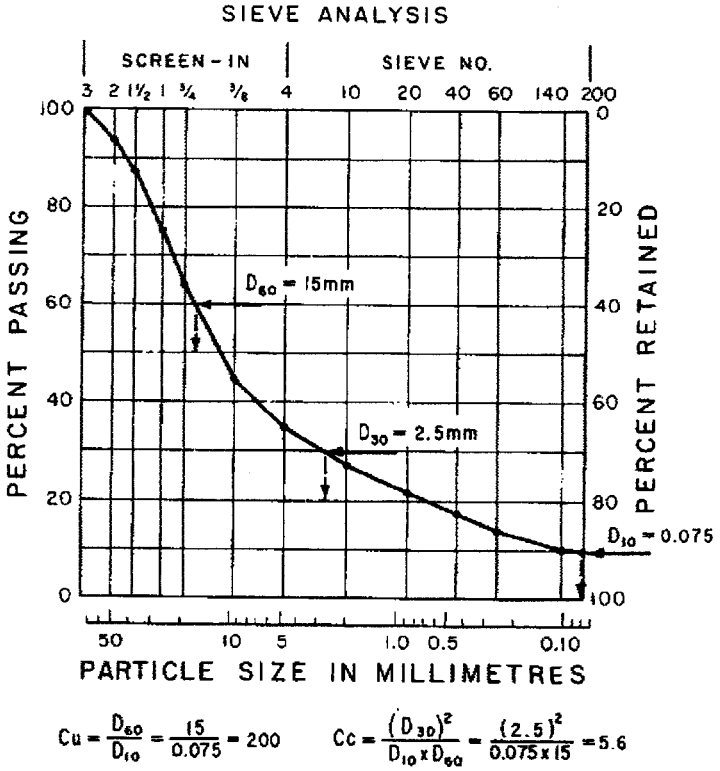


FIG. 3 Plasticity Chart



$$Cu = \frac{D_{60}}{D_{10}} = \frac{15}{0.075} = 200 \qquad Cc = \frac{(D_{30})^2}{D_{10} \times D_{60}} = \frac{(2.5)^2}{0.075 \times 15} = 5.6$$

FIG. 4 Cumulative Particle-Size Plot

GP, or *poorly graded sand,* SP, if either the Cu or the Cc criteria for well-graded soils are not satisfied.

12.4 If more than 12 % of the test specimen passes the No. 200 (75-μm) sieve, the soil shall be considered a coarse-grained soil with fines. The fines are determined to be either clayey or silty based on the plasticity index versus liquid limit plot on Fig. 3. (See 9.8.2.1 if insufficient material available for testing). (See Note 6)