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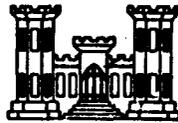
# FORECASTING TRAFFICABILITY OF SOILS

Report 8

## VARIABILITY OF PHYSICAL PROPERTIES OF LOESS SOILS WARREN COUNTY, MISSISSIPPI

by

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## FOREWORD

The study reported herein is part of a research program being conducted under Task 1-V-O-21701-A-046-02, "Surface Mobility," of Department of the Army Project 1-V-O-21701-A-046, "Trafficability and Mobility Research," under the sponsorship and guidance of the Directorate of Research and Development, U. S. Army Materiel Command. The study was conducted by personnel of the U. S. Army Engineer Waterways Experiment Station (WES), Mobility and Environmental (M&E) Division, under the general supervision of Mr. W. J. Turnbull, Technical Assistant for Soils and Environmental Engineering; Mr. W. G. Shockley, Chief, M&E Division; Mr. S. J. Knight, Assistant Chief, M&E Division; Mr. A. A. Rula, Chief, Vehicle Studies Branch; and Mr. E. S. Rush, Chief, Soil-Vehicle Studies Section.

The initial fieldwork and analyses were conducted during 1958-1960 by the Forest Service, U. S. Department of Agriculture, with Mr. L. E. Andrew as project leader under the supervision of Mr. H. D. Burke and Dr. F. W. Stearns of the Southern Forest Experiment Station. The final analyses were made and the report was prepared by Mr. C. A. Carlson and the late Mr. A. R. McDaniel.

Directors of the WES during the conduct of this study and the preparation and publication of this report were COL Edmund H. Lang, CE, COL Alex G. Sutton, Jr., CE, and COL John R. Oswalt, Jr., CE. Technical Director was Mr. J. B. Tiffany.

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### CONVERSION FACTORS, BRITISH TO METRIC UNITS OF MEASUREMENT

British units of measurement used in this report can be converted to metric units as follows:

<u>Multiply</u>	<u>By</u>	<u>To Obtain</u>
inches	2.54	centimeters
feet	0.3048	meters
miles	1.609344	kilometers
acres	4046.9	square meters
pints	0.473166	liters
pounds	0.45359237	kilograms
square inches	6.4516	square centimeters

## SUMMARY

This study was undertaken to determine if the average of soil strength values obtained in a small area can be reliably applied to larger areas. The values of those soil properties commonly used in predicting soil strength and classifying soils were compared for areas differing in size. Six test sites in each of four soil series of loessial origin were established in Warren County, Mississippi, using series boundaries on soil survey maps for locating the sites. The series were the Memphis and Loring in the uplands and the Collins and Falaya in the bottomlands. Each site consisted of five sampling rows and each row had four sampling positions. Plots of pedologically distinct soil series were identified from field examination within sites and were used as an additional subdivision of test areas. Tests were conducted on four occasions to collect data on soil strength and moisture content, and once to collect data on other physical properties of the soil.

The four soil series could not be distinguished by soil strength because the cone index varied widely for any one series and the range of cone index for each series was approximately the same. The soils of the 6- to 12-in. layer of the uplands differed from those of the bottomlands in clay content and plasticity, but there was no corresponding difference in strength. The poorly drained Henry series and alluvial-fill soils of the uplands, as identified in the field, had the lowest cone indexes. Certain plots exhibited consistently different cone indexes for each sampling visit than did other plots in the same series, and certain rows in the same plot showed consistently different cone indexes. However, these differences could not be explained satisfactorily in terms of soil series, or soil properties commonly used in the Unified Soil Classification System and the U. S. Department of Agriculture textural classification. Limited data suggest that in future trafficability studies a terrain geometry classification system would be useful for identifying areas considered uniform in soil type but variable in soil strength by indicating areas having differences in reception or retention of water and differential erosion or deposition. Also, the effect of soil factors such as organic matter content, structure, and natural cementing agents should be determined. In a row of relatively uniform soil, five samplings for moisture content and static physical properties, and 10 measurements for soil strength should be made to provide acceptable mean values for trafficability use.

Basic data for each test site are included as Appendix A.

FORECASTING TRAFFICABILITY OF SOILS  
VARIABILITY OF PHYSICAL PROPERTIES OF LOESS SOILS  
WARREN COUNTY, MISSISSIPPI

PART I: INTRODUCTION

Background

1. In 1945, the U. S. Army Engineer Waterways Experiment Station (WES) began a series of investigations to determine and evaluate soil properties that affect movement of military vehicles.<sup>1</sup> Instruments were designed and built to measure soil strength, and soil strength measurements were correlated with the performance of a wide range of vehicles in prepared test lanes. Later, many soils in different terrains were studied to determine soil strength-vehicle performance relations. Other studies were conducted under diverse soil, weather, and site conditions to develop methods for predicting soil moisture content and its influence on trafficability. From these studies, trafficability classifications and tentative methods for predicting soil moisture have been derived.<sup>2,3</sup>

2. The soil moisture and strength prediction methods were developed from test data obtained from relatively small areas, about the size of a conventional military vehicle. The measurements obtained in these tests are averages of soil property values that occur within the overall ground contact area of the vehicle. Although studies have been conducted to determine specific soil and site conditions for small test areas, no test has been made of the validity of applying these measurements over large areas. The next step, then, is to determine if the measurements obtained from tests in small areas can be applied to large areas or extrapolated to other areas of similar soil. Knowledge is needed, also, of soil and site factors that define and bound an area considered uniform for soil trafficability purposes.

### Purpose

3. The purposes of this study were to:
  - a. Determine if the average of soil strength values obtained in a small area can be reliably used for a larger area of similar soil.
  - b. Determine whether the application of small area test results to larger areas is consistent with passage of time, as the soil moisture content changes.
  - c. Determine whether the variations in values of static soil properties (i.e. those that do not vary with time) and site factors used in soil moisture prediction methods are consistent with variations in strengths for small and large areas.
  - d. Consider the influence on soil strength of soil and site factors other than those that have been intensely studied.
  - e. Determine variation and sampling intensities of soil properties, pertinent to trafficability prediction.

### Scope

4. The study was confined to relatively uniform soils developed from loess in Warren County, Mississippi. Four pedological soil series, two in upland positions differing in drainage and two in bottomland positions differing in drainage, were examined. Data were collected at 24 sites, six on each soil series. The static properties and site factors for each site were measured once during the winter-spring period. The dynamic properties that vary with time (i.e. soil strength and moisture content), were measured on four occasions during the year following the measurement of the static properties.

### Definitions

5. Specialized terms used in this report are defined below.

Soil series. A group of soils having genetic horizons similar in diagnostic characteristics and arrangement in the soil profile, and developed from a particular type of parent material. Except for texture, especially of the A horizon, the morphological features of the soil profile,

as exhibited in the physical characteristics and thickness of the soil horizons, do not vary significantly within a series.

Loess. Deposit of windblown material, predominantly silty in texture but often containing significant amounts of clay and fine sand.

Soil separates. Mineral particles, less than 2 mm in equivalent diameter, ranging between specified size limits. The names and sizes of separates recognized in the United States are sand, 2.0-0.05 mm; silt, 0.05-0.002 mm; and clay, <0.002 mm.

Fines. Soil grains finer than 0.074 mm (passing a No. 200 sieve).

Liquid limit (LL). The moisture content at which a pat of soil, cut by a groove of standard dimensions, will flow together for a distance of 1/2 in.\* under the impact of 25 blows with a standard instrument and procedure. It represents the moisture content at which the characteristics of a mixture of soil and water change from plastic to liquid.

Plastic limit (PL). The moisture content at which a soil just begins to crumble when rolled out into 1/8-in.-diameter threads. It represents the moisture content corresponding to an arbitrary limit between the plastic and semisolid states of consistency.

Elasticity index (PI). The numerical difference in moisture content between the liquid and plastic limits.

Specific gravity. The ratio of the weight of soil after drying to a constant weight at 105 C to the weight of an equal volume of water.

Dry density. Weight of soil after drying at 105 C to a constant weight per unit volume of the soil in its natural structure, expressed as pounds per cubic foot or grams per cubic centimeter. It is comparable to bulk density and dry unit weight of intact samples.

Soil moisture content (MC). The soil moisture content expressed as a percentage of the weight of water driven off at 105 C to the weight of the remaining dry soil.

Moisture tension. Considered to be the force or tension by which water is held to the surface of soil particles or within interstices; it

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\* A table of factors for converting British units of measurement to metric units is given on page vii.

varies inversely with the soil moisture content. The moisture-tension relation for a particular soil is determined by means of a laboratory device at a sequence of tension or pressure settings. At a given moisture content, the tension is equal to the negative or gage pressure to which free water in the instrument has been subjected in order to be in hydraulic equilibrium, through a permeable wall or membrane, with the water in the soil.

Dynamic property. A property whose value changes with time and weather, e.g. moisture content or soil strength.

Static property. A property with a fixed value, for this study considered unchangeable with time, e.g. grain size or plasticity.

Soil strength. The resistance of a soil to an applied stress. The strength varies with moisture content and the nature, arrangement, and size distribution of the soil particles, and the test itself. The principal unit of strength used in trafficability studies is cone index.

Trafficability. The ability of a soil to permit the movement of a military vehicle.

Critical layer. The layer of soil regarded as most pertinent to establishing relations between soil strength and vehicle performance. In fine-grained soils and sands with fines, poorly drained, it is usually the 6- to 12-in. layer. However, the critical layer may vary with weight of vehicle and with soil strength profile.

Cone index (CI). An index of the shearing resistance of soil obtained with the cone penetrometer. The value represents the resistance of the soil to penetration of a 30-deg cone of 0.5-sq-in. base or projected area. The number, although considered dimensionless, is actually pounds of force on the handle divided by the area of the cone base in square inches.

Remolding index (RI). A ratio expressing the change in strength of a soil that will occur under vehicular traffic.

Rating cone index (RCI). The product of the measured cone index and the remolding index for the critical layer of soil.

Cone penetrometer. A field instrument consisting of a shaft with a 30-deg right cone mounted on one end, and a proving ring with dial gage and handle mounted on the other.

Trafficability sampler. A piston-type soil sampler for obtaining soft soil samples. The sample may be used in its entirety for making a remolding test or cut to known volumes, by the use of spacer bars or pins, for determining dry density.

Remolding equipment. A cylinder of the same diameter as the trafficability sampler cylinder mounted vertically on a base, and a 2-1/2-lb drop hammer that travels 12 in. on an 18-in. section of a cone penetrometer shaft fitted with a circular foot.

Median. The value of the middle item in an array.

Mean. The average value of all items in a sample. It is calculated by dividing the algebraic sum of the observations by their number.

Normal distribution. A type of distribution that serves to describe the frequency of occurrence of many natural facts and phenomena. It has an exact mathematical expression and is the basis of most statistical measures and inferences.

Standard deviation from the mean. The standard deviation from the mean is an index of dispersion of individuals in a sample about the mean of the sample. It is calculated as the square root of the mean of the squared deviations taken from the mean of the distribution. For a sample having a normal distribution, 68 percent of the individuals will have values within plus or minus one standard deviation from the mean.

Probability. As used in statistics, the probability of a given event is the expected frequency of occurrence of this event among events of like sort.

Significance. Significance is a measure of reliability. A given difference is called significant or reliable when the experimenter is satisfied that it cannot be explained away as having arisen from sampling fluctuations or sampling accidents.

Level of significance. A measure of reliability qualified by a statement of probability. A given difference is called significant at the 5 percent level if the probability is 95 times out of 100 that it cannot be explained as having arisen from a sampling accident; a difference is significant at the 1 percent level if the probability is 99 times out of 100 that it cannot be explained away as having arisen from a sampling accident.

Variance. An index of dispersion or variability of sample values or means. It is also called the mean square and is numerically equal to the square of the standard deviation.

F-test. A test comparing variances of two sets of values in a study in order to determine the probability of one set being like the other. The F-value is the ratio of the two variances, which in this study is that of the larger area, the plot variance, divided by that of the smaller area, the row variance. If the ratio is small, the variance of plot values is common with that of the rows within the plots, and the existence of plot differences is remote. If the ratio is large, exceeding a predetermined value based on a normal distribution, the probability exists that the plot values are not common with rows within plots and therefore that plot differences occur.

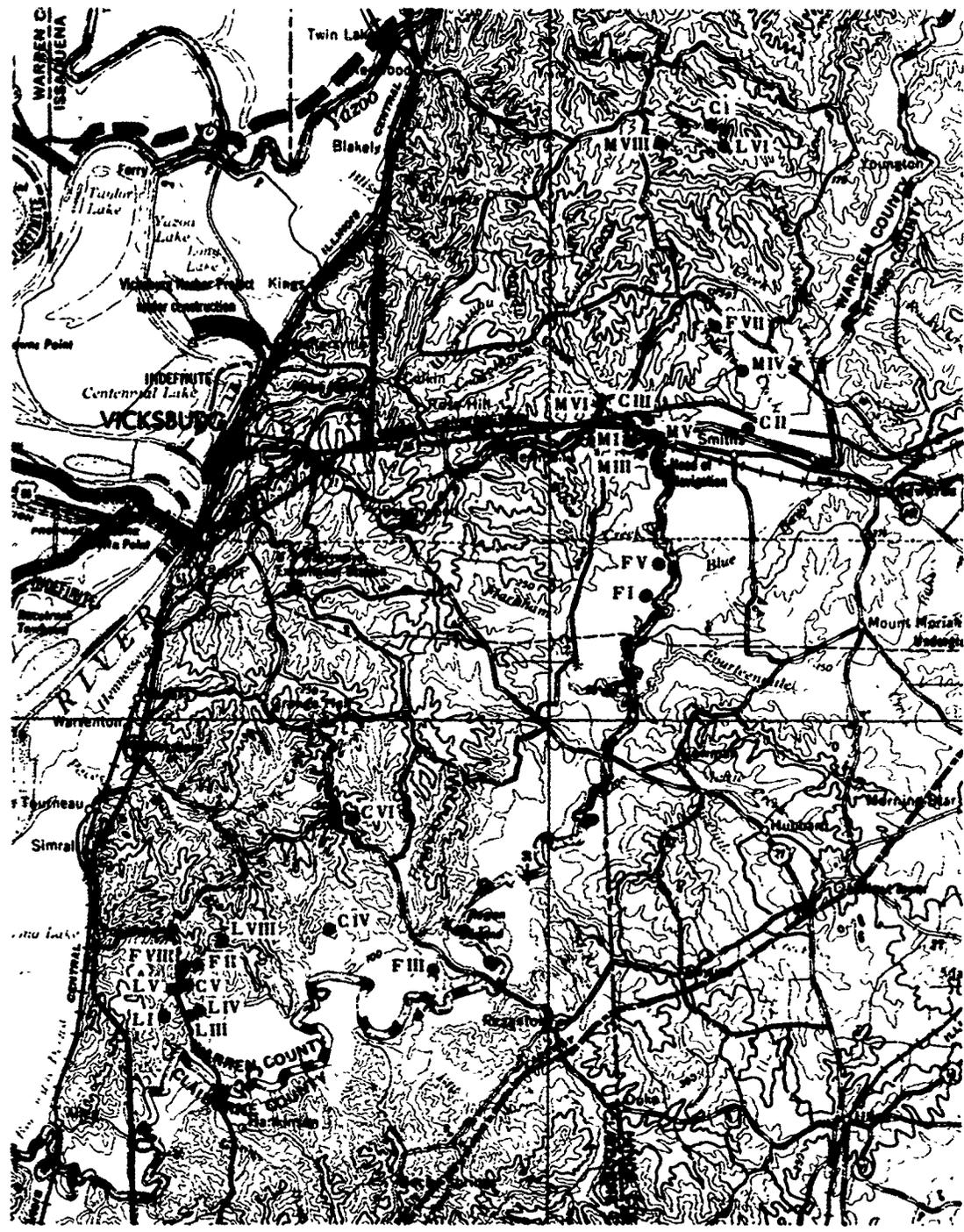
## PART II: TEST PROGRAM

### Test Area

6. The study was conducted in the eastern and southern parts of Warren County, Mississippi, in soils derived from loess overlying Tertiary sediments. The county is bounded on the east by the Big Black River, with a valley 1 to 2 miles wide, and on the west by the Mississippi River. The loess deposit thins from a depth of 60 ft near the Mississippi River Valley to a few feet on the hilltops 30 miles to the east. The deep loess has been severely eroded, forming narrow valleys with 30- to 100-ft differences in relief and with steep slopes that are frequently steeper than 50 percent. The valley bottoms are narrow and flat; the hilltops are often narrow ridges, although some wide, flat uplands occur. The loess hills bordering the Big Black River frequently have less slope and relief than the deeper loess hills further west. The terrain pattern of the test area is shown in fig. 1.

7. Soils developed from loess are relatively uniform, consisting primarily of silt, with some fine sand and clay. Differences occur between upland and bottomland soils. The upland loessial soils have weathered in place resulting in an increase in the clay content and a silty clay texture in a layer 10 to 20 in. below the surface, in contrast to a silt loam texture above and below the layer. Due to erosion of the surface at some locations, the clayey layer is at or near the surface. The bottomland soils are derived from recent alluvium washed in from the loess hills, and generally have a silt loam texture throughout the profile. Some bottomland soils along the Big Black River have higher contents of sand resulting from admixtures of sandy Tertiary materials. Loessial terrace soils also occur along the Big Black River, but these soils were not studied.

8. Sequences of soil series with drainages ranging from good to poor are distinguished for the upland and bottomland loessial soils of Warren County. In soils of the uplands, a fragipan occurs in and below the clayey layer. The prevalent soil series and approximate depths to the fragipan, where present, are as follows: Memphis, no fragipan; Loring, 36 in.; Grenada, 24 in.; and Henry, 15 in. In soils of the bottomlands, shallow



NOTE: SEE TABLE 1 FOR SITE IDENTIFICATION AND GENERAL DATA.

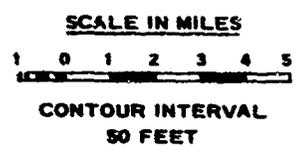


Fig. 1. Test site locations

groundwater tables have developed a mottled structureless soil layer zone with dark gray and brown colors. The prevalent soil series and approximate depths to the mottled zone are as follows: Collins, 20 in.; Falaya, 10 in.; and Waverly, 3 in.

### Test Sites

#### Selection

9. Sites were selected from soil survey maps of areas mapped as one soil series. It was desired to test soil series of uplands and bottomlands that differed widely in drainage, but examination of the maps showed that very poor and very well-drained soils were not common in the county; therefore, only soils of fair to intermediate drainage in the Memphis and Loring series of the uplands and the Collins and Falaya series of the bottomlands were selected for testing. For each of the four series, six test sites were randomly picked from more than 200 selected locations on the soil maps. The locations of the sites are shown in fig. 1. All sites were non-forested so as to minimize the influence of vegetation in the analyses.

#### Layout

10. Sites ranged from 100 to 540 ft in length, as determined by the distance between soil map boundaries, and were 30 ft in width. The length of the site was oriented upslope in the uplands, and between the drainage channel and the foot of the uplands in the bottomlands. The site layout is shown in fig. 2. The smallest test area, the row, was established across the width of the site, parallel to the contour of the terrain. Five

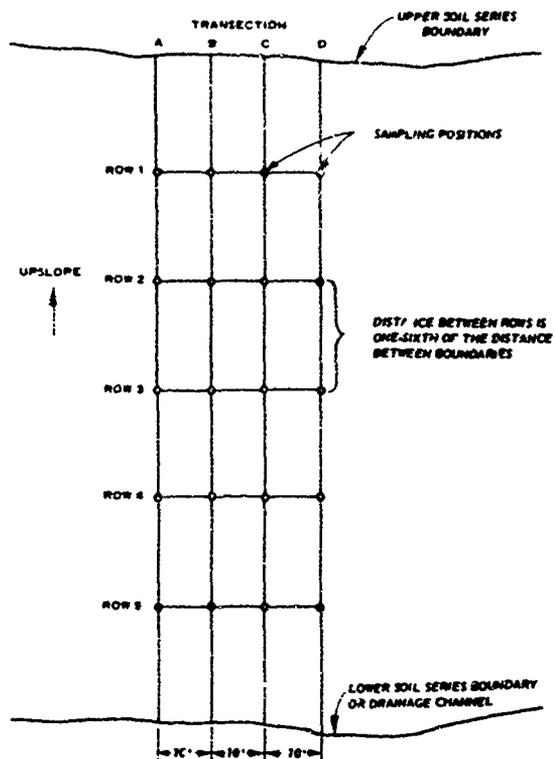


Fig. 2. Site layout

equidistant rows were established at each site, with spacing between rows governed by the site length. Four sampling positions (A, B, C, and D) were located 10 ft apart along each row.

#### Description

11. The locations and descriptions of the test sites including notes on topography, drainage, vegetation, and land use are given in table 1. Photographs of the sites, inset soil survey maps of areas of 1/2-mile radius around the sites, and the orientation of the sites are shown in plate 1.\* More than 50 percent of the areas are mapped as soil series complexes of two or more dominant soil series. For example, 90 percent of the area surrounding site M VIII, a Memphis soil, was mapped as soil complexes. Macrogeometry and microgeometry of the test sites were described by the Geology Branch of the WES, using semiquantitative techniques devised by them.<sup>5,6</sup>

#### Selection of Test Plots

12. During sampling at the sites it became obvious that there were inclusions of soil other than that of the mapped soil series. The inclusions were not unexpected since small areas of unlike soils are difficult, if not impossible, to delineate and show at the scale of the soil survey maps. To determine the prevalence and nature of these inclusions, the soils were identified in the field by row, and the series identifications were changed where necessary.\*\* Each two or more rows at a site of the same soil series identified in the field were grouped together for analysis and designated as a plot. Rows of a plot were not necessarily adjacent. Thus, a site identified in the field as a single soil series consisted of one plot; another site identified in the field as two soil series consisted

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\* The soil maps were taken from unpublished field sheets of the standard soil survey conducted by the Soil Conservation Service of the U. S. Department of Agriculture. Subboundaries separating classes of erosion and slopes are not shown. The results of the soil survey and the maps were published subsequently in 1964.<sup>4</sup>

\*\* Identifications were made by Mr. Y. H. Havens, State Soil Correlator, Soil Conservation Service, Jackson, Mississippi.

of two plots. A cross-reference of soil series by sites and plots is shown in table 2. Field identifications were not made at five sites because the sites or access avenues to the sites were inundated at the time the identifications were made; of the remaining sites the series identifications were changed for 36 of the 95 rows, resulting in a grouping of soils into 23 plots, each with two to five rows. Single rows of a field-identified soil series were not designated as plots and were not included in plot and row analysis. In the uplands the major changes of the field identification were the delineation of areas of alluvial fill and the Henry series from areas mapped as Memphis. In the bottomlands, field identification of Collins and Falaya frequently differed from map identifications. The Hymon series was identified from soils mapped as Collins. Two different soil series were identified at each of four sites.

#### Data Collection

13. Samples were collected once at a site to obtain data on the static properties of the soil; four visits were made to obtain data on the dynamic properties of the soil for a range of weather conditions. Data were obtained from each of the 20 sampling positions at a site. Tests on successive visits followed a preset pattern that included moving the sampling position one pace from a previous location to preclude testing soil that had been disturbed in a previous test.

##### Static properties

14. One-pint bulk samples were taken from the surface to 6-in. and 6- to 12-in. layers and analyzed following standard test procedures,<sup>7</sup> for liquid and plastic limits, specific gravity, and grain sizes. Soil cores were taken with the modified San Dimas soil sampler in 3-in. vertical increments from the surface to a depth of 12 in. and used to determine dry density and soil moisture content at saturation, 0.015-, 0.03-, and 0.06-atm tensions.<sup>8,9</sup>

##### Dynamic properties

15. For those properties that vary with time, sampling and

measurements for a given visit to all sites were obtained as quickly as possible to prevent inconsistencies in test results that could result from interim drying or wetting of the soil. Samples for moisture content were taken from the surface to 6-in. and 6- to 12-in. layers, and a remolding index test was conducted on a sample from the 6- to 12-in. layer. Cone penetrometer measurements were taken at 3-in. vertical increments from the surface to 18 in. It was necessary to measure strength when the soil was fairly moist to be within the range of the test instruments. The first winter season was dry, and although two visits were made, the soil was too firm to obtain a sufficient number of strength measurements for analysis. Following a heavy rain in April, another visit was made (visit A). To assure getting data from firm soils, a 0.2-sq-in. cone penetrometer was used. Because of the dry condition experienced on previous visits, no attempt was made to measure moisture contents or take remolding index samples from the 6- to 12-in. layer. In late February of the second winter, a full round of testing was accomplished (visit B). A few days later a 5-in. rain occurred, and an abbreviated set of tests was conducted for check purposes (visit C). Three cone penetrometer measurements were taken at the A position of all rows, and moisture and remolding index samples at the A position of rows 1, 3, and 5. A final visit (visit D) was made in May to collect data for drier conditions. Sampling was the same as on the third visit, except that moisture samples were taken at position A of all rows.

16. Sampling and measurements followed standard test procedures.<sup>1</sup> Moisture contents were determined by oven-drying the soil to a constant weight. For the surface to 6-in. average cone index, the surface, 3-, and 6-in. readings were averaged; for the 6- to 12-in. average cone index, the 6-, 9-, and 12-in. readings were averaged.

### PART III: ANALYSIS

17. A small area, considered uniform from a trafficability standpoint, varies because of point-to-point differences in soil materials and moisture content; however, for practical purposes, the area is considered to be of one kind or under one condition of the soil. In a larger area, variation is generally greater because of a gradual change in soil material or condition across the area, or inclusion of different kinds of materials or conditions. For trafficability purposes, it is desired to delineate between areas of relatively uniform soil material or condition. In this study, data of soil properties meaningful to trafficability were grouped by soil series and layer, and by topography, site, plot, and row, and analyzed to determine the variability for areas differing in size. Basic data obtained in this study are given in detail in Appendix A.

#### Variation by Soil Series

18. One means of distinguishing soil kinds is by soil series, in which soils are grouped pedologically, according to similarities in properties, layer, and parent material. This description is widely used in agriculture and is the basis for delineating soils on most soil maps, so the logical start in the study of variability was to test the usefulness of series as a means of differentiating trafficability conditions. Data from soil series identified from maps (at sites) and from soil series identified in the field (at plots) were analyzed to determine the differences of soil properties for each grouping.

#### Soil series identified from maps

19. The soil series identified from maps included Memphis and Loring in the uplands, and Collins and Falaya in the bottomlands. An analysis of variation of soil properties between series was compared with variation between sites within series.<sup>10</sup>

20. Soil properties, including grain sizes, plasticity, specific gravity, density, and moisture content at 0.06-atm soil moisture tension, were analyzed by 6-in. layers. Results, given in table 3 under "Series

Identified from Soil Maps," include mean values for each soil series, derived from average site values, and the standard deviation of the site values. The probable significance of differences between series values for each property was determined from the statistical F-value; i.e. the ratio of the variance between series to that between sites within series.<sup>11</sup> For example, the average values of sand content for Memphis, Loring, Collins, and Falaya soils are 12, 10, 15, and 12 percent, respectively, whereas the standard deviation of a site value within any series is  $\pm 1.7$  percent (table 3). The F-ratio of variances is not significant (NS), having a value of 1.44, whereas a minimum F of 2.74 is needed to show a significant difference among series; i.e., the spread of values in sand content between series is small compared to the variability between sites within series.

21. The values for sand, silt, fines, and plastic limit did not differ meaningfully among soil series (see table 3). However, differences in values of clay content for the 0- to 6-in. and 6- to 12-in. layers, and liquid limit and plasticity index for the 6- to 12-in. layer, are indicated between uplands and bottomlands soils rather than by series; the uplands have higher values than those of the bottomlands. Differences also exist in dry density and soil moisture content (0.06-atm tension) values, primarily between the Falaya bottomland and Loring upland soils. However, the Collins bottomland and Memphis upland soils do not differ in these properties. Cone index and moisture content data are not shown here because they had not been collected at this stage of the analysis.

Soil series identified  
from field observation

22. Analysis by static properties. A second analysis was made using data for series identified in the field. Results, shown in table 3, under "Series Identified from Field Observations," are essentially the same for the Memphis-Loring upland soil series and Collins-Falaya bottomland soil series as in the analysis of the soil series identified from maps. Statistical analyses for silt, fines, and plastic limit were not made because the analysis of mapped soil series had shown that these properties were extremely uniform; the similarity of series mean values may be noted in table 3. Also, as in the analysis of series identified from maps,

differences occur in clay contents, liquid limits, and plasticity indexes, particularly in the 6- to 12-in. layer. Clay contents in the 6- to 12-in. layer of the Memphis and Loring upland soils averaged 23 percent; those of the Collins and Falaya bottomland soils averaged 12 percent. The liquid limits of the upland soils averaged 43 percent; those of the bottomland soils averaged 32 percent. The plasticity indexes of the upland soils averaged 19 percent; those of the bottomland soils averaged 7 percent. Thus, distinct differences were again indicated between Memphis-Loring upland and Collins-Falaya bottomland series groupings for soil properties that are generally used in soil classification. The soil property values of alluvial fill and the Henry series in the uplands were different from those of the Memphis and Loring series from which the soils were separated, and were similar to the values for bottomland Collins and Falaya series. The Hyman soil, not of pure loess origin, had a higher sand content than the others.

23. Analysis by dynamic properties. Surprisingly, cone index showed no statistically significant differences between series for either soil layer on any sampling visit. Hence, even though the soil series were correctly identified, the series designation was not useful for differentiating these loess soils by cone index. Some trends were evident, however. The strengths of the upland Memphis and Loring series were higher than those of the bottomland Collins and Falaya series at the less moist conditions (on visits A and D), but were almost the same at the more moist conditions (on visits B and C). Also, soils of the alluvial fill and Henry series, that had been separated from the upland Memphis and Loring series, had consistently low strength, usually lower than the bottomland soil series on all visits.

24. Moisture contents differed significantly between series, primarily in the surface to 6-in. layer. Bottomland Collins and Falaya soils had higher moisture contents than the upland Memphis and Loring soils, but at the more moist conditions of visits B and C, differences were small. Moisture contents of the alluvial fill and Henry series of the uplands were as high or higher than those of the bottomland soils on all visits.

25. On the basis of data from the four visits, it can be concluded

that cone indexes of soil series of intermediate drainage are not different. However, lower cone indexes are indicated for soil series with poor drainage than for soil series of intermediate drainage. The analysis shows that even though differences in physical properties (including moisture content) of the soil may occur between series, there may be no meaningful differences in cone index. This statement does not preclude the possibility that strength differences in loess may be differentiated on some basis other than pedological soil series, or that soil series classification may be useful for differentiating strengths of soils from diverse parent materials.

#### Variation by Plots and Rows Within Uplands and Bottomlands

##### Division into groups

26. An analysis of variance by plots and rows was conducted on Memphis, Loring, Collins, and Falaya series identified in the field. The other field-identified series were not included because the data for these soils were insufficient for proper analysis. The nine plots of Memphis and Loring and the ten plots of Collins and Falaya were grouped into uplands and bottomlands, respectively. This grouping simplified calculations and was deemed proper because previous analysis showed a similarity of properties between series within each of these groups (see paragraphs 21 and 22). Results of the analysis are given in table 4.

##### Variation by plots

27. Analysis by static properties. The data show differences in mean clay contents, liquid limits, and plasticity indexes between uplands and bottomlands of the 6- to 12-in. soil layer similar to those found in the analysis by series. However, significant differences in those properties also occur between plots within each group, with the exception of liquid limit in bottomlands. For the surface to 6-in. layer, as in the analysis by series, no differences occur between groups for liquid limit and plasticity index; however, differences again occur between plots within each group. Differences in sand content, dry density, and moisture content at 0.06-atm soil moisture tension were recorded between plots within each group, but only small differences were found for specific gravity. Silts,

finer, and plastic limit were not tested because the small range in plot values precluded any significant difference between plots. In some instances, differences between plots were greater than those between upland and bottomland groups.

28. Analysis by dynamic properties. Highly significant differences in cone index and moisture content were found between plots in both groups for each of the visits.\* The differences in cone index between plots contrast sharply with the findings in the analysis by series (see paragraph 23). Also important is the similarity in the means and ranges of cone indexes and moisture contents between plots of uplands and plots of bottomlands for each of the visits. The range in cone index of bottomland plots overlapped that of the upland plots except for the less moist soil conditions of visits A and D, when some of the upland plots had higher strengths. The overlap of values in ranges of moisture contents between uplands and bottomlands was not as inclusive as that for cone indexes, but was still considerable when compared to the discrete ranges for clay, liquid limit, and plasticity index in the 6- to 12-in. layer.

Variation by rows

29. Data from rows within plots were analyzed with the variance attributable to plots excluded (table 4). For most properties, appreciable differences occurred between rows of the uplands and between rows of the bottomlands. The ranges of cone index values of the two groups were similar on all visits, and the mean strengths were about the same on visits B and C, but were somewhat higher in the uplands on visits A and D. The pattern of differences between rows was the same as between plots except that values for the rows exhibited more overlap than those for the plots in the 6- to 12-in. layer for clay content and liquid limit. Row data had a wider range than plot data and the distinction between uplands and bottomlands was not as good. The data indicate that trafficability cannot be discretely quantified by soil series designation or upland-bottomland groupings because of the large cone index variability of plots and rows within the larger units.

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\* Moisture contents for visits C and D were not included in this analysis because sampling was not complete on all rows.

## Variations of Plots and Rows

### Comparison of plot cone indexes

30. The array of cone index values for all plots regardless of series and upland-bottomland groupings was next examined. Cone index values for the four visits were averaged, and the array arranged in order of increasing values. Visit values were graphed in the same sequence (plate 2). Some irregularities in visit values are apparent, but in general, the progression for each visit follows that of the average, showing the consistency of plot differences irrespective of time of sampling. The general intermingling in the array of plots irrespective of series and upland-bottomland groupings reveals why no differentiation by series or groups was found. Three Loring plots in the upland (L1, L2, and L4) had high strengths, but the next plots (F2 and C2&F7) of slightly lower strengths were bottomlands. Of the seven weakest plots, five, including one Loring, were uplands. However, of these, two plots of alluvial fill and one plot of the poorly drained Henry series were inclusions that had been separated from the mapped Memphis series. A true Memphis soil also occurred in this group.

31. Two of the four sites, each of which was divided into two plots after field identification of the soil, showed such similar cone indexes throughout the site for the four-visit average that the plots within each were recombined for this part of the analysis, namely plots C3 with F6, and C2 with F7. Plots of the other two sites had distinct cone index differences; the second weakest plot, AF2, was separated from the seventh strongest plot, M4, and the third weakest plot, HNL, was separated from the strongest plot, M3.

### Relations between cone index and other soil properties by plots

32. Analyses were made to determine the relation between plot cone indexes and other soil properties of the plot, including dry density, moisture content, plasticity index, and clay content, in the 6- to 12-in. layer. The relations are shown in plate 3. Moisture contents and cone indexes were averaged for all visits to a plot, and each average was

used to characterize the plots. Dry density showed the best probable correlation, exhibiting high strength at high density, but the range in values was small (0.11 g per cc). Moisture content showed poorer correlation (significant at 5 percent level), but with a large range of values (from 23 to 31 percent) and was inversely related to cone index. Correlations were poor with plasticity index (significant at 20 percent level), and clay content (not significant at 20 percent level) and with other soil properties including liquid limit and silt content (not shown).

33. Although it is well established that grain sizes and plasticity constants are related to soil strength, the poor correlations of these properties indicate that they cannot be used to explain strength differences between plots in this study; their effects were secondary to those of such properties as moisture content and dry density. The irregularities in the trends of the arrays of plot values occurred whether correlation was good or poor, although they were more pronounced in the poor correlations. Why upland plots M1 and L3 have the normally low strength of bottomland soils but other soil properties characteristic of the upland soils, and why bottomland plots C2 and F7 and F2 have the normally high strengths of the uplands are not explained completely by moisture content or dry density data. The implication is that other factors not defined in this study contribute significantly to the variation.

#### Comparison of row cone indexes

34. The analysis of variance of soil properties showed highly significant differences between rows. However, the analysis did not indicate which rows were different or the persistence of difference with time, so variation by rows was examined in more detail. For the first comparison, rows of a plot were ranked from 1 (weakest) to 5 according to increasing average strength for all visits. Then rows of a given rank from all the plots were averaged for each visit (plate 4). A consistent difference in cone index is found between the high- and low-strength rows for all visits; differences are indeterminate for intermediate rows.

35. The cone index of the lowest strength row was not always statistically different from that of the highest strength row in a plot or from the plot average of the remaining rows, so a pooled variance based on all

visits (derived from pooled standard deviation in table 4) was used to select extreme rows (i.e. those with statistically different high and/or low average cone indexes) in each plot. Only three rows, AF1 row 3, C3 and F6 row 3, and HYL row 2, had higher values than the plot average of the remaining rows, whereas 13 rows had lower values. Two rows with low strengths were found in each of three plots, F2 rows 2 and 3, L2 rows 2 and 5, and L1 rows 2 and 3. Soft areas occurred in a plot far oftener than did firm areas and were found throughout the array, although the strongest plots had the double soft rows. Soft rows were found at any row position. The average difference between the low-strength row and the plot average of the remaining rows was 93 CI; the median difference was 63 CI. Either difference is appreciable in terms of trafficability.

36. The cone index values of 10 plots with low-strength rows were plotted by visits in plate 5. The data show a consistent difference in cone index between the average for the plot, excluding the extreme rows (described in paragraph 35) and the low-strength row. Individual measurements of the low-strength row generally cluster about the row mean, showing that all points in the row were uniformly low in strength and the low value of the mean was not caused by a few erratic values. Some individual measurements in the low-strength rows were higher than plot averages on visit A, but not on visits B, C, and D.

#### Relations between cone indexes and other soil properties, by rows

37. Analyses were made to determine whether the cone indexes of low-strength rows would correlate with other soil properties of the row. The procedure followed that relating plot cone index to other soil properties, discussed in paragraph 32, except that the cone index of the low-strength row was compared with the average cone index of the plot excluding the extreme rows. The B, C, and D visit values of cone index and moisture content were averaged and used as area indexes of strength and moisture, respectively. The relations of cone indexes of low-strength rows and of cone indexes of plot averages with other soil properties including dry density, moisture content, clay content, and plasticity index were similar to those found in the previous analysis of plots (see plate 6). A good

positive correlation occurred between cone index and dry density; a good inverse correlation occurred between cone index and moisture content; and no relation existed between cone index and clay content or plasticity index.

38. When average plot values (extreme rows excluded) were compared with the low-strength row values, the row value of dry density was always lower than that of its plot and the row value of moisture content was higher than that of its plot with one exception (plot F1). No pattern appeared between plots and rows for clay content and plasticity index. The differences among row strengths, like the differences among plot strengths, cannot be ascribed to differences in the grain size or plasticity of the soil, but must result from differences in density, moisture content, and other factors, such as those governing reception and retention of water, state of packing, structure, etc. The low-strength row is a small areal unit distinct from the average of the rows in the plot.

#### Relation of cone index and moisture content

39. In the analysis for correlations between cone index and moisture content of plots and rows previously discussed, values for the visits were averaged to provide one value for each area irrespective of time. In this analysis, soil strength-moisture relation is based on data averaged for the plot for each individual visit. The graphs of cone index versus moisture content for the 0- to 6-in. and 6- to 12-in. layers show inverse relations (plate 7). The spread of values at a given moisture content (about 200 CI for the surface to 6-in. layer and about 150 CI for the 6- to 12-in. layer) is too great for meaningful grouping of these loess soils together as one trafficability unit. Grouping by soil series for the 6- to 12-in. layer (plate 8) shows more closely defined relations, especially for the Memphis and Loring series. However, the spread of plot values even for a given visit (ranging about 100 CI) indicates that additional criteria are needed to accurately differentiate areas of dissimilar cone indexes within areas of the same series on the same day. The number of visits to a plot were too few to truly determine soil moisture-strength relations.

### Remolding index variation

40. Only 200 remolding tests were made, compared to nearly 1000 cone index tests, because the soil was generally too firm to permit insertion of the remolding sampler. The data were not only sparse, but they were biased also because only the weak spots were tested. One hundred sixty-one of the tests were made on visit B, and 71 of these were on Falaya plots; only 25 tests were made on visit C and only 14 tests were made on visit D. A rigorous analysis could not be made because of the data limitation and bias; nevertheless, some measure of variability was obtained.

41. Data at all four sampling positions in a row, used for analysis of variance between rows, were collected from only 31 rows on visit B; 15 of the rows were Falaya. A difference in remolding index between rows was found. The standard deviation was  $\pm 0.12$  RI for a sample within a row, a measure of variability in a uniform area of these loess soils. When remolding index data were analyzed as individuals, irrespective of rows, the standard deviation was  $\pm 0.16$  RI and the mean was 0.47 RI.

42. Data from the other 76 tests, from rows with less than four remolding index tests, were grouped by visit, series, and then by all tests together, and analyzed. The results and those of an analysis of data from all 200 tests are as follows:

	<u>No. of Samples</u>	<u>Mean Remold- ing Index</u>	<u>Standard Deviation <math>\pm</math></u>
Visit			
B	37	0.53	0.16
C	25	0.55	0.21
D	14	0.69	0.34
Series			
Alluvial fill and Henry Memphis and Loring	23	0.48	0.29
Collins, Falaya, and Hymon	33	0.59	0.18
All samples, <4 sampling positions/row	76	0.57	0.23
All samples	200	0.51	0.20

The mean remolding index is highest for the drier soils of visit D, and the variability of the soil for this visit is proportionally higher. Although the alluvial fill-Henry group had the lowest mean remolding index, it had the largest range of values; seven samples were less than 0.25 RI and five samples were more than 0.60 RI, including one with 1.68 RI, the highest in the study. The upland (Memphis and Loring) group had about the same mean remolding index and standard deviation as the bottomland (Collins and Falaya). The variation of all samples was almost twice that within rows.

43. The plot averages of remolding index were graphed versus those of moisture content for all visits (plate 9) and show an approximate inverse relation. Similar graphs of remolding index versus dry density, clay content, liquid limit, and plasticity index were made, but no trends were indicated. Plot and row differences could not be determined from these data.

#### Influence of Rainfall, Terrain, and Other Factors

44. Results showed that cone index values of small areas, such as rows or plots, could not be applied with reasonable accuracy to large areas, designated by soil series or upland-bottomland groups, due to the large and overlapping ranges in values for the small areas. Furthermore, the soil classification parameters could not be used to differentiate the high-strength from low-strength areas; clay content and plasticity index did not correlate with strength differences among plots or rows, even though these properties differed as much as 15 percent among plots or rows. The influence of these properties on strength apparently was masked by more dominant influences of other factors. Significant moisture content differences were found for certain plots and rows irrespective of soil series. Since moisture content correlated with strength, moisture differences within a plot are undoubtedly one cause of the strength variations in plots and rows. Questions arise as to why the moisture differences existed, how the moist spots can be ascertained and accounted for in trafficability estimations across an area, and whether factors other than moisture contribute materially to the strength differences.

#### Moisture conditions at sampling

45. Wetting or drying during sampling can produce differences in soil moisture and strength that would mask the inherent variability between areas. To minimize these effects between sites for a particular visit, sampling was accomplished in one day with no rainfall, and in winter or spring when the rate of drying is small. The moisture condition can be considered the same throughout the testing area (although moisture contents were not) as sampling progressed during a visit day.

#### Antecedent rainfall

46. The effect of antecedent rainfall on plot strength differences is believed to be small, since sampling was done in late winter and spring when rains are general and soils are near the field-maximum moisture content. There is no positive assurance that antecedent rainfall was uniform, since rain gages were not maintained at the test sites; however, at weather stations 10 to 30 miles away bracketing the test area, rainfall measurements were relatively uniform for 19 days preceding each visit. The amounts, tabulated below, indicate that the entire area, including the test sites, received fairly uniform precipitation.

Rain Gage Station	Location of Station from Sites	Rainfall, in.			
		Visit A	Visit B	Visit C	Visit D
Germania	North	5.22	2.20	6.72	2.78
Vicksburg	West	5.27	2.84	5.46	3.93
Oakley	East	3.41	2.47	6.61	3.74
Utica	Southeast	4.69	1.87	5.97	2.95
Port Gibson	South	4.21	1.97	4.38	3.97

47. Plot data substantiate the uniformity of precipitation. Sites were generally located in two clusters, 18 miles apart (fig. 1) with a few sites outlying from them. Strength and moisture differences between plots less than a mile apart within a cluster were as great as between clusters, and large differences occurred between plots at the same test site, 50 to 100 ft apart. Thus, strength differences did not exhibit an areal difference that can be attributed to rainfall pattern.

#### Water table

48. Part of the moisture differences may arise from differences in

depth to shallow water tables, which were not considered. However, the differences between plots were as great in the uplands as in the bottomlands; the upland soils, except for the Henry plot, were moderately to well drained, supposedly with no influencing water table within the surface 4 ft of soil.

#### Density and structure

49. The moisture differences did not explain all the strength differences between rows and plots; the low-strength rows had lower strengths than the balance of the plots at comparable moisture contents. Soil density was associated with strength, shown by the positive correlations for plots and rows. Density differences are due in part to structure of the soil (i.e. the arrangement, size, and durability of the clumps or aggregates of the soil) but structure may influence strength directly. Structural differences in the surface layers could have originated by several means. The structure of recently transported material is quite different from that of soil developed in place. The transported material occurs in the bottomlands, but can occur in fill areas of the uplands. These fills may have the same texture, plasticity, and even moisture content as the mature soil, yet strength may differ due to structural differences per se. Soil layers or horizons, such as the surface A horizon and subsoil B horizon, differing in structure, density, and other properties may occur at the same depth due to differential erosion or to development of different thicknesses in a horizon between rows or plots. Structural differences may also result from differing cultural practices. A pasture developed from a woodland can differ from a pasture developed from an old field. Soil structure was not determined in this study because quantitative procedures for determination were not available.

#### Organic matter

50. Organic matter content, which is not generally considered in WES studies relating properties of soil to strength, can influence soil strength directly or indirectly through its effect on moisture content, plasticity, and structure. The organic content can change with cultural practices and over short distances. Threshold values and quantitative relations of the effect of organic matter on soil strength are unknown.

## Terrain

51. The terrain configuration can influence the reception and retention of water with runoff from high spots to low spots. Thus, moisture content differences could occur even though the rainfall pattern was essentially the same over the area. An analysis of the terrain configuration may indicate areas of differential erosion and deposition that relate to differences in soil structure and organic content.

52. Topographic position. A qualitative topographic position classification used in trafficability studies recognizes uplands, terrace, and bottomlands with subdivisions of flat, depression, upper slope, and lower slope. The divisions are not well defined, and classification, in many cases, depends on the judgment of the field observer. In the study reported herein, some sites were 540 ft long and included more than one topographic position. Classification at all sites was done by row, and rows of different topographic positions were examined for differences. The flat areas of the uplands tended to have the lowest strengths; no other trend could be discerned. Most Collins and Falaya rows were bottomland flats, so no differential grouping could be made. This study indicates that a more rigorous definition of classes is needed to enhance the utility of this classification for trafficability purposes.

53. Terrain geometry. The Geology Branch of WES classified microgeometry of each site for trafficability use, using 50 ft of the length and the full width of the site.<sup>6</sup> Macrogeometry was also classified within a half-mile radius of each site. The relations between cone index and microgeometry and macrogeometry factors are considered here.

54. Microgeometry factors included overall slope, number of slope reversals, modal relief differences, and surface length increase. Cone index of the row nearest the geometry profile was used as a strength measurement. Some trends were shown, as for modal relief differences (plate 10), but scatter generally was wide.

55. Macrogeometry classification was based on terrain conditions within a half-mile radius of the sites (plate 1), so both row and plot strengths were considered. The factors classified included plan profile, characteristic slope, and characteristic relief. An additional factor,

occurrence of slopes steeper than 50 percent, was not used since most sites were in the same slope occurrence class. The macrogeometry factors showed trends with cone index as good or better than the trends for microgeometry factors (plate 10). The broad, flat areas with low relief had lower strengths than the more dissected areas in both uplands and bottomlands, but the point scatter was wide for each of the factors. The relation between row and plot cone index values was better than that between cone index of plot and any of the microgeometry or macrogeometry factors. Results indicate that these factors can aid in estimating trafficability conditions, but they must be improved, perhaps by using the mesoscale, before they can be of any value in accurately predicting trafficability. The terrain surrounding the area of concern also must be defined with reference to its influence on trafficability, though not necessarily by a fixed dimension, and not necessarily equally in all directions.

56. Terrain and plot values. Field notes, topographical maps, and aerial photographs were examined to obtain data on terrain features on and surrounding the plots. The data were compared with cone index of the plots to determine the influence of the features on trafficability. Features studied were distance to hillcrest above row 1; relief difference above row 1; convex or concave curvature of plot surface compared to surroundings; degree of erosion; area of watershed above site; valley floor width; and creek bed depth. Data were listed in order of increasing cone index (table 5). Examination of the data shows that in the uplands curvature of the area and strength are related, with strength lower in concave areas than in convex ones. In the bottomlands, sites in the lower parts of large watersheds had lower strength than sites in the upper reaches, with little drainage area above them. Other features such as degree of erosion, valley width, and creek depth exhibited some trends. Thus, some terrain features can be used to distinguish kinds of trafficability conditions. When they are recognized and taken into account, better deployment of vehicles and prediction of their movements will be possible.

57. Terrain and low-strength row values. Possible influence of features of terrain on extreme low-strength rows was considered next. Differences in strengths between rows could not be resolved from examination

of maps and photographs, so field notes were used to provide information. Data were sparse, so only general observations are offered to explain the low-strength rows. Row M1-5 occurred at the lower end of a concave slope. The soil of row AF1-2 consisted of deep local alluvium which was upslope from shallower local alluvium, resulting in conditions conducive to the development of a perched water table that may have influenced the strength of the soil. Row C3&F6-4 was possibly a filled old drainageway. Row F1-1 was near the toe of a slope and had overlying alluvial fill, but the alluvial fill was not deep enough to classify the row as such. Row L1-3 was a concave row in an otherwise convex plot. Row L5-5 may have been upslope from an old erosion-control terrace. Information was insufficient to suggest a cause for the low-strength rows of the other four plots. Although terrain features noted herein generally are too small to map, they should be observed and considered in any trafficability analysis because they can immobilize a vehicle. The development and use of a suitable terrain geometry classification may have the most immediate promise for differentiating trafficability conditions within areas considered uniform in soil type but variable in soil strength.

#### Sampling Requirements

58. The number of samples required to test areas of soil considered uniform should be sufficient to provide values within limits of a desired accuracy. For trafficability purposes, areal units for testing and application should be relatively uniform in strength. Data on soil properties used in estimating soil strength should be obtained from samples from the same areas. This study showed that neither series, upland and bottomland groupings of series, nor plots defined an area uniform in cone index. Because of the large variation in strength within these areal divisions, their use would result in large error in the delineation of trafficability conditions. Sampling requirements for these areas also would be large. The row was used for estimating sampling requirements. The 30-ft-long row, corresponding in length to test sites of previous moisture-strength studies, is a minimal size for sampling, approximating the length of most military vehicles.

#### Sampling by rows versus clusters

59. Row uniformity was checked using cone index measurements of the four visits. On visits A and B samples were taken at 10-ft intervals along the 30-ft row; on visits C and D three samples were taken in a cluster (within 1 ft of each other) at position A. The need to sample all plots within one day and the limited number of personnel available for testing prevented taking both cluster and row samples on the same visit, although this would have been desirable. Data from the upland soils (Memphis and Loring) and bottomland soils (Collins and Falaya) were used. Data were divided further into wet soil condition for visits B and C and moist soil condition for visits A and D.

60. To check consistency of variation between visits divorced from row or cluster effect, single samples from position A of all rows were analyzed (table 6). A difference in variation, expressed by standard deviations and coefficients of variation, occurred between wet and moist sampling conditions; however, with either condition variation was consistent between visits or between upland and bottomland positions. Next, the first three samples in a row were compared with the three in a cluster. The standard deviations of individuals in the triplicate sampling were very close to those of single samples, showing that the pattern of variation was the same. The between rows or cluster effect was next removed, so that variation within rows could be compared to that within clusters. The standard deviations and the standard error of means show that there was some increase in variability in going from the smaller area of clusters to the larger area of rows. The standard error of the bottomland soils increased from 12 to 18 CI on the wet soil condition visits, and from 27 to 39 CI on the moist soil condition visits. It should be noted that a twofold to threefold greater variability occurred between moist and wet conditions than between cluster and row sampling. Thus, the variability of the row can be used as a reasonable measure of the basic variability of these soils, although the basic variation of cone index is larger than desired (for triplicate sampling the standard error was about 16 units when wet and 38 units when moist).

#### Estimating number of samples

61. With knowledge of basic variation (i.e. the standard deviation or error mean square), a value for allowable error or desired accuracy, and the probability level for attaining that accuracy, the number of samples required to give an acceptable average value of a property can be calculated.\*<sup>11</sup> The error terms were derived from pooled deviations (table 4) since the upland and bottomland groups did not differ in trafficability characteristics. The plot and row means of the soil properties varied as much in the uplands as in the bottomlands, and their ranges overlapped, so separate sampling plans were not prescribed.

62. The estimate for number of samples can vary considerably, depending upon the desired accuracy (i.e. allowable error) of the factor and the probability level for attaining that accuracy. A larger number of samples would be prescribed for a highly accurate average (i.e. within a narrow range) and for a high chance of success for the average to fall within the narrow range than for an average with a lower accuracy (i.e. within a broader range) and lesser probability. Also, for a given accuracy and probability, a highly variable material (i.e. one with a high standard deviation) would require more samples than a more uniform material. The estimate for number of samples must consider both the desired result and the nature of the material; a close tolerance for highly varied material would lead to a prohibitive sampling requirement.

63. Cone index and moisture content measurements in natural soils vary more than those for grain size, plasticity, and other static properties. A lesser probability level of 20 percent was used for these dynamic properties compared to 5 percent for the static properties. This indicates that there is a 20 percent chance that the measured mean for cone index or moisture content will differ from the true mean by more than the desired accuracy, but only a 5 percent chance that the static properties will. The use of a lower order of probability for natural conditions that are inherently variable is accepted in various fields, e.g. weather and rainfall forecasting.

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$$* \text{ Number of samples } (n) = \frac{[\text{probability } ("t")]^2 \times [\text{standard deviation } (s)]^2}{[\text{allowable error of factor } (L)]^2}$$

64. The desired accuracy for an average value of a factor for a row was selected considering what is meaningful and attainable. Cone index accuracy, the primary consideration for trafficability, was set at  $\pm 10$  units. The magnitude of variation within the row (table 4) was too great to justify selection of a smaller value. In fact, variation of cone index on the moist soil condition visits was relatively high so that the accuracy range had to be increased to  $\pm 20$  units to keep the required number of samples reasonable. Cone index was above 200 on the moist soil condition visits, so the lower accuracy would not be critical. A 1 percent accuracy was selected for moisture content because previous studies have shown that for many soils a change of 1 percent results in a change of 20 CI. Three percent was considered a reasonable degree of accuracy for most static properties and 0.04 g per cc for dry density, since this is equivalent to a pore capacity change sufficient to retain 1 percent moisture for the average soil.

#### Sampling requirements for rows

65. The estimates of the number of samples for cone index varied by visit and soil layer (table 7). About 10 samples were needed for the wet soil conditions of visits B and C, but more were required for the moist conditions of visit A, even though the range of allowed accuracy was greater. The number of samples for remolding index was three for an accuracy of  $\pm 0.10$ , and 10 for an accuracy of  $\pm 0.05$ . The latter accuracy is not unrealistic; a difference of 0.10 RI is 10 RCI at 100 CI. The data collected for this study provided little opportunity to evaluate the number of moisture content samples since rows did not have replicated samplings on visits C and D. However, for visit B, the required number of samples for both layers (5) was less than half that required for cone index (11 for the 0- to 6-in. layer and 18 for the 6- to 12-in. layer). About five were required for most static soil properties. In current studies, three samples are taken—at the top, middle, and bottom sections of the plot—and composited as one sample for analysis. Estimates of sample number for dry density and moisture tension, determined on core samples of natural soils, ranged from two to six. At present, three samples are taken for each layer. This study shows that the number of samples required to properly

characterize loess soils are greater than are currently being taken in trafficability prediction studies. A need to increase the sampling intensity by 30 to 60 percent to attain a minimum desired accuracy is indicated.

#### Applicability of These Results to Other Soils

66. The soils investigated in this study were derived from loess, which is one of the more uniform soil parent materials. Mean values by grain size, plasticity, and density (table 3, field observations), were practically identical between series and between layers except for the 6- to 12-in. layer of the Memphis and Loring upland soils. The higher clay contents, liquid limits, and plasticity indexes of these soils reflected the genesis and illuviation of clay from the upper A to the B horizon. In contrast, strength measurements varied, which can be partly attributed to local differences in moisture content. These local differences are not unique to loess, but will occur in any soil, regardless of parent material. In comparisons of diverse soils, such as silt with clay, expected correlations of strength with grain size and plasticity may be poorer than anticipated, as evidenced in this study, because of the influence of other unknown factors. In other strength studies covering a variety of soils from locations throughout the United States, relations with the known physical properties were relatively poor. Obviously, other factors need to be defined to account for strength differences.

## PART IV: CONCLUSIONS AND RECOMMENDATIONS

### Conclusions

67. The following conclusions can be made from this study:
- a. Neither map- nor field-identified soil series of moderate- to well-drained loess soil in Warren County, Mississippi, can be used to delineate with sufficient accuracy areas of uniform trafficability. Also, no distinction in trafficability can be made for these series grouped into uplands and bottomlands even though differences do occur in clay content and plasticity constants in the 6- to 12-in. layer (table 3 and pars. 21-25).
  - b. Inclusions of soils, different from those mapped and with lower strengths, were found within the mapped boundaries. These soils, recent alluvial fills and a poorly drained Henry series, covered areas of sufficient size to pose problems in trafficability and should be accounted for, even though some of these areas are too small to depict on maps (table 3 and pars. 12, 23-25).
  - c. The variation of soil strength and moisture content within small areas (plots and rows) was large and masked real differences that may exist between soil series or upland and bottomland series groupings. Because of the large variation, values derived from small areas cannot be applied to large areas with any degree of confidence (table 4 and pars. 28 and 29).
  - d. The cone index differences among plots and rows were significant and consistent for the four visits (plates 2 and 4, and pars. 30 and 34). These differences can be ascribed to differences in local conditions of terrain and soil, rather than to differences in rainfall patterns or other meteorological events (pars. 45-47).
  - e. Small areas of low strength were found as inclusions within larger areas of higher strength (plate 5 and par. 36). These low-strength areas are difficult to identify and explain because the soils are not pedologically distinct and do not substantially differ in grain size or plasticity from soils of the larger enclosed area (plates 3 and 6, and pars. 32, 33, 37, 38, and 44). A suitable terrain geometry classification may have the most immediate promise for identifying these small areas. Differences in the geometry of terrain are observable and suggest probable differences in the reception and retention of water which this study shows, by inference, to be factors that can account for soil strength differences. The terrain geometry also may indicate other

differences associated with surface water movement such as differential soil erosion and deposition that would result in possible differences in dry density, structure, and organic content of the soil (pars. 51-55).

- f. Estimates of the number of samples required to provide reliable mean values for trafficability purposes, based on measurements within rows of relatively uniform soil, indicate that five samples should be taken for determination of the static physical properties, five samples for determination of moisture content, ten measurements for cone index, and ten measurements for remolding index. Ten remolding index tests will provide an accuracy of  $\pm 0.05$  unit, whereas three samples will give an accuracy less than desired, i.e.  $\pm 0.10$  unit (table 7 and par. 65).

#### Recommendations

68. The following recommendations are offered for guidance in future studies:

- a. A terrain geometry classification system suitable for trafficability purposes should be developed.
- b. Studies should be conducted to identify and evaluate the effects on trafficability of soil factors that have not been considered in WES trafficability studies, such as organic content, soil structure, and natural cementing agents.
- c. The number of samples should be increased to five for static properties and to ten for strength measurements.

#### LITERATURE CITED

1. Knight, S. J., "Trafficability of Soils; A Summary of Trafficability Studies Through 1955," Technical Memorandum No. 3-240, 14th Supplement, Dec 1956, U. S. Army Engineer Waterways Experiment Station, CE, Vicksburg, Miss.
2. Carlson, C. A. and Horton, J. S., "Forecasting Trafficability of Soils; Development and Testing of Some Average Relations for Predicting Soil Moisture," Technical Memorandum No. 3-331, Report 5, June 1959, U. S. Army Engineer Waterways Experiment Station, CE, Vicksburg, Miss.
3. Meyer, M. P. and Knight, S. J., "Trafficability of Soils; Soil Classification," Technical Memorandum No. 3-240, 16th Supplement, Aug 1961, U. S. Army Engineer Waterways Experiment Station, CE, Vicksburg, Miss.
4. United States Department of Agriculture, Soil Conservation Service, "Soil Survey; Warren County, Mississippi," Series 1961, No. 9, Nov 1964, Government Printing Office, Washington, D. C.
5. Van Lopik, J. R. and Kolb, C. R., "Handbook; A Technique for Preparing Desert Terrain Analogs," Technical Report No. 3-506, May 1959, U. S. Army Engineer Waterways Experiment Station, CE, Vicksburg, Miss.
6. Saucier, R. T., "A Technique for Mapping Terrain Microgeometry," Technical Report No. 3-612, Nov 1962, U. S. Army Engineer Waterways Experiment Station, CE, Vicksburg, Miss.
7. U. S. Army, Office, Chief of Engineers, "Engineering and Design: Laboratory Soils Testing," EM 1110-2-1906, May 1965, Government Printing Office, Washington, D. C.
8. Andrews, L. A. and Broadfoot, W. N., "The San Dimas Soil Core Sampler," Soil Science, Vol 85, No. 6, June 1958, pp 297-301.
9. Leamer, R. W. and Shaw, B., "A Simple Apparatus for Measuring Non-Capillary Porosity on an Extensive Scale," Journal American Society of Agronomy, Vol 33, No. 11, 1941, pp 1003-1008.
10. Andrews, L. E. and Stearns, F. W., "Physical Characteristics of Four Mississippi Soils," Soil Science Society of America Proceedings, Vol 27, No. 6, Nov-Dec 1963, pp 693-696.
11. Snedecor, G. W., Statistical Methods Applied to Experiments in Agriculture and Biology, 5th ed., The Iowa State College Press, Ames, Iowa, 1956.

Table 1

Location and Description of Test Sites

Site Designation	Location		Orientation Rows 1 to 5	Distance Between Rows ft	Aspect	Topography		Slope %	Drainage		Vegetation	Land Use
	Latitude	Longitude				Position	Surface		Internal			
<b>Memphis Series</b>												
M I	32°20'58"	90°43'18"	N 0° E	48.0	S	Upland ridge and slope	4	Medium	Medium	Grass and weeds	Idle field	
M III	32°20'33"	90°42'38"	N 340° E	75.0	N	Upland flat	<1	Medium	Medium	Grass and weeds	Pasture	
M IV	32°22'30"	90°40'15"	N 180° E	55.0	N	Upland slope	2-9	Medium	Medium	Row crops	Cultivated	
M V	32°20'54"	90°42'14"	N 100° E	52.0	W	Upland ridge and slope	2	Medium	Medium	Grass	Pasture	
M VI	32°20'54"	90°42'22"	N 350° E	70.0	S	Upland flat and slope	0-2	Medium	Medium	Grass	Pasture	
M VIII	32°27'24"	90°42'28"	N 315° E	35.0	SE	Upland ridge	3	Medium	Medium	Weeds and grass	Idle	
<b>Loring Series</b>												
L I	32°08'36"	90°54'36"	N 50° E	60.0	SW	Upland ridge	2	Medium	Medium	Grass	Pasture	
L III	32°08'31"	90°53'53"	N 315° E	75.0	SE	Upland upper slope	6	Good	Medium	Grass	Pasture	
L IV	32°08'36"	90°53'51"	N 240° E	75.0	NE	Upland slope	6	Good	Medium	Grass	Pasture	
L V	32°09'00"	90°54'27"	N 0° E	90.0	S	Upland upper slope	6	Good	Medium	Grass	Pasture	
L VI	32°27'40"	90°40'50"	N 10° E	60.0	S	Upland upper slope	3	Good	Medium	Grass	Pasture	
L VIII	32°10'10"	90°53'27"	N 285° E	55.0	NE	Upland upper slope	12	Good	Medium	Grass	Pasture	
<b>Collins Series</b>												
C I	32°27'34"	90°41'15"	N 285° E	22.5	Level	Bottomland flat	<1	Poor	Poor	Grass and weeds	Pasture	
C II	32°21'00"	90°40'08"	N 10° E	70.0	Level	Bottomland levee	1	Medium	Poor	Grass	Pasture	
C III	32°21'06"	90°42'52"	N 245° E	55.0	Level	Bottomland flat	1	Poor	Poor	Grass and weeds	Pasture	
C IV	32°10'42"	90°50'30"	N 110° E	50.0	Level	Bottomland flat	1	Poor	Poor	Grass	Pasture	
C V	32°09'05"	90°54'09"	N 265° E	37.0	Level	Bottomland flat	1	Poor	Poor	Weeds	Pasture	
C VI	32°12'33"	90°49'42"	N 355° E	17.0	S	Bottomland flat	2	Medium	Poor	Grass	Idle	
<b>Falaya Series</b>												
F I	32°17'27"	90°42'20"	N 290° E	50.0	Level	Bottomland flat	<1	Poor	Poor	Grass, brambles, and saplings	Idle	
F II	32°09'35"	90°54'22"	N 315° E	35.0	SE	Bottomland flat	2	Medium	Medium	Grass	Pasture	
F III	32°09'45"	90°47'15"	N 65° E	30.0	Level	Bottomland flat	<1	Poor	Poor	Grain	Cultivated	
F V	32°18'00"	90°42'08"	N 350° E	30.0	Level	Bottomland flat	<1	Poor	Poor	Grass, brambles, and saplings	Idle	
F VII	32°23'12"	90°41'04"	N 0° E	20.0	S	Bottomland flat	2	Poor	Poor	Grass and weeds	Idle	
F VIII	32°09'30"	90°54'33"	N 190° E	33.5	N	Bottomland flat	2	Medium	Medium	Grass and weeds	Cultivated	

Table 2  
 Cross-Reference of Soil Series by Sites and Plots

Site No. for Soil Series Identified on Maps	Plot No. for Soil Series Identified in Field					Hymon
	Alluvial Fill	Uplands Memphis	Loring	Henry	Bottomlands Falaya	
<b>Memphis Series</b>						
M I		--	--	--	--	--
M III		M2	--	--	--	--
M IV	--	M1	--	--	--	--
M V	--	M4 (1, 5)	--	--	--	--
M VI	--	M3 (4, 5)	--	HNI (1, 2)	--	--
M VIII	--		--	Not identified	--	--
<b>Loring Series</b>						
L I	--		L2	--	--	--
L III	--		L5	--	--	--
L IV	--		L4	--	--	--
L V	--		L3	--	--	--
L VI	--		L1	--	--	--
L VIII	--			Not identified	--	--
<b>Collins Series</b>						
C I	--			--	C2 (2, 3, 4)	F7 (1, 5)
C II	--			--		
C III	--			--	C1	
C IV	--			--		F3 (1, 2, 3, 4)
C V	--			--		F2
C VI	--			--		
<b>Falaya Series</b>						
F I	--					
F II	--					
F III	--				C3 (1, 3)	F6 (2, 4, 5)
F V	--					
F VII	--					
F VIII	--					
	--					F1 (1, 2, 3, 4)

Note: Figures in parentheses refer to row numbers in plot. Plots with no row numbers listed contain five rows of same soil series.

Table 3  
Soil Property Values for Soil Series

Soil Property and Unit of Measure	Series Identified from Soil Maps				"F" Significance Series/Sites	Series Identified from Field Observations				Standard Deviation of Plot Value	"F" Significance Series/Plots		
	Series Means from Site Values		Series Means from Plot Values			Series Means from Plot Values		Series Means from Plot Values					
	Memphis	Loring	Collins	Falava		Alvin	Henry	Hydon	Hydon				
0- to 6-in. Soil Layer	Sand, %	12	10	15	12	11	14	12	12	12	30	2.0	**
	Silt, %	73	71	71	72	71	75	76	76	76	73	2.0	**
	Clay, %	16	19	11	16	18	11	11	12	12	13	2.9	**
	Fines, %	99	99	96	99	99	98	98	98	99	98	3.0	NS
	LL, %	35	36	30	39	31	34	34	36	35	34	2.5	NS
	PL, %	25	25	26	27	27	24	27	27	27	26	2.5	NS
	PI, %	10	11	8	10	10	10	10	9	8	8	3.0	NS
	Specific gravity	1.44	1.46	1.42	1.34	1.46	1.46	1.46	1.46	1.46	1.46	0.01	NS
	Density, g/cc	28.1	27.5	29.5	32.8	27.1	27.5	30.0	30.2	30.8	29.3	1.41	NS
	MC (0.06-atm ten.), %					27.1	27.5	30.0	30.2	30.8	29.3	1.2	**
CI	At visit A				26.4	28.5	31.3	32.2	33.6	32.1	32.0	1.8	**
	At visit B				28.2	29.5	30.3	31.2	33.6	31.1	32.4	1.8	**
	At visit C				27.3	28.6	28.9	30.7	34.2	31.2	31.2	2.0	**
	At visit D				22.5	22.2	25.6	27.8	30.0	32.0	28.9	2.2	**
6- to 12-in. Soil Layer	Sand, %	183	201	148	146	201	148	146	105	166	211	67	NS
	Silt, %	138	152	132	141	152	141	141	106	148	148	69	NS
	Clay, %	40	42	38	44	42	38	38	44	44	41	1.8	**
	Fines, %	100	100	100	100	100	98	99	99	99	92	3.2	**
	LL, %	44	42	42	44	42	42	42	33	31	26	3.8	**
	PL, %	24	24	24	24	24	26	26	25	24	24	2.2	**
	PI, %	15	18	7	20	18	6	6	8	7	10	3.5	**
	Specific gravity	1.47	1.50	1.45	1.42	1.47	1.47	1.47	1.44	1.44	1.42	0.01	**
	Density, g/cc	27.5	26.7	28.5	29.8	27.3	26.9	28.8	28.8	27.2	29.0	0.02	**
	MC (0.06-atm ten.), %					27.3	26.9	28.8	28.8	27.2	29.0	0.9	*
Not sampled	At visit A				27.4	27.7	28.3	29.3	33.4	31.0	28.8	1.4	NS
	At visit B				26.8	26.6	28.1	29.2	29.8	28.2	29.4	1.9	NS
	At visit C				21.7	20.1	23.3	27.0	26.6	29.4	25.9	2.9	**
	At visit D												
	At visit A				206	323	210	240	173	166	223	100	NS
	At visit B				183	263	231	201	152	177	203	56	NS
	At visit C				184	207	201	195	150	128	173	52	NS
	At visit D				383	458	312	297	254	238	275	101	NS

Note: NS, not significant at the 5% level.  
\* Significant at the 5% level.  
\*\* Significant at the 1% level.

Table 4  
Plot and Row Mean Soil Property Values by Uplands and Bottomlands

Soil Property of PLUMS	Uplands				Bottomlands				Bottomlands				Bottomlands					
	Plot Values		Significance Plot/Rows	Rows/Plots	Plot Values		Significance Rows/Plots	Rows/Plots	Row Values		Significance Rows/Samples	Rows/Samples	Row Values		Significance Rows/Samples	Rows/Samples	Standard Deviation of Individual Measurements	
	Mean	Range			Mean	Range			Mean	Range			Mean	Range			Uplands	Bottomlands
Sand, %	11	9-13	**	**	12	8-16	**	**	11	8-14	**	**	12	8-24	**	**	1.75	1.72
	71	68-77			76	72-80			72	67-79			76	67-82			4.75	1.49
	18	11-22			12	9-15			17	9-30			12	8-21			3.51	2.55
	99	98-100			98	97-100			99	98-100			98	99-100			3.55	2.34
	35	27-38			36	31-43			35	28-42			35	32-45			0.082	0.005
PI, %	25	24-26	**	**	27	26-28	**	**	25	23-28	**	**	27	25-30	**	**	1.24	1.31
	10	3-13	**	**	9	7-15	**	**	10	0-17	**	**	9	0-17	**	**	2.6	2.0
	7.66	2.64-2.68	**	**	2.6	2.64-2.67	**	**	2.66	2.64-2.68	**	**	2.66	2.64-2.67	**	**	1.6	1.7
MC (0.06-atm ten.), %	1.46	1.43-1.50	NS	*	1.40	1.34-1.45	**	**	1.45	1.44-1.51	**	**	1.40	1.30-1.50	**	**	2.6	2.0
	27.3	25.6-28.1	*	*	30.1	28.5-32.0	*	*	27.4	25.1-29.9	*	*	30.0	26.0-32.4	**	**	1.6	1.7
CI	28.0	24.0-29.9	*	*	32.0	29.8-36.1	*	*	28.4	20.9-32.2	*	*	31.7	27.0-39.8	**	**	54.0	41.4
	19.0	25.6-31.9	**	**	30.6	27.1-33.6	**	**	20.2	24.1-33.3	**	**	30.9	27.2-36.6	**	**	25.3	26.0
	28.0	25.6-30.2	**	**	27.1	22.7-31.2	**	**	28.3	24.8-32.0	**	**	30.4	26.8-37.2	**	**	19.0	17.2
	22.3	21.0-23.4	**	**	27.1	22.7-31.2	**	**	22.4	30.7-28.6	**	**	27.4	21.2-34.7	**	**	40.9	27.9
	193	86-293	**	**	147	69-235	**	**	186	79-420	**	**	149	57-290	**	**	1.92	1.27
Sand, %	9	8-11	NS	NS	12	8-16	**	**	9	5-12	**	*	12	7-22	**	**	3.74	1.34
	68	63-73			71	73-78			68	72-78			71	68-81			4.48	1.53
	23	17-28			13	9-15			23	12-36			13	7-18			4.39	1.77
	100	99-100			99	98-100			100	98-100			99	98-100			0.010	0.006
	43	39-46	**	**	33	31-36	**	**	42	29-53	**	**	33	29-43	**	**	0.068	0.026
PI, %	24	23-26	*	*	25	24-26	**	**	24	22-27	**	**	25	23-27	**	**	1.08	0.88
	19	11-24	*	*	8	6-12	**	**	18	6-28	**	**	6	4-17	**	**	1.08	0.88
	2.69	2.65-2.71	**	**	2.67	2.67-2.68	**	**	2.69	2.66-2.72	**	**	2.67	2.65-2.68	**	**	1.08	0.88
MC (0.06-atm ten.), %	1.49	1.47-1.53	**	**	1.44	1.41-1.47	**	**	1.49	1.47-1.55	**	**	1.44	1.37-1.55	**	**	1.08	0.88
	27.0	25.6-28.9	**	**	28.8	27.5-30.4	**	**	27.0	24.8-29.9	**	**	28.7	27.3-30.7	**	**	1.08	0.88
CI	27.6	25.8-31.1	**	**	29.0	27.3-31.2	**	**	27.7	24.7-33.8	**	**	30.0	23.9-34.4	**	**	1.6	1.6
	26.7	24.6-29.4	**	**	28.9	26.7-33.2	**	**	26.8	21.8-30.7	**	**	29.0	24.9-35.4	**	**	1.6	1.6
	20.8	17.0-25.7	**	**	25.9	18.9-30.0	**	**	21.0	10.4-26.6	**	**	26.2	16.6-33.3	**	**	1.6	1.6
	280	156-473	**	**	231	144-336	**	**	235	97-717	**	**	230	118-224	**	**	20.1	22.4
CI	192	130-268	**	**	210	174-248	**	**	194	104-298	**	**	234	74-400	**	**	32.9	33.2
	192	130-268	**	**	197	152-286	**	**	176	115-334	**	**	191	45-330	**	**	25.1	21.0
	192	130-268	**	**	197	152-286	**	**	176	115-334	**	**	191	45-330	**	**	25.1	21.0
	192	130-268	**	**	197	152-286	**	**	176	115-334	**	**	191	45-330	**	**	25.1	21.0

\*\* Significant at the 5% level.  
\* Significant at the 1% level.

Table 5  
Cone Index, Moisture Content, and Terrain Information for Plots

Plot	Avg CI 4 Visits 6-12 in.	Avg MC, % 3 Visits 6-12 in.	Row Spac- ing ft	Plot Slope %	Distance Upslope from Row 1		Surface Curvature	Erosion
					Distance to Crest ft	Relief Diff ft		
<u>Uplands</u>								
AF2	164	30.1	52	2, 1*	100	5	Concave	Fill
HN1	170	29.5	70	0	On flat	0	Slight concave	None
M1	176	26.9	55	6, 3*	200	10	Concave	{Rows 1&2 severe {Rows 4&5 none
L3	191	27.5	90	6, 2*	100	5	Concave	Severe
AF1	201	27.0	48	4, 2*	50	5	Concave	Fill
HY1	218	28.0	70	0, 2*	On crest	0	Flat to convex	None
M2	221	26.2	75	0	On flat	0	Straight	None
L5	262	24.4	75	4, 6*	75	5	Convex	{Row 1 some {Rows 2-5 none
M4	283	25.1	52	2	On crest	0	Convex	Some
L2	332	23.8	60	2	60	0	Convex	Some to severe
L1	352	24.7	60	3	100	5	Convex	Severe
L4	354	23.5	75	6	300	10	Straight	Some
M3	364	23.1	70	2	150	5	Convex	Severe

Plot	Avg CI 4 Visits 6-12 in.	Avg MC, % 3 Visits 6-12 in.	Row Spac- ing ft	Plot Slope %	Distance Upslope from Row 1		Watershed Area acres	Valley Floor Width ft	Creek Bed Depth ft
					Distance to Crest ft	Relief Diff ft			
<u>Bottomlands</u>									
F3	121	31.2	50	1	1400	60	503	500	8
F4	180	30.3	33	2	400	40	732	425	10
C1	205	27.0	55	1, 2*	500	40	22,600	450	10
C3&F6	209	26.2	33	1, 2*	400	40	708	425	10
F1	252	27.4	20	2	150	30	45	180	2
F5	259	27.3	37	1	300	40	416	330	6
C2&F7	296	28.3	23	<1	500	60	108	170	4
F2	319	27.0	17	2	300	50	318	375	9

\* Slope changed within the plot; upper slope--left value, lower slope--right value.

Table 6  
Sampling by Rows Versus Clusters

Condi- tion	Topo- graphic Position	Visit	Sam- pling Group	Single Sampling			Triple Sampling		
				Std Dev	Mean	Coeff of Varia- tion	Indi- vidual Std Dev	Within Group Std Error	
Wet	Upland	B	Row	62	201	0.31	56	35	20
		C	Cluster	56	198	0.28	57	25	14
	Bottomland	B	Row	78	205	0.38	76	31	18
		C	Cluster	69	194	0.35	67	21	12
Moist	Upland	A	Row	173	299	0.58	181	90	52
		D	Cluster	179	423	0.42	183	54	31
	Bottomland	A	Row	115	246	0.47	99	68	39
		D	Cluster	108	294	0.37	113	47	27

Table 7

Sampling Requirements for Soil Properties by Rows

Soil Property	Prob- ability Level, %	Accuracy Desired +	Est No. of Samples	
			0- to 6-in. Layer	6- to 12-in. Layer
Cone index				
Visit A	20	20 units	10	26
Visit B	20	10 units	11	18
Visit C	20	10 units	5	9
Visit D	20	20 units	5	11
Remolding index	20	0.10 unit	--	3
	20	0.05 unit	--	10
Moisture content				
Visit A	20	1%	9	--
Visit B	20	1%	5	5
Sand	5	3%	2	2
Clay	5	3%	6	4
Liquid limit	5	3%	4	5
Plasticity index	5	3%	4	5
Specific gravity	5	0.05 unit	1	1
Dry density	5	0.04 g/cc	3	2
Moisture content (0.06-atm tension)	5	1%	6	4

Key for Identification of Symbols Used in Plate 1

V	Vicksburg silt loam
C	Collins silt and silt loam
VC	Vicksburg and Collins silt loam
F	Falaya silt and silt loam
W	Waverly silt
WF	Waverly and Falaya silt
S	Swamp
T	Lintonia silt
R	Richland silt
O	Olivier silt
K	Calhoun silt
HY	Hymon silt loam
M	Memphis silt
L	Loring silt
LM	Loring and Memphis silt
MN	Memphis and Natchez silt
HN	Henry silt



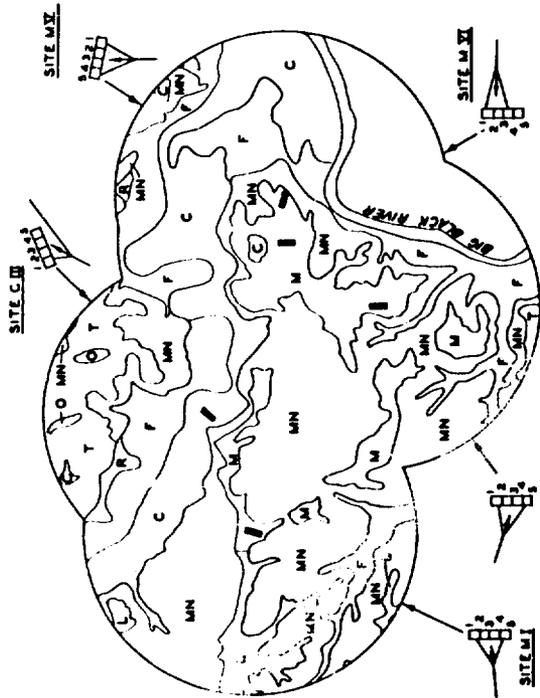
SITE CIII. PLOT CI COLLINS SERIES  
AT ALL ROWS



SITE MZ. PLOT M4 MEMPHIS SERIES  
AT ROWS 1 AND 5  
PLOT AF2 ALLUVIAL FILL  
AT ROWS 2, 3, AND 4



SITE MVI. PLOT HN HENRY SERIES  
AT ROWS 1 AND 2  
PLOT M3 MEMPHIS SERIES  
AT ROWS 4 AND 5



SITE MIII. PLOT M2 MEMPHIS SERIES  
AT ALL ROWS



SITE MI. PLOT AF1 ALLUVIAL FILL  
AT ALL ROWS

**VIEW, ORIENTATION, AND  
SOILS OF TEST SITES**

SHEET 1 OF 5



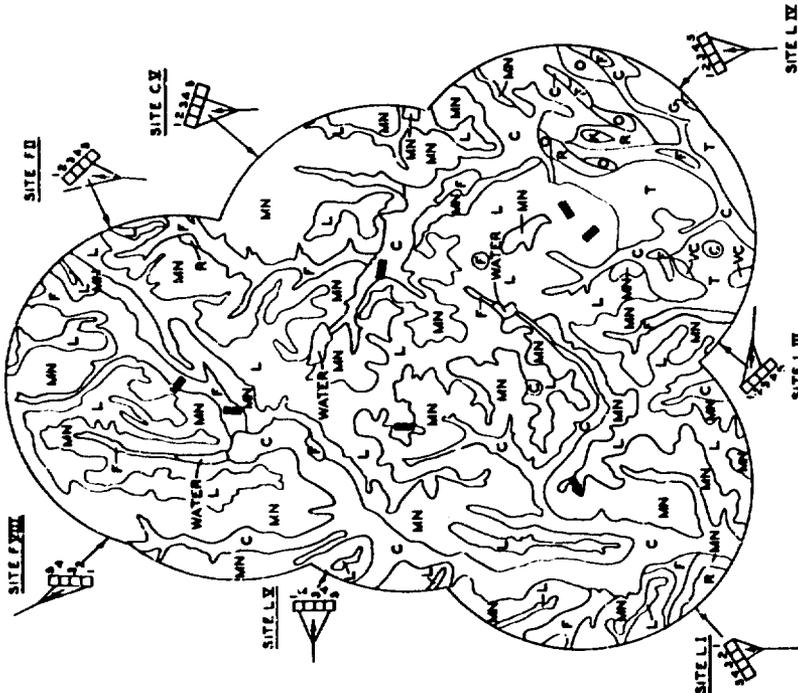
SITE F VIII. PLOT F4 FALAYA SERIES  
AT ROWS 1, 2, 3, AND 4



SITE L V. PLOT L3 LORING SERIES  
AT ALL ROWS



SITE L I. PLOT L2 LORING SERIES  
AT ALL ROWS



SITE F D. PLOT C3 COLLINS SERIES  
AT ROWS 1 AND 3  
PLOT F6 FALAYA SERIES  
AT ROWS 2, 4, AND 5



SITE C Z. PLOT F5 FALAYA SERIES  
AT ROWS 1, 2, 3, AND 4



SITE L IV. PLOT L4 LORING SERIES  
AT ALL ROWS



SITE L III PLOT L5 LORING SERIES  
AT ALL ROWS

**VIEW, ORIENTATION, AND  
SOILS OF TEST SITES**



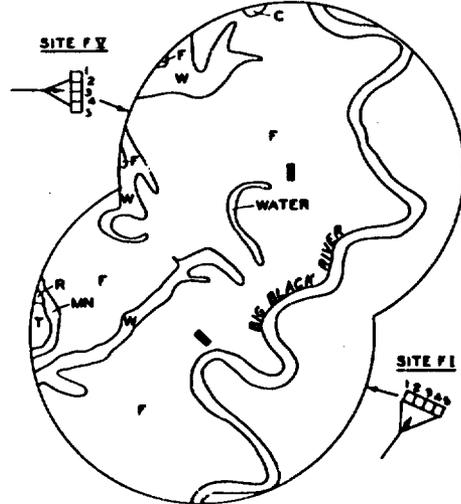
SITE F VII. PLOT F I FALAYA SERIES AT ALL ROWS



SITE F V. FALAYA MAP UNIT



SITE F VII



SITE F V



SITE F III



SITE F I



SITE F III. FALAYA MAP UNIT



SITE F I. FALAYA MAP UNIT

VIEW, ORIENTATION, AND SOILS OF TEST SITES

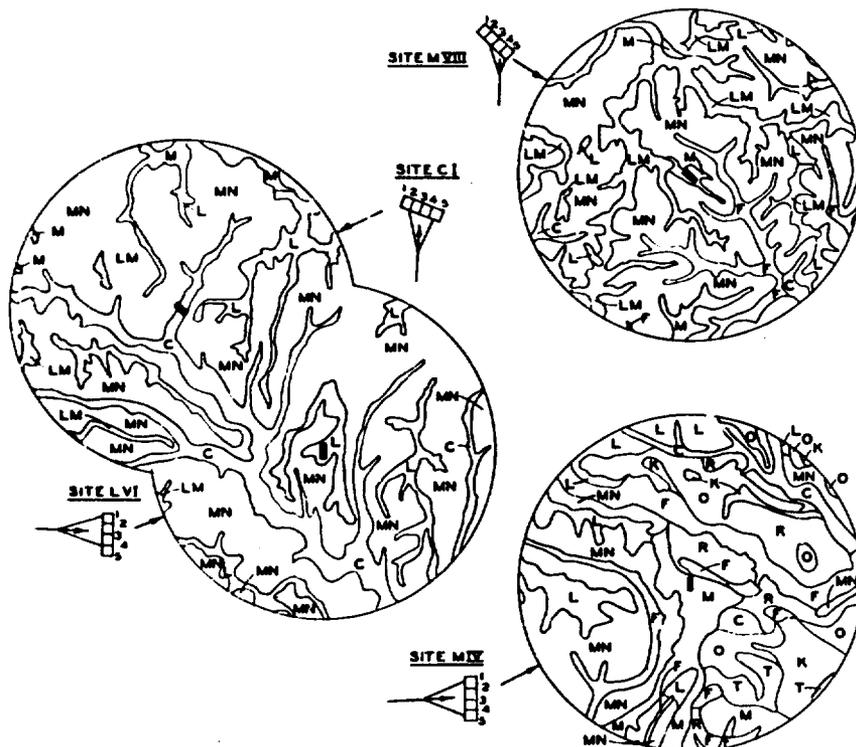
SHEET 3 OF 5



SITE CI. PLOT F7 FALAYA SERIES  
AT ROWS 1 AND 5  
PLOT C2 COLLINS SERIES  
AT ROWS 2, 3, AND 4



SITE M VIII. MEMPHIS MAP UNIT



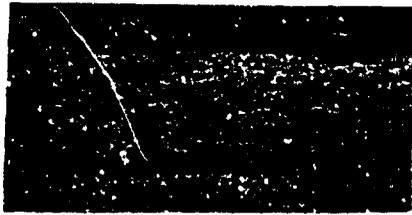
SITE LVI. PLOT L1 LORING SERIES  
AT ALL ROWS



SITE M IX. PLOT M1 MEMPHIS SERIES  
AT ALL ROWS

### VIEW, ORIENTATION, AND SOILS OF TEST SITES

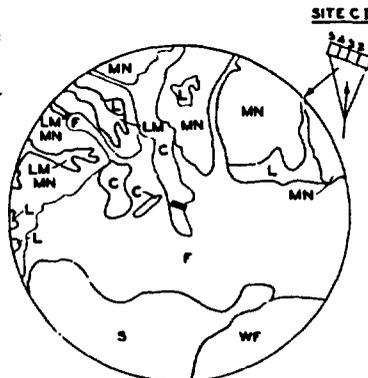
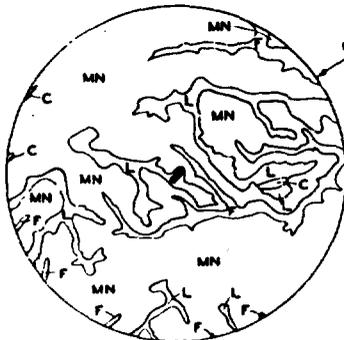
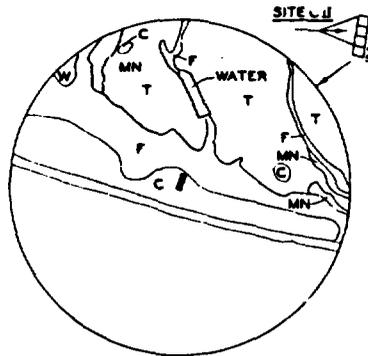
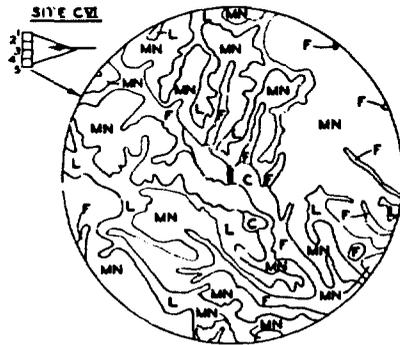
SHEET 4 OF 5



SITE C.VI. PLOT F2 FALAYA SERIES  
AT ALL ROWS



SITE C.II. PLOT HYI HYMON SERIES  
AT ALL ROWS



SITE L.VIII. LORING MAP UNIT



SITE C.IV. PLOT F3 FALAYA SERIES  
AT ALL ROWS

**VIEW, ORIENTATION, AND  
SOILS OF TEST SITES**

SHEET 5 OF 5

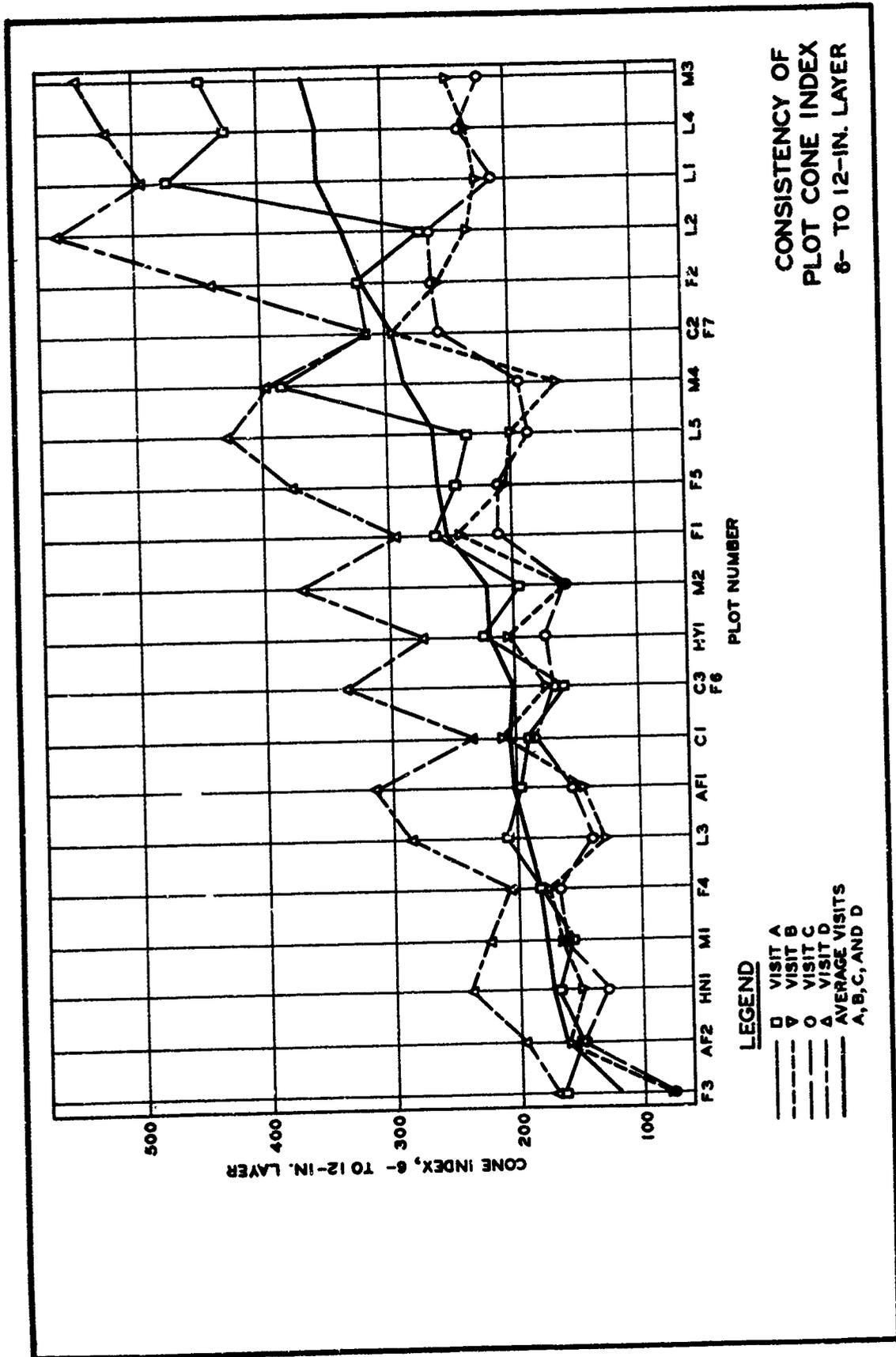
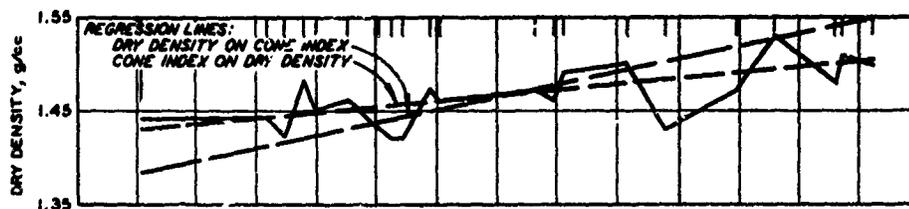
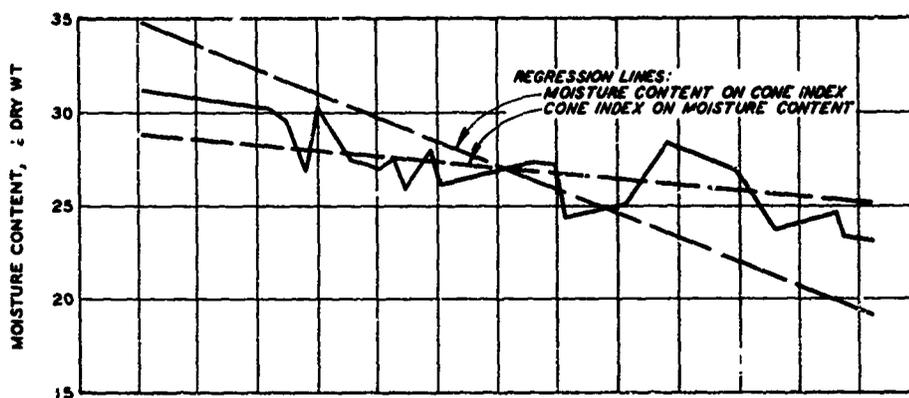


PLATE 2



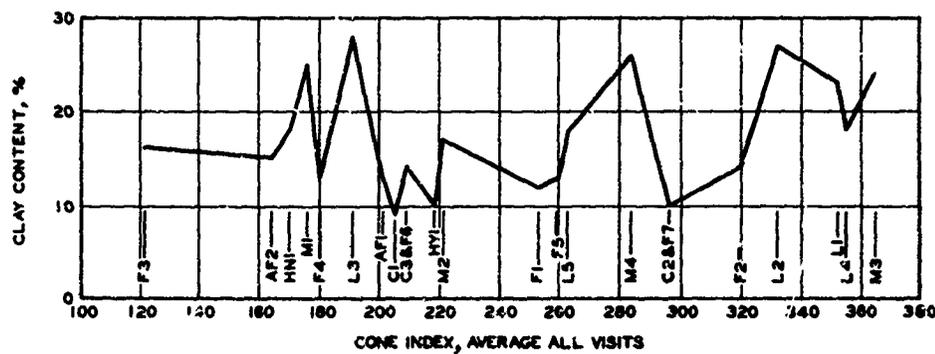
$r=0.68$ , HIGHLY SIGNIFICANT, < 1% LEVEL



$r=0.49$ , SIGNIFICANT, 5% LEVEL



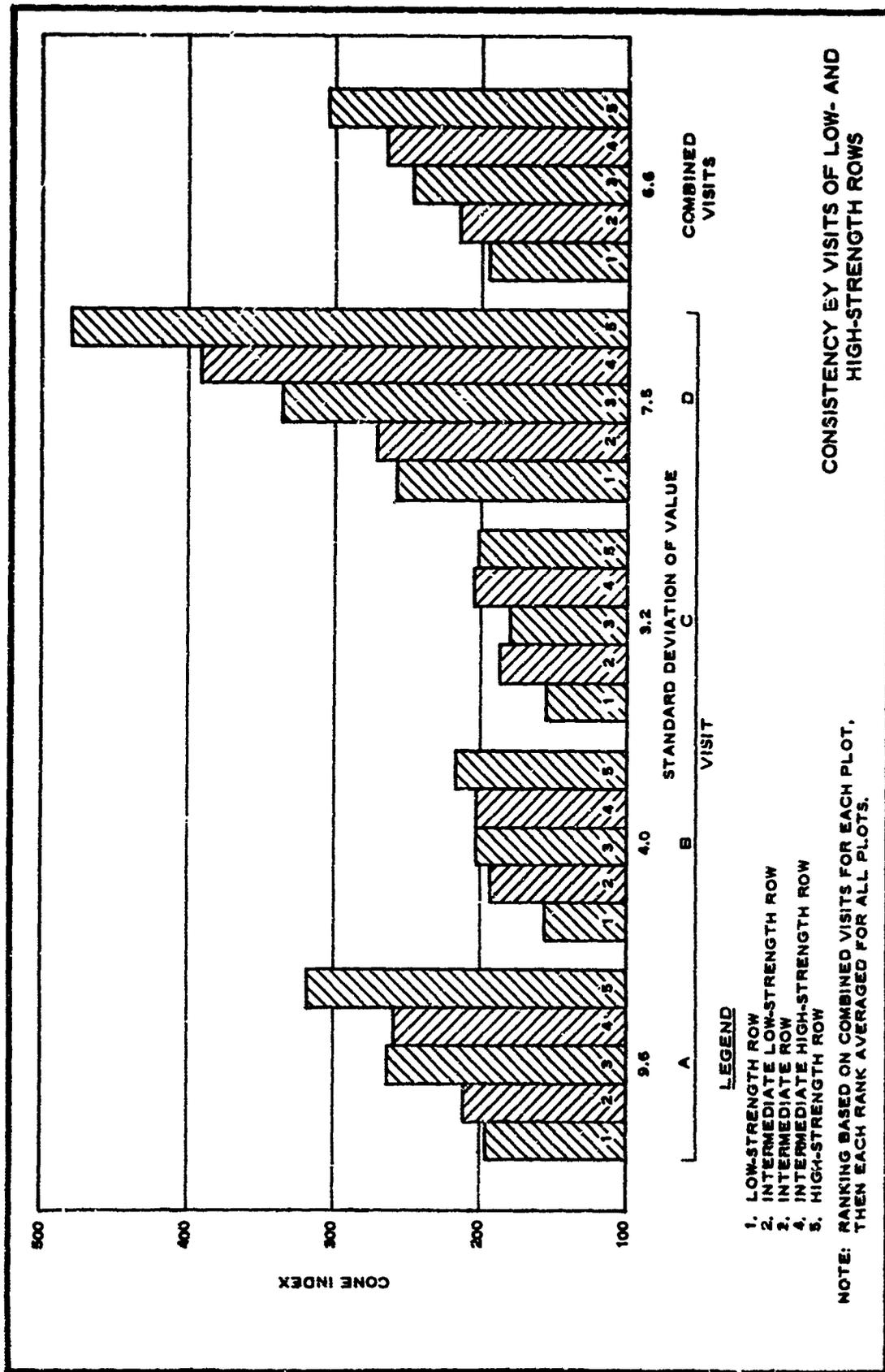
$r=0.33$ , SIGNIFICANT, 20% LEVEL



$r=0.27$ , NOT SIGNIFICANT, > 20% LEVEL

NOTE: r DESIGNATES SAMPLE CORRELATION COEFFICIENT.

**COMPARISON OF PHYSICAL PROPERTIES AND CONE INDEX  
6- TO 12-IN. LAYER**

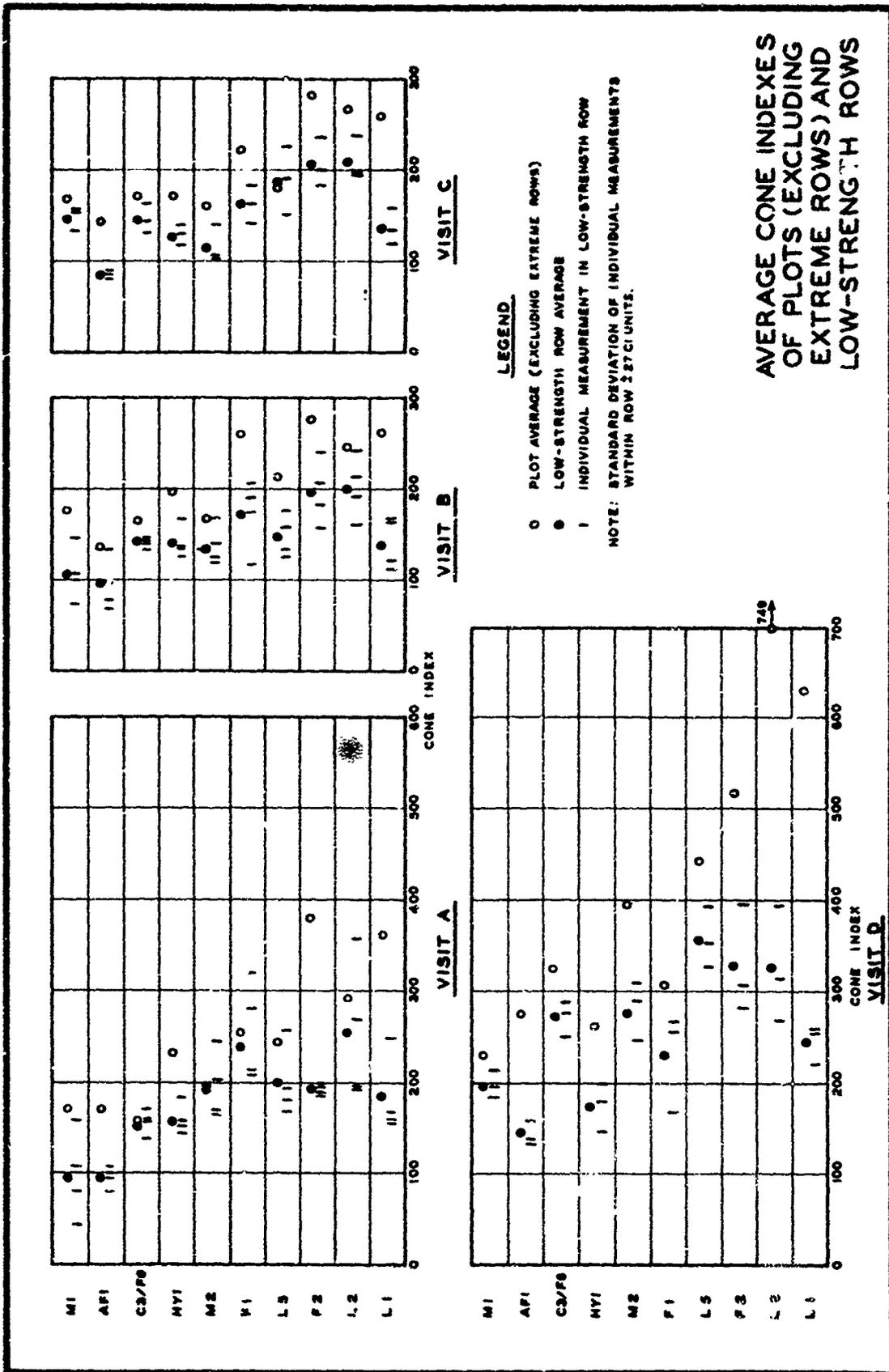


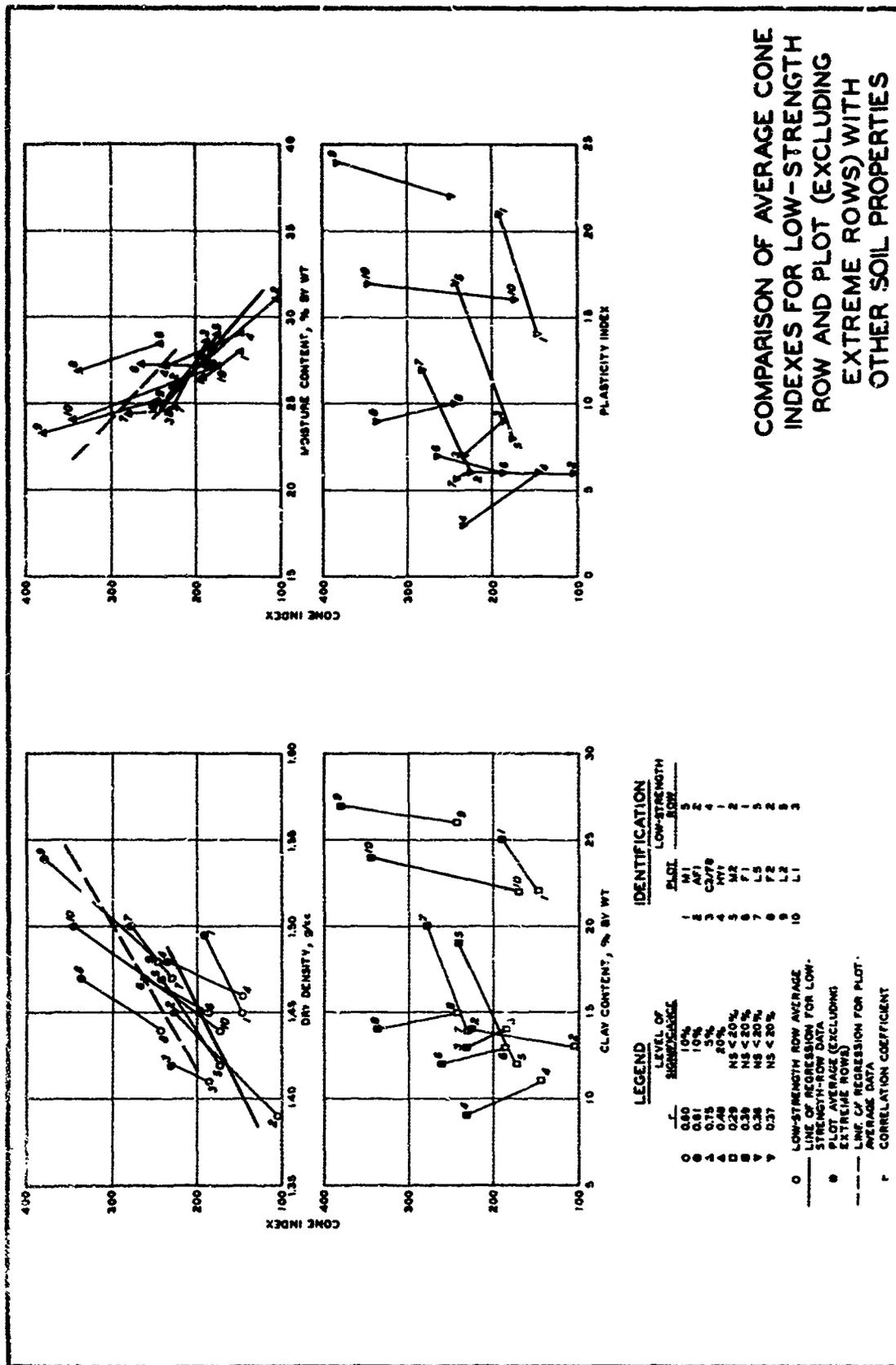
**CONSISTENCY BY VISITS OF LOW- AND HIGH-STRENGTH ROWS**

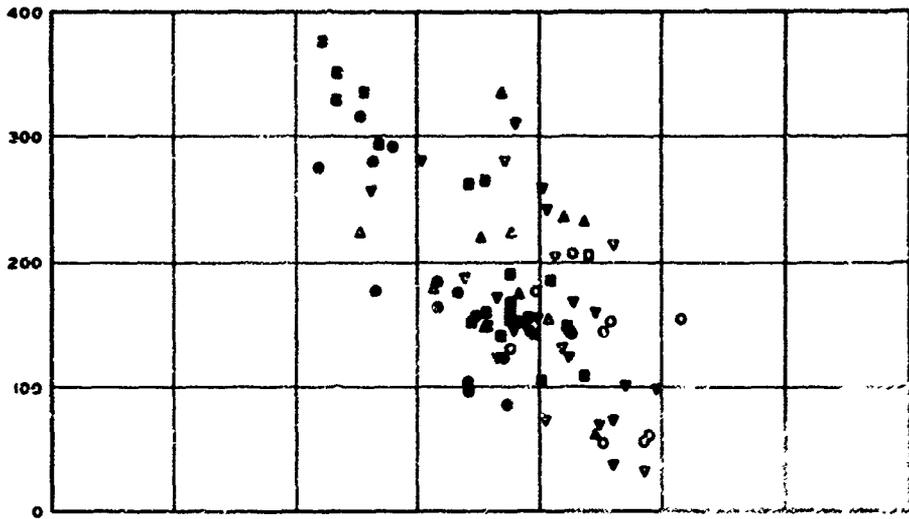
- LEGEND**
- 1. LOW-STRENGTH ROW
  - 2. INTERMEDIATE LOW-STRENGTH ROW
  - 3. INTERMEDIATE ROW
  - 4. INTERMEDIATE HIGH-STRENGTH ROW
  - 5. HIGH-STRENGTH ROW

**NOTE:** RANKING BASED ON COMBINED VISITS FOR EACH PLOT, THEN EACH RANK AVERAGED FOR ALL PLOTS.

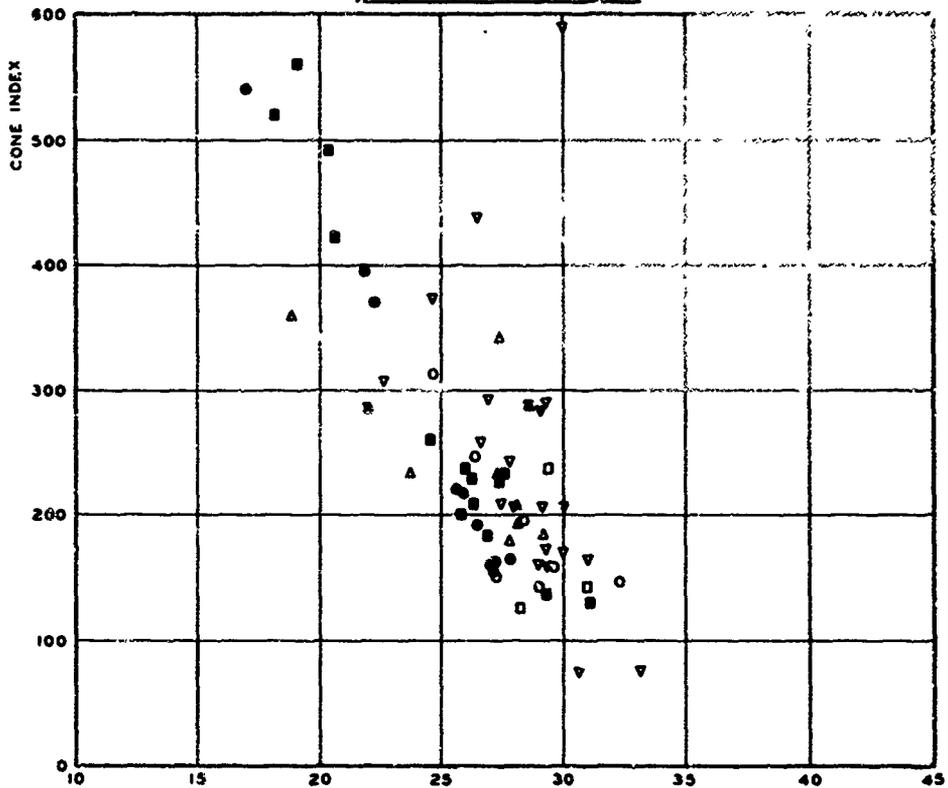
PLATE 4







0- TO 6-IN. SOIL LAYER

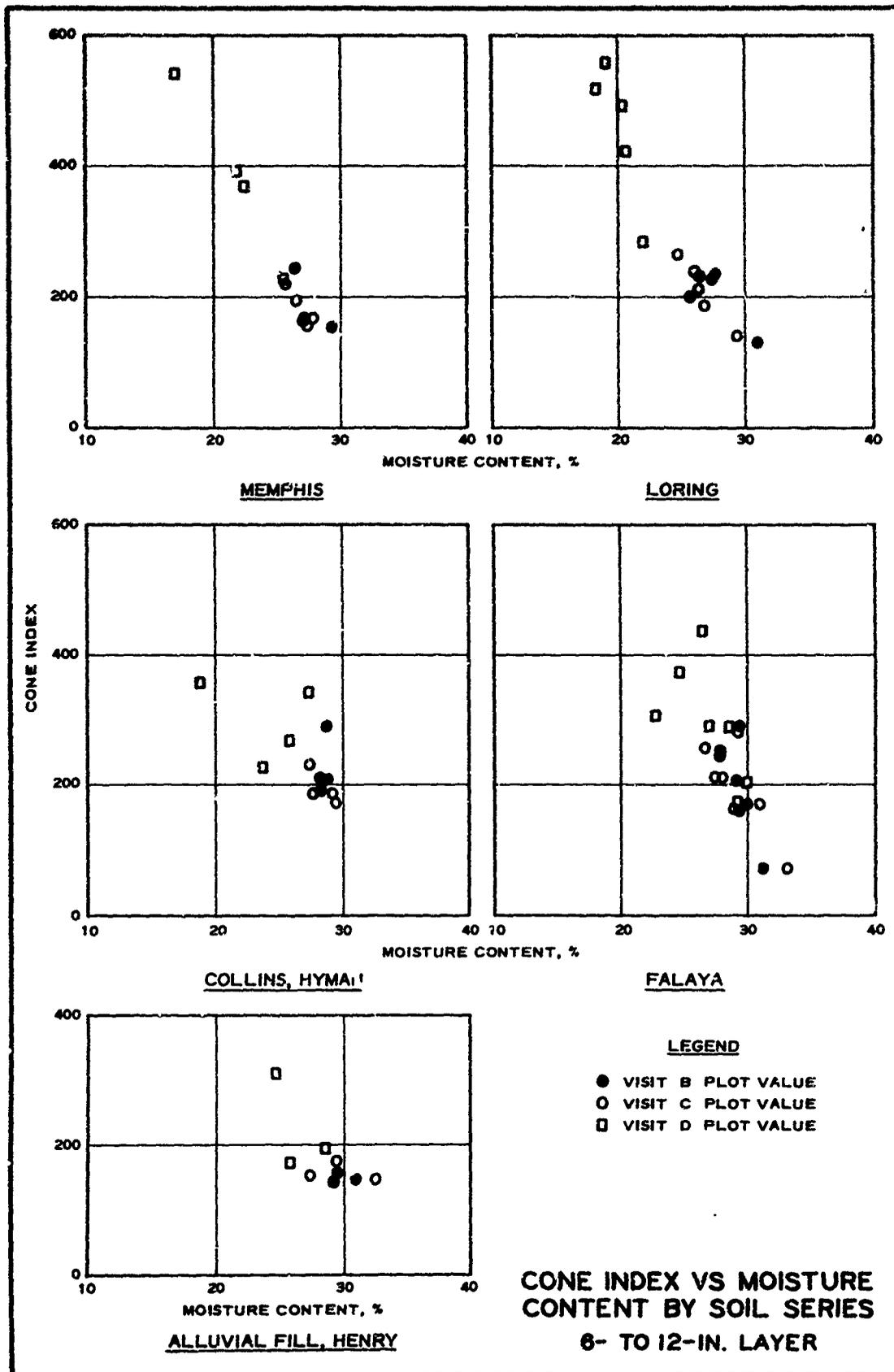


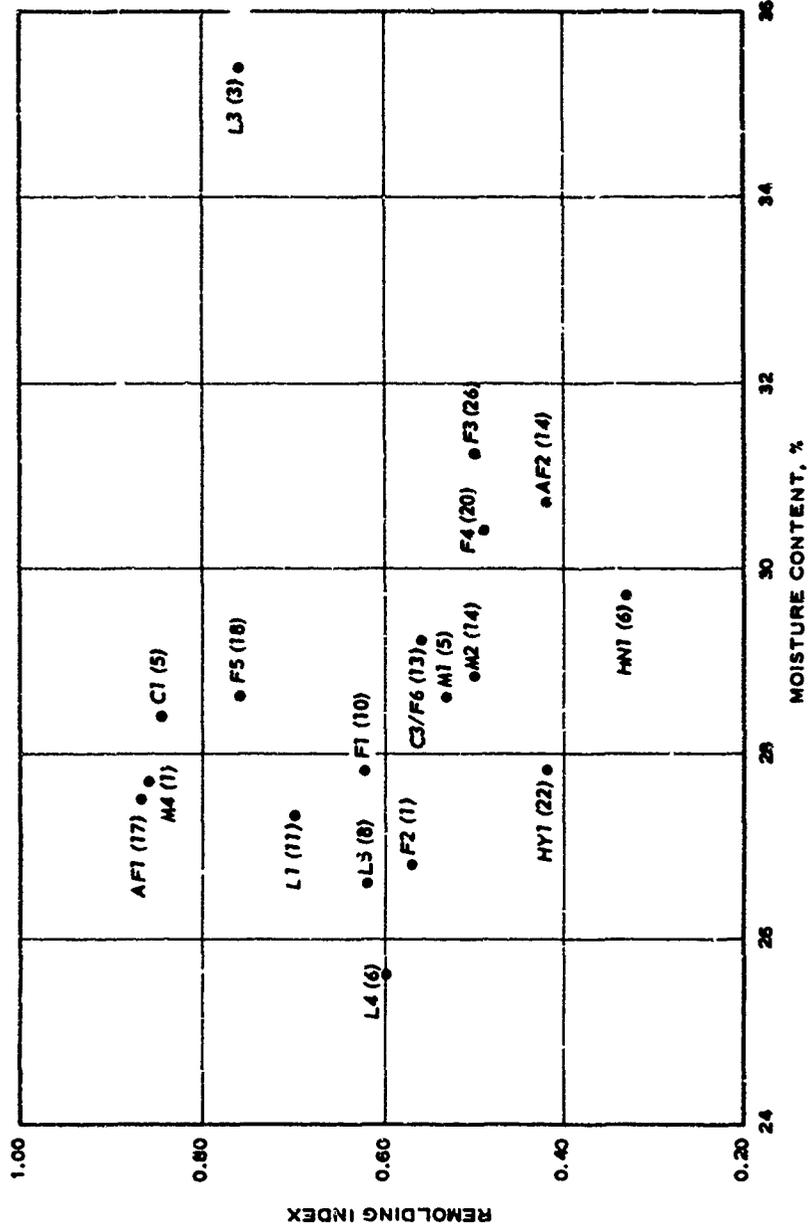
6- TO 12-IN. SOIL LAYER

**LEGEND**

- ALLUVIAL FILL
- MEMPHIS
- LORING
- HENRY
- ▲ COLLINS
- ▼ FALAYA

**CONE INDEX VS  
MOISTURE CONTENT  
ALL VISITS AND PLOTS**





REMOLDING INDEX VS MOISTURE CONTENT  
BY PLOT AVERAGE  
6- TO 12-IN. LAYER

NOTE: NUMBER OF VALUES PER PLOT IS SHOWN IN PARENTHESES AFTER PLOT DESIGNATION.

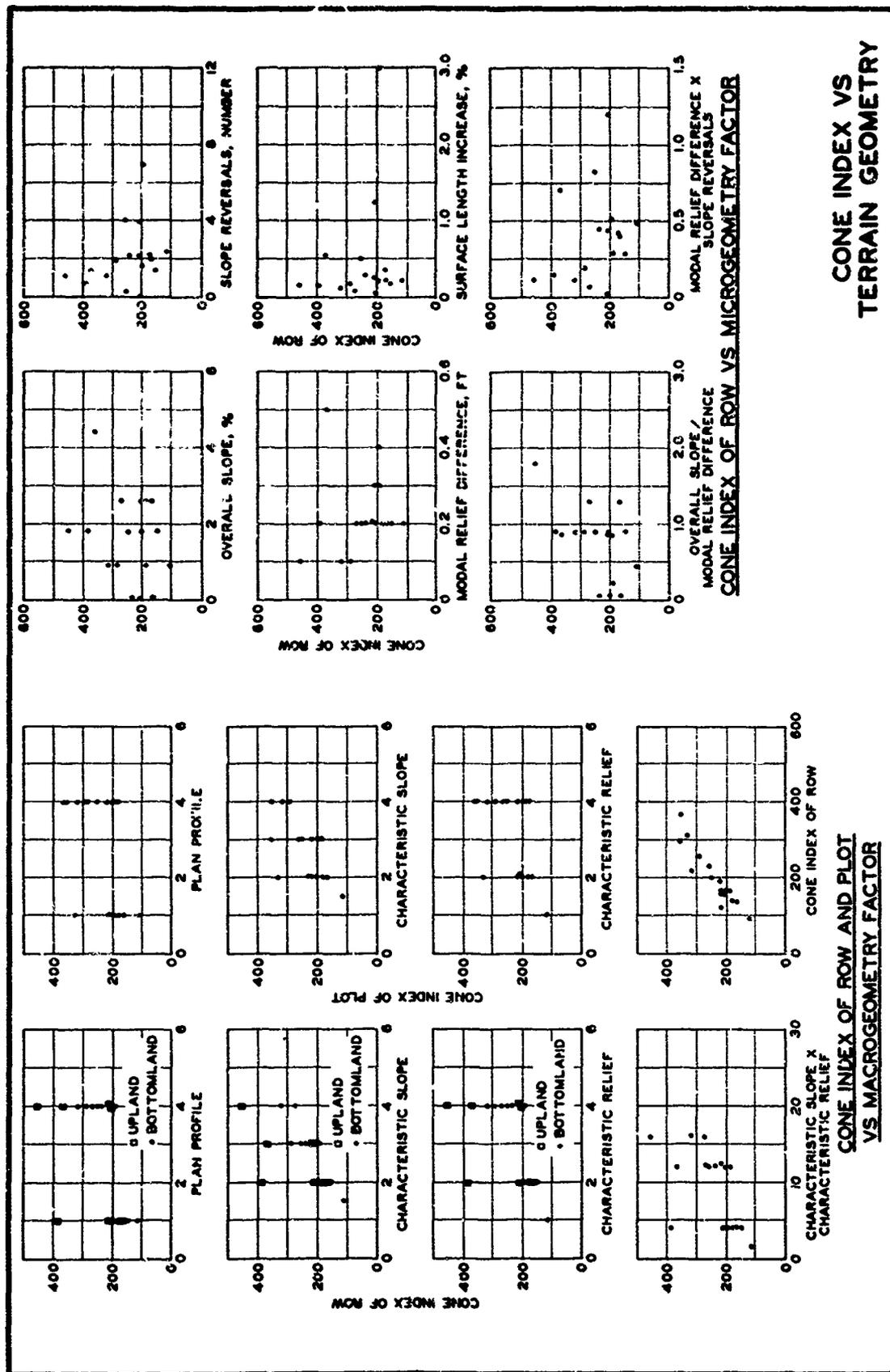


PLATE 10

**CONE INDEX VS  
TERRAIN GEOMETRY**

**CONE INDEX OF ROW AND PLOT  
VS MACROGEOMETRY FACTOR**

## APPENDIX A: BASIC DATA

This appendix contains basic data for each of the test sites. Table A1 contains soil strength measurements including cone index and moisture content obtained on four visits to each site. Table A2 contains data on soil properties including United States Department of Agriculture and Unified Soil Classification System soil classes, grain-size analysis, dry density, specific gravity, and moisture contents at 0-, 0.015-, 0.03-, and 0.06-atm tensions.

Table A1  
Strength and Moisture Content of Soils at Test Sites\*

Identification				Visit A			Visit B			Visit C			Visit D									
Site	Plot	Row	Position	CI		MC	CI		RI	MC		CI		RI	MC							
				0-6	6-12	0-6	0-6	6-12	0-12	0-6	6-12	0-6	6-12	0-6	6-12	0-6	6-12					
<u>Alluvial Fill</u>																						
M I	AF1	1	A	42	82	33.9	49	97	0.67	29.1	28.3											
			A1										27	110		28.1	26.4	150	275			
			A2										53	173		162	282		21.1	20.1		
			A3										47	140		192	202					
		B	12	158	29.2	32	217			0.44	29.4	27.8										
		C	18	32	33.4	26	63				30.8	30.6										
		D	52	158	23.5	62	120				28.8	27.4										
		2	A	42	80	36.3	13	79	1.18	33.6	32.6											
			A1										34	87		65	138		30.8	30.8		
			A2										37	83		65	153					
			A3										48	86		100	132					
		B	55	100	34.7	60	133	0.28	34.1	31.6												
C	68	108	35.9	64	95	0.32	33.2	31.3														
D	48	95	38.4	35	67	0.24	36.7	30.2														
3	A	95	350	41.2	34	205	0.49	35.4	26.6													
	A1										123	295		34.2	27.5	158	550	29.4	24.9			
	A2										86	227				205	600					
	A3										82	217				188	592					
B	50	358	39.9	26	216				36.2	28.1												
C	65	238	35.0	122	290				33.7	22.1												
D	232	525	39.1	93	190	0.40	31.5	29.8														
4	A	75	155	35.4	55	120	0.48	35.5	30.2													
	A1										36	97		108	282		31.2	22.7				
	A2										30	105		95	258							
	A3										50	107		100	258							
B	52	212	30.6	67	112	0.33	37.7	28.6														
C	50	192	40.7	102	238				35.6	29.5												
D	32	220	33.4	86	196	0.45	36.9	27.6														
5	A	82	218	32.0	86	182	0.19	38.3	31.2													
	A1										67	195	0.51	35.2	27.9	120	258	1.68	31.5	25.0		
	A2										64	167		115	288							
	A3										77	193		140	330							
B	45	208	32.5	59	136	0.47	38.0	29.1														
C	62	255	31.5	57	107	0.67	36.8	27.9														
D	38	180	34.0	36	73	0.64	34.5	31.6														
M V	AF2	2	A	148	155	31.3	212	203	0.49	31.8	27.1											
			A1										170	160		168	145		32.9	27.2		
			A2										173	145		188	158					
			A3										160	150		195	225					
		B	192	208	31.1	193	192	0.50	32.5	28.1												
		C	162	182	31.4	149	143	0.52	31.0	27.6												
		D	132	120	31.5	125	134	0.66	33.4	28.0												
		3	A	105	162	37.3	120	157	0.20	34.1	32.2											
			A1										133	172	0.23	35.7	32.3	270	218	0.63	30.8	30.3
			A2										125	158				218	200			
			A3										122	153				188	162			
		B	188	212	34.3	129	153	0.25	37.1	31.7												
C	170	150	36.1	130	192	0.28	32.3	32.9														
D	162	182	31.8	172	163	0.28	34.4	32.1														
4	A	100	45	30.9	147	142	0.34	30.9	28.2													
	A1										198	125		232	236		30.3	27.7				
	A2										168	128		242	218							
	A3										167	142		182	200							
B	130	145	30.8	158	151	0.38	30.3	29.6														
C	158	142	34.0	177	142	0.38	32.2	28.4														
D	120	102	31.3	143	137	0.40	34.4	29.1														
<u>Memphis Soil Series</u>																						
M IV	M1	1	A	105	180	27.6	122	217		27.2	27.5											
			A1										115	175		26.0	27.3	152	212	21.8	26.3	
			A2										87	175		150	230					
			A3										153	290		100	200					
		B	130	158	27.2	70	159				27.3	27.4										
		C	130	220	28.3	112	196				26.9	25.8										
		D	132	242	27.7	105	202				27.3	27.3										
		2	A	42	118	29.0	93	170														
			A1										97	142		195	238		23.5	24.4		
			A2										103	172		125	188					
			A3										125	183		138	192					
		B	88	145	29.6	87	133				28.2	27.1										
C	62	158	29.1	78	182				26.5	26.2												
D	145	205	26.0	109	195				26.8	26.9												

(Continued)

Note: "0-6" and "6-12" indicate 0- to 6-in. and 6- to 12-in. soil layers, respectively. CI indicates cone index. MC indicates moisture content, percent dry weight. RI indicates remolding index.

\* Data are listed by plots according to field-identified soil series.

(1 of 9 sheets)

Table A1 (Continued)

Identification				Visit A			Visit B			Visit C			Visit D							
Site	Plot	Row	Position	CI	MC	MC	CI	RI	MC	CI	RI	MC	CI	RI	MC					
				0-6	6-12	0-6	0-6	6-12	6-12	0-6	6-12	6-12	0-6	6-12	0-6	6-12	0-6	6-12		
<b>Memphis Soil Series (Continued)</b>																				
M IV	M1	3	A	62	132	27.3	92	160	28.5	26.9										
			A1								100	148	27.4	27.3	100	262	22.4	29.1		
			A2									148	210			208	245			
			A3									95	202			175	230			
		B	92	205	25.2	97	187	27.5	26.2											
		C	72	175	29.8	73	220	26.7	26.7											
		D	92	230	30.1	96	168	25.7	25.2											
		4	A	62	150	30.7	94	184	26.4	26.8										
			A1									100	145			205	255	23.2	26.1	
			A2									103	165			188	268			
			A3									78	105			175	232			
		B	48	75	28.8	72	100	27.4	27.0											
C	110	225	30.6	122	202	26.6	27.8													
D	55	108	28.3	118	159	25.3	26.7													
5	A	62	80	28.1	140	144	0.53	28.0	28.8											
	A1									117	157	0.52	28.2	26.7	250	212	25.5	26.6		
	A2									85	152			190	182					
	A3									123	132			230	195					
B	25	42	28.3	89	71	0.68	28.6	28.5												
C	70	108	31.8	92	102	0.45	28.3	29.1												
D	142	158	30.1	101	100	0.46	27.9	28.1												
M III	M2	1	A	222	220	31.2	167	173	0.44	31.7	31.2									
			A1									163	175	0.31	32.0	28.3	312	275	26.3	24.6
			A2									117	145			320	345			
			A3									147	140			380	292			
		B	210	173	29.5	165	158	0.69	31.8	28.6										
		C	280	213	29.0	160	170	0.62	31.9	27.9										
		D	200	240	31.4	145	148	0.47	31.8	27.4										
		2	A	157	163	32.1	147	138	0.37	31.4	39.1									
			A1									155	140			118	245	27.3	25.2	
			A2									157	100			308	308			
			A3									127	103			332	288			
		B	140	247	32.9	145	160	0.57	33.3	30.4										
C	153	167	30.2	120	118	0.45	34.3	32.4												
D	188	202	33.7	132	122	0.57	33.1	30.1												
3	A	167	167	29.3	200	198		29.9	28.3											
	A1									217	193	0.55	27.3	26.9	300	375	22.6	22.7		
	A2									147	125			282	392					
	A3									222	188			312	292					
B	247	240	30.4	113	143		31.5	27.4												
C	157	193	27.4	180	142		31.0	28.1												
D	193	200	29.1	137	185		32.1	26.5												
4	A	193	217	29.8	142	142		28.4	27.7											
	A1									158	190			312	538	17.4	16.3			
	A2									155	170			420	525					
	A3									160	175			375	525					
B	137	143	28.7	183	212		31.0	27.7												
C	143	167	28.7	143	152		31.2	28.8												
D	150	183	30.0	120	167		31.3	28.5												
5	A	182	222	28.0	127	183	0.54	30.4	29.0											
	A1									120	173	28.1	26.5	295	382	19.2	23.2			
	A2									138	190			350	405					
	A3									128	160			356	388					
E	153	212	29.0	133	198	0.60	30.3	26.9												
C	125	183	30.2	150	142	0.72	31.0	28.1												
D	163	163	28.5	128	138	0.66	31.7	28.0												
M IV	M3	4	A	138	145	26.2	235	257		24.6	26.3									
			A1									132	152			218	332	23.3	23.6	
			A2									168	177			230	392			
			A3									160	205			225	355			
		B	125	200	27.6	184	187		26.5	27.5										
		C	182	238	27.4	146	270		25.9	25.9										
		D	220	270	27.2	206	226		27.2	28.1										
		5	A	520	720	22.0	173	272		24.9	24.8									
			A1									172	260	25.6	25.8	275	688	18.8	10.4	
			A2									185	258			345	732			
			A3									177	272			368	750			
		B	388	650	20.4	128	246		24.9	26.2										
C	250	632	20.3	195	247		26.4	26.5												
D	520	732	20.8	195	284		26.4	25.8												
M V	M4	1	A	210	300	27.3	138	162		27.8	26.8									
			A1									163	123	26.5	25.1	392	605	21.2	21.2	
			A2									180	203			212	270			
			A3									170	210			345	512			
B	158	375	24.6	143	203		27.0	26.0												
C	150	305	26.4	125	146		28.4	26.8												
D	170	412	28.8	127	158		27.2	26.4												

(Continued)

(2 of 9 sheets)

Table A1 (Continued)

Identification			Visit A			Visit B			Visit C			Visit D			
Site	Plot	Row	Position	CI	RI	MC	CI	RI	MC	CI	RI	MC	CI	RI	MC
				0-6	6-12	0-6	0-6	6-12	6-12	0-6	6-12	6-12	0-6	6-12	0-6
<u>Memphis Soil Series (Continued)</u>															
M V	M4	5	A	128	455	25.9	105	147	0.86	30.0	27.7				
			A1							130	170	28.2	27.9	300	368
			A2							143	168			212	300
			A3							158	177			225	325
			B	322	650	23.6	145	178		27.7	28.0				
			C	162	242	27.0	120	162		31.3	27.7				
			D	108	225	29.6	99	135		28.9	27.5				
<u>Loring Soil Series</u>															
L VI	L1	1	A	358	650	20.4	155	298		27.2	26.0				
			A1							162	250	29.5	25.7	512	750
			A2							182	270			482	750
			A3							158	282			445	750
			B	350	750	26.7	137	243		26.9	26.5				
			C	232	468	31.1	103	203		32.0	28.1				
			D	258	368	29.0	163	203		31.0	28.0				
		2	A	142	250	28.7	168	235	0.26	27.4	29.0				
			A1							150	163			268	375
			A2							128	130			230	355
			A3							85	115			255	278
			B	182	300	26.6	133	168	0.23	28.7	24.3				
			C	125	208	30.6	173	232	0.50	31.7	29.6				
			D	142	258	32.1	173	223	0.34	33.3	29.4				
		3	A	100	250	32.6	157	162	0.51	32.3	29.4				
			A1							137	133	1.02	29.6	27.2	218
			A2							162	118			175	255
			A3							172	157			168	220
			B	83	158	32.4	92	120	0.57	31.5	29.1				
			C	83	168	30.5	103	163	0.64	35.8	29.2				
			D	100	158	32.5	98	110		30.6	27.6				
		4	A	375	600	27.9	158	232		25.5	28.0				
			A1							140	218			280	368
			A2							138	220			282	338
			A3							170	232			345	468
			B	532	718	23.7	222	250		24.1	24.9				
			C	425	692	25.3	215	257		25.4	26.6				
			D	268	600	29.1	165	275		27.8	26.4				
		5	A	225	618	27.2	170	293		28.1	26.2				
			A1							185	282	27.4	26.1	592	750
			A2							168	300			475	750
			A3							183	298			532	750
			B	442	750	19.7	198	297		25.7	27.5				
			C	458	750	22.3	250	300*		25.6	26.4				
			D	442	750	25.8	180	300*	0.37	26.9	25.8				
L I	L2	1	A	180	218	30.2	200	300		32.4	27.4				
			A1							207	300	29.3	23.8	525	750
			A2							220	300			412	750
			A3							217	300			420	718
			B	242	255	28.5	207	193		29.1	25.1				
			C	180	220	26.5	237	300		30.8	25.5				
			D	175	308	27.6	195	185		28.6	27.3				
		2	A	230	418	33.0	240	300		30.4	24.7				
			A1							207	300			232	275
			A2							225	300			232	225
			A3							230	300			200	268
			B	142	108	30.3	130	132		34.2	28.0				
			C	100	142	30.1	200	250		31.7	26.1				
			D	112	200	33.6	150	217		32.6	27.3				
		3	A	130	192	30.8	170	293		30.1	27.2				
			A1							153	260	29.3	24.3	480	750
			A2							188	287			455	750
			A3							207	300			438	750
			B	130	332	26.8	188	230		29.6	28.0				
			C	112	250	28.2	143	218		29.7	30.4				
			D	112	330	28.1	193	240		30.3	28.8				
		4	A	318	625	23.6	175	240		30.4	28.5				
			A1							167	237			432	732
			A2							173	200			458	750
			A3							182	225			432	732
			B	162	445	26.8	113	170		33.2	29.9				
			C	162	188	28.1	227	300		27.4	28.0				
			D	170	170	29.5	233	300		28.7	28.6				

(Continued)

(3 of 9 sheets)

Table A1 (Continued)

Identification			Visit A			Visit B			Visit C			Visit D						
Site	Plot	Row	Position	CI	MC	CI	RI	MC	CI	RI	MC	CI	RI	MC				
				0-6	6-12	0-6	0-6	6-12	6-12	0-6	6-12	0-6	6-12	0-6	6-12	0-6	6-12	
<b>Loring Soil Series (Continued)</b>																		
L I	12	5	A	220	358	27.5	180	240	30.3	21.5								
			A1								183	193	27.7	25.8	268	268		
			A2													19.3	22.0	
			A3															
	B	205	270	27.6	175	213	32.2	29.1										
	C	112	195	34.5	158	190	30.2	28.0										
	D	200	192	26.3	175	160	28.6	31.8										
	L V	L3	1	A	155	258	29.9	120	143	35.5	32.9							
				A1								125	133	29.4	29.7	242	342	
				A2													21.3	19.5
				A3														
			B	168	242	28.0	103	125	30.9	31.9								
C			180	238	29.2	105	187	31.7	30.8									
D			118	168	28.6	93	145	31.2	29.7									
2			A	118	150	28.8	62	72	0.80	13.5	33.3							
			A1									70	127			300	280	
			A2									75	130			305	250	
			A3									70	143			220	255	
B			132	180	32.0	117	148	32.6	29.1									
C		150	150	28.2	105	117	0.74	29.1	40.0									
D		150	130	31.4	132	95	0.75	34.0	32.7									
3		A	145	155	31.3	95	127	33.1	31.9									
		A1									103	108	0.54	31.1	30.7	350	320	
		A2									103	127			342	300		
		A3									100	115			338	320		
B		200	200	28.3	105	142	36.4	31.4										
C		220	282	28.9	145	188	31.8	30.6										
D		220	262	29.1	115	135	30.2	30.0										
4		A	175	245	29.7	72	95	31.2	31.2									
		A1									102	133			350	342		
		A2									120	145			332	308		
	A3									123	123			325	275			
B	132	180	29.0	112	123	32.2	32.4											
C	188	230	29.3	135	113	30.5	26.5											
D	218	350	22.0	162	167	25.1	29.6											
5	A	108	150	34.2	78	93	33.8	31.8										
	A1									130	147	30.1	27.9	225	208			
	A2									140	172			250	208			
	A3									127	170			250	225			
B	125	205	24.8	136	157	34.4	27.8											
C	125	200	30.8	93	127	33.6	28.9											
D	132	188	29.4	137	123	31.4	30.3											
L IV	14	1	A	182	455	28.4	117	260	29.0	25.6								
			A1								135	263	25.9	24.7	230	468		
			A2									157	247			255	598	
			A3									170	277			230	380	
		B	162	318	29.6	162	245	28.3	24.9									
		C	158	438	32.2	133	213	28.5	26.5									
		D	338	750	24.5	120	267	27.2	24.2									
		2	A	308	550	31.1	120	167	30.3	27.8								
			A1									147	220			392	732	
			A2									108	177			385	750	
			A3									100	163			396	750	
		B	345	750	23.1	128	152	30.4	29.9									
	C	458	750	25.6	112	177	30.6	27.4										
	D	350	442	22.1	115	240	30.7	26.9										
	3	A	145	382	23.8	138	280	29.9	27.0									
		A1									93	210	28.9	28.0	258	482		
		A2									137	237			350	492		
		A3									82	170			345	545		
	B	288	588	24.6	167	243	28.3	27.7										
	C	132	300	32.9	95	210	27.7	25.9										
	D	332	525	27.4	122	225	29.1	26.1										
	4	A	208	308	28.0	217	257	0.72	24.6	23.5								
		A1									193	287			412	445		
		A2									198	292			400	418		
A3										180	257			318	405			
B	145	220	28.8	187	220	24.4	27.0											
C	155	150	29.6	210	293	24.2	25.7											
D	175	205	33.0	227	287	23.2	24.6											
5	A	362	345	23.9	223	235	0.56	29.2	25.4									
	A1									212	300	0.58	27.2	25.2	308	325		
	A2									177	170			358	400			
	A3									205	300			333	608			
B	332	255	27.2	210	253	0.60	26.9	26.0										
C	320	458	25.5	213	210	0.43	26.7	27.4										
D	382	342	23.3	203	213	0.49	27.8	27.8										

(Continued)

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Table A1 (Continued)

Identification				Visit A			Visit B			Visit C			Visit D		
Site	Plot	Row	Position	CI	MC	CI	RI	MC	CI	RI	MC	CI	RI	MC	
				0-6	6-12	0-6	6-12	0-6	6-12	0-6	6-12	0-6	6-12	0-6	6-12
<u>Loring Soil Series (Continued)</u>															
L III	L5	1	A	125	405	24.9	113	178		27.5	23.5				
			A1						88	167		27.2	27.8	430	550
			A2						117	143				442	682
			A3						77	149				362	558
			B	138	155	39.7	143	207		28.9	25.7				
			C	132	432	23.0	113	163		28.0	25.2				
			D	92	175	27.2	147	223		29.7	25.1				
		2	A	133	155	28.8	173	227		25.7	21.8				
			A1						150	170				308	392
			A2						170	197				292	268
			A3						182	230				305	312
			B	118	118	33.2	150	243		27.6	24.9				
			C	208	432	28.4	147	177		27.3	25.6				
			D	168	242	28.6	143	223		27.1	25.0				
		3	A	145	155	27.4	147	187	0.57	28.7	26.0				
			A1						157	273	0.79	27.0	26.3	312	355
			A2						163	187				322	332
			A3						210	183				325	358
			B	250	262	29.6	152	247		28.1	24.8				
			C	132	318	31.2	167	250		27.4	24.3				
			D	212	270	27.3	143	217		26.9	23.7				
		4	A	130	230	31.5	153	220		28.4	26.3				
			A1						157	173				350	608
			A2						180	187				325	400
			A3						142	150				345	392
			B	108	132	32.3	173	193	0.45	29.3	26.5				
			C	125	208	31.8	160	237		30.4	26.5				
			D	132	220	31.3	167	217		29.2	26.2				
		5	A	95	168	30.0	140	177	0.52	29.8	27.1				
			A1						160	227	0.54	29.7	26.6	305	392
			A2						152	150				320	350
			A3						142	190				258	325
			B	168	258	23.9	100	132	0.73	29.2	27.4				
			C	138	192	30.7	97	157	0.61	30.5	27.4				
			D	142	180	30.0	113	125	0.55	31.0	26.5				
<u>Henry Soil Series</u>															
M VI	HD1	1	A	120	206	29.4	127	145		30.0	34.5				
			A1						135	147	0.32	31.2	28.2	168	230
			A2						193	145				195	305
			A3						128	125				138	150
			B	130	195	32.2	122	101		30.0	35.2				
			C	138	150	30.1	145	190		31.0	32.8				
			D	145	108	30.7	162	139		31.2	34.4				
		2	A	208	155	32.3	183	171	0.23	31.3	27.4				
			A1						165	138				230	245
			A2						128	110				250	275
			A3						153	100				270	220
			B	180	112	32.9	164	172	0.31	31.6	26.5				
			C	188	245	36.4	128	108	0.38	33.1	28.9				
			D	218	158	32.8	155	148	0.22	32.7	28.0				
<u>Collins Soil Series</u>															
C III	CI	1	A	208	218	30.2	213	223	0.73	30.3	29.7				
			A1						162	212	0.67	30.7	30.0	192	242
			A2						178	202				270	345
			A3						208	157				295	320
			B	182	142	29.1	156	182	0.81	30.5	30.1				
			C	155	255	30.8	209	278		31.0	30.1				
			D	125	130	30.4	200	203	0.68	31.6	29.1				
		2	A	142	220	31.2	178	163		30.5	28.2				
			A1						156	200				132	145
			A2						167	177				168	232
			A3						168	185				188	238
			B	125	208	31.0	198	235		29.4	28.5				
			C	142	138	30.7	237	227		28.2	28.8				
			D	158	182	31.7	183	229		29.9	29.2				
		3	A	150	225	30.3	161	177		29.3	28.2				
			A1						155	140	29.8	28.5	150	232	1.14
			A2						192	247				188	230
			A3						175	208				155	230
			B	150	238	29.1	187	219		28.7	28.0				
			C	182	238	31.0	154	193		28.5	27.5				
			D	95	130	31.8	145	162		28.5	28.8				

(Continued)

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Table A1 (Continued)

Identification				Visit A			Visit B			Visit C			Visit D									
Site	Plot	Row	Position	CI	MC	0-6	CI	RI	MC	CI	RI	MC	CI	RI	MC							
				0-6	6-12	0-6	0-6	6-12	0-6	6-12	0-6	6-12	0-6	6-12	0-6							
<u>Collins Soil Series (Continued)</u>																						
C III	C1	4	A	152	138	30.0	74	241	29.3	26.6												
			A1									103	215		132	145	26.6	24.6				
			A2									118	200		168	232						
			A3									115	180		188	238						
	B	142	138	28.2	204	208			27.8	27.1												
	C	162	192	27.2	186	181			27.6	27.1												
	D	125	208	28.4	187	215			27.8	27.0												
	5	A	122	192	28.5	179	211			27.3	27.4											
		A1										150	163	30.4	28.9	150	238	24.1	23.5			
		A2										142	163			188	230					
		A3										142	137			155	230					
		B	82	188	29.1	171	253			29.3	26.3											
C		142	210	25.9	155	175			27.9	27.6												
D		118	195	30.0	155	206			30.0	26.6												
C I	C2	2	A	282	382	42.0	262	300			31.5	28.8										
			A1										270	222		338	308	28.8	26.4			
			A2										250	222		355	220					
			A3										222	203		292	275					
		B	300	358	31.1	240	300			31.9	28.0											
		C	175	225	33.0	267	300			29.9	28.3											
		D	225	238	30.2	232	300			31.1	28.2											
		3	A	242	250	31.7	262	300			31.4	28.5										
			A1											245	290	28.8	27.4	288	305	28.5	27.1	
			A2											237	283			282	300			
			A3											222	250			382	392			
		B	175	218	32.5	152	194			32.1	30.7											
	C	182	282	31.4	200	300			31.2	28.3												
	D	275	268	30.5	260	300			29.1	28.5												
	4	A	262	305	30.8	245	300			30.6	28.8											
		A1											203	212			370	392	28.3	26.7		
		A2											167	220			430	470				
		A3											202	210			338	420				
	B	205	318	28.6	257	300			32.6	28.8												
	C	282	408	29.8	203	300			29.9	28.9												
	D	218	318	29.6	270	300			30.8	28.0												
	F II	C3	1	A	82	142	31.6	133	157			28.6	27.2									
				A1										100	140	0.60	28.3	27.2	145	425	24.2	21.2
				A2										117	180			170	275			
A3													85	205			168	308				
B			63	80	30.6	187	160			27.5	28.0											
C			88	132	33.6	120	133	0.35		27.8	27.8											
D		55	120	33.5	153	223			28.8	28.8												
3		A	55	180	32.8	160	217			27.5	27.8											
		A1											142	202	27.1	28.4	303	392	21.2	16.6		
		A2											143	207			295	355				
		A3											136	155			258	392				
B		62	175	32.5	147	180			26.6	27.2												
C	42	145	32.0	180	205			28.0	30.9													
D	68	182	31.8	220	263			26.5	27.5													
<u>Falaya Soil Series</u>																						
F VII	F1	1	A	192	208	27.0	140	115	0.67	27.8	27.9											
			A1										177	183	0.46	27.6	28.6	142	268	24.5	24.5	
			A2										153	140			182	255				
			A3										178	162			175	168				
		B	195	280	26.8	142	190	0.32		27.6	27.7											
		C	145	212	27.7	127	173	0.64		27.9	29.0											
		D	300	320	28.3	160	207			30.1	28.8											
		2	A	212	392	28.5	118	250			29.9	26.9										
			A1											143	188			188	238	26.7	29.4	
			A2											172	185			150	245			
			A3											147	192			232	262			
		B	120	280	29.7	123	257			29.3	26.4											
C	158	258	30.4	192	300	0.51		28.7	26.2													
D	52	238	29.2	180	230			31.2	26.9													
3	A	225	350	30.5	147	300			29.6	26.6												
	A1											157	247	0.84	30.2	26.8	195	355	0.72	26.8	27.7	
	A2											150	225			205	295					
	A3											142	215			250	350					
B	125	270	27.2	177	233			28.1	27.7													
C	212	312	29.1	152	300			31.2	27.6													
D	120	280	31.8	133	220	0.57		31.5	27.9													

(Continued)

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Table A1 (Continued)

Identification				Visit A			Visit B			Visit C			Visit D							
Site	Plot	Row	Position	CI	MC	CI	MC	CI	MC	CI	MC	CI	MC	CI	MC					
				0-6	6-12	0-6	6-12	0-6	6-12	0-6	6-12	0-6	6-12	0-6	6-12					
Ferry's Soil Series (Continued)																				
F VII	F1	4	A	119	200	30.7	188	300	0.41	28.8										
			A1								143	220			175	292	28.1	26.5		
			A2								170	182			240	420				
			A3								120	183			212	355				
			B	80	192	30.5	163	300	0.48	30.4	27.8									
			C	182	270	30.7	150	247		31.2	26.6									
	D	132	175	31.1	140	168	0.34	29.3	29.4											
	A	92	170	34.4	187	293		28.9	28.1											
	A1									152	280	30.7	27.1	162	308	29.1	26.8			
	A2									138	270			155	286					
	A3									143	273			180	300					
	B	115	218	31.0	168	243		30.4	28.8											
C	108	200	31.6	168	300		32.6	29.7												
D	160	200	30.2	122	192		31.5	28.1												
C VI	F2	1	A	368	750	30.4	194	287		30.0	29.7									
			A1								203	300	24.8	24.9	312	362	30.4	28.5		
			A2								143	300			270	280				
			A3								227	300			312	330				
			B	282	300	28.5	193	300		30.0	29.7									
			C	200	232	31.6	187	247		32.8	30.7									
		D	312	375	28.7	143	223		31.0	29.5										
		A	162	188	34.6	143	183		32.0	31.0										
		A1									130	200			268	395	26.2	27.0		
		A2									150	183			270	305				
		A3									180	237			295	260				
		B	158	188	32.8	140	157		31.4	29.8										
	C	145	192	32.8	173	207		31.9	30.5											
	D	242	200	34.0	143	240		32.8	28.8											
	A	170	282	30.7	177	247		30.4	28.2											
	A1									143	233	30.5	28.3	180	208	29.1	26.9			
	A2									170	233			232	258					
	A3									147	260			262	405					
	B	163	275	31.4	157	257		32.2	28.6											
	C	132	275	34.0	173	267		32.2	28.6											
	D	242	242	30.6	193	247		32.2	27.7											
	A	158	392	31.3	163	297		30.7	27.5											
	A1									120	247			232	612	30.5	24.4			
	A2									140	280			258	625					
A3									123	243			258	650						
B	142	342	31.2	177	287		33.8	26.0												
C	175	220	32.1	133	247		34.2	27.6												
D	170	275	32.0	167	277		30.6	26.5												
A	162	330	26.9	207	300	0.57	29.2	26.8												
A1									260	300	27.6	27.0	292	570	24.4	25.8				
A2									240	300			405	642						
A3									190	273			355	580						
B	362	518	26.8	223	300		29.2	29.1												
C	258	530	27.3	140	247		28.9	21.1												
D	275	518	27.2	173	287		31.4	18.5												
C IV	F2	1	A	130	125	32.4	42	37	0.56	37.1	32.4									
			A1								47	80	0.49	32.1	31.5	50	138	0.61	31.5	29.8
			A2								30	67			80	158				
			A3								28	62			75	95				
			B	158	158	31.5	18	45	0.49	33.5	32.1									
			C	125	130	31.8	27	93	0.51	33.9	31.2									
		D	120	162	31.5	55	103	0.40	35.2	28.8										
		A	168	212	27.4	45	115	0.48	34.5	30.8										
		A1									33	77			50	158	32.3	29.3		
		A2									30	82			50	170				
		A3									32	97			62	168				
		B	132	170	32.6	50	70	0.39	32.1	32.1										
	C	188	150	33.1	35	48	0.57	35.3	29.9											
	D	132	118	34.8	17	66	0.37	36.1	30.4											
	A	180	205	32.7	53	53	0.40	33.4	31.0											
	A1									17	40	0.37	35.2	33.6	82	195	0.59	29.9	29.6	
	A2									13	40			70	100					
	A3									13	55			82	138					
	B	160	205	30.1	50	60	0.37	32.8	37.5											
	C	150	168	29.6	73	107	0.46	31.4	29.3											
	D	145	130	31.1	30	55	0.37	35.5	30.0											
	A	130	188	29.7	37	50	0.59	35.1	30.7											
	A1									47	92			80	195	30.1	29.7			
	A2									42	92			132	168					
A3									43	125			112	220						
B	142	132	31.1	35	73	0.41	31.8	29.1												
C	132	148	31.9	48	82	0.55	31.5	30.7												
D	155	170	29.6	37	87	0.50	32.5	28.9												

(Continued)

(7 of 9 sheets)

Table A1 (Continued)

Identification				Visit A			Visit B			Visit C			Visit D											
Site	Plot	Row	Position	CI		MC	CI		RI	MC		CI		RI	MC									
				0-6	6-12	0-6	0-6	6-12	0-6	6-12	0-6	6-12	0-6	6-12	0-6	6-12								
<b>Palaya Soil Series (Continued)</b>																								
C IV	F3	5	A	168	162	28.8	38	75	0.24	31.8	31.6													
			A1									53	92	0.66	35.7	34.6	55	168	0.59	27.8	27.9			
			A2									38	52				45	188						
			A3									40	78				82	212						
			B	132	158	28.5	28	80	0.56	30.1	30.1													
			C	142	192	29.2	52	90	0.47	31.1	30.5													
			D	108	182	29.0	42	75	0.57	30.9	30.6													
			F VIII	F4	1	A	132	182	36.2	106	157	0.41	36.0	33.6										
						A1									90	103	0.41	37.2	35.4	145	205	0.49	31.9	32.8
						A2									90	112				138	195			
A3												87	103				130	192						
B	88	108				42.0	88	108	0.32	35.3	32.7													
C	70	125				34.5	83	122	0.47	38.5	32.9													
D	82	232			37.2	123	140	0.87	35.5	38.3														
2	A	70			145	35.2	90	167	0.29	34.4	29.8													
	A1											90	150				105	168		34.7	33.3			
	A2											90	170				125	138						
	A3											97	157				108	218						
	B	50			158	40.6	125	233	0.42	34.1	33.0													
	C	53	188	37.5	90	230	0.48	35.4	30.2															
D	95	238	39.4	110	187	0.52	35.9	29.5																
3	A	A1	68	150	39.6	90	177	0.49	33.1	28.1														
		A2									107	218	0.52	32.6	26.6	130	212	0.55	30.9	27.9				
		A3									120	203				132	220							
		B	65	138	37.2	112	220	0.51	31.3	24.4						150	250							
		C	70	220	42.0	67	195	0.64	37.4	29.7														
		D	30	155	40.4	120	187	0.47	31.5	23.6														
	4	A	118	292	35.4	138	203	0.65	31.3	27.3														
		A1									110	212				118	270		27.5	26.2				
		A2									103	200				118	175							
		A3									117	203				120	230							
		B	20	130	27.1	80	103	0.41	28.0	26.3														
		C	112	232	21.2	107	192	0.34	28.1	28.4														
D	70	192	31.7	118	155	0.46	31.1	32.4																
C V	F5	1	A	68	195	35.0	145	197	0.69	30.4	29.4													
			A1									120	277	0.92	31.4	28.4	342	362		26.9	25.4			
			A2									147	213				232	308						
			A3									120	190				330	412						
			B	232	358	30.5	133	148	0.56	30.0	31.7													
			C	220	208	31.7	143	160	0.60	34.1	29.2													
		D	242	200	30.8	92	170	0.88	30.3	29.5														
		2	A	150	142	35.3	117	208	0.57	33.2	29.6													
			A1									140	157				285	312		26.3	26.8			
			A2									140	200				200	358						
			A3									135	127				258	332						
			B	95	150	31.7	142	227	0.51	30.1	26.5													
C	70		262	33.6	98	243	0.57	32.8	28.4															
D	120	275	29.6	133	147	0.59	29.8	29.3																
3	A	A1	218	305	32.6	135	207	0.70	31.6	31.1														
		A2									205	278	0.80	27.7	27.7	232	332		25.4	26.8				
		A3									252	270				350	392							
		B	180	338	34.0	175	287	0.71	33.9	28.9						305	342							
		C	205	282	29.0	147	278	0.78	30.4	28.0														
		D	80	188	33.3	82	197	0.71	29.5	28.8														
	4	A	215	255	30.6	152	197	0.42	30.1	30.5														
		A1									140	180				250	395		22.1	19.8				
		A2									120	163				245	500							
		A3									177	177				258	450							
		B	182	230	32.4	127	210	0.73	29.9	28.7														
		C	158	292	32.4	145	260	0.68	29.9	27.5														
D	132	268	34.2	143	210	0.67	30.1	29.3																
F II	F6	2	A	120	230	29.0	157	167		29.1	28.1													
			A1									120	187				218	318		23.5	24.5			
			A2									138	173				168	238						
			A3									113	207				255	255						
			B	82	192	32.5	187	150	0.57	28.7	28.6													
			C	62	100	30.2	193	153	0.36	29.1	29.7													
		D	62	225	29.6	153	227		30.7	28.1														
		4	A	52	138	33.8	163	143	0.49	28.5	31.3													
			A1									133	143				232	288		24.5	25.1			
			A2									127	163				258	275						
			A3									120	130				225	250						
			B	58	158	33.6	128	142	0.45	27.7	25.9													
C	52		158	32.8	147	133	0.42	27.8	29.8															
D	70	170	33.4	173	150	0.46	28.5	29.6																

(Continued)

(8 of 9 sheets)

Table A1 (Concluded)

Identification				Visit A			Visit B			Visit C			Visit D					
Site	Plot	Row	Position	CI	MC	CI	RI	MC	CI	RI	MC	CI	RI	MC				
				0-6	6-12	0-6	6-12	0-6	6-12	0-6	6-12	0-6	6-12	0-6	6-12			
<u>Palaya Soil Series (Continued)</u>																		
P II	P6	5	A	128	208	35.4	155	185	0.54	29.9	28.5							
			A1									138	145	0.71	28.4	29.0	318	342
			A2									118	150				375	425
			A3									133	153				250	368
			B	62	138	33.2	120	157	0.45	31.1	29.9							
			C	35	168	33.2	113	148	0.42	28.9	29.1							
			D	30	162	34.0	100	170	0.42	29.2	29.7							
C I	Y7	1	A	182	375	39.0	255	300		29.2	28.4							
			A1									270	262	31.3	28.1	300	382	
			A2									252	265			292	305	
		A3									252	292			288	292		
		B	268	325	35.9	203	227		32.4	29.0								
		C	232	368	29.8	272	300		29.4	29.6								
				D	182	325	38.8	245	300		31.4							
			5	A	232	332	29.5	265	300		30.5	32.0						
	A1										250	300	28.9	30.4	300	275		
	A2										270	300			355	238		
				B	242	308	30.9	233	300		39.4	29.7						
				C	225	425	30.4	242	300		23.7	28.6						
			D	158	292	29.6	212	300		26.5	28.6							
<u>Hymon Soil Series</u>																		
C II	HY1	1	A	175	158	31.8	133	137	0.28	34.6	30.1							
			A1									150	130	0.33	32.9	31.7	162	175
			A2									122	140			155	145	
			A3									123	117			192	200	
					B	150	150	30.6	143	167		32.2	26.8					
					C	175	142		123	132	0.46	33.0	27.4					
					D	182	182	32.5	120	125	0.32	33.9	32.9					
				2	A	242	275	34.9	178	300		37.2	30.3					
		A1										195	173			170	358	
		A2										197	232			162	350	
		A3										217	245			168	303	
					B	300	280	36.3	155	215		37.7	30.0					
				C	158	158	40.6	180	300	0.30	39.2	32.8						
				D	292	308	35.6	188	300	0.42	36.8	32.1						
			3	A	232	308	34.4	185	300	0.77	33.3	26.9						
	A1										168	167	0.53	31.8	29.5	230	368	
	A2										172	202			280	332		
	A3										183	233			345	342		
				B	218	192	32.3	213	158	0.64	34.3	28.8						
				C	218	150	31.6	155	100	0.21	34.6	31.1						
				D	242	232	37.3	123	163	0.14	33.0	30.6						
			4	A	208	342	35.2	152	295	0.15	30.1	26.9						
	A1										157	183			245	245		
	A2										175	192			188	188		
A3										152	152			318	270			
			B	232	250	30.0	182	127	0.33	29.3	27.3							
			C	168	153	28.8	188	148	0.13	28.0	26.3							
			D	168	250	31.2	195	297	0.08	29.9	25.9							
		5	A	168	182	25.8	150	178	0.17	29.6	27.9							
A1										135	118	0.16	28.9	27.0	195	255		
A2										138	153			192	205			
A3										165	157			182	192			
			B	175	168	26.9	183	123	0.23	26.8	28.2							
			C	318	382	26.0	220	190	0.35	26.8	26.1							
			D	192	192	26.5	187	300	0.55	28.8	27.4							

Table 2

Classification and Properties of Soils at Test Sites\*

Site	Plot	Row	Column	Grain-Size Analysis, %										Liquid Limit, %	Plasticity Index, %	Soil Moisture, % at 0.075-mm	Soil Moisture, % at 0.0075-mm																
				Sand		Silt		Clay		Fines		Atterberg Limits, %	Density, g/cc					Specific Gravity	Saturation, %	Tension, lb/in <sup>2</sup>	Tension, lb/in <sup>2</sup>												
				0-6	6-12	0-6	6-12	0-6	6-12	0-6	6-12											0-6	6-12	0-6	6-12								
Alluvial Fill																																	
M I	AF1	A	SIL	14	12	67	65	74	73	11	13	99.0	98.0	38	35	26	23	12	12	1.36	1.36	2.69	2.71	32.6	32.1	31.3	30.8	30.8	30.3	29.9	29.2		
			SIL	15	9	69	74	74	74	16	17	98.8	99.4	31	29	24	23	25	25	7	6	1.34	1.41	2.63	2.70	33.0	30.7	30.7	30.7	30.7	29.9	29.9	28.6
		SIL	11	13	73	73	16	16	99.4	99.6	33	30	25	25	23	23	25	25	8	5	1.28	1.40	2.68	2.70	28.9	31.6	27.8	27.8	27.2	27.2	26.5	26.5	
		SIL	10	10	64	72	26	26	99.6	99.8	35	33	23	23	23	23	23	22	12	11	1.50	1.42	2.69	2.71	28.4	34.0	27.8	27.8	27.2	31.2	26.7	30.0	
	AF2	A	SIL	12	12	77	75	11	13	99.4	99.6	34	31	30	26	5	5	1.24	1.40	2.69	2.70	34.5	32.0	31.6	31.6	30.1	30.1	30.1	30.1	30.1	29.4	29.4	
			SIL	10	11	77	77	17	17	99.4	99.6	34	32	27	26	7	6	1.36	1.41	2.68	2.71	34.5	32.0	31.6	31.6	30.1	30.1	30.1	30.1	30.1	29.6	29.6	
		SIL	10	12	74	76	16	16	98.4	99.6	36	31	27	26	9	5	1.36	1.35	2.69	2.70	32.6	34.3	32.2	31.8	31.8	31.0	31.2	31.2	31.0	31.0	30.0	30.0	
		SIL	9	14	74	73	17	17	99.4	99.4	38	32	31	26	17	6	1.35	1.40	2.69	2.70	33.4	31.6	32.7	30.8	32.2	30.2	30.2	31.6	31.6	29.5	29.5		
	AF3	A	SIL	15	14	73	77	12	12	98.6	99.6	36	26	28	26	8	0	1.40	1.51	2.68	2.70	32.4	26.0	31.3	26.0	30.6	30.6	30.6	30.6	30.6	30.0	25.0	25.0
			SIL	12	16	75	76	13	13	98.6	99.4	39	27	27	26	13	1	1.30	1.43	2.68	2.69	35.6	29.6	34.7	29.1	34.2	28.6	33.6	33.6	28.0	28.0		
		SIL	12	15	76	75	12	12	98.2	98.4	34	27	26	25	7	2	1.32	1.46	2.69	2.70	36.6	28.8	35.2	28.2	34.0	27.8	29.2	27.3	27.2	27.2			
		SIL	11	10	76	79	13	11	98.8	99.3	36	32	27	24	9	8	1.34	1.46	2.68	2.71	35.3	29.6	34.6	29.2	34.0	28.8	33.5	28.0	28.0				
AF4	A	SIL	10	9	73	74	17	17	99.0	99.8	37	30	27	24	10	6	1.30	1.48	2.69	2.71	38.4	26.4	37.2	26.0	36.6	25.8	35.7	35.7	25.2	25.2			
		SIL	11	9	79	73	10	10	99.0	99.2	33	32	27	23	6	9	1.43	1.48	2.60	2.71	30.6	29.0	29.8	28.6	29.4	28.1	28.9	27.9	27.9				
	SIL	14	14	74	74	14	14	98.2	98.8	41	30	30	24	10	3	1.41	1.44	2.68	2.70	31.2	30.7	30.2	29.1	29.8	27.8	29.2	27.3	27.3					
	SIL	12	10	77	78	11	12	97.8	99.6	37	29	28	25	9	4	1.29	1.49	2.68	2.71	38.0	29.2	36.9	28.5	36.2	27.9	35.4	27.3	27.3					
AF5	A	SIL	12	12	75	78	15	10	98.0	99.6	41	30	30	28	11	2	1.31	1.42	2.68	2.70	37.0	24.2	35.1	30.2	34.5	29.2	33.6	28.6	28.6				
		SIL	15	10	74	75	11	15	98.8	99.4	31	29	25	23	6	6	1.37	1.48	2.68**	2.71**	33.8	27.0	32.4	26.0	31.6	25.5	36.9	25.0	25.0				
	SIL	12	13	74	74	14	13	98.2	98.8	41	30	30	25	11	5	1.27	1.47	2.69	2.70	38.3	27.1	36.2	26.6	35.4	26.4	34.4	26.0	26.0					
	SIL	13	10	74	74	15	13	98.6	99.6	36	29	26	24	10	5	1.34	1.42	2.68	2.71	34.6	29.4	33.6	28.7	33.0	28.4	32.0	27.4	27.4					
AF2	A	SIL	15	14	73	72	12	12	99.0	99.0	37	32	28	23	5	9	1.40	1.42	2.66	2.69	32.2	31.6	30.9	30.6	30.6	29.9	30.0	29.2	29.2				
		SIL	14	12	76	72	10	14	98.8	99.2	37	31	28	22	9	9	1.44	1.50	2.66	2.69	30.1	29.2	27.0	28.7	26.6	28.2	26.0	26.0					
	SIL	16	11	75	71	9	18	97.2	99.6	34	33	25	21	12	12	1.40	1.46	2.66	2.69	31.0	29.2	29.8	28.2	29.3	27.4	28.8	26.9	26.9					
	SIL	15	11	75	68	10	21	97.5	99.4	31	40	23	21	8	19	1.44	1.49	2.66	2.69	29.2	27.4	28.4	26.7	27.9	26.4	27.4	26.2	26.2					
AF3	A	SIL	12	9	78	77	10	14	98.6	98.8	43	29	33	24	10	5	1.37	1.36	2.66	2.69	33.8	37.2	32.4	34.4	32.0	33.6	31.5	32.6	32.6				
		SIL	12	10	78	76	10	14	99.0	98.6	35	33	28	26	7	7	1.39	1.39	2.66	2.69	32.8	31.8	31.5	32.3	31.0	31.8	30.4	31.1	31.1				
	SIL	12	10	79	77	9	13	99.0	99.0	35	33	28	25	8	8	1.42	1.47	2.66	2.69	30.7	30.2	29.7	29.0	29.4	28.6	28.8	28.2	28.2					
	SIL	13	10	79	77	8	13	98.8	99.4	26	31	24	23	2	2	1.44	1.44	2.66	2.69	30.6	31.8	29.2	29.8	28.8	28.6	28.2	28.2						
AF4	A	SIL	12	10	78	75	9	15	99.0	99.4	36	35	28	24	8	11	1.42	1.42	2.66	2.70	32.7	31.2	30.8	30.0	30.4	29.2	29.8	28.7	28.7				
		SIL	12	10	78	74	10	16	99.0	99.2	35	29	28	22	7	7	1.42	1.44	2.66	2.70	32.6	31.2	30.9	29.4	30.6	28.8	29.8	28.2	28.2				
	SIL	12	10	79	73	9	17	98.8	99.4	34	29	25	21	9	8	1.40	1.46	2.66	2.70	32.8	30.6	31.4	28.8	31.0	28.0	30.4	27.6	27.6					
	SIL	13	10	77	76	10	14	98.0	99.4	36	30	27	20	9	10	1.40	1.44	2.66	2.70	32.8	31.9	31.6	30.1	31.2	29.4	30.5	28.9	28.9					
M IV	M1	M1	SIL	12	8	70	62	18	30	99.6	99.8	41	54	25	27	16	27	1.44	1.48	2.66**	2.71	30.1	30.0	28.6	28.6	28.4	28.4	27.9	29.2	29.2			
			SIL	7	7	64	62	29	31	99.8	99.8	49	54	24	29	25	25	1.46	1.50	2.69	2.71	29.3	28.5	28.3	27.8	28.0	27.8	27.8	27.8				
			SIL	11	8	59	63	20	29	99.4	99.8	36	48	23	23	13	13	1.50	1.48	2.69	2.71	28.4	28.0	27.1	28.2	27.1	28.2	26.8	27.6	27.6			
			SIL	12	6	65	66	23	28	99.4	100.0	40	54	25	25	15	29	1.42	1.50	2.69	2.71	31.0	28.6	29.6	27.7	29.1	27.7	28.1	27.6	27.6			

(Continued)

Note: "0-6" and "6-12" indicate 0- to 6-in. and 6- to 12-in. soil layers, respectively.  
 \* Data are listed by plots according to field-identified soil series.  
 \*\* Estimated.

Table A2 (Continued)

Site	Plot	Box	Elev	Posi-	Classification		Grain-size analysis, %		Atterberg Limits		Density		Specific Gravity		Saturation		Tension		0.002-mm		0.00425-mm												
					USDA	UNSC	Sand	Silt	Clay	LL	PL	PI	G <sub>s</sub>	G <sub>m</sub>	G <sub>w</sub>																		
																									0-6	6-12	0-6	6-12	0-6	6-12	0-6	6-12	0-6
M IV	ML	2	A	SIL	SIL	CL	14	74	57	13	19	99.4	99.6	26	36	24	23	2	15	1.40	1.44	2.66	2.69	33.8	29.8	31.6	28.9	30.6	27.8	30.0	27.0		
						CL	12	12	18	15	99.2	99.8	28	42	22	22	20	1.40	1.52	2.69	2.69	34.2	23.7	2.71	2.71	27.6	28.4	27.0	28.2	27.6	28.0	27.8	27.8
						CH	11	8	72	66	37	26	99.4	99.8	33	52	25	25	8	27	1.38	1.44	2.68	2.71	33.2	30.5	30.6	29.2	29.8	29.0	28.9	28.9	28.9
	3	A	SIL	SIL	CL	12	12	18	12	73	18	99.4	99.8	36	41	22	26	14	15	1.48	1.52	2.66	2.68	29.0	28.5	27.2	27.0	26.8	26.8	26.3	26.6		
					CL	13	13	64	14	27	99.0	99.8	32	48	23	23	9	23	1.46	1.52	2.67	2.70	29.6	28.0	28.5	26.9	27.2	26.6	26.2	26.2			
					CL	12	8	74	64	14	28	99.4	99.8	31	45	24	28	7	17	1.47	1.52	2.67	2.70	28.0	27.4	26.9	26.2	26.4	26.3	26.2	26.3		
	4	A	SIL	SIL	CL	13	9	72	66	15	25	99.4	99.8	31	43	23	28	6	20	1.48	1.52	2.67	2.70	28.4	28.6	27.7	27.8	27.0	27.6	26.8	27.4		
					CL	15	8	73	63	10	29	99.4	99.8	30	44	25	27	5	17	1.38	1.46	2.66	2.70	32.0	29.4	29.9	28.5	29.0	28.0	28.6	27.6		
					CL	7	8	68	62	25	30	99.2	99.8	28	47	24	24	8	23	1.46	1.47	2.67	2.69	29.1	30.0	27.8	29.0	27.1	28.8	26.6	28.6		
	5	A	SIL	SIL	CL	14	9	72	69	11	22	98.2	99.0	31	34	23	21	8	14	1.51	1.44	2.66	2.69	28.4	30.3	27.3	29.5	26.6	28.8	26.4	28.4		
					CL	14	8	77	69	10	23	99.2	99.8	30	37	24	23	4	14	1.47	1.46	2.66	2.70	30.0	29.8	28.9	28.6	28.2	28.3	27.8	27.9		
					CL	14	8	77	72	10	16	99.0	99.0	30	30	24	24	6	16	1.47	1.47	2.66	2.70	30.2	28.9	28.8	28.2	28.0	27.6	27.6	27.2		
6	A	SIL	SIL	CL	13	13	77	72	43	17	99.0	99.6	29	40	25	22	4	18	1.46	1.43	2.66	2.68	29.5	30.9	28.4	30.4	27.6	29.5	27.2	29.2			
				CL	10	11	81	78	9	10	98.4	99.6	26	35	26	23	0	13	1.38	1.41	2.64	2.67	34.0	31.4	31.7	29.6	30.8	28.6	30.4	28.1			
				CL	13	12	77	73	10	18	99.0	99.4	30	30	27	24	3	9	1.44	1.46	2.64	2.67	32.4	30.6	29.6	29.2	28.6	28.4	27.6	28.0	27.3		
7	A	SIL	SIL	CL	13	11	77	72	43	17	99.0	99.6	29	41	29	25	1	13	1.46	1.43	2.66	2.68	29.3	31.0	27.8	29.7	27.0	28.8	26.5	28.2			
				CL	10	11	81	78	9	11	98.0	99.6	26	31	25	22	1	9	1.42	1.38	2.64	2.67	31.6	32.0	29.9	30.4	29.0	29.0	28.6	28.6			
				CL	13	12	77	73	10	18	99.0	99.4	30	30	27	24	3	5	1.38	1.42	2.64	2.67	32.4	31.0	30.6	29.0	29.4	27.8	28.0	27.4			
8	A	SIL	SIL	CL	13	11	77	73	10	18	99.0	99.6	29	41	29	25	0	16	1.43	1.44	2.64	2.67	30.0	31.8	28.5	30.2	27.5	29.6	27.4	29.2			
				CL	13	10	77	73	10	17	98.4	99.6	30	36	25	22	3	16	1.46	1.51	2.64	2.67	30.0	28.4	28.0	27.4	27.8	26.6	27.4	26.4			
				CL	12	10	77	73	10	18	99.0	99.6	29	37	26	23	5	13	1.44	1.45	2.64	2.67	29.8	29.2	28.0	28.0	27.4	26.9	26.9	26.2			
9	A	SIL	SIL	CL	13	12	77	73	10	18	99.0	99.6	29	41	29	25	4	21	1.46	1.51	2.64	2.67	30.1	29.4	28.6	28.4	27.8	27.6	27.4	27.3			
				CL	12	11	76	73	12	19	98.8	99.4	33	43	28	28	3	21	1.44	1.49	2.64	2.67	30.0	29.0	28.4	28.3	27.4	27.8	27.0	27.6			
				CL	12	10	77	73	10	18	99.0	99.6	29	41	29	25	4	21	1.46	1.49	2.64	2.67	29.3	29.1	29.0	28.1	28.3	27.2	27.8	27.0			
10	A	SIL	SIL	CL	13	12	77	73	10	18	99.0	99.6	29	41	29	25	3	24	1.46	1.46	2.64	2.67	31.4	29.4	29.1	28.3	28.4	27.6	27.4	27.3			
				CL	12	9	73	67	13	24	97.6	99.6	29	41	24	24	5	17	1.40	1.48	2.64	2.67	32.9	30.1	28.1	29.0	28.2	28.5	28.6	28.2			
				CL	13	9	76	68	13	23	99.0	99.6	28	37	28	23	0	14	1.40	1.46	2.65	2.67	31.1	29.1	29.1	28.3	28.4	27.6	27.8	27.4			
11	A	SIL	SIL	CL	11	9	72	69	17	22	99.6	99.8	34	44	24	24	8	19	1.46	1.46	2.67	2.71	28.0	29.6	26.9	28.6	27.0	28.0	26.1	28.7			
				CL	11	8	69	63	24	24	99.0	99.6	34	44	24	24	10	22	1.49	1.44	2.68	2.71	27.1	29.1	26.0	27.4	26.9	27.7	27.2	27.2			
				CH	9	8	67	63	24	24	99.8	99.8	34	44	24	24	10	31	1.50	1.50	2.69	2.71	26.1	28.9	27.2	28.8	27.2	28.1	27.2	26.2			
12	A	SIL	SIL	CL	10	9	68	63	22	28	99.6	99.8	34	44	25	23	9	11	1.54	1.54	2.69	2.71	26.1	26.6	25.2	25.9	25.0	26.0	24.6	25.6			
				CL	10	9	68	63	22	28	99.6	99.8	34	44	25	23	9	11	1.54	1.54	2.69	2.71	26.1	26.6	25.2	25.9	25.0	26.0	24.6	25.6			
				CH	10	9	68	63	22	28	99.6	99.8	34	44	25	23	9	11	1.54	1.54	2.69	2.71	26.1	26.6	25.2	25.9	25.0	26.0	24.6	25.6			

(Continued)

\*\* Estimated.

Table A2 (Continued)

Site	Plot	Rep	Mo	Yr	Post- ion	Gravimetric Analysis				Soil Moisture, % at					
						Wt	Vol	Density	Specific Gravity	0-15 cm	15-30 cm	30-45 cm	Total		
						Wt	Vol	Density	Specific Gravity	0-15 cm	15-30 cm	30-45 cm	Total		
M VI	MG	5	A	SIL	SIL	9	99.8	99.8	1.54	2.67	27.1	28.0	26.1	26.8	
						11	99.4	99.6	1.46	2.69	29.6	28.0	28.4	27.0	28.4
						10	99.6	99.6	1.52	2.69	26.9	27.6	26.0	28.0	26.0
						10	99.8	99.8	1.50	2.69	27.0	30.3	25.5	28.4	28.2
	MA	2	A	SIL	SIL	9	99.0	99.6	1.48	2.66	30.0	27.8	29.1	27.4	
						11	99.4	99.6	1.48	2.66	31.1	28.2	28.6	27.9	
						10	99.4	99.6	1.48	2.66	27.4	28.2	28.6	27.9	
						10	99.6	99.6	1.48	2.66	28.0	28.0	27.4	26.2	
	3	A	SIL	SIL	SIL	14	97.8	99.8	1.52	2.71	36.2	27.5	25.2	26.8	
						16	97.8	99.8	1.48	2.66	33.4	28.4	31.1	27.6	
						16	97.8	99.8	1.51	2.66	27.6	28.2	25.8	27.4	
						11	97.8	99.8	1.51	2.66	27.1	29.6	26.2	28.8	
L VI	L1	A	SIL	SIL	16	98.8	100.0	1.42	2.68	29.6	23.4	28.2	27.2		
					20	99.4	99.8	1.42	2.68	28.1	27.6	27.2	27.0		
					14	99.4	99.8	1.46	2.68	29.4	29.1	28.3	28.4		
					10	99.4	99.8	1.41	2.66	31.2	29.2	30.4	28.6		
	2	A	SIL	SIL	SIL	6	98.8	99.2	1.44	2.66	29.5	30.6	28.4	29.0	
						5	99.4	99.4	1.46	2.66	28.4	29.6	27.2	28.3	
						7	99.4	99.4	1.39	2.66	32.2	31.1	30.7	30.1	
						5	99.4	99.4	1.39	2.66	32.2	30.8	30.6	29.2	
	3	A	SIL	SIL	SIL	9	96.8	99.0	1.42	2.67	32.2	30.2	31.0	30.4	
						10	96.8	99.0	1.40	2.65	32.4	30.2	30.8	29.2	
						10	96.8	99.0	1.42	2.65	31.6	29.3	30.2	28.3	
						9	96.8	99.0	1.42	2.65	31.3	31.1	30.2	29.5	
4	A	SIL	SIL	SIL	18	99.8	99.8	1.48	2.69	28.0	27.8	27.4	26.8		
					21	99.8	99.8	1.48	2.69	28.2	27.6	26.8	27.5		
					15	99.8	99.8	1.47	2.68	28.7	28.2	27.6	27.3		
					17	99.8	99.8	1.48	2.68	31.0	27.5	30.2	26.7		
5	A	SIL	SIL	SIL	15	99.2	99.8	1.48	2.68	28.8	28.0	27.7	27.3		
					16	99.2	99.8	1.48	2.68	28.5	28.0	27.7	27.4		
					19	99.2	99.8	1.46	2.68	29.2	27.4	28.2	26.6		
					13	99.2	99.8	1.48	2.68	28.8	28.0	27.7	27.2		
12	1	A	SIL	SIL	16	99.2	99.8	1.51	2.65	31.0	28.8	29.4	27.0		
					20	99.6	99.8	1.44	2.68	32.2	27.0	31.3	26.8		
					23	99.8	99.8	1.44	2.68	31.8	26.1	30.2	29.8		
					5	99.8	99.8	1.44	2.68	31.5	25.8	30.1	29.3		
2	A	SIL	SIL	SIL	8	99.2	99.8	1.34	2.64	35.7	28.1	33.6	26.9		
					10	99.4	99.8	1.45	2.64	32.4	27.4	31.0	26.4		
					6	99.4	99.8	1.40	2.68	30.0	26.4	30.3	26.5		
					9	99.4	99.8	1.40	2.68	31.2	26.4	30.3	26.5		

(Continued)

est. Estimated.

(3 of 10 sheets)

Table A2 (Continued)

Site	Plot	Row	Column	Post- treatment	Classification			Grain-Size Analysis, %			Atterberg Limits			PI	PI <sub>1</sub>	PI <sub>2</sub>	PI <sub>3</sub>	PI <sub>4</sub>	PI <sub>5</sub>	PI <sub>6</sub>	PI <sub>7</sub>	PI <sub>8</sub>	PI <sub>9</sub>	PI <sub>10</sub>	PI <sub>11</sub>	PI <sub>12</sub>	PI <sub>13</sub>	PI <sub>14</sub>	PI <sub>15</sub>	PI <sub>16</sub>	PI <sub>17</sub>	PI <sub>18</sub>	PI <sub>19</sub>	PI <sub>20</sub>	PI <sub>21</sub>	PI <sub>22</sub>	PI <sub>23</sub>	PI <sub>24</sub>	PI <sub>25</sub>	PI <sub>26</sub>	PI <sub>27</sub>	PI <sub>28</sub>	PI <sub>29</sub>	PI <sub>30</sub>	PI <sub>31</sub>	PI <sub>32</sub>	PI <sub>33</sub>	PI <sub>34</sub>	PI <sub>35</sub>	PI <sub>36</sub>	PI <sub>37</sub>	PI <sub>38</sub>	PI <sub>39</sub>	PI <sub>40</sub>	PI <sub>41</sub>	PI <sub>42</sub>	PI <sub>43</sub>	PI <sub>44</sub>	PI <sub>45</sub>	PI <sub>46</sub>	PI <sub>47</sub>	PI <sub>48</sub>	PI <sub>49</sub>	PI <sub>50</sub>	PI <sub>51</sub>	PI <sub>52</sub>	PI <sub>53</sub>	PI <sub>54</sub>	PI <sub>55</sub>	PI <sub>56</sub>	PI <sub>57</sub>	PI <sub>58</sub>	PI <sub>59</sub>	PI <sub>60</sub>	PI <sub>61</sub>	PI <sub>62</sub>	PI <sub>63</sub>	PI <sub>64</sub>	PI <sub>65</sub>	PI <sub>66</sub>	PI <sub>67</sub>	PI <sub>68</sub>	PI <sub>69</sub>	PI <sub>70</sub>	PI <sub>71</sub>	PI <sub>72</sub>	PI <sub>73</sub>	PI <sub>74</sub>	PI <sub>75</sub>	PI <sub>76</sub>	PI <sub>77</sub>	PI <sub>78</sub>	PI <sub>79</sub>	PI <sub>80</sub>	PI <sub>81</sub>	PI <sub>82</sub>	PI <sub>83</sub>	PI <sub>84</sub>	PI <sub>85</sub>	PI <sub>86</sub>	PI <sub>87</sub>	PI <sub>88</sub>	PI <sub>89</sub>	PI <sub>90</sub>	PI <sub>91</sub>	PI <sub>92</sub>	PI <sub>93</sub>	PI <sub>94</sub>	PI <sub>95</sub>	PI <sub>96</sub>	PI <sub>97</sub>	PI <sub>98</sub>	PI <sub>99</sub>	PI <sub>100</sub>	PI <sub>101</sub>	PI <sub>102</sub>	PI <sub>103</sub>	PI <sub>104</sub>	PI <sub>105</sub>	PI <sub>106</sub>	PI <sub>107</sub>	PI <sub>108</sub>	PI <sub>109</sub>	PI <sub>110</sub>	PI <sub>111</sub>	PI <sub>112</sub>	PI <sub>113</sub>	PI <sub>114</sub>	PI <sub>115</sub>	PI <sub>116</sub>	PI <sub>117</sub>	PI <sub>118</sub>	PI <sub>119</sub>	PI <sub>120</sub>	PI <sub>121</sub>	PI <sub>122</sub>	PI <sub>123</sub>	PI <sub>124</sub>	PI <sub>125</sub>	PI <sub>126</sub>	PI <sub>127</sub>	PI <sub>128</sub>	PI <sub>129</sub>	PI <sub>130</sub>	PI <sub>131</sub>	PI <sub>132</sub>	PI <sub>133</sub>	PI <sub>134</sub>	PI <sub>135</sub>	PI <sub>136</sub>	PI <sub>137</sub>	PI <sub>138</sub>	PI <sub>139</sub>	PI <sub>140</sub>	PI <sub>141</sub>	PI <sub>142</sub>	PI <sub>143</sub>	PI <sub>144</sub>	PI <sub>145</sub>	PI <sub>146</sub>	PI <sub>147</sub>	PI <sub>148</sub>	PI <sub>149</sub>	PI <sub>150</sub>	PI <sub>151</sub>	PI <sub>152</sub>	PI <sub>153</sub>	PI <sub>154</sub>	PI <sub>155</sub>	PI <sub>156</sub>	PI <sub>157</sub>	PI <sub>158</sub>	PI <sub>159</sub>	PI <sub>160</sub>	PI <sub>161</sub>	PI <sub>162</sub>	PI <sub>163</sub>	PI <sub>164</sub>	PI <sub>165</sub>	PI <sub>166</sub>	PI <sub>167</sub>	PI <sub>168</sub>	PI <sub>169</sub>	PI <sub>170</sub>	PI <sub>171</sub>	PI <sub>172</sub>	PI <sub>173</sub>	PI <sub>174</sub>	PI <sub>175</sub>	PI <sub>176</sub>	PI <sub>177</sub>	PI <sub>178</sub>	PI <sub>179</sub>	PI <sub>180</sub>	PI <sub>181</sub>	PI <sub>182</sub>	PI <sub>183</sub>	PI <sub>184</sub>	PI <sub>185</sub>	PI <sub>186</sub>	PI <sub>187</sub>	PI <sub>188</sub>	PI <sub>189</sub>	PI <sub>190</sub>	PI <sub>191</sub>	PI <sub>192</sub>	PI <sub>193</sub>	PI <sub>194</sub>	PI <sub>195</sub>	PI <sub>196</sub>	PI <sub>197</sub>	PI <sub>198</sub>	PI <sub>199</sub>	PI <sub>200</sub>	PI <sub>201</sub>	PI <sub>202</sub>	PI <sub>203</sub>	PI <sub>204</sub>	PI <sub>205</sub>	PI <sub>206</sub>	PI <sub>207</sub>	PI <sub>208</sub>	PI <sub>209</sub>	PI <sub>210</sub>	PI <sub>211</sub>	PI <sub>212</sub>	PI <sub>213</sub>	PI <sub>214</sub>	PI <sub>215</sub>	PI <sub>216</sub>	PI <sub>217</sub>	PI <sub>218</sub>	PI <sub>219</sub>	PI <sub>220</sub>	PI <sub>221</sub>	PI <sub>222</sub>	PI <sub>223</sub>	PI <sub>224</sub>	PI <sub>225</sub>	PI <sub>226</sub>	PI <sub>227</sub>	PI <sub>228</sub>	PI <sub>229</sub>	PI <sub>230</sub>	PI <sub>231</sub>	PI <sub>232</sub>	PI <sub>233</sub>	PI <sub>234</sub>	PI <sub>235</sub>	PI <sub>236</sub>	PI <sub>237</sub>	PI <sub>238</sub>	PI <sub>239</sub>	PI <sub>240</sub>	PI <sub>241</sub>	PI <sub>242</sub>	PI <sub>243</sub>	PI <sub>244</sub>	PI <sub>245</sub>	PI <sub>246</sub>	PI <sub>247</sub>	PI <sub>248</sub>	PI <sub>249</sub>	PI <sub>250</sub>	PI <sub>251</sub>	PI <sub>252</sub>	PI <sub>253</sub>	PI <sub>254</sub>	PI <sub>255</sub>	PI <sub>256</sub>	PI <sub>257</sub>	PI <sub>258</sub>	PI <sub>259</sub>	PI <sub>260</sub>	PI <sub>261</sub>	PI <sub>262</sub>	PI <sub>263</sub>	PI <sub>264</sub>	PI <sub>265</sub>	PI <sub>266</sub>	PI <sub>267</sub>	PI <sub>268</sub>	PI <sub>269</sub>	PI <sub>270</sub>	PI <sub>271</sub>	PI <sub>272</sub>	PI <sub>273</sub>	PI <sub>274</sub>	PI <sub>275</sub>	PI <sub>276</sub>	PI <sub>277</sub>	PI <sub>278</sub>	PI <sub>279</sub>	PI <sub>280</sub>	PI <sub>281</sub>	PI <sub>282</sub>	PI <sub>283</sub>	PI <sub>284</sub>	PI <sub>285</sub>	PI <sub>286</sub>	PI <sub>287</sub>	PI <sub>288</sub>	PI <sub>289</sub>	PI <sub>290</sub>	PI <sub>291</sub>	PI <sub>292</sub>	PI <sub>293</sub>	PI <sub>294</sub>	PI <sub>295</sub>	PI <sub>296</sub>	PI <sub>297</sub>	PI <sub>298</sub>	PI <sub>299</sub>	PI <sub>300</sub>	PI <sub>301</sub>	PI <sub>302</sub>	PI <sub>303</sub>	PI <sub>304</sub>	PI <sub>305</sub>	PI <sub>306</sub>	PI <sub>307</sub>	PI <sub>308</sub>	PI <sub>309</sub>	PI <sub>310</sub>	PI <sub>311</sub>	PI <sub>312</sub>	PI <sub>313</sub>	PI <sub>314</sub>	PI <sub>315</sub>	PI <sub>316</sub>	PI <sub>317</sub>	PI <sub>318</sub>	PI <sub>319</sub>	PI <sub>320</sub>	PI <sub>321</sub>	PI <sub>322</sub>	PI <sub>323</sub>	PI <sub>324</sub>	PI <sub>325</sub>	PI <sub>326</sub>	PI <sub>327</sub>	PI <sub>328</sub>	PI <sub>329</sub>	PI <sub>330</sub>	PI <sub>331</sub>	PI <sub>332</sub>	PI <sub>333</sub>	PI <sub>334</sub>	PI <sub>335</sub>	PI <sub>336</sub>	PI <sub>337</sub>	PI <sub>338</sub>	PI <sub>339</sub>	PI <sub>340</sub>	PI <sub>341</sub>	PI <sub>342</sub>	PI <sub>343</sub>	PI <sub>344</sub>	PI <sub>345</sub>	PI <sub>346</sub>	PI <sub>347</sub>	PI <sub>348</sub>	PI <sub>349</sub>	PI <sub>350</sub>	PI <sub>351</sub>	PI <sub>352</sub>	PI <sub>353</sub>	PI <sub>354</sub>	PI <sub>355</sub>	PI <sub>356</sub>	PI <sub>357</sub>	PI <sub>358</sub>	PI <sub>359</sub>	PI <sub>360</sub>	PI <sub>361</sub>	PI <sub>362</sub>	PI <sub>363</sub>	PI <sub>364</sub>	PI <sub>365</sub>	PI <sub>366</sub>	PI <sub>367</sub>	PI <sub>368</sub>	PI <sub>369</sub>	PI <sub>370</sub>	PI <sub>371</sub>	PI <sub>372</sub>	PI <sub>373</sub>	PI <sub>374</sub>	PI <sub>375</sub>	PI <sub>376</sub>	PI <sub>377</sub>	PI <sub>378</sub>	PI <sub>379</sub>	PI <sub>380</sub>	PI <sub>381</sub>	PI <sub>382</sub>	PI <sub>383</sub>	PI <sub>384</sub>	PI <sub>385</sub>	PI <sub>386</sub>	PI <sub>387</sub>	PI <sub>388</sub>	PI <sub>389</sub>	PI <sub>390</sub>	PI <sub>391</sub>	PI <sub>392</sub>	PI <sub>393</sub>	PI <sub>394</sub>	PI <sub>395</sub>	PI <sub>396</sub>	PI <sub>397</sub>	PI <sub>398</sub>	PI <sub>399</sub>	PI <sub>400</sub>	PI <sub>401</sub>	PI <sub>402</sub>	PI <sub>403</sub>	PI <sub>404</sub>	PI <sub>405</sub>	PI <sub>406</sub>	PI <sub>407</sub>	PI <sub>408</sub>	PI <sub>409</sub>	PI <sub>410</sub>	PI <sub>411</sub>	PI <sub>412</sub>	PI <sub>413</sub>	PI <sub>414</sub>	PI <sub>415</sub>	PI <sub>416</sub>	PI <sub>417</sub>	PI <sub>418</sub>	PI <sub>419</sub>	PI <sub>420</sub>	PI <sub>421</sub>	PI <sub>422</sub>	PI <sub>423</sub>	PI <sub>424</sub>	PI <sub>425</sub>	PI <sub>426</sub>	PI <sub>427</sub>	PI <sub>428</sub>	PI <sub>429</sub>	PI <sub>430</sub>	PI <sub>431</sub>	PI <sub>432</sub>	PI <sub>433</sub>	PI <sub>434</sub>	PI <sub>435</sub>	PI <sub>436</sub>	PI <sub>437</sub>	PI <sub>438</sub>	PI <sub>439</sub>	PI <sub>440</sub>	PI <sub>441</sub>	PI <sub>442</sub>	PI <sub>443</sub>	PI <sub>444</sub>	PI <sub>445</sub>	PI <sub>446</sub>	PI <sub>447</sub>	PI <sub>448</sub>	PI <sub>449</sub>	PI <sub>450</sub>	PI <sub>451</sub>	PI <sub>452</sub>	PI <sub>453</sub>	PI <sub>454</sub>	PI <sub>455</sub>	PI <sub>456</sub>	PI <sub>457</sub>	PI <sub>458</sub>	PI <sub>459</sub>	PI <sub>460</sub>	PI <sub>461</sub>	PI <sub>462</sub>	PI <sub>463</sub>	PI <sub>464</sub>	PI <sub>465</sub>	PI <sub>466</sub>	PI <sub>467</sub>	PI <sub>468</sub>	PI <sub>469</sub>	PI <sub>470</sub>	PI <sub>471</sub>	PI <sub>472</sub>	PI <sub>473</sub>	PI <sub>474</sub>	PI <sub>475</sub>	PI <sub>476</sub>	PI <sub>477</sub>	PI <sub>478</sub>	PI <sub>479</sub>	PI <sub>480</sub>	PI <sub>481</sub>	PI <sub>482</sub>	PI <sub>483</sub>	PI <sub>484</sub>	PI <sub>485</sub>	PI <sub>486</sub>	PI <sub>487</sub>	PI <sub>488</sub>	PI <sub>489</sub>	PI <sub>490</sub>	PI <sub>491</sub>	PI <sub>492</sub>	PI <sub>493</sub>	PI <sub>494</sub>	PI <sub>495</sub>	PI <sub>496</sub>	PI <sub>497</sub>	PI <sub>498</sub>	PI <sub>499</sub>	PI <sub>500</sub>	PI <sub>501</sub>	PI <sub>502</sub>	PI <sub>503</sub>	PI <sub>504</sub>	PI <sub>505</sub>	PI <sub>506</sub>	PI <sub>507</sub>	PI <sub>508</sub>	PI <sub>509</sub>	PI <sub>510</sub>	PI <sub>511</sub>	PI <sub>512</sub>	PI <sub>513</sub>	PI <sub>514</sub>	PI <sub>515</sub>	PI <sub>516</sub>	PI <sub>517</sub>	PI <sub>518</sub>	PI <sub>519</sub>	PI <sub>520</sub>	PI <sub>521</sub>	PI <sub>522</sub>	PI <sub>523</sub>	PI <sub>524</sub>	PI <sub>525</sub>	PI <sub>526</sub>	PI <sub>527</sub>	PI <sub>528</sub>	PI <sub>529</sub>	PI <sub>530</sub>	PI <sub>531</sub>	PI <sub>532</sub>	PI <sub>533</sub>	PI <sub>534</sub>	PI <sub>535</sub>	PI <sub>536</sub>	PI <sub>537</sub>	PI <sub>538</sub>	PI <sub>539</sub>	PI <sub>540</sub>	PI <sub>541</sub>	PI <sub>542</sub>	PI <sub>543</sub>	PI <sub>544</sub>	PI <sub>545</sub>	PI <sub>546</sub>	PI <sub>547</sub>	PI <sub>548</sub>	PI <sub>549</sub>	PI <sub>550</sub>	PI <sub>551</sub>	PI <sub>552</sub>	PI <sub>553</sub>	PI <sub>554</sub>	PI <sub>555</sub>	PI <sub>556</sub>	PI <sub>557</sub>	PI <sub>558</sub>	PI <sub>559</sub>	PI <sub>560</sub>	PI <sub>561</sub>	PI <sub>562</sub>	PI <sub>563</sub>	PI <sub>564</sub>	PI <sub>565</sub>	PI <sub>566</sub>	PI <sub>567</sub>	PI <sub>568</sub>	PI <sub>569</sub>	PI <sub>570</sub>	PI <sub>571</sub>	PI <sub>572</sub>	PI <sub>573</sub>	PI <sub>574</sub>	PI <sub>575</sub>	PI <sub>576</sub>	PI <sub>577</sub>	PI <sub>578</sub>	PI <sub>579</sub>	PI <sub>580</sub>	PI <sub>581</sub>	PI <sub>582</sub>	PI <sub>583</sub>	PI <sub>584</sub>	PI <sub>585</sub>	PI <sub>586</sub>	PI <sub>587</sub>	PI <sub>588</sub>	PI <sub>589</sub>	PI <sub>590</sub>	PI <sub>591</sub>	PI <sub>592</sub>	PI <sub>593</sub>	PI <sub>594</sub>	PI <sub>595</sub>	PI <sub>596</sub>	PI <sub>597</sub>	PI <sub>598</sub>	PI <sub>599</sub>	PI <sub>600</sub>	PI <sub>601</sub>	PI <sub>602</sub>	PI <sub>603</sub>	PI <sub>604</sub>	PI <sub>605</sub>	PI <sub>606</sub>	PI <sub>607</sub>	PI <sub>608</sub>	PI <sub>609</sub>	PI <sub>610</sub>	PI <sub>611</sub>	PI <sub>612</sub>	PI <sub>613</sub>	PI <sub>614</sub>	PI <sub>615</sub>	PI <sub>616</sub>	PI <sub>617</sub>	PI <sub>618</sub>	PI <sub>619</sub>	PI <sub>620</sub>	PI <sub>621</sub>	PI <sub>622</sub>	PI <sub>623</sub>	PI <sub>624</sub>	PI <sub>625</sub>	PI <sub>626</sub>	PI <sub>627</sub>	PI <sub>628</sub>	PI <sub>629</sub>	PI <sub>630</sub>	PI <sub>631</sub>	PI <sub>632</sub>	PI <sub>633</sub>	PI <sub>634</sub>	PI <sub>635</sub>	PI <sub>636</sub>	PI <sub>637</sub>	PI <sub>638</sub>	PI <sub>639</sub>	PI <sub>640</sub>	PI <sub>641</sub>	PI <sub>642</sub>	PI <sub>643</sub>	PI <sub>644</sub>	PI <sub>645</sub>	PI <sub>646</sub>	PI <sub>647</sub>	PI <sub>648</sub>	PI <sub>649</sub>	PI <sub>650</sub>	PI <sub>651</sub>	PI <sub>652</sub>	PI <sub>653</sub>	PI <sub>654</sub>	PI <sub>655</sub>	PI <sub>656</sub>	PI <sub>657</sub>	PI <sub>658</sub>	PI <sub>659</sub>	PI <sub>660</sub>	PI <sub>661</sub>	PI <sub>662</sub>	PI <sub>663</sub>	PI <sub>664</sub>	PI <sub>665</sub>	PI <sub>666</sub>	PI <sub>667</sub>	PI <sub>668</sub>	PI <sub>669</sub>	PI <sub>670</sub>	PI <sub>671</sub>	PI <sub>672</sub>	PI <sub>673</sub>	PI <sub>674</sub>	PI <sub>675</sub>	PI <sub>676</sub>	PI <sub>677</sub>	PI <sub>678</sub>	PI <sub>679</sub>	PI <sub>680</sub>	PI <sub>681</sub>	PI <sub>682</sub>	PI <sub>683</sub>	PI<
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Table 12 (Continued)

Site	Plot	Row	Position	Particle-Size Analysis, %												Classification		Values												Dry Density		Specific Gravity		Saturation		Soil Moisture, %		Tension	
				USDA						UNSC						USDA		UNSC		USDA		UNSC		USDA		UNSC		USDA		UNSC		USDA		UNSC					
				0-6	6-12	12-20	20-60	60-200	>200	0-6	6-12	12-20	20-60	60-200	>200	0-6	6-12	0-6	6-12	0-6	6-12	0-6	6-12	0-6	6-12	0-6	6-12	0-6	6-12	0-6	6-12	0-6	6-12	0-6	6-12				
I IV	14	3	A	SIL	SIL	CL	13	11	75	72	12	17	99.4	99.8	29	38	25	24	14	1.46	1.53	2.64	2.66	29.6	26.8	27.8	25.3	26.7	24.5	26.6	24.4								
				ME	ME	CL	11	12	76	71	13	16	99.6	99.8	31	31	25	24	6	1.46	1.50	2.64	2.66	28.2	26.6	26.3	25.0	25.0	24.3	24.9	24.2								
				CL	CL	CL	13	11	73	71	14	18	99.0	99.8	28	33	27	22	1	1.42	1.52	2.64	2.66	30.7	26.9	28.7	25.1	26.9	24.2	26.8	24.0								
				ME	ME	CL	12	12	74	75	14	13	99.4	99.8	32	32	27	33	5	1.47	1.47	2.64	2.65	27.8	29.0	26.4	27.4	25.4	26.4	25.4	26.4								
	4	A	B	SIL	SIL	CL	12	12	78	72	10	16	99.2	99.4	32	31	26	22	6	1.40	1.48	2.64	2.66	32.3	27.9	30.2	27.2	30.4	26.6	29.8	26.0								
				ME	ME	CL	13	11	76	75	11	14	99.5	99.8	36	30	28	23	8	1.41	1.51	2.64	2.66	32.3	27.9	30.2	26.0	28.2	24.8	28.4	24.6								
				CL	CL	CL	14	11	76	75	10	14	99.6	99.8	30	30	26	22	4	1.42	1.50	2.64	2.66	30.9	28.7	29.0	26.6	28.0	25.6	28.0	25.3								
				ME	ME	CL	14	11	78	73	8	16	98.8	99.6	30	29	25	23	5	1.40	1.50	2.64	2.66	32.6	27.9	30.1	26.0	28.4	25.0	28.4	24.8								
	5	A	B	SIL	SIL	CL	14	11	76	75	10	14	99.0	99.4	30	35	26	24	4	1.52	1.48	2.64	2.68	26.5	29.4	25.1	27.8	24.8	27.4	24.4	26.8								
				ME	ME	CL	14	12	76	76	10	13	98.4	99.6	30	32	25	23	5	1.48	1.48	2.64	2.68	28.2	29.9	26.6	27.6	26.5	27.0	25.9	25.6								
				CL	CL	CL	13	12	75	75	11	13	99.6	99.6	33	31	28	22	5	1.50	1.48	2.64	2.68	28.8	30.5	26.5	27.8	26.0	27.0	25.6	26.4								
				ME	ME	CL	14	14	76	76	10	10	99.8	99.0	32	27	26	25	6	1.47	1.46	2.64	2.65	28.9	30.1	27.0	27.9	26.8	27.5	26.2	26.8								
I III	15	1	A	SIL	SIL	CL	14	1	64	59	22	40	97.6	99.8	38	53	20	25	18	1.49	1.45	2.65	2.72	27.8	30.7	26.6	29.5	26.4	29.4	26.4	29.3								
				ME	ME	CL	4	9	67	59	29	32	99.8	99.8	38	56	23	23	15	1.46	1.54	2.69	2.71	29.9	28.5	28.0	27.2	27.6	27.2	27.2	26.9								
				CL	CL	CL	6	2	67	59	27	32	98.8	99.8	37	41	24	23	13	1.56	1.55	2.69	2.71	25.1	26.6	24.2	25.8	24.2	25.8	24.2	25.6								
				ME	ME	CL	7	2	71	60	22	30	98.8	99.8	46	50	25	23	21	1.50	1.53	2.68	2.72	28.8	26.2	26.7	25.0	26.4	25.5	26.0	25.0								
2	A	B	SIL	SIL	ME	7	14	80	74	13	12	99.2	99.4	32	27	26	22	6	1.39	1.52	2.66	2.65	31.7	27.2	30.0	25.3	29.6	24.8	29.0	24.4									
			ME	ME	CL	15	8	73	78	12	14	99.4	99.2	35	28	25	23	10	1.40	1.46	2.64	2.66	30.6	28.0	28.5	26.4	28.3	26.0	28.0	25.2									
			CL	CL	CL	8	14	79	73	13	13	97.8	99.6	29	30	24	21	5	1.50	1.52	2.66	2.65	26.8	26.2	25.0	24.6	24.6	24.2	24.2	24.0									
			ME	ME	CL	5	5	77	77	17	13	99.2	99.6	35	33	29	23	5	1.43	1.49	2.67	2.70	29.4	27.2	27.8	25.8	27.4	25.4	27.0	25.0									
3	A	B	SIL	SIL	ME	14	10	76	77	10	13	99.0	99.0	34	29	29	25	5	1.44	1.44	2.64	2.65	28.4	31.9	27.2	28.5	26.8	27.6	26.4	27.1									
			ME	ME	CL	14	13	74	75	12	12	98.6	98.8	30	29	24	21	6	1.48	1.48	2.64	2.65	28.5	28.9	27.0	26.5	26.6	25.9	26.4	25.5									
			CL	CL	CL	6	7	78	80	15	14	98.2	98.8	34	28	29	22	5	1.44	1.54	2.66	2.67	30.2	25.6	28.6	24.2	24.2	24.0	23.7	23.7									
			ME	ME	CL	4	4	80	79	14	17	98.8	99.2	28	39	26	22	2	1.46	1.58	2.66	2.67	28.6	24.8	26.8	23.4	26.3	23.1	25.9	22.8									
4	A	B	SIL	SIL	ME	6	12	79	75	15	13	97.2	98.4	33	29	27	23	6	1.41	1.43	2.66	2.66	31.6	31.2	29.6	29.0	29.2	28.6	28.8	28.0									
			ME	ME	CL	14	7	74	77	12	16	98.0	97.0	35	29	29	24	6	1.37	1.48	2.64	2.70	34.4	29.4	32.2	27.1	31.8	26.6	31.4	27.2									
			CL	CL	CL	8	7	80	73	13	13	97.4	97.8	34	38	27	21	7	1.45	1.48	2.66	2.65	28.6	28.4	27.2	26.8	26.8	26.3	26.6	25.8									
			ME	ME	CL	7	12	80	75	13	13	97.4	98.0	32	29	25	22	7	1.40	1.46	2.66	2.65	31.6	32.0	29.6	28.8	29.1	27.2	28.8	27.4									
5	A	B	SIL	SIL	ME	11	11	76	77	11	12	97.4	98.0	33	31	25	25	8	1.42	1.46	2.64	2.65	31.0	29.8	28.5	27.6	28.4	27.2	27.9	27.0									
			ME	ME	CL	11	12	77	76	11	12	97.6	98.0	33	30	27	24	6	1.42	1.44	2.64	2.65	28.4	30.0	26.8	28.0	26.6	27.6	26.2	27.2									
			CL	CL	CL	11	17	80	73	11	17	98.0	98.4	31	30	26	23	5	1.46	1.48	2.65	2.69	28.8	28.0	27.2	26.4	26.9	26.2	26.6	25.7									
			ME	ME	CL	15	11	81	75	14	14	97.6	99.0	30	31	27	22	3	1.45	1.50	2.66	2.69	29.2	27.5	28.0	26.0	28.0	25.9	27.6	25.5									
M VI	MVI	1	A	SIL	SIL	ME	8	15	74	65	18	20	97.6	91.2	34	41	24	26	10	1.46	1.38	2.68	2.70	28.9	34.1	28.0	33.0	27.8	32.6	27.4	32.2								
				ME	ME	CL	10	10	76	70	14	20	96.8	96.0	35	43	25	27	10	1.50	1.38	2.68	2.70	28.1	33.2	27.5	32.3	27.2	31.8	26.8	31.2								
				CL	CL	CL	9	12	76	68	15	20	95.4	94.4	35	35	24	24	11	1.40	1.34	2.68	2.69	32.7	37.1	31.4	35.5	31.2	35.2	30.8	34.6								
				ME	ME	CL	10	13	70	67	20	20	96.6	94.6	34	41	24	26	10	1.47	1.35	2.68	2.69	29.2	36.1	28.0	34.6	27.8	34.3	27.4	33.6								
2	A	B	SIL	SIL	ME	16	20	75	65	9	15	91.4	37.0	33	28	28	21	5	1.42	1.48	2.66	2.70	32.2	28.2	30.6	26.8	30.2	26.3	29.8	25.8									
			ME	ME	CL	15	15	73	67	12	18	91.0	36.0	31	27	26	21	6	1.42	1.52	2.67	2.70	32.2	25.8	30.8	24.6	30.4	23.8	29.8	23.4									
			CL	CL	CL	15	15	75	67	10	18	96.3	96.6	35	27	28	22	7	1.37	1.48	2.67	2.70	34.4	26.8	32.6	25.6	32.2	25.0	31.6	24.7									
			ME	ME	CL	15	15	73	71	12	14	93.4	96.0	37	27	25	22	5	1.37	1.45	2.67	2.69	33.0	29.2	31.6	28.0	31.4	27.3	30.8	26.6									

.. Estimated.

(Continued)

(5 of 10 sheets)

Table A2 (Continued)

Site	Plot	Row	Col	Classification				Soil Series Analysis				Soil Characteristics				Soil Moisture														
				USDA		USDA		USDA		USDA		USDA		USDA		USDA		USDA		USDA										
				0-6	6-12	0-6	6-12	0-6	6-12	0-6	6-12	0-6	6-12	0-6	6-12	0-6	6-12	0-6	6-12	0-6	6-12									
C III	C1	1	A	S1L	S1L	8	89	81	9	11	99.6	99.8	49	34	28	27	12	7	1.44	1.38	2.67	30.6	30.4	29.6	31.2	29.5	30.5	28.9	29.4	
				S1L	S1L	9	79	81	13	10	97.6	99.8	37	31	27	25	3	4	1.44	1.44	2.67	30.0	31.4	29.2	30.8	28.8	30.0	28.2	29.7	
				C1L	S1L	10	79	80	11	10	99.8	99.6	37	34	28	28	9	7	1.44	1.44	2.67	30.2	30.2	29.2	30.8	29.0	30.0	28.1	28.8	
				D	S1L	9	81	81	10	10	99.8	99.8	34	34	25	27	7	6	1.43	1.43	2.67	30.7	30.7	29.6	30.8	29.2	30.2	28.9	29.0	
	2	A	S1L	S1L	S1L	S1L	12	80	78	8	10	99.0	99.6	38	32	29	29	6	6	1.42	1.42	2.67	31.6	34.2	30.7	32.2	29.8	31.1	29.1	30.2
					S1L	S1L	11	80	77	9	10	99.2	99.2	36	32	29	26	7	6	1.41	1.43	2.67	30.8	30.9	31.0	30.2	30.2	28.2	29.0	
					C	S1L	13	77	78	10	10	99.0	99.6	37	34	29	24	8	9	1.43	1.42	2.67	30.8	32.2	29.7	31.0	29.2	30.0	28.7	29.3
					D	S1L	13	78	77	10	10	99.2	99.2	35	30	31	25	8	5	1.38	1.40	2.67	30.7	32.2	31.8	31.3	31.3	30.4	30.4	29.4
	3	A	S1L	S1L	S1L	S1L	15	76	75	9	10	98.0	97.2	34	31	28	26	4	2	1.33	1.40	2.66	35.8	33.2	34.2	31.7	33.1	30.2	31.0	29.0
					S1L	S1L	15	75	75	8	10	97.8	97.0	37	28	31	26	4	2	1.30	1.38	2.66	37.2	34.9	35.7	34.7	34.7	31.1	31.1	29.3
					C	S1L	15	76	75	9	8	98.0	95.2	34	29	27	25	3	4	1.34	1.39	2.67	34.4	33.0	33.7	31.0	33.0	29.8	31.7	28.5
					D	S1L	15	75	75	8	10	97.5	96.4	34	30	27	26	5	4	1.33	1.42	2.66	34.6	33.5	33.5	31.1	33.8	30.0	32.4	28.5
4	A	S1L	S1L	S1L	S1L	20	72	68	8	8	94.4	89.6	34	29	27	23	7	6	1.37	1.49	2.66	34.4	27.9	33.1	26.9	32.3	27.1	31.3	25.0	
				S1L	S1L	25	25	66	7	9	89.7	86.8	31	24	25	24	6	4	1.40	1.45	2.65	33.4	32.1	30.8	31.0	30.0	30.0	28.8	29.0	
				C	S1L	25	20	67	7	8	88.8	84.0	31	29	28	26	5	3	1.41	1.43	2.65	31.3	35.0	30.1	30.2	29.4	29.7	28.7	28.0	
				D	S1L	25	20	67	7	8	93.0	93.8	29	30	26	24	3	6	1.36	1.44	2.65	33.8	30.4	32.2	29.3	31.0	28.4	30.8	27.1	
5	A	S1L	S1L	S1L	S1L	15	77	71	8	10	94.4	93.6	30	27	28	22	2	5	1.40	1.42	2.66	30.7	32.2	29.8	30.7	29.4	29.7	28.1	28.3	
				S1L	S1L	20	70	69	10	11	93.8	94.2	33	29	27	22	6	7	1.30	1.43	2.66	37.0	33.0	34.7	30.8	34.0	29.8	27.8	28.4	
				C	S1L	20	73	70	8	10	94.4	94.6	34	29	29	25	5	4	1.37	1.43	2.66	32.8	32.0	31.0	30.4	31.0	29.5	30.1	28.4	
				D	S1L	23	69	70	8	10	96.6	94.4	35	30	27	24	8	6	1.34	1.44	2.65	34.5	31.7	33.2	30.7	32.7	29.4	31.4	28.4	
6	A	S1L	S1L	S1L	S1L	14	76	74	10	10	99.0	99.4	34	31	27	27	7	4	1.47	1.41	2.67	30.0	34.2	28.7	32.0	28.4	31.4	28.3	30.9	
				S1L	S1L	15	75	74	10	10	99.6	99.2	34	32	26	26	6	6	1.44	1.42	2.67	32.2	33.8	30.8	31.6	30.2	31.1	30.4	30.8	
				C	S1L	15	75	75	10	10	99.6	99.2	34	33	27	27	7	6	1.43	1.46	2.67	30.0	30.7	30.2	30.2	29.8	29.7	29.7	29.5	
				D	S1L	15	75	75	10	10	99.6	99.5	33	31	26	25	7	6	1.46	1.43	2.67	30.3	30.8	29.0	30.9	28.8	30.2	28.7	29.3	
3	A	S1L	S1L	S1L	S1L	15	75	75	9	10	99.6	99.6	33	33	28	24	5	9	1.46	1.46	2.67	31.3	32.0	30.2	30.2	29.7	29.8	29.0	29.0	
				S1L	S1L	17	74	74	9	9	99.6	99.6	33	31	26	26	5	5	1.48	1.44	2.67	30.7	31.4	29.1	30.1	29.6	28.7	28.7	28.8	
				C	S1L	16	75	75	9	9	99.6	99.4	33	31	24	27	4	4	1.46	1.45	2.67	31.8	31.4	30.0	29.4	29.6	29.0	29.2	28.7	
				D	S1L	16	75	75	9	10	99.4	99.6	33	31	27	24	6	7	1.45	1.44	2.67	31.5	32.0	29.8	30.4	29.4	30.0	29.0	29.6	
4	A	S1L	S1L	S1L	S1L	15	75	75	10	9	99.8	99.8	35	33	28	27	7	6	1.44	1.44	2.67	32.2	32.3	30.4	30.2	30.1	29.8	29.8	29.5	
				S1L	S1L	14	75	77	9	9	99.6	99.8	33	33	27	26	6	5	1.48	1.44	2.67	30.0	32.2	29.0	30.6	28.7	30.2	28.3	29.7	
				C	S1L	15	75	75	10	10	99.8	99.6	34	32	27	26	7	4	1.40	1.47	2.67	31.0	31.4	32.0	29.9	31.7	29.6	31.2	28.9	
				D	S1L	16	75	75	9	9	99.6	99.6	32	31	26	27	6	4	1.46	1.45	2.67	31.0	30.8	29.2	29.2	29.2	28.8	28.8	28.4	
1	A	S1L	S1L	S1L	S1L	12	75	72	13	14	99.2	98.4	35	31	26	26	9	5	1.33	1.40	2.66	34.7	30.6	33.0	29.8	32.2	29.1	31.4	28.2	
				S1L	S1L	12	75	75	13	11	99.6	99.6	36	35	27	28	9	7	1.32	1.44	2.67	34.3	30.1	32.8	29.0	32.0	28.4	31.2	27.9	
				C	S1L	12	76	76	12	12	99.4	99.8	36	32	27	25	9	7	1.35	1.42	2.67	33.4	31.2	32.6	30.5	31.8	29.9	31.1	29.0	
				D	S1L	11	75	75	14	14	99.8	99.8	36	33	27	27	9	6	1.27	1.44	2.66	38.1	29.6	36.6	29.0	35.7	28.4	30.6	27.9	
3	A	S1L	S1L	S1L	S1L	12	77	75	11	13	99.4	99.4	31	31	24	23	9	8	1.34	1.44	2.67	33.6	30.6	32.0	29.4	31.6	29.2	30.2	28.0	
				S1L	S1L	12	74	74	12	12	99.2	99.4	32	32	27	28	8	4	1.39	1.45	2.66	31.7	29.9	30.5	28.8	30.2	28.6	28.2	27.0	
				C	S1L	12	74	76	14	12	99.4	99.4	36	31	26	23	10	9	1.34	1.44	2.68	34.6	31.7	32.9	29.9	32.2	29.4	31.7	28.0	
				D	S1L	12	76	76	12	12	99.2	99.4	33	31	20	26	7	5	1.43	1.43	2.65	29.7	31.2	29.1	30.1	28.6	29.5	28.3	28.0	

\*\* Estimated.

(Continued)

Table A2 (Continued)

F VII	FR	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100	101	102	103	104	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120	121	122	123	124	125	126	127	128	129	130	131	132	133	134	135	136	137	138	139	140	141	142	143	144	145	146	147	148	149	150	151	152	153	154	155	156	157	158	159	160	161	162	163	164	165	166	167	168	169	170	171	172	173	174	175	176	177	178	179	180	181	182	183	184	185	186	187	188	189	190	191	192	193	194	195	196	197	198	199	200	201	202	203	204	205	206	207	208	209	210	211	212	213	214	215	216	217	218	219	220	221	222	223	224	225	226	227	228	229	230	231	232	233	234	235	236	237	238	239	240	241	242	243	244	245	246	247	248	249	250	251	252	253	254	255	256	257	258	259	260	261	262	263	264	265	266	267	268	269	270	271	272	273	274	275	276	277	278	279	280	281	282	283	284	285	286	287	288	289	290	291	292	293	294	295	296	297	298	299	300	301	302	303	304	305	306	307	308	309	310	311	312	313	314	315	316	317	318	319	320	321	322	323	324	325	326	327	328	329	330	331	332	333	334	335	336	337	338	339	340	341	342	343	344	345	346	347	348	349	350	351	352	353	354	355	356	357	358	359	360	361	362	363	364	365	366	367	368	369	370	371	372	373	374	375	376	377	378	379	380	381	382	383	384	385	386	387	388	389	390	391	392	393	394	395	396	397	398	399	400	401	402	403	404	405	406	407	408	409	410	411	412	413	414	415	416	417	418	419	420	421	422	423	424	425	426	427	428	429	430	431	432	433	434	435	436	437	438	439	440	441	442	443	444	445	446	447	448	449	450	451	452	453	454	455	456	457	458	459	460	461	462	463	464	465	466	467	468	469	470	471	472	473	474	475	476	477	478	479	480	481	482	483	484	485	486	487	488	489	490	491	492	493	494	495	496	497	498	499	500	501	502	503	504	505	506	507	508	509	510	511	512	513	514	515	516	517	518	519	520	521	522	523	524	525	526	527	528	529	530	531	532	533	534	535	536	537	538	539	540	541	542	543	544	545	546	547	548	549	550	551	552	553	554	555	556	557	558	559	560	561	562	563	564	565	566	567	568	569	570	571	572	573	574	575	576	577	578	579	580	581	582	583	584	585	586	587	588	589	590	591	592	593	594	595	596	597	598	599	600	601	602	603	604	605	606	607	608	609	610	611	612	613	614	615	616	617	618	619	620	621	622	623	624	625	626	627	628	629	630	631	632	633	634	635	636	637	638	639	640	641	642	643	644	645	646	647	648	649	650	651	652	653	654	655	656	657	658	659	660	661	662	663	664	665	666	667	668	669	670	671	672	673	674	675	676	677	678	679	680	681	682	683	684	685	686	687	688	689	690	691	692	693	694	695	696	697	698	699	700	701	702	703	704	705	706	707	708	709	710	711	712	713	714	715	716	717	718	719	720	721	722	723	724	725	726	727	728	729	730	731	732	733	734	735	736	737	738	739	740	741	742	743	744	745	746	747	748	749	750	751	752	753	754	755	756	757	758	759	760	761	762	763	764	765	766	767	768	769	770	771	772	773	774	775	776	777	778	779	780	781	782	783	784	785	786	787	788	789	790	791	792	793	794	795	796	797	798	799	800	801	802	803	804	805	806	807	808	809	810	811	812	813	814	815	816	817	818	819	820	821	822	823	824	825	826	827	828	829	830	831	832	833	834	835	836	837	838	839	840	841	842	843	844	845	846	847	848	849	850	851	852	853	854	855	856	857	858	859	860	861	862	863	864	865	866	867	868	869	870	871	872	873	874	875	876	877	878	879	880	881	882	883	884	885	886	887	888	889	890	891	892	893	894	895	896	897	898	899	900	901	902	903	904	905	906	907	908	909	910	911	912	913	914	915	916	917	918	919	920	921	922	923	924	925	926	927	928	929	930	931	932	933	934	935	936	937	938	939	940	941	942	943	944	945	946	947	948	949	950	951	952	953	954	955	956	957	958	959	960	961	962	963	964	965	966	967	968	969	970	971	972	973	974	975	976	977	978	979	980	981	982	983	984	985	986	987	988	989	990	991	992	993	994	995	996	997	998	999	1000	1001	1002	1003	1004	1005	1006	1007	1008	1009	1010	1011	1012	1013	1014	1015	1016	1017	1018	1019	1020	1021	1022	1023	1024	1025	1026	1027	1028	1029	10
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Table A2 (Continued)

Site	Plot	No.	Soil Classification	Grain-Size Analysis, %				Atterberg Limits				PI	Dry		Specific Gravity	Soil Moisture, % at														
				Sand		Clay		LL		PL			Density	Moisture		Saturation		Tension												
				0-0.075	0.075-0.425	0.425-0.75	0.75-2.0	0.075	0.425	0.075	0.425					0-6	6-12	0-6	6-12	0-6	6-12									
CV	F5	2	CL	9	10	79	73	12	17	96.6	99.4	35	36	23	9	13	1.45	1.45	2.66	2.67	31.2	30.9	30.4	30.5	29.4	29.8	23.0	29.6		
		3	ML	9	10	50	50	11	15	99.2	99.0	35	35	27	10	10	1.41	1.48	2.66	2.69	31.0	30.5	31.6	30.2	30.7	29.4	30.1	29.2		
		4	ML	6	14	82	77	12	9	99.6	99.8	35	26	26	9	7	1.44	1.44	2.66	2.68	30.6	31.7	31.1	31.6	30.0	29.7	29.8	29.5		
	3	A	7	ML	7	11	79	78	12	11	99.6	99.8	33	32	26	9	7	1.46	1.48	2.66	2.68	31.2	30.5	30.1	31.0	29.1	29.7	29.9	29.6	
			8	ML	7	10	81	78	12	12	99.6	99.8	33	31	26	12	6	1.48	1.48	2.66	2.67	29.4	30.2	29.0	30.0	28.3	29.1	28.3	29.0	
			9	ML	9	9	79	79	12	14	99.8	99.8	36	35	26	13	9	1.51	1.46	2.66	2.69	28.2	30.8	27.7	30.3	27.0	29.2	26.9	27.0	
		B	8	ML	9	8	79	78	12	14	99.6	99.8	36	34	25	11	10	1.40	1.48	2.65	2.69	31.9	30.2	31.7	29.6	30.9	28.9	30.7	28.6	
			9	ML	9	10	78	75	13	12	99.4	99.8	39	34	27	12	10	1.43	1.46	2.65	2.68	31.7	30.5	30.4	29.7	29.5	29.0	29.2	28.7	
			10	ML	9	8	79	77	12	15	99.0	99.8	38	36	26	7	10	1.50	1.48	2.65	2.68	29.7	31.0	28.0	29.9	27.2	29.1	27.2	28.9	
	F II	76	A	10	ML	10	10	78	77	12	13	99.2	99.4	34	33	27	11	11	1.46	1.48	2.65	2.68	29.7	30.1	29.3	29.5	28.6	28.9	28.5	28.9
				11	ML	9	8	77	78	13	13	99.6	99.8	35	35	27	11	7	1.50	1.48	2.65	2.69	28.4	31.2	27.8	29.4	27.3	29.5	27.1	29.4
				12	ML	9	7	78	78	13	13	99.6	99.8	35	35	27	11	10	1.51	1.48	2.65	2.68	28.2	29.9	27.3	29.5	27.1	28.7	27.1	28.6
B			11	ML	11	12	74	74	15	14	99.6	99.4	38	32	28	10	6	1.36	1.42	2.67	2.66	33.3	30.8	32.2	30.4	31.6	30.0	31.0	29.5	
			12	ML	11	10	77	76	13	14	99.8	99.8	37	34	26	11	9	1.28	1.42	2.67	2.67	38.3	31.3	37.0	30.4	36.0	30.0	35.0	29.5	
			13	ML	10	10	77	76	13	14	99.8	99.8	37	34	26	11	7	1.35	1.44	2.68	2.68	34.0	29.0	32.0	29.4	31.4	29.0	30.6	28.6	
4		A	12	ML	11	11	77	77	12	13	99.6	99.8	36	32	26	10	8	1.38	1.40	2.67	2.67	33.3	32.6	32.4	31.4	31.6	30.8	31.0	30.3	
			13	ML	12	12	76	76	12	15	99.2	99.0	34	35	25	26	9	1.34	1.41	2.65	2.66	33.8	32.0	32.7	31.1	32.0	30.5	31.3	30.0	
			14	ML	12	12	74	74	14	14	99.2	99.0	35	34	26	26	9	1.38	1.46	2.66	2.67	32.7	30.6	32.3	29.2	30.9	28.7	30.0	28.1	
		B	15	ML	11	11	74	74	12	14	99.8	99.8	37	34	26	11	9	1.35	1.44	2.68	2.68	34.0	29.0	32.0	29.4	31.4	29.0	30.6	28.6	
			16	ML	11	11	77	77	12	13	99.6	99.8	36	32	26	10	8	1.38	1.40	2.67	2.67	33.0	31.4	31.4	31.6	31.0	31.3	30.0	29.2	
			17	ML	11	11	77	77	12	12	99.2	99.6	36	32	25	26	9	1.36	1.36	2.65	2.65	33.0	31.1	31.4	31.6	31.0	31.3	30.0	29.2	
5	A	18	ML	12	13	73	73	13	14	98.9	99.0	35	33	25	27	10	1.28	1.40	2.67	2.66	36.2	31.1	33.3	30.1	32.3	29.5	31.2	28.9		
		19	ML	11	11	74	74	15	15	98.6	99.4	36	33	25	27	11	1.32	1.36	2.66	2.67	34.2	34.0	33.7	31.1	32.9	32.4	32.2	31.5		
		20	ML	12	12	72	76	13	15	98.6	99.8	37	33	25	24	11	1.30	1.42	2.67	2.67	36.3	29.1	35.5	29.1	35.0	28.6	34.1	28.0		
	B	21	ML	12	13	76	75	12	12	98.8	99.2	33	32	27	24	6	1.31	1.42	2.65	2.66	34.5	30.6	33.5	30.0	32.7	29.5	31.9	28.7		
		22	ML	14	15	76	75	12	10	99.6	99.8	34	31	28	26	6	1.37	1.42	2.67	2.67	34.2	34.0	32.8	31.7	32.3	31.0	31.8	30.3		
		23	ML	14	14	76	76	10	10	99.8	99.8	38	31	27	25	11	1.46	1.42	2.67	2.67	33.4	33.2	32.0	31.4	31.6	30.8	31.4	30.2		
77	A	24	ML	14	14	77	75	9	11	99.8	99.8	34	32	24	24	10	1.42	1.42	2.67	2.67	32.8	34.2	31.5	31.8	31.2	31.0	31.6	29.8		
		25	ML	14	14	77	76	9	10	99.0	99.0	37	35	26	27	7	1.39	1.39	2.67	2.67	35.4	35.4	33.6	33.3	33.2	32.9	33.0	32.6		
		26	ML	15	15	76	76	9	10	99.0	99.8	37	35	26	28	7	1.40	1.44	2.67	2.67	32.4	32.2	30.6	29.9	30.4	29.5	30.1	29.1		
	B	27	ML	15	15	75	75	10	10	99.4	99.8	35	33	28	28	5	1.42	1.42	2.67	2.67	34.0	33.7	32.0	31.4	31.4	31.0	31.1	30.5		
		28	ML	15	15	75	75	9	9	99.4	99.8	35	33	28	28	5	1.42	1.42	2.67	2.67	34.0	33.7	32.0	31.4	31.4	31.0	31.1	30.5		
		29	ML	15	15	75	75	9	9	99.4	99.8	35	33	28	28	4	1.35	1.40	2.67	2.67	34.0	33.7	32.0	31.4	31.4	31.0	31.1	30.5		
78	A	30	ML	19	20	73	65	11	10	93.4	87.4	36	29	26	24	10	1.35	1.44	2.67	2.65	34.8	30.4	33.9	29.5	33.8	29.2	33.5	28.6		
		31	ML	19	19	70	55	11	11	93.3	77.4	36	28	25	22	10	1.35	1.49	2.67	2.65	34.8	28.7	33.7	27.3	33.7	27.0	33.1	28.4		
		32	ML	18	18	70	55	12	12	93.6	78.0	34	28	26	24	10	1.32	1.46	2.67	2.66	36.3	29.2	34.8	28.1	34.4	27.8	34.1	27.4		
	B	33	ML	21	19	69	69	12	12	96.2	86.1	33	30	27	24	6	1.32	1.48	2.65	2.65	36.3	28.4	34.7	27.6	34.4	27.3	33.4	28.9		
		34	ML	20	18	71	71	9	9	94.0	87.4	31	31	29	27	7	1.35	1.40	2.66	2.67	32.3	31.7	31.3	30.1	30.9	29.1	31.0	29.1		
		35	ML	20	18	68	71	10	10	94.1	86.1	31	31	29	27	7	1.40	1.47	2.66	2.66	30.5	29.7	29.9	28.6	29.3	27.8	29.4	27.1		
D	36	ML	20	18	68	71	10	10	94.1	86.1	31	31	29	27	7	1.32	1.44	2.66	2.66	30.5	29.7	29.9	28.6	29.3	27.8	29.4	27.1			
	37	ML	20	18	68	71	10	10	94.1	86.1	31	31	29	27	7	1.32	1.44	2.66	2.66	30.5	29.7	29.9	28.6	29.3	27.8	29.4	27.1			
	38	ML	20	18	68	71	10	10	94.1	86.1	31	31	29	27	7	1.32	1.44	2.66	2.66	30.5	29.7	29.9	28.6	29.3	27.8	29.4	27.1			

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FORECASTING TRAFFICABILITY OF SOILS; VARIABILITY OF PHYSICAL PROPERTIES OF LOESS SOILS, WARREN COUNTY, MISSISSIPPI			
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13. ABSTRACT This study was to determine if the average of soil strength values obtained in a small area can be reliably applied to larger areas. Values of properties used in predicting soil strength and classifying soils were compared for areas differing in size. Six test sites in each of four loessial soil series were established, using series boundaries on soil survey maps to locate the sites. The series were Memphis and Loring in the uplands and Collins and Falaya in the bottomlands. Each site had five sampling rows; each row had four sampling positions. Plots of pedologically distinct soil series were identified from field examination within sites and were used as an additional subdivision of test areas. Soil strength and moisture content data were collected on four visits, other physical property data on one visit. The four series could not be distinguished by soil strength because the cone indexes (CI's) varied widely for any one series and the range of CI for each series was about the same. Soils of the 6- to 12-in. layer of the uplands differed from those of the bottomlands in clay content and plasticity, but not in strength. The poorly drained Henry series and alluvial-fill soils of the uplands, as identified in the field, had the lowest CI's. Certain plots exhibited consistently different CI's for each visit than did other plots in the same series, and certain rows in the same plot showed consistently different CI's. These differences could not be explained satisfactorily in terms of soil series, or soil properties commonly used in the Unified Soil Classification System and the U. S. Department of Agriculture textural classification. Limited data suggest that in future studies a terrain geometry classification system would be useful for identifying areas considered uniform in soil type but variable in strength by indicating areas of differential erosion or deposition. Also, the effect of soil factors such as organic matter content, structure, and natural cementing agents should be determined. In a row of relatively uniform soil, five samplings for moisture content and static physical properties and ten for soil strength should be made to provide acceptable mean values for trafficability use. Appendix A includes basic data for each site.			

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