A PRACTICAL APPROACH TO GROUPING SOILS BY KEY SOIL PROPERTIES

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TABLE OF CONTENTS

Chapter Page

Chapter Page

Chapter Page

LIST OF TABLES

Table Page

LIST OF FIGURES

CHAPTER I

INTRODUCTION

Laboratory data required to effectively use the *Keys to Soil Taxonomy* (Soil Survey Staff, 1996) may not be available when making on-site land assessments evaluating potential land use. When attempting to apply soil taxonomy (Soil Survey Staff, 1996) in field conditions, many conjunctions qualifying multiple paragraphs of criteria create confusion. Soil characteristics used multiple times at various levels of the classification create repetition in qualifying statements. The taxonomic classification (Soil Survey Staff, 1996) Pergelic Cryoboroll is one example, where soil temperature is the criteria for acceptance into both the suborder (Boroll) and the great group (Cryoboroll) levels (Bockheim, et al.,1996). Splitting Pergelic Cryoboroll (Soil Survey Staff, 1996) into Pergelic, Cryo-, bor-, and -oll yields classes with meanings that are not obvious. Interpreted tersely, Pergelic Cryoborolls are of the Mollisol order with a base saturation of fifty percent or more (order-oll for Mollisol), a frigid, cryic, or pergelic soil temperature regime (suborder-Boroll), a cryic or pergelic soil temperature regime (great group-Cryoboroll), and a mean annual soil temperature of less than zero degrees Celsius (subgroup-Pergelic Cryoboroll), (Soil Survey Staff, 1996). This taxonomic classification (Soil Survey Staff, 1996) example is redundant and lacks any indication of soil properties such as soil depth or drainage.

Keys to Soil Taxonomy (Soil Survey Staff, 1996) isn't a simple key because it is designed to be usable for map scales (Smith, 1983). Using the soil taxonomic classification system (Soil Survey Staff, 1996), a given characteristic is used multiple times in more than one category versus a simple key where a characteristic is used once.

A simple key using a given characteristic once in only one category can result in too many categories. Soil taxonomy (Soil Survey Staff, 1996) has a limited total number of categories (Smith, 1986).

Users of soil classification systems are not concerned with the terminology of the system, but what information the system provides about a given soil in terms of use, management, and interpretations. The best scientific classification system includes the greatest number of the most important statements about the subject being classified (Smith, 1986). However, the system fails to meet the needs of the user when too many statements are used. The resulting string of complicated definitions and terminology is often too obscure for non-specialists to interpret. Accurate taxonomic classifications are difficult to produce when using *Keys to Soil Taxonomy* (Soil Survey Staff, 1996) and are often not interpretable as taxonomic classes. Difficulties in using this system are encountered by classifiers around the globe (Cline, 1980). Current taxonomic names given to soils are unfamiliar to all but a few soil scientists, obscuring communication between professionals and non-professionals such as extension agents and farmers (Tabor, 1992). *Soil Taxonomy* (Soil Survey Staff, 1975) evolved primarily to aid the preparation of soil surveys for mapping soils and the interpretation of mapping units. The taxonomic classification system (Soil Survey Staff, 1996) may not produce groupings that serve the user's (farmers, highway department personnel, rural and urban planners, etc.) needs. Smith (1986) recommended that the user propose changes for better groupings. Definitions found in *Keys to Soil Taxonomy* (Soil Survey Staff, 1996) may be unnecessary for local interpretations for land use (Smith, 1986). Prominent features or properties distinguish one soil from another and should be used as criteria for classification. The characteristic or property chosen for a grouping should itself be significant for the objective of the grouping (Cline, 1967).

A simplified approach is needed where field determination of observable and textural characteristics of the soil is used to establish soil classification. Observable and textural field characteristics should be immediately useful for local interpretations for land use. A simplified practical approach will facilitate the exchange of information between professionals and non-professionals.

The soil series is the term most often used by soil classifiers to identify a soil individual. Soil series are soil pedons (volumes) which represent soil properties and establish a unique set of layers. Soil series have been used by soil scientists since the recognition of the soil resource and the start of the soil mapping program in the United States. The number of soil series have increased as larger areas of land are surveyed and the range in soil properties have narrowed.

Soil Taxonomy (Soil Survey Staff, 1975) incorporated the soil series as the most detailed level in soil classification. By increasing the number of soil series, similarities in soil properties are less apparent. Since the series are the unifying level and concept when classifying soils, soil series should be the starting point for soil classification. Identifying certain soil-related properties at the soil series level would enable groupings of soils based on the properties most important to the user and provide a simplified and practical classification.

Included in the U.S. Soil Survey Reports (United States Department of Agriculture-Natural Resources Conservation Service; USDA, NRCS) for each county is a typical soil pedon description of each series found in the county and the range of soil properties allowed for each series. The typical pedon description is representative of the soil most frequently occurring in the series. The typical pedon is then the mode of the series. Wide ranges allowed in each series for properties including texture and color create too much overlap for sorting and grouping data. The soil series permits a quantitative set of values for data manipulation with the least soil property overlap by using the soil properties of the typical pedon.

The objectives of this study are to: 1) ascertain if beginning soil classifiers can clearly see texture, color, structure (key soil properties) and boundaries in a soil profile, 2) categorize the soil series of Oklahoma based on key soil properties, 3) demonstrate how the resultant soil groupings by key soil properties compare to the taxonomic classification (Soil Survey Staff, 1996) of the soils.

CHAPTER II

REVIEW OF LITERATURE

INTRODUCTION

Most classification systems devised for the natural sciences consider the properties or attributes of the individual under study. Only in soil classification (Soil Survey Staff, 1996) are external forces and conditions such as temperature regimes used in conjunction with soil characteristics. Following the classification systems of other natural sciences, soils should be grouped on the basis of characteristics chosen as being important or significant (Rice, 1927). The most significant soil-related properties are readily apparent and easy to communicate.

Many properties must be measured to properly compare or differentiate soils (Davis and Adams, 1927). Citing many properties not directly related to what the user wants to know is inefficient and burdensome. Cline (1967) stated that classification organizes our knowledge so that relationships between properties of objects will be understood easily. The interactive nature of soil-related properties (drainage and soil color, soil particle size and permeability) aids in understanding these relationships.

Until the 1950's, the primary purpose of soil surveys was to aid in agricultural planning. Subsequent land development prompted the need for interpretations for the purpose of urban planning, septic system design, and water wells (Klingebiel, 1991). Improved soil productivity should not be the main focus of soil science research (Yaalon, 1996). Users of soil data may not have the same knowledge or agricultural bias as a soil classifier. Personal bias dictates how an individual categorizes soil. Observers will not perceive the same properties as important, so they categorize differently. A multi-use approach is needed that is tailored to the needs of many users.

Recognizing the spatial variability of soil properties aids in determining land use capabilities. Variability of soil properties such as sand, silt and clay content, horizon thickness within mapping units and soil classification levels, increases with the size of the area sampled (Gibson, et al, 1983). Past studies have focused on the spatial variability of elements within sampling units, (Drees and Wilding, 1973), variability of properties in morphologically matched pairs of pedons, (Mausbach, et al, 1980), morphological variability comparing horizon thickness and texture from profile to profile within mapping units, (McCormack and Wilding, 1969), and within-pedon pH variability, (Patterson and Wall, 1982). Arnold and Wilding (1991) noted that if soil variability is systematic, it can be mapped. If it is random, we can only describe it. Studies have focused on soil variability related to mapping units. Classifying soil series by common soil properties and their variability has not been studied.

SOIL JUDGING

Soil judging contests give students the opportunity to interpret and analyze field information and to exercise their critical thinking skills (Cooper, 1991). These skills are necessary for those in soil science and related fields.

A key consideration in grouping ranges of observable soil properties is determining whether people will agree on what they see in a given soil (such as distinguishing horizons in a soil profile). Variability in describing a soil profile is due to multiple property values within the profile and descriptions by different individuals (Reheis, et al, 1989). Variability is an important factor when classifying soil and becomes a major obstacle to overcome and/or incorporate when devising classification systems. The values of the properties chosen for a proposed classification system must be those that are easily agreed upon by many individuals observing the same soil profile.

National and regional soil judging contests provide a valuable source of information which can be used to compare soil judging experience and contest scores. This information can be used to determine if experience increases accuracy in making decisions such as horizon boundary depths. Soil judging contest results have not been systematically studied. Studying scorecard answers from soil judging contests can aid in determining which soil properties are accurately described and should be used for soil classification purposes.

THE SOIL SERIES

The soil series is the lowest level of the classification system (Soil Survey Staff, 1996). Differentiating characteristics of the series are based on the types and configuration of horizons (Brady and Weil, 1996).

In the early half of the 20th century, soil series were described by a particular set of characteristics including but not limited to the composition of parent material, and ranges in properties such as soil texture, color, and pH. The importance of any one characteristic within a set varied with each grouping (Ableiter, 1949). All the soils within a given series, below plowing depth, did not vary substantially in differentiating characteristics or in the configuration of genetic horizons (Simonson, 1964). Soil texture, color, structure, geology of soil material, horizon arrangement, number of horizons, chemical composition, and horizon thickness are those key properties which Marbut considered important for the differentiation of a soil series (Smith, 1983). Although little has been added to the description of a series since their development, emphasis in the second half of the century has focused on current ranges of properties and not on surface properties assumed to be removed by erosion.

Wilding, et al (1983) state the purpose of mapping is to take data and experience obtained from one place and apply it to other areas. Devising an approach to grouping soil by using observable key soil-related properties fulfills this purpose. Currently, soils are separated by following the *Keys to Soil Taxonomy* (Soil Survey Staff, 1996). Soils are then placed in the series whose descriptive range fits the soil being classified. This method of placement contradicts the unifying concept of the soil series by using best-fit to place the soil in a series. The unifying concept of the series are the series properties and they should be applied to grouping the soil.

NINE OBSERVABLE SOIL-RELATED PROPERTIES

Introduction

Of all the soil-related properties, field observable and textural properties are the most obvious to users of soil information and soil classifiers. The most obvious properties are the simplest to communicate. Visual keys are useful in speeding field identification. The least transient soil properties and features are the best criteria for classification (Bridges, 1970).

Soil texture, color, structure, depth, slope gradient, landform/site position, number of soil horizons, parent material, and drainage class were chosen as the nine observable and textural soil properties most important in distinguishing characteristics of a soil series (Smith, 1983). In addition, the properties were chosen for the ease of identification.

Soil Texture

Soil texture is the attribute most often used to characterize a soil's physical makeup (Hillel, 1982). Using particle size distribution, other properties can be estimated for a soil. Sandy soils tend to exhibit a low cation exchange capacity (CEC) due to the relatively small surface area of sand grains. With their large surface area, clayey soils generally exhibit a higher CEC. Particle size distribution influences soil characteristics including hydraulic conductivity, water holding capacity, permeability, surface runoff, and leaching potential. Soil texture is often the first and most significant property investigated. Aside from the surface layer, texture is not readily altered, so it is considered a fundamental soil property (Brady and Weil, 1996).

Twelve textural groups are used to describe soil horizons. At the family level of classification, the family particle size triangle consists of seven groups. In the family particle size class, particle size distribution is obtained from the control section which may include a range of textures.

Landform/Site Position

Pedologists have recognized that soils are systematically related to the landscape (Wilding and Drees, 1978). Although not a soil characteristic, landform is part of the three dimensions of soil volumes and as such is included as a soil-related property (Bushnell, 1927). As a topographic feature, landform/site position is considered one of five major soil forming factors. Coupled with slope, landscape position affects soil water movement and surface runoff. Landform and landscape positions of local areas have considerable influence on the distribution of soils with specific properties (McCracken and Helm, 1994). However, correlation between landscape position and particle size distribution has not been clearly established. In a study of soil variability and parent material uniformity, Stolt, et al (1993) found that variability in particle size distribution and elemental composition attributed to landscape position was minimal (<8%), suggesting that parent material differences or horizon differentiation may be more important in explaining spatial variability in soils than landscape position.

Smith (1986) remarked that if a series occurred on two different landscape positions that differences in positions in the landscape indicated differences in the behavior or the genesis of the soil and should be used to separate this soil into two series. Smith (1986) noted that identification of a single series in different landscape positions suggests that neither genetic nor use relationships of the soil have been studied thoroughly.

Depth of Soil

Soil depth is a readily measureable property. Many people viewing the same soil can determine soil depth directly. Depth of soil is a key consideration for agricultural applications such as determining crop type to be grown. Deep soils have a greater potential moisture-holding capacity compared to shallow soils (Brady and Weil, 1996). Soil depth refers to the depth at which root penetration is strongly inhibited because of physical or chemical limitations. The variation in potential root penetration depths of different crops, varieties and plant species is largely ignored (always assumes a deep rooted crop) by the five divisions of soil depth. The 5 divisions of very shallow, shallow, moderately deep, deep, and very deep correspond to soil depths of <25 cm, 25 - 50 cm, 50 - 100 cm, 100 - 150 cm, and ≥150 cm respectively (Soil Survey Staff, 1993). Depth ranges are a standard guide. Healthy plants have deep, vigorous feeding root systems compared to the roots of undernourished, unhealthy plants whose roots are dwarfed by shallow soils (Phillips Petroleum, 1963). Root penetration is, in part, dependent on the plant species. Some species are typically deep-rooted and are used to standardize soil depth (Meyers and Anderson, 1939). Both winter wheat and sorghum grow in Oklahoma. The root system of winter wheat reaches its highest absorption level between 1.1 to 1.2 m. This level is the typical depth to which many roots penetrate (Weaver and Bruner, 1927). The root system of winter wheat reaches a maximum depth of 1.5-2.1 m. The root penetration of sorghum is slightly less than winter wheat and reaches the highest absorption level between 0.9-1.2 m. and has a maximum root penetration depth of 1.4-1.8 m (Weaver, 1926).

Number of Layers

Subsurface diagnostic features are not always obvious to the untrained eye. Subsurface horizon suffix letter designations are subjective, even among professional soil scientists. For these reasons, master horizons including concurrent layers and lithologic discontinuities are used to distinguish layers in this study rather than master horizons subdivided by subsurface horizon suffix letter designation combinations.

The number of soil horizons or layers aids in determining the genesis of the soil, and paired with texture, can indicate lithologic discontinuities. Drees and Wilding (1973) found that geomorphic and pedogenic studies emphasize the importance of recognizing lithologic and stratigraphic discontinuities in soil profiles. Drees and Wilding (1973) also found that multiple interpretations of genesis are dependent upon whether or not a discontinuity is identified.

Soil Structure

One of the most important physical properties determining productivity is soil structure (Kohnke, 1986). Soil structure refers to the arrangement of soil particles and is dependent on soil forming conditions. There are four primary structure shapes including spheroidal, platy, prismlike, and blocklike. Type of structure can be an indication of other soil conditions. Many surface soils high in organic matter have spheroidal (crumb) structure, especially grasslands and soils with earthworm activity. Platy (platelike) structure is found in surface horizons of forest soils and in clayey soils compacted by heavy machinery. Columnar (prismlike) structure in subsoils is associated with high sodium content. Prismatic structure is common in arid and semiarid regions and often accompany shrink-swell clay types. Most subsoils contain block-like structure (Soil Survey Staff, 1993).

The degree of structural development is influenced by soil drainage, aeration, and root penetration (Brady, 1996). Well-structured soils are less prone to erosion and aid in increasing crop yields (Bridges, 1970). Structure influences hydraulic conductivity, root penetration, heat transfer, aeration, porosity, and hydrological, engineering, agricultural and land use considerations. Farming practices such as plowing and cultivation change and often degrade soil structure.

Soil Color

Soil color provides insight to soil forming processes. Dark colors can indicate high organic matter content, light gray colors suggest leaching of cations, red colors indicate iron oxide content, blue-gray tones and redoximorphic features indicate a seasonal excess of water during soil formation (Kohnke, 1986). The importance of soil color in a profile is to distinguish layers in soil. Inferences are then made on other profile characteristics (Melville and Atkinson, 1985). Color, such as black for manganese oxide and green for glauconite can indicate the soil mineralogy (Brady and Weil, 1996).

Soil Parent Material

Parent material influences soil particle size distribution and weathering and is directly related to the mineralogical composition of the soil (Cady, 1967). Geologic material was one of the original eight characteristics used to distinguish soil series (Smith, 1983). Parent material determines or produces particular soil textures. The geologic time of soil formation can be determined by knowing the type of soil parent material. Depth of soil and soil pH can be influenced by soil parent material. Weathering of parent material such as granite can produce acidic soil conditions just as basalt can produce basic soil conditions. Coarse grained rocks have a higher weathering rate than finer grained rocks (Buol, et al, 1989).

Drainage

Drainage capabilities of a soil, coupled with landform/site position and slope are crucial in crop selection and other land uses. The success or failure of a chosen land use including roadway and building construction is dependent to a large extent on the soil's wetness class.

The lateral ground surface and depth relationships comprising the soil catena are greatly influenced by the internal soil drainage. Soils in higher landscape positions are well-drained becoming poorer drained downslope. Soil drainage is also reflected in the soil color. The catena progression relates soil drainage to landscape position. The higher landscape positions are usually well-drained soils with oxidized red colors, becoming mottled in the zone of a fluctuating water table in lower landscape positions. Gleyed colors are found at the base of the slope where the soil is poorly drained (Birkeland, 1984).

Types of vegetation that will grow in an area are influenced by the drainage ability of a soil. Water-tolerant plants including rice and wetland forest species thrive under excessively moist conditions and are often used to identify wetlands. Most terrestrial plants do not thrive in these conditions due to poor aeration with an inadequate supply of oxygen for respiration (Brady and Weil, 1996).

Slope

As a topographical feature, slope is part of the five main soil forming factors. Gradient, curvature, length and aspect comprise slope (Soil Survey Div. Staff, 1993). Soil temperature and moisture are influenced by the slope of the land. Generally, soils on south-facing slopes are warmer, have less moisture and organic matter, and are shallower than soils on north-facing slopes (Brady, 1996) in the northern hemisphere. Slope often determines the amount of surface water runoff. Generally, soils on steep slopes are prone to higher runoff rates and less infiltration than soils on gentler slopes.

SOIL TAXONOMY

The string of terms that comprise the taxonomic classification of a soil (Soil Survey Staff, 1996) reveals many specific soil properties and is accessible if terminology is known for both the individual formative element and the whole unit. A prefix placed in one part of the taxonomic classification has new meaning when located in a different part of the classification. The terms themselves are numerous and cumbersome. Meanings of these terms are not readily apparent and diminish the value of utilizing the classification system. When attempting to apply the classification system in the field, many qualifying conjunctions make it difficult to accurately follow the *Keys To Soil Taxonomy* (Soil Survey Staff, 1996). Required data are not readily available in the field, forcing the user to make assumptions in order to classify the soil.

The user of soils information may want basic soil property data to make an overall assessment of the soil before committing further resources to the project (Milburn, et al, 1988). A simplified approach to classifying soil that would meet the user's needs would entail the use of 1) measureable soil properties whenever possible to ensure agreement among different people viewing the same soil, 2) observable soil properties to include users who may not have laboratory data available to them, 3) properties least apt to change over time, and 4) soil property values (for example, where soil depth is the property, the soil property values would be very deep, deep, moderately deep, shallow and very shallow) rather than technical jargon that few can decipher.

Many individuals from various countries have contributed to current knowledge on soils. Concepts related to classification systems outside the U.S. are valuable as they helped mold present concepts in U.S. classification. It was estimated that *Keys to Soil Taxonomy* (Soil Survey Staff, 1996) would be utilized outside of the U.S. The fact that other countries have developed their own system of classification is evidence to the contrary. In 1961, the Food and Agriculture Organization (FAO) and the United Nations Educational, Scientific and Cultural Organization (UNESCO) collaborated on a soil map project that would correlate soil units on a global scale. The purpose of this project was to create a uniform legend that would correlate soil units worldwide (FAO-Unesco, 1974).

CHAPTER III

MATERIALS AND METHODS

SOIL JUDGING

Surveys and Scorecards

Soil pits used for the contests were described by several professional soil scientists who together reached a general concensus before filling out the answer key. Each soil scientist contributed and discussed his/her observations until a cooperative agreement was reached.

Information obtained from 2 national and one regional soil judging contest was used to examine the relationship between levels of knowledge and correct answers, and the level necessary to accurately determine soil profile characteristics.

The 1996 national contest held in Stillwater, OK consisted of 4 contest soil pits, 17 teams and 67 team members. Participants were presented with a survey coded to match the student's scorecards (Figures 1 and 2). The survey requested information from the student including the number of years spent judging soil. Soil profiles used in the 4 contest pits included Konawa (Fine-loamy, mixed, thermic Ultic Haplustalf), Grainola (Fine, mixed, thermic Udertic Haplustalf), Mclain (Fine, mixed, thermic, Udertic Argiustoll), and Bethany (Fine, mixed, thermic Pachic Paleustoll) series.

For the contests, students were separated into 8 groups. Two groups (A and B) judged 1 pit during the 50 minutes allowed per pit. Groups A and B rotated turns in the pit following the time schedule of 5 minutes in, 5 minutes out, 10 minutes in, 10 minutes out, and a 20 minute free-for-all. The 1997 national contest followed a slightly different time schedule of 10 minutes in, 10 minutes out, 10 minutes in, 10 minutes out, and a 10

SCORECARD
36TH NATIONAL INTERCOLLEGIATE SOIL JUDGING CONTEST
OKLAHOMA STATE UNIVERSITY, STILLWATER
APRIL 1996

Site Number______

Contest ID_______

SCORE: Part I___
Part II ___
Part III___
Part IV___

Part I SOIL MORPHOLOGY

TOTAL__________

Describe_____mineral horizons within a depth of ___ centimeters.

Horizon				Boundary		Boundary distinguished by Texture (T) Structure (S) Color (C)	Clay %	Texture Class	Color			Redox Features		Structure		Score
Prefix (1)	**Master** (2)	**Sub** (2)	**No.** (1)	**Depth** (cm.) (2)	**Dist.** (2)	(2)	(2)	(4)	**Hue** (2)	**Value** (2)	**Chroma** (2)	**Abundance** (2)	**Contrast** (2)	**Grade** (2)	**Shape** (2)	

PART I SCORE__________

Part II. SITE CHARACTERISTICS

A. Site Position (5)
_____Floodplain
_____Stream Terrace
_____Dune
_____Upland-Summit
_____Upland-Shoulder
_____Upland-Backslope
_____Upland-Footslope

B. Parent Material (5 each)
_____Alluvium
_____Residuum
_____Eolian sand

C. Slope Gradient (5)
_____0-1%
_____1-3%
_____3-5%
_____5-8%
_____8-12%
_____12-20%
_____20-45%
_____≥45%

PART II SCORE__________

Figure 1. National contest scorecard from 1996 - front side

Figure 2. National contest scorecard from 1996 – back side

PART III. SOIL TAXONOMY

A. Diagnostic Surface Horizons (10)

_____ Mollic epipedon
_____ Ochric epipedon
_____ Umbric epipedon
_____ None

B. Subsurface Horizons and Features (10 each)

_____ Argillic
_____ Calcic
_____ Cambic
_____ Lithic contact
_____ Albic
_____ Natric
_____ Paralithic contact
_____ Slickensides
_____ None

C. Order (10)

_____ Alfisol
_____ Entisol
_____ Inceptisol
_____ Mollisol
_____ Vertisol
_____ Ultisol

D. Family Particle Size Class (5)

____

PART III SCORE_____

PART IV. INTERPRETATIONS

A. Hydraulic Conductivity/Surface (5)

_____ High
_____ Moderate
_____ Low

B. Hydraulic Conductivity/Soil (5)

_____ High
_____ Moderate
_____ Low

C. Water Retention Diff. (5)

_____ Very High ≥ 30 cm
_____ High 22.5 - 30 cm
_____ Medium 15 - 22.5 cm
_____ Low 7.5 - 15 cm
_____ Very Low < 7.5 cm

D. Wetness Class (5)

_____ Class 1: ≥ 150 cm
_____ Class 2: 100 - 150 cm
_____ Class 3: 50 - 100 cm
_____ Class 4: 25 - 50 cm
_____ Class 5: < 25 cm

E. Surface Runoff (5)

_____ Ponded
_____ Very Slow
_____ Slow
_____ Medium
_____ Rapid
_____ Very Rapid

PART IV SCORE_____

minute free for all. After 50 minutes, all groups rotated to the next soil pit. This schedule was followed until all groups had judged all 4 soil pits.

Soil properties on the scorecards included but were not limited to master horizon letter designations, depth of each boundary, texture, hue, value, chroma, structure grade and shape for each horizon, slope, site position, wetness class, and parent material. Students were equipped with clinometers or Abney levels to determine slope for the contest pits. Two rods were set up near each pit for the student to measure slope. Choices on scorecards were 8 slope ranges, in percent.

Scorecard and survey data were entered into an Excel (for Windows) spreadsheet. Point totals of each category for each pit were cross-referenced with that judger's number of years of judging experience taken from the individual surveys.

The 1996 regional soil judging contest held in Lubbock, Texas consisted of 4 contest soil pits, 7 teams, and 28 team members. Survey questions and scorecard properties studied were the same as for the 1996 national contest. Figures 3 and 4 represent the scorecards used in the contest. Soils of the 4 contest pits included the series Randall (Fine, montmorillonitic, thermic Ustic Epiaquert), Olton (Fine, mixed, superactive, thermic Aridic Paleustoll), Weymouth (Fine, loamy, mixed, thermic Typic Ustochrept) mapped as Mansker (Fine-loamy, carbonatic, thermic Calciorthidic Paleustoll), and Berda (Fine-loamy, mixed, superactive, thermic Aridic Ustochrept) mapped as Berthoud (Fine-loamy, mixed, mesic Aridic Ustochrept).

The 1997 national soil judging contest held in Madison, Wisconsin consisted of 4 contest soil pits, 16 teams, and 63 team members. Survey questions and scorecard properties studied remained the same as the 1996 regional and national contests. Figures

SCORE CARD
ASA REGION IV COLLEGIATE SOILS CONTEST
TEXAS TECH UNIVERSITY
Fall 1996

Site Number_______

Contest ID_______

SCORE Part I___
Part II ___
Part III___
Part IV___

TOTAL___________

Part I. SOIL MORPHOLOGY

Describe_____mineral horizons within a depth of______centimeters.

Horizon			Distinctness of Boundary		Clay %	Texture	Color			Redox Features		Structure	
Master (2)	**Sub (2)**	**No. (1)**	**Depth (cm.) (2)**	**(2)**	**(2)**	**(4)**	**Hue (2)**	**Value (2)**	**Chroma (2)**	**Abundance (2)**	**Contrast (2)**	**Grade (2)**	**Shape (2)**

(Possible score 29 - points for each horizon)

PART I SCORE___________

Part II. SITE CHARACTERISTICS

A. Site Position (5)
____Depression
____Floodplain
____Footslope
____Stream terrace
____Upland

B. Parent Material (5 each)
____Alluvium
____Colluvium
____Residuum
____Eolian deposits
____Lacustrine deposits

C. Slope Gradient (5)
____0-1% ____8-12%
____1-3% ____12-20%
____3-5% ____20-45%
____5-8% ____>45%

D. Erosion
____Class 1
____Class 2
____Class 3
____Class 4

PART II SCORE___________

Figure 3. Regional contest scorecard from 1996 - front side

Figure 4. Regional contest scorecard from 1996 – back side

PART III. SOIL TAXONOMY

A. Diagnostic Surface Horizons (10)

_____ Mollic epipedon
_____ Ochric epipedon
_____ None

B. Subsurface Horizons and features (10 each)

_____ Argillic
_____ Calcic
_____ Cambic
_____ Gypsic
_____ Lithic contact
_____ Paralithic contact
_____ Petrocalcic
_____ Salic
_____ Slickensides

C. Order (10)

_____ Alfisol
_____ Aridisol
_____ Entisol
_____ Inceptisol
_____ Mollisol
_____ Vertisol

PART III SCORE_____

PART IV. INTERPRETATIONS

A. Hydraulic Conductivity/Surface (5)

_____ High
_____ Moderate
_____ Low

B. Hydraulic Conductivity/Soil (5)

_____ High
_____ Moderate
_____ Low

C. Water Retention Diff. (5)

_____ Very High 30 cm
_____ High 22.5 - 30 cm
_____ Medium 15 - 22.5 cm
_____ Low 7.5 - 15 cm
_____ Very Low < 7.5 cm

D. Wetness Class (5)

_____ Class 1: ≥ 150 cm
_____ Class 2: 100 - 150 cm
_____ Class 3: 50 - 100 cm
_____ Class 4: 25 - 50 cm
_____ Class 5: < 25 cm

E. Surface Runoff (5)

_____ Ponded
_____ Very Slow
_____ Slow
_____ Medium
_____ Rapid
_____ Very Rapid

PART IV SCORE_____

5 and 6 represent the scorecards used in the contest. Soil series as represented by the contest pits included 2 soils of Kidder (Fine-loamy, mixed, mesic Typic Hapludalf), 1 Plano (Fine-silty, mixed, superactive, mesic Typic Argiudoll), and 1 Kegonsa (Fine-silty over sandy or sandy-skeletal, mixed, mesic Mollic Hapludalf).

A statistical analysis program; SAS version 6.11 for Windows was used to determine means, mean separation (Duncan), and percent observations. The purpose of this part of the study was to see if there was a relationship between the number of years of soil judging experience and percentage of correct answers. Additionally, we wanted to evaluate the percentage of people scoring ≥80% correct (8 out of 10 or 16 out of 20 points) in each soil property being studied. For soil property categories worth 8 points total the student scored in 2 point increments. In these categories we were interested in the percentage of people scoring at least 75% correct (6 out of 8 points). This information will aid in determining which soil properties are readily observed in a soil profile by trained individuals.

SAS/Data Analysis

Of the 67 participants in the 1996 National Soil Judging Contest, 59 filled out and returned surveys. Only surveyed student data was analyzed. Soil judgers were separated into groups by experience, ≤1 year, 2 years, ≥3 years judging experience. Soil property categories were then analyzed by experience.

Of the 28 participants in the 1996 Regional Soil Judging Contest, 22 filled out and returned surveys. Only surveyed student data was analyzed. Judgers were separated into

NATIONAL SOIL JUDGING SCORECARD
UW-RIVER FALLS AND UW-MADISON
APRIL 25, 1997

SITE NO.________ CONTESTANT I.D._____

TOTAL SCORE_________

Describe___________horizons to a depth of __________cm Nail is in third mineral horizon at__________cm.

I. Soil Morphology

A. HORIZON						B. TEXTURE				C COLOR			D STRUCTURE		E CONSIST	F MOTTLES	
Master P.M. (2)	**Master Ltr. (2)**	**Sub. (2)**	**No. (2)**	**Lower Depth (cm) (2)**	**Dist. (2)**	**Sand % (+-5) (2)**	**Clay % (+-5) (2)**	**Coarse Frag. (2)**	**Class (2)**	**Hue (2)**	**Value (2)**	**Chroma (2)**	**Grade (2)**	**Shape (2)**	**Moist Strength (2)**	**Abun-dance (2)**	**Contrast (2)**

PAGE TOTAL________

Figure 5. National contest scorecard from 1997 - front side

Figure 6 National contest scorecard from 1997 - back side

II. Site and Soil Characteristics

A. Parent Material (5-15)
- _____ Recent alluvium
- _____ Glacial outwash
- _____ Lacustrine deposit
- _____ Glacial till
- _____ Loess
- _____ Eolian sand
- _____ Beach deposit
- _____ Colluvium
- _____ Residuum

B. Landform (5)

1 Constructional
- _____ Floodplain
- _____ Stream terrace
- _____ Alluvial fan
- _____ Beach ridge
- _____ Sand dune
- _____ Lake plain
- _____ Loess hillslope
- _____ Outwash plain
- _____ Till plain/drumlin/moraine
- _____ Kame/esker

2 Erosional
- _____ Upland headslope
- _____ Upland sideslope
- _____ Upland noseslope
- _____ Interfluve

C Slope Profile (5)
- _____ Summit
- _____ Shoulder
- _____ Backslope
- _____ Footslope
- _____ None

E. Erosion Class (5)
- _____ Class 1
- _____ Class 2
- _____ Class 3
- _____ Class 4
- _____ Deposition

F Hyd. Cond., Surface (5)
- _____ High
- _____ Moderate
- _____ Low

G Hyd Cond., Limiting (5)
- _____ High
- _____ Moderate
- _____ Low

H. Surface Runoff (5)
- _____ Negligible
- _____ Very low
- _____ Low
- _____ Medium
- _____ High
- _____ Very High

I Soil Wetness Class (5)
- _____ (> 150 cm)
- _____ (100-150 cm)
- _____ (50-99 cm)
- _____ (25-49 cm)
- _____ (<25 cm)

J Effective Soil Depth (5)
- _____ Very Deep (> 150 cm)
- _____ Deep (100-150 cm)
- _____ Mod. Deep (50-99 cm)
- _____ Shallow (25-49 cm)
- _____ V Shallow (<25 cm)

III. Soil Classification

A Epipedon (5)
- _____ Mollic
- _____ Ochric
- _____ None

B. Subsurface Horizon/Feature (5-15)
- _____ Albic
- _____ Argillic
- _____ Cambic
- _____ Lithic
- _____ Paralithic
- _____ None

C Order (5)
- _____ Alfisol
- _____ Entisol
- _____ Inceptisol
- _____ Mollisol

D. Suborder (5)
- _____ Alb
- _____ Aqu
- _____ Fluv
- _____ Ochr
- _____ Orth
- _____ Psamm
- _____ Ud

E. Great Group (5)
- _____ Alb
- _____ Argi
- _____ Calci
- _____ End (o)
- _____ Eutr (o)
- _____ Fluv
- _____ Hapl
- _____ Ochr

Figure 6. National contest scorecard from 1997 - back side- continued

D. Slope (5)
- _____ Concave
- _____ < 1 %
- _____ 1-5%
- _____ 5-10%
- _____ 10-15%
- _____ 15-20%
- _____ > 20%

K. Water Retention Difference (5)
- _____ Very low (< 7.5 cm)
- _____ Low (7.5-14.9 cm)
- _____ Mod. (15-22 9 cm)
- _____ High (> 22.5 cm)

- _____ Pale
- _____ Psamm
- _____ Quartzi
- _____ Ud (I)

F. Particle Size Class (5)

____

groups by experience, ≤1 year, and ≥2 years judging experience. Soil property categories were then analyzed by experience.

All 63 participants in the 1997 National Soil Judging Contest filled out and returned surveys. Judgers were separated into groups, ≤1 year, 2 years, and ≥3 years soil judging experience. Soil property categories were then analyzed by experience.

NINE OBSERVABLE SOIL-RELATED PROPERTIES

Soil-related properties and features for each of the 577 soil series of Oklahoma obtained from the United States Department of Agriculture (USDA) series description sheets (USDA-Natural Resources Conservation Service) were entered in a Paradox for Windows version 5.0 database. Soil properties and features entered were obtained from the typical pedon and the range of characteristics description. The 577 soil series of Oklahoma were sorted based on the individual values of each soil property. Soil depth, drainage class, slope, soil color (hue, value and chroma), parent material, site position, texture, structure (grade and shape), and number of horizons were the soil properties chosen for this study. Every combination of the chosen sortable soil properties used in this study separated the 577 series into groups. Soil properties used in the groupings were compared to their taxonomic classifications (Soil Survey Staff, 1996) from the order to the family levels to evaluate whether the chosen soil properties used in this study are clearly presented in the classification.

Master horizons were chosen for this study. Master horizons including transition horizons, lithologic discontinuities and concurrent (formed at the same time) horizons were recognized as separate master horizons. The number of master horizons in a soil series were sorted by the number of master horizons represented in the typical pedon; 1, 2, 3, 4, 5, 6, or 7. Soil depth of the typical pedon was sorted by the 5 values of very deep (≥150 cm), deep (100-150 cm), moderately deep (50-100 cm), shallow (25-50 cm), and very shallow (<25 cm). Criteria for master horizons and depths follow those given in the *Soil Survey Manual* (Soil Survey Div. Staff, 1993). Soil series were sorted into one of the 6 drainage categories. Drainage values consisted of excessively drained, well drained (water table >91.4 cm), moderately well drained (water table between 45.7 and 91.4 cm), somewhat poorly drained (water table between 22.9 and 45.7 cm), poorly drained (water table between 0 and 22.9 cm) and very poorly drained (Soil Survey Div. Staff, 1993). Soils were sorted based on moist value and chroma soil colors of the typical pedon A horizon at the 3/3 (value/chroma - Munsell Color Chart) level. Soils with A horizons of ≤3/3 were sorted by whether moist values and chromas of ≤3/3 extended below the A horizon. Texture was sorted by the family particle size class (Soil Survey Staff, 1996). Structure shapes of subangular blocky, angular blocky, prismatic, platy, granular, and crumb were sorted based on the center master horizon in the typical pedon. Slope was sorted based on the slope gradient allowed for each soil series. Site Position was sorted based on the site position in which each soil series can be found.

COMPARISON WITH *KEYS TO SOIL TAXONOMY*

Sorting soil series by the chosen key soil properties in this study results in groupings of soils for each value. Every combination of each set of values separated the 577 series into soil property combinations.

Taxonomic classifications of the resultant soil property combinations were then compared to the *Keys To Soil Taxonomy* (Soil Survey Staff, 1996). Levels of classification studied were order, suborder, great group, subgroup, and family. The 577 series were sorted by their subgroup taxonomic classifications limiting our camparisons to only the subgroups associated with the 577 series. The subgroups were divided into their respective prefixes starting at the order level of classification and ending with the family level (Soil Survey Staff, 1996). Comparisons were made at each level of classification to evaluate if the 9 properties under study were readily apparent in the *Keys to Soil Taxonomy* (Soil Survey Staff, 1996).

CHAPTER IV

RESULTS AND DISCUSSION

SOIL JUDGING

SAS/Data Analysis

1996 National Soil Judging Contest - Stillwater, Oklahoma

The 1996 national contest population contained 59 surveyed students; 26 had ≤1 year, 18 had 2 years, and 15 had ≥3 years of soil judging experience. Each soil judger described 4 pits. Each student to pit combination was treated as a separate individual for statistical analysis. Fifty-nine surveyed soil judgers, each judging 4 pits were referred to as 236 "students" (student to pit combination). The following national contest statistical data are based on 236 "students" (Appendix A).

1997 National Soil Judging Contest - Madison, Wisconsin

The 1997 national contest population contained 63 surveyed students; 15 had ≤1 year, 25 had 2 years, and 23 had ≥3 years of soil judging experience. Each soil judger described 4 pits. Each student to pit combination was treated as a separate individual for statistical analysis. Sixty-three surveyed soil judgers, each judging 4 pits were referred to as 252 "students" (student to pit combination). The following national contest statistical data are based on 252 "students" (Appendix B).

Values for soil properties changed with each pit. Pit 1 contained 5 horizons. Pits 2, 3, and 4 contained 6 horizons. Scores for properties including master horizon, boundary depth, texture, color, and structure had points which changed from pit 1 to pits 2, 3, and

4. The parent material category had total points which changed from pits 1 and 2 to pit 3 to pit 4.

1996 Regional Soil Judging Contest - Lubbock, Texas

The 1996 regional contest contained 22 surveyed students; 12 had ≤1 year, and 10 had ≥2 years of soil judging experience. Each student judged 4 soil pits. Each student to pit combination was treated as a separate individual for statistical analysis providing 88 "students" (student to pit combinations). The following statistical data are based on 88 "students" (Appendix C).

Master Horizons

1996 National Soil Judging Contest

The master horizon column was worth 10 points for each pit. Seventy-four percent of the ≤1 year of experience students scored ≥80% correct in this category. The highest frequency of 44 occurred at 8 points. Seventy-four percent of the 2 years of experience students scored ≥80% correct. The highest frequency of 29 was at 10 points. Seventy percent of the ≥3 years of experience students scored ≥80% correct for this category. The highest frequency of 24 was at 10 points. The sample mean for students with 2 years experience is slightly higher than those with ≤1 year and ≥3 years of experience. The population mean for the master horizon category was 8.0 with a standard deviation of 1.94 (Tables 1 and 2). Separation of means (Duncan) indicated no difference between the ≤1, 2 and ≥3 years of experience groups at a 0.05 significance level.

Table 1. Summary – Soil property means for each contest by experience.

*Contest	Exper (yrs)	N	MAS10	DEPTH8	TEX20	HUE10	VALUE10	CHROMA10
1996 Nat'l	≤1	104	8.0	2.4	7.7	5.9	6.9	4.4
	2	72	8.1	2.7	8.8	6.1	7.7	4.6
	≥3	60	8.1	2.7	10.6	7.3	6.9	4.4
			STRG10	STRS10	PM5	SLPE5	SITEPOS5	WETCLASS5
	≤1	104	5.2	5.6	3.9	4.2	1.6	3.6
	2	72	5.7	5.8	4.0	4.3	2.3	3.9
	≥3	60	6.1	5.7	3.8	4.5	2.0	3.6
		N		BOUND.DIST.BY6		N		BOUND.DIST.BY8
	≤1	26		2.2		78		3.4
	2	18		2.6		54		3.8
	≥3	15		1.7		45		3.6
			MAS10	DEPTH8	TEX10	HUE10	VALUE10	CHROMA10
1997 Nat'l	≤1	15	7.6	4.1	3.7	6.4	5.5	5.3
	2	25	8.1	3.9	3.9	7.8	6.4	5.4
	≥3	23	8.2	4.8	4.4	7.2	7.0	5.0
			STRG10	STRS10	PM10	PM15		
	≤1	15	5.2	8.0	8.3	6.7		
	2	25	6.2	7.8	8.4	8.4		
	≥3	23	6.2	7.4	7.6	8.9		
			MAS12	DEPTH10	TEX12	HUE12	VALUE12	CHROMA12
	≤1	45	9.8	3.8	7.0	10.3	8.5	7.2
	2	75	10.5	4.6	7.5	10.1	8.6	7.8
	≥3	69	10.4	4.8	7.3	10.4	9.1	7.3
			STRG12	STRS12		N	STRG10	
	≤1	45	6.5	8.1		30	2.3	
	2	75	7.8	8.4		50	3.5	
	≥3	69	7.7	8.0		46	2.5	
			SLPE5	SITEPOS5	FPS5	WETCLASS5	SOILD5	
	≤1	60	3.4	3.9	1.8	3.8	4.6	
	2	100	4.4	4.0	3.1	4.0	4.7	
	≥3	92	4.0	3.6	2.4	4.0	4.7	
			MAS10	DEPTH8	TEX20	HUE10	VALUE10	CHROMA10
1996 Reg'l	≤1	48	8.5	4.5	12.6	5.8	6.9	6.9
	≥2	40	8.8	4.1	12.7	5.3	6.4	6.6
			STRG10	STRS10	PM5	SLPE5	SITEPOS5	WETCLASS5
	≤1	48	4.9	5.7	3.7	4.0	4.2	3.4
	≥2	40	6.2	5.4	3.6	4.3	4.3	3.4

*MAS10=master horizons-10 points, MAS12=master horizons-12 points, DEPTH8=boundary depth-8 points, DEPTH10= boundary depth-10 points, TEX20=texture-20 points, TEX12=texture-12 points, TEX10=texture-10 points, HUE10=hue-10 points, HUE12=hue-12 points, VALUE10=value-10 points, VALUE12=value-12 points, CHROMA10=chroma-10 points.

Table 1. continued

CHROMA12=chroma-12 points, STRG10=structure grade-10 points, STRG12=structure grade-12 points, STRS10=structure shape-10 points, STRS12=structure shape-12 points, PM5=parent material-5 points, PM10=parent material-10 points, PM15=parent material-15 points, SLPE=slope-5 points, SITEPOS5=site position-5 points, WETCLASS5=wetness class-5 points, FPS5=family particle size class-5 points, BOUND. DIST. BY6=boundary distinguished by-6 points, BOUND. DIST. BY8=boundary distinguished by-8 points, SOILD5=soil depth-5 points, N=number of observations.

Table 2. Means and standard deviation for soil properties in 3 soil judging contests.

1996 National Soil Judging Contest

Variable (Total Points)	Population	Mean	Std. Deviation
Master Horizons (10)	236	8.0	1.94
Boundary Depth (8)	236	2.6	1.86
Boundary Distinguished By (6)	59	2.2	1.22
Boundary Distinguished By (8)	177	3.6	1.90
Texture (20)	236	8.8	5.66
Hue (10)	236	6.3	2.90
Value (10)	236	7.1	2.18
Chroma (10)	236	4.4	2.78
Structure Grade (10)	236	5.6	2.41
Structure Shape (10)	236	5.7	2.08
Parent Material (5)	236	3.9	2.08
Slope (5)	236	4.3	1.72
Site Position (5)	236	1.9	2.44
Wetness Class (5)	236	3.7	2.21

1997 National Soil Judging Contest

Variable (Total Points)	Population	Mean	Std. Deviation
Master horizons (10)	63	8.0	1.34
Master horizons (12)	189	10.3	1.89
Boundary depth (8)	63	4.3	1.52
Boundary depth (10)	189	4.5	1.99
Texture (10)	63	4.1	2.71
Texture (12)	189	7.3	2.35
Hue (10)	63	7.3	2.55
Hue (12)	189	10.3	1.99
Value (10)	63	6.4	2.35
Value (12)	189	8.8	2.55
Chroma (10)	63	5.2	2.01
Chroma (12)	189	7.4	2.66
Structure grade (10)	63	6.0	2.23
Structure grade (12)	189	7.4	2.47
Structure shape (10)	63	7.7	1.84
Structure shape (12)	189	8.2	3.13
Parent material (5)	126	2.9	2.48
Parent material (10)	63	8.1	3.17
Parent material (15)	63	8.2	3.95
Slope (5)	252	4.0	2.00
Site position (5)	252	3.8	2.13
Family particle size (5)	252	3.5	2.50
Wetness class (5)	252	3.9	2.06
Soil depth (5)	252	4.7	1.22

Table 2. continued.

1996 Regional Soil Judging Contest

Variable	Population	Mean	Std. Deviation
Master horizons (10)	88	8.6	1.59
Boundary depth (8)	88	4.3	2.11
Texture (20)	88	12.6	5.49
Hue (10)	88	5.6	3.24
Value (10)	88	6.6	2.40
Chroma (10)	88	6.8	2.41
Structure grade (10)	88	5.5	3.20
Structure shape (10)	88	5.6	2.50
Parent material (5)	88	3.7	2.19
Slope (5)	88	4.1	1.94
Site position (5)	88	4.2	1.84
Wetness class (5)	88	3.4	2.34

1997 National Soil Judging Contest

Soil pits varied as to the number of horizons in each pit and therefore changed the total value of the soil property categories. For example, the master horizon category was worth 2 points for each horizon. Describing 5 horizons, the category was worth 10 points, with 6 horizons, 12 points. Worth 12 points, the percentage of students scoring at least 80% resulted in fractions of points (9.6 points) which was not attainable in the contest. For this reason, the number of students scoring at least 10 out of 12 points (approx. 83%) was used. Likewise, in categories worth 8 points, the percentage of students scoring at least 75% correct (6 out of 8 points) was used. This method was applied to all categories in all 3 contests to obtain a category point value without fractions.

The master horizon category was worth 10 points for pit 1 and 12 points each for pits 2, 3, and 4. For pit 1, 73% of the ≤1 year, 92% of the 2 year, and 96% of the ≥3 years of experience groups scored ≥80% correct. Highest frequencies in pit 1 were at the 8 point mark. Sample means were high for all groups compared to other categories. The population mean was 8 with a standard deviation of 1.3 (Tables 1 and 2). Separation of means (Duncan) indicated no difference between the ≤1, 2, and ≥3 years of experience groups at the 0.05 significance level.

For pits 2, 3, and 4, 44% of the ≤1 year, 84% of the 2 year, and 80% of the ≥3 years of experience groups scored ≥83% correct. Highest frequencies in the 12 point pit were at the 12 point mark. Sample means were high for all 3 groups. The population mean was 10 with a standard deviation of 1.8 (Tables 1 and 2). Separation of means (Duncan) indicated a difference between the ≤1 year and the 2 years of experience groups at the 0.05 significance level. There was no difference between the 2 and ≥3 years of experience groups at the 0.05 level of significance (Duncan).

1996 Regional Soil Judging Contest

The master horizon category was worth 10 points. Ninety percent of the ≤1 year of experience group scored ≥80% correct. The highest frequency was 23 at 8 points. Ninety percent of the ≥2 years of experience group scored ≥80% correct. The highest frequency was 21 at 10 points. The ≥2 years of experience group had the highest sample mean. The population mean was 8.64 with a standard deviation of 1.59 (Tables 1 and 2). Separation of means (Duncan) indicated no difference between ≤1 and ≥2 years of experience groups at a 0.05 significance level.

Summary

In contests and practice pits, a nail was placed in the 3rd horizon and soil judgers were told how many horizons and to what depth in the pit they should describe. Since this information is given, it is unclear whether the soil judger would identify the horizons correctly lacking this information. The given information limits the use of the contest results compared to actual soil field interpretation procedures. In both national contests, it appears that the percentage of students scoring at least 80% correct was higher in the 2 most experienced groups, although separation of means did not identify this occurrence as being significant. Many students scored high in this category. By scoring high, these students indicated they were aware of major differences from one horizon to the next. Not scoring high could be due to difficulty in distinguishing horizons when a gradual or diffuse boundary is present. Low scores could also be due to confusing master horizons with transition horizons, where the latter displays properties from both the master horizon above and below. Since the majority of soil judgers recognize differences from one horizon to the next, number of master horizons is a property suitable for purposes of classification. The number of master horizons of the typical pedon of each series is an important criteria in the 9 soil properties classification.

Boundary Depth

1996 National Soil Judging Contest

The boundary depth category was worth 10 points for each pit. Since the lowest boundary was given to the soil judgers, the lowest boundary depth was not counted as points for this study, making this category worth 8 points. Approximately 8.6% of the ≤1 year of experience students scored ≥75% correct with a high frequency of 40 at 2 points. Approximately 9.7% of the 2 years of experience students scored ≥75% correct with a high frequency of 29 at 2 points. Ten percent of the ≥3 years of experience students scored ≥75% correct with a high frequency of 30 at 2 points. The sample means for students with ≥3 years of experience is higher than soil judgers with 2, then ≤1 year of experience. The population mean for the category was 2.6 with a standard deviation of 1.87 (Tables 1 and 2). Separation of means (Duncan) indicated no difference between the ≤1, 2, and ≥3 years of experience groups at the 0.05 level of significance.

1997 National Soil Judging Contest

Eliminating the lowest boundary (since it is given to the soil judgers), the boundary depth category was worth 8 points for pit 1 and 10 points each for pits 2, 3, and 4. For pit 1, 27% of the ≤1year, 16% of the 2 year, and 52% of the ≥3 years of experience groups scored ≥75% correct. Highest frequencies, located at the 4 point mark, were 8 for the ≤1, 16 for the 2, and at the 6 point mark, 11 for the ≥3 years of experience group. Sample means were 4.1 for the ≤1 year, 3.9 for the 2 year, and 4.8 for the ≥3 years of experience groups. The population mean was 4 with a standard deviation of 1.5 with highest frequencies at 4 and 6 points (Tables 1 and 2). Separation of means (Duncan) indicated no difference between ≤1, 2, and ≥3 years of experience groups at the 0.05 significance level.

For pits 2, 3, and 4, 9% of the ≤1 year, 12% of the 2 year, and 10% of the most experienced students scored ≥80% correct. Sample means were 3.8 for the ≤1 year, 4.6 for the 2 year, and 4.8 for the ≥3 years of experience groups. Highest frequencies of 17 for the ≤1 year, 37 for the 2 year, and 26 for the ≥3 years of experience groups were at the 4 point mark. The population mean was 4.5 with a standard deviation of 2 (Tables 1 and 2). Separation of means (Duncan) indicated differences between the ≤1 year and the 2 years of experience groups and between the ≤1 year and the ≥3 years of experience groups at the 0.05 significance level.

1996 Regional Soil Judging Contest

The boundary depth category was worth 8 points. Thirty-three percent of the ≤1 year of experience group scored ≥75% correct with a high frequency of 21 at 4 points. Thirtyfive percent of the ≥2 years of experience group scored ≥75% correct with a high frequency of 13 at 4 points. The group with the least amount of experience had the highest sample mean. The population mean was 4.30 with a standard deviation of 2.11 (Tables 1 and 2). Separation of means (Duncan) indicated no difference between ≤1 and ≥2 years of experience groups at the 0.05 level of significance.

Summary

Soil judgers were expected to do well in distinguishing boundaries, since this category influences answers for other soil properties such as texture, color, and structure. A nail is placed in the third horizon in practice as well as contest pits. The nail serves as an aid in distinguishing horizons. When grading scorecards, soil judgers are given the benefit of a plus or minus centimeter range (usually 2-5 cm). Their answer must fall within the allowed range to receive credit. Although some statistical data indicated a difference in means between experience groups, the means and the percent of people scoring at least 75% correct was low. Increase in years of experience did not have a significant effect on scores. Incorrect boundaries imply that soil judgers are more likely to score incorrectly in other important categories such as soil texture and structure.

The pits used for the contests were described by several professional soil scientists who reached a general concensus before filling out the answer key. Each soil scientist contributed and discussed his/her observations until an agreement was reached. The horizon boundaries are therefore relative to the professionals selected. The professional soil scientists are not the same for each contest. The analysis of answers selected by professionals is unknown. This unknown variance of professional answers should be quantified to determine expectations for boundary answers for soil judging.

Soil judgers will soon be employed and be asked to describe soils. There will not be a nail placed in the 3rd horizon for them nor will they be given the number of horizons to look for when they are asked to describe a soil. Ceasing the practice of placing the nail in the 3rd horizon and indicating how many horizons to look for may improve the student's observational skills. In soil judging contests, it is up to the soil judger to decide how to separate the horizons based on a combination of texture, color, and structure. A uniform procedure is needed for identification of boundary distinctions. A uniform approach would separate the horizons by one property only or by a consecutive order of properties, or separate and record the boundaries of each property, then take the mean. Since students are unable to recognize boundaries of horizons as demonstrated by soil judgers scoring poorly in this category, boundary depth was not chosen as a feasible soil property for the purpose of classification.

Boundary Distinguished By

<u>1996 National Soil Judging Contest</u>

This category occurred only on the 1996 national contest scorecard. There were 2 "boundary distinguished by" categories. One category was worth 6 points and represented pit B. Approximately 7.7% of the ≤1 year of experience students scored ≥80% correct with a high frequency of 9 at 1 point. Five and a half percent of the 2 years of experience students scored 83% correct with a high frequency of 8 at 2 points. No student in the ≥3 years of experience group scored ≥83% correct in this category. The highest frequency was 6 at 2 points. The 2 years of experience group had the highest sample mean. The population mean was 2.19 with a standard deviation of 1.22 (Tables 1 and 2). Separation of means (Duncan) confirmed a difference between the 2 and ≥3 years of experience groups at the 0.05 significance level.

The second "boundary distinguished by" category, representing pits A, C, and D, was worth 8 points. Thirteen percent of the ≤1 year of experience students scored ≥75% correct with a high frequency of 14 at each 3 and 4 points. Twenty percent of the 2 years of experience students scored ≥75% correct with a high frequency of 11 at each 3 and 4 points. Thirty-one percent of the ≥3 years of experience students scored ≥75% correct with a high frequency of 11 at 6 points. The group with 2 years of soil judging experience had the highest sample mean. The population mean was 3.55 with a standard deviation of 1.9 (Tables 1 and 2). Separation of means (Duncan) indicated no difference between ≤1, 2 and ≥3 years of experience groups at the 0.05 significance level.

<u>Summary</u>

The "boundary distinguished by" category represented the properties used by the soil judger to separate his/her boundaries. The soil judger could enter T, C, or S (texture, color, or structure) or any combination of these properties he/she felt separated one horizon from the next. Answers in this category were affected by where the student chose his/her boundary depths and should coincide with answers given in texture, color and structure categories. Overall, increase in years experience did not significantly affect scores. Students scored low in the "boundary distinguished by" category because it was a new category and not taken seriously. Including this category in the contest was an attempt to identify what properties soil judgers were using to distinguish horizons. Unfortunately, "boundary distinguished by" was not included on scorecards of the regional 1996 or the national 1997 contests. Including this category in future contests would allow direct detailed information of how soil judgers separate boundaries.

Texture

<u>1996 National Soil Judging Contest</u>

The texture column was worth 20 points. Twenty percent of the ≤1 year of experience group scored ≥80% correct with a high frequency of 30 at 8 points. Eighteen percent of the 2 years of experience group scored ≥80% correct with a high frequency of 26 at 8 points. Thirty-two percent of the ≥3 years of experience group scored ≥80% correct with a high frequency of 19 at 8 points. The ≥3 years of experience group had the highest sample mean, then the 2 year, then ≤1 year of experience groups. The population mean was 8.8 with a standard deviation of 5.66 (Tables 1 and 2). Separation of means (Duncan) confirmed a difference between the ≥3 and 2 years of experience groups and the ≥3 and ≤1 years of experience groups at a 0.05 significance level.

<u>1997 National Soil Judging Contest</u>

The texture category in pit 1, worth 10 points, resulted in 7% of the ≤1 year, 12% of the 2 years, and 13% of the ≥3 years of experience students scoring ≥80% correct. Sample means were 3.7 for the ≤1 year, 3.9 for the 2 years, and 4.4 for the ≥3 years of experience groups. The population mean was 4.1 with a standard deviation of 2.7 and highest frequencies at 4 and 6 points (Tables 1 and 2). Separation of means (Duncan) indicated no difference between the ≤1, 2, and ≥3 years of experience groups at the 0.05 significance level.

For pits 2, 3, and 4 worth 12 points each, 13% of the ≤1 year, 25% of the 2 years and 26% of the ≥3 years of experience groups scored ≥83% correct. Sample means were 7.0 for the ≤1 year, 7.5 for the 2 years, and 7.3 for the ≥3 years of experience groups. The population mean was 7.3 with a standard deviation of 2.4 and highest frequencies at 6 and 8 points (Tables 1 and 2). Separation of means (Duncan) indicated no difference between the ≤1, 2, and ≥3 years of experience groups at the 0.05 significance level.

1996 Regional Soil Judging Contest

The texture category was worth 20 points. Forty-six percent of the ≤1 year of experience group scored ≥80% correct. The highest frequency was 15 at 16 points. Forty-three percent of the ≥2 years of experience group scored ≥80% correct with a high frequency of 12 at 12 points. The group with the most experience had the highest sample mean. The population mean was 12.6 with a standard deviation of 5.49 (Tables 1 and 2). Separation of means (Duncan) indicated no difference between the ≤1 and ≥2 years of experience groups at a 0.05 level of significance.

Summary

Students spend many hours practicing texturing soil both in the laboratory as well as in the field and therefore are expected to do well in this category. Means for scores of soil texture were expected to be closer to 8 out of 10 and 10 out of 12 points, respectively. Percentages of soil judgers scoring at least 80% correct should be closer to the 80% mark regardless of experience level. Increase in years of experience did not increase scores.

An exception was the 1996 national contest where a higher percentage of the most experienced group scored at least 80% correct. However, the means for soil texture are low. Soil texture is a very basic property for students to identify. Great emphasis and importance are placed on soil texture with respect to use and management of soils. It is crucial that the student master the ability to texture soil. Students choose from 12 basic textural classes in addition to numerous sand-size and coarse fragment modifiers. Future research should focus on determining if the 12 divisions currently used for the textural triangle are necessary for use and management interpretations. Using fewer broad soil textural categories may improve the soil judger's ability to determine soil texture accurately without compromising land use interpretations. Low scores indicate soil texture is not a suitable property for classification purposes. However, the emphasis placed on particle size for use and management purposes supersedes the low scores, keeping it as a soil property important for classification purposes.

Soil Color

<u>1996 National Soil Judging Contest</u>

The hue category was worth 10 points. Forty-three percent of the ≤1 year of experience group scored ≥80% correct with a high frequency of 31 at 8 points. Forty-seven percent of the 2 years of experience group scored ≥80% correct with a high frequency of 22 at 8 points. Sixty-five percent of the ≥3 years of experience group scored ≥80% correct with a high frequency of 23 at 8 points. The ≥3 years of experience group had the highest sample mean, then the 2 years, then the ≤1 year of experience groups. The population mean was 6.31 with a standard deviation of 2.9 (Tables 1 and 2).

Separation of means (Duncan) confirmed a difference between the ≥3 and 2 year groups and between the ≥3 years and ≤1 year of experience groups at a 0.05 level of significance.

The value column was worth 10 points. Fifty percent of the ≤1 year of experience group scored ≥80% correct with a high frequency of 35 at 6 points. Seventy-one percent of the 2 years of experience group scored ≥80% correct with a high frequency of 33 at 8 points. Fifty-two percent of the ≥3 years of experience group scored ≥80% correct with a high frequency of 19 at 8 points. The 2 years of experience group had the highest sample mean. The population mean was 7.14 with a standard deviation of 2.18 (Tables 1 and 2). Separation of means (Duncan) indicated a difference between the 2 and the ≤1 and between the 2 and the ≥3 years of experience groups at a 0.05 level of significance.

The chroma category was worth 10 points. Twenty percent of the ≤1 year of experience group scored ≥80% correct with a high frequency of 29 at 4 points. Twenty-two percent of the 2 years of experience group scored ≥80% correct with a high frequency of 21 at 6 points. Seventeen percent of the ≥3 years of experience group scored ≥80% correct with a high frequency of 17 at 6 points. The 2 years of experience group had the highest sample mean, then ≥3 years, then the ≤1 year of experience groups. The population mean was 4.4 with a standard deviation of 2.78 (Tables 1 and 2). Separation of means (Duncan) indicated no difference between the ≤1, 2, and ≥3 years of experience groups at the 0.05 significance level.

<u>1997 National Soil Judging Contest</u>

The hue category was worth 10 points for pit 1 and 12 points for each of pits 2, 3, and 4. For the 10 point pit, 33% of the ≤1 year, 68% of the 2 years, and 61% of the ≥3 years of experience groups scored ≥80% correct. Sample means for each group were 6.4 for the ≤1 year, 7.8 for the 2 years, and 7.2 for the ≥3 years of experience groups. The population mean was 7.3 with a standard deviation of 2.6 with highest frequencies at 4 and 10 points (Tables 1 and 2). Separation of means (Duncan) indicated no difference between the ≤1, 2, and ≥3 years of experience groups at a 0.05 significance level.

For the 12 point pits, 69% of the ≤1 year, 73% of the 2 years, and 78% of the ≥3 years of experience groups scored ≥83% correct. Sample means for hue were slightly over 10 for each of the three groups. The population mean was 10 with a standard deviation of 2 and highest frequencies at 8 and 12 points (Tables 1 and 2). Separation of means (Duncan) indicated no difference between the ≤1, 2, and ≥3 years of experience groups at the 0.05 significance level.

The value category was worth 10 points for pit 1 and 12 points for each of pits 2, 3, and 4. For the 10 point pit, percentages of each group scoring at least 80% correct were slightly higher for the most experienced group than the 2 less experienced groups. Sample means were 5.5 for the ≤1 year, 6.4 for the 2 years, and 7.0 for the ≥3 years of experience groups (Tables 1 and 2). Pit 1 had a population mean of 6.4 with a standard deviation of 2.4 and highest frequencies at 4 and 6 points. Separation of means (Duncan) indicated a difference between the ≤1 year and the ≥3 years of experience groups at the 0.05 significance level.

Pits 2, 3, and 4 had a population mean of 8.8 for value with a standard deviation of 2.6 with the highest frequencies at 8, 10, and 12 points. Sample means were 8.5 for the ≤1 year, 8.6 for the 2 years, and 9.1 for the ≥3 years of experience groups (Tables 1 and 2).

The percentage of each group scoring ≥83% correct all were within 44-55%. Separation of means (Duncan) indicated no difference between the ≤1, 2 and ≥3 years of experience groups at the 0.05 significance level.

The chroma category was worth 10 points for pit 1 and 12 points for each of pits 2, 3, and 4. For pit 1, 13% of the ≤1 year, 32% of the 2 years, and 9% of the ≥3 years of experience students scored ≥80% correct. Sample means for all three groups were slightly higher than 5. The population mean was 5.2 with a standard deviation of 2 and the highest frequencies at 10, 8, and 4 points (Tables 1 and 2). Separation of means (Duncan) indicated no difference between ≤1, 2, and ≥3 years of experience groups at a 0.05 significance level.

For pits 2, 3, and 4, percentages of groups scoring at least 83% correct for chroma were all low and ranged between 24 and 35%, with the 2 years of experience group having the highest percentage. Sample means for each group were between 7 and 8. The population mean was 7.5 with a standard deviation of 2.7 and highest frequencies at 6 and 8 points (Tables 1 and 2). Separation of means (Duncan) indicated no difference between ≤1, 2, and ≥3 years of experience groups at a 0.05 significance level.

<u>1996 Regional Soil Judging Contest</u>

The hue category was worth 10 points with 44% of the ≤1 year of experience group scoring ≥80% correct with a high frequency of 9 at each 6 and 8 points. Thirty-three percent of the ≥2 years of experience group scored ≥80% correct with a high frequency of 8 at 4 points. The group with the least amount of experience had the highest sample mean. The population mean was 5.57 with a standard deviation of 3.24 (Tables 1 and 2).

Separation of means (Duncan) indicated no difference between ≤1 and ≥2 years of experience groups at a 0.05 level of significance.

The value category was worth 10 points. Forty-six percent of the ≤1 year of experience group scored ≥80% correct with a high frequency of 16 at 8 points. Thirty-eight percent of the ≥2 years of experience group scored ≥80% correct with a high frequency of 10 at 6 points. The group with the least amount of experience had the highest sample mean. The population mean was 6.63 with a standard deviation of 2.40 (Tables 1 and 2). Separation of means (Duncan) indicated no difference between the ≤1 and ≥2 years of experience groups at a 0.05 level of significance.

The chroma category was worth 10 points. Thirty-eight percent of the ≤1 year of experience group scored ≥80% correct. The highest frequency was 19 at 6 points. Forty-three percent of the ≥2 years of experience group scored ≥80% correct with a high frequency of 9 at 10 points. The group with the least experience had the highest sample mean. The population mean was 6.78 with a standard deviation of 2.41 (Tables 1 and 2). Separation of means (Duncan) indicated no difference between ≤1 and ≥2 years of experience groups at a 0.05 level of significance.

Summary

Color chips on the hue pages of Munsell Color Charts tend to overlap resulting in 2 almost identical color chips on different hue pages or adjacent chips on the same hue page. Incorrect answers in the hue category could be attributed to this close comparison. Because of the similarities between adjacent hues, a range in hue should be accepted. Although the national 1996 contest indicated a marked difference between groups, the

1997 national and 1996 regional contests did not. Hue was not chosen as a feasible property for the nine soil property classification.

The 1996 contest revealed an increase in scores for value with an increase in experience although it was the 2 years of experience group, not the ≥3 years of experience group which had the highest percentage of students scoring at least 80% correct. Separation of means indicated no difference between groups for the national 1997 or the regional 1996 contests.

In the chroma category, there was no significant difference between groups in either the 1996 national or the 1996 regional contests. The 2 years of experience group in the 1997 national contest appeared to have a larger percentage of students scoring higher than the other 2 groups, but separation of means (Duncan) did not confirm this observation.

Increase in experience did not have a consistent significant effect on scores of hue, value or chroma. Moisture content in the sample and the amount of light incident on the sample both influence the apparent hue, value and chroma of the color chips. Moist soil samples appear darker than drier samples. Soil samples appear lighter in color in the sunlight and darker in color under shady or overcast conditions.

One solution to consistent measurement conditions would be to accept a range in color or record hue, value, and chroma at predetermined specified depths versus an unidentified area within the apparent horizon. Color measurements taken by several individuals at specific depths in a profile are more likely to be closer in color resulting in more people obtaining the same answers. Since color at a specified depth is more likely to result in consistent values and chromas and students are able to distinguish master horizons, the value and chroma of the A horizon was a suitable choice for the nine soil properties classification. Due to emphasis being placed on mollic colors (≤3 value and chroma, moist), whether or not a given soil meets the mollic color requirements was a criteria for the 9 soil properties classification.

Soil Structure

1996 National Soil Judging Contest

The structure-grade category was worth 10 points. Twenty-three percent of the ≤1 year of experience group scored ≥80% correct with the highest frequency of 36 at 6 points. Thirty-three percent of the 2 years of experience group scored ≥80% correct with the highest frequency of 23 at 6 points. Forty-two percent of the ≥3 years of experience group scored ≥80% correct with the highest frequency of 21 at 8 points. The ≥3 years of experience group had the highest sample mean, then the 2 years of experience group, then the ≤1 year of experience group. The population mean was 5.6 with a standard deviation of 2.42 (Tables 1 and 2). Separation of means (Duncan) confirmed a difference between the ≥3 years and the ≤1 year of experience groups at a 0.05 level of significance.

The structure-shape category was worth 10 points. Twenty-five percent of the ≤1 year of experience group scored ≥80% correct with the highest frequency of 36 at 6 points. Twenty-six percent of the 2 years of experience group scored ≥80% correct with the highest frequency of 34 at 6 points. Twenty-five percent of the ≥3 years of experience group scored ≥80% correct with the highest frequency of 24 at 6 points. The 2 years of experience group had the highest sample mean, then the ≥3 years, then ≤1 year of experience groups. The population mean was 5.7 with a standard deviation of 2.08

(Tables 1 and 2). Separation of means (Duncan) indicated no difference between ≤1, 2, and ≥3 years of experience groups at a 0.05 level of significance.

<u>1997 National Soil Judging Contest</u>

The structure-grade category was worth 10 points for pit 1 and 12 points for each of pits 2, 3, and 4. For pit 1, 20% of the ≤1 year, 40% of the 2 years, and 43% of the ≥3 years of experience groups scored ≥80% correct. Sample means between the groups ranged from 5.2 to 6.2. For pit 1, the population mean was 6.0 with a standard deviation of 2.2 and highest frequencies at 4, 6, and 8 points (Tables 1 and 2). Separation of means (Duncan) indicated no difference between ≤1, 2, and ≥3 years of experience groups at the 0.05 significance level.

For pits 2, 3, and 4, the population mean was 7.5 with a standard deviation of 2.5 and highest frequencies at 6, 8, and 10 points. Sample means for structure grade between the groups ranged from 6.5 to 7.8 (Tables 1 and 2). Twenty-two percent of the ≤1 year, 31% of the 2 years, and 33% of the ≥3 years of experience groups scored ≥83% correct. Separation of means (Duncan) indicated a difference between the ≤1 year and the 2 years of experience groups and between the ≤1 year and the ≥3 years of experience groups at the 0.05 significance level.

The structure-shape category was worth 10 points for pit 1 and 12 points for each of pits 2, 3, and 4. For pit 1, the percentage of each group scoring ≥80% correct was 67, 76, and 74% respectively. Sample means between groups ranged from 7.4 to 8.0. Pit 1 had a population mean of 7.7 with a standard deviation of 1.8 and highest frequencies at 6, 8, and 10 points (Tables 1 and 2). Separation of means (Duncan) indicated no difference between ≤1, 2, and ≥3 years of experience groups at the 0.05 significance level.

Pits 2, 3, and 4 had a population mean of 8.1 for structure shape with a standard deviation of 3.1 and highest frequencies at 10 points. Sample means between groups ranged from 8.0 to 8.4 (Tables 1 and 2). All groups scored about the same, the percentage of students scoring ≥80% correct at 47, 56, and 48% respectively. Separation of means (Duncan) indicated no difference between ≤1, 2, and ≥3 years of experience groups at the 0.05 significance level.

1996 Regional Soil Judging Contest

The structure-grade category was worth 10 points. Twenty-nine percent of the ≤1 year of experience group scored ≥80% correct with the highest frequency of 12 at 4 points. Forty-eight percent of the ≥2 years of experience group scored ≥80% correct with the highest frequency of 11 at 10 points. The group with the most experience had the highest sample mean. The population mean was 5.5 with a population of 88 and a standard deviation of 3.2 (Tables 1 and 2). Separation of means (Duncan) indicated no difference between ≤1 and ≥2 years of experience groups at a 0.05 significance level.

The structure-shape category was worth 10 points. Thirty-three percent of the ≤1 years of experience group scored ≥80% correct with the highest frequency of 17 at 6 points. Twenty-five percent of the ≥2 years of experience group scored ≥80% correct with the highest frequency of 13 at 6 points. The group with the least experience had the highest sample mean. The population mean was 5.6 with a standard deviation of 2.5

(Tables 1 and 2). Separation of means (Duncan) indicated no difference between ≤1 and ≥2 years of experience groups at a 0.05 significance level.

Summary

Experience helped improve scores in the structure-grade but not in the structure-shape category. The percentages of good scores are low. From direct observations of soil judgers in practice pits, soil judgers seem to have a difficult time determining structure, both grade and shape. Soil judgers tend to select the default structure which is the most commonly found structure in that area, usually subangular blocky. Both grade and shape are difficult to quantify since both are quality not a quantity terms. In practice pits, soil judgers recognize structure shape better than structure grade. The irregular face of the soil profile often makes it difficult to clearly see structure. Lacking well-defined, quantifiable boundaries for structure-grade, it is not a suitable property for the purposes of classification. Although students scored poorly in both grade and shape, the emphasis placed on soil structure as related to use and management superseded the low percentages. Since shape is easily recognized by students during practice, structure-shape was chosen as a soil property suitable for purposes of classification. However, on soil description sheets, structure-shape in the control section and in the centermost horizon of the typical pedon of each series often had values that overlapped substantially. This overlap of structure values created ineffective groupings. Structure shape, as presented in soil description sheets, is not currently feasible for use in the 9 soil properties classification.

Parent Material

1996 National Soil Judging Contest

The parent material category was worth 5 points. On contest scorecards, soil judgers had 3 parent materials to choose from. Seventy-nine percent of the ≤1 year of experience group scored 100% correct with the highest frequency of 82 at 5 points. Seventy-nine percent of the 2 years of experience group scored 100% correct with the highest frequency of 57 at 5 points. Seventy-five percent of the ≥3 years of experience group scored 100% correct with the highest frequency of 45 at 5 points. The ≤1 year of experience group had the highest sample mean, then the 2 years, then the ≥3 years of experience groups. The population mean was 3.9 with a standard deviation of 2.08 (Tables 1 and 2). Separation of means (Duncan) indicated no difference between ≤1, 2, and ≥3 years of experience groups at the 0.05 level of significance.

1997 National Soil Judging Contest

The parent material category was worth 5 points (1 parent material) for pits 1 and 2, 10 points (2 parent materials) for pit 3 and 15 points (three parent materials) for pit 4. Soil judgers had 9 parent materials to choose from. For pits 1 and 2, approximately 50% of the least experienced group and most experienced group chose the correct parent material compared to 70% of the 2 years of experience group. The population mean was 2.9 with a standard deviation of 2.5 (Tables 1 and 2). Separation of means (Duncan) confirmed a difference between the ≤1 year and the 2 years of experience groups at a 0.05 significance level.

For pit 3, 87% of the ≤1 year and the ≥3 years and 100% of the 2 years of experience groups correctly chose 1 out of 2 parent materials. The population mean was 8.1 with a standard deviation of 3.2 (Tables 1 and 2). Separation of means (Duncan) indicated no difference between ≤1, 2, and ≥3 years of experience groups at the 0.05 significance level.

For pit 4, 53% of the ≤1 year, 72% of the 2 years, and 87% of the ≥3 years of experience students correctly chose 2 out of 3 parent materials. The population mean was 8.2 with a standard deviation of 3.9 (Tables 1 and 2). Separation of means (Duncan) indicated no difference between ≤1, 2, and ≥3 years of experience groups at the 0.05 significance level.

1996 Regional Soil Judging Contest

The parent material category was worth 5 points. Soil judgers had 5 parent materials to choose from. Seventy-one percent of the ≤1 year of experience group scored 100% correct. The highest frequency was 34 at 5 points. Seventy-three percent of the ≥2 years of experience group scored 100% correct. The highest frequency was 29 at 5 points. The group with the least experience had the highest sample mean. The population mean was 3.65 with a standard deviation of 2.19 (Tables 1 and 2). Separation of means (Duncan) indicated no difference between ≤1 and ≥2 years of experience groups at a 0.05 significance level.

Summary

Overall, students scored well in this category. All groups performed about the same except in the 1997 national contest where the group scoring the highest changed from pit to pit. The number of parent material choices rather than experience influenced the percentage of students scoring high. The fewer lithologic discontinuities as well as the fewer number of parent materials on the scorecard resulted in higher percentages of soil judgers scoring higher in each group compared to fill in the blank answers. In contests, students are given multiple choice and are not told how many in the list he/she is supposed to name. Since the soil judgers are given a list to choose from, it is unclear whether correct answers reflect knowledge or guessing. Although an incorrect answer indicates the student does not know, a correct answer means he/she either knew the answer or guessed correctly. If the soil judgers were not given a list and instead were asked to write in their answers, a better indication of their grasp of parent materials would be identified. Developing a relationship between experience and parent material, with the current arrangement of a given list of multiple choice, is misleading and not helpful for the objectives of this study. Parent material was chosen as a suitable soil property for the purpose of classification, but because it was not presented on the soil series description sheets (USDA-NRCS) in a way conducive to effective sorting. On the description sheets, vague descriptive terms of material formed in or from were often given instead of parent material. Parent material was not chosen as a property for the 9 soil properties classification.

Slope Gradient

<u>1996 National Soil Judging Contest</u>

The slope gradient category was worth 5 points. Eighty-five percent of the ≤1 year of experience group scored 100% correct with the highest frequency of 88 at 5 points.

Eighty-six percent of the 2 years of experience group scored 100% correct with the highest frequency of 62 at 5 points. Ninety percent of the ≥3 years of experience group scored 100% correct with the highest frequency of 54 at 5 points. The sample mean was highest in the ≥3 years of experience group, then the 2 years, then the ≤1 year of experience groups. The population mean was 4.4 with a standard deviation of 1.71 (Tables 1 and 2). Separation of means (Duncan) indicated no difference in the ≤1, 2, and ≥3 years of experience groups at the 0.05 significance level.

1997 National Soil Judging Contest

The slope gradient category was worth 5 points. Sixty-eight percent of the ≤1 year, 88% of the 2 years, and 79% of the ≥3 years of experience groups scored 100% correct. The population mean was 4 with a standard deviation of 2 and the highest frequencies at the 5 point mark (Tables 1 and 2). Sample means were 3.4, 4.4 and 4.0 for each of the 3 groups, respectively. Separation of means (Duncan) confirmed a difference between the ≤1 year and the 2 years of experience groups at the 0.05 significance level.

1996 Regional Soil Judging Contest

The slope gradient category was worth 5 points. Seventy-nine percent of the ≤1 year of experience group scored 100% correct. The highest frequency was 38 at 5 points. Eighty-five percent of the ≥2 years of experience group scored 100% correct. The highest frequency was 34 at 5 points. The group with the most experience had the highest sample mean. The population mean was 4.1 with a standard deviation of 1.94 (Tables 1 and 2). Separation of means (Duncan) indicated no difference between ≤1 and ≥2 years of experience groups at a 0.05 significance level.

Summary

Students scored high in this category. Increase in experience influenced percentages of students scoring high in the 1997 national contest. Experience did not have an effect in the 1996 national or regional contest. To determine slope gradient for the contest pits, students are equipped with clinometers or Abney levels. Two stakes are set 30 m apart near each pit for the student to measure slope gradient. Choices on scorecards are 8 percent slope gradient ranges. Soil judgers were expected to do well in this category because they were given slope rods and proper equipment. One reason for not scoring well in slope is inaccurately using the clinometer. With one side of the clinometer in degrees and one side in percent, students sometimes recorded the wrong side. Also the stakes used to take slope are often not the same height above the ground. Students must measure the height of the stakes to ensure the clinometer is lined up at the same height for both stakes. A second reason stems from obtaining slope measurements that closely border 2 different ranges and is not within the accuracy of the slope instrument. Assuming the student is properly reading the clinometer, we would expect students to measure slope correctly every time. Scoring could be improved by allowing the soil judgers to write in their numbers for slope then grading a plus and minus fraction of a percent spread. Slope was chosen as 1 of the 9 properties suitable for purposes of classification, but it was not presented in the soil series description sheets (USDA-NRCS) in a way conducive to effective separating of the soils. Slope gradient ranges overlapped creating ineffective groupings. Slope gradient could not be utilized for the 9 soil properties classification.

Site Position

1996 National Soil Judging Contest

The site position category was worth 5 points. On contest scorecards, judgers were given 7 choices for site positions. Thirty-three percent of the ≤1 years of experience group scored 100% correct with the highest frequency of 70 at 0 points. Forty-six percent of the 2 years of experience group scored 100% correct with the highest frequency of 39 at 0 points. Forty percent of the ≥3 years of experience group scored 100% correct with the highest frequency of 36 at 0 points. The highest sample mean was in the group with 2 years of soil judging experience, then the ≥3 years, then ≤1 year of experience groups. The population mean was 1.93 with a standard deviation of 2.44 (Tables 1 and 2). Separation of means (Duncan) indicated no difference between ≤1, 2, and ≥3 years of experience groups at a 0.05 significance level.

1997 National Soil Judging Contest

The site position category was worth 5 points. Between 72 and 79% of each of the 3 groups scored 100% correct. The population mean was 4 with a standard deviation of 2 and the highest frequencies at the 5 point mark (Tables 1 and 2). Separation of means (Duncan) indicated no difference between ≤1, 2, and ≥3 years of experience groups at the 0.05 significance level.

1996 Regional Soil Judging Contest

The site position category was worth 5 points. Eighty-three percent of the ≤1 year of experience group scored 100% correct with the highest frequency of 40 at 5 points. Eighty-five percent of the ≥2 years of experience group scored 100% correct with the highest frequency of 34 at 5 points. The group with the most experience had the highest sample mean. The population mean was 4.2 with a standard deviation of 1.88 (Tables 1 and 2). Separation of means (Duncan) indicated no difference between ≤1 and ≥2 years of experience groups at a 0.05 significance level.

Summary

Experience did not have an effect on scores in this category. Percentages of students scoring well remained about the same for all groups within a given contest. Overall, students did not score well in the 1996 national contest. Group performance improved in the 1997 national contest. Percentages of students scoring high in each group was highest in the regional 1996 contest.

Like parent material, soil judgers are given a list of site position choices and are not told how many in the list he/she is supposed to name. Since the soil judgers are given a list to choose from, it is unclear whether the correct answers reflect knowledge or guessing. Although an incorrect answer indicates the student does not know, a correct answer means he/she either knew the answer or guessed correctly. If the soil judgers were not given a list and instead were asked to write in their answers, a truer indication of their grasp of identifying this soil-related property would be obtained. With the current arrangement of a given list of choices, looking for a relationship between experience and site position is not a good indication of the student's abilities. Site position was chosen as a suitable soil property for the purpose of classification, but it was not presented on the soil series description sheets (USDA-NRCS) in a way conducive to effective sorting. Soils of a given series were often located on too many site positions which resulted in ineffective groupings. For this reason, site position was not used as a property for the nine soil properties classification.

Wetness Class

1996 National Soil Judging Contest

The wetness class category was worth 5 points. On the scorecards, soil judgers were given 5 wetness classes. Seventy-two percent of the ≤1 year of experience group scored 100% correct with the highest frequency of 75 at 5 points. Seventy-eight percent of the 2 years of experience group scored 100% correct with the highest frequency of 56 at 5 points. Forty percent of the ≥3 years of experience group scored 100% correct with the highest frequency of 43 at 5 points. The group with 2 years of soil judging experience had the highest sample mean, then the ≤1 year, then the ≥3 years of experience groups. The population mean was 3.7 with a standard deviation of 2.21 (Tables 1 and 2). Separation of means (Duncan) indicated no difference between ≤1, 2, and ≥3 years of experience groups at a 0.05 significance level.

1997 National Soil Judging Contest

The wetness class category was worth 5 points. All 3 groups scored well with 77% of the ≤1 year, 79% of the 2 years, and 79% of the ≥3 years of experience students scoring 100% correct. The population mean was 4 with a standard deviation of 2 and highest frequencies at the 5 point mark (Tables 1 and 2). Separation of means (Duncan) indicated no difference between ≤1, 2, and ≥3 years of experience groups at a 0.05 significance level.

1996 Regional Soil Judging Contest

The wetness class category was worth 5 points. Sixty-nine percent of the ≤1 year of experience group scored 100% correct with the highest frequency of 33 at 5 points. Sixty-eight percent of the ≥2 years of experience group scored 100% correct with the highest frequency of 27 at 5 points. The group with the least experience had the highest sample mean. The population mean was 3.4 with a standard deviation of 2.34 (Tables 1 and 2). Separation of means (Duncan) indicated no difference between ≤1 and ≥2 years of experience groups at a 0.05 significance level.

Summary

Experience negatively affected scores in the 1996 national contest, where the most experienced group scored much lower than the 2 less experienced groups. However, separation of means, did not support this observation. All 3 groups had close scores for the 1997 national and 1996 regional soil judging contests.

Wetness classes were poorly represented in the 12 contest pits. Out of the 12 contest pits (all three contests combined), 10 were well-drained soils, 1 was moderately well drained, and 1, a poorly drained soil. More variety should be presented in future contests.

Soil judgers score either 0 or 5 points for wetness class. In order to receive credit the soil judger chooses one of the five wetness classes based on "depth to a wet state". Class 1 is not wet above 150 cm; class 2 is wet in some part between 100 and 150 cm; class 3 is wet in some part between 50 and 100 cm; class 4 is wet in some part between 25 and 50 cm; and class 5 is wet above 25 cm. Soil judgers choose one of the classes based on redoximorphic features and gleying. Moisture content in the soil and the amount of light incident on the sample both influence the apparent value and chroma of color chips which could be responsible for incorrect answers. There is confusion between identifying mottling versus redoximorphic features. Definitions for these terms have changed in recent years and some people continue to use the terms based on old definitions. Assuming the soil judger can identify redoximorphic features and has adequate time to view the profile, soil judgers are expected to score correctly in this category every time. Students scored well in this category and this supports the use of drainage class as a property suitable for the 9 soil properties classification.

Family Particle Size Class

<u>1997 National Soil Judging Contest</u>

This category was analyzed only on the 1997 national contest scorecard. The family particle size category was worth 5 points. All groups scored lower than expected in this category. Soil judgers could score either 0 or 5 points. Of the 3 groups, 35% of the ≤1 year, 62% of the 2 years, and 48% of the ≥3 years of experience students scored 100% correct. Both the population mean and standard deviation were 2.5 (Tables 1 and 2). Separation of means (Duncan) confirmed a difference between the ≤1 year and the 2 years of experience groups at a 0.05 significance level.

<u>Summary</u>

Family particle size classes were not adaquately represented in the 12 contest pits. Of the 12 soil pits used in the contest, 5 had a fine family particle size class, 5 had a fine-loamy family particle size class, and 1 had a fine-silty family particle size class, and 1 had a fine-silty over sandy or sandy skeletal family particle size class.

The percentage of students correctly naming the family particle size was highest in the group with 2 years of soil judging experience. Choosing the correct family particle size class depended on the student's choices for textures in the profile and his/her ability to remember the particle size class breaks on the triangle associated with this category. The family particle size class triangle has different textural breaks and names and 7 main divisions plus coarse fragments compared to the series textural triangle with 12 main divisions plus coarse fragments and sand divisions. The percent sand, silt and clay boundaries of the family particle size triangle overlap the boundaries of the texture triangle, creating many groups for the soil judgers to remember.

The clayey (very fine) division of the family particle size triangle encompasses only the clay texture of the series texture triangle. The clayey (fine) division of the family particle size triangle encompasses some sandy clay, clay, clay loam, silty clay and silty clay loam textures of the series texture triangle. The fine-loamy division of the family particle size triangle encompasses some sandy clay loam, sandy loam, loam, clay loam and silty clay loam textures of the series textural triangle. The fine-silty division of the family particle size triangle encompasses some silty clay loam and silt loam textures of the series textural triangle. The sandy division of the family particle size triangle encompasses all the sand and some of the loamy sand divisions of the series textural triangle. The coarse-loamy division of the family particle size triangle encompasses some of the sandy loam, loam, silt loam and silt textures of the series textural triangle. The coarse-silty division of the family particle size triangle encompasses some silt and silt loam textures.

High scores in the series texture category increases the likelihood of scoring correctly in the family particle size category. The soil judger's ability to translate textures from one triangle to the other was crucial in scoring for this category. Also, as stated earlier, scoring correctly in the texture category depends on locating the correct boundary depths and selecting the proper sample.

Family particle size class represents the control section which can include a range in textures. For soils that have an argillic horizon, the control section is the upper 50 cm of the argillic. For those soils without an argillic, the control section is 25 to 100 cm. Soil judgers record their answer for this category and do not select from a list, so they must be familiar with the terminology of both triangles. On scorecards, some soil judgers often errored by using terms from the series textural triangle as answers for the family particle size class. This error indicates that students are confused with the use of 2 triangles. Family particle size was chosen as a property suitable for the purpose of the 9 soil properties classification. The importance of soil texture to land use management superseded the relatively low scores.

Soil Depth

1997 National Soil Judging Contest

The soil depth category, worth 5 points, only existed on the 1997 national contest scorecard. All groups scored well in this category, the percent of students scoring 100% correct ranging from 92 - 95% between the three groups. The population mean was 4.7 with a standard deviation of 4.2 and highest frequencies at the 5 point mark (Tables 1 and

2). Separation of means (Duncan) indicated no difference between ≤1, 2, and ≥3 years of experience groups at a 0.05 significance level.

Summary

Soil depth classes were not adaquately represented in the 3 contests. Of the 12 soil pits used in the contests (three contests combined), 5 were very deep soils, 5 were deep soils, and 2 were moderately deep soils.

Soil depth is one category where everyone does well since this is an easily observable and measureable property. Because soil depth is an easily observable and measureable property important for land use, soil depth should be included in all soil judging contests. The soil judgers were given 5 choices including very deep, deep, moderately deep, shallow, and very shallow. These divisions correspond to the soil depth measurements of >150 cm, 100-150 cm, 50-100 cm, 25-50 cm, and <25 cm, respectively. Given a tape measure, soil judgers should score correctly in this category every time, even when the choices are not given to them. Soil depth is an important property and can be easily identified. Soil depth was chosen as a property suitable for the purpose of the 9 soil properties classification.

Contest Summary

The ability of the soil judgers to accurately describe soil properties in the 12 contest soil profiles aided in determining which soil properties should be used for soil classification. Based on the results of the 3 soil judging contests, people with various levels of soil experience should be able to agree on and accurately identify the soil properties of soil depth, number of master horizons, wetness class, and slope gradient, parent material, and site position. Soil properties which are important for separating soils for use and management but need a systematic approach devised for people to accurately and consistently describe them include texture, hue, value, chroma, and structure-grade and shape. Based on these results, the 9 soil properties chosen as those properties most suitable for classification include soil depth, drainage class, number of master horizons, slope, value and chroma of the A horizon, parent material, site position, structure shape, and family particle size class.

NINE SOIL PROPERTIES

Problems Encountered With Soil Series Description Sheets

Values for the chosen properties were obtained from existing published soil series description data. Soil series description sheets contain information which is not in a database "friendly" format. Soil series description sheets are intended to be used by the general public via county soil surveys. The information contained within these sheets must be clear and concise to ensure that information is interpreted correctly. In reviewing the soil properties found in the 577 soil series descriptions used for this study, many descrepancies were noted and are discussed in the following pages.

Soil series description sheets (Figure 7) for the 577 soil series of Oklahoma are continuously being updated. Until 3 years ago, the responsibility for updating these sheets was with the state correlator (a federal employee of the National Resources Conservation Service, USDA). Currently, the responsibility of updating the series lies with the office (NRCS, USDA) in charge of the MLRA (Major Land Resource Area) code for that soil. However, some of these sheets have not been updated since 1967 due to lack of manpower and funding. Terminology, horizon designations, the listing of

Figure 7. Soil description sheet for Heman series.

LOCATION HEMAN OK

Established Series
JGF,RFG
7/95

HEMAN SERIES

The Heman series consists of very deep, moderately well drained, very slowly permeable soils on flood plains. These nearly level soils formed in recent calcareous and saline clayey alluvial sediments over sandy alluvial sediments. These soils are on flood plains of major drainageways and some of their tributaries throughout the Central Rolling Red Plains (MLRA-78C). Water runs off the surface slowly. Depth to a water table ranges from 30 to 50 inches from November through May. Slope ranges from 0 to 1 percent. At the type location the mean annual rainfall is 24 inches and the mean annual air temperature is 59 degrees F.

TAXONOMIC CLASS: Clayey over sandy or sandy-skeletal, mixed, thermic Vertic Ustochrepts

TYPICAL PEDON: Heman clay, occasionally flooded, rangeland: (Colors are for dry soil unless otherwise stated.)

A--0 to 3 inches; reddish brown (5YR 4/3) clay, dark reddish brown (5YR 3/3) moist; strong fine angular blocky structure; extremely hard, extremely firm; common fine and very fine roots; few fine concretions of iron and manganese; slightly effervescent; moderately alkaline; abrupt smooth boundary. (3 to 12 inches thick)

Bkss--3 to 24 inches; reddish brown (5YR 5/4) clay, reddish brown (5YR 4/4) moist; moderate fine angular blocky structure; extremely hard, extremely firm; few very fine roots; common fine concretions of calcium carbonate; few fine pockets of salt crystals; few fine concretions of iron and manganese; many pressure faces and few slickensides; strongly effervescent; moderately alkaline; clear smooth boundary. (14 to 28 inches thick)

2C1--24 to 36 inches; light red (2.5YR 6/6) sand, red (2.5YR 5/6) moist; single grain; loose; slightly effervescent; moderately alkaline; clear smooth boundary. (12 to 59 inches thick)

2C2--36 to 80 inches; light reddish brown (5YR 6/4) coarse sand, reddish brown (5YR 5/4) moist; single grain; loose; slightly effervescent; moderately alkaline.

TYPE LOCATION: Woods County, Oklahoma; 2 miles south and 3 miles west of Waynoka; 100 feet north and 100 feet east of the southwest corner of Sec. 17, T. 24 N., R. 16 W.

RANGE IN CHARACTERISTICS: Typically this soil is moderately alkaline and calcareous throughout. Depth to water table ranges from 30 to 50 inches. Depth to lithologic discontinuity ranges from 20 to 40 inches.

The A horizon has hue of 5YR or 2.5YR, value of 4 (3 moist), and chroma of 2 through 4. Calcium carbonate in the form of threads and concretions may be present. Electrical conductivity of extract is less than 2 dS/m (mmhos/cm).

The Bkss horizon has hue of 5YR or 2.5YR, value of 4 or 5 (3 or 4 moist), and chroma of 4 through 6. Calcium carbonate in the form of films, threads, and concretions range from few to common. Pressure faces range from few to many. Salt accumulations range from few to common masses of crystals and electrical conductivity ranges from 2 to 8 dS/m (mmhos/cm).

The C horizon, where present, is similar to the B horizon but contains stratification of coarser materials.

The 2C horizon has hue of 2.5YR through 10YR, value of 5 through 8 (4 through 7 moist), and chroma of 2 through 6. Texture is sand, coarse sand, or loamy sand.

COMPETING SERIES: There are no competing series in this family. Soils in similar families are the Beckman (OK), Mangum (TX) and Treadway (OK) series. The Beckman, Mangum, and Treadway soils do not have strongly contrasting particle-size classes within the control section.

Figure 7. continued

GEOGRAPHIC SETTING: Herman soils are on nearly level flood plains of major drains and their tributaries of the Central Rolling Red Plains (MLRA 78C). They formed in recent calcareous and saline clayey alluvial fan sediments at the mouth of drains from Permian red bed material which have been deposited over stratified sandy alluvial sediments. Slopes are mainly less than 1 percent. Mean annual precipitation ranges from 20 to 28 inches. Mean annual temperature ranges from 57 to 64 degrees F. Thornthwaite annual P-E index ranges from 32 to 44.

GEOGRAPHICALLY ASSOCIATED SOILS: These are the similar Beckman (OK) series and the Gracemore (OK), Knoco(OK), Lincoln (OK), and Vernon (OK) series. Beckman soils are along drainageways at slightly higher elevations. Knoco and Vernon soils formed in shales and clays of the Permian age on adjacent uplands. Gracemore and Lincoln soils are lower in elevation and formed in recent sandy alluvial sediments along major drains. They have a sandy textural control section and Gracemore soils have a high water table.

DRAINAGE AND PERMEABILITY: Herman soils are moderately well drained. Runoff is slow and permeability is very slow. These soils are occasionally flooded for very brief periods during April through October. Depth to a water table ranges from 30 to 50 inches from November through May.

USE AND VEGETATION: Used mainly as native range for beef cattle. Alkali sacaton and buffalograss are the dominate grasses, and mesquite and broomweed are the primary invaders. Some areas are cultivated to wheat or grain sorghum.

DISTRIBUTION AND EXTENT: Central Rolling Red Plains (MLRA 78C) of Oklahoma, Texas, and possibly Kansas. The series is of minor extent.

SERIES ESTABLISHED: Woods County, Oklahoma; 1995

REMARKS: Soil Interpretation Record: Series OK0352.

These soils were formerly mapped as Yahola clay and Miller.

Diagnostic Horizons and Features:

Ochric epipedon - 0 to 3 inches. Cambic horizon- the zone from 3 inches to a depth of 24 inches (the Bk horizon) Vertic subgroup- Cracks within 125 cm of the mineral soil surface that are 5 mm or more wide through a thickness of 30 cm or more for some time in most years, and slickensides or wedge shaped aggregates in a layer 15 cm or more thick that has its upper boundary within 125 cm of the mineral soil surface, or a linear extensibility of 6.0 cm or more between the mineral soil surface and a depth of 100 cm.

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information such as diagnostic features, as well as the location of specific information on these sheets require revision. Series names classified as inactive, and the changes in the soil classification system both affect information and necessitate updating of these sheets. Changes occur more frequently than the updating of these sheets, resulting in outdated information in print. Many series description sheets updated recently still contain outdated information. Eighteen of the 577 series still have old taxonomic classifications but are reported as up to date.

Older series description sheets, from the 1970's and earlier, lack specific information such as depth of soil, pH, solum thickness, and diagnostic features. One major descrepancy is the use of old horizon designations on updated sheets. Although the letters, numbers and symbols were changed in the early 1980's, many of the sheets, including the updated 1995 sheets still utilize the old horizon designations. The use of A1, A2, and A3 designations persist in the current system, making it difficult to decipher whether an A2 is an A or an E horizon (An E now replaces was an A2 in the old designation). Until all of the old designations have been purged and replaced with the new designations, outdated information will continue to create confusion.

Soil series description sheets contain both a typical pedon description as well as the range of characteristics allowed for that series. On the majority of these sheets, soil structure is only given in the typical pedon description and not in the range of characteristics for the series. Values for pH are also often lacking in the range of characteristics. Lack of soil properties such as pH, texture, and color in the range of characteristics signifies that no attempt has been made to identify soil variability. Soil variability should be given for the typical pedon description by always providing an average and the range of characteristics for all soil properties. Values in the typical pedon and the range of characteristics should also be consistent since the typical pedon is a subset of the range.

There is a persistent use in soil series description sheets of exceptions or additional criteria a soil can have and still be considered the same series. Qualifiers such as "some pedons have" and "some pedons lack" are often included in the range of characteristics. This is a carryover from mapping unit criterion which allows the use of inclusions. An example is the eroded pedon in the Binger series. Soils with an eroded pedon should not be in the Binger series if the horizon is less than 7 inches thick. In profiles of consecutive A, AC and C horizons for example, where the C is comprised of shale and chalky limestone, the range of characteristics does not give solum thickness but does include depth to paralithic contact. The solum is defined as the set of horizons related pedogenetically; the A, E and B horizons. The solum of the above-mentioned profile should be recorded as the A and AC. Series and mapping unit criteria should be kept separate.

Family particle size classes (Soil Survey Staff, 1996) are not given for soils distinguished as being psammentic, arenic, or grossarenic. For ease of data manipulation and sorting, these soils should have a reported family particle size class of sandy. Solum thickness is not given for soils that are sandy (most psamments), or for soils with sandy or sandy-skeletal family particle size classes. For consistency, soil series description sheets for these soils should state a "sandy" family particle size class.

Some soil horizons list on description sheets names for colors rather than hue, value and chroma number-letter designations. For ease of data manipulation, correlators should use the soil color letter and number combinations only or in addition to the descriptive names.

Currently, when a natric horizon is identified, it is understood that an argillic subsurface horizon is present (Soil Survey Staff, 1996). Including an argillic as a diagnostic feature would lessen the confusion especially to those not as familiar with soils terminology trying to extract specific information from description sheets.

Instead of the A horizon thickness, on some series description sheets, thickness of the A and E horizons combined are given. A and E horizon information is often given together in one paragraph making it difficult to distinguish which soil properties apply to which horizons. Combining horizon information also makes it difficult to isolate missing information.

Many isolated descrepancies and typographical errors exist such as in the Wilson series description sheet which has a weak fine granular structure that is massive when dry. Soil structure does not change with moisture content. Lack of information creates inconsistencies such as with the Burleson series description sheets, which reports that "not all pedons have" a 2C when all that appears in the typical pedon and the range of characteristics is a 2CB.

The format of soil series description sheets is outdated. Although the present paragraph format is readable, it is difficult to locate specific information especially when attempting to extract information for database usage. A tabular format which more efficiently meets the needs of the database user is recommended.

Problems Encountered Sorting the Nine Soil Properties

Five depth values of very deep, deep, moderately deep, shallow and very shallow were taken directly from the soil series description sheets. The 577 series, divided by soil depth values are listed in Appendix D.

Six drainage classes of excessively drained, well drained, moderately well drained, somewhat poorly drained, poorly drained, and very poorly drained were taken directly from the soil series description sheets. The 577 series, divided by drainage classes, are listed in Appendix E.

Information presented in the soil series description sheets suggest that each series can have a range of horizons. The number of horizons within the range of the series is not specified. Since the typical pedon is representative of the series, we chose to sort the number of master horizons from the typical pedon. There are a maximum of 7 master horizons. The 577 series, divided by number of master horizons, are listed in Appendix F.

Family particle size classes were obtained from the taxonomic classification string in the soil series description sheets. The 577 series are divided into 18 family particle size classes including a blank category containing arenic soils and psamments. For sorting purposes, the blank category is included in the sandy particle size group. The 577 series, divided by the 17 particle sizes, are listed in Appendix G.

Appendix H lists the soil series (out of 577 possible) whose A horizon has a value and chroma of 3/3 or less. This information was taken from the typical pedon descriptions. The resultant list is broken down further by the series whose 3/3 value and chroma extend below the A horizon.

Values for soil structure, slope gradient, site position and parent material were presented in the soil series description sheets contained wide ranges which discouraged effective sorting. Values within each property overlapped creating too many values for sorting. For example some series can have a slope between 0 – 8%, other series can have a slope of 1 – 25 % and others, a slope of 4 – 35%. This overlap results in series that fall within many slope gradient ranges creating ineffective groupings. Similar problems were encountered with soil structure-shape, where many horizons had ranges which included many shapes. In addition, multiple shapes were found within any given horizon with the inclusion of "parting to" in the description. Many site positions were named for any one soil. For example, some soils were found on terraces, floodplains, and sideslopes. Other soils were found on floodplains and sideslopes. Multiple site positions created too much overlap to effectively sort the series. Parent materials were not often named directly. Materials formed in/from often substituted for parent material. Descriptions of these materials were often too vague to correctly identify the parent material. Vague descriptions and soil properties and site positions which overlapped created conditions which discouraged effective sorting of soil structure, slope gradient, parent material, and site position.

The 577 soil series fit into 142 key soil property value combinations including the number of master horizons in the typical pedon, soil depth, drainage class, value and chroma of the A horizon being ≤3/3 moist, whether or not the ≤3/3 value and chroma extended beyond the A horizon, and family particle size of the control section (Table 3). The 4 soil property combinations are specific to the 577 series and do not represent every

Table 3. Placement of the 577 soil series into 142 soil property combinations.

Combinations*	# of Series	Series
2-VD-E>n-S	6	Dwyer, Gaddy, Jester, Lincoln, Tivoli, Valent
2-VD-W≤y-FL/LSK/CL/F	4	Florita, Frioton, Kanima, Manzano
2-VD-W≤n-CL/FL/F/FSi/LSK	9	Clearfork, Conlen, Eldorado, Etowah, Gowen, Gowton, Healing, Parida, Staser
2-VD-W>n-F/FSi/Cl/FL/S	11	Beckman, Britwater, Clairemont, Kiomatia, Madill, Oklared, Pickwick, Pulaski, Veal, Westola, Yahola
2-VD-MW≤y-VF/F	4	Durant, Kaufman, Ships, Trinity
2-VD-MW≤n-F	1	Agra
2-VD-MW>n-CL/FSi	2	Dela, Rexor
2-VD-SP≤y-FSi	1	Wynona
2-VD-SP≤n-CL	1	Wann
2-VD-P≤n-S/F/FLoS/FLoSSK	3	Ezell, Randall, Sweetwater
2-VD-P>n-FSi/CL/F/S	4	Adaton, Bibb, Gracemore, Lightning
2-D-E≤n-S/LSK	2	Likes, Midco
2-D-E>n-S	5	Crevasse, Eufala, Glentosh, Nutivoli, Sayers
2-D-W≤y-FL/F/CL/FSi	7	Darrouzett, Dioxice, Elandco, Gruver, Indiahoma, Paymaster, Pullman
2-D-W≤n-FL/CL	10	Bippus, Bunyan, Dallam, Justin, Mansker, Pocassel, Portales, Spur, Sunray, Texline
2-D-W>n-F/LSK/S/FL/CL/L/VF/CSi/FSi	20	Aydelotte, Barge, Brownfield, Ceda, Coalgate, Corlena, Elsah, Emachaya, Harvey, Ironbridge, Latimer, Latrass, Robinsonville, Severn, Spurlock, Tulia, Venadito, Vingo, Yomont, Zavala
2-D-MW≤n-FSi	1	Jay
2-D-MW>n-FL/CL	2	Hamden, Iuka
2-D-SP≤n-CL/FSi/FL	3	Boggy, Hopco, Zenda
2-D-SP>n-FSi/CSi/CL	4	Arkabutla, Pushmataha, Retrop, Tullahassee
2-D-P≤n-F	2	Ness, Tuscumbia
2-D-P>n-FSi	1	Rosebloom
2-MD-W>n-F	1	Whitefield
2-S-E≤n-L	1	Hedville
2-S-W≤n-L/C/LSK/CSK	6	Acma, Kiti, Rayford, Slaughter, Tarrant, Woodford
2-S-W>n-L/CL	4	Cartersville, Knoco, Lequire, Pastura
2-VS-E≤n-L	1	Sogn
2-VS-E>n-L	1	Burson
2-VS-W≤n-L	2	Cornick, Shidler
2-VS-W>n-L	3	Blocker, Cottonwood, Potter
3-VD-E≤n-S/CL	3	Aline, Derby, Wisby
3-VD-E>n-S	2	Eda, Goodnight
3-VD-W≤y-FSi/F/FL	13	Albers, Bethany, Dale, Dodson, Ivan, Mclain, Norge, Okay, Ost, Reading, Tobosa, Verdigris, Westsum

Table 3. continued.

Combinations*	# of Series	Series
3-VD-W≤n-CSi/FSi/CL/FL/F/CSK/CoSK/CoSSK	16	Bayard, Bergstrom, Brico, Canadian, Clark, Cuevoland, Huntington, Keokuk, Kerrick, Minco, Port, Redport, Reinach, Slaughterville, Teamey, Woods
3-VD-W>n-FL/F/L/C/FSi/CSi/CL/VD/S	28	Amber, Aspermont, Bastrop, Baxter, Boxville, Colby, Dean, Deepwood, Doakum, Enterprise, Gasil, Harrah, Karma, Larton, Mangum, Mobeetie, Norwood, Otero, Perico, Pratt, Rochelle, Ruella, Tiak, Treadway, Vona, Wheatwood, Wichita, Winters
3-VD-MW>n-F	1	Counts
3-VD-MW≤y-F/VF/CoL	6	Brewless, Burleson, Pawhuska, Pledger, Wabbaseka, Wilson
3-VD-MW≤n-F/FL/CoS/CoSSK	6	Carman, Clarita, Heman, Miller, Redlake, Watonga
3-VD-SP>n-S/FSi/CL	3	Daycreek, Lafe, Tribbey
3-VD-SP≤y-F/CoL	5	Lataner, Lela, Muldrow, Roebuck, Wetbeth
3-VD-SP≤n-S/L/F/FLoS/FLoSK	5	Dillwyn, Elsmere, Lesho, Meno, Moreland
3-VD-P≤y-CoS/CoSSK	1	Lebron
3-VD-P≤n-F	1	Ustibuck
3-VD-P>n-F/CL/L	3	Bocox, Gracemont, Harjo
3-D-W≤y-F/FL/LSK	6	Caradan, Heiden, Humbarger, Majada, Sherm, Zaneis
3-D-W≤n-CL/FL/FSi/CSi/F	19	Attica, Cannon, Capps, Capulin, Choska, Cleora, Crisfield, Cyril, Elkader, Guy, Idabel, Kenesaw, Kingsdown, Lugert, Missler, Noble, Penden, Tamford, Ulysses
3-D-W>y-FL	1	Rickmore
3-D-W>n-L/FL/LSK/F/CL/FSi	13	Case, Coushatta, Ferris, Guadalupe, Hardeman, Hawley, Heatly, Hernandez, Kim, Larue, Smithdale, Weymouth, Yanush.
3-D-MW≤y-F	3	Agan, Lofton, Okemah
3-D-MW≤n-FSi/F	7	Asher, Burwell, Buttermilk, Garvin, Hollywood, Normangee, Roscoe.
3-D-MW>n-S/F/CL/FL	10	Elysian, Galey, Goltry, Kullit, Lipan, Naldo, Shermore, Tonti,Vermejo, Woodtell
3-D-SP>n-CL	1	Las Animas
3-D-SP≤n-F/FSi/C/S/CL	5	Felker, Kinta, Krier, Panola, Waldeck
3-D-P≤y-F	1	Osage
3-D-P≤n-F	1	Quarles
3-D-P>n-CL	1	Clodine
3-MD-W≤y-F/FL	2	Clime, Friona
3-MD-W≤n-FL/F/FSi/LSK	5	Cobb, Nashville, Somervell, Steedman, Vinson
3-MD-W>n-LSK/FL/CL/FSi/F	11	Bigfork, Binger, Chupadera, Dill, Obaro, Owens, Stamford, Sumter, Tussy, Tyende, Vernon
3-MD-MW≤y-F	1	San Saba
3-MD-MW>y-FSi	1	Wakita
3-S-E≤y-LSK	1	Balltown
3-S-E≤n-S/L	2	Darsil, Kipson

Table 3. continued

Combinations*	# of Series	Series
3-S-E>n-L	1	Cordell
3-S-W≤y-LSK/C/CSK	3	Lueders, Purves, Swink
3-S-W≤n-L/LSK	8	Apache, Clebit, Collinsville, Coweta, Darnell, Loco, Plack, Talpa
3-S-W>n-L/C/LSK	9	Cosh, Ironmound, Travertine, Glenrio, Highview, Masham, Quinlan, Travessilla, Wellsford
3-S-P≤n-C	1	Talihini
3-VS-W≤n-L	1	Kimbrough
4-VD-E≤y-CL	1	Albion
4-VD-E≤n-S	1	Glenpool
4-VD-W≤y-F/FSi/FL/CL	15	Abilene, Braman, Doolin, Holdredge, Hollister, Irene, Kirkland, Lawrie, Lawton, Manter, Renfrow, Richfield, Satanta, Tillman, Vanoss,
4-VD-W≤n-FL/CL/LSK/FSi	13	Abbie, Asa, Colmor, Duffau, Farry, Fortyone, Konawa, Mansic, Miles, Mulhall, Oklark, Riverton, Teller
4-VD-W>n-FL/CL/FSi/CSi/CSK/L	11	Brackett, Delwin, Devol, Ennis, Gallion, Grandfield, Noark, Nobscot, Ochlockonee, Pickton, Roxana,
4-VD-MW≤y-F/FL	5	Brewer, Garton, Irwin, Tabler, Waynoka
4-VD-MW≤n-F	2	Choteau, Seminole
4-VD-MW>y-FSi	1	Oscar
4-VD-MW>n-F/FSi/LSK/C/FL	8	Axtell, Captina, Grandmore, Muskogee, Nixa, Sacul, Tamaha, Wing
4-VD-SP≤n-F/CoL/FSi	4	Drummond, Leshara, Taloka, Waurika
4-VD-SP>y-F	1	Healdton
4-VD-P≤y-F	1	Pharoah
4-VD-P≤n-FSi/CL	2	Hibsaw, Weleetka
4-VD-P>y-F	1	Pocola
4-VD-P>n-F/FSi	4	Alusa, Carytown, Cupco, Wrightsville
4-D-E>n-S	1	Flo
4-D-W≤y-FSi/F/FL	12	Benchley, Catoosa, Corbin, Elmont, Lula, Mason, Newtonia, Ravia, Renthin, Secesh, Shellabarger, Westview
4-D-W≤n-FL/C/FSi/F	8	Carey, Carnasaw, Chickasha, Crockett, Dalhart, Kenn, Lea, Romia,
4-D-W>y-FL	1	Razort
4-D-W>n-FL/FSi/F/LSK	17	Bernow, Berthoud, Bronte, Burford, Cahaba, Caston, Greendale, Honeycreek, Kamie, Konsil, Mcknight, Menard, Saffell, Sallisaw, Waben, Weatherford, Whakana
4-D-MW≤y-F	5	Bonham, Culp, Flatonia, Foard, Wolco
4-D-MW≤n-FSi/F/VF	4	Bosville, Homa, Moyers, Radley
4-D-MW>y-F	1	Hinkle
4-D-MW>n-F/FSi/C	6	Huska, Neff, Stapp, Stifler, Vian, Wister
4-D-SP≤y-F/CoL	3	Lomill, Mayes, Woodson
4-D-SP>n-CSi/FSi	2	Frizzell, Lawrence
4-MD-E≤n-LSK	1	Pickens
4-MD-E>n-SSK	1	Wewoka

Table 3. continued

Combinations*	# of Series	Series
4-MD-W≤y-F/FL	5	Camero, Coyle, Maloy, Piedmont, Scullin
4-MD-W≤n-FSi/CSi/LSK/FL/F/CSi	11	Dilworth, Gotebo, Grainola, Kingfisher, Nash, Nowata, Oktaha, Sherless, Spiro, Stoneburg, Teagard
4-MD-W>n-CLSK/LSK/FL/CSi	5	Honobia, Nashoba, Pirum, Stephenville, Woodward
4-MD-MW≤y-F	1	Eram
4-MD-MW≤n-C	1	Vinita
4-MD-SP≤n-F	1	Niotaze
4-S-W≤y-L/C/LSK	4	Claremore, Lenapah, Timhill, Lucien
4-S-W≤n-L	1	Hector
4-S-MW>n-C	1	Tuskahoma
5-VD-W≤y-FL/FSi	8	Lovedale, Madge, Navina, Pond Creek, Selman, St. Paul, Teval, Tipton
5-VD-W≤n-FSi/CLSK/FL	3	Ashport, Craig, Easpur
5-VD-W>n-CL/L/FL/C	6	Dougherty, Kirvin, Ruston, Shrewder, Stidham, Wolfpen
5-VD-MW≤y-F	2	Martin, Summit
5-VD-MW≤n-F/FL	4	Chaney, Dennis, Wetsaw, Windthorst
5-VD-MW>n-FL/F	2	Kemp, Porum
5-VD-SP≤n-FL	1	Bathel
5-VD-P≤y-F	1	Carwile
5-VD-P≤n-F	1	Parsons
5-VD-P>n-FSi	2	Boley, Guyton
5-D-W≤y-FL/FSi	6	Altus, Caspiana, Farnum, Fitzhugh, Grant, Milan
5-D-W≤n-FSi/C/FL/LSK/L	5	Bengal, Denton, Littleaxe, Panama, Tenaha
5-D-W>n-FSi/F/FL/LSK	7	Barnsdall, Blevins, Mckamie, Octavia, Sherwood, Speer, Wilburton
5-D-MW≤y-F/FL	3	Apperson, Dwight, Prue
5-D-MW≤n-F	2	Chigley, Liberal
5-D-MW>n-F/FL	2	Cadeville, Locust
5-D-SP>n-F/FSi	2	Cherokee, Johnsburg
5-MD-W≤y-FL/F	4	Bates, Bostwick, Labette, Lancaster
5-MD-W≤n-LSK/F	3	Bromide, Cowton, Naru
5-MD-W>n-FL/C	3	Endsaw, Hartsell, Linker
5-MD-MW≤y-F	1	Foraker
5-MD-MW>n-FL/F	2	Clearview, Sobol
5-MD-P>n-FSi	1	Alikchi
5-S-E>n-LSK	1	Goldston
6-VD-E>n-LSK	1	Clarksville
6-VD-W>n-CSi	1	Weswood
6-VD-MW>n-FL	1	Freestone
6-VD-SP≤n-FSi	1	Tomast

Table 3. continued

Combinations*	# of Series	Series
6-VD-SP>n-FSi	1	Taft
6-D-W≤n-FLoC/C	2	Denman, Enders
6-D-W>n-CL	1	Springer
6-D-P≤n-FSi	1	Bonn
6-MD-W>n-FL/LSK	2	Bolivar, Zafra
7-VD-MW>n-FSi	1	Dickson
7-D-W>n-CSi	1	Keo
7-D-MW≤n-FLoC	1	Newalla

*Combinations = number of master horizons (2-7)-soil depth class (very deep-VD, deep-D, moderately deep-MD, shallow-S, and very shallow-VS)-drainage class (excessively drained-E, well drained-W, moderately well drained-MW, somewhat poorly drained-SP, and poorly drained-P)-value and chroma of A horizon with reference to 3/3 (≤, >)-whether or not the 3/3 or less value and chroma extend below the A horizon (y or n)-and the family particle size classes of the soils. Groupings do not include every possible combination of the key soil properties, but rather, every combination exclusive to the 577 soil series of Oklahoma.

conceivable combination. Family particle size classes representing the soil series that fall into each combination was then added to the 142 combinations in Table 3. Each string contains the number of master horizons, soil depth, drainage, whether the A horizon has a value/chroma of ≤3/3, represented by the ≤ sign, or a value/chroma of >3/3, represented by the > sign, whether or not the ≤3/3 colors extend below the A horizon (y or n), and the family particle size classes for series contained in the string.

The 142 groups represent the 577 soil series of Oklahoma in a readable format presenting properties that are both important for separating soils for major differences in land use and are those that individuals can readily perceive and agree with.

CLASSIFICATION COMPARISON

Introduction

The 577 soil series of Oklahoma were divided into their 194 taxonomic subgroups (Table 4) according to the *Keys to Soil Taxonomy* (Soil Survey Staff, 1996). These subgroups were then evaluated from the order level of classification through the subgroup level to determine if the properties chosen for this study are clearly represented within the taxonomic classification (Appendix I) of the 577 series. *The Keys To Soil Taxonomy* (Soil Survey Staff, 1996) is a key whose properties are added or deleted by the process of elimination. To go directly to the classification precludes the process taken to reach that classification. The process may include the 9 soil properties used in this study. The process began at the order level and ended with the family level.

Table 4. The 577 Oklahoma series placed in their 194 subgroups.

Subgroup	# of Series	Series Name
Vertic Hapludalfs	2	Mckamie, Woodtell
Ultic Hapludalfs	10	Barnsdall, Bolivar, Cowton, Kenn, Romia, Secesh, Speer, Spiro, Waben, Wilburton
Aquic Hapludalfs	2	Bathel, Sobol
Albaquic Hapludalfs	2	Cadeville, Tuskahoma
Oxyaquic Hapludalfs	2	Clearview, Rexor
Glossaquic Hapludalfs	1	Frizzell
Typic Hapludalfs	2	Gallion, Karma
Aquertic Chromic Hapludalfs	1	Homa
Aquollic Hapludalfs	2	Liberal, Moyers
Aquultic Hapludalfs	1	Neff
Mollic Hapludalfs	1	Razort
Aquic Arenic Hapludalfs	1	Bocox
Mollic Natrustalfs	4	Drummond, Hinkle, Huska, Pawhuska
Typic Natrustalfs	1	Oscar
Aquic Natrustalfs	1	Wing
Udertic Paleustalfs	4	Agan, Axtell, Aydelotte, Crockett
Psammentic Paleustalfs	3	Aline, Eufala, Goltry
Udic Paleustalfs	5	Bastrop, Chigley, Duffau, Springer, Windthorst
Arenic Paleustalfs	2	Heatly, Nobscot
Aquic Paleustalfs	2	Chaney, Niotaze
Typic Paleustalfs	4	Delwin, Miles, Wichita, Winters
Ultic Paleustalfs	4	Galey, Gasil, Harrah, Konsil
Aridic Paleustalfs	4	Dallam, Perico, Rickmore, Vingo
Arenic Aridic Paleustalfs	1	Brownfield
Calcidic Paleustalfs	2	Spurlock, Tulia
Udic Rhodustalfs	2	Binger, Cosh
Typic Epiaqualfs	1	Cupco
Chromic Vertic Epiaqualfs	1	Lightning
Vertic Epiaqualfs	2	Panola, Pocola
Vertic Albaqualfs	1	Alusa
Typic Albaqualfs	1	Cherokee
Mollic Albaqualfs	2	Parsons, Taloka
Typic Paleudalfs	6	Baxter, Boxville, Britwater, Kamie, Sallisaw, Yanush
Glossic Paleudalfs	3	Bernow, Naldo, Whakana
Albaquic Paleudalfs	2	Bosville, Counts
Mollic Paleudalfs	3	Craig, Prue, Riverton
Psammentic Paleudalfs	2	Flo, Glenpool
Glossaquic Paleudalfs	2	Freestone, Porum
Aquic Paleudalfs	6	Hamden, Muskogee, Stigler,Tamaha, Vian, Wetsaw
Arenic Paleudalfs	3	Larton, Larue, Wolfpen
Grossarenic Paleudalfs	1	Pickton
Udic Haplustalfs	3	Attica, Naru, Newalla
Ultic Haplustalfs	5	Bromide, Konawa, Littleaxe, Stephenville, Weatherford
Aridic Haplustalfs	3	Bronte, Dalhart, Vona
Arenic Haplustalfs	2	Dougherty, Stidham
Typic Haplustalfs	9	Cobb, Devol, Fortyone,Grandfield, Grandmore, Honeycreek, Mcknight, Menard, Rochelle

Table 4. continued.

Subgroup	# of Series	Series Name
Udertic Haplustalfs	3	Grainola, Normangee,Steedman
Aquic Arenic Haplustalfs	1	Meno
Psammentic Haplustalfs	1	Pratt
Oxyaquic Vertic Haplustalfs	1	Wilson
Typic Ochraqualf	2	Adaton, Clodine
Mollic Ochraqualfs	1	Quarles
Glossic Natraqualfs	1	Bonn
Albic Natraqualfs	1	Carytown
Vertic Natraqualfs	1	Healdton
Haplic Glossudalfs	1	Elysian
Typic Glossaqualfs	3	Alikchi, Guyton, Wrightsville
Mollic Fragiudalfs	1	Jay
Aquic Fragiudalfs	1	Lawrence
Typic Fragiudalfs	1	Shermore
Glossic Natrudalfs	1	Lafe
Vertic Natrudalfs	1	Wister
Ustollic Calciorthids	5	Chupadera, Dean, Harvey, Hernandez, Potter
Ustalfic Haplargids	1	Doakum
Ustochreptic Camborthids	1	Glenrio
Ustollic Camborthids	1	Parida
Typic Natrargids	1	Tyende
Ustic Petrocalcids	1	Pastura
Vertic Ustifluvents	1	Beckman
Typic Ustifluvents	9	Bunyan, Clairemont, Corlena, Lincoln, Pulaski, Sayers, Westola, Yomont, Zavala
Udic Ustifluvents	2	Gaddy, Yahola
Mollic Udarents	1	Barge
Alfic Udarents	9	Blocker, Cartersville, Coalgate, Emachaya, Ironbridge, Kanima, Latimer, Lequire, Whitefield
Aeric Fluvaquents	3	Arkabutla, Boggy, Ezell
Typic Fluvaquents	3	Bibb, Las Animas, Rosebloom
Vertic Fluvaquents	1	Harjo
Aquic Udifluvents	6	Boley, Iuka, Kemp, Pushmataha, Retrop, Tullahassee
Typic Udifluvents	12	Ceda, Dela, Elsah, Kiomatia, Madill, Mideo, Norwood, Ocklockonee, Oklared, Robinsonville, Roxana, Severn
Oxyaquic Udifluvents	3	Gracemont, Gracemore, Tribbey
Ustic Torriorthents	7	Burson, Colby, Cottonwood, Florita, Kim, Knoco,Vermejo
Lithic Ustic Torriorthents	1	Travessilla
Typic Udipsamments	1	Crevasse
Typic Quartzipsamment	1	Glentosh
Ustic Quartzipsamments	1	Darsil
Aquic Ustipsamments	2	Daycreek, Dillwyn
Argic Ustipsamments	2	Derby, Eda
Typic Ustipsamments	5	Goodnight, Jester, Likes, Nutivoli, Tivoli
Ustic Torripsamments	2	Dwyer, Valent
Ustarents*	1	Latrass
Aridic Ustorthents	1	Otero

Table 4. continued.

Subgroup	# of Series	Series Name
Typic Ustorthents	1	Wewoka
Vertic Halaquept	1	Hibsaw
Aeric Halaquept	1	Krier
Fluventic Eutrochrept	2	Coushatta, Idabel
Dystric Fluventic Eutrochrept	1	Keo
Vertic Eutrochrepts	1	Redlake
Rendollic Eutrochrepts	1	Sumter
Lithic Dystrochrepts	3	Clebit, Hector, Pickens
Fluventic Dystochrepts	2	Ennis, Greendale
Typic Dystrochrepts	2	Goldston, Nashoba
Udic Ustochrepts	10	Amber, Brackett, Darnell, Dill, Highview, Ironmound, Masham, Noble, Nuella, Travertine
Typic Ustochrepts	15	Aspermont, Burford, Case, Deepwood, Enterprise,Gotebo, Hardeman, Obero, Owens, Quinlan, Shrewder,Vernon, Wellsford,Weymouth, Woodward
Aridic Ustochrepts	3	Berthoud, Mobeetie, Veal
Lithic Ustochrepts	1	Cordell
Fluventic Ustochrepts	3	Guadalupe, Hawley,Wheatwood
Vertic Ustochrepts	3	Heman, Mangum, Tussy
Torrertic Ustochrepts	1	Treadway
Udifluventic Ustochrepts	1	Weswood
Vertic Epiaquepts	1	Tuscumbia
Entic Haplustolls	4	Acme, Cornick, Kingsdown,Vinson
Lithic Haplustolls	8	Apache, Hedville, Kiti, Rayford, Shidler, Sogn,Timhill, Woodford
Fluventic Haplustolls	7	Asher, Ashport, Easpur,Keokuk, Lugert, Pocasset, Spur
Cumulic Haplustolls	10	Bergstrom, Bippus,Clearfork, Cyril, Elandco,Gowen, Humbarger,Manzano, Paymaster, Port
Pachic Haplustolls	3	Buttermilk, Dale, Reinach
Udic Haplustolls	7	Canadian, Crisfield, Lucien, Minco, Nash, Nashville, Slaughterville
Aridic Haplustolls	2	Capps, Ulysses
Udorthentic Haplustolls	2	Clime, Kipson
Torriorthentic Haplustolls	3	Bayard, Colmor, Elkader
Aquic Haplustolls	1	Elsmere
Udertic Haplustolls	3	Garvin, Lomill, Matoy
Fluvaquentic Haplustolls	4	Lesho, Waldeck, Wann, Zenda
Typic Haplustolls	3	Kenesaw, Loco, Missler
Vertic Haplustolls	1	Teagard
Aridic Argiustolls	7	Abbie, Capulin, Carnero, Majada, Manter, Satanta,Richfield
Pachic Argiustolls	14	Abilene, Altus, Braman,Corbin, Dodsum, Farnum,Irene, Irwin, Lawrie,Pond Creek, St.Paul, Tipton,Westview, Wolco
Udic Argiustolls	21	Albion, Carman, Chickasha, Coyle, Grant, Kingfisher,Labette, Lancaster, Lovedale, Milan, Navina, Ravia, Scullin, Shellabarger, Stoneburg, Teller, Teval,Vanoss, Waynoka, Wisby, Zaneis

Table 4. continued.

Subgroup	# of Series	Series Name
Udertic Argiustolls	10	Benchley, Brewer, Brewless, Dilworth, Mclain, Piedmont,Renthin, Tabler, Westsum,Wetbeth
Typic Argiustolls	8	Brico, Carey, Farry, Lawton, Madge, Mason, Ost, Selman
Vertic Argiustolls	5	Caradan, Culp, Flatonia, Lofton, Woods
Typic Argiudolls	11	Bates, Caspiana, Catoosa,Elmont, Fitzhugh, Healing, Holdrege, Lula, Nowata,Okay, Reading
Aquic Argiudolls	2	Bonham, Eram
Lithic Argiudolls	2	Claremore, Lenapah
Aquertic Argiudolls	2	Garton, Martin
Udertic Paleustolls	4	Agra, Durant, Kirkland, Renfrow
Pachic Paleustolls	3	Bethany, Darrouzett,Hollister
Petrocalcic Paleustolls	3	Friona, Lea, Slaughter
Aridic Paleustolls	1	Gruver
Udic Paleustolls	3	Justin, Mulhall, Norge
Torrertic Paleustolls	2	Pullman, Sherm
Typic Paleustolls	1	Tillman
Calciargidic Paleustolls	4	Conlen, Mansker, Sunray, Texline
Fluventic Hapludolls	7	Asa, Choska, Cleora, Huntington, Radley, Teamey,Wabbaseka
Lithic Hapludolls	3	Balltown, Collinsville, Swink
Cumulic Hapludolls	6	Cannon, Gowton, Ivan, Redport, Staser, Verdigris
Typic Hapludolls	1	Coweta
Vertic Hapludolls	3	Frioton, Latanier, Moreland
Fluvaquentic Hapludolls	1	Lebron
Aquic Hapludolls	1	Talihini
Cumulic Haplaquolls	1	Hopco
Fluvaquentic Haplaquolls	1	Sweetwater
Aridic Argiborolls	1	Bostwick
Cumulic Epiaquolls	1	Wynona
Typic Calciustolls	3	Clark, Penden, Somervell
Aridic Calciustolls	6	Cuevoland, Dioxice, Guy, Mansic, Oklark, Portales
Udic Calciustolls	1	Denton
Petrocalcic Calciustolls	3	Kerrick, Kimbrough, Plack
Lithic Calciustolls	4	Lueders, Purves, Talpa,Tarrant
Typic Argiaquolls	2	Carwile, Muldrow
Vertic Argiaquolls	2	Mayes, Pharoah
Abruptic Argiaquolls	1	Woodson
Aquic Paleudolls	4	Burwell, Choteau, Dennis, Okema
Typic Paleudolls	2	Eldorado, Newtonia
Fluvaquentic Endoaquolls	1	Leshara
Vertic Endoaquolls	1	Osage
Leptic Natrustolls	1	Wakita
Typic Natrustolls	4	Doolin, Dwight, Foard, Seminole
Vertic Argialboll	1	Waurika
Aquic Hapludults	3	Sacul, Stapp, Venita
Arenic Hapludults	1	Tenaha

Table 4. continued.

Subgroup	# of Series	Series Name
Typic Hapludults	18	Bengal, Bigfork, Cahaba,Carnasaw, Denman, Enders,Endsaw, Hartsells, Honobia,Kirvin, Linker, Oktaha,Pirum, Saffell, Sherless, Sherwood, Smithdale, Zafra
Aquic Paleudults	3	Felker, Kullit, Tiak
Typic Paleudults	9	Blevins, Caston, Clarksville, Etowah,Noark, Octavia, Panama, Pickwick, Ruston
Typic Fragiudults	2	Captina, Tonti
Glossic Fragiudults	3	Dickson, Locust, Nixa
Aquic Fragiudults	1	Johnsburg
Glossaquic Fragiudults	1	Taft
Aeric Paleaquults	2	Kinta, Tomast
Typic Umbraquults	1	Weleetka
Typic Chromusterts	1	Stamford
Udorthentic Chromusterts	1	Venadito
Aquic Hapluderts	2	Apperson, Summit
Typic Hapluderts	3	Kaufman, Pledger, Trinity
Chromic Hapluderts	1	Ships
Oxyaquic Hapluderts	1	Hollywood
Udic Haplusterts	7	Burleson, Clarita, Heiden, Lela, Miller, Tamford,Watonga
Chromic Udic Haplusterts	1	Ferris
Leptic Udic Haplusterts	2	Foraker, San Saba
Aridic Haplusterts	2	Albers, Tobosa
Typic Haplusterts	1	Indiahoma
Entic Pellusterts	1	Lipan
Udic Pellusterts	1	Ness
Typic Pellusterts	1	Roscoe
Ustic Epiaquerts	2	Randall, Ustibuck
Aeric Epiaquerts	1	Roebuck

* There is no subgroup for soils of the great group Udarent.

Master Horizon

The number of master horizons a soil contains is not directly indicated in the order, suborder, great group, subgroup, or family levels of classification (Soil Survey Staff, 1996). Horizons are inferred in the Entisol order where horizonation consists of A and C. Formative elements of the taxonomic classifications can indicate potential horizons assuming knowledge of the meanings or derivations of the elements. The "hapla" prefix is interpreted as meaning fewest horizons. The haplic great group contain the least horizons required to keep a soil in that particular order or suborder.

Soil Depth

Soil depth is not a direct criteria in the order, suborder, great group, subgroup, or family level of classification. Indirectly, it is discussed when referring to depth to fragipans, duripans, densic, lithic, or paralithic contact, petroferric, petrogypisic or petrocalcic layers in some orders (Vertisols, Aridisols, Histosols, Spodosols, Andisols, Ultisols, Inceptisols, Mollisols, Alfisols). Alternating contingent criteria (ACC) for some great groups (Paleaquults, Paleudults) include the absence of densic, lithic, paralithic or petroferric layers to 150 cm. Alternating contingent criteria for some subgroups (Leptic Haplusterts) includes the absence of densic, lithic, or paralithic layers to 100 cm. The presence or absence of lithic contact within 50 cm is ACC for some great groups (Haplaquolls) and subgroups (Lithic Torriorthents, Lithic Ustochrepts, Lithic Dystrochrepts, Lithic Calciustolls, Lithic Haplustolls, Lithic Argiudolls, Lithic Hapludolls).

Formative elements of the taxonomic classification can indicate potential depth assuming knowledge of the meanings or derivations of the elements. The "lithic" formative element derived from stone indicates the presence of shallow lithic contact which indirectly indicates soil depth. Smith (1986) explained that depth was specified as a series property, so it was separated at the series level of classification.

<u>Wetness Class</u>

Drainage class is not indicated directly at the order, suborder, great group, subgroup or family levels of classification. Saturation ACC exist for some orders (Aridisols, Histosols). Indirectly, ACC indicates the presence or absence of aquic conditions for some orders (Inceptisols). For some suborders (Aquents, Usterts, Aquerts, Aqualfs, Aquepts, Albolls, Aquults) and subgroups (Aquertic Argiudoll, Aquic Argiudoll, Fluvaquentic Hapludolls, Aquic Hapludolls), the existence or absence of aquic conditions or artificial drainage is often a basis for ACC. The suborder (Aqualfs, Aquents, Albolls, Aquolls, Aquults) and subgroup (Aquertic Argiudolls, Aquic Argiudolls, Fluvaquentic Hapludolls, Aquic Hapludolls, Aquic Hapluderts) levels include redox features or conditions as ACC. Alternating contingent criteria for saturated conditions is found in the suborder (Aquents) and subgroup (Oxyaquic Hapludalfs, Oxyaquic Vertic Haplustalfs, Ustochreptic Camborthids) levels. Redox concentration criteria is indicated at the suborder (Aquept, Aquolls, Aquerts), great group (Paleustalfs, Paleudolls), and subgroup (Aquic Ustipsamment, Aquic Paleudults, Aquic Hapludults) levels. Episaturation is often a basis for alternating contingent criteria at the great group level (Epiaqualfs, Epiaquepts, Epiaquolls, Epiaquerts). Redoximorphic depletions or aquic conditions ACC exists at the subgroup (Aquertic Chromic Hapludalfs, Aquic Arenic Hapludalfs, Albaquic Hapludalfs, Glossaquic Hapludalfs, Aquollic Hapludalfs, Aquic Hapludalfs, Glossaquic Paleudalfs, Aquic Paleudalfs, Aquic Natrustalfs, Aquic

Paleustalfs, Aquic Fragiudalfs, Aquic Arenic Haplustalfs, Aquic Udifluvents, Fluvaquentic Haplustolls, Aquic Haplustolls, Aquic Paleudolls, Glossaquic Fragiudults, Aquic Fragiudults, Aquic Paleudults, Aquic Hapludults, Aquic Hapluderts) level of classification. Saturation ACC exist for some subgroups (Oxyaquic Udifluvents, Oxyaquic Hapluderts).

Smith (1986) discussed that the correlation staff felt that distinctions between well drained and moderately well drained soils could be handled at the series level. Drainage classes poorer than moderately well drained were important enough to distinguish with a subgroup separation such as an aquic subgroup. The four subdivisions then included soils that were freely drained, poorly drained soils with aeric subgroups, and aquic and typic subgroups.

Formative elements of the taxonomic classification can indicate potential drainage conditions assuming knowledge of the meanings or derivations of the elements. In the formative element "epiaquic", "epi" meaning over and aquic indicates surface wetness. The formative element "aqu" derived from water indicates wetness characteristics.

Slope Gradient

Slope gradient of <25 % is named as ACC for some suborders (Fluvents), and subgroups (Udifluventic Ustochrepts, Fluventic Eutrochrepts, Fluventic Dystrochrepts, Fluvaquentic Endoaquolls, Cumulic Haplustolls, Fluventic Haplustolls, Fluvaquentic Haplustolls, Fluvaquentic Hapludolls, Fluventic Hapludolls). Slopes are specified as being >25% for some great groups (Haplaquolls), and ≤25% for some subgroups (Cumulic Hapludolls).

Slope is incorporated in aquic great groups. Slope was used primarily as phase criterion (below the series level) due to its importance in use and management. Slope was thought to be important when considering the difficulty/ease of removing excess water (Smith, 1986).

Formative elements of the taxonomic classification can indicate potential slope assuming knowledge of the meanings or derivations of the elements. The formative element "fluv" derived from river indicates a floodplain which could be interpreted as a soil having a nearly level slope gradient.

Soil Color

Soil color is indicated directly at the order, suborder (Aquepts, Aquolls), great group (Haplaquolls, Umbraquults) and subgroup (Mollic Ochraqualfs, Mollic Udarents, Cumulic Epiaquoll, Aridic Argiboroll, Pachic Paleustolls, Pachic Argiustolls, Cumulic Haplustolls, Pachic Haplustolls, Cumulic Hapludolls) levels by the presence or absence of mollic colors (moist value/chroma of $\leq$3/3) or a mollic epipedon. Soil color as ACC is noted with reference to epipedon and horizons criteria for umbric, ochric, cambic, anthropic, albic, mollics and for albic horizons (see formative elements below). Soil colors are mentioned indirectly for the ochric or anthropic epipedon at the order (Aridisol), and suborder (Aquepts, Ochrept) levels. Albic horizons, mollic epipedons, cambic horizons, and associated soil color requirements are given as possible ACC for the Mollisol order. Alternating contingent criteria for albic horizons are given for the Spodosol order. Some suborders and great groups (Albolls, Glossaqualfs) include albic colors as ACC. Cambic horizons are ACC at the order (Inceptisols), great group

(Camborthids), and subgroup (Torriorthentic Haplustolls, Udorthentic Haplustolls, Entic Haplustolls) levels. Suborders (Aqualf) have chroma ACC ≤2 and ≤1 on ped faces. Chroma ACC is indicated at the suborder level (Aquents, Aquepts, Aquults, Aquerts), and in conjunction with redoximorphic depletions in layers with aquic conditions at the subgroup (Albaquic Hapludalfs, Aquultic Hapludalfs, Aquollic Hapludalfs, Aquic Hapludalfs, Albaquic Paleudalfs, Aquic Paleudalfs, Glossaquic Paleudalfs) level. Chromas of ≤1 in the lower part of the mollic for is criteria for some suborders (Aquolls). Color ACC below the mollic epipedon is indicated at the suborder (Aquolls) and subgroup (Aquic Hapludolls, Fluvaquentic Hapludolls) levels. Hue, values or chromas are specified as ACC for the "matrix" in soils of some suborders (Aquolls, Aqualfs), great groups (Paleustalfs, Rhodustalfs, Ochraqualfs, Paleustolls, Paleudolls, Chromusterts), and subgroups (Typic Glossaqualfs, Ustochreptic Camborthids, Aeric Fluvaquents, Aquic Udifluvents, Aeric Halaquepts, Aquic Haplustolls, Aquertic Argiudolls, Aquic Argiudolls, Aeric Paleaqults, Glossaquic Fragiudults, Glossic Fragiudults, Aquic Paleudults, Aquic Hapludults, Aeric Epiaquerts, Typic Chromusterts, Typic Pellusterts Chromic Haplusterts, Chromic Hapluderts). Some great groups (Umbraqualfs) refer to color indirectly by identifying umbric epipedons. Ap horizon color ACC exists for some subgroups (Mollic Albaqualfs, Chromic Vertic Epiaqualfs, Aquertic Chromic Hapludalfs, Aquollic Hapludalfs, Mollic Hapludalfs, Mollic Natrustalfs, Mollic Paleudalfs, Mollic Fragiudalfs, Typic Glossaqualfs). Some subgroups (Glossic Natraqualfs, Glossic Paleudalfs, Glossic Natrudalf, Glossaquic Hapludalfs, Glossic Natrudalfs) include as ACC, albic materials or interfingering of albic materials in the argillic. Color is indirectly used in the organic carbon criteria at the suborder (Fluvents), great group (Fluvaquents, Haplaquolls), and subgroup (Ustollic Calciorthids, Ustochreptic Camborthids, Udifluventic Ustochrepts, Fluventic Ustochrepts, Fluventic Eutrochrepts, Fluventic Dystrochrepts, Fluvaquentic Endoaquolls, Fluvaquentic Haplustolls, Fluventic Haplustolls, Cumulic Hapludolls, Fluvaquentic Hapludolls, Fluventic Hapludolls, Cumulic Haplustolls) levels.

Formative elements of the taxonomic classification can indicate potential color assuming knowledge of the meanings or derivations of the elements. The formative element "chrom" meaning color, is an indication of high chroma. "Rhod", derived from rose, indicates dark red colors. "Alb", derived from white, indicates a bleached eluvial horizon. "Ochr", derived from pale, indicates a light colored surface. "Umbr", derived from shade, indicates a dark colored surface. "Pell", derived from dusky, indicates low chroma. "Sombr", derived from dark, indicates a dark horizon.

Soil Texture

Soil textures are limited to specific clay percentages in the Vertisol order. The Histosol order contains specific criteria for organic matter, sapric, hemic, and fibric materials. Soil texture is indirectly identified by the presence or absence of argillic, natric or kandic horizons at the order (Aridisols, Ultisols, Spodosol, Mollisols, Alfisols), suborder (Alboll, Aquults, Aqualfs), great group (Natraqualfs, Kandiaqualfs, Natrudalfs, Paleustalfs, Rhodustalfs, Natrargids, Rhodustalfs, Argiaquolls, Argiborolls, Natrustolls, Paleustolls, Calciustolls, Argiustolls, Paleudolls, Argiudolls) and subgroup (Albaquic Hapludalf, Glossaquic Hapludalf, Aquultic Hapludalfs, Aquollic Hapludalfs, Aquic Hapludalfs, Ultic Hapludalfs, Glossaquic Paleudalfs, Albaquic Paleudalfs, Psammentic

Paleudalfs, Glossic Paleudalfs, Aquic Arenic Haplustalfs, Psammentic Haplustalfs, Ultic Haplustalfs, Alfic Udarents, Argic Ustipsamment, Glossaquic Fragiudult, Glossic Fragiudults, Arenic Hapludults) levels. Ultisols include epipedon ACC of sandy or sandy skeletal texture. The Vertisol order contains ACC for clay percentages, slickensides, and the periodic opening and closing of cracks which indicates clayey textures. Oxisol have as criteria an oxic horizon which contains ACC for texture. Suborders (Aqualfs, Argids) and subgroups (Aquertic Chromic Hapludalfs, Psammentic Paleustalfs, Arenic Aridic Paleustalfs, Ultic Paleustalfs) contain argillic, natric, or kandic horizon ACC. Specific texture ACC is given at the suborder (Aquents, Psamments), great groups (Calciorthids, Haplaquolls, Calciustolls) and subgroup (Typic Glossaqualfs, Pachic Paleustolls, Pachic Argiustolls, Cumulic Haplustolls, Pachic Haplustolls, Cumulic Hapludolls) levels based on textures coarser or finer than loamy fine sand. Some great groups (Albaqualfs) have ACC for abrupt texture changes between ochric or albic and argillic horizons. Some subgroups (Aquic Arenic Hapludalfs, Psammentic Paleudalfs, Arenic Paleudalfs, Glossarenic Paleudalfs, Arenic Aridic Paleustalfs, Arenic Paleustalfs, Psammentic Paleustalfs, Aquic Arenic Haplustalfs, Psammentic Haplustalfs, Arenic Haplustalfs, Arenic Hapludults) have sandy or sandy skeletal particle size ACC. Clayey or clayey skeletal particle size class ACC exist for great groups (Paleustalfs). Abrupt texture changes are included in the ACC for subgroups (Albaquic Hapludalfs). Sand to non-carbonate clay ratio ACC is present in subgroups (Ustollic Calciorthids, Ustochreptic Camborthids). Clay increase or decrease ACC exist in great groups (Paleaquults, Paleudults), and subgroups (Abruptic Argiaquolls, Glossic Fragiudults). Family particle size class ACC are exist for some orders (Spodosols, Ultisols). Calcic, cambic and gypsic horizons contain ACC for texture. Horizons including kandic, natric, cambic, oxic, and histic contain texture criteria.

Formative elements of the taxonomic classification can indicate potential textures assuming knowledge of the meanings or derivations of the elements. "Psamm" or "arenic", meaning sand, indicates sandy textures. "Grossarenic", meaning thick sand, indicates sandy textures. "Arg", meaning illuvial clay, indicates argillic properties. "Kandic" indicates low activity clays.

At the family level of classification, family particle size classes are given. The family level was developed as the level this information would be most useful in terms of use and management (Smith, 1986). The family particle size class can include a range of textures. The control section was chosen for the family particle size class as it was less likely disturbed by human activity (plowing, etc.).

Site Position

Site position is not indicated directly at any level of classification although inferences can be made where slope is mentioned as ACC. Formative elements of the taxonomic classification can indicate potential site positions assuming knowledge of the meanings or derivations of the elements. The formative element "fluv" derived from river indicates a floodplain.

Parent Material

Parent material is indicated in the Andisol order where characteristics associated with volcanic ash are criteria. Parent material is also indicated in Histosols where organic matter criteria is specified. The family level of classification specifies the mineralogy class for each series which can indicate parent material. For the 577 series of Oklahoma the mineralogy classes included mixed, montmorillonitic, smectitic, siliceous, calcareous and carbonatic.

Parent material was indicated through the mineralogy class and particle size distribution at the family level of classification. This was intentional and thought to be the level of classification of which this information would be most useful (Smith, 1986). Formative elements of the taxonomic classification can indicate parent materials assuming knowledge of the meanings or derivations of the elements. The formative element "quartz" indicates a high quartz content. "Gibbs" indicates the presence of gibbsite. "Plinth" indicates the presence of plinthite. "Calc", derived from lime indicates a calcic horizon.

Soil Structure

Structure is indicated at the subgroup (Typic Chromusterts) level of classification where the presence or absence of prismatic or blocky structure within one meter of the surface is included as ACC. Structure exists at the subgroup (Typic Pellusterts) level where the presence or absence of prismatic or blocky structure with clay skins on ped faces is ACC. Structure is implied where prismatic or columnar structure is criteria used in identifying natric horizons. The absence of hard and massive structures is criteria in the Mollisol order.

Implementing Soil Taxonomy Levels

Smith (1986) discusses how genesis is considered in the order, suborder, great group, but mostly at the subgroup levels of classification. At these levels, the intent was to permit inferences for small-scale maps and to aid in identifying specific kinds of soil. In general, genetic factors influenced the higher levels of classification and interpretive factors influenced the lower levels of classification. The suborder level contained information which divided the "wet soils". Differences in degree were to be reflected at different categoric levels. An example would be the aquic suborder or great group. Differences in degrees of the aquic moisture regime are reflected at the subgroup level of classification. The subgroup level was intended to encompass soils which had primary features of one taxon and some requirements of another. Subgroups were meant to relate soils in a given great group including those soils which share properties with soils of other great groups (intergrades) as well as those soils which have properties which are not common to soils of any other great group (extragrades). Additionally, the subgroup level relates the order, suborder and great group levels. The family level was intended to reflect important differences as related to growing plants and engineering implications. The emphasis of physical properties that affected plant growth and engineering applications at the family level surfaced in the third approximation to soil taxonomy (Soil Survey Staff, 1975). At the family level, major interpretations for use and management could be made. It was not the intent of the family level to extract the most precise quantitative interpretations such as crop yield per hectare. It was intended that at the phase level, determinations could be made as to the practicality or impracticality of growing annual crops. Family names, for the most part, represented the dominant (most common) series contained within the family.

Table 5 consists of the subgroups for the 577 soil series of Oklahoma and the soil properties including the number of master horizons in the typical pedon, soil depth, drainage class, value and chroma of the A horizon above or below 3/3, and the value and chroma below the A horizon above or below 3/3. The number of series within each

Table 5. Number of soil series in each subgroup with soil properties in common.

Subgroup	# of Series	# OF SERIES WITH IN COMMON: # Master Horizons Typical Pedon	Soil Depth	Drainage Class	Value/Chroma A Horizon Above or Below 3/3	Value/Chroma Below A Horizon Above or Below 3/3
Vertic Hapludalfs	2	1	2	1	2	2
Ultic Hapludalfs	10	5	7	10	5	9
Aquic Hapludalfs	2	2	1	1	1	2
Albaquic Hapludalfs	2	1	1	2	2	2
Oxyaquic Hapludalfs	2	1	1	2	2	2
Glossaquic Hapludalfs	1	1	1	1	1	1
Typic Hapludalfs	2	1	2	2	2	2
Aquertic Chromic Hapludalfs	1	1	2	2	2	2
Aquollic Hapludalfs	2	1	2	2	2	2
Aquultic Hapludalfs	1	1	1	1	1	1
Mollic Hapludalf	1	1	1	1	1	1
Aquic Arenic Hapludalfs	1	1	1	1	1	1
Mollic Natrustalfs	4	3	2	3	2	2
Typic Natrustalfs	1	1	1	1	1	1
Aquic Natrustalfs	1	1	1	1	1	1
Udertic Paleustalfs	4	2	3	2	2	3
Psammentic Paleustalfs	3	2	2	2	2	3
Udic Paleustalfs	5	2	3	3	3	5
Arenic Paleustalfs	2	1	1	2	2	2
Aquic Paleustalfs	2	1	1	1	2	2
Typic Paleustalfs	4	2	4	4	3	4
Ultic Paleustalfs	4	3	2	3	4	4
Aridic Paleustalfs	4	2	3	4	3	3
Arenic Aridic Paleustalfs	1	1	1	1	1	1
Calcidic Paleustalfs	2	2	2	2	2	2
Udic Rhodustalfs	2	2	1	2	2	2
Typic Epiaqualfs	1	1	1	1	1	1
Chromic Vertic Epiaqualfs	1	1	1	1	1	1
Vertic Epiaqualfs	2	1	1	1	1	1
Vertic Albaqualfs	1	1	1	1	1	1
Typic Albaqualfs	1	1	1	1	1	1
Mollic Albaqualfs	2	1	2	1	2	2

Table 5. continued

Subgroup	# of Series	# OF SERIES WITH IN COMMON: # Master Horizons Typical Pedon	Soil Depth	Drainage Class	Value/Chroma A Horizon Above or Below 3/3	Value/Chroma Below A Horizon Above or Below 3/3
Typic Paleudalfs	6	3	3	6	6	6
Glossic Paleudalfs	3	2	3	2	3	3
Albaquic Paleudalfs	2	1	1	2	1	2
Mollic Paleudalfs	3	2	2	2	3	2
Psammentic Paleudalfs	2	2	1	2	1	2
Glossaquic Paleudalfs	2	1	2	2	2	2
Aquic Paleudalfs	6	4	3	6	5	6
Arenic Paleudalfs	3	2	2	3	3	3
Grossarenic Paleudalfs	1	1	1	1	1	1
Udic Haplustalfs	3	1	2	2	3	3
Ultic Haplustalfs	5	3	2	5	3	5
Aridic Haplustalfs	3	2	2	3	2	3
Arenic Haplustalfs	2	2	2	2	2	2
Typic Haplustalfs	9	7	5	8	6	9
Udertic Haplustalfs	3	2	2	2	3	3
Aquic Arenic Haplustalfs	1	1	1	1	1	1
Psammentic Haplustalfs	1	1	1	1	1	1
Oxyaquic Vertic Haplustalfs	1	1	1	1	1	1
Typic Ochraqualf	2	1	1	2	2	2
Mollic Ochraqualfs	1	1	1	1	1	1
Glossic Natraqualfs	1	1	1	1	1	1
Albic Natraqualfs	1	1	1	1	1	1
Vertic Natraqualfs	1	1	1	1	1	1
Haplic Glossudalfs	1	1	1	1	1	1
Typic Glossaqualfs	3	2	2	3	2	2
Mollic Fragiudalfs	1	1	1	1	1	1
Aquic Fragiudalfs	1	1	1	1	1	1
Typic Fragiudalfs	1	1	1	1	1	1
Glossic Natrudalfs	1	1	1	1	1	1
Vertic Natrudalfs	1	1	1	1	1	1
Ustollic Calciorthids	5	3	2	5	5	5

Table 5. continued

Subgroup	# of Series	# OF SERIES WITH IN COMMON: # Master Horizons Typical Pedon	Soil Depth	Drainage Class	Value/Chroma A Horizon Above or Below 3/3	Value/Chroma Below A Horizon Above or Below 3/3
Ustalfic Haplargids	1	1	1	1	1	1
Ustochreptic Camborthids	1	1	1	1	1	1
Ustollic Camborthids	1	1	1	1	1	1
Typic Natrargids	1	1	1	1	1	1
Ustic Petrocalcids	1	1	1	1	1	1
Vertic Ustifluvents	1	1	1	1	1	1
Typic Ustifluvents	9	9	5	7	8	9
Udic Ustifluvents	2	2	2	1	2	2
Mollic Udarents	1	1	1	1	1	1
Alfic Udarents	9	9	4	9	8	8
Aeric Fluvaquents	3	3	2	2	2	3
Typic Fluvaquents	3	2	2	2	3	3
Vertic Fluvaquents	1	1	1	1	1	1
Aquic Udifluvents	6	4	4	3	6	6
Typic Udifluvents	12	9	7	10	11	12
Oxyaquic Udifluvents	3	2	3	2	3	3
Ustic Torriorthents	7	4	2	5	6	6
Lithic Ustic Torriorthents	1	1	1	1	1	1
Typic Udipsamments	1	1	1	1	1	1
Typic Quartzipsamment	1	1	1	1	1	1
Ustic Quartzipsamments	1	1	1	1	1	1
Aquic Ustipsamments	2	2	2	2	1	2
Argic Ustipsamments	2	2	2	2	1	2
Typic Ustipsamments	5	4	3	5	4	5
Ustic Torripsamments	2	2	2	2	2	2
Ustarents*	1	1	1	1	1	1
Aridic Ustorthents	1	1	1	1	1	1
Typic Ustorthents	1	1	1	1	1	1
Vertic Halaquept	1	1	1	1	1	1
Aeric Halaquept	1	1	1	1	1	1
Fluventic Eutrochrept	2	2	2	2	1	2

Table 5. continued

Subgroup	# of Series	# OF SERIES WITH IN COMMON: # Master Horizons Typical Pedon	Soil Depth	Drainage Class	Value/Chroma A Horizon Above or Below 3/3	Value/Chroma Below A Horizon Above or Below 3/3
Dystric Fluventic Eutrochrept	1	1	1	1	1	1
Vertic Eutrochrepts	1	1	1	1	1	1
Rendollic Eutrochrepts	1	1	1	1	1	1
Lithic Dystrochrepts	3	2	2	2	3	3
Fluventic Dystochrepts	2	2	1	2	2	2
Typic Dystrochrepts	2	1	1	1	2	2
Udic Ustochrepts	10	9	5	10	8	10
Typic Ustochrepts	15	11	4	15	14	15
Aridic Ustochrepts	3	1	2	3	3	3
Lithic Ustochrepts	1	1	1	1	1	1
Fluventic Ustochrepts	3	3	2	3	3	3
Vertic Ustochrepts	3	3	2	2	2	3
Torrentic Ustochrepts	1	1	1	1	1	1
Udifluventic Ustochrepts	1	1	1	1	1	1
Vertic Epiaquepts	1	1	1	1	1	1
Entic Haplustolls	4	2	1	4	4	4
Lithic Haplustolls	8	6	6	6	8	7
Fluventic Haplustolls	7	3	4	6	7	7
Cumulic Haplustolls	10	6	5	10	10	5
Pachic Haplustolls	3	3	2	2	3	2
Udic Haplustolls	7	5	3	7	7	6
Aridic Haplustolls	2	2	2	2	2	2
Udorthentic Haplustolls	2	2	1	1	2	1
Torriorthentic Haplustolls	3	2	2	3	3	3
Aquic Haplustolls	1	1	1	1	1	1
Udertic Haplustolls	3	2	2	1	3	2
Fluvaquentic Haplustolls	4	4	2	4	4	4
Typic Haplustolls	3	3	2	3	3	3
Vertic Haplustolls	1	1	1	1	1	1
Aridic Argiustolls	7	5	4	7	7	5
Pachic Argiustolls	14	8	9	12	14	14

Table 5. continued

Subgroup	# of Series	# OF SERIES WITH # Master Horizons Typical Pedon	Soil Depth	Drainage Class	Value/Chroma A Horizon Above or Below 3/3	Value/Chroma Below A Horizon Above or Below 3/3
		IN COMMON				
Udic Argiustolls	21	11	9	17	21	15
Udertic Argiustolls	10	6	6	6	10	9
Typic Argiustolls	8	4	6	8	8	5
Vertic Argiustolls	5	3	4	3	5	4
Typic Argiudolls	11	5	5	11	11	9
Aquic Argiudolls	2	2	1	2	2	2
Lithic Argiudolls	2	2	2	2	2	2
Aquertic Argiudolls	2	1	2	2	2	2
Udertic Paleustolls	4	2	4	2	4	3
Pachic Paleustolls	3	1	2	3	3	3
Petrocalcic Paleustolls	3	1	1	3	3	2
Aridic Paleustolls	1	1	1	1	1	1
Udic Paleustolls	3	1	2	3	3	2
Torrertic Paleustolls	2	1	2	2	2	2
Typic Paleustolls	1	1	1	1	1	1
Calciargidic Paleustolls	4	4	3	4	4	4
Fluventic Hapludolls	7	5	4	5	7	6
Lithic Hapludolls	3	3	3	2	3	2
Cumulic Hapludolls	6	4	5	6	6	4
Typic Hapludolls	1	1	1	1	1	1
Vertic Hapludolls	3	2	2	2	3	2
Fluvaquentic Hapludolls	1	1	1	1	1	1
Aquic Hapludolls	1	1	1	1	1	1
Cumulic Haplaquolls	1	1	1	1	1	1
Fluvaquentic Haplaquolls	1	1	1	1	1	1
Aridic Argiborolls	1	1	1	1	1	1
Cumulic Epiaquolls	1	1	1	1	1	1
Typic Calciustolls	3	3	1	3	3	3
Aridic Calciustolls	6	2	3	6	6	5
Udic Calciustolls	1	1	1	1	1	1
Petrocalcic Calciustolls	3	3	1	3	3	3

Table 5. continued

Subgroup	# of Series	# OF SERIES WITH ... IN COMMON: # Master Horizons Typical Pedon	Soil Depth	Drainage Class	Value/Chroma A Horizon Above or Below 3/3	Value/Chroma Below A Horizon Above or Below 3/3
Lithic Calciustolls	4	3	4	4	3	2
Typic Argiaquolls	2	1	2	1	2	2
Vertic Argiaquolls	2	2	1	1	2	2
Abruptic Argiaquolls	1	1	1	1	1	1
Aquic Paleudolls	4	2	2	4	4	3
Typic Paleudolls	2	1	1	2	2	1
Fluvaquentic Endoaquolls	1	1	1	1	1	1
Vertic Endoaquolls	1	1	1	1	1	1
Leptic Natrustolls	1	1	1	1	1	1
Typic Natrustolls	4	3	2	3	4	3
Vertic Argialboll	1	1	1	1	1	1
Aquic Hapludults	3	3	1	3	2	3
Arenic Hapludults	1	1	1	1	1	1
Typic Hapludults	18	7	9	18	12	18
Aquic Paleudults	3	3	2	1	2	3
Typic Paleudults	9	4	5	8	7	9
Typic Fragiudults	2	1	1	2	2	2
Glossic Fragiudults	3	1	2	3	3	3
Aquic Fragiudults	1	1	1	1	1	1
Glossaquic Fragiudults	1	1	1	1	1	1
Aeric Paleaquults	2	1	1	2	2	2
Typic Umbraquults	1	1	1	1	1	1
Typic Chromusterts	1	1	1	1	1	1
Udorthentic Chromusterts	1	1	1	1	1	1
Aquic Hapluderts	2	1	1	2	2	2
Typic Hapluderts	3	2	3	3	3	3
Chromic Hapluderts	1	1	1	1	1	1
Oxyaquic Hapluderts	1	1	1	1	1	1
Udic Haplusterts	7	7	5	4	7	4
Chromic Udic Haplusterts	1	1	1	1	1	1
Leptic Udic Haplusterts	2	1	2	2	2	2

Table 5. continued

Subgroup	# of Series	# OF SERIES WITH # Master Horizons Typical Pedon	Soil Depth	Drainage Class	Value/Chroma A Horizon Above or Below 3/3	Value/Chroma Below A Horizon Above or Below 3/3
		IN COMMON				
Aridic Haplusterts	2	2	2	2	2	2
Typic Haplusterts	1	1	1	1	1	1
Entic Pellusterts	1	1	1	1	1	1
Udic Pellusterts	1	1	1	1	1	1
Typic Pellusterts	1	1	1	1	1	1
Ustic Epiaquerts	2	1	2	2	2	2
Aeric Epiaquerts	1	1	1	1	1	1

subgroup that have these properties in common are the numbers listed below each soil property heading. These soil properties are important for use and management interpretations. The unifying concept of the series dictates that soils in a given subgroup have like soil properties. Table 5 reveals that many soils within a subgroup have dissimilar soil properties.

CHAPTER V

SUMMARY AND CONCLUSION

Nine key soil properties are identified as potential criteria for a practical soil classification developed from soil series description sheets (USDA-NRCS). Soil series description sheets must be improved to serve the needs of many users, updated regularly, and be available in a format conducive to database usage. Soil variability must be consistently expressed by average and range values for all key soil properties. The key soil properties, however, are not consistently identified during field soil profile descriptions with persons having 3 years or less experience under soil contest conditions. A new classification scheme must use soil properties that are readily observable and textural. Most of the 9 key soil properties studied are not currently directly used in the *Keys to Soil Taxonomy* (Soil Survey Staff, 1996). The soil properties, when indicated, exist as alternating contingent criteria. Groupings of the series based on 5 of the 9 soil properties important for land use management reveal that dissimilar soils exist within the subgroup level of taxonomic classification. The proposed 9 soil properties classification scheme will expedite the use of soil series data for computer models and programs and provide a consistent classification scheme based on soil properties important to the user.

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APPENDIX A

Years Experience (y axis) by Master Horizons-10 Points (x axis)

Frequency, Percent, Row Pct, Col Pct	0	2	4	6	8	10	Total
≤1	0	2	3	22	44	33	104
	0.00	0.85	1.27	9.32	18.64	13.98	44.07
	0.00	1.92	2.88	21.15	42.31	31.73	
	0.00	66.67	27.27	44.90	51.16	38.37	
2	0	1	4	14	24	29	72
	0.00	0.42	1.69	5.93	10.17	12.29	30.51
	0.00	1.39	5.56	19.44	33.33	40.28	
	0.00	33.33	36.36	28.57	27.91	33.72	
≥3	1	0	4	13	18	24	60
	0.42	0.00	1.69	5.51	7.63	10.17	25.42
	1.67	0.00	6.67	21.67	30.00	40.00	
	100.00	0.00	36.36	26.53	20.93	27.91	
Total	1	3	11	49	86	86	236
	0.42	1.27	4.66	20.76	36.44	36.44	100.00

Years Experience (y axis) by Boundary Depth-8 (x axis)

Frequency, Percent, Row Pct, Col Pct	0	2	4	6	8	Total
≤1	28	40	27	8	1	104
	11.86	16.95	11.44	3.39	0.42	44.07
	26.92	38.46	25.96	7.69	0.96	
	57.14	40.40	40.91	44.44	25.00	
2	13	29	23	6	1	72
	5.51	12.29	9.75	2.54	0.42	30.51
	18.06	40.28	31.94	8.33	1.39	
	26.53	29.29	34.85	33.33	25.00	
≥3	8	30	16	4	2	60
	3.39	12.71	6.78	1.69	0.85	25.42
	13.33	50.00	26.67	6.67	3.33	
	16.33	30.30	24.24	22.22	50.00	
Total	49	99	66	18	4	236
	20.76	41.95	27.97	7.63	1.69	100.00

Years Experience (y axis) by "Boundary Distinguished By"- 6 Points (x axis)

Frequency, Percent, Row Pct, Col Pct	0	1	2	3	4	5	Total
≤1	1	9	7	4	3	2	26
	1.69	15.25	11.86	6.78	5.08	3.39	44.07
	3.85	34.62	26.92	15.38	11.54	7.69	
	33.33	60.00	33.33	36.36	50.00	66.67	
2	1	1	8	4	3	1	18
	1.69	1.69	13.56	6.78	5.08	1.69	30.51
	5.56	5.56	44.44	22.22	16.67	5.56	
	33.33	6.67	38.10	36.36	50.00	33.33	
≥3	1	5	6	3	0	0	15
	1.69	8.47	10.17	5.08	0.00	0.00	25.42
	6.67	33.33	40.00	20.00	0.00	0.00	
	33.33	33.33	28.57	27.27	0.00	0.00	
Total	3	15	21	11	6	3	59
	5.08	25.42	35.59	18.64	10.17	5.08	100.00

Years Experience (y axis) by "Boundary Distinguished By"- 8 Points (x axis)

Frequency, Percent, Row Pct, Col Pct	0	1	2	3	4	5	6	7	Total
≤1	3	11	13	14	14	13	7	3	78
	1.69	6.21	7.34	7.91	7.91	7.34	3.95	1.69	44.07
	3.85	14.10	16.67	17.95	17.95	16.67	8.97	3.85	
	37.50	52.38	46.43	43.75	46.67	56.52	28.00	30.00	
2	2	4	7	11	11	8	7	4	54
	1.13	2.26	3.95	6.21	6.21	4.52	3.95	2.26	30.51
	3.70	7.41	12.96	20.37	20.37	14.81	12.96	7.41	
	25.00	19.05	25.00	34.38	36.67	34.78	28.00	40.00	
≥3	3	6	8	7	5	2	11	3	45
	1.69	3.39	4.52	3.95	2.82	1.13	6.21	1.69	25.42
	6.67	13.33	17.78	15.56	11.11	4.44	24.44	6.67	
	37.50	28.57	28.57	21.88	16.67	8.70	44.00	30.00	
Total	8	21	28	32	30	23	25	10	177
	4.52	11.86	15.82	18.08	16.95	12.99	14.12	5.65	100.00

Years Experience (y axis) by Texture-20 Points (x axis)

Frequency, Percent, Row Pct, Col Pct	0	4	8	12	16	20	Total
≤1	21	22	30	10	16	5	104
	8.90	9.32	12.71	4.24	6.78	2.12	44.07
	20.19	21.15	28.85	9.62	15.38	4.81	
	70.00	47.83	40.00	31.25	41.03	35.71	
2	8	13	26	12	8	5	72
	3.39	5.51	11.02	5.08	3.39	2.12	30.51
	11.11	18.06	36.11	16.67	11.11	6.94	
	26.67	28.26	34.67	37.50	20.51	35.71	
≥3	1	11	19	10	15	4	60
	0.42	4.66	8.05	4.24	6.36	1.69	25.42
	1.67	18.33	31.67	16.67	25.00	6.67	
	3.33	23.91	25.33	31.25	38.46	28.57	
Total	30	46	75	32	39	14	236
	12.71	19.49	31.78	13.56	16.53	5.93	100.00

Years Experience (y axis) by Hue-10 Points (x axis)

Frequency, Percent, Row Pct, Col Pct	0	2	4	6	8	10	Total
≤1	6	16	15	22	31	14	104
	2.54	6.78	6.36	9.32	13.14	5.93	44.07
	5.77	15.38	14.42	21.15	29.81	13.46	
	50.00	51.61	60.00	44.00	40.79	33.33	
2	3	14	5	16	22	12	72
	1.27	5.93	2.12	6.78	9.32	5.08	30.51
	4.17	19.44	6.94	22.22	30.56	16.67	
	25.00	45.16	20.00	32.00	28.95	28.57	
≥3	3	1	5	12	23	16	60
	1.27	0.42	2.12	5.08	9.75	6.78	25.42
	5.00	1.67	8.33	20.00	38.33	26.67	
	25.00	3.23	20.00	24.00	30.26	38.10	
Total	12	31	25	50	76	42	236
	5.08	13.14	10.59	21.19	32.20	17.80	100.00

Years Experience (y axis) by Value-10 Points (x axis)

Frequency, Percent, Row Pct, Col Pct	0	2	4	6	8	10	Total
≤1	0	7	10	35	33	19	104
	0.00	2.97	4.24	14.83	13.98	8.05	44.07
	0.00	6.73	9.62	33.65	31.73	18.27	
	0.00	63.64	43.48	52.24	38.82	38.78	
2	0	1	5	15	33	18	72
	0.00	0.42	2.12	6.36	13.98	7.63	30.51
	0.00	1.39	6.94	20.83	45.83	25.00	
	0.00	9.09	21.74	22.39	25.00	36.73	
≥3	1	3	8	17	19	12	60
	0.42	1.27	3.39	7.20	8.05	5.08	25.42
	1.67	5.00	13.33	28.33	31.67	20.00	
	100.00	27.27	34.78	25.37	22.35	24.49	
Total	1	11	23	67	85	49	236
	0.42	4.66	9.75	28.39	36.02	20.76	100.00

Years Experience (y axis) by Chroma-10 Points (x axis)

Frequency, Percent, Row Pct, Col Pct	0	2	4	6	8	10	Total
≤1	16	17	29	21	16	5	104
	6.78	7.20	12.29	8.90	6.78	2.12	44.07
	15.38	16.35	27.88	20.19	15.38	4.81	
	45.71	43.59	51.79	35.59	41.03	62.50	
2	10	14	11	21	15	1	72
	4.24	5.93	4.66	8.90	6.36	0.42	30.51
	13.89	19.44	15.28	29.17	20.83	1.39	
	28.57	35.90	19.64	35.59	38.46	12.50	
≥3	9	8	16	17	8	2	60
	3.81	3.39	6.78	7.20	3.39	0.85	25.42
	15.00	13.33	26.67	28.33	13.33	3.33	
	25.71	20.51	28.57	28.81	20.51	25.00	
Total	35	39	56	59	39	8	236
	14.83	16.53	23.73	25.00	16.53	3.39	100.00

Years Experience (y axis) by Structure Grade -10 Points (x axis)

Frequency, Percent, Row Pct, Col Pct	0	2	4	6	8	10	Total
≤1	6	14	24	36	19	5	104
	2.54	5.93	10.17	15.25	8.05	2.12	44.07
	5.77	13.46	23.08	34.62	18.27	4.81	
	66.67	51.85	46.15	48.00	31.67	38.46	
2	2	9	14	23	20	4	72
	0.85	3.81	5.93	9.75	8.47	1.69	30.51
	2.78	12.50	19.44	31.94	27.78	5.56	
	22.22	33.33	26.92	30.67	33.33	30.77	
≥3	1	4	14	16	21	4	60
	0.42	1.69	5.93	6.78	8.90	1.69	25.42
	1.67	6.67	23.33	26.67	35.00	6.67	
	11.11	14.81	26.92	21.33	35.00	30.77	
Total	9	27	52	75	60	13	236
	3.81	11.44	22.03	31.78	25.42	5.51	100.00

Years Experience (y axis) by Structure Shape-10 Points (x axis)

Frequency, Percent, Row Pct, Col Pct	0	2	4	5	6	8	10	Total
≤1	2	10	30	0	36	18	8	104
	0.85	4.24	12.71	0.00	15.25	7.63	3.39	44.07
	1.92	9.62	28.85	0.00	34.62	17.31	7.69	
	33.33	66.67	50.00	0.00	38.30	35.29	88.89	
2	3	1	15	0	34	19	0	72
	1.27	0.42	6.36	0.00	14.41	8.05	0.00	30.51
	4.17	1.39	20.83	0.00	47.22	26.39	0.00	
	50.00	6.67	25.00	0.00	36.17	37.25	0.00	
≥3	1	4	15	1	24	14	1	60
	0.42	1.69	6.36	0.42	10.17	5.93	0.42	25.42
	1.67	6.67	25.00	1.67	40.00	23.33	1.67	
	16.67	26.67	25.00	100.00	25.53	27.45	11.11	
Total	6	15	60	1	94	51	9	236
	2.54	6.36	25.42	0.42	39.83	21.61	3.81	100.00

Years Experience (y axis) by Parent Material -5 Points (x axis)

Frequency, Percent, Row Pct, Col Pct	0	5	Total
≤1	22	82	104
	9.32	34.75	44.07
	21.15	78.85	
	42.31	44.57	
2	15	57	72
	6.36	24.15	30.51
	20.83	79.17	
	28.85	30.98	
≥3	15	45	60
	6.36	19.07	25.42
	25.00	75.00	
	28.85	24.46	
Total	52	184	236
	22.03	77.97	100.00

Years Experience (y axis) by Slope-5 Points (x axis)

Frequency, Percent, Row Pct, Column Pct	0	5	Total
≤1	16	88	104
	6.78	37.29	44.07
	15.38	84.62	
	50.00	43.14	
2	10	62	72
	4.24	26.27	30.51
	13.89	86.11	
	31.25	30.39	
≥3	6	54	60
	2.54	22.88	25.42
	10.00	90.00	
	18.75	26.47	
Total	32	204	236
	13.56	86.44	100.00

Years Experience (y axis) by Site Position-5 Points (x axis)

Frequency, Percent, Row Pct, Col Pct	0	5	Total
≤1	70	34	104
	29.66	14.41	44.07
	67.31	32.69	
	48.28	37.36	
2	39	33	72
	16.53	13.98	30.51
	54.17	45.83	
	26.90	36.26	
≥3	36	24	60
	15.25	10.17	25.42
	60.00	40.00	
	24.83	26.37	
Total	145	91	236
	61.44	38.56	100.00

Years Experience (y axis) by Wetness Class-5 Points (x axis)

Frequency, Percent, Row Pct, Col Pct	0	5	Total
≤1	29	75	104
	12.29	31.78	44.07
	27.89	72.12	
	46.77	43.10	
2	16	56	72
	6.78	23.73	30.51
	22.22	77.78	
	25.81	32.18	
≥3	17	43	60
	7.20	18.22	25.42
	28.33	71.67	
	27.42	24.71	
Total	62	174	236
	26.27	73.73	100.00

Analysis of Variance-Means Classified by the Variable Experience

Exper	N	MAS10	DEPTH 8	TEX20	HUE10	VALUE10	CHROMA10
≤1	104	7.98	2.35	7.73	5.89	6.90	4.37
2	72	8.11	2.69	8.78	6.11	7.72	4.56
≥3	60	8.14	2.73	10.6	7.30	6.87	4.43

Exper	N	STRG10	STRS10	PM5	SLPE5	POS5	WET5
≤1	104	5.21	5.58	3.94	4.23	1.63	3.61
2	72	5.72	5.81	3.96	4.31	2.29	3.89
≥3	60	6.13	5.65	3.75	4.50	2.0	3.58

	BDB6			BDB8	
Exper	N	Mean	Exper	N	Mean
≤1	26	2.19	1	78	3.37
2	18	2.56	2	54	3.80
≥3	15	1.73	3	45	3.56

Population Means

Variable	Population	Mean	Std. Deviation
Master Horizons(10)	236	8.0	1.94
Boundary Depth (8)	236	2.6	1.86
Boundary Distinguished By (6)	59	2.2	1.22
Boundary Distinguished By (8)	177	3.6	1.90
Texture (20)	236	8.8	5.66
Hue (10)	236	6.3	2.90
Value (10)	236	7.1	2.18
Chroma (10)	236	4.4	2.78
Structure Grade (10)	236	5.6	2.41
Structure Shape (10)	236	5.7	2.08
Parent Material (5)	236	3.9	2.08
Slope (5)	236	4.3	1.72
Site Position (5)	236	1.9	2.44
Wetness Class (5)	236	3.7	2.21

APPENDIX B

Years Experience (y axis) by Master Horizons-10 Points (x axis)

Frequency, Percent, Row Pct, Col. Pct	2	4	6	8	10	Total
≤1	1	0	3	8	3	15
	1.59	0.00	4.76	12.70	4.76	23.81
	6.67	0.00	20.00	53.33	20.00	
	100.00	0.00	60.00	17.39	30.00	
2	0	0	2	20	3	25
	0.00	0.00	3.17	31.75	4.76	39.68
	0.00	0.00	8.00	80.00	12.00	
	0.00	0.00	40.00	43.48	30.00	
≥3	0	1	0	18	4	23
	0.00	1.59	0.00	28.57	6.35	36.51
	0.00	4.35	0.00	78.26	17.39	
	0.00	100.00	0.00	39.13	40.00	
Total	1	1	5	46	10	63
	1.59	1.59	7.94	73.02	15.87	100.00

Years Experience (y axis) by Master Horizons -12 Points (x axis)

Frequency, Percent, Row Pct, Col Pct	2	4	6	8	10	12	Total
≤1	1	0	4	10	13	17	45
	0.53	0.00	2.12	5.29	6.88	8.99	23.81
	2.22	0.00	8.89	22.22	28.89	37.78	
	100.00	0.00	50.00	32.26	20.31	20.24	
2	0	1	2	9	27	36	75
	0.00	0.53	1.06	4.76	14.29	19.05	39.68
	0.00	1.33	2.67	12.00	36.00	48.00	
	0.00	100.00	25.00	29.03	42.19	42.86	
≥3	0	0	2	12	24	31	69
	0.00	0.00	1.06	6.35	12.70	16.40	36.51
	0.00	0.00	2.90	17.39	34.78	44.93	
	0.00	0.00	25.00	38.71	37.50	36.90	
Total	1	1	8	31	64	84	189
	0.53	0.53	4.23	16.40	33.86	44.44	100.00

Years Experience (y axis) by Boundary Depth-8 Points (x axis)

Frequency, Percent, Row Pct, Col Pct	0	2	4	6	8	Total
≤1	0	3	8	4	0	15
	0.00	4.76	12.70	6.35	0.00	23.81
	0.00	20.00	53.33	26.67	0.00	
	0.00	30.00	25.00	21.05	0.00	
2	0	5	16	4	0	25
	0.00	7.94	25.40	6.35	0.00	39.68
	0.00	20.00	64.00	16.00	0.00	
	0.00	50.00	50.00	21.05	0.00	
≥3	1	2	8	11	1	23
	1.59	3.17	12.70	17.46	1.59	36.51
	4.35	8.70	34.78	47.83	4.35	
	100.00	20.00	25.00	57.89	100.00	
Total	1	10	32	19	1	63
	1.59	15.87	50.79	30.16	1.59	100.00

Years Experience (y axis) by Boundary Depth -10 Points (x axis)

Frequency, Percent, Row Pct, Col Pct	0	2	4	6	8	10	Total
≤1	4	12	17	8	4	0	45
	2.12	6.35	8.99	4.23	2.12	0.00	23.81
	8.89	26.67	37.78	17.78	8.89	0.00	
	57.14	36.36	21.25	16.33	21.05	0.00	
2	0	13	37	16	9	0	75
	0.00	6.88	19.58	8.47	4.76	0.00	39.68
	0.00	17.33	49.33	21.33	12.00	0.00	
	0.00	39.39	46.25	32.65	47.37	0.00	
≥3	3	8	26	25	6	1	69
	1.59	4.23	13.76	13.23	3.17	0.53	36.51
	4.35	11.59	37.68	36.23	8.70	1.45	
	42.86	24.24	32.50	51.02	31.58	100.00	
Total	7	33	80	49	19	1	189
	3.70	17.46	42.33	25.93	10.05	0.53	100.00

Years Experience (y axis) by Texture -10 Points (x axis)

Frequency, Percent, Row Pct, Col Pct	0	2	4	6	8	10	Total
≤1	2	3	6	3	1	0	15
	3.17	4.76	9.52	4.76	1.59	0.00	23.81
	13.33	20.00	40.00	20.00	6.67	0.00	
	18.18	27.27	37.50	17.65	16.67	0.00	
2	5	6	3	8	2	1	25
	7.94	9.52	4.76	12.70	3.17	1.59	39.68
	20.00	24.00	12.00	32.00	8.00	4.00	
	45.45	54.55	18.75	47.06	33.33	50.00	
≥3	4	2	7	6	3	1	23
	6.35	3.17	11.11	9.52	4.76	1.59	36.51
	17.39	8.70	30.43	26.09	13.04	4.35	
	36.36	18.18	43.75	35.29	50.00	50.00	
Total	11	11	16	17	6	2	63
	17.46	17.46	25.40	26.98	9.52	3.17	100.00

Years Experience (y axis) by Texture-12 Points (x axis)

Frequency, Percent, Row Pct, Col Pct	0	2	4	6	8	10	12	Total
≤1	1	3	5	7	23	5	1	45
	0.53	1.59	2.65	3.70	12.17	2.65	0.53	23.81
	2.22	6.67	11.11	15.56	51.11	11.11	2.22	
	100.00	27.27	29.41	16.67	30.67	13.16	20.00	
2	0	3	8	13	32	17	2	75
	0.00	1.59	4.23	6.88	16.93	8.99	1.06	39.68
	0.00	4.00	10.67	17.33	42.67	22.67	2.67	
	0.00	27.27	47.06	30.95	42.67	44.74	40.00	
≥3	0	5	4	22	20	16	2	69
	0.00	2.65	2.12	11.64	10.58	8.47	1.06	36.51
	0.00	7.25	5.80	31.88	28.99	23.19	2.90	
	0.00	45.45	23.53	52.38	26.67	42.11	40.00	
Total	1	11	17	42	75	38	5	189
	0.53	5.82	8.99	22.22	39.68	20.11	2.65	100.00

Years Experience (y axis) by Hue -10 Points (x axis)

Frequency, Percent, Row Pct, Col Pct	2	4	6	8	10	Total
≤1	0	6	4	1	4	15
	0.00	9.52	6.35	1.59	6.35	23.81
	0.00	40.00	26.67	6.67	26.67	
	0.00	35.29	44.44	7.69	17.39	
2	0	5	3	6	11	25
	0.00	7.94	4.76	9.52	17.46	39.68
	0.00	20.00	12.00	24.00	44.00	
	0.00	29.41	33.33	46.15	47.83	
≥3	1	6	2	6	8	23
	1.59	9.52	3.17	9.52	12.70	36.51
	4.35	26.09	8.70	26.09	34.78	
	100.00	35.29	22.22	46.15	34.78	
Total	1	17	9	13	23	63
	1.59	26.98	14.29	20.63	36.51	100.00

Years Experience (y axis) by Hue -12 Points (x axis)

Frequency, Percent, Row Pct, Col Pct	2	4	6	8	10	12	Total
≤1	0	0	2	12	8	23	45
	0.00	0.00	1.06	6.35	4.23	12.17	23.81
	0.00	0.00	4.44	26.67	17.78	51.11	
	0.00	0.00	28.57	30.77	15.69	25.84	
2	1	1	3	15	23	32	75
	0.53	0.53	1.59	7.94	12.17	16.93	39.68
	1.33	1.33	4.00	20.00	30.67	42.67	
	100.00	50.00	42.86	38.46	45.10	35.96	
≥3	0	1	2	12	20	34	69
	0.00	0.53	1.06	6.35	10.58	17.99	36.51
	0.00	1.45	2.90	17.39	28.99	49.28	
	0.00	50.00	28.57	30.77	39.22	38.20	
Total	1	2	7	39	51	89	189
	0.53	1.06	3.70	20.63	26.98	47.09	100.00

Years Experience (y axis) by Value-10 Points (x axis)

Frequency, Percent, Row Pct, Col Pct	2	4	6	8	10	Total
≤1	2	5	4	3	1	15
	3.17	7.94	6.35	4.76	1.59	23.81
	13.33	33.33	26.67	20.00	6.67	
	66.67	29.41	20.00	27.27	8.33	
2	1	7	8	4	5	25
	1.59	11.11	12.70	6.35	7.94	39.68
	4.00	28.00	32.00	16.00	20.00	
	33.33	41.18	40.00	36.36	41.67	
≥3	0	5	8	4	6	23
	0.00	7.94	12.70	6.35	9.52	36.51
	0.00	21.74	34.78	17.39	26.09	
	0.00	29.41	40.00	36.36	50.00	
Total	3	17	20	11	12	63
	4.76	26.98	31.75	17.46	19.05	100.00

Years Experience (y axis) by Value -12 Points (x axis)

Frequency, Percent, Row Pct, Col Pct	2	4	6	8	10	12	Total
≤1	2	2	10	10	11	10	45
	1.06	1.06	5.29	5.29	5.82	5.29	23.81
	4.44	4.44	22.22	22.22	24.44	22.22	
	100.00	12.50	38.46	18.87	23.40	22.22	
2	0	8	8	26	18	15	75
	0.00	4.23	4.23	13.76	9.52	7.94	39.68
	0.00	10.67	10.67	34.67	24.00	20.00	
	0.00	50.00	30.77	49.06	38.30	33.33	
≥3	0	6	8	17	18	20.00	69
	0.00	3.17	4.23	8.99	9.52	10.58	36.51
	0.00	8.70	11.59	24.64	26.09	28.99	
	0.00	37.50	30.77	32.08	38.30	44.44	
Total	2	16	26	53	47	45	189
	1.06	8.47	13.76	28.04	24.87	23.81	100.00

Years Experience (y axis) by Chroma -10 Points (x axis)

Frequency, Percent, Row Pct, Col Pct	0	2	4	6	8	10	Total
≤1	0	1	5	7	2	0	15
	0.00	1.59	7.94	11.11	3.17	0.00	23.81
	0.00	6.67	33.33	46.67	13.33	0.00	
	0.00	25.00	21.74	31.82	18.18	0.00	
2	2	2	7	6	7	1	25
	3.17	3.17	11.11	9.52	11.11	1.59	39.68
	8.00	8.00	28.00	24.00	28.00	4.00	
	100.00	50.00	30.43	27.27	63.64	100.00	
≥3	0	1	11	9	2	0	23
	0.00	1.59	17.46	14.29	3.17	0.00	36.51
	0.00	4.35	47.83	39.13	8.70	0.00	
	0.00	25.00	47.83	40.91	18.18	0.00	
Total	2	4	23	22	11	1	63
	3.17	6.35	36.51	34.92	17.46	1.59	100.00

Years Experience (y axis) by Chroma - 12 Points (x axis)

Frequency, Percent, Row Pct, Col Pct	0	2	4	6	8	10	12	Total
≤1	1	1	7	13	12	7	4	45
	0.53	0.53	3.70	6.88	6.35	3.70	2.12	23.81
	2.22	2.22	15.56	28.89	26.67	15.56	8.89	
	50.00	20.00	25.00	27.66	23.08	19.44	21.05	
2	1	2	10	12	24	18	8	75
	0.53	1.06	5.29	6.35	12.70	9.52	4.23	39.68
	1.33	2.67	13.33	16.00	32.00	24.00	10.67	
	50.00	40.00	35.71	25.53	46.15	50.00	42.11	
≥3	0	2	11	22	16	11	7	69
	0.00	1.06	5.82	11.64	8.47	5.82	3.70	36.51
	0.00	2.90	15.94	31.88	23.19	15.94	10.14	
	0.00	40.00	39.29	46.81	30.77	30.56	36.84	
Total	2	5	28	47	52	36	19	189
	1.06	2.65	14.81	24.87	27.51	19.05	10.05	100.00

Years Experience (y axis) by Structure Grade -10 Points (x axis)

Frequency, Percent, Row Pct, Col Pct	0	2	4	6	8	10	Total
≤1	1	1	5	5	2	1	15
	1.59	1.59	7.94	7.94	3.17	1.59	23.81
	6.67	6.67	33.33	33.33	13.33	6.67	
	50.00	33.33	33.33	25.00	10.00	33.33	
2	0	1	7	7	8	2	25
	0.00	1.59	11.11	11.11	12.70	3.17	39.68
	0.00	4.00	28.00	28.00	32.00	8.00	
	0.00	33.33	46.67	35.00	40.00	66.67	
≥3	1	1	3	8	10	0	23
	1.59	1.59	4.76	12.70	15..87	0.00	36.51
	4.35	4.35	13.04	34.78	43.48	0.00	
	50.00	33.33	20.00	40.00	50.00	0.00	
Total	2	3	15	20	20	3	63
	3.17	4.76	23.81	31.75	31.75	4.76	100.00

Years Experience (y axis) by Structure Grade-12 Points (x axis)

Frequency, Percent, Row Pct, Col Pct	0	2	4	6	8	10	12	Total
≤1	2	3	7	14	9	9	1	45
	1.06	1.59	3.70	7.41	4.76	4.76	0.53	23.81
	4.44	6.67	15.56	31.11	20.00	20.00	2.22	
	66.67	60.00	36.84	27.45	16.36	18.75	12.50	
2	1	0	4	20	27	20	3	75
	0.53	0.00	2.12	10.58	14.29	10.58	1.59	39.68
	1.33	0.00	5.33	26.67	36.00	26.67	4.00	
	33.33	0.00	21.05	39.22	49.09	41.67	37.50	
≥3	0	2	8	17	19	19	4	69
	0.00	1.06	4.23	8.99	10.05	10.05	2.12	36.51
	0.00	2.90	11.59	24.64	27.54	27.54	5.80	
	0.00	40.00	42.11	33.33	34.55	39.58	50.00	
Total	3	5	19	51	55	48	8	189
	1.59	2.65	10.05	26.98	29.10	25.40	4.23	100.00

Years Experience (y axis) by Structure Shape -10 Points (x axis)

Frequency, Percent, Row Pct, Col Pct	2	4	6	8	10	Total
≤1	0	0	5	5	5	15
	0.00	0.00	7.94	7.94	7.94	23.81
	0.00	0.00	33.33	33.33	33.33	
	0.00	0.00	45.45	15.63	35.71	
2	0	2	4	14	5	25
	0.00	3.17	6.35	22.22	7.94	39.68
	0.00	8.00	16.00	56.00	20.00	
	0.00	40.00	36.36	43.75	35.71	
≥3	1	3	2	13	4	23
	1.59	4.76	3.17	20.63	6.35	36.51
	4.35	13.04	8.70	56.52	17.39	
	100.00	60.00	18.18	40.63	28.57	
Total	1	5	11	32	14	63
	1.59	7.94	17.46	50.79	22.22	100.00

Years Experience (y axis) by Structure Shape-12 Points (x axis)

Frequency, Percent, Row Pct, Col Pct	0	2	4	6	8	10	12	Total
≤1	1	2	4	7	10	15	6	45
	0.53	1.06	2.12	3.70	5.29	7.94	3.17	23.81
	2.22	4.44	8.89	15.56	22.22	33.33	13.33	
	20.00	22.22	20.00	25.93	31.25	23.81	18.18	
2	1	3	8	12	9	29	13	75
	0.53	1.59	4.23	6.35	4.76	15.34	6.88	39.68
	1.33	4.00	10.67	16.00	12.00	38.67	17.33	
	20.00	33.33	40.00	44.44	28.13	46.03	39.39	
≥3	3	4	8	8	13	19	14	69
	1.59	2.12	4.23	4.23	6.88	10.05	7.41	36.51
	4.35	5.80	11.59	11.59	18.84	27.54	20.29	
	60.00	44.44	40.00	29.63	40.63	30.16	42.42	
Total	5	9	20	27	32	63	33	189
	2.65	4.76	10.58	14.29	16.93	33.33	17.46	100.00

Years Experience (y axis) by Parent Material -5 Points (x axis)

Frequency, Percent, Row Pct, Col Pct	0	5	Total
≤1	16	14	30
	12.70	11.11	23.81
	53.33	46.67	
	29.63	19.44	
2	15	35	50
	11.90	27.78	39.68
	30.00	70.00	
	27.78	48.61	
≥3	23	23	46
	18.25	18.25	36.51
	50.00	50.00	
	42.59	31.94	
Total	54	72	126
	42.86	57.14	100.00

Years Experience (y axis) by Parent Material -10 Points (x axis)

Frequency, Percent, Row Pct, Col Pct	0	5	10	Total
≤1	2	1	12	15
	3.17	1.59	19.05	23.81
	13.33	6.67	80.00	
	40.00	7.14	27.27	
2	0	8	17	25
	0.00	12.70	26.98	39.68
	0.00	32.00	68.00	
	0.00	57.14	38.64	
≥3	3	5	15	23
	4.76	7.94	23.81	36.51
	13.04	21.74	65.22	
	60.00	35.71	34.09	
Total	5	14	44	63
	7.94	22.22	69.84	100.00

Years Experience (y axis) by Parent Material -15 Points (x axis)

Frequency, Percent, Row Pct, Col Pct	0	5	10	15	Total
≤1	4	3	7	1	15
	6.35	4.76	11.11	1.59	23.81
	26.67	20.00	46.67	6.67	
	44.44	37.50	16.28	33.33	
2	3	4	16	2	25
	4.76	6.35	25.40	3.17	39.68
	12.00	16.00	64.00	8.00	
	33.33	50.00	37.21	66.67	
≥3	2	1	20	0	23
	3.17	1.59	31.75	0.00	36.51
	8.70	4.35	86.96	0.00	
	22.22	12.50	46.51	0.00	
Total	9	8	43	3	63
	14.29	12.70	68.25	4.76	100.00

Years Experience (y axis) by Slope -5 Points (x axis)

Frequency, Percent, Row Pct, Col Pct	0	5	Total
≤1	19	41	60
	7.54	16.27	23.81
	31.67	68.33	
	38.00	20.30	
2	12	88	100
	4.76	34.92	39.68
	12.00	88.00	
	24.00	43.56	
≥3	19	73	92
	7.54	28.97	36.51
	20.65	79.35	
	38.00	36.14	
Total	50	202	252
	19.84	80.16	100.00

Years Experience (y axis) by Site Position- 5 Points (x axis)

Frequency, Percent, Row Pct, Col Pct	0	5	Total
≤1	13	47	60
	5.16	18.65	23.81
	21.67	78.33	
	21.67	24.48	
2	21	79	100
	8.33	31.35	39.68
	21.00	79.00	
	35.00	41.15	
≥3	26	66	92
	10.32	26.19	36.51
	28.26	71.74	
	43.33	34.38	
Total	60	192	252
	23.81	76.19	100.00

Years Experience (y axis) by Family Particle Size-5 Points (x axis)

Frequency, Percent, Row Pct, Col Pct	0	5	Total
≤1	14	46	60
	5.56	18.25	23.81
	23.33	76.67	
	25.93	23.23	
2	21	79	100
	8.33	31.35	39.68
	21.00	79.00	
	38.89	39.90	
≥3	19	73	92
	7.54	28.97	36.51
	20.65	79.35	
	35.19	36.87	
Total	54	198	252
	21.43	78.57	100.00

Years Experience (y axis) by Soil Depth -5 Points (x axis)

Frequency, Percent, Row Pct, Col Pct	0	5	Total
≤1	5	55	60
	1.98	21.83	23.81
	8.33	91.67	
	31.25	23.31	
2	6	94	100
	2.38	37.30	39.68
	6.00	94.00	
	37.50	39.83	
≥3	5	87	92
	1.98	34.52	36.51
	5.43	94.57	
	31.25	36.86	
Total	16	236	252
	6.35	93.65	100.00

Years Experience (y axis) by Wetness Class-5 Points (x axis)

Frequency, Percent, Row Pct, Col Pct	0	5	Total
≤1	14	46	60
	5.56	18.25	23.81
	23.23	76.67	
	25.93	23.23	
2	21	79	100
	8.33	31.35	39.68
	21.00	79.00	
	38.89	39.90	
≥3	19	73	92
	7.54	28.97	36.51
	20.65	79.35	
	35.19	36.87	
Total	54	198	252
	21.43	78.57	100.00

Population Means

Variable	Population	Mean	Std. Deviation
Master horizons (10)	63	8.0	1.34
Master horizons (12)	189	10.3	1.89
Boundary depth (8)	63	4.3	1.52
Boundary depth (10)	189	4.5	1.99
Texture (10)	63	4.1	2.71
Texture (12)	189	7.3	2.35
Hue (10)	63	7.3	2.55
Hue (12)	189	10.3	1.99
Value (10)	63	6.4	2.35
Value (12)	189	8.8	2.55
Chroma (10)	63	5.2	2.01
Chroma (12)	189	7.4	2.66
Structure grade (10)	63	6.0	2.23
Structure grade (12)	189	7.4	2.47
Structure shape (10)	63	7.7	1.84
Structure shape (12)	189	8.2	3.13
Parent material (5)	126	2.9	2.48
Parent material (10)	63	8.1	3.17
Parent material (15)	63	8.2	3.95
Slope (5)	252	4.0	2.00
Site position (5)	252	3.8	2.13
Family particle size (5)	252	3.5	2.50
Wetness class (5)	252	3.9	2.06
Soil depth (5)	252	4.7	1.22

Analysis of Variance-Means Classified by Variable Experience

EXPER	N	MAS10	DEPTH8	TEX10	HUE10	VALUE10	CHROMA10
≤1	15	7.6	4.1	3.7	6.4	5.5	5.3
2	25	8.1	3.9	3.9	7.8	6.4	5.4
≥3	23	8.2	4.8	4.4	7.2	7.0	5.0

Analysis of Variance-Means Classified by Variable Experience - continued

EXPER	N	STRG10	STRS10	PM10	PM15
≤1	15	5.2	8.0	8.3	6.7
2	25	6.2	7.8	8.4	8.4
≥3	23	6.2	7.4	7.6	8.9

EXPER	N	MAS12	DEPTH10	TEX12	HUE12	VALUE12	CHROMA12
≤1	45	9.8	3.8	7.0	10.3	8.5	7.2
2	75	10.5	4.6	7.5	10.1	8.6	7.8
≥3	69	10.4	4.8	7.3	10.4	9.1	7.3

EXPER	N	STRG12	STRS12
≤1	45	6.5	8.1
2	75	7.8	8.4
≥3	69	7.7	8.0

EXPER	N	STRG12
≤1	30	2.3
2	50	3.5
≥3	46	2.5

Analysis of Variance-Means Classified by Variable Experience – continued

EXPER	N	SLOPE5	POS5	FPS5	WETC5	SOILD5
≤1	60	3.4	3.9	1.8	3.8	4.6
2	100	4.4	4.0	3.1	4.0	4.7
≥3	92	4.0	3.6	2.4	4.0	4.7

APPENDIX C

Years Experience (y axis) by Master Horizons-10 Points (x axis)

Frequency, Percent, Row Pct, Col Pct	2	4	6	8	10	Total
≤1	1	0	4	23	20	48
	1.14	0.00	4.55	26.14	22.73	54.55
	2.08	0.00	8.33	47.92	41.67	
	100.00	0.00	66.67	60.53	48.78	
≥2	0	2	2	15	21	40
	0.00	2.27	2.27	17.05	23.86	45.45
	0.00	5.00	5.00	37.50	52.50	
	0.00	100.00	33.33	39.47	51.22	
Total	1	2	6	38	41	88
	1.14	2.27	6.82	43.18	46.59	100.00

Years Experience (y axis) by Boundary Depth-8 Points (x axis)

Frequency, Percent, Row Pct, Col Pct	0	2	4	6	8	Total
≤1	0	11	21	10	6	48
	0.00	12.50	23.86	11.36	6.82	54.55
	0.00	22.92	43.75	20.83	12.50	
	0.00	55.00	61.76	52.63	54.55	
≥2	4	9	13	9	5	40
	4.55	10.23	14.77	10.23	5.68	45.45
	10.00	22.50	32.50	22.50	12.50	
	100.00	45.00	38.24	47.37	45.45	
Total	4	20	34	19	11	88
	4.55	22.73	38.64	21.59	12.50	100.00

Years Experience (y axis) by Texture -20 Points (x axis)

Frequency, Percent, Row Pct, Col Pct	0	4	8	12	16	20	Total
≤1	3	3	7	13	15	7	48
	3.41	3.41	7.95	14.77	17.05	7.95	54.55
	6.25	6.25	14.58	27.08	31.25	14.58	
	60.00	50.00	53.85	52.00	62.50	46.67	
≥2	2	3	6	12	9	8	40
	2.27	3.41	6.82	13.64	10.23	9.09	45.45
	5.00	7.50	15.00	30.00	22.50	20.00	
	40.00	50.00	46.15	48.00	37.50	53.33	
Total	5	6	13	25	24	15	88
	5.68	6.82	14.77	28.41	27.27	17.05	100.00

Years Experience (y axis) by Hue-10 Points (x axis)

Frequency, Percent, Row Pct, Col Pct	0	1	2	3	4	5	Total
≤1	7	0	2	0	7	2	48
	7.95	0.00	2.27	0.00	7.95	2.27	54.55
	14.58	0.00	4.17	0.00	14.58	4.17	
	63.64	0.00	33.33	0.00	46.67	100.00	
≥2	4	2	4	2	8	0	40
	4.55	2.27	4.55	2.27	9.09	0.00	45.45
	10.00	5.00	10.00	5.00	20.00	0.00	
	36.36	100.00	66.67	100.00	53.33	0.00	
Total	11	2	6	2	15	2	88
	12.50	2.27	6.82	2.27	17.05	2.27	100.00

Years Experience (y axis) by Hue-10 Points (x axis) - continued

Frequency, Percent, Row Pct, Col Pct	6	7	8	9	10	Total
≤1	9	0	9	8	4	48
	10.23	0.00	10.23	9.09	4.55	54.55
	18.75	0.00	18.75	16.67	8.33	
	64.29	0.00	69.23	66.67	44.44	
≥2	5	2	4	4	5	40
	5.68	2.27	4.55	4.55	5.68	45.45
	12.50	5.00	10.00	10.00	12.50	
	35.71	100.00	30.77	33.33	55.56	
Total	14	2	13	12	9	88
	15.91	2.27	14.77	13.64	10.23	100.00

Years Experience (y axis) by Value-10 Points (x axis)

Frequency, Percent, Row Pct, Col Pct	0	2	3	4	5	Total
≤1	1	1	1	3	2	48
	1.14	1.14	1.14	3.41	2.27	54.55
	2.08	2.08	2.08	6.25	4.17	
	33.33	20.00	100.00	50.00	66.67	
≥2	2	4	0	3	1	40
	2.27	4.55	0.00	3.41	1.14	45.45
	5.00	10.00	0.00	7.50	2.50	
	66.67	80.00	0.00	50.00	33.33	
Total	3	5	1	6	3	88
	3.41	5.68	1.14	6.82	3.41	100.00

Years Experience (y axis) by Value-10 Points (x axis) - continued

Frequency, Percent, Row Pct, Col Pct	6	7	8	9	10	Total
≤1	12	6	16	0	6	48
	13.64	6.82	18.18	0.00	6.82	54.55
	25.00	12.50	33.33	0.00	12.50	
	54.55	54.55	69.57	0.00	50.00	
≥2	10	5	7	2	6	40
	11.36	5.68	7.95	2.27	6.82	45.45
	25.00	12.50	17.50	5.00	15.00	
	45.45	45.45	30.43	100.00	50.00	
Total	22	11	23	2	12	88
	25.00	12.50	26.14	2.27	13.64	100.00

Years Experience (y axis) by Chroma-10 Points (x axis)

Frequency, Percent, Row Pct, Col Pct	2	3	4	5	6	Total
≤1	2	1	4	1	19	48
	2.27	1.14	4.55	1.14	21.59	54.55
	4.17	2.08	8.33	2.08	39.58	
	33.33	33.33	57.14	25.00	73.08	
≥2	4	2	3	3	7	40
	4.55	2.27	3.41	3.41	7.95	45.45
	10.00	5.00	7.50	7.50	17.50	
	66.67	66.67	42.86	75.00	26.92	
Total	6	3	7	4	26	88
	6.82	3.41	7.95	4.55	29.55	100.00

Years Experience (y axis) by Chroma-10 Points (x axis) - continued

Frequency, Percent, Row Pct, Col Pct	7	8	9	10	Total
≤1	3	5	1	12	48
	3.41	5.68	1.14	13.64	54.55
	6.25	10.42	2.08	25.00	
	42.86	38.46	100.00	57.14	
≥2	4	8	0	9	40
	4.55	9.09	0.00	10.23	45.45
	10.00	20.00	0.00	22.50	
	57.14	61.54	0.00	42.86	
Total	7	13	1	21	88
	7.95	14.77	1.14	23.86	100.00

Years Experience (y axis) by Structure Grade-10 Points (x axis)

Frequency, Percent, Row Pct, Col Pct	0	2	4	6	8	10	Total
≤1	5	9	12	8	9	5	48
	5.68	10.23	13.64	9.09	10.23	5.68	54.55
	10.42	18.75	25.00	16.67	18.75	10.42	
	71.43	52.94	75.00	53.33	52.94	31.25	
≥2	2	8	4	7	8	11	40
	2.27	9.09	4.55	7.95	9.09	12.50	45.45
	5.00	20.00	10.00	17.50	20.00	27.50	
	28.57	47.06	25.00	46.67	47.06	68.75	
Total	7	17	16	15	17	16	88
	7.95	19.32	18.18	17.05	19.32	18.18	100.00

Years Experience (y axis) by Structure Shape-10 Points (x axis)

Frequency, Percent, Row Pct, Col Pct	0	2	4	6	8	10	Total
≤1	3	5	7	17	13	3	48
	3.41	5.68	7.95	19.32	14.77	3.41	54.55
	6.25	10.42	14.58	35.42	27.08	6.25	
	60.00	55.56	38.89	56.67	61.90	60.00	
≥2	2	4	11	13	8	2	40
	2.27	4.55	12.50	14.77	9.09	2.27	45.45
	5.00	10.00	27.50	32.50	20.00	5.00	
	40.00	44.44	61.11	43.33	38.10	40.00	
Total	5	9	18	30	21	5	88
	5.68	10.23	20.45	34.09	23.86	5.68	100.00

Years Experience (y axis) by Parent Material-5 Points (x axis)

Frequency, Percent, Row Pct, Col Pct	0	2	5	Total
≤1	11	3	34	48
	12.50	3.41	38.64	54.55
	22.92	6.25	70.83	
	50.00	100.00	53.97	
≥2	11	0	29	40
	12.50	0.00	32.95	45.45
	27.50	0.00	72.50	
	50.00	0.00	46.03	
Total	22	3	63	88
	25.00	3.41	71.59	100.00

Years Experience (y axis) by Slope-5 Points (x axis)

Frequency, Percent, Row Pct, Col Pct	0	5	Total
≤1	10	38	48
	11.36	43.18	54.55
	20.83	79.17	
	62.50	52.78	
≥2	6	34	40
	6.82	38.64	45.45
	15.00	85.00	
	37.50	47.22	
Total	16	72	88
	18.18	81.82	100.00

Years Experience (y axis) by Site Position-5 Points (x axis)

Frequency, Percent, Row Pct, Col Pct	0	5	Total
≤1	8	40	48
	9.09	45.45	54.55
	16.67	83.33	
	57.14	54.05	
≥2	6	34	40
	6.82	38.64	45.45
	15.00	85.00	
	42.86	45.95	
Total	14	74	88
	15.91	84.09	100.00

Years Experience (y axis) by Wetness Class-5 Points (x axis)

Frequency, Percent, Row Pct, Col Pct	0	5	Total
≤1	15	33	48
	17.05	37.50	54.55
	31.25	68.75	
	53.57	55.00	
≥2	13	27	40
	14.77	30.68	45.45
	32.50	67.50	
	46.43	45.00	
Total	28	60	88
	31.82	68.18	100.00

Analysis of Variance-Means Classified by Variable Experience

EXPER	N	MAS10	DEPTH8	TEX20	HUE10	VALUE10	CHROMA10
≤1	48	8.54	4.46	12.58	5.83	6.85	6.92
≥2	40	8.75	4.1	12.70	5.25	6.35	6.63

EXPER	N	STRG10	STRS10	PM5	SLOPE5	POS5	WET5
≤1	48	4.92	5.71	3.67	3.96	4.17	3.44
≥2	40	6.20	5.35	3.63	4.25	4.25	3.38

Population Means

Variable	Population	Mean	Std. Deviation
Master horizons (10)	88	8.6	1.59
Boundary depth (8)	88	4.3	2.11
Texture (20)	88	12.6	5.49
Hue (10)	88	5.6	3.24
Value (10)	88	6.6	2.40
Chroma (10)	88	6.8	2.41
Structure grade (10)	88	5.5	3.20
Structure shape (10)	88	5.6	2.50
Parent material (5)	88	3.7	2.19
Slope (5)	88	4.1	1.94
Site position (5)	88	4.2	1.84
Wetness class (5)	88	3.4	2.34

APPENDIX D

Placement of the 577 Soil Series by Soil Depth Values

Soil Depth	# of Series	Series
Very Deep	245	Abbie, Abilene, Adaton, Agra, Albers, Albion, Aline, Alusa, Amber, Asa, Ashport, Aspermont, Axtell, Bastrop, Bathel, Baxter, Bayard, Beckman, Bergstrom, Bethany, Bibb, Bocox, Boley, Boxville, Brackett, Braman, Brewer, Brewless, Brico, Britwater, Burleson, Canadian, Caplina, Carman, Carwile, Carytown, Chancy, Choteau, Clairemont, Clarita, Clark, Clarksville, Clearfork, Colby, Colmor, Conlen, Counts, Craig, Cuevoland, Cupco, Dale, Daycreek, Dean, Deepwood, Dela, Delwin, Dennis, Derby, Devol, Dickson, Dillwyn, Doakum, Dodson, Doolin, Dougherty, Drummond, Dufau, Durant, Dwyer, Easpur, Eda, Eldorado, Elsemere, Ennis, Enterprise, Etowah, Ezell, Farry, Florita, Fortyone, Freestone, Frioton, Gaddy, Gallion, Garton, Gasil, Glenpool, Goodnight, Gowen, Gowton, Gracemont, Gracemore, Grandfield, Grandmore, Guyton, Harjo, Harrah, Healdton, Healing, Heman, Hibsaw, Holdrege, Hollister, Huntington, Irene, Irwin, Ivan, Jester, Kanima, Karma, Kaufman, Kemp, Keokuk, Kerrick, Kiomatia, Kirkland, Kirvin, Konawa, Lafe, Larton, Latanier, Lawrie, Lawton, Lebron, Lela, Leshara, Lesho, Lightning, Lincoln, Lovedale, Madge, Madill, Mangum, Mansic, Manter, Manzano, Martin, Mclain, Meno, Miles, Miller, Minco, Mobeetie, Moreland, Muldrow, Mulhall, Muskogee, Navina, Nixa, Noark, Nobscot, Norge, Norwood, Ochlockonee, Okay, Oklared, Oklark, Oscar, Ost, Otero, Parida, Parsons, Pawhuska, Perico, Pharoah, Pickton, Pickwick, Pledger, Pocola, Pond Creek, Port, Porum, Pratt, Pulaski, Randall, Reading, Redlake, Redport, Reinach, Renfrow, Rexor, Richfield, Riverton, Rochelle, Roebuck, Roxana, Ruella, Ruston, Sacul, Satanta, Selman, Seminole, Ships, Shrewder, Slaughterville, St. Paul, Staser, Stidham, Summit, Sweetwater, Tabler, Taft, Taloka, Tamaha, Tearney, Teller, Teval, Tiak, Tillman, Tipton, Tivoli, Tobosa, Tomast, Treadway, Tribbey, Trinity, Ustibuck, Valent, Vanoss, Veal, Verdigris, Vona, Wabbaseka, Wann, Watonga, Waurika, Waynoka, Weleetka, Westola, Westsum, Weswood, Wetbeth, Wetsaw, Wheatwood, Wichita, Wilson, Windthorst, Wing, Winters, Wisby, Wolfpen, Woods, Wrightsville, Wynona, Yahola
Deep	218	Agan, Altus, Apperson, Arkabutla, Asher, Attica, Aydelotte, Barge, Bamsdall, Benchley, Bengal, Bernow, Berthoud, Bippus, Blevins, Boggy, Bonham, Bonn, Bosville, Bronte, Brownfield, Bunyan, Burford, Burwell, Buttermilk, Cadeville, Cahaba, Cannon, Capps, Capulin, Caradan, Carey, Carnasaw, Case, Caspiana, Caston, Catoosa, Ceda, Cherokee, Chickasha, Chigley, Choska, Cleora, Clodine, Coalgate, Corbin, Corlena, Coushatta, Crevasse, Crisfield, Crockett, Culp, Cyril, Dalhart, Dallam, Darrouzett, Denman, Denton, Dioxice, Dwight, Elandco, Elkader, Elmont, Elsah, Elysian, Emachaya, Enders, Eufala, Farnum, Felker, Ferris, Fitzhugh, Flatonia, Flo, Foard, Frizzell, Galey, Garvin, Glentosh, Goltry, Grant, Greendale, Gruver, Guadalupe, Guy, Hamden, Hardeman, Harvey, Hawley, Heatly, Heiden, Hernandez, Hinkle, Hollywood, Homa, Honeycreek, Hopco, Humbarger, Huska, Idabel, Indiahoma, Ironbridge, Iuka, Jay, Johnsburg, Justin, Kamie, Kenesaw, Kenn, Keo, Kim, Kingsdown, Kinta, Konsil, Krier, Kullit, Larue, Las Animas, Latimer, Latrass, Lawrence, Lea, Liberal, Likes, Lipan, Littleaxe, Locust, Loflon, Lomill, Lugert, Lula, Majada, Mansker, Mason, Mayes, Mckamie, Mcknight, Menard, Midco, Milan, Missler, Moyers, Naldo, Neff, Ness, Newalla, Newtonia, Noble, Normangee, Nutivoli, Octavia, Okemah, Osage, Panama, Panola, Paymaster, Penden, Pocasset, Portales, Prue, Pullman, Pushmataha, Quarles, Radley, Ravia, Razort, Renthin, Retrop, Rickmore, Robinsonville, Romia, Roscoe, Rosebloom, Saffell, Salisaw, Sayers, Secesh, Severn, Shellabarger, Sherm, Shermore, Sherwood, Smithdale, Speer, Springer, Spur, Spurlock, Stapp, Stigler, Sunray, Tamford, Tenaha, Texline, Tonti, Tulia, Tullahassee, Tuscumbia, Ulysses, Venadito, Vernejo, Vian, Vingo, Waban, Waldeck, Weatherford, Westview, Weymouth, Whakana, Wilburton, Wister, Wolco, Woodson, Woodtell, Yanush, Yomont, Zaneis, Zevala, Zenda
Mod. Deep	63	Alikchi, Bates, Bigfork, Binger, Bolivar, Bostwick, Bromide, Carnero, Chupadera, Clearview, Clime, Cobb, Cowton, Coyle, Dill, Dilworth, Endsaw, Eram, Foraker, Friona, Gotebo, Grainola, Hartsells, Honobia, Kingfisher, Labette, Lancaster, Linker, Matoy, Naru, Nash, Nashoba, Nashville, Niotaze, Nowata, Obaro, Oklaha, Owens, Pickens, Piedmont, Pyrum, San Saba, Scullin, Sherless, Sobol, Somervell, Spiro, Stamford, Steedman, Stephenville, Stoneburg, Sumter, Teagard, Tussy, Tyende, Vernon, Vinita, Vinson, Wakita, Wewoka, Whitefield, Woodward, Zafra
Shallow	43	Acme, Apache, Balltown, Cartersville, Claremore, Clebit, Collinsville, Cordell, Cosh, Coweta, Darnell, Darsil, Glenrio, Goldston, Hector, Hedville, Highview, Ironmound, Kipson, Kiti, Knoco, Lenapah, Lequire, Loco, Lucien, Lueders, Masham, Pastura, Plack, Purves, Quinlan, Rayford, Slaughter, Swink, Tarlihini, Talpa, Tarrant, Timhill, Travertine, Travessilla, Tuskahoma, Wellsford, Woodford
Very Shal.	8	Blocker, Burson, Cornick, Cottonwood, Kimbrough, Potter, Shidler, Sogn

APPENDIX E

Placement of the 577 Soil Series by Drainage Class

Drainage Class	# of Series	Series
Exc. Drained	32	Albion, Aline, Balltown, Burson, Clarksville, Cordell, Crevasse, Darsil, Derby, Dwyer, Eda, Eufala, Flo, Gaddy, Glenpool, Glentosh, Goldston, Goodnight, Hedville, Jester, Kipson, Likes, Lincoln, Midco, Nutivoli, Pickens, Sayers, Sogn, Tivoli, Valent, Wewoka, Wisby
Well Drained	367	Abbie, Abilene, Acme, Albers, Altus, Amber, Apache, Asa, Ashport, Aspermont, Attica, Aydelotte, Barge, Barnsdall, Bastrop, Bates, Baxter, Bayard, Beckman, Benchley, Bengal, Bergstrom, Bernow, Berthoud, Bethany, Bigfork, Binger, Bippus, Blevins, Blocker, Bolivar, Bostwick, Boxville, Brackett, Braman, Brico, Britwater, Bromide, Bronte, Brownfield, Bunyan, Burford, Cahaba, Canadian, Cannon, Capps, Capulin, Caradan, Carey, Carnasaw, Carnero, Cartersville, Case, Caspiana, Caston, Catoosa, Ceda, Chickasha, Choska, Chupadera, Clairemont, Claremore, Clark, Clearfork, Clebit, Cleora, Clime, Coalgate, Cobb, Colby, Collinsville, Colmor, Conlen, Corbin, Corlena, Cornick, Cosh, Cottonwood, Coushatta, Coweta, Cowton, Coyle, Craig, Crisfield, Crockett, Cuevoland, Cyril, Dale, Dalhart, Dallam, Darnell, Darrouzett, Dean, Deepwood, Delwin, Denman, Denton, Devol, Dill, Dilworth, Dioxice, Doakum, Dodson, Doolin, Dougherty, Duffau, Easpur, Elandco, Eldorado, Elkader, Elmont, Elsah, Emachaya, Enders, Endsaw, Ennis, Enterprise, Etowah, Farnum, Farry, Ferris, Fitzhugh, Florita, Fortyone, Friona, Frioton, Gallion, Gasil, Glenrio, Gotebo, Gowen, Gowton, Grainola, Grandfield, Grant, Greendale, Gruver, Guadalupe, Guy, Hardeman, Harrah, Hartsells, Harvey, Hawley, Healing, Heatly, Hector, Heiden, Hernandez, Highview, Holdredge, Hollister, Honeycreek, Honobia, Humbarger, Huntington, Idabel, Indiahoma, Irene, Ironbridge, Ironmound, Ivan, Justin, Kamie, Kanima, Karma, Kenesaw, Kenn, Keo, Keokuk, Kerrick, Kim, Kimbrough, Kingfisher, Kingsdown, Kiomatia, Kirkland, Kirvin, Kiti, Knoco, Konawa, Konsil, Labette, Lancaster, Larton, Larue, Latimer, Latrass, Lawrie, Lawton, Lea, Lenapah, Lequire, Linker, Littleaxe, Loco, Lovedale, Lucien, Lueders, Lugert, Lula, Madge, Madill, Majada, Mangum, Mansic, Mansker, Manter, Manzano, Masham, Mason, Matoy, Mckamie, Mcknight, Mclain, Menard, Milan, Miles, Minco, Missler, Mobeetie, Mulhall, Naru, Nash, Nashoba, Nashville, Navina, Newtonia, Noark, Noble, Nobscot, Norge, Norwood, Nowata, Obaro, Ochlockonee, Octavia, Okay, Oklared, Oklark, Oktaha, Ost, Otero, Owens, Panama, Panda, Pastura, Paymaster, Penden, Perico, Pickton, Pickwick, Piedmont, Pirum, Plack, Pocasset, Pond Creek, Port, Portales, Potter, Pratt, Pulaski, Pullman, Purves, Quinlan, Ravia, Rayford, Razort, Reading, Redport, Reinach, Renfrow, Renthin, Richfield, Rickmore, Riverton, Robinsonville, Rochelle, Romia, Roxana, Ruella, Ruston, Saffell, Sallisaw, Satanta, Scullin, Secesh, Selman, Severn, Shellabarger, Sherless, Sherm, Sherwood, Shidler, Shrewder, Slaughter, Slaughterville, Smithdale, Somervell, Speer, Spiro, Springer, Spur, Spurlock, St. Paul, Stamford, Staser, Steedman, Stephenville, Stidham, Stoneburg, Sumter, Sunray, Swink, Talpa, Tamford, Tarrant, Teagard, Teamey, Teller, Tenaha, Teval, Texline, Tiak, Tillman, Timhill, Tipton, Tobosa, Travertine, Travessilla, Treadway, Tulia, Tussy, Tyende, Ulysses, Vanoss, Veal, Venadito, Verdigris, Vernon, Vingo, Vinson, Vona, Waben, Weatherford, Wellsford, Westola, Westsum, Westview, Weswood, Weymouth, Whakana, Wheatwood, Whitefield, Wichita, Wilburton, Winters, Wolfpen, Woodford, Woods, Woodward, Yahola, Yanush, Yomont, Zafra, Zaneis, Zavala
Mod. Well Drained	101	Agan, Agra, Apperson, Asher, Axtell, Bonham, Bosville, Brewer, Brewless, Burleson, Burwell, Buttermilk, Cadeville, Captina, Carman, Chaney, Chigley, Choteau, Clarita, Clearview, Counts, Culp, Dela, Dennis, Dickson, Durant, Dwight, Elysian, Eram, Flatonia, Foard, Foraker, Freestone, Galey, Garton, Garvin, Goltry, Grandmore, Hamden, Heman, Hinkle, Hollywood, Homa, Huska, Irwin, Iuka, Jay, Kaufman, Kemp, Kullit, Liberal, Lipan, Locust, Lofton, Martin, Miller, Moyers, Muskogee, Naldo, Neff, Newalla, Nixa, Normangee, Okemah, Oscar, Pawhuska, Pledger, Porum, Prue, Radley, Redlake, Rexor, Roscoe, Sacul, San Saba, Seminole, Shermore, Ships, Sobol, Stapp, Stigler, Summit, Tabler, Tamaha, Tonti, Trinity, Tuskahoma, Vernejo, Vian, Vinita, Wabbaseka, Wakita, Watonga, Waynoka, Wetsaw, Wilson, Windthorst, Wing, Wister, Wolco, Woodtell
Somewhat Poorly Drained	44	Arkabutla, Bathel, Boggy, Cherokee, Daycreek, Dillwyn, Drummond, Elsmere, Felker, Frizzell, Healdton, Hopco, Johnsburg, Kinta, Krier, Lafe, Las Animas, Latanier, Lawrence, Lela, Leshara, Lesho, Lomill, Mayes, Meno, Moreland, Muldrow, Niotaze, Panola, Pushmataha, Retrop, Roebuck, Taft, Taloka, Tomast, Tribbey, Tullahassee, Waldeck, Wann, Waurika, Wetbeth, Woodson, Wynona, Zenda
Poorly Drained	33	Adaton, Alikchi, Alusa, Bibb, Bocox, Boley, Bonn, Carwile, Carytown, Clodine, Cupco, Ezell, Gracemont, Gracemore, Guyton, Harjo, Hibsaw, Lebron, Lightning, Ness, Osage, Parsons, Pharoah, Pocola, Quarles, Randall, Rosebloom, Sweetwater, Talihina, Tuscumbia, Ustibuck, Weleetka, Wrightsville

APPENDIX F

Placement of the 577 Soil Series by the Number of Master Horizons in the Typical Pedon

Master Horizons	# of Series	Series
2	122	Acme, Adaton, Agra, Arkabutla, Aydelotte, Barge, Beckman, Bibb, Bippus, Blocker, Boggy, Britwater, Brownfield, Bunyan, Burson, Cartersville, Ceda, Clairemont, Clearfork, Coalgate, Conlen, Corlena, Cornick, Cottonwood, Crevasse, Dallam, Darrouzett, Dela, Dioxice, Durant, Dwyer, Elandco, Eldorado, Elsah, Ernachaya, Etowah, Eufala, Ezell, Florita, Frioton, Gaddy, Glentosh, Gowen, Gowton, Gracemore, Gruver, Hamden, Harvey, Healing, Hedville, Hopco, Indiahoma, Ironbridge, Iuka, Jay, Jester, Justin, Kanima, Kaufman, Kiomatia, Kiti, Knoco, Latimer, Latrass, Lequire, Lightning, Likes, Lincoln, Madill, Mansker, Manzano, Midco, Ness, Nutivoli, Oklared, Panda, Pastura, Paymaster, Pickwick, Pocasset, Portales, Potter, Pulaski, Pullman, Pushmataha, Randall, Rayford, Retrop, Rexor, Robinsonville, Rosebloom, Sayers, Severn, Shidler, Ships, Slaughter, Sogn, Spur, Spurlock, Staser, Sunray, Sweetwater, Tarrant, Texline, Tivoli, Trinity, Tulia, Tullahassee, Tuscumbia, Valent, Veal, Venadito, Vingo, Wann, Westola, Whitefield, Woodford, Wynona, Yahola, Yomont, Zavala, Zenda
3	207	Agan, Albers, Aline, Amber, Apache, Asher, Aspermont, Attica, Balltown, Bastrop, Baxter, Bayard, Bergstrom, Bethany, Bigfork, Binger, Bocox, Boxville, Brewless, Brico, Burleson, Burwell, Buttermilk, Canadian, Cannon, Capps, Capulin, Caradan, Carman, Case, Choska, Chupadera, Clarita, Clark, Clebit, Cleora, Clime, Clodine, Cobb, Colby, Collinsville, Cordell, Cosh, Counts, Coushatta, Coweta, Crisfield, Cuevoland, Cyril, Dale, Darnell, Darsil, Daycreek, Dean, Deepwood, Derby, Dill, Dillwyn, Doakum, Dodson, Eda, Elkader, Elsmere, Elysian, Enterprise, Felker, Ferris, Friona, Galey, Garvin, Gasil, Glenrio, Goltry, Goodnight, Gracemont, Guadalupe, Guy, Hardeman, Harjo, Harrah, Hawley, Heatly, Heiden, Heman, Hernandez, Highview, Hollywood, Humbarger, Huntington, Idabel, Ironmound, Ivan, Karma, Kenesaw, Keokuk, Kerrick, Kim, Kimbrough, Kingsdown, Kinta, Kipson, Krier, Kullit, Lafe, Larton, Larue, Las Animas, Latanier, Lebron, Lela, Lesho, Lipan, Loco, Lofton, Lueders, Lugert, Majada, Mangum, Masham, Mclain, Meno, Miller, Minco, Missler, Mobeetie, Moreland, Muldrow, Naldo, Nashville, Noble, Norge, Normangee, Norwood, Obaro, Okay, Okemah, Osage, Ost, Otero, Owens, Panola, Pawhuska, Penden, Perico, Plack, Pledger, Port, Pratt, Purves, Quarles, Quinlan, Reading, Redlake, Redport, Reinach, Rickmore, Rochelle, Roebuck, Roscoe, Ruella, San Saba, Sherm, Shermore, Slaughterville, Smithdale, Somervell, Stamford, Steedman, Sumter, Swink, Talihini, Talpa, Tamford, Tearney, Tiak, Tobosa, Tonti, Travertine, Travessilla, Treadway, Tribbey, Tussy, Tyende, Ulysses, Ustibuck, Verdigris, Vermejo, Vernon, Vinson, Vona, Wabbaseka, Wakita, Waldeck, Watonga, Wellsford, Westsum, Wetbeth, Weymouth, Wheatwood, Wichita, Wilson, Winters, Wisby, Woods, Woodtell, Yanush, Zaneis
4	162	Abbie, Abilene, Albion, Alusa, Asa, Axtell, Benchley, Bernow, Berthoud, Bonham, Bosville, Brackett, Braman, Brewer, Bronte, Burford, Cahaba, Captina, Carey, Carnasaw, Carnero, Carytown, Caston, Catoosa, Chickasha, Choteau, Claremore, Colmor, Corbin, Coyle, Crockett, Culp, Cupco, Dalhart, Delwin, Devol, Dilworth, Doolin, Drummond, Duffau, Elmont, Ennis, Eram, Farry, Flatonia, Flo, Foard, Fortyone, Frizzell, Gallion, Garton, Glenpool, Gotebo, Grainola, Grandfield, Grandmore, Greendale, Healdton, Hector, Hibsaw, Hinkle, Holdrege, Hollister, Homa, Honeycreek, Honobia, Huska, Irene, Irwin, Kamie, Kenn, Kingfisher, Kirkland, Konawa, Konsil, Lawrence, Lawrie, Lawton, Lea, Lenapah, Leshara, Lomill, Lucien, Lula, Mansic, Manter, Mason, Maloy, Mayes, Mcknight, Menard, Miles, Moyers, Mulhall, Muskogee, Nash, Nashoba, Neff, Newtonia, Niotaze, Nixa, Noark, Nobscot, Nowata, Ochlockonee, Oklark, Oktaha, Oscar, Pharoah, Pickens, Pickton, Piedmont, Pirum, Pocola, Radley, Ravia, Razort, Renfrow, Renthin, Richfield, Riverton, Romia, Roxana, Sacul, Saffell, Sallisaw, Satanta, Scullin, Secesh, Seminole, Shellabarger, Sherless, Spiro, Stapp, Stephenville, Stigler, Stoneburg, Tabler, Taloka, Tamaha, Teagard, Teller, Tillman, Timhill, Tuskahoma, Vanoss, Vian, Vinita, Waben, Waurika, Waynoka, Weatherford, Weleetka, Westview, Wewoka, Whakana, Wing, Wister, Wolco, Woodson, Woodward, Wrightsville

Placement of the 577 Soil Series by the Number of Master Horizons in the Typical Pedon - continued

5	72	Alikchi, Altus, Apperson, Ashport, Barnsdall, Bates, Bathel, Bengal, Blevins, Boley, Bostwick, Bromide, Cadeville, Carwile, Caspiana, Chaney, Cherokee, Chigley, Clearview, Cowton, Craig, Dennis, Denton, Dougherty, Dwight, Easpur, Endsaw, Farnum, Fitzhugh, Foraker, Goldston, Grant, Guyton, Hartsells, Johnsburg, Kemp, Kirvin, Labette, Lancaster, Liberal, Linker, Littleaxe, Locust, Lovedale, Madge, Martin, Mckamie, Milan, Naru, Navina, Octavia, Panama, Parsons, Pond Creek, Porum, Prue, Ruston, Selman, Sherwood, Shrewder, Sobol, Speer, St. Paul, Stidham, Summit, Tenaha, Teval, Tipton, Wetsaw, Wilburton, Windthorst, Wolfpen
6	11	Bolivar, Bonn, Clarksville, Denman, Enders, Freestone, Springer, Taft, Tomast, Weswood, Zafra
7	3	Dickson, Keo, Newalla

APPENDIX G

Placement of the 577 Soil Series by Family Particle Size

Family Particle Size	# of Series	Series
Fine	144	Abilene, Agan, Agra, Albers, Alusa, Apperson, Axtell, Aydelotte, Baxter, Beckman, Benchley, Bethany, Bonham, Bosville, Boxville, Brewer, Brewless, Bronte, Burleson, Cadeville, Caradan, Carnero, Carwile, Carytown, Chaney, Cherokee, Chigley, Chteau, Clarita, Clearfork, Clime, Counts, Cowton, Crockett, Culp, Darrouzett, Dennis, Dilworth, Dodson, Doolin, Durant, Dwight, Emachaya, Eram, Ferris, Flatonia, Foard, Foraker, Frioton, Garton, Garvin, Grainola, Gruver, Harjo, Healdton, Heiden, Hinkle, Hollister, Hollywood, Huska, Indiahoma, Ironbridge, Irwin, Kirkland, Labette, Latimer, Latrass, Lawton, Lela, Liberal, Lightning, Lipan, Lofton, Mangum, Martin, Matoy, Mayes, Mckamie, Mclain, Miller, Missler, Moreland, Moyers, Muldrow, Ness, Niotaze, Normangee, Okemah, Osage, Owens, Panola, Parsons, Pawhuska, Pharoah, Piedmont, Pocola, Porum, Pullman, Quarles, Randall, Redlake, Renfrow, Renthin, Richfield, Roebuck, Roscoe, San Saba, Scullin, Seminole, Sherm, Sobol, Stamford, Steedman, Stigler, Summit, Tabler, Taloka, Tamaha, Tamford, Teagard, Tillman, Tobosa, Treadway, Tuscumbia, Tussy, Ustibuck, Vermejo, Vernon, Watonga, Waurika, Westsum, Wetbeth, Whitefield, Wichita, Wilson, Windthorst, Wing, Winters, Wister, Wolco, Woods, Woodson, Woodtell, Wrightsville
Fine -loamy	126	Abbie, Altus, Bastrop, Bates, Bathel, Bernow, Berthoud, Binger, Bippus, Bolivar, Bostwick, Brackett, Britwater, Bunyan, Cahaba, Cannon, Capps, Capulin, Carman, Case, Chickasha, Clark, Clearview, Cobb, Conlen, Coyle, Dalhart, Dallam, Dean, Delwin, Dioxice, Doakum, Duffau, Easpur, Ennis, Etowah, Farnum, Farry, Fitzhugh, Freestone, Friona, Galey, Gasil, Gowen, Gowton, Grandfield, Grandmore, Greendale, Hamden, Harrah, Hartsells, Harvey, Hernandez, Honeycreek, Humbarger, Justin, Kamie, Karma, Kemp, Kenn, Kerrick, Kim, Konawa, Konsil, Kullit, Landcaster, Lea, Linker, Littleaxe, Locust, Lovedale, Madge, Mansic, Mansker, Manzano, Mcknight, Menard, Milan, Miles, Mulhall, Naldo, Navina, Octavia, Okay, Oktaha, Ost, Penden, Perico, Pirum, Portales, Prue, Ravia, Razort, Rickmore, Rochelle, Romia, Ruella, Ruston, Sallisaw, Satanta, Secesh, Shellabarger, Sherless, Shermore, Sherwood, Smithdale, Speer, Spur, Staser, Stephenville, Stoneburg, Sunray, Teller, Teval, Texline, Tipton, Tonti, Tulia, Veal, Waynoka, Weatherford, Wetsaw, Weymouth, Whakana, Zaneis, Zenda
Fine-silty	87	Adaton, Alikchi, Akabutla, Asa, Asher, Ashport, Aspermont, Barge, Barnsdall, Bergstrom, Blevins, Boley, Bonn, Braman, Burford, Burwell, Buttermilk, Captina, Carey, Caspiana, Catoosa, Clairemont, Coalgate, Colby, Colmor, Corbin, Coushatta, Cuevoland, Cupco, Dale, Denton, Dickson, Elandco, Elkader, Elmont, Felker, Gallion, Grant, Guyton, Healing, Hibsaw, Holdrege, Hopco, Huntington, Irene, Ivan, Jay, Johnsburg, Kingfisher, Lafe, Lawrence, Lawrie, Leshara, Lula, Mason, Muskogee, Nashville, Neff, Newtonia, Norge, Norwood, Obaro, Oscar, Pickwick, Pond Creek, Port, Radley, Reading, Redport, Retrop, Rexor, Rosebloom, Selman, Spiro, St. Paul, Sumter, Taft, Tomast, Ulysses, Vanoss, Verdigris, Vian, Vinson, Wakita, Westview, Wheatwood, Wynona
Coarse -loamy	55	Albion, Attica, Bayard, Bibb, Boggy, Canadian, Chupadera, Cleora, Clodine, Crisfield, Cyril, Dela, Devol, Dill, Elysian, Florita, Fortyone, Gracemont, Guadalupe, Guy, Hardeman, Hawley, Idabel, Iuka, Kingsdown, Las Animas, Madill, Manter, Mobeetie, Noble, Ochlockonee, Oklared, Oklark, Otero, Panda, Paymaster, Pocasset, Pulaski, Robinsonville, Shrewder, Slaughterville, Springer, Spurlock, Tribbey, Tullahassee, Tyende, Vingo, Vona, Waldeck, Wann, Weleetka, Westola, Wisby, Yahola, Zavala
Loamy	41	Acme, Apache, Blocker, Bocox, Brownfield, Burson, Cartersville, Claremore, Collinsville, Cordell, Cornick, Cosh, Cottonwood, Coweta, Darnell, Dougherty, Heatly, Hector, Hedville, Ironmound, Kimbrough, Kipson, Larton, Larue, Lequire, Loco, Lucien, Meno, Nobscot, Pastura, Pickton, Plack, Potter, Quinlan, Shidler, Sogn, Stidham, Talpa, Tenaha, Tryessilla, Wolfpen
Loamy -skeletal	32	Balltown, Bigfork, Bromide, Caston, Ceda, Clarksville, Clebit, Eldorado, Elsah, Goldston, Kanima, Kiti, Lueders, Majada, Midco, Naru, Nashoba, Nixa, Nowata, Panama, Pickens, Rayford, Riverton, Saffell, Somervell, Timhill, Travertine, Waban, Wilburton, Woodford, Yanush, Zafra
Clayey	20	Bengal, Carnasaw, Enders, Endsaw, Glenrio, Highview, Kinta, Kirvin, Knoco, Lenapah, Masham, Purves, Sacul, Slaughter, Stapp, Talihini, Tiak, Tuskahoma, Vinita, Wellsford
Coarse-silty	19	Amber, Choska, Deepwood, Enterprise, Frizzell, Gotebo, Kenesaw, Keo, Keokuk, Lugert, Minco, Nash, Pushmataha, Reinach, Roxana, Severn, Weswood, Woodward, Yomont
Sandy	15	Aline, Corlena, Elsemere, Eufala, Ezell, Flo, Gaddy, Glenpool, Goltry, Gracemore, Kiomatia, Krier, Lincoln, Pratt, Sayers

Placement of the 577 Soil Series by Family Particle Size-continued

(BLANK)	14	Crevasse, Darsil, Daycreek, Derby, Dillwyn, Dwyer, Eda, Glentosh, Goodnight, Jester, Likes, Nutivoli, Tivoli, Valent
Clayey Skeletal	6	Brico, Craig, Honobia, Noark, Swink, Tarrant
Very Fine	6	Homa, Kaufman, Pledger, Ships, Trinity, Venadito
Clayey over Loamy	4	Drummond, Latanier, Lomill, Wabbaseka
Clayey over Sandy/Sandy Skeletal	3	Heman, Lebron, Teamey
Fine Loamy over Clayey	2	Denman, Newalla
Sandy Skeletal	1	Wewoka
Fine Loamy over Sandy Skeletal	1	Lesho
Fine Loamy over Sandy/Sandy Skeletal	1	Sweetwater

APPENDIX H

Placement of the 577 Soil Series by Hue/Value of ≤3/3 in the Typical Pedon - A Horizon

# of Series With an A Horizon ≤3/3	Series	Of the 330, # of Series ≤3/3 Below the A Horizon	Series
330	Abbie, Abilene, Acme, Agan, Agra, Albers, Albion, Aline, Altus, Apache, Apperson, Asa, Asher, Ashport, Attica, Balltown, Bates, Bathel, Bayard, Benchley, Bengal, Bergstrom, Bethany, Bippus, Boggy, Bonham, Bonn, Bostwick, Bosville, Braman, Brewer, Brewless, Brico, Bromide, Bunyan, Burleson, Burwell, Buttermilk, Canadian, Cannon, Capps, Capulin, Caradan, Carey, Carman, Carnasaw, Carnero, Carwile, Caspiana, Catoosa, Chaney, Chickasha, Chigley, Choska, Choteau, Claremore, Clarita, Clark, Clearfork, Clebit, Cleora, Clime, Cobb, Collinsville, Colmor, Conlen, Corbin, Cornick, Coweta, Cowton, Coyle, Craig, Crisfield, Crockett, Cuevoland, Culp, Cyril, Dale, Dalhart, Dallam, Darnell, Darrouzett, Darsil, Denman, Dennis, Denton, Derby, Dillwyn, Dilworth, Dioxice, Dodson, Doolin, Drummond, Duffau, Durant, Dwight, Easpur, Elandco, Eldorado, Elkader, Elmont, Elsmere, Enders, Eram, Etowah, Ezell, Farnum, Farry, Felker, Fitzhugh, Flatonia, Florita, Foard, Foraker, Fortyone, Friona, Frioton, Garton, Garvin, Glenpool, Gotebo, Gowen, Gowton, Grainola, Grant, Gruver, Guy, Healing, Hector, Hedville, Heiden, Heman, Hibsaw, Holdrege, Hollister, Hollywood, Homa, Hopco, Humbarger, Huntington, Idabel, Indiahoma, Irene, Irwin, Ivan, Jay, Justin, Kanima, Kaufman, Kenesaw, Kenn, Keokuk, Kerrick, Kimbrough, Kingfisher, Kingsdown, Kinta, Kipson, Kirkland, Kitt, Konawa, Krier, Labette, Lancaster, Latanier, Lawrie, Lawton, Lea, Lebron, Lela, Lenapah, Leshara, Lesho, Liberal, Likes, Littleaxe, Loco, Lofton, Lomill, Lovedale, Lucien, Lueders, Lugert, Lula, Madge, Majada, Mansic, Mansker, Manter, Manzano, Martin, Mason, Matoy, Mayes, Mclain, Meno, Midco, Milan, Miles, Miller, Minco, Missler, Moreland, Moyers, Muldrow, Mulhall, Naru, Nash, Nashville, Navina, Ness,	135	Abilene, Agan, Albers, Albion, Altus, Apperson, Balltown, Bates, Benchley, Bethany, Bonham, Bostwick, Braman, Brewer, Brewless, Burleson, Caradan, Carnero, Carwile, Caspiana, Catoosa, Claremore, Clime, Corbin, Coyle, Culp, Dale, Darrouzett, Dioxice, Dodson, Doolin, Durant, Dwight, Elandco, Elmont, Eram, Farnum, Fitzhugh, Flatonia, Florita, Foard, Foraker, Friona, Frioton, Garton, Grant, Gruver, Heiden, Holdrege, Hollister, Humbarger, Indiahoma, Irene, Irwin, Ivan, Kanima, Kaufman, Kirkland, Labette, Lancaster, Latanier, Lawrie, Lawton, Lebron, Lela, Lenapah, Lofton, Lomill, Lovedale, Lucien, Lueders, Lula, Madge, Majada, Manter, Manzano, Martin, Mason, Matoy, Mayes, Mclain, Milan, Muldrow, Navina, Newtonia, Norge, Okay, Okemah, Osage, Ost, Pawhuska, Paymaster, Pharoah, Piedmont, Pledger, Pond Creek, Prue, Pullman, Purves, Ravia, Reading, Renfrow, Renthin, Richfield, Roebuck, San Saba, Satanta, Scullin, Secesh, Selman, Shellabarger, Sherm, Ships, St. Paul, Summit, Swink, Tabler, Teval, Tillman, Timhill, Tipton, Tobosa, Trinity, Vanoss, Verdigris, Wabbaseka, Waynoka, Westsum, Westview, Wetbeth, Wilson, Wolco, Woodson, Wynona, Zaneis

Newalla, Newtonia, Niotaze, Noble, Norge, Normangee, Nowata, Okay, Okemah, Oklark, Oktaha, Osage, Ost, Panama, Panola, Parida, Parsons, Pawhuska, Paymaster, Penden, Pharoah, Pickens, Piedmont, Plack, Pledger, Pocasset, Pond Creek, Port, Portales, Prue, Pullman, Purves, Quarles, Radley, Randall, Ravia, Rayford, Reading, Redlake, Redport, Reinach, Renfrow, Renthin, Richfield, Riverton, Roebuck, Romia, Roscoe, San Saba, Satanta, Scullin, Secesh, Selman, Seminole, Shellabarger, Sherless, Sherm, Shidler, Ships, Slaughter, Slaughterville, Sogn, Somervell, Spiro, Spur, St. Paul, Staser, Steedman, Stoneburg, Summit, Sunray, Sweetwater, Swink, Tabler, Talihini, Taloka, Talpa, Tamford, Tarrant, Teagard, Tearney, Teller, Tenaha, Teval, Texline, Tillman, Timhill, Tipton, Tobosa, Tomast, Trinity, Tuscumbia, Ulysses, Ustibuck, Vanoss, Verdigris, Vinita, Vinson, Wabbaseka, Waldeck, Wann, Watonga, Waurika, Waynoka, Weleetka, Westsum, Westview, Wetbeth, Wetsaw, Wilson, Windthorst, Wisby, Wolco, Woodford, Woods, Woodson, Wynona, Zaneis, Zenda

APPENDIX I

Series	Taxonomic Classification
Abbie	Fine loamy, mixed, thermic Aridic Argiustoll
Abilene	Fine, mixed, thermic Pachic Argiustoll
Acme	Loamy, mixed, thermic, shallow, Entic Haplustoll
Adaton	Fine-silty, mixed, thermic Typic Ochraqualf
Agan	Fine, mixed, thermic Udertic Paleustalf
Agra	Fine, mixed thermic Udertic Paleustoll
Albers	Fine, smectitic, mesic Aridic Haplustert
Albion	Coarse-loamy, mixed, mesic Udic Argiustoll
Alikchi	Fine-silty, siliceous, thermic Typic Glossaqualf
Aline	Sandy, mixed, thermic Psammentic Paleustalf
Altus	Fine-loamy, mixed, thermic Pachic Argiustoll
Alusa	Fine montmorillonitic, thermic Vertic Albaqualf
Amber	Coarse-silty, mixed, thermic Udic Ustochrepts
Apache	Loamy, mixed, mesic Lithic Haplustoll
Apperson	Fine, montmorillonitic, thermic Aquic Hapludert
Arkabutla	Fine-silty, mixed, acid, thermic Aeric Fluvaquent
Asa	Fine-silty, mixed, hyperthermic Fluventic Hapludoll
Asher	Fine-silty, mixed, thermic Fluventic Haplustoll
Ashport	Fine-silty, mixed, thermic Fluventic Haplustoll
Aspermont	Fine-silty, mixed, thermic Typic Ustochrept
Attica	Coarse-loamy, mixed, thermic Udic Haplustalf
Axtell	Fine, montmorillonitic, thermic Udertic Paleustalf
Aydelotte	Fine, mixed, thermic Udertic Paleustalf
Balltown	Loamy-skeletal, mixed, thermic Lithic Hapludoll
Barge	Fine-silty, mixed, nonacid, thermic Mollic Udarent
Barnsdall	Fine-silty, mixed, thermic Ultic Hapludalf
Bastrop	Fine-loamy, mixed, thermic Udic Paleustalf
Bates	Fine-loamy, siliceous, thermic Typic Argiudoll
Bathel	Fine-loamy, mixed, thermic Aquic Hapludalf
Baxter	Fine, mixed, mesic Typic Paleudalf
Bayard	Coarse-loamy, mixed, mesic Torriorthentic Haplustoll
Beckman	Fine, mixed (calcareous), thermic Vertic Ustifluvent
Benchley	Fine, montmorillonitic, thermic Udertic Argiustoll
Bengal	Clayey, mixed, thermic Typic Hapludult
Bergstrom	Fine-silty, mixed, thermic Cumulic Haplustoll
Bernow	Fine-loamy, siliceous, thermic Glossic Paleudalf
Berthoud	Fine-loamy, mixed, mesic Aridic Ustochrept
Bethany	Fine, mixed, thermic Pachic Paleustoll
Bibb	Coarse-loamy, siliceous, acid, thermic Typic Fluvaquent
Bigfork	Loamy-skeletal, siliceous, thermic Typic Hapludult
Binger	Fine-loamy, mixed, thermic Udic Rhodustalf
Bippus	Fine-loamy, mixed, thermic Cumulic Haplustoll
Blevins	Fine-silty, siliceous, thermic Typic Paleudult
Blocker	Loamy, mixed, nonacid, thermic, shallow Alfic Udarent
Bocox	Loamy, mixed, thermic Aquic Arenic Hapludalf
Boggy	Coarse-loamy, siliceous, nonacid, thermic Aeric Fluvaquent
Boley	Fine-silty, mixed, nonacid, thermic Aquic Udifluvent

Series	Taxonomic Classification
Bolivar	Fine-loamy, mixed, thermic Ultic Hapludalf
Bonham	Fine, montmorillonitic, thermic Aquic Argiudoll
Bonn	Fine-silty, mixed, thermic Glossic Natraqualf
Bostwick	Fine-loamy, mixed Aridic Argiboroll
Bosville	Fine, mixed, thermic Albaquic Paleudalf
Boxville	Fine, mixed, thermic Typic Paleudalf
Brackett	Fine-loamy, carbonatic, thermic Udic Ustochrept
Braman	Fine-silty, mixed, thermic Pachic Argiustoll
Brewer	Fine, mixed, thermic Udertic Argiustoll
Brewless	Fine, mixed, thermic Udertic Argiustoll
Brico	Clayey-skeletal, mixed, thermic Typic Argiustoll
Britwater	Fine-loamy, mixed, mesic Typic Paleudalf
Bromide	Loamy-skeletal, siliceous, thermic Ultic Haplustalf
Bronte	Fine, mixed, thermic Aridic Haplustalf
Brownfield	Loamy, mixed, thermic Arenic Aridic Paleustalf
Bunyan	Fine-loamy, mixed, nonacid, thermic Typic Ustifluvent
Burford	Fine-silty, mixed, thermic Typic Ustochrept
Burleson	Fine, montmorillonitic, thermic Udic Haplustert
Burson	Loamy, mixed(calcareous), thermic, shallow Ustic Torriorthent
Burwell	Fine-silty, mixed, thermic Aquic Paleudoll
Buttermilk	Fine-silty, mixed, thermic Pachic Haplustoll
Cadeville	Fine, mixed thermic Albaquic Hapludalf
Cahaba	Fine-loamy, siliceous, thermic Typic Hapludult
Canadian	Coarse-loamy, mixed, thermic Udic Haplustoll
Cannon	Fine-loamy, mixed, thermic Cumulic Hapludoll
Capps	Fine-loamy, mixed, mesic Aridic Haplustoll
Captina	Fine-silty, siliceous, mesic Typic Fragiudult
Capulin	Fine-loamy, mixed, mesic Aridic Argiustoll
Caradan	Fine, montmorillonitic, thermic Vertic Argiustoll
Carey	Fine-silty, mixed, thermic Typic Argiustoll
Carman	Fine-loamy, mixed, thermic Udic Argiustoll
Carnasaw	Clayey, mixed, thermic Typic Hapludult
Carnero	Fine, mixed, mesic Aridic Argiustoll
Cartersville	Loamy, mixed, nonacid, thermic, shallow Alfic Udarent
Carwile	Fine, mixed, thermic Typic Argiaquoll
Carytown	Fine, mixed, thermic Albic Natraqualf
Case	Fine-loamy, mixed thermic Typic Ustochrept
Caspiana	Fine-silty, mixed, thermic Typic Argiudolls
Caston	Loamy-skeletal, siliceous, thermic Typic Paleudult
Catoosa	Fine-silty, mixed, thermic Typic Argiudoll
Ceda	Loamy-skeletal, siliceous, nonacid, thermic Typic Udifluvent
Chaney	Fine, mixed, thermic Aquic Paleustalf
Cherokee	Fine, mixed, thermic Typic Albaqualf
Chickasha	Fine-loamy, mixed, thermic Udic Argiustoll
Chigley	Fine, mixed, thermic Udic Paleustalf
Choska	Coarse-silty, mixed, thermic Fluventic Hapludoll
Choteau	Fine, mixed, thermic Aquic Paleudoll
Chupadera	Coarse-loamy, mixed, mesic Ustollic Calciorthid
Clairemont	Fine-silty, mixed (calcareous), thermic Typic Ustifluvent

Series	Taxonomic Classification
Claremore	Loamy, mixed, thermic Lithic Argiudoll
Clarita	Fine, montmorillonitic, thermic Udic Haplustert
Clark	Fine-loamy, mixed, thermic Typic Calciustoll
Clarksville	Loamy-skeletal, siliceous, mesic Typic Paleudult
Clearfork	Fine, mixed, thermic Cumulic Haplustoll
Clearview	Fine-loamy, mixed, thermic Oxyaquic Hapludalf
Clebit	Loamy-skeletal, siliceous, thermic Lithic Dystrochrept
Cleora	Coarse-loamy, mixed, thermic Fluventic Hapludoll
Clime	Fine, mixed, mesic Udorthentic Haplustoll
Clodine	Coarse-loamy, siliceous, thermic Typic Ochraqualf
Coalgate	Fine-silty, mixed, nonacid, thermic Alfic Udarent
Cobb	Fine-loamy, mixed, thermic Typic Haplustalf
Colby	Fine-silty, mixed (calcareous), mesic Ustic Torriorthent
Collinsville	Loamy, siliceous, thermic Lithic Hapludoll
Colmor	Fine-silty, mixed, mesic Torriorthentic Haplustoll
Conlen	Fine-loamy, carbonatic, mesic Calciargidic Paleustoll
Corbin	Fine-silty, mixed, thermic Pachic Argiustoll
Cordell	Loamy, mixed, thermic Lithic Ustochrept
Corlena	Sandy, mixed, mesic Typic Ustifluvent
Cornick	Loamy, mixed, thermic, shallow Entic Haplustoll
Cosh	Loamy, mixed, thermic, shallow Udic Rhodustalf
Cottonwood	Loamy, mixed (calcareous), thermic, shallow Ustic Torriorthent
Counts	Fine, mixed, thermic Albaquic Paleudalf
Coushatta	Fine-silty, mixed, thermic Fluventic Eutrochrept
Coweta	Loamy, siliceous, thermic, shallow Typic Hapludoll
Cowton	Fine, mixed, thermic Ultic Hapludalf
Coyle	Fine-loamy, siliceous, thermic Udic Argiustoll
Craig	Clayey-skeletal, mixed, thermic Mollic Paleudalf
Crevasse	Mixed, thermic Typic Udipsamment
Crisfield	Coarse-loamy, mixed, thermic Udic Haplustoll
Crockett	Fine, montmorillonitic, thermic Udertic Paleustalf
Cuevoland	Fine-silty, mixed, mesic Aridic Calciustoll
Culp	Fine, mixed, thermic Vertic Argiustoll
Cupco	Fine-silty, siliceous, thermic Typic Epiaqualf
Cyril	Coarse-loamy, mixed, thermic Cumulic Haplustoll
Dale	Fine-silty, mixed, thermic Pachic Haplustoll
Dalhart	Fine-loamy, mixed, mesic Aridic Haplustalf
Dallam	Fine-loamy, mixed, mesic Aridic Paleustalf
Darnell	Loamy, siliceous, thermic, shallow Udic Ustochrept
Darrouzett	Fine, mixed, thermic Pachic Paleustoll
Darsil	Thermic, shallow & coated Ustic Quartzipsamment
Daycreek	Mixed, thermic Aquic Ustipsamment
Dean	Fine-loamy, carbonatic, mesic Ustollic Calciorthid
Deepwood	Coarse-silty, mixed, thermic Typic Ustochrept
Dela	Coarse-loamy, siliceous, nonacid, thermic Typic Udifluvent
Delwin	Fine-loamy, mixed, thermic Typic Paleustalf
Denman	Fine-loamy over clayey, siliceous, thermic Typic Hapludult
Dennis	Fine, mixed, thermic Aquic Paleudoll
Denton	Fine-silty, carbonatic, thermic Udic Calciustoll

Series	Taxonomic Classification
Derby	Mixed, thermic Argic Ustipsamment
Devol	Coarse-loamy, mixed, thermic Typic Haplustalf
Dickson	Fine-silty, siliceous, thermic Glossic Fragiudult
Dill	Coarse-loamy, mixed, thermic Udic Ustochrept
Dillwyn	Mixed, mesic Aquic Ustipsamment
Dilworth	Fine, mixed, thermic Udertic Argiustoll
Dioxice	Fine-loamy, mixed, mesic Aridic Calciustoll
Doakum	Fine-loamy, mixed, mesic Ustalfic Haplargid
Dodson	Fine, mixed, thermic Pachic Argiustoll
Doolin	Fine, montmorillonitic, thermic Typic Natrustoll
Dougherty	Loamy, mixed, thermic Arenic Haplustalf
Drummond	Clayey over loamy, mixed, thermic Mollic Natrustalf
Duffau	Fine-loamy, siliceous, thermic Udic Paleustalf
Durant	Fine, montmorillonitic, thermic Udertic Paleustoll
Dwight	Fine, montmorillonitic, mesic Typic Natrustoll
Dwyer	Mixed, mesic Ustic Torripsamment
Easpur	Fine-loamy, mixed, thermic Fluventic Haplustoll
Eda	Mixed, thermic Argic Ustipsamment
Elandco	Fine-silty, mixed, thermic Cumulic Haplustoll
Eldorado	Loamy-skeletal, mixed, thermic Typic Paleudoll
Elkader	Fine-silty, mixed, mesic Torriorthentic Haplustoll
Elmont	Fine-silty, mixed, mesic Typic Argiudoll
Elsah	Loamy-skeletal, mixed, nonacid, mesic Typic Udifluvent
Elsmere	Sandy, mixed, mesic Aquic Haplustoll
Elysian	Coarse-loamy, siliceous, thermic Haplic Glossudalf
Emachaya	Fine, mixed, nonacid, thermic Alfic Udarent
Enders	Clayey, mixed, thermic Typic Hapludult
Endsaw	Clayey, mixed, thermic Typic Hapludult
Ennis	Fine-loamy, siliceous, thermic Fluventic Dystrochrept
Enterprise	Coarse-silty, mixed, thermic Typic Ustochrept
Eram	Fine, mixed, thermic Aquic Argiudoll
Etowah	Fine-loamy, siliceous, thermic Typic Paleudult
Eufala	Sandy, siliceous, thermic Psammentic Paleustalf
Ezell	Sandy, mixed, thermic Aeric Fluvaquent
Farnum	Fine-loamy, mixed, mesic Pachic Argiustoll
Farry	Fine-loamy, mixed, thermic Typic Argiustoll
Felker	Fine-silty, siliceous, thermic Aquic Paleudult
Ferris	Fine, montmorillonitic, thermic Chromic Udic Haplustert
Fitzhugh	Fine-loamy, mixed, thermic Typic Argiudoll
Flatonia	Fine, montmorillonitic, thermic Vertic Argiustoll
Flo	Sandy, siliceous, thermic Psammentic Paleudalf
Florita	Coarse-loamy, mixed, nonacid, mesic Ustic Torriorthent
Foard	Fine, montmorillonitic, thermic Typic Natrustoll
Foraker	Fine, montmorillonitic, thermic Leptic Udic Haplustert
Fortyone	Coarse-loamy, mixed, thermic Typic Haplustalf
Freestone	Fine-loamy, siliceous, thermic Glossaquic Paleudalf
Friona	Fine-loamy, mixed, thermic Petrocalcic Paleustoll
Frioton	Fine, montmorillonitic, mixed, thermic Vertic Hapludoll
Frizzell	Coarse-silty, siliceous, thermic Glossaquic Hapludalf

Series	Taxonomic Classification
Gaddy	Sandy, mixed, thermic Udic Ustifluvent
Galey	Fine-loamy, mixed, thermic Ultic Paleustalf
Gallion	Fine-silty, mixed, thermic Typic Hapludalf
Garton	Fine, mixed, thermic Aquertic Argiudoll
Garvin	Fine, montmorillonitic, thermic Udertic Haplustoll
Gasil	Fine-loamy, siliceous, thermic Ultic Paleustalf
Glenpool	Sandy, siliceous, thermic Psammentic Paleudalf
Glenrio	Clayey, mixed, thermic, shallow Ustochreptic Camborthid
Glentosh	Thermic, coated Typic Quartzipsamment
Goldston	Loamy-skeletal, siliceous, thermic, shallow Typic Dystrochrept
Goltry	Sandy, mixed, thermic Psammentic Paleustalf
Goodnight	Mixed, thermic Typic Ustipsamment
Gotebo	Coarse-silty, mixed, thermic Typic Ustochrept
Gowen	Fine-loamy, mixed, thermic Cumulic Haplustoll
Gowton	Fine-loamy, mixed, thermic Cumulic Hapludoll
Gracemont	Coarse-loamy, mixed (calcareous), thermic Oxyaquic Udifluvent
Gracemore	Sandy, mixed, thermic Oxyaquic Udifluvent
Grainola	Fine, mixed, thermic Udertic Haplustalf
Grandfield	Fine-loamy, mixed, thermic Typic Haplustalf
Grandmore	Fine-loamy, mixed, thermic Typic Haplustalf
Grant	Fine-silty, mixed, thermic Udic Argiustoll
Greendale	Fine-loamy, siliceous, mesic Fluventic Dystrochrept
Gruver	Fine, mixed, mesic Aridic Paleustoll
Guadalupe	Coarse-loamy, mixed, thermic Fluventic Ustochrept
Guy	Coarse-loamy, mixed, mesic Aridic Calciustoll
Guyton	Fine-silty, siliceous, thermic Typic Glossaqualf
Hamden	Fine-loamy, siliceous, thermic Aquic Paleudalf
Hardeman	Coarse-loamy, mixed, thermic Typic Ustochrept
Harjo	Fine, mixed (calcareous), thermic Vertic Fluvaquent
Harrah	Fine-loamy, siliceous, thermic Ultic Paleustalf
Hartsells	Fine-loamy, siliceous, thermic Typic Hapludult
Harvey	Fine-loamy, mixed, mesic Ustollic Calciorthid
Hawley	Coarse-loamy, mixed, thermic Fluventic Ustochrept
Healdton	Fine mixed, thermic Vertic Natraqualf
Healing	Fine-silty, mixed, mesic Typic Argiudoll
Heatly	Loamy, mixed, thermic Arenic Paleustalf
Hector	Loamy, siliceous, thermic Lithic Dystrochrept
Hedville	Loamy, mixed, mesic Lithic Haplustoll
Heiden	Fine, montmorillonitic, thermic Udic Haplustert
Heman	Clayey over sandy or sandy skeletal, mixed, thermic, Vertic Ustochrept
Hernandez	Fine-loamy, mixed, mesic Ustollic Calciorthid
Hibsaw	Fine-silty, mixed, thermic Vertic Halaquept
Highview	Clayey, mixed, thermic, shallow Udic Ustochrept
Hinkle	Fine, montmorillonitic, thermic Mollic Natrustalf
Holdrege	Fine-silty, mixed, mesic Typic Argiudoll
Hollister	Fine, mixed, thermic Pachic Paleustoll
Hollywood	Fine, smectitic, thermic Oxyaquic Hapludert
Homa	Very fine, mixed, thermic Aquertic Chromic Hapludalf
Honeycreek	Fine-loamy, mixed, thermic Typic Haplustalf

Series	Taxonomic Classification
Honobia	Clayey-skeletal, mixed, thermic Typic Hapludult
Hopco	Fine-silty, mixed, thermic Cumulic Haplaquoll
Humbarger	Fine-loamy, mixed, mesic Cumulic Haplustoll
Huntington	Fine-silty, mixed, mesic Fluventic Hapludoll
Huska	Fine, mixed, thermic Mollic Natrustalf
Idabel	Coarse-loamy, mixed, thermic Fluventic Eutrochrept
Indiahoma	Fine, smectitic, thermic Typic Haplustert
Irene	Fine-silty, mixed, thermic Pachic Argiustoll
Ironbridge	Fine, mixed, nonacid, thermic Alfic Udarent
Ironmound	Loamy, mixed, thermic, shallow Udic Ustochrept
Irwin	Fine, mixed, mesic Pachic Argiustoll
Iuka	Coarse-loamy, siliceous, acid, thermic Aquic Udifluvent
Ivan	Fine-silty, mixed, mesic Cumulic Hapludoll
Jay	Fine-silty, mixed, thermic Mollic Fragiudalf
Jester	Mixed, thermic Typic Ustipsamment
Johnsburg	Fine-silty, mixed, mesic Aquic Fragiudult
Justin	Fine-loamy, mixed, thermic Udic Paleustoll
Kamie	Fine-loamy, mixed, thermic Typic Paleudalf
Kanima	Loamy-skeletal, mixed, nonacid, thermic Alfic Udarent
Kanna	Fine-loamy, mixed, thermic Typic Hapludalf
Kaufman	Very-fine, montmorillonitic, thermic Typic Hapludert
Kemp	Fine-loamy, mixed, nonacid, thermic Aquic Udifluvent
Kenesaw	Coarse-silty, mixed, mesic Typic Haplustoll
Kenn	Fine-loamy, siliceous, thermic Ultic Hapludalf
Keo	Coarse-silty, mixed, thermic Dystric Fluventic Eutrochrept
Keokuk	Coarse-silty, mixed, thermic Fluventic Haplustoll
Kerrick	Fine-loamy, mixed, mesic Petrocalcic Calciustoll
Kim	Fine-loamy, mixed (calcareous), mesic Ustic Torriorthent
Kimbrough	Loamy, mixed, thermic, shallow Petrocalcic Calciustoll
Kingfisher	Fine-silty, mixed, thermic Udic Argiustoll
Kingsdown	Coarse-loamy, mixed, thermic Entic Haplustoll
Kinta	Clayey, mixed, thermic Aeric Paleaquult
Kiomatia	Sandy, mixed, thermic Typic Udifluvent
Kipson	Loamy, mixed, mesic, shallow Udorthentic Haplustoll
Kirkland	Fine, mixed, thermic Udertic Paleustoll
Kirvin	Clayey, mixed, thermic Typic Hapludult
Kiti	Loamy-skeletal, mixed, thermic Lithic Haplustoll
Knoco	Clayey, mixed (calcareous), thermic, shallow Ustic Torriorthent
Konawa	Fine-loamy, mixed, thermic Ultic Haplustalf
Konsil	Fine-loamy, siliceous, thermic Ultic Paleustalf
Krier	Sandy, mixed, thermic Aeric Halaquept
Kullit	Fine-loamy, siliceous, thermic Aquic Paleudult
Labette	Fine, mixed, mesic Udic Argiustoll
Lafe	Fine-silty, mixed, thermic Glossic Natrudalf
Lancaster	Fine-loamy, mixed, mesic Udic Argiustoll
Larton	Loamy, siliceous, thermic Arenic Paleudalf
Larue	Loamy, siliceous, thermic Arenic Paleudalf
Las Animas	Coarse-loamy, mixed (calcareous), mesic Typic Fluvaquent
Latanier	Clayey over loamy, mixed, thermic Vertic Hapludoll

Series	Taxonomic Classification
Latimer	Fine, mixed, nonacid, thermic Alfic Udarent
Latrass	Fine, mixed, thermic Ustarent
Lawrence	Fine-silty, mixed, mesic Aquic Fragiudalf
Lawrie	Fine-silty, mixed, thermic Pachic Argiustoll
Lawton	Fine, mixed, thermic Typic Argiustoll
Lea	Fine-loamy, mixed, thermic Petrocalcic Paleustoll
Lebron	Clayey over sandy or sandy skeletal, mixed, thermic Fluvaquentic Hapludoll
Lela	Fine, mixed, thermic Udic Haplustert
Lenapah	Clayey, smectitic, thermic Lithic Argiudoll
Lequire	Loamy, mixed, nonacid, thermic, shallow Alfic Udarent
Leshara	Fine-silty, mixed, mesic Fluvaquentic Endoaquoll
Lesho	Fine-loamy over sandy or sandy skeletal, mixed, thermic Fluvaquentic Haplustoll
Liberal	Fine, mixed, thermic Aquollic Hapludalf
Lightning	Fine, mixed, thermic Chromic Vertic Epiaqualf
Likes	Mixed, thermic Typic Ustipsamment
Lincoln	Sandy, mixed, thermic Typic Ustifluvent
Linker	Fine-loamy, siliceous, thermic Typic Hapludult
Lipan	Fine, smectitic, thermic Entic Pellustert
Littleaxe	Fine-loamy, siliceous, thermic Ultic Haplustalf
Loco	Loamy, mixed, thermic, shallow Typic Haplustoll
Locust	Fine-loamy, mixed, thermic Glossic Fragiudult
Lofton	Fine, mixed, thermic Vertic Argiustoll
Lomill	Clayey over loamy, mixed, thermic Udertic Haplustoll
Lovedale	Fine-loamy, mixed, thermic Udic Argiustoll
Lucien	Loamy, mixed, thermic, shallow Udic Haplustoll
Lueders	Loamy-skeletal, carbonatic, thermic Lithic Calciustoll
Lugert	Coarse-silty, mixed, thermic Fluventic Haplustoll
Lula	Fine-silty, mixed, thermic Typic Argiudoll
Madge	Fine-loamy, mixed, thermic Typic Argiustoll
Madill	Coarse-loamy, mixed, non-acid, thermic Typic Udifluvent
Majada	Loamy-skeletal, mixed, mesic Aridic Argiustoll
Mangum	Fine, mixed, thermic Vertic Ustochrept
Mansic	Fine-loamy, mixed, thermic Aridic Calciustoll
Mansker	Fine-loamy, carbonatic, thermic Calciargidic Paleustoll
Manter	Coarse-loamy, mixed, mesic Aridic Argiustoll
Manzano	Fine-loamy, mixed, mesic Cumulic Haplustoll
Martin	Fine, montmorillonitic, mesic Aquertic Argiudoll
Masham	Clayey, mixed, thermic, shallow Udic Ustochrept
Mason	Fine-silty, mixed, thermic Typic Argiustoll
Matoy	Fine, montmorillonitic, thermic Udertic Haplustoll
Mayes	Fine, montmorillonitic, thermic Vertic Argiaquoll
Mckamie	Fine, mixed, thermic Vertic Hapludalf
Mcknight	Fine-loamy, mixed, thermic Typic Haplustalf
Mclain	Fine, mixed, thermic Udertic Argiustoll
Menard	Fine-loamy, mixed, thermic Typic Haplustalf
Meno	Loamy, mixed, thermic Aquic Arenic Haplustalf
Midco	Loamy-skeletal, siliceous, nonacid, mesic Typic Udifluvent
Milan	Fine-loamy, mixed, thermic Udic Argiustoll
Miles	Fine-loamy, mixed, thermic Typic Paleustalf

Series	Taxonomic Classification
Miller	Fine, mixed, thermic Udic Haplustert
Minco	Coarse-silty, mixed, thermic Udic Haplustoll
Missler	Fine, mixed, thermic Typic Haplustoll
Mobeetie	Coarse-loamy, mixed, thermic Aridic Ustochrept
Moreland	Fine, mixed, thermic Vertic Hapludoll
Moyers	Fine, mixed, thermic Aquollic Hapludalf
Muldrow	Fine, mixed, thermic Typic Argiaquoll
Mulhall	Fine-loamy, siliceous, thermic Udic Paleustoll
Muskogee	Fine-silty, mixed, thermic Aquic Paleudalf
Naldo	Fine-loamy, mixed, thermic Glossic Paleudalf
Naru	Loamy-skeletal, mixed, thermic Udic Haplustalf
Nash	Coarse-silty, mixed, thermic Udic Haplustoll
Nashoba	Loamy-skeletal, siliceous, thermic Typic Dystrochrept
Nashville	Fine-silty, mixed, thermic Udic Haplustoll
Navina	Fine-loamy, mixed, thermic Udic Argiustoll
Neff	Fine-silty, siliceous, thermic Aquultic Hapludalf
Ness	Fine, smectitic, mesic Udic Pellustert
Newalla	Fine-loamy over clayey, siliceous, thermic Udic Haplustalf
Newtonia	Fine-silty, mixed, thermic Typic Paleudoll
Niotaze	Fine, montmorillonitic, thermic Aquic Paleustalf
Nixa	Loamy-skeletal, siliceous, mesic Glossic Fragiudult
Noark	Clayey-skeletal, mixed, mesic Typic Paleudult
Noble	Coarse-loamy, siliceous, thermic Udic Ustochrept
Nobscot	Loamy, mixed, thermic Arenic Paleustalf
Norge	Fine-silty, mixed thermic Udic Paleustoll
Normangee	Fine, montmorillonitic thermic Udertic Haplustalf
Norwood	Fine-silty, mixed (calcareous), thermic Typic Udifluvent
Nowata	Loamy-skeletal, mixed, thermic Typic Argiudoll
Nutivoli	Mixed, thermic Typic Ustipsamment
Obaro	Fine-silty, mixed, thermic Typic Ustochrept
Ochlockonee	Coarse-loamy, siliceous, acid, thermic Typic Udifluvent
Octavia	Fine-loamy, siliceous, thermic Typic Paleudult
Okay	Fine-loamy, mixed, thermic Typic Argiudoll
Okemah	Fine, mixed, thermic Aquic Paleudoll
Oklared	Coarse-loamy, mixed (calcareous), thermic Typic Udifluvent
Oklark	Coarse-loamy, mixed, thermic Aridic Calciustoll
Oktaha	Fine-loamy, siliceous, thermic Typic Hapludult
Osage	Fine, smectitic, thermic Vertic Endoaquoll
Oscar	Fine-silty, mixed, thermic Typic Natrustalf
Ost	Fine-loamy, mixed, thermic Typic Argiustoll
Otero	Coarse-loamy, mixed (calcareous), mesic Aridic Ustorthent
Owens	Fine, mixed, thermic Typic Ustochrept
Panama	Loamy-skeletal, siliceous, thermic Typic Paleudult
Panola	Fine, smectitic, thermic Vertic Epiaqualf
Parida	Coarse-loamy, mixed, mesic Ustollic Camborthid
Parsons	Fine, mixed, thermic Mollic Albaqualf
Pastura	Loamy, mixed, mesic, shallow Ustic Petrocalcid
Pawhuska	Fine, mixed, thermic Mollic Natrustalf
Paymaster	Coarse-loamy, mixed mesic Cumulic Haplustoll

Series	Taxonomic Classification
Penden	Fine-loamy, mixed, mesic Typic Calciustoll
Perico	Fine-loamy, mixed, mesic Aridic Paleustalf
Pharoah	Fine, mixed, thermic Vertic Argiaquoll
Pickens	Loamy-skeletal, mixed, thermic Lithic Dystrochrept
Pickton	Loamy, siliceous, thermic Grossarenic Paleudalf
Pickwick	Fine-silty, mixed, thermic Typic Paleudult
Piedmont	Fine, mixed, thermic Udertic Argiustoll
Pirum	Fine-loamy, siliceous, thermic Typic Hapludult
Plack	Loamy, mixed, mesic, shallow Petrocalcic Calciustoll
Pledger	Very-fine, montmorillonitic, hyperthermic Typic Hapludert
Pocasset	Coarse-loamy, mixed, thermic Fluventic Haplustoll
Pocola	Fine, mixed, thermic Vertic Epiaqualf
Pond Creek	Fine-silty, mixed, thermic Pachic Argiustoll
Port	Fine-silty, mixed, thermic Cumulic Haplustoll
Portales	Fine-loamy, mixed, thermic Aridic Calciustoll
Porum	Fine, mixed, thermic Glossaquic Paleudalf
Potter	Loamy, carbonatic, thermic, shallow Ustollic Calciorthid
Pratt	Sandy, mixed, mesic Psammentic Haplustalf
Prue	Fine-loamy, siliceous, thermic Mollic Paleudalf
Pulaski	Coarse-loamy, mixed, nonacid, thermic Typic Ustifluvent
Pullman	Fine, mixed, thermic Torrertic Paleustoll
Purves	Clayey, montmorillonitic, thermic Lithic Calciustoll
Pushmataha	Coarse-silty, siliceous, nonacid, thermic Aquic Udifluvent
Quarles	Fine, mixed, thermic Mollic Ochraqualf
Quinlan	Loamy, mixed, thermic, shallow Typic Ustochrept
Radley	Fine-silty, mixed, thermic Fluventic Hapludoll
Randall	Fine, montmorillonitic, thermic Ustic Epiaquert
Ravia	Fine-loamy, mixed, thermic Udic Argiustoll
Rayford	Loamy-skeletal, mixed, thermic Lithic Haplustoll
Razort	Fine-loamy, mixed, mesic Mollic Hapludalf
Reading	Fine-silty, mixed, mesic Typic Argiudoll
Redlake	Fine, mixed, thermic Vertic Eutrochrept
Redport	Fine-silty, mixed, thermic Cumulic Hapludoll
Reinach	Coarse-silty, mixed, thermic Pachic Haplustoll
Renfrow	Fine, mixed, thermic Udertic Paleustoll
Renthin	Fine, mixed, thermic Udertic Argiustoll
Retrop	Fine-silty, mixed (calcareous), thermic Aquic Udifluvent
Rexor	Fine-silty, siliceous, thermic Oxyaquic Hapludalf
Richfield	Fine, montmorillonitic, mesic Aridic Argiustoll
Rickmore	Fine-loamy, mixed, mesic Aridic Paleustalf
Riverton	Loamy-skeletal, mixed, thermic Mollic Paleudalf
Robinsonville	Coarse-loamy, mixed, nonacid, thermic Typic Udifluvent
Rochelle	Fine-loamy, mixed, thermic Typic Haplustalf
Roebuck	Fine, montmorillonitic, thermic Aeric Epiaquert
Romia	Fine-loamy, siliceous, thermic Ultic Hapludalf
Roscoe	Fine, smectitic, thermic Typic Pellustert
Rosebloom	Fine-silty, mixed, acid, thermic Typic Fluvaquent
Roxana	Coarse-silty, mixed, nonacid, thermic Typic Udifluvent
Ruella	Fine-loamy, mixed, thermic Udic Ustochrept

Series	Taxonomic Classification
Ruston	Fine-loamy, siliceous, thermic Typic Paleudult
Sacul	Clayey, mixed, thermic Aquic Hapludult
Saffell	Loamy-skeletal, siliceous, thermic Typic Hapludult
Sallisaw	Fine-loamy, siliceous, thermic Typic Paleudalf
San Saba	Fine, montmorillonitic, thermic Leptic Udic Haplustert
Satanta	Fine-loamy, mixed, mesic Aridic Argiustoll
Sayers	Sandy, mixed, thermic Typic Ustifluvent
Scullin	Fine, mixed, thermic Udic Argiustoll
Secesh	Fine-loamy, siliceous, mesic Ultic Hapludalf
Selman	Fine-silty, mixed, thermic Typic Argiustoll
Seminole	Fine, mixed, thermic Typic Natrustoll
Severn	Coarse-silty, mixed (calcareous), thermic Typic Udifluvent
Shellabarger	Fine-loamy, mixed, mesic Udic Argiustoll
Sherless	Fine-loamy, mixed, thermic Typic Hapludult
Sherm	Fine, mixed, mesic Torrertic Paleustoll
Shermore	Fine-loamy, siliceous, thermic Typic Fragiudalf
Sherwood	Fine-loamy, mixed, thermic Typic Hapludult
Shidler	Loamy, mixed, thermic Lithic Haplustoll
Ships	Very-fine, mixed, thermic Chromic Hapludert
Shrewder	Coarse-loamy, mixed, thermic Typic Ustochrept
Slaughter	Clayey, mixed, thermic, shallow Petrocalcic Paleustoll
Slaughterville	Coarse-loamy, mixed, thermic Udic Haplustoll
Smithdale	Fine-loamy, siliceous, thermic Typic Hapludult
Sobol	Fine, mixed, thermic Aquic Hapludalf
Sogn	Loamy, mixed, mesic Lithic Haplustoll
Somervell	Loamy-skeletal, carbonatic, thermic Typic Calciustoll
Speer	Fine-loamy, siliceous, thermic Ultic Hapludalf
Spiro	Fine-silty, siliceous, thermic Ultic Hapludalf
Springer	Coarse-loamy, mixed, thermic Udic Paleustalf
Spur	Fine-loamy, mixed, thermic Fluventic Haplustoll
Spurlock	Coarse-loamy, carbonatic, mesic Calcidic Paleustalf
St. Paul	Fine-silty, mixed, thermic Pachic Argiustoll
Stamford	Fine, smectitic, thermic Typic Chromustert
Stapp	Clayey, mixed, thermic Aquic Hapludult
Staser	Fine-loamy, mixed, thermic Cumulic Hapludoll
Steedman	Fine, montmorillonitic, thermic Udertic Haplustalf
Stephenville	Fine-loamy, siliceous, thermic Ultic Haplustalf
Stidham	Loamy, mixed, thermic Arenic Haplustalf
Stigler	Fine, mixed, thermic Aquic Paleudalf
Stoneburg	Fine-loamy, mixed, thermic Udic Argiustoll
Summit	Fine, montmorillonitic, thermic Aquic Hapludert
Sumter	Fine-silty, carbonatic, thermic Rendollic Eutrochrept
Sunray	Fine-loamy, mixed, mesic Calciargidic Paleustoll
Sweetwater	Fine-loamy over sandy/sandy-skeletal, mixed, (calcareous), thermic Fluvaquentic Haplaquoll
Swink	Clayey-skeletal, montmorillonitic, thermic Lithic Hapludoll
Tabler	Fine, montmorillonitic, thermic Udertic Argiustoll
Taft	Fine-silty, siliceous, thermic Glossaquic Fragiudult
Talihini	Clayey, mixed, thermic, shallow Aquic Hapludoll

Series	Taxonomic Classification
Taloka	Fine, mixed, thermic Mollic Albaqualf
Talpa	Loamy, mixed, thermic Lithic Calciustoll
Tamaha	Fine, mixed, thermic Aquic Paleudalf
Tamford	Fine, montmorillonitic, thermic Udic Haplustert
Tarrant	Clayey-skeletal, montmorillonitic, thermic Lithic Calciustoll
Teagard	Fine, mixed, thermic Vertic Haplustoll
Tearney	Clayey over sandy or sandy-skeletal, mixed, thermic Fluventic Hapludoll
Teller	Fine-loamy, mixed, thermic Udic Argiustoll
Tenaha	Loamy, siliceous, thermic Arenic Hapludult
Teval	Fine-loamy, mixed, thermic Udic Argiustoll
Texline	Fine-loamy, mixed, mesic Calciargidic Paleustoll
Tiak	Clayey, mixed, thermic Aquic Paleudult
Tillman	Fine, mixed, thermic Typic Paleustoll
Timhill	Loamy-skeletal, mixed, thermic Lithic Haplustoll
Tipton	Fine-loamy, mixed, thermic Pachic Argiustoll
Tivoli	Mixed, thermic Typic Ustipsamment
Tobosa	Fine, montmorillonitic, thermic Aridic Haplustert
Tomast	Fine-silty, siliceous, thermic Aeric Paleaquult
Tonti	Fine-loamy, mixed, mesic Typic Fragiudult
Travertine	Loamy-skeletal, siliceous, thermic, shallow Udic Ustochrept
Travessilla	Loamy, mixed (calcareous), mesic Lithic Ustic Torriorthent
Treadway	Fine, mixed (calcareous) thermic Torrertic Ustochrept
Tribbey	Coarse-loamy, mixed, nonacid, thermic Oxyaquic Udifluvent
Trinity	Very-fine, montmorillonitic, thermic Typic Hapludert
Tulia	Fine-loamy, carbonatic, thermic Calcidic Paleustalf
Tullahassee	Coarse-loamy, mixed, nonacid, thermic Aquic Udifluvent
Tuscumbia	Fine, mixed, nonacid, thermic Vertic Epiaquept
Tuskahoma	Clayey, mixed, thermic, shallow Albaquic Hapludalf
Tussy	Fine, montmorillonitic, thermic Vertic Ustochrept
Tyende	Coarse-loamy, mixed, mesic Typic Natrargid
Ulysses	Fine-silty, mixed, mesic Aridic Haplustoll
Ustibuck	Fine, montmorillonitic, thermic Ustic Epiaquert
Valent	Mixed, mesic Ustic Torripsamment
Vanoss	Fine-silty, mixed, thermic Udic Argiustoll
Veal	Fine-loamy, carbonatic, thermic Aridic Ustochrept
Venadito	Very-fine, smectitic, mesic Udorthentic Chromustert
Verdigris	Fine-silty, mixed, thermic Cumulic Hapludoll
Vermejo	Fine, mixed (calcareous), mesic Ustic Torriorthent
Vernon	Fine, mixed, thermic Typic Ustochrept
Vian	Fine-silty, siliceous, thermic Aquic Paleudalf
Vingo	Coarse-loamy, mixed, mesic Aridic Paleustalf
Vinita	Clayey, mixed, thermic Aquic Hapludult
Vinson	Fine-silty, mixed, thermic Entic Haplustoll
Vona	Coarse-loamy, mixed, mesic Aridic Haplustalf
Wabbaseka	Clayey over loamy, mixed, thermic Fluventic Hapludoll
Waben	Loamy-skeletal, siliceous, mesic Ultic Hapludalf
Wakita	Fine-silty, mixed, thermic Leptic Natrustoll
Waldeck	Coarse-loamy, mixed, thermic Fluvaquentic Haplustoll
Wann	Coarse-loamy, mixed, mesic Fluvaquentic Haplustoll

Series	Taxonomic Classification
Watonga	Fine, montmorillonitic, thermic Udic Haplustert
Waurika	Fine, montmorillonitic, thermic Vertic Argialboll
Waynoka	Fine-loamy, mixed, thermic Udic Argiustoll
Weatherford	Fine-loamy, siliceous, thermic Ultic Haplustalf
Weleetka	Coarse-loamy, mixed, thermic Typic Umbraquult
Wellsford	Clayey, mixed, thermic, shallow, Typic Ustochrept
Westola	Coarse-loamy, mixed (calcareous), thermic Typic Ustifluvent
Westsum	Fine, mixed, thermic Udertic Argiustoll
Westview	Fine-silty, mixed, thermic Pachic Argiustoll
Weswood	Coarse-silty, mixed, thermic Udifluventic Ustochrept
Wetbeth	Fine, mixed, thermic Udertic Argiustoll
Wetsaw	Fine-loamy, siliceous, thermic Aquic Paleudalf
Wewoka	Sandy-skeletal, siliceous, thermic Typic Ustorthent
Weymouth	Fine-loamy, mixed, thermic Typic Ustochrept
Whakana	Fine-loamy, mixed, thermic Glossic Paleudalf
Wheatwood	Fine-silty, mixed, thermic Fluventic Ustochrept
Whitefield	Fine, mixed, nonacid, thermic Alfic Udarent
Wichita	Fine, mixed, thermic Typic Paleustalf
Wilburton	Loamy-skeletal, siliceous, thermic Ultic Hapludalf
Wilson	Fine, montmorillonitic, thermic Oxyaquic Vertic Haplustalf
Windthorst	Fine, mixed, thermic Udic Paleustalf
Wing	Fine, mixed, thermic Aquic Natrustalf
Winters	Fine, mixed, thermic Typic Paleustalf
Wisby	Coarse-loamy, mixed, thermic Udic Argiustoll
Wister	Fine, mixed, thermic Vertic Natrudalf
Wolco	Fine, mixed, thermic Pachic Argiustoll
Wolfpen	Loamy, siliceous, thermic Arenic Paleudalf
Woodford	Loamy-skeletal, siliceous, thermic Lithic Haplustoll
Woods	Fine, mixed, thermic Vertic Argiustoll
Woodson	Fine, montmorillonitic, thermic Abruptic Argiaquoll
Woodtell	Fine, montmorillonitic, thermic Vertic Hapludalf
Woodward	Coarse-silty, mixed, thermic Typic Ustochrept
Wrightsville	Fine, mixed, thermic Typic Glossaqualf
Wynona	Fine-silty, mixed, thermic Cumulic Epiaquoll
Yahola	Coarse-loamy, mixed (calcareous), thermic Udic Ustifluvent
Yanush	Loamy-skeletal, siliceous, thermic Typic Paleudalf
Yomont	Coarse-silty, mixed (calcareous), thermic Typic Ustifluvent
Zafra	Loamy-skeletal, siliceous, thermic Typic Hapludult
Zaneis	Fine-loamy, siliceous, thermic Udic Argiustoll
Zavala	Coarse-loamy, mixed, nonacid, hypothermic Typic Ustifluvent
Zenda	Fine-loamy, mixed, thermic Fluvaquentic Haplustoll

APPENDIX J

OKLAHOMA STATE UNIVERSITY
INSTITUTIONAL REVIEW BOARD
HUMAN SUBJECTS REVIEW

Date: 04-16-96 **IRB#:** AG-96-022

Proposal Title: A METHOD OF GROUPING SOILS

Principal Investigator(s): Brian Carter, Kelly Ponte

Reviewed and Processed as: Exempt

Approval Status Recommended by Reviewer(s): Approved

ALL APPROVALS MAY BE SUBJECT TO REVIEW BY FULL INSTITUTIONAL REVIEW BOARD AT NEXT MEETING.
APPROVAL STATUS PERIOD VALID FOR ONE CALENDAR YEAR AFTER WHICH A CONTINUATION OR RENEWAL REQUEST IS REQUIRED TO BE SUBMITTED FOR BOARD APPROVAL.
ANY MODIFICATIONS TO APPROVED PROJECT MUST ALSO BE SUBMITTED FOR APPROVAL.

Comments, Modifications/Conditions for Approval or Reasons for Deferral or Disapproval are as follows:

Signature: [signature] Date: April 22, 1996

Chair of Institutional Review Board

VITA

Kelly Jean Ponte

Candidate for the Degree of

Master of Science

Thesis: A PRACTICAL APPROACH TO GROUPING SOILS BY KEY SOIL PROPERTIES

Major Field: Agronomy

Biographical:

Personal Data: Born in New Bedford, Massachusetts, On August 23, 1961, the daughter of George and Joann Ponte.

Education: Received Associate in Arts degree from Cape Cod Community College, Barnstable, Massachusetts in August 1992 and a Bachelor of Science degree in Plant and Soil Sciences from the University of Massachusetts, Amherst, in May 1995. Completed the requirements for the Master of Science degree with a major in Agronomy at Oklahoma State University in July, 1997.

Experience: Employed as a field technician by the University of Massachusetts in Amherst, Department of Plant and Soil Sciences as an undergraduate from 1992-1995. Employed as a graduate research assistant by Oklahoma State University, Department of Agronomy, 1995 to present.

Professional Memberships: Soil Science Society of America